



Public Perceptions and Support of Renewable Energy in North America in the Context of Global Climate Change

Bjoern Hagen¹ · David Pijawka¹

Published online: 14 December 2015

© The Author(s) 2015. This article is published with open access at Springerlink.com

Abstract There is substantial interest in developing a coherent and effective North American renewable energy policy as a way to secure energy but also to mitigate global climate change. Based on surveys of the public in Canada, Mexico, and the United States, the article shows the levels of concern over climate change threats, perceived risk, knowledge of climate change policies, levels of uncertainty, and other perception factors to help understand the relationships between public perceptions and policy preferences for renewable energy. Results show national differences between the three countries in nearly all climate change perceptions, with Mexico reflecting the highest levels of concern and the United States the lowest. Mexico also shows the greatest support for renewable energy sources. However, the results show very high levels of uncertainty about climate change dimensions concerning risk, science, and knowledge and the effectiveness of policy approaches. The data demonstrate strong statistical correlations between risk perception factors and preferences for mitigation policies in the form of renewable energy policies.

Keywords Climate change · Cross-national comparison · Environmental policy · North America · Public perceptions · Renewable energy

1 Introduction

Climate change (CC) poses significant risks for current and future generations. Overall, scientists generally concur that the rapid changes experienced in global climate during the last several decades are mostly caused by human activities which have led to increasing emissions of greenhouse gases (GHG) (IPCC 2013). The need for adaptation to, and mitigation of, CC is recognized as a major challenge to scientists, decision makers, and the general public. This article examines the potential for renewable energy policies becoming successful as mitigation strategies in Canada, Mexico, and the United States by looking at public perceptions and attitudes toward these issues and policies. While there have been public polls taken on CC, mostly in the United States and Europe (DEFRA 2002; Wolf and Moser 2011; EC 2014), this article presents the results of a scientific study that identifies the key social variables that contribute to climate change perceptions and the role of these perceptions in support of renewable energy policies. The results of the analysis help to understand the public's level of support for mitigation and adaptation strategies.

It is projected that global temperatures will continue to increase if effective actions are not implemented to reduce the total annual GHG emissions. In contrast to CC adaptation, scientists and decision makers recognize that mitigation efforts are less dependent on local responses and more on national and international cooperation. This has compelled an increasing number of local, regional, national, and international organizations to establish and promulgate carbon emission reductions. Many countries have signed various international treaties, such as the Kyoto Protocol (1997) and the Copenhagen Accord (2009), setting GHG reduction goals and strengthening the international collaboration in combating CC. Yet, countries will

✉ Bjoern Hagen
bhagen1@asu.edu

¹ School of Geographical Sciences and Urban Planning,
Arizona State University, Tempe, AZ 85287, USA

not be able to fulfill their international commitments and GHG reduction targets without policies that provide opportunities for involving local jurisdictions and gaining public buy-into reduce GHG emissions and ensure energy security in North America. Despite increasing supplies of energy in North America from domestic shale gas and fracking for oil, there is significant interest among citizens and policymakers to reduce GHG emissions and their increasing CC impacts. Renewable energy development offers local energy independence, job creation and economic development, improved environmental quality, ecological integrity, improved human health, and other benefits. At the continental, national, and regional levels, it offers energy and climate security (NACTS 2011). However, are the various threats of CC perceived differently among the three countries resulting in dissimilar policy preferences for renewable energy sources?

Securing consistent energy supplies in currently energy-poor areas of North America, particularly through trans-border transmission of renewable energy, builds overall energy security not only by serving energy voids and negating the need to import energy from nations offshore but also by mitigating the “push” of migration from the south. Some areas of North America have no indigenous conventional energy resources. Thus locally developed renewable energy is not only intrinsically attractive but can be a more productive and efficient way to produce the power to meet local needs. While adding renewable energy to the transmission grid can be initially challenging, it offers the opportunity to increase overall electrical reliability and local energy development.

Well-designed renewable energy policies are less successful if public perception factors are not recognized. The level of public support for policies is often impacted by the way the public processes information and how it perceives threats and other perceptual factors such as trust in government and the private sector (Bord et al. 1998). Very little is known about the perceptions of CC risks and of the mitigation policies linked to renewable energy, especially at the international level (Leiserowitz 2010; Schneider et al. 2010). To date, only a limited number of multinational surveys exist uncovering some of these issues (Wolf and Moser 2011). However, in order to design, communicate, and implement national and international alternative clean energy policies in a successful manner, it is necessary to have a good understanding of the public’s perceptions regarding the threats of CC and how this factor impacts the public’s level of support of renewable energy policies. While this may be known for many natural hazards, it is less understood when it comes to CC. Moreover, very little is known about public perceptions related to mitigation of CC impacts. Through survey research, the article examines a wide range of public perceptions of CC threats including

the political saliency of CC and renewable energy, self-reported knowledge of ways to reduce CC, and mitigation policy preferences with implications for renewable energy. The idea of the relative importance of where an issue—in this case climate change—is ranked among all the other socioeconomic problem areas confronting nations is known as political saliency, that is the degree of importance in relation to causing the government to act.

The willingness to adopt renewable energy policies especially at the local level is critical to CC mitigation. This article explores perceptual differences among the three countries and the relationships between CC perceptions (such as level of concern, self-reported knowledge, or perceived political saliency of CC) and the level of support for renewable energy policies. The findings with respect to CC perceptions and mitigation support contribute to the literature in hazards perceptions and their role in policy. Improved knowledge of these perception factors makes it possible for decision makers and communicators to advance both CC and renewable energy communication programs more effectively. The primary research questions in the study were:

- (1) How concerned is the public in North America about climate change; are dealing with climate change and developing renewable energy sources perceived as salient policy objectives; and what is the level of awareness of existing mitigation policies?
- (2) What are the perceptual differences between the publics of the three North American countries and to what degree do the perceptual factors of concern, knowledge, and political saliency impact public support for renewable energy policy?

2 Literature Background: Public Perceptions of Climate Change

In the wake of global concerns over CC and the recent scientific evidence from the Intergovernmental Panel on Climate Change (IPCC), countries are concerned about the increasing levels of GHG emissions as well as energy security and energy independence (Wüstenhagen et al. 2007; IPCC 2014). One approach for achieving this strategic goal involves increasing the share of renewable energy through public policies and new energy infrastructure. Such measures require public support; yet, there is uncertainty about this support and its connection to CC.

A significant amount of literature exists addressing public support for different energy sources. Dating back to research in the late 1970s, solar energy as well as energy conservation policies frequently have been identified in public opinion polls as the preferred energy alternatives to

coal, oil, or nuclear energy (Farhar 1996; Greenberg 2009). In 2008, the Program on International Policy Attitudes (WorldPublicOpinion.org 2008) conducted a poll of 21 nations (including Mexico and the United States, but not Canada), with a total of 20,790 respondents. This poll revealed that (on average) 77 % of the publics in these countries support governmental efforts to increase the use of renewable energy such as solar. Even confronted with the fact that an increased share of renewable energy sources would lead to higher energy costs, 69 % of the polled populations still favored renewables. The data demonstrate that only a minority of the populations among all countries expressed concern that a comprehensive change in energy policy toward renewable energy sources would hurt the economy. Another 2008 study focusing on public energy preferences among the public in the United States (Greenberg 2009) showed that over 90 % of the respondents were in favor of renewable energy.

These polls and surveys suggest large public support and preferences for renewable energy over other sources of energy. However, perceptions can change over time due to factors such as extreme events, amount and type of media coverage or level of reporting, economic conditions, scientific information, values, and worldviews (Slovic 2000). For example, a majority of the most recent poll data, gathered when the recent worldwide financial crisis had only just begun, showed that perceptions regarding renewable energy sources might have changed as economic concerns such as job security increased (Leiserowitz 2005, 2010; Ockwell et al. 2009).

Despite a few U.S. and international polls, there has been a notable paucity of academic research on examining public support for renewable energy, the variability in that support, and the factors behind that support or lack of support. One of these factors is the perception of CC risk, which also has not received widespread academic attention despite repeated calls for that research.

Support for perception research began in the 1980s and the body of knowledge in the fields of risk perception and risk communication has grown considerably since then (Slovic et al. 1981; Slovic 1987, 2000; Wardekker 2004). Social science and social behavioral research show that public risk perceptions have a significant and measurable impact on individual behavior, and this needs to be considered in developing CC policies and renewable energy strategies (Slovic 2000). Nevertheless, CC perception is still a relatively new topic, especially at the international level and outside the United States, with few comparative studies. Understanding these perceptions can explain why there is reluctance to advance CC policies in countries such as the United States, the United Kingdom, and Australia (Hulme 2009; Capstick et al. 2015). Understanding public perceptions of CC risks and their relation to renewable

energy can vary by country, and policymakers need to know this for developing multinational energy policies.

In contrast to the limited number of studies on CC perceptions at the international level, there is a relatively large body of knowledge available for the United States. The first surveys in the United States were conducted in the early 1980s, though strong public interest did not emerge until 1988 (Bord et al. 1998), a key year for the development of public concern for CC. First, the United States was hit by a severe drought and heat wave. Second, and more importantly, James Hansen gave testimony before Congress that CC had been observed and that it was anthropogenic (Read et al. 1994). Overall, the existing body of research and the surveys performed support the argument that the American public is aware of CC, believes that it is real, and is highly concerned about it (Whitmarsh et al. 2011; Wolf and Moser 2011; Fischer et al. 2012). In many cases, however, CC is still considered a low priority in the context of other societal issues. Americans regard both the environment and CC as relatively low national priorities, with minimal political saliency (Dunlap and Saad 2001; Leiserowitz 2010). The low standing of CC as a concern reflects a widespread public perception that the issue is removed in space and time. Ockwell et al. (2009) came to the same conclusion, arguing that the American public believes CC will primarily affect future generations and less developed countries. Public concern for CC is influenced by uncertainties in the sciences, public misconceptions, miscommunication, and by competition for attention on an overwhelming socio-environmental agenda (Lorenzoni et al. 2005; Smith 2005; Moser 2006).

Research also identified a contradiction in American CC risk perceptions and policy preferences (Moser 2006; Leiserowitz 2010). On the one hand, the U.S. public strongly supports a range of national and international policies to mitigate CC. On the other hand, several carbon tax proposals are strongly opposed. The American public largely supports policy action at the national and international scale, but resists tax policies that directly affect people. At this juncture, very little is known about the level of public acceptance and willingness to support CC policies as well as how or if these levels differ at the national and international levels.

This study advances the assessment of national differences, across the three North American countries, in perceptions of CC threats, the level of public support for political action, and the acceptance of a set of mitigation strategies. The study fills a gap in the literature in several ways. First, it attempts to explicate the level of concerns over CC. Second, the analyses explore reasons to explain the high levels of uncertainty among the public. Third, the comparative country analysis explains differences between the countries. Lastly, the study shows relationships

between CC perceptions and policy support for mitigation strategies.

3 Methods

The data presented in this article were gathered through survey research, between August 2010 and March 2011. The households surveyed were selected randomly within the parameters of socioeconomic categories and ownership of computers. The sampling process was guided by two parameters. Every respondent had to be at least 18 years old, and the total population sample for each country represented the country's socioeconomic characteristics in terms of age, household income, level of education, gender, and spatial distribution. The three countries were surveyed using internet panels consisting of demographically representative samples for each country. The internet panels were provided by Survey Sampling International (SSI), who also hosted the survey and was responsible for data collection. The survey questions and response items are based on previous studies in the area of public climate perceptions (Lorenzoni and Pidgeon 2006; Maibach et al. 2009; EC 2014). Although we achieved representative sample sizes for each country to be able to generalize to the populations, there are limitations to the use of Internet panels. Individuals on Internet panels are typically self-selected. Low-income individuals who do not have computer access typically are underrepresented. Representative sampling based on gender, age, and income also frequently does not reflect the national statistics in the distribution. In this case, for example, we did not have sufficient sampling numbers to be able to generalize to individual

geographical units within the countries, but this is common when working at the national scale using landline surveys. In the case of this study, we did not look at responses based on areal unit populations within the country. Table 1 shows the socioeconomic characteristics of the different country samples with respect to gender, age, and household income. The level of education was measured as well, but not included in the table because of the different education systems in Canada, the United States, and especially in Mexico.

The survey instrument developed in this research is comprised of eight sections. Questions are grouped together thematically and focus on CC risk and threat perceptions, level of concern over CC impacts, self-reported knowledge, trust in different sources of information and risk managers, and willingness to support various policies or commit to behavioral changes. The majority of the questions in the survey were closed-ended, multiple-choice questions, which can readily be coded and analyzed statistically (Henerson et al. 1987). The questions mainly consisted of "Likert-type scaling," and answers were balanced equally. This means that the number of favorable and unfavorable answer categories are equal to prevent statistical biases. The Likert-scales used in the survey instrument were mostly 5- to 7-point scales, the answers ranging from strongly disagree to strongly agree, with a neutral answer possibility in-between. The survey instrument was tested and reviewed by national researchers, experienced in both survey research and CC, to ensure the validity of the Likert-scales and other multiple-choice questions. In total, 2312 households were surveyed—947 from the United States, 826 from Mexico, and 539 from Canada. Due to these large sample sizes and biased toward

Table 1 Socioeconomic characteristics of the populations surveyed in Canada, Mexico, and the United States

Country	North America	Canada	Mexico	United States
Sample size (households)	2312	539	826	947
Gender (%)				
Female	61.2	60.8	58.4	64.1
Male	38.8	39.2	38.6	35.9
Age groups (%)				
18–24	7.1	8.9	7.7	5.5
25–34	22.1	18.9	28.7	18.1
35–44	17.1	16.5	28.7	7.4
Household income (%)				
Don't know/prefer not to answer	14.5	0	32.9	6.8
Less than \$20,000	36.0	21.7	59.3	23.8
\$20,000–\$29,999	10.2	15.8	3.6	12.8
\$30,000–\$39,000	8.9	13.2	1.2	13.1
\$40,000–\$49,000	8.5	13.9	1.1	11.8

Data presented in this article were gathered through survey research, between August 2010 and March 2011, using Internet panels in Canada, Mexico, and the United States. The internet panels were provided by Survey Sampling International (SSI), who also hosted the survey and was responsible for data collection

current CENSUS data, the estimated margin of error was low for North America as a whole and for the individual countries. The overall margin of error was $\pm 2.7\%$ with a 95% confidence level. For the three individual countries, the margin of error varies from $\pm 3.18\%$ to $\pm 4.22\%$. This study applied basic statistical methods such as frequency distributions and descriptive statistics, as well as standard multiple regression. All regression results were considered significant at $p < 0.001$, which means that there is less than a 0.1% chance that the particular F-ratio would happen if the null hypothesis were true.

There is an ongoing debate about using Likert-type data and scales for standard multiple regression analysis. This contention focuses on whether Likert-scales can be treated as interval data, which is a key assumption that has to be met for multiple regression analysis (Field 2009). In the field of social sciences (in which this study is situated), Likert-type data are consistently treated as interval data and used in the regression analysis (Johnson and Slovic 1995; Peters et al. 1997; Sjoberg 1998; Leiserowitz 2006). Because of this, additional steps were taken in this research to further decrease the likelihood of information loss and erroneous results as well as to acknowledge the arguments by skeptics, who caution against the use of Likert-type scales as interval data.

Research suggests that when Likert-type data are used in multiple regression analyses, the estimates improve if the answer scales have more than three points and a sample size of 300 participants (Owuor 2001). Both of these points were considered in this study—no Likert-scale used has less than 4 points, and the smallest country sample consists of over 530 people. Furthermore, Brown (2011) argues that indexes created from Likert-type data not only further reduce the likelihood for errors but also are actually “true” interval data (Wan and Wand 1996; Jamison 2004). Therefore, all variables chosen as predictor variables were recoded into dummy variables before they were entered into the regression model. In so doing, all independent variables used in the regression models have only two categories and thus meet the requisite assumptions for this type of statistical analysis (Field 2009). The dummy variables were coded in a way that the lowest answer on the Likert-scale (the answer with the value 1) functions as a baseline in the regression model’s coefficient outputs. Ordinal regression was used to confirm the results from the standard multiple regression model.

4 Results

The following sections present the results of the survey data analyses relevant to this article. Sections 4.1, 4.2 and 4.3 focus on how concerned the public in Canada, the United States, and Mexico are about the possible impact of

CC, how they perceive the political saliency of CC as well as of developing a comprehensive clean energy policy, to what degree renewable energy policies are supported, and the participants self-reported knowledge about the ways in which CC can be reduced. In addition Sect. 4.3 also discusses how the policy preferences in regards to renewable energy differ among the three countries. Sections 4.4 and 4.5 present the results of different regression models, which were used to determine the impact of socioeconomic variables and specific perception factors on the variation in the general level of support for renewable energy policies among the survey participants.

4.1 Level of Concern and Political Saliency Regarding Climate Change

A 5-point Likert-scale question asked about the public’s level of concern about the possible impacts of CC in the three countries. Responses were categorized from “not at all concerned” to “highly concerned.” On the continental scale, the responses show that 36.2% of respondents are highly concerned, 33.8% are concerned, and 15.3% somewhat concerned (Fig. 1). Only 7.8% of the 2312 households participating in the survey answered that they are not concerned at all. This indicates that a large majority of the public is concerned or highly concerned about climate change and its potential impacts. This becomes even more apparent when the frequencies of the three answer categories “highly concerned,” “concerned,” and “somewhat concerned” are combined. As an aggregate, 85.3% of the North American population indicated at least some degree of concern regarding the possible impacts of CC. Mexico has the largest percentage who are highly concerned (56.9%), and 91.9% of Mexico’s survey participants indicated that they are either concerned or highly concerned, followed by Canada, with 70.7%, and the United States, with 51%. Compared to Mexico and Canada, a much higher percentage of the survey participants from the United States (15.2%) answered that they are not at all concerned.

An important aspect of public concern over CC pertains to where people position that issue within the range of problem areas on which the government can place focus (political saliency). One question in the survey assessed political saliency by asking the participants to indicate how important it is for government to act on nine separate problem areas such as (1) lowering the rate of violent crime; (2) improving the nation’s schools; (3) reducing poverty; (4) increasing employment; (5) reducing global climate change; (6) improving air and water quality; (7) preventing global terrorism; (8) eliminating illegal drugs; and (9) developing a comprehensive clean energy policy. The political saliency of CC can be considered one

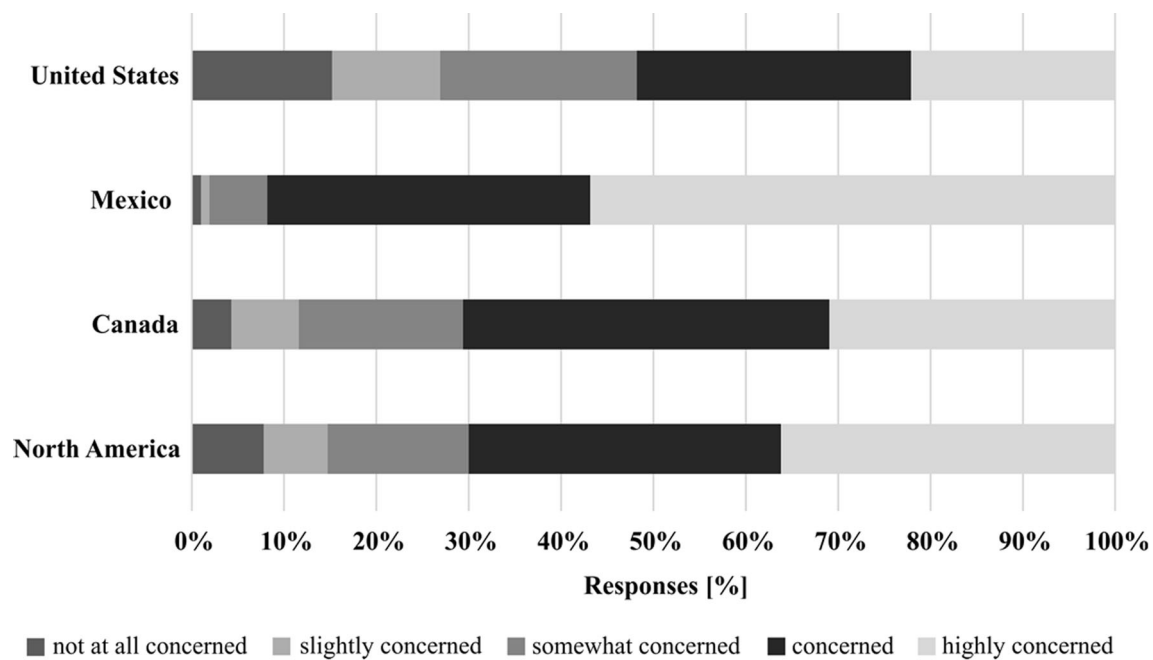


Fig. 1 Level of concern about the possible impacts of climate change. *Note* Survey participants were asked on a scale from 1 to 5, where 1 is “not at all concerned” and 5 is “highly concerned,” how concerned they are about the possible impacts of climate change

measure of the level of concern about CC within the societal context of other concerns.

The results show that out of the nine societal issues presented, CC is regarded as the least salient one for the government to place importance on. The mean value suggests that people do believe that CC is an important problem, but certainly not the most pressing one. Only 38.7 % of the surveyed publics in the three countries perceive CC as a “very important” issue for the government (Fig. 2), far below the issues of violent crime, schools, employment, and poverty. However, when the two categories “important” and “very important,” are combined, 76.8 % of the survey participants want government to be involved in mitigating CC.

The public in Mexico is the most supportive of governmental action, with 49.8 % identifying CC as a very important societal issue, followed by Canada with 38 %. The lowest percentage in this category is the United States, with only 30 % expressing the view that the government should handle CC as a very important issue. Interestingly, the 15.7 % of survey respondents in the United States characterizing the reduction of CC as unimportant and no need for governmental action is significantly higher compared to the two other countries.

4.2 Political Saliency and Public Support for Renewable Energy Policies

Similar to the issue of CC, and its perceived importance compared to other societal issues, developing comprehensive

clean energy strategies ranks in the bottom third in terms of political saliency. Only 41.1 % of all survey participants believe that government should place a high level of importance on developing a comprehensive clean energy policy, but only 4.8 % see developing a comprehensive clean energy policy as an unimportant task (Fig. 3). This suggests that the public overall acknowledges the role of government in a potential energy transition process shifting from fossil fuels to renewable energy sources.

Over 50 % of the Mexican respondents believe that it is very important for the government to develop a comprehensive clean energy policy, the highest percentage among the three countries. Less than 10 % of Mexican respondents considered it an unimportant or low-priority issue. The Canadian responses show similar results, with 83.6 % of the Canadian survey participants arguing that it is an important or very important task for the government. In the United States, the largest of the three countries, over 25 % of the respondents indicated that the political saliency of establishing a clean energy regime is an unimportant or low-priority topic.

4.3 Public Support for Renewable Energy Policies and Self-Reported Knowledge About How to Mitigate Climate Change

Mitigation of CC by reducing greenhouse gas emissions has been the target of global treaties, national strategies, and now local initiatives. Strategies supporting the

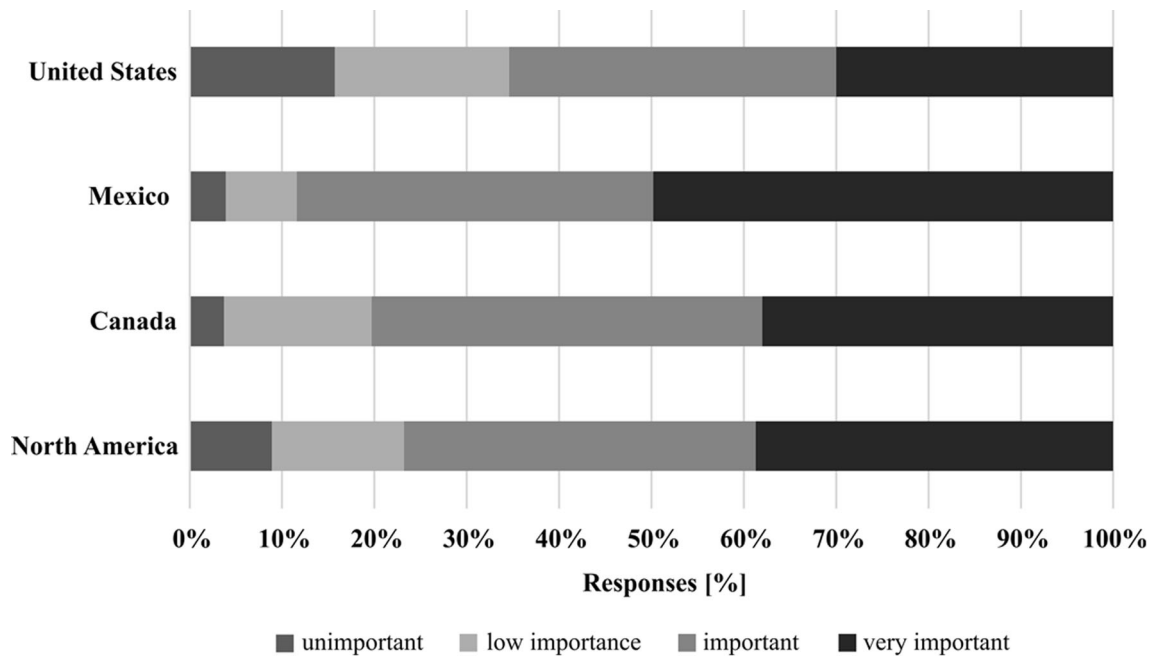


Fig. 2 Perceived political saliency of climate change. *Note* Survey participants were asked on a scale from 1 to 4, where 1 is “unimportant” and 4 is “very important,” what level of importance the government should place on reducing climate change

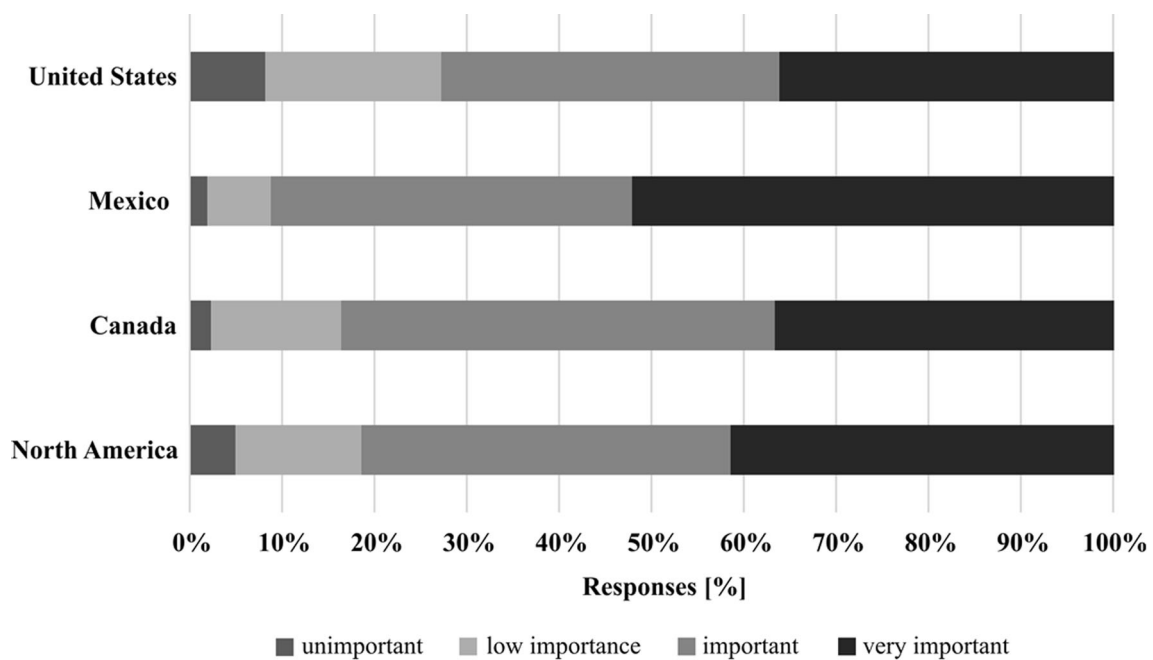


Fig. 3 Perceived political saliency of developing a comprehensive clean energy policy. *Note* Survey participants were asked on a scale from 1 to 4, where 1 is “unimportant” and 4 is “very important,” what level of importance the government should place on developing a comprehensive clean energy policy

development and applications of renewable energy have been fundamental to these reductions. A significant portion of the survey contains questions about behavioral intentions and levels of support for a variety of renewable energy strategies and possible regulations. Survey

participants were asked, for example, for their level of support of policies that (1) require higher utility rates for continuing to use non-renewable energy sources (a disincentive); (2) require electric utilities to produce at least 20 % of their electricity from renewable energy sources by

Table 2 General public support for renewable energy policies

	Strongly oppose (%)	Moderately oppose (%)	Undecided (%)	Moderately support (%)	Strongly support (%)
North America	8.1	5.9	22.0	31.1	32.9
Canada	5.8	6.7	24.9	33.9	28.8
Mexico	3.5	3.2	12.9	31.0	49.3
United States	12.9	7.7	26.9	30.3	22.1

Index was calculated based on questions asking the survey participants on a scale from 1 to 5, where 1 is “strongly oppose” and 5 is “strongly support” about their level of support for a variety of renewable energy strategies and possible regulations

the year 2020; (3) provide subsidies to industry to invest in alternative energy development; (4) require installation of solar panels or photovoltaics on buildings; and (5) require an increased use of biofuels.

A policy requiring higher utility rates for the consumer when using non-renewable energy sources faces strong opposition in the United States with over 37 % of the survey respondents stating moderate to strong opposition followed by Canada with 28.2 % and Mexico with 21.9 %. On the other end of the spectrum the data suggest that almost one quarter of the population in Mexico would strongly support such an initiative. It is also worth mentioning that close to one third of the populations in all three countries are undecided whether to support or oppose a policy, which would increase the costs of non-renewable energy. The policy support among the Mexican public is even stronger for a policy that would require electric utilities to produce at least 20 % of their electricity energy sources by the year 2020. Over half of the respondents in Mexico indicated strong support, which is significantly more compared to the 39 % in Canada and 30.2 % in the United States. Again, the opposition is the strongest in the United States with close to 15 % of the respondents expressing moderate or strong opposition, followed by Canada (10.6 %), and Mexico (3.2 %). A third policy that would provide subsidies to industries investing in alternative energy generates strong level of support among the respondents from all three countries. However, the amount of moderate to strong support in Mexico with 83.8 % is significantly higher compared to the 67.4 % in Canada and 58.9 % in the United States. The United States and Canada have also similar levels of moderate opposition with 6.7 and 6.3 % respectively. Yet, the 10.2 % of respondents in the United States stating that they are strongly opposed to the idea of industry subsidies is more than twice as much as in Canada (3.9 %) and more than 5 times as much compared to Mexico (1.9 %). Requiring the installation of solar panels or photovoltaic on buildings is also the strongest contested by the public in the United States. In total, 16.4 % of the respondents in the United States voiced strong or moderate opposition to such a policy. This is

more than the opposition from Canada (8.4 %) and Mexico (1.9 %) combined. Furthermore, a substantial number of people in the United States (25.8 %) and Canada (19.9 %) are undecided and neither support or oppose the idea of requiring more solar installations on buildings. For Mexico the data show that only 5.4 % of the public is undecided. Nonetheless, over 50 % in Canada and the United States moderately or strongly support such a policy, which is still significantly below the 63.7 % for Mexico. The fifth and final renewable energy related policy used in the survey would result in an increased use of biofuels. Similar to the previous policies, the public in the United States seems to be most skeptical with 10 % strongly opposing such a measure and only 18.2 % strongly supporting it. The data also show similarities between Canada and the United States with 34 and 35 % respectively being undecided in regards to increasing the use of biofuels. However, Canada faces less opposition from its public with only 4.3 % strongly opposing such a policy and 22.6 % strongly supporting it. In Mexico 55.7 % strongly support an increased use of Biofuels and only 1.1 % stated strong opposition.

Based on these individual questions an additive index was created, representing the overall public support for renewable energy policies. Table 2 shows the distribution of the public’s general level of support for renewable energy policies. Over 60 % of the North American population is generally in favor of policies that would strengthen and expand renewable energy sources with 32.9 % strongly supporting renewable energy policy. A clear majority favors renewable energy policies. However, there is a significant amount of uncertainty as well, with 22 % of all respondents stating that they are undecided about whether or not to support renewable energy policies. This large level of indecision is troubling and requires explanation.

In Canada and the United States, about one quarter of the public are undecided about whether or not to support policies for renewable energy. Still, in both countries the majority indicates at least moderate (if not strong) support for renewable energy policies in general. Comparing all three countries, the United States shows the highest opposition, with over 20 % strongly to moderately

opposing the idea of new sustainable energy policies and the lowest percentage of people strongly supporting such policies in general. In contrast, Mexico shows the least amount of opposition with less than 7 % of the public stating any opposition. The moderate support levels are very similar among the three national samples. In Mexico, almost 50 % show strong support for developing renewable energy policies, which is as much as the strong support from the other two countries together. Also, a smaller percentage of people seem to be uncertain about supporting renewable energy policy in Mexico, corresponding with high levels of public concern about CC.

With respect to overall renewable energy support, the data suggest that at the North American scale the public is open to and supportive of direct and indirect policies supporting renewable energy. The public, however, does show reservations with respect to policies that pose direct individual costs, such as higher utility rates if using energy from non-renewable sources. But requiring the installation of solar panels on buildings, which also requires initial private investment, has over 70 % support by the public. At the country-specific level, uncertainties are very similar among all samples when it comes to requiring higher utility rates for using non-renewable energy sources. This specific policy strategy faces more opposition than any other policy direction and has the least amount of support. Mexico is somewhat of an outlier and generally shows less opposition and uncertainty than the other two national samples for Canada and the United States, and high levels of support.

While the levels of uncertainty among the public remain substantial in terms of CC and over supporting new renewable energy policies, the literature shows that when people have a better understanding of CC science, they tend to be more supportive of mitigation efforts (Moser 2006; Moench 2007). Therefore, the survey asked the participants to self-report their knowledge about the ways in which CC can be reduced. About 55 % of the North American public feels informed or very informed about the options available for CC mitigation. On average, one-third feel somewhat informed, acknowledging not knowing all the pertinent information. Around 9 % admit to not feeling informed at all. It is noteworthy that 41.2 % of Canadians sampled indicated that they only feel somewhat informed about CC mitigation options, followed by the United States with 37.6 %. This suggests a large degree of uncertainty. The data also show that the United States is the least confident in knowledge, with less than 50 % of respondents stating that they feel informed or very informed about the ways CC can be reduced. In contrast, the Mexican public feels quite confident in their level of knowledge with only 5 % stating that they do not feel informed at all and less than 30 % feeling only somewhat informed.

4.4 Socioeconomic Variables and Climate Change Risk Perception

In order to identify potential factors that impact the public's risk perceptions and policy support, one of the research objectives of this study was to see how socioeconomic characteristics impact the public's perceptions towards CC. Regressions were used to test the hypothesis that the general public concern for CC can be largely explained by socioeconomic variables. However, the regression analysis did not confirm the hypothesis. The results show that the socioeconomic variables (age, gender, level of education, and household income) are not a strong predictor of perceived risks of CC. Instead, the calculated R and R^2 scores showed only a small correlation between the independent and dependent variables. At no point does the R score reach 0.3 indicating at least a medium relationship between the predictor and outcome variables. Thus, the data indicate that the socioeconomic characteristics do not have a significant impact on the way CC risks are perceived.

4.5 Factors Influencing Public Support for Renewable Energy

Four multiple regression models were developed and confirmed by ordinal regressions to analyze the extent of how factors (independent variables) such as (1) the level of concern over CC impacts; (2) political saliency of CC; (3) political saliency of developing a comprehensive clean energy policy; and (4) self-reported knowledge of CC mitigation, affect public support for renewable energy policies (dependent variable).

The first regression model focused on the relationship of the public's level of concern about CC impacts and support for renewable energy policies. In general, an R score of 0.5 and higher indicates that the independent variables have strong effects on the dependent variables; a value of less than 0.3 suggests a weak relationship (Field 2009). As shown in Table 3a, with an R score of 0.600 or above, the regression analysis shows a strong and statistically significant relationship between the two variables for North America ($R = 0.600$) as a whole and the United States ($R = 0.614$). In contrast, the R values for Canada ($R = 0.450$) and Mexico ($R = 0.289$) suggest a medium or weak relationship for the two countries. The coefficient of determination (R^2) ranges from 0.083 to 0.377 among the four samples. The data show that between 8.3 % (Mexico) and 37.7 % (United States) of the variation in the public's support for renewable energy policies can be explained by the perceived level of concern over possible negative impacts of CC. The Nagelkerke Pseudo R^2 value from the

Table 3 Relationship of the public's level of concern about climate change impacts and support for renewable energy policies

Impact of public's level of concern regarding climate change impacts on support of renewable energy policies in general								
Sample	<i>R</i>	<i>R</i> ²	Adj. <i>R</i> ²	SE of the estimate	Change statistics			
					<i>R</i> ² change	<i>F</i> change	Sig. <i>F</i> change	Pseudo <i>R</i> ^{2a}
North America	0.600	0.360	0.359	0.75443	0.360	324.898	0.000	0.338
Canada	0.450	0.202	0.196	0.72697	0.202	33.890	0.000	0.211
Mexico	0.289	0.083	0.079	0.58103	0.083	18.660	0.000	0.075
United States	0.614	0.377	0.375	0.85163	0.337	142.721	0.000	0.373

Coefficients for dummy variables for complete North American sample					
Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.
	<i>B</i>	SE			
1 (Constant)	2.517	0.058		43.763	0.000
Not at all concerned vs. slightly concerned	0.894	0.083	0.239	10.753	0.000
Not at all concerned vs. somewhat concerned	1.234	0.071	0.463	17.464	0.000
Not at all concerned vs. concerned	1.722	0.063	0.868	27.141	0.000
Not at all concerned vs. highly concerned	2.039	0.063	1.044	32.331	0.000

^a Ordinal regression—Nagelkerke Pseudo *R*²

ordinal regression ranges from 0.075 to 0.373 and confirms the linear regression results.

Dummy variables were used to ensure that the independent variables only consist of two categories. Table 3b shows the coefficients for the dummy variables of the first regression model for the complete North American sample. Each dummy variable is labeled in a way to illustrate what it represents. For example, the first dummy variable demonstrated the difference between the change in the level of renewable energy policy support for the group of people who stated that they are not at all concerned about possible negative impacts of CC and the ones who are slightly concerned. The unstandardized beta values (*B*) show a positive relationship between the public concern and policy support. Compared to the “not at all concerned” group, with a beta value of 2.039, the change in the level of support for renewable energy policies is the greatest among the people who feel highly concerned about CC impacts. Nevertheless, for all dummy variables, the results are statistically significant, showing that level of concern does have impacts on policy support in the direction of strengthening renewable energy.

The data from the individual countries echo the coefficient results. All country results demonstrate a positive relationship between the predictor and outcome variable. Similar to the *R* values reported in Table 3a, the United States has the highest unstandardized beta values among all three countries, emphasizing the significant role of risk perception on policy support in the United States—

followed to a lesser degree by Canada and Mexico. With respect to Mexico and Canada, the t-test shows that the coefficient results for the first dummy variable (not at all concerned vs. slightly concerned) are not significant. This indicates that the level of policy support does not vary between people who are not at all concerned or slightly concerned. It is likely that the publics in Canada and Mexico support renewables in general and are also strongly concerned over CC threats.

The second regression model tested the relationship between political saliency of reducing CC impacts and support for renewable energy. Again, the North American sample shows a strong relationship with *R* = 0.492 and *R*² = 0.242. The results show that for North America as a whole, the variation in renewable energy policy support can be explained to 24.2 % by political saliency. For the United States, the t-tests confirm statistically significant results for all dummy variables showing that increasing the public's perception of the political saliency increases policy support for renewable energy. With an unstandardized beta value of 1.878, the greatest difference in renewable energy support is found between those in the United States who stated that CC mitigation is an unimportant issue and those who believe it is very important that the government take action. In the case of Mexico, the t-test scores were not significant for any of the dummy variables, underscoring the low *R* scores of the regression model. This indicates that the political saliency of reducing CC is not a major factor during public

Table 4 Relationship of the public’s perceived level of political saliency for developing a comprehensive clean energy policy and support for renewable energy policies

Impact of the public’s perceived political saliency of developing a comprehensive clean energy policy on support of renewable energy policies in general

Sample	<i>R</i>	<i>R</i> ²	Adj. <i>R</i> ²	SE of the estimate	Change statistics			
					<i>R</i> ² change	<i>F</i> change	Sig. <i>F</i> change	Pseudo <i>R</i> ^{2a}
North America	0.487	0.238	0.237	0.82350	0.238	239.655	0.000	0.219
Canada	0.349	0.122	0.117	0.76202	0.122	24.795	0.000	0.119
Mexico	0.174	0.030	0.027	0.59720	0.030	8.599	0.000	0.044
United States	0.579	0.335	0.333	0.87982	0.335	158.164	0.000	0.330

Coefficients for dummy variables for complete North American sample

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.	
	<i>B</i>	SE	Beta			
1	(Constant)	2.538	0.081		31.436	0.000
	Unimportant vs. low importance	0.941	0.093	0.342	10.094	0.000
	Unimportant vs. important	1.590	0.085	0.827	18.672	0.000
	Unimportant vs. very important	1.902	0.085	0.996	22.385	0.000

^a Ordinal regression—Nagelkerke Pseudo *R*²

decision-making processes of supporting or opposing renewable energy policies in Mexico.

The third regression model tested the public’s perceived level of political saliency for developing a comprehensive clean energy policy and its influence on their support for renewable energy policies in general. As displayed in Table 4a, the *R* value for North America is just below 0.5, indicating a medium to strong relationship between the two variables. The United States is the only country for which the regression model provides strong results with an *R* = 0.579 and *R*² = 0.335. The results show a medium relationship for Canada (*R* = 0.349 and *R*² = 0.122) and a weak one for Mexico (*R* = 0.174 and *R*² = 0.030). The Pseudo *R*² scores provided by the ordinal regression are also very similar ranging from 0.044 for Mexico to 0.330 for the United States. The regression model demonstrates 33.5 % of the variation in renewable energy policy support among the public in the United States, 12.2 % in Canada, and up to 3 % for Mexico. This is a significant difference, especially considering that Mexico overwhelmingly perceives the development of a comprehensive clean energy policy as an important to very important issue. No other country in this study perceives the political saliency of renewable energy as high as Mexico. The coefficient output of the third regression model shows a positive relationship between the independent and dependent variables for all samples. This means that as the perceived political saliency for developing a comprehensive clean energy policy increases, support for renewable energy policies increases

as well. The coefficient results for the North American sample with the t-test confirming that all unstandardized beta values are statistically significant is illustrated in Table 4b.

The fourth and final regression model analyzed the impact of the level of self-reported knowledge regarding ways to reduce CC (and the degree to which renewable energy policies are supported). In this case, the previous roles of the country samples are somewhat reversed. Confirmed by the additional ordinal regression, the results show only a low relationship of *R* < 0.3 between the two variables for North America (*R* = 0.178 and *R*² = 0.032), Canada (*R* = 0.206 and *R*² = 0.042), and Mexico (*R* = 0.227 and *R*² = 0.052). In the case of the United States, the results provided are not statistically significant at all. The relationship among all samples is the greatest for Mexico where 5.2 % of the variation in policy support can be explained by the reported level of knowledge about CC mitigation. Although, this is not a high percentage, the output of the coefficients shows that all unstandardized coefficients are statistically significant for Mexico, which is not the case in the other regression models discussed. Therefore, all levels of knowledge do impact the degree of renewable energy policy support in a positive way. In Canada, the coefficient results and the t-test in particular show that in terms of the level of policy support it does not matter whether someone characterizes themselves as not informed or somewhat informed about ways to mitigate CC.

5 Conclusion

Overall, the data depict a clear picture of public support for renewable energy policies in North America. We found that the majority of populations in Canada, the United States, and Mexico perceives the political saliency of developing a comprehensive clean energy policy as “important” or “very important.” The public overwhelmingly supports renewable energy policies in the three countries—with the only noteworthy opposition coming from the United States. In this case, one out of five survey participants in the U.S. sample stated strong or moderate opposition. However, similar to the importance of mitigating CC, the political saliency of advancing clean energy ranks in the lower third, below many societal issues faced in everyday life, such as crime, education, employment, illegal drugs, or air and water quality. This confirms previous studies and polls at national levels that suggested general public support for renewable energy (DEFRA 2002; Wolf and Moser 2011; EC 2014), but the survey results also show that pursuing renewable energy sources is not perceived as the most pressing issue.

Although there is a consensus in all three countries of policy support for renewable energy as a viable CC mitigation mechanism, country differences remain. The Mexican survey sample shows (1) the most support in terms of increasing the share of renewable energy; (2) the most concern about CC; and (3) that two out of three respondents feel informed or very informed about the ways to reduce CC. Respondents from Canada and the United States feel informed at about the same level, but less so than their Mexican counterparts. Canada is both more supportive of renewable energy policies and demonstrates a greater concern about CC than the United States. Generally, the U.S. public is most skeptical toward new renewable energy policies as well as government involvement and is the least concerned about CC, relative to the other two countries, but there is ample support for renewable energy sources to at least discuss a North American strategy.

A key finding, supported by some of the literature (Lorenzoni and Pidgeon 2006; Leiserowitz et al. 2010), shows that large uncertainties remain especially in terms of both the public’s willingness to support renewable energy policies and in self-reported knowledge regarding CC mitigation options. This is also supported by the polling studies (DEFRA 2002; Wolf and Moser 2011; EC 2014). Over one-third in Mexico and about one-half of the people in the United States and Canada feel not at all or only somewhat informed about CC mitigation. On the continental scale, about one-third is undecided in terms of supporting any renewable energy policies and thus might

not be aware of the multiple benefits of increasing the share of renewable energy. These data suggest an important role of educating the public on CC as well as the benefits of renewable energy policies.

With CC still a controversial topic in the political arena, people who are undecided today could very well make the difference in the future success of renewable energy, energy security, and CC mitigation. The comparatively high amount of public uncertainty and indecisiveness show that public behavior and perceptions present an opportunity to increase policy support and foster behavioral changes in the future through well-designed and broadly disseminated communication programs by establishing a personal connection to CC impacts and thus increase the level of concern and support for mitigation and adaptation policies.

The importance of understanding public perceptions of CC for policy development is apparent from the results of this study. However, it is also apparent that communicators need to be aware of perception factors that clearly influence the decision-making process and impact the degree of policy support. These perceptions vary by type and magnitude among the three North American countries. The level of concern over possible negative impacts of CC have the strongest influence on renewable energy policy support. The data show a strong relationship between each of the three predictor and independent variables and renewable energy policy support in the United States. The relationships are only moderate for Canada and mostly weak or not significant for Mexico. For Mexico, the results reveal that perception factors outside of the focus of this study must play a role in influencing the public’s decision of whether or not to support renewable energy sources. Knowledge of mitigation options is not a strong predictor for the level of policy support for any of the three countries. Simultaneously, the analysis shows that characteristics such as age, gender, household income, or education are not strong predictors for someone’s attitude or risk perceptions towards CC.

What have we learned? First, the research supports the earlier poll surveys regarding widespread support and interest for developing renewable energy policies, but this study demonstrates that there are also differences among countries engaging in that support. The willingness to support renewable energy sources is often conditional, influenced by other factors, such as costs and taxes—especially in the United States. Second, this study provides strong support that risk perceptions of CC threats are related to policy support for renewable energy initiatives. This finding may be intuitively obvious, but the data support this relationship. Support for renewable energy sources is conditional, but concern over CC risks is the dominant factor.

This study should function as a benchmark for follow-up research adding more countries to the database as well as enabling longitudinal research for the countries addressed in this study. Research with larger sample sizes per country and more survey questions is needed to further improve the understanding of the perceptual differences between countries and which variables can explain them. From the responses of the three countries, this study shows that there is substantial public support for new renewable energy policies at the North American scale and policy initiatives among the three countries can be developed. However, differences remain and implementing effective communication programs can be an effective tool for building public support.

Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

References

- Bord, R.J., A. Fisher, and R.E. O'Connor. 1998. Public perceptions of global warming: United States and international perspectives. *Climate Research* 11(1): 75–84.
- Brown, J.D. 2011. Likert items and scales of measurement? *SHIKEN: JALT Testing & Evaluation SIG Newsletter* 15(1): 10–14.
- Capstick, S., L. Whitmarsh, W. Poortinga, N. Pidgeon, and P. Upham. 2015. International perceptions of climate change over the past quarter century. *WIREs Climate Change* 6(1): 35–61.
- DEFRA (Department for Environment, Food & Rural Affairs). 2002. *Survey of public attitudes to quality of life and to the environment: 2001*. London: Department for Environment, Food & Rural Affairs.
- Dunlap, R., and L. Saad. 2001. *Only one in four Americans are anxious about the environment*. Washington, DC: Gallup World Headquarters.
- EC (European Commission). 2014. Special eurobarometer 409—climate change. Brussels: Directorate-General for Climate Action.
- Farhar, B.C. 1996. Energy and the environment: The public view. REPP issue brief number 3. <http://pointfocus.com/images/pdfs/issuebr3.pdf>. Accessed 7 Nov 2015.
- Field, A. 2009. *Discovering statistics using SPSS*. London: SAGE Publications.
- Fischer, A., V. Peters, M. Neebe, J. Vavra, A. Kriel, M. Lapka, and B. Megysi. 2012. Climate change? No, wise resource use is the issue: Social representations of energy, climate change and the future. *Environmental Policy and Governance* 22(3): 161–176.
- Greenberg, M. 2009. Energy sources, public policy, and public preferences: Analysis of US national and site-specific data. *Energy Policy* 37(8): 3242–3249.
- Henerson, M.E., L.L. Morris, and C.T. Fitz-Gibbon. 1987. *How to measure attitudes*, 2nd edn. Newbury Park, CA: SAGE Publications.
- Hulme, M. 2009. *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge, UK: Cambridge University Press.
- IPCC (Intergovernmental Panel on Climate Change). 2013. *Climate change 2013: The physical science basis. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- IPCC (Intergovernmental Panel on Climate Change). 2014. *Climate change 2014: Mitigation of climate change. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- Jamison, S. 2004. Likert scales: How to (ab)use them. *Medical Education* 38(12): 1212–1218.
- Johnson, B.B., and P. Slovic. 1995. Presenting uncertainty in health risk assessment: Initial studies of its effects on risk perception and trust. *Risk Analysis* 15(4): 485–494.
- Leiserowitz, A. 2005. American risk perceptions: Is climate change dangerous? *Risk Analysis* 25(6): 1433–1442.
- Leiserowitz, A. 2006. Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climate Change* 77(1): 45–72.
- Leiserowitz, A. 2010. Risk perception and behavior. In *Climate change science and policy*, ed. S.H. Schneider, A. Rosencranz, M.D. Mastrandrea, and K. Kuntz-Duriseti. Washington, DC: Island Press.
- Leiserowitz, A., M. Edward, and C. Roser-Renouf. 2010. Climate change in the American mind: Americans' global warming beliefs and attitudes in January 2010. Yale University and George Mason University: Yale Project on Climate Change.
- Lorenzoni, I., and N. Pidgeon. 2006. Public views on climate change: European and USA perspectives. *Climate Change* 77(1): 73–95.
- Lorenzoni, I., N. Pidgeon, and R. O'Connor. 2005. Dangerous climate change: The role for risk research. *Risk Analysis* 25(6): 1387–1398.
- Maibach, E., C. Roser-Renouf, and A. Leiserowitz. 2009. *Global warming's six Americas 2009: An audience segmentation analysis*. <http://www.climatechangecommunication.org/images/files/GlobalWarmingsSixAmericas2009c.pdf>. Accessed 5 Nov 2015.
- Moench, M. 2007. Adapting to climate change and the risks associated with other natural hazards: Methods for moving from concepts to action. In *Working with the winds of change: Towards strategies for responding to the risk associated with climate change and other hazards*, ed. M. Moench and A. Dixit. Kathmandu: ISET-Nepal.
- Moser, S.C. 2006. Talk of the city: Engaging urbanities on climate change. *Environmental Research Letter* 1: 1–10.
- NACTS (North American Center for Transborder Studies). 2011. *Cooperation on transborder renewable energy development and exchange*. Tempe, AZ: Arizona State University.
- Ockwell, D., L. Whitmarsh, and S. O'Neill. 2009. Reorienting climate change communication for effective mitigation: Forcing people to be green or fostering grass-roots engagement? *Science Communication* 30(3): 305–327.
- Owuor, C.O. 2001. *Implications of using Likert data in multiple regression analysis*. Vancouver: University of British Columbia.
- Peters, R.G., V.T. Covelto, and D.B. McCallum. 1997. The determinants of trust and credibility in environmental risk communication. *Risk Analysis* 17(1): 43–54.
- Read, D., A. Bostrom, M. Granger Morgan, B. Fischhoff, and T. Smuts. 1994. What do people know about global climate change? 2. Survey studies of educated laypeople. *Risk Analysis* 14(6): 971–982.
- Schneider, S.H., A. Rosencranz, M.D. Mastrandrea, and K. Kuntz-Duriseti. 2010. *Climate change science and policy*. Washington, DC: Island Press.
- Sjoberg, L. 1998. World views, political attitudes and risk perception. *Risk: Health, Safety & Environment* 9(2): 137–152.

- Slovic, P. 1987. Perception of risk. *Science* 236(4799): 280–285.
- Slovic, P. 2000. *The perception of risk*. London: Earthscan.
- Slovic, P., B. Fischhoff, and S. Lichtenstein. 1981. Perceived risk: Psychological factors and social implications. In *The assessment of perception of risk*, ed. F. Warner and D.H. Slater. London: The Royal Society.
- Smith, J. 2005. Dangerous news: Media decision making about climate change risk. *Risk Analysis* 25(6): 1471–1482.
- Wan, J., and C.K. Wand. 1996. *LISREL approaches to interaction effects in multiple regression*. Thousand Oaks, CA: Sage Publications.
- Wardekker, J.A. 2004. *Risk communication on climate change*. Utrecht: Utrecht University.
- Whitmarsh, L., G. Seyfang, and S. O’Neill. 2011. Public engagement with carbon and climate change: To what extent is the public “carbon capable”? *Global Environmental Change* 21(1): 56–65.
- Wolf, J., and S.C. Moser. 2011. Individual understandings, perceptions, and engagement with climate change: Insights from in-depth studies across the world. *Wiley Interdisciplinary Reviews: Climate Change* 2(4): 547–569.
- WorldPublicOpinion.org. 2008. World public strongly favor requiring more wind and solar energy, more efficiency, even if it increases costs. http://www.worldpublicopinion.org/pipa/pdf/nov08/WPO_Energy_Nov08_longart.pdf. Accessed 4 Nov 2015.
- Wüstenhagen, R., M. Wolsink, and M.J. Bürer. 2007. Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy* 35(5): 2683–2691.