
By

Larissa Xu

A thesis submitted to the School of Environmental Studies in conformity with the requirements for the degree of Bachelor of Science (Honours)

Queen’s University

Kingston, Ontario, Canada

April 2017

Copyright © Larissa Xu, 2017
Abstract

Increasing concerns over climate change have created a global resurgence in interest for the use of nuclear energy (World Nuclear Association, 2017). Canada is in a position to become a world leader in the nuclear industry; however, negative public perception has been cited as a key obstacle preventing the industry from moving forward both domestically and internationally (Canada's Public Policy Forum, 2014). Despite identifying the importance of industry communication, it has been largely overlooked as a factor that influences public perception in previous studies, which have mainly focused on single determinants of public opinion. In this study, the null hypothesis stated that the integration of industry communication within a community would not have any affect on public perception of nuclear energy. The alternate hypothesis stated that the integration of industry communication would have either a positive or negative effect. Surveys were distributed to 50 participants (25 from Pickering, Ontario; 25 from Guelph, Ontario). The surveys measured perception of nuclear energy across four main categories: trust, fairness, knowledge, and experience with the technology, as well as overall level of support. Residents from Pickering displayed significantly more positive responses across all four categories, which rejected the null hypothesis and supported the alternate hypothesis. However, this was not shown to lead to greater levels of support for the construction of new reactors. While it is evident that existing communication is effective enough to foster public acceptance, overall lack of support for the construction of new reactors, and the persistence of negative perceptions about nuclear energy in non-nuclear communities are issues that should be examined further given the critical need for public support in the future growth of the industry.
Acknowledgements

I would like to thank my supervisor, Dr. Warren Mabee, and examiner, Dr. Graham Whitelaw for providing me with the opportunity to conduct this research. I would also like to thank Dr. Alice Hovorka for acting as a great course coordinator throughout the year, and members of the General Research Ethics Board who provided useful feedback and approval of my research methods.
Table of Contents

List of Figures and Tables ........................................................................................................ IV

List of Appendices ..................................................................................................................... V

1. Introduction .......................................................................................................................... 1
   1.1. Canada’s climate change goals ...................................................................................... 1
   1.2. Potential for nuclear energy in climate change mitigation .......................................... 2
   1.3. Status of nuclear energy in Canada .............................................................................. 6
   1.4. Public opinion studies ............................................................................................... 8
   1.5. Current study ............................................................................................................. 12

2. Methods .............................................................................................................................. 13
   2.1. Recruitment ................................................................................................................ 13
   2.2. Survey design ............................................................................................................ 14

3. Results .................................................................................................................................. 15

4. Discussion ................................................................................................................................ 17
   4.1. Public acceptance factors .......................................................................................... 17
   4.2. Overall support .......................................................................................................... 22
   4.3. Emergency preparedness ......................................................................................... 23
   4.4. Limitations ................................................................................................................ 23
   4.5. Future research ......................................................................................................... 24

5. Summary ................................................................................................................................ 26

References ...................................................................................................................................... 28

Appendices .................................................................................................................................. 32
List of Figures and Tables

**Figures**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Greenhouse gas emissions projections versus targets 2020-2030</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Life-cycle air emissions of electricity sources</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Support for nuclear power 1983-1993</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Support for nuclear power 2002-2010</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Mean values for survey questions 1-20</td>
</tr>
</tbody>
</table>

**Tables**

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Energy densities of various fuel types</td>
</tr>
<tr>
<td>Table 2</td>
<td>Communication methods used by Pickering nuclear industry</td>
</tr>
<tr>
<td>Table 3</td>
<td>Overall support for nuclear energy</td>
</tr>
</tbody>
</table>
List of Appendices

| Appendix A | Letter of information |
| Appendix B | Survey |
| Appendix C | Survey responses |
| Appendix D | Industry description of used fuel dry storage process |
| Appendix E | Media description of used fuel dry storage process |
1. Introduction

1.1. Canada’s climate change goals

The recent ratification of the Paris Agreement stipulates a global response to combat climate change; limiting global temperature rises to less than 2°C, which is the anticipated threshold at which abrupt and irreversible damage will occur (United Nations, 2014). This will require greenhouse gas emissions to be near zero by the second half of the century, and thus the immediate mobilization of individual citizens, government, and industries (United Nations, 2014).

As a signing member of this agreement, in January 2017 Canada issued The Pan-Canadian Framework on Clean Growth and Climate Change, with the fundamental goal of addressing climate change while continuing to grow the economy (Government of Canada, 2017). The framework consists of four main pillars: pricing carbon pollution; taking complementary measures to further reduce emissions; taking measures to adapt to climate change impacts and build resilience; and taking actions to accelerate innovation, support clean technology, and create jobs (Government of Canada, 2017).

It is estimated that by 2050, the failure to act could cost Canada $21-43 billion per year due to climate-related risks such as severe weather events; the effects of which have already cost Canada billions over recent years (Government of Canada, 2017). Figure 1 depicts the gap between Canada’s projected greenhouse gas emissions and the emissions targets set for 2020 and 2030. The black line represents projected emissions based on a “business as usual” scenario, while the red and blue lines indicate a range for this projection based on variances in future economics and energy prices (Government of Canada, 2017). Based on current trends, it is
evident that without immediate and drastic intervention, it is unlikely that these targets will be met.

Despite its relatively small population, Canada remains one of the world’s top ten emitters of greenhouse gases (Nejat, Jomehzadeh, Taheri, Gohari, & Majid, 2015). According to Environment Canada, in 2014, “The oil and gas sector was the largest greenhouse gas emitter in Canada” (Environment and Climate Change Canada, 2016), and although it has since been phased out in Ontario, coal remains a dominant source of electricity production in Alberta (75%), Saskatchewan (60%), and Nova Scotia (over 60%) (Weis, Partington, Thibault, Gibson, & Anderson, 2012). Thus, the upcoming decisions of energy companies, and the politics that influence them will be vital in determining the success or failure to meet, or at least approach the framework’s proposed targets.

1.2. Potential for nuclear energy in climate change mitigation

A global resurgence of interest in nuclear energy has developed in response to concerns over climate change and increasing energy demands. According to the World Nuclear
Association, over 45 countries, ranging from affluent to developing nations, are actively considering the development of nuclear energy programs (World Nuclear Association, 2017). Reports from the International Energy Agency and Nuclear Energy Agency have also incorporated nuclear energy as part of a long-term energy strategy (Nuclear Energy Agency, 2016). While it would be impossible to completely eliminate the risks associated with nuclear energy, or any type of energy source, it is imperative to consider both the risks and benefits from an objective point of view, and the potential environmental impacts of each course of action. The following arguments represent ways in which the expansion of nuclear energy may provide climate change benefits both globally and within Canada, and are important to consider alongside the outstanding risks.

*Greenhouse gas reduction*

Nuclear energy has the unique ability to produce energy in quantities that are comparable to fossil fuels, while achieving greenhouse gas reductions similar to renewables (Brook, et al., 2014). With the exception of hydroelectricity, nuclear energy exhibits one of the lowest life-

![Figure 2. Life-cycle air emissions of electricity sources (Canadian Electricity Association, 2006)](image-url)
cycle carbon emissions of all electricity sources (Canadian Electricity Association, 2006).

According to the International Atomic Energy Agency, if no nuclear plants were operating, annual global CO$_2$ emissions would be approximately 2.5 billion times higher (General, 2016).

Further, the energy density of Uranium-235; the fuel used in nuclear reactors, is exponentially higher than that of any other conventional or non-conventional fuel type (Layton, 2008). Table 1 provides a comparison of the energy densities of various fuel sources. To put this in perspective, if a mass of coal could be used to move a vehicle 10m, the same mass of Uranium-235 could be used to move the vehicle 1,625,000m (Hore-Lacy, 2003).

### Table 1. Energy densities of various fuel types

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Reaction Type</th>
<th>Energy Density (MJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>Chemical</td>
<td>16</td>
</tr>
<tr>
<td>Coal</td>
<td>Chemical</td>
<td>24</td>
</tr>
<tr>
<td>Ethanol</td>
<td>Chemical</td>
<td>26.8</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>Chemical</td>
<td>38</td>
</tr>
<tr>
<td>Crude oil</td>
<td>Chemical</td>
<td>44</td>
</tr>
<tr>
<td>Diesel</td>
<td>Chemical</td>
<td>45</td>
</tr>
<tr>
<td>Gasoline</td>
<td>Chemical</td>
<td>46</td>
</tr>
<tr>
<td>Natural gas</td>
<td>Chemical</td>
<td>55</td>
</tr>
<tr>
<td>Uranium-235</td>
<td>Nuclear</td>
<td>3,900,000</td>
</tr>
</tbody>
</table>

**Contribution to baseload energy supply**

According to Ayres et al., (2004), electricity generating systems are classified into two types: baseload and peak load suppliers. Baseload energy suppliers must provide enough energy to meet the minimum energy demand at all times. Therefore, they must supply reliable energy at a continuous and constant rate. Peak load energy suppliers operate intermittently with the purpose of meeting peak demands, which can occur daily, monthly, or seasonally. To ensure electricity demand is met at all times, a combination of these systems is used (Ayres et al., 2004).
While renewables are the desired option for long-term greenhouse gas reduction, only preliminary discussions have occurred surrounding the use of renewables as baseload suppliers (Matek & Gawell, 2015), and the feasibility of this has been highly debated among the literature. According to a report by the Canadian Electricity Association, due to Canada’s diverse landscape, economy, and resource base, electricity production methods are highly dependant on resources available in each province. Currently, baseload supply in Canada is met by thermal (mainly coal-based), hydro, or nuclear energy systems, of which nuclear is the only low-carbon source that is not limited by local natural resources. In addition, electricity transfer between provinces is minimal compared to that between Canadian provinces and the United States, where energy trade is more profitable (Canadian Electricity Association, 2006). Since the transfer capacities between provincial grids is limited, this would not allow baseload demands to be met through the transmission of energy from neighbouring provinces, even if they have an abundance of clean energy that could contribute to the baseload supply. Nuclear energy can be used independently to provide a clean, baseload source regardless of locally available natural resources.

Energy security

Climate change and energy security are inextricably linked, and the use of nuclear energy has the potential to provide resilience against climate change through increased energy security. Reducing dependence on fossil fuels by diversifying fuel sources can reduce a country’s vulnerability to both volatile fuel prices and disruptions in power supplies. Research by Adamantiades & Kessides (2009) states that the majority of the expenses for nuclear energy production are associated with the plant’s construction phase, while the cost of electricity production is minimally dependant on low-cost uranium fuel. In contrast, fossil fuel-based plants
have low construction costs, with electricity production costs that are highly dependant on volatile fuel prices. According to this research, “A doubling in the price of uranium would cause only a 5-6% increase in the total cost of electricity generation, while a similar increase in the price of natural gas would lead to a 65% increase in gas-fired electricity costs” (Adamantiades & Kessides, 2009).

Further, research by Lidsky & Miller (1998) states that in addition to influencing fuel prices, an increasingly unpredictable climate combined with resource scarcity may affect imports through political unrest or natural disasters, which could force countries to rely on fuel reserves. For example, many countries import fuel via pipelines, air, or sea, which may become vulnerable to increasing environmental or political instability. Since the energy density of uranium is high, the cost to import it is approximately one tenth the amount it would cost to import the volume of coal that would produce the same amount of energy. It also has the ability to be stored for longer periods of time compared to coal which degrades more quickly (Lidsky & Miller, 1998), making it a beneficial resource to utilize as a reserve.

In summary, the aforementioned factors have the potential to provide significant benefits for international climate change mitigation. In addition, they would serve to address three out of the four main pillars of the Pan-Canadian Framework on Green Growth and Climate Change through taking complementary measures to further reduce emissions; taking measures to adapt to climate change impacts and build resilience; and taking actions to accelerate innovation, support clean technology, and create jobs (Government of Canada, 2017).
1.3. Status of nuclear energy in Canada

Canada’s nuclear industry is at a critical point both domestically and internationally. As a country with a well-established reputation in the nuclear industry, Canada is in a position to capitalize on the forthcoming international developments through the provision of technology, fuel, and services (Canada's Public Policy Forum, 2014). According to a report on the future of Canada’s nuclear energy sector, Canada has the second largest uranium deposits in the world; a strong record of leading-edge technology; well-developed regulatory systems for safety and environmental standards; a network of research centres and universities to support research and development; and a well-educated workforce (Canada's Public Policy Forum, 2014).

Despite possessing this potential within an emerging market, Canada’s nuclear industry has suffered from a lack of funding, difficulty obtaining approval for new construction and waste disposal projects (Canada's Public Policy Forum, 2014), and the majority of Canada’s reactors will be reaching the end of their life cycle within the next 20 years (World Nuclear Association, 2016). In contrast, many countries have full government and public support for their nuclear programs, and have already surpassed Canada in terms of development (Canada's Public Policy Forum, 2014).

While there are variances in support between provinces (Canadian Nuclear Association, 2012), overall, it is evident that there has never been strong public support for nuclear energy in Canada despite its large and historical contribution to energy production. A recent poll found that with the exception of Ontario, which was slightly above 50%, general support for nuclear energy was below 50% across all other provinces (Canadian Nuclear Association, 2012). A report by Canada’s Public Policy Forum determined that, “Public perception of nuclear energy is a key obstacle for creating the political will that is necessary to generate the level of support that could
make Canada’s industries more globally competitive. In addition, most engineers and specialists do not feel that it is their responsibility to advocate on behalf of the industry” (Canada's Public Policy Forum, 2013). Industry experts have additionally recognized that historically, Canadian industries have been unable to adequately communicate their safety track record, the environmental benefits of nuclear energy, and have failed to dispel myths that have fuelled public concerns over safety matters (Canada's Public Policy Forum, 2013). For example, the following points of contention are consistently and often effectively used to validate arguments against nuclear energy:

- Nuclear waste management is an unresolved problem
- Nuclear energy production will lead to the proliferation of nuclear weapons
- Nuclear plants can explode like nuclear bombs
- Nuclear plants emit dangerous levels of radiation into the environment
- Nuclear plants are inherently unsafe, and have the potential to become a Chernobyl, Three Mile Island, or Fukushima (Canadian Nuclear Safety Commission, 2015)

Public support is a key determinant in the nuclear industry’s success, thus, the ability to obtain national support may be the difference between the industry’s progression or further decline. If this support is to be increased, it is highly important for industries to understand both the superficial and underlying factors that shape public opinion, and based on these identify ways in which they can be most influential.

1.4. Public opinion studies

Public opinion research is a mechanism through which these factors can be identified and explored. A review of Canadian public research relating to nuclear energy shows that opinion polls, which have been conducted regularly since the 1970s, have been the main method used to measure public opinion for various aspects of nuclear energy such as overall acceptance, support
for new plant production, level of concern over nuclear waste, and general safety of nuclear plants (Abacus Data, 2011; Canadian Nuclear Association, 2012; Jenkins Research Inc, 2011).

Need for inclusion of communicative factors

Despite experts citing the importance of strong public communication and historical shortcomings in this area, it has not been discussed in any national or provincial studies that were found, and has been largely overlooked as a factor that influences public perception. For the purposes of this paper, communication will be defined as, “Giving, receiving or exchanging ideas, information, signals or messages through appropriate media, enabling individuals or groups to persuade, to seek information, to give information or to express emotions” (Jureddi & Brahmaiah, 2016). Table 2 provides a summary of the methods through which the nuclear industry located in Pickering, Ontario uses to communicate with its surrounding community.

Table 2. Methods used by Pickering nuclear industry to communicate with the public

<table>
<thead>
<tr>
<th>Method of communication</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Media                   | - Newspapers  
                          - Industry website  
                          - Really Simple Syndication (RSS) feed  
                          - YouTube channel  
                          - Twitter  
                          - Instagram  |
| Tours                   | - Self-guided information centers  
                          - Virtual tours  |
| Community outreach      | - Corporate citizenship program  
                          - Pickering Community Advisory Council  
                          - KI pill distribution  
                          - Community information sessions  
                          - Public consultation  |
| Daily conduct and historical practices | - Waste management  
                          - Transparency  
                          - Adherence to standards and regulations  
                          - Professionalism  
                          - Employee training  
                          - Environmental stewardship  
                          - Independent environmental monitoring program  |

(Ontario Power Generation, 2017)
It is evident that significant efforts have been made to integrate industry communication within the community; providing citizens with opportunities to both seek information and express their opinions. However, there have been no studies to determine the effectiveness of this communication within the Pickering community, and further, whether or not this has influenced public perception of nuclear energy.

Need for a comprehensive framework

Further, analysis of public opinion polls has focused largely on single determinants of public perceptions. For example, tendencies to support or oppose nuclear energy are commonly explained in terms of factors such as gender, income, education level, and proximity to major accidents. Specifically, comparisons of attitudes before and after Three Mile Island (1979), Chernobyl (1986), and Fukushima (2011) have been used to explain trends in public opinion (Jenkins Research Inc, 2011).

General theories about public perception of technology state that people tend to accept or oppose certain technologies based on an overall evaluation of risks and benefits (Finucane et al., 2000). Considering the historical difficulties in overcoming concerns about the safety of nuclear energy through rational arguments, Weart (1991) describes nuclear energy as, “the most extreme case where public fear of technology goes beyond what seems reasonable in the light of actual experience.” Simple risk-benefit calculations become particularly complex for high-risk technologies such as nuclear energy, where emotional and psychological factors become involved. Thus, decisions to support or reject it cannot be adequately explained in terms isolated factors, which necessitates a comprehensive approach when studying the factors that influence these opinions. This is difficult to incorporate with the polling method, which generally asks few short, simple questions, and thus it has not been reflected in existing research.
The following framework developed by Huijts (2012) proposes several major factors that influence sustainable technology acceptance. It follows a well-established finding that affective feelings, or general attitudes about hazardous events influence risk-benefit perceptions. This idea is known as the “affect heuristic”, which suggests that people assess hazardous events based on an aggregate of feelings. If these feelings are mainly positive, people see less risks and more benefits, but if feelings are mainly negative, people see more risks and less benefits. This study will incorporate four of the major factors that influence sustainable technology acceptance: trust, fairness, knowledge, and experience with the technology. (Huijts, Molin, & Steg, 2012).

Trust. When forming opinions about technologies where little is known, trust in those who are responsible for its operation has been found to have a significant influence in how people perceive its risks and benefits; particularly with high risk technologies such as nuclear power (Huijts, Molin, & Steg, 2012).

Fairness. The evaluation of a technology or its implementation is influenced by perceived distributive fairness, which is contingent on how the risks and benefits are thought to be distributed, and procedural fairness, which is contingent on the extent to which people are involved in the decision-making process. Both distributive and procedural fairness have found to positively influence technology acceptance, particularly among citizens living in close proximity to its use and in cases where decisions are ultimately made by others (Huijts, Molin, & Steg, 2012).

Knowledge. Perception of a technology’s risks and benefits is influenced by knowledge of how the technology works and the effects of its usage. Level of knowledge has been shown to have varying effects on perception, depending on the type of technology. For example, multiple studies have shown that increased knowledge about hydrogen fuel use decreases perceived safety
risks (Achterberg et al., 2010; O’Garra et al., 2008), while Ellis et al. (2007) found that increased knowledge about wind power has no correlation with acceptance.

**Experience with the technology.** Experience with a technology can be increased through direct usage or observations made after its implementation. For example, it was found that after allowing employees to gain experience with a company’s hydrogen vehicle through a ride and drive clinic, more people equated their feelings of safety with hydrogen vehicles to gasoline vehicles (Huijts, Molin, & Steg, 2012).

In contrast to the polling method, these factors can not only provide a more in-depth analysis of the factors that contribute to public acceptance of nuclear energy, but can be independently improved upon through industry efforts.

### 1.5. Current study

It is clear that the influence of public-industry communication is an important factor that has been largely overlooked in previous studies. Furthermore, the need for a comprehensive approach when studying these factors has not been reflected in existing research, which has typically focused on single determinants of public perception through the use of opinion polls. This research bridged these gaps by exploring the influence of industry communication on public perception of nuclear energy using a comprehensive framework.

The purpose of this study was to examine whether industry communication had an effect on public perception of nuclear energy, and further, identify areas where communication has been successful, opportunities for improvement, and provide suggestions for further research. The study compared public opinion of nuclear energy between two municipalities: one in which industry communication was highly integrated, and another in which it was largely absent. It was
taken into consideration that while increased communication may likely have a positive effect on public opinions, there is also the possibility that the effect could be neutral or negative. For example, increased communication and awareness about nuclear energy production could cause greater public concern. Therefore, the null and alternative hypotheses were as follows:

\( H_0 \): The presence of industry communication will have no effect on public perception of nuclear energy.

\( H_1 \): The presence of industry communication will have either a positive or negative effect on public perception of nuclear energy.

2. Methods

2.1. Recruitment

An experimental and control group were selected based on geographic location. Both cities represented suburban areas with a diverse population in terms of education, ethnicity, gender, age, and socioeconomic background. The experimental group were residents of the City of Pickering, Ontario, which contains a nuclear power plant that has been in operation since 1971 (World Nuclear Association, 2016). This location represents the centre of the primary zone\(^1\) around the Pickering nuclear plant, and is representative of a community in which industry communication has been highly integrated. The City of Guelph, Ontario was selected as a control group. In contrast, Guelph is located approximately 90 km outside of the primary zone, and is isolated from nuclear power plants and waste management facilities (Canadian Nuclear Safety Commission, 2014).

\(^1\) The primary zone covers a 10km radius surrounding the Pickering nuclear plant. In the event of an emergency, alerts must be issued for this entire area, and potassium-iodide pills must be available to everyone (Canadian Nuclear Safety Commission, 2014).
Commission, 2014). Thus, it was representative of a community in which industry communication has not been integrated at all.

Participants for the experimental group were recruited from February 13th – 15th between the hours of 3:00 pm and 7:00 pm, and participants for the control group were recruited from February 16th – 17th between the hours of 3:00 pm and 7:00 pm. Identical paper surveys (See Appendix B) were administered randomly throughout public areas in Pickering and Guelph, including libraries, community centres, train stations, and malls. The sample of participants was meant to represent the general public of both cities, so to be eligible to participate in the study they had to meet the following criteria: be a resident of the city in which the surveys were being distributed, and have no prior or current affiliation, or formal education related to nuclear energy. Data from those who did not meet these criteria were excluded. There were no limitations for age, gender, socioeconomic background, ethnicity, or education level.

Participants who agreed to complete the survey were asked to read through the letter of information (See Appendix A) before proceeding to answer any questions. I then moved a reasonable distance away with my back turned so that they were given adequate privacy. All survey questions were read and answered independently by the participant.

2.2. Survey design

The surveys contained 20 questions that measured four major factors that influence sustainable energy technology acceptance: trust, fairness, knowledge, and experience with the technology. Participants answered each question using a Likert Scale, with a negative, neutral, or positive response ranging from strongly disagreeing (1) as the most negative, to strongly agreeing (5) as the most positive. They were then asked about their overall level of support for
nuclear energy in Canada. Responses in each category were statistically evaluated to determine mean values and relationships between various factors within the survey.

3. Results

A total of 25 surveys were collected from eligible participants in Pickering, and 25 from eligible participants in Guelph. Responses for questions 1-20 for each city are shown in Appendix C.

Figure 5 displays the mean values for survey questions 1-20 for Pickering and Guelph. These values were compared using a two-tail, two-sample t-test assuming unequal variances. The level of statistical significance was set to $p < .05$. It was found that Pickering residents displayed significantly higher mean values ($p = .00009$) than Guelph across all four categories.

![Mean values for Survey Questions 1-20](image)

**Figure 3.** Mean values for survey questions 1-20

Responses from Pickering residents were consistently more positive than those from Guelph residents for all questions with the exception of question 14, which asked respondents about the portion of their energy that comes from nuclear power. Further, the responses from
Pickering residents were not only more positive, but the majority (55%) of Pickering residents expressed positive responses (greater than 3), in comparison to Guelph residents where the majority (80%) expressed negative responses (less than 3).

Individual categories did not exhibit significant trends. For example, mean values were not consistently high, low, or neutral across any specific category. In addition, extreme positive and extreme negative results were rare. Although the mean values were higher for Pickering overall, responses followed similar trends for both cities in terms of increasing and decreasing positivity (i.e. Mean values increased and decreased similarly with each question for both cities). A notable exception occurred at question 17, which asked respondents whether they knew what the emergency procedure was in the event of an accident. Here, the mean values differed by almost twice the amount of any other question.

A comparison of overall support for nuclear energy is displayed in Table 3. Results indicated that of those surveyed, the majority of residents from both Pickering (77%) and Guelph (63%) were in agreement that Canada should continue the use of existing nuclear plants, but not build new ones; indicating partial support for nuclear energy. Opposition for nuclear energy was slightly higher in Pickering, and support for nuclear energy was higher in Guelph.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Pickering</th>
<th>Guelph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear power is dangerous and all operating nuclear plants should be shut down.</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>Canada should continue the use of existing nuclear plants, but not build new ones.</td>
<td>77%</td>
<td>63%</td>
</tr>
<tr>
<td>Nuclear power is a safe and important source of energy, and Canada should build new plants.</td>
<td>9%</td>
<td>26%</td>
</tr>
</tbody>
</table>
4. Discussion

4.1. Public acceptance factors

Industry communication was previously defined as, “Giving, receiving or exchanging ideas, information, signals or messages through appropriate media, enabling individuals or groups to persuade, to seek information, to give information, or to express emotions” (Jureddi & Brahmaiah, 2016). This included the use of media, information centers, community outreach, daily conduct, and historical practices. It was predicted that the integration of industry communication within a community may have either a positive, neutral, or negative effect on public perception of nuclear energy. Based on responses for survey questions 1-20, which measured four major factors that influence sustainable technology acceptance (Huijts, Molin, & Steg, 2012), it was found that responses from the experimental group (Pickering residents) were significantly more positive than those from the control group (Guelph residents) across all categories. These results rejected the null hypothesis, which stated that the integration of industry communication would have no effect on public perception of nuclear energy (i.e. The means would be the same for both populations), and supported the alternate hypothesis, which stated that the integration of industry communication would have either a positive or negative effect on public perception of nuclear energy (i.e. The means would differ significantly between the two populations). In this case, the effect was positive. These results have several possible explanations.

A major finding from research conducted on risk perception found that, “Laypeople have difficulty understanding the quantitative information of a hazard. Rather, they rely on the hazard’s qualitative characteristics, such as its controllability or the dreadedness of the hazard’s consequences” (Slovic, 1987). The remainder of this section will examine how the way in which
people develop perceptions about nuclear energy is particularly congruent with this theory, and how this may contribute to the discrepancies observed between Pickering and Guelph.

There are two major caveats that render the quantitative information that is available to the general public difficult to understand: credibility and comprehensiveness. There is an overwhelming amount of quantitative information issued by both scholarly and non-scholarly sources. For example, a review of scientific literature, industry and government websites, and mainstream media reveals that compelling arguments can be found to both support and refute each of the major common points of contention surrounding nuclear energy that were previously stated. These included:

- Nuclear waste management is an unresolved problem
- Nuclear energy production will lead to the proliferation of nuclear weapons
- Nuclear plants can explode like nuclear bombs
- Nuclear plants emit dangerous levels of radiation into the environment
- Nuclear plants are inherently unsafe, and have the potential to become a Chernobyl, Three Mile Island, or Fukushima (Canadian Nuclear Safety Commission, 2015)

While these are presented as facts by anti-nuclear groups, who are often scientists themselves, they have also been dispelled and presented as myths by industry experts and nuclear advocates. These polar views are reflective of the controversies that exist both between the public and scientists, and within the scientific community itself. This may pose major difficulties in determining the credibility of information sources.

Further, the terms and units used in the descriptions of quantitative data can be highly technical, and difficult to interpret by someone who does not have any formal education or background in the nuclear field. A reputable, objective source of information may be rendered meaningless if it is not presented in a way that the average person can understand, or if it is presented in a more comprehensive way by another source. In the case of nuclear energy, a
media article written by a non-scientist in layperson’s terms may be much easier to understand than a scientific report.

Appendix D and Appendix E display two infographics explaining the dry storage process of used nuclear fuel. The first (See Appendix D) is taken from the Pickering nuclear industry’s website, while the second (See Appendix E) is taken from a blog from The Long Now Foundation; an organization focused on long-term solutions to modern issues. Although both figures describe the same process accurately, the non-scientific source is arguably much more easy to interpret. It is written in five steps rather than 22, the graphics are large, aesthetic, and simple, and it is explained without the use of scientific jargon.

Another important difference is the tone used in each of these explanations. While this difference is subtle, it can convey significantly different meanings to the reader. The industry’s procedure is much like a simple, step-by-step instruction manual. For example, it describes the final steps as, “Dry storage casket transferred to storage building, indoor secure storage” (Ontario Power Generation, 2016). The blog’s description of this stage is much more open to interpretation: “It will sit like this, above ground, on site at nuclear reactors, usually monitored by armed guards until it is moved elsewhere” (Mensing, 2012). The greater ambiguity may encourage readers to wonder if the used fuel simply sits out in the open, if there are times when it is not guarded, and what its fate is when it must be moved “elsewhere”. Although this source may be easier to understand, it is easy to see how it could provide opportunity for greater scrutiny and uncertainty.

This example is only one of many scenarios where the complexity of the quantitative information about certain aspects of nuclear energy may lead people to accept the most comprehensible source if presented with more than one, and further, how the chosen source of
information, whether scientific or non-scientific can reduce the objectivity of the information through the way it is presented. This further creates a barrier to achieving proper understanding of these often perplexing concepts.

In sum, understanding the quantitative information available, and further, deciphering which sources are credible clearly pose challenges to the general public. In the context of nuclear energy, this conforms with the former part of Slovic’s theory which states that, “Laypeople have difficulty understanding the quantitative information of a hazard” (Slovic, 1987), and may elicit the latter part of the theory which states that, “Rather, they [the general public] rely on the hazard’s qualitative characteristics, such as its controllability or the dreadedness of the hazard’s consequences” (Slovic, 1987).

Although the Canadian nuclear industry has a respectable safety track record, global events have proven that despite all of the safety measures in place, human error and environmental instability are factors that will always undermine the ability to have complete control over its potentially harmful effects. The catastrophic and uncontrollable nature of these consequences, which have been accentuated by the media, make it difficult to consider quantitative information about nuclear energy without also considering the qualitative characteristics. A study conducted by Weart (1991) across Japan and the United States found that, “For evoking feelings of dread, reactor accidents outweigh every other modern risk, including problems that each year visibly harm millions of people” (Weart, 1991).

Given the perplexity of the quantitative information available to the public, reliance on these qualitative characteristics may take precedent, creating further difficulties in using rational assessments to evaluate the risks and benefits, and develop positive perceptions.
Slovic’s theory about risk perception can be used to explain the discrepancies found between Pickering and Guelph. It is possible that the way in which Pickering residents make quantitative and qualitative observations, that in turn influence their perceived risks of nuclear energy, may be influenced by increased exposure to communication from an overarching, reputable figure that is present in their community. This is a key difference between the two cities that were selected.

First, Pickering residents inherently have a greater incentive to explore information about nuclear energy given their likelihood to be directly affected by the social, environmental, and economic risks and benefits of the industry. While the average Pickering resident may not be any more capable of deciphering the controversial and complex quantitative information that is available to the general public, the provision of this information through industry communication efforts in their community provides a common source of highly accessible information which residents can take advantage of. Further, because these methods of communication are developed specifically for the general public, this may not only increase the likelihood of residents attaining quantitative information from a scientific source, but increase the ability for this information to be understood.

A more critical difference; however, may be the reinforcement of this quantitative information with positive qualitative information provided by the industry’s non-verbal forms of communication, that is, its daily conduct and historical practices. The Pickering nuclear plant has been operating safely since 1971 with no major accidents (World Nuclear Association, 2017). Based on environmental monitoring results, there has been no evidence to date that those living within the community have suffered from health effects as a result of their proximity to the power plant (Ontario Power Generation, 2017).
Pickering residents can attest to the health and environmental effects of nuclear energy production through daily observations that can be made, whether consciously or subconsciously, by simply living in the community. For example, the Pickering Beach and Waterfront Trail are located directly beside the nuclear power plant, and are highly frequented by locals and people from surrounding communities throughout the year. This provides positive reinforcement of the quantitative information the industry has provided regarding commitments to safety, environmental regulations, and waste management practices, and may also help to dispel the negative connotations associated with nuclear energy in a way that cannot be accomplished in a non-nuclear city such as Guelph.

4.2. Overall support

Another important aspect to explore is whether acceptance of nuclear energy fosters increased support. Public consultation is an integral component of the processes used to obtain licenses for new nuclear projects, so regardless of how well the existing technology is accepted, major decisions for new projects will be contingent on those who take actions to actively support or oppose these proposals. During this study, while it was found that residents of Pickering, Ontario were significantly more accepting of nuclear energy compared to Guelph, when asked about overall support, 91% of Pickering participants were opposed to the construction of new reactors. Therefore, increased acceptance did not equate to greater overall level of support.

This is not consistent with the affect heuristic, which suggests that people see less risks and more benefits if feelings toward a hazard are mainly positive. These findings have important implications, because if most people are more inclined to take actions against a technology toward which their attitudes are mainly positive, this may indicate that the existing technology is
merely tolerated. People may recognize the benefits of nuclear energy, but be less inclined to do so when it is being proposed “in their backyard”.

Another notable observation was that strong opposition for nuclear energy was slightly higher in Pickering, and strong support for nuclear energy was higher in Guelph; however, due to the small sample size in this study, definitive conclusions could not be made.

4.3. Emergency preparedness

The largest difference between the mean values occurred for question 17, which asked residents whether they knew what the emergency procedure was in the event of a nuclear accident. Here, the mean values differed by almost twice the amount of any other question. One possible explanation for this discrepancy could be the recent distribution of potassium-iodide (KI) pills to all homes and businesses within 10km of the Pickering nuclear plant. These pills reduce the risk of thyroid cancer development in the event of an accident, especially among children, and packages contain enough pills to treat a family of four. They also contain a brochure with a simple overview of emergency procedures, and instructions for taking the pills. Since knowledge of emergency procedures was the greatest observable difference between the cities, it is possible that having increased knowledge of emergency procedures could contribute to increased acceptance of nuclear energy, and may be an important focus in public outreach and monetary investment.

4.4. Limitations

Random selection. When measuring public opinion, a randomly selected sample is highly important to ensure that responses are representative of the entire population. To ensure each person in the population has an equal chance of being selected, surveys conducted by official
organizations often use interval sampling, where surveyors have a list of the population and select every $n^{th}$ person, or multi-stage selection, where areas are divided geographically into “Primary Sampling Units (PSUs) and people are then selected from these blocks depending on the population densities of each (Brooker & Schaefer, 2005). Due to the small scale and limited resources of this study, surveys were handed out by hand. This was predominantly carried out in public areas during the day, so people who did not frequent these areas would not have been approached.

Sample size. Another limitation was the sample size, which was relatively small due to the limited scope of this study. This produced a large sample error, which could have been reduced with a greater sample size; however, for the purposes of this study it was enough to draw several interesting speculations.

Overrepresentation. Due to the small sample size, demographic factors were not always evenly distributed. For example, in both populations, more females completed surveys than males, and more people reported having no children. In Guelph, there were a particularly higher number of people over the age of 55, and a large number of people with graduate degrees compared to Pickering. The majority of the people who agreed to take the surveys in both cities had a college level education or above, so these groups were over-represented. However, this limitation is not specific to this study, as people with higher education are often more likely to participate in academic research (Brooker & Schaefer, 2005).

4.5. Future research

It appears that adequate public research has been conducted to conclude that Canadians are not strongly supportive of nuclear energy, and it is clear that industry communication can be
an effective tool for changing public opinions. Therefore, focusing on the implementation of more innovative public communication approaches in combination with studies to test their effectiveness may be highly beneficial moving forward.

Altering behavioural tendencies will require future studies to focus on factors that foster active support for new nuclear energy projects, and those that can be directly addressed by the industry. For example, determining the influences of gender, which is a fixed characteristic, on public support may not be as practical as determining that greater knowledge about emergency response plans increases support; something that can be directly improved upon by the industry through the investment in emergency response strategies and public awareness of these plans. Here, the benefits of incorporating a more comprehensive approach rather than the traditional polling method may prove advantageous.

An online survey involving 2,200 Canadians conducted in September 2015 found that 71% believed that global warming was caused by human activity, and approximately the same percentage wanted to see more efforts to reduce greenhouse gas emissions (Anderson, 2016). Cross-referencing Canadian public research in areas that can be addressed through the use of nuclear energy production may be a useful tactic. Since it is known that the majority of Canadians are concerned about climate change and would like to see more efforts to reduce emissions, arguments for nuclear energy can be framed in a way that communicates the benefits of nuclear energy in terms of climate change and emission reductions.

Furthermore, Weart (1991) suggests that the key to gaining public support for nuclear energy is to directly address peoples’ fears and anticipations about the technology. One example of this was to charge those who are responsible for the use and disposal of radioactive waste, and give the money to residents living near the waste repository to encourage them to hire their own
experts to conduct environmental monitoring. While this may not be practical in all settings, the fundamental concept is significant, as the industry is communicating their commitment to making substantial efforts to identify and address local concerns. By enabling the public to conduct their own environmental monitoring, which is generally conducted by the industry, they [the public] can hold the industry to greater accountability in terms of environmental practices. Further, this allows the public to assume greater control in the event that any type of contamination should occur, in contrast to having them rely on blind faith in the industry’s adherence to regulations and transparency. Incorporating communication strategies with tangible results may foster greater trust between the industry and the public, and increase support for the technology if experiences are positive.

5. Summary

The issuing of comprehensive strategies such as the Paris Agreement and the Pan-Canadian Framework on Clean Growth and Climate Change show evidence of strong political will to take drastic and immediate measures to address climate change. The benefits of nuclear energy, including its ability to reduce emissions, produce large quantities of energy, and provide energy security make it an ideal candidate as part of a long-term energy strategy focused on climate change mitigation and adaptation. In Canada, lack of public and political support has created stagnation, while in other countries it has been a source of strength for the development of new nuclear energy projects.

Focusing public opinion research on identifying factors that encourage active support for nuclear energy may be an important consideration in upcoming years. Additionally, framing arguments in the nuclear debate in a way that clearly illustrates the industry’s potential role in
addressing issues of mass public concern, such as climate change, may fundamentally change the way people evaluate its risks and benefits.

While there will likely never be a simple solution to gaining public and political support, developing innovative communication and technological strategies to address this issue could prove to be a very worthwhile investment to ensure the long-term health of Canada’s environment.
References


LETTER OF INFORMATION
An assessment of the influence of industry communication on public perception of nuclear energy: A case study of Pickering, Ontario

Dear participant,

I am a student in the Department of Environmental Studies at Queen’s University, and am in the process of writing my undergraduate thesis. Current research suggests that negative public perception is a key obstacle for generating the level of support that is needed to make Canadian nuclear industries more globally competitive. The purpose of this study is to gain a better understanding of the effectiveness of communication between the nuclear industry and the public, and the effects this may have on public acceptance of nuclear energy.

Your participation in this research is completely voluntary and there are no direct benefits to you. You may decline altogether, or leave blank any questions you do not wish to answer. There is no risk associated with your participation in this research. Your responses will remain confidential and anonymous, and will not be identified with you personally. No one other than the researchers will know your individual answers to this questionnaire, and it will be reported only as a collective combined total. Data from this research will be securely stored for a minimum of 5 years, after which they will be destroyed.

If you agree to participate in this project, please answer the following survey questions as best you can. The questions are straightforward, and will ask your opinion about various aspects of the nuclear industry. Since nuclear energy can be a sensitive subject for some, please be advised before beginning the survey. To ensure confidentiality, please do not write your name on the questionnaire. The survey should take approximately 10 minutes, however there is no time limit to complete it. Please return the questionnaire as soon as it is complete. Once the completed survey has been submitted, your data cannot be withdrawn from the study since it can no longer be identified with you. Your decision to complete and return this survey will be interpreted as an indication of your consent to participate.

This research is purely academic, and not associated with the nuclear industry or any related parties. If you have any questions regarding the survey or this research project in general, feel free to contact my supervisor, Dr. Warren Mabee, at w.mabee@queensu.ca. Any questions concerning your rights as a research participant may be directed to the Chair of the General Research Ethics Board at 613-533-6081 or Chair.GREB@queensu.ca.

Thank you for your participation.

Sincerely,

Larissa Xu
Appendix B

Please select the most appropriate answer.

---

**Are you currently a resident of Pickering/Guelph, Ontario?**

Yes  No

**Do you have any prior or current work experience, or formal education related to nuclear energy?**

Yes  No

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not Sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I do not feel that living close to a nuclear plant would put my short-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>term or long-term health at risk.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not feel that nuclear energy production would put my surrounding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>environment at risk.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are safe solutions for managing nuclear waste.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I trust industry professionals are well-trained, and able to deal with</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>any safety or security problems that could develop.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not feel that nuclear plants and waste storage systems are</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vulnerable to extreme weather events or terrorist attacks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel informed about major decisions made by the nuclear industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i.e. Decisions about waste disposal, building new reactors, and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>shutting down old ones).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that I have enough information to form educated opinions about</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>these decisions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that I have the opportunity to voice any questions or concerns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>that I have about these decisions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would have the confidence to voice these questions or concerns to the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>industry if given the opportunity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have access to information regarding the nuclear industry or know</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>where to find it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This information is written in a way that is easy for me to understand.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand the link between nuclear energy and climate change.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is possible to be exposed to safe levels of radiation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know what portion of my electricity comes from nuclear energy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know how the cost of nuclear energy production compares to other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy sources in Ontario.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have a basic understanding of how and where nuclear waste is</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>managed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I know what the emergency procedure is in the event of an accident.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not Sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

Most of what I know about nuclear energy has come directly from the industry (rather than TV, social media, word of mouth, or other sources).

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not Sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

Nuclear information centers, info sessions, and/or industry websites have helped increase my knowledge about nuclear energy.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not Sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

I feel that the nuclear industry has made a substantial effort to reach out to me and my community to help us feel more informed/familiar with technology safety and industry decisions.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not Sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

Select the statement that best describes your overall level of support for nuclear energy.

- [ ] Nuclear power is dangerous and all operating nuclear plants should be shut down.
- [ ] Canada should continue the use of existing nuclear plants, but not build new ones.
- [ ] Nuclear power is a safe and important source of energy, and Canada should build new plants.

**Gender**
- [ ] Male
- [ ] Female
- [ ] Prefer not to specify

**Age**
- [ ] Under 18
- [ ] 18-24
- [ ] 25-34
- [ ] 35-44
- [ ] 45-54
- [ ] 55+

**Education level**
- [ ] High school or below
- [ ] College
- [ ] Undergraduate
- [ ] Graduate
- [ ] Doctorate

**Combined annual household income**
- [ ] $0 - $24,999
- [ ] $25,000 - $49,999
- [ ] $50,000 - $74,999
- [ ] $75,000 - $99,999
- [ ] $100,000+

**Number of children**
- [ ] 0
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4+
Appendix C

SURVEY QUESTIONS 1-5 (TRUST)

1. I do not feel that living close to a nuclear plant would put my short-term or long-term health at risk.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>4%</td>
<td>28%</td>
<td>24%</td>
<td>40%</td>
<td>4%</td>
</tr>
<tr>
<td>G</td>
<td>20%</td>
<td>36%</td>
<td>24%</td>
<td>12%</td>
<td>8%</td>
</tr>
</tbody>
</table>

2. I do not feel that nuclear energy production would put my surrounding environment at risk.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>4%</td>
<td>44%</td>
<td>20%</td>
<td>28%</td>
<td>4%</td>
</tr>
<tr>
<td>G</td>
<td>24%</td>
<td>40%</td>
<td>16%</td>
<td>16%</td>
<td>4%</td>
</tr>
</tbody>
</table>

3. There are safe solutions for managing nuclear waste.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>8%</td>
<td>17%</td>
<td>46%</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td>G</td>
<td>17%</td>
<td>33%</td>
<td>38%</td>
<td>8%</td>
<td>4%</td>
</tr>
</tbody>
</table>

4. I trust industry professionals are well-trained, and able to deal with any safety or security problems that could develop.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>13%</td>
<td>29%</td>
<td>50%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>G</td>
<td>4%</td>
<td>8%</td>
<td>28%</td>
<td>60%</td>
<td>0%</td>
</tr>
</tbody>
</table>

5. I do not feel that nuclear plants and waste storage systems are vulnerable to extreme weather events or terrorist attacks.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>12%</td>
<td>24%</td>
<td>54%</td>
<td>28%</td>
<td>4%</td>
</tr>
<tr>
<td>G</td>
<td>17%</td>
<td>54%</td>
<td>21%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

SURVEY QUESTIONS 6-11 (FAIRNESS)

6. I feel informed about major decisions made by the nuclear industry (i.e. Decisions about waste disposal, building new reactors, and shutting down old ones).

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>17%</td>
<td>29%</td>
<td>17%</td>
<td>29%</td>
<td>8%</td>
</tr>
<tr>
<td>G</td>
<td>24%</td>
<td>52%</td>
<td>16%</td>
<td>8%</td>
<td>0%</td>
</tr>
</tbody>
</table>

7. I feel that I have enough information to form educated opinions about these decisions.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>12%</td>
<td>28%</td>
<td>24%</td>
<td>36%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>16%</td>
<td>40%</td>
<td>36%</td>
<td>8%</td>
<td>0%</td>
</tr>
</tbody>
</table>

8. I feel that I have the opportunity to voice any questions or concerns that I have about these decisions.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>16%</td>
<td>36%</td>
<td>32%</td>
<td>40%</td>
<td>4%</td>
</tr>
<tr>
<td>G</td>
<td>12%</td>
<td>36%</td>
<td>16%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

9. I would have the confidence to voice these questions or concerns to the industry if given the opportunity.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>29%</td>
<td>20%</td>
<td>50%</td>
<td>56%</td>
<td>17%</td>
</tr>
<tr>
<td>G</td>
<td>24%</td>
<td>20%</td>
<td>56%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

10. I have access to information regarding the nuclear industry or know where to find it.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>21%</td>
<td>29%</td>
<td>46%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>G</td>
<td>4%</td>
<td>32%</td>
<td>32%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

11. This information is written in a way that is easy for me to understand.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>8%</td>
<td>25%</td>
<td>46%</td>
<td>8%</td>
<td>17%</td>
</tr>
<tr>
<td>G</td>
<td>4%</td>
<td>13%</td>
<td>46%</td>
<td>29%</td>
<td>8%</td>
</tr>
</tbody>
</table>
### SURVEY QUESTIONS 12-17 (KNOWLEDGE)

12. I understand the link between nuclear energy and climate change.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>8%</td>
<td>25%</td>
<td>25%</td>
<td>33%</td>
<td>8%</td>
</tr>
<tr>
<td>G</td>
<td>13%</td>
<td>29%</td>
<td>33%</td>
<td>17%</td>
<td>8%</td>
</tr>
</tbody>
</table>

13. It is possible to be exposed to safe levels of radiation.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>8%</td>
<td>13%</td>
<td>25%</td>
<td>42%</td>
<td>13%</td>
</tr>
<tr>
<td>G</td>
<td>12%</td>
<td>20%</td>
<td>48%</td>
<td>12%</td>
<td>8%</td>
</tr>
</tbody>
</table>

14. I know what portion of my electricity comes from nuclear energy.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>4%</td>
<td>33%</td>
<td>42%</td>
<td>21%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>20%</td>
<td>12%</td>
<td>44%</td>
<td>16%</td>
<td>8%</td>
</tr>
</tbody>
</table>

15. I know how the cost of nuclear energy production compares to other energy sources in Ontario.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>4%</td>
<td>29%</td>
<td>42%</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>24%</td>
<td>32%</td>
<td>32%</td>
<td>12%</td>
<td>0%</td>
</tr>
</tbody>
</table>

16. I have a basic understanding of how and where nuclear waste is managed.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>8%</td>
<td>25%</td>
<td>25%</td>
<td>29%</td>
<td>8%</td>
</tr>
<tr>
<td>G</td>
<td>20%</td>
<td>32%</td>
<td>24%</td>
<td>24%</td>
<td>0%</td>
</tr>
</tbody>
</table>

17. I know what the emergency procedure is in the event of an accident.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>4%</td>
<td>8%</td>
<td>21%</td>
<td>28%</td>
<td>8%</td>
</tr>
<tr>
<td>G</td>
<td>50%</td>
<td>21%</td>
<td>29%</td>
<td>8%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### SURVEY QUESTIONS 18-20 (EXPERIENCE WITH TECHNOLOGY)

18. Most of what I know about nuclear energy has come directly from the industry (rather than TV, social media, word of mouth, or other sources).

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>4%</td>
<td>46%</td>
<td>21%</td>
<td>29%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>25%</td>
<td>54%</td>
<td>4%</td>
<td>17%</td>
<td>0%</td>
</tr>
</tbody>
</table>

19. Nuclear information centers, info sessions, and/or industry websites have helped increase my knowledge about nuclear energy.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>4%</td>
<td>25%</td>
<td>25%</td>
<td>42%</td>
<td>4%</td>
</tr>
<tr>
<td>G</td>
<td>17%</td>
<td>48%</td>
<td>9%</td>
<td>26%</td>
<td>0%</td>
</tr>
</tbody>
</table>

20. I feel that the nuclear industry has made a substantial effort to reach out to me and my community to help us feel more informed/familiar with technology safety and industry decisions.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>13%</td>
<td>21%</td>
<td>29%</td>
<td>33%</td>
<td>4%</td>
</tr>
<tr>
<td>G</td>
<td>43%</td>
<td>26%</td>
<td>22%</td>
<td>9%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Appendix D

(Ontario Power Generation, 2016)
Appendix E

1. 'High-Level' Nuclear Waste Production

Over time, fissionable U-235 isotopes become "spent," meaning they can't be used to produce electricity anymore in typical nuclear reactors. But the spent fuel is radioactive, deadly and extremely hot. The Department of Energy calls this "high-level nuclear waste."

2. Pooling

The spent fuel is removed from the reactor and stored in pools of water to cool down. It'll stay here for five-to-ten years.

3. Dry Cask Storage

After the spent fuel has cooled, it's transferred to a solid steel cask, encapsulated in feet-thick concrete. It will sit like this, above ground, on site at nuclear reactors, usually monitored by armed guards, until it's moved elsewhere.

4. Transportation

When there's a place for the dry casks to go, they're placed into portable transportation canisters and taken via rail or truck to waste storage facilities. All the storage facilities in the US are considered temporary.

5. Deep, Permanent Storage

High-level nuclear waste is buried deep underground permanently. There is only one permanent nuclear waste storage facility in the world — WIPP outside Carlsbad, New Mexico. Zero high-level nuclear waste facilities exist in the world. Yucca would have been the first.

(Mensing, 2012)