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# Public perceptions of tidal energy between Australia and Canada

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Bachelor's thesis

Sustainable Coastal Management

Raseborg 2020

# BACHELOR'S THESIS

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Specialization: Environmental Science
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Title: Public perceptions of tidal energy between Australia and Canada

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Date: November 2020 Number of pages: 46 Appendices: 4

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## Abstract

The tidal energy industry is developing rapidly worldwide. However, it is solar and wind power that saturate the media and make up the majority of sustainable energy installations. Why is there seemingly so little activity regarding tidal energy? This research investigates challenges for tidal energy, especially targeting public perception in two countries in different hemispheres: Australia and Canada. To investigate this, a survey was distributed to people living in both countries. Scientific and academic literature was also reviewed to give insight into how the future might look regarding marine renewable energy (MRE) and offshore renewable energy such as tidal energy.

Looking at previous research done in the fields of sustainability and social science and conducting a survey on public opinion, this thesis identifies some of the obstacles and challenges that the tidal energy industry faces: construction costs, technical challenges, lack of research and knowledge and social and cultural factors. With the two surveys, this study concluded that both residents in Australia (based on 64 respondents) and Canada (40 respondents) are not confident in distinguishing the difference between tidal energy and wave energy, pointing towards a gap in knowledge about tidal energy. The thesis identified communication and possibly media coverage as a solution to obstacles for the advancement of tidal energy arising from public opposition. Respondents from Australia showed a greater interest in more media coverage of tidal energy than the respondents from Canada. Both groups of respondents were concerned with their energy being green and both groups perceived tidal energy as green. The biggest concerns were the same for the two groups: disruption and injury to wildlife and impact on nearby land.

The thesis also presents an evaluation of the potential for the tidal energy industry to overcome these issues and what possible solutions look like. As a multidisciplinary study, concerned with the technological, economical and human dimensions of tidal energy and its industry, it offers a multifaceted overview of various issues at hand and attempts to compile knowledge from various fields into a comprehensive look at the sustainability and viability of tidal energy.

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Language: English Key words: tidal energy, sustainability, public perception

Abbreviations: kwh (kilowatt hour), MW (megawatt), GW (gigawatt)

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# 1 Introduction

## 1.1 Overview (Background)

Generating energy from tides is not something new and the tidal energy industry worldwide is developing rapidly; as of 2019, tidal turbine engineers are putting megawatt (MW) scale devices to the test in real conditions whilst new offshore alternatives for testing are worked on and sufficient laboratories are soon to become reality (Khare et al., 2019, p. 117).

The first ever tidal power station was developed in 1966 in France and named the Rance Tidal Power Station. The plant which cost $100 million USD to build at the time has already paid for itself through cost savings and is still in operation providing 600MKwh yearly. (Tethys)

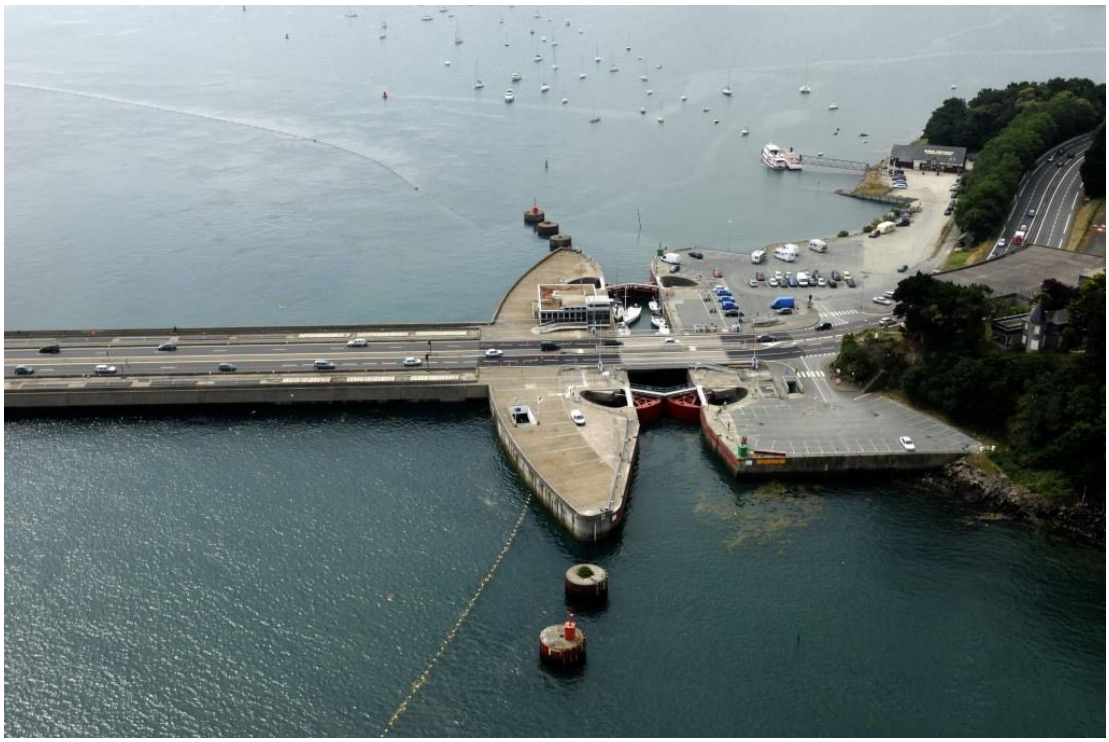

**Figure 1 - Rance Tidal Power Station (Source: EDF France)**

The first tidal stream generator prototype, a 15-kilowatt system, was demonstrated in 1994. A second prototype the world's first large-scale sustainable tidal energy generator "SeaGen" went

online in 2008. SeaGen was scrapped in the summer of 2019 after providing almost 12GWh to the Northern Ireland power grid. (National Geographic)

Tidal energy and other marine energy sources continue to see development and expansion but there are still a variety of challenges to these offshore renewable energy sources. By conducting a survey, discussing the results and looking at previous research in sustainability, this thesis identifies the biggest challenges and focuses on investigating possible obstacles posed by public perception.

## 1.2 Relevance of the study

With global population increase so too rises the need for new sustainable sources of energy. There is seemingly little evidence of the overall drawbacks of tidal energy and therefore little to discredit its importance and viability as a source of energy so long as the necessary prerequisites (mainly location and availability of tides) are properly understood. Husseini (2018) and Borthwick (2016) are examples of authors who have started the discussion of the overall picture of tidal energy including both the promising aspects of it but also the drawbacks that call for more attention.

With a growing need for more sources of sustainable energy comes an equal need for further research on the topic regarding its sustainability. This paper aims to help realise the importance of tidal energy and the public barriers that exist which prevent tidal energy from becoming more invested upon area of green energy.

Another question posed is how people in different hemispheres of the world perceive tidal energy and how does education and the media influence their perception? Using an online survey, residents living in both Australia and Canada were asked a series of 12 questions in order to gauge their understanding of tidal energy in the hopes to highlight possible pain points and obstacles that may exist which hinder the growth of the tidal energy sector in these countries.

Australia and Canada are two countries in a good position to take advantage of tidal energy. Canada is one of the few countries in the world that has made developments and investments

in the tidal energy sector and already has a tidal station in operation (Ingenium). Australia is also a good location for tidal energy with some of the strongest tides in the world. Australia has also taken advantage of this and has one of the world's largest tidal turbines in use and more tidal energy projects are being planned (Australian Renewable Energy Agency 2020).

However, the Australian government has yet to commit to policy that can efficiently mitigate climate change. Australia is also being accused of using the Covid-19 pandemic as an opportunity and excuse for expanding the gas industry, since the levels of greenhouse gas emissions have been low due to the pandemic (Climate Action Tracker 2020a). The Canadian government also has yet to commit to an effective strategy. Climate Action Tracker states:

> "The Canadian government is at a crossroads: it could either continue with the slow implementation of an inadequate climate plan, or adopt a recovery package that accelerates the transition to a zero emissions future."

(Climate Action Tracker 2020b).

Finally, this study also wants to uncover any possible misinformation among the public, which could also pose a barrier for tidal energy. To help meet this goal, specific questions were chosen in the survey which gave respondents the ability to choose concerns that do not relate to tidal energy. If a significant amount of people chose these answers it may indicate areas of confusion regarding the obstacles and impacts of tidal energy and suggest areas for education and related tidal energy management sectors to improve upon regarding social and public understanding.

**Figure 2 - Annapolis Royal Generating Station, Canada (Source: PowerTechnology)**

## 1.3 Tidal energy versus wave energy

It can be difficult to distinguish between wave and tidal energy. In shorthand, tidal energy is generated by the gravitational pull of the moon and sun and converted into power via underwater turbines that are installed in a fixed location where tides are in enough abundance and strength to generate power. Where tides are not in abundance, dams and barrages can also be used to increase efficiency and output (Khare, 2019). Turbines located out in open water rotate on average of 12-18 times per minute depending on tide strength. (Arenawire, 2017)

Wave energy on the other hand has a few methods of production but the most common is produced by the up and down motion of waves which drive hydraulic pumps that generate energy (Khare, 2019). In more detail, the wind produces waves which in turn produce wave energy, such that available wind in the area is the most important factor for efficient production of wave energy.

# 2 Scope and Research Questions

This thesis will investigate the following research questions:

- What are the challenges for the future of tidal energy?
- What is the public perception of tidal energy in Australia and Canada?

With new projects, research, discussions, innovation and advancements towards solar and wind power saturating the media and making up most sustainable energy design projects what is the public's perception of tidal energy and for example its viability and social impact? Are there any misconceptions about tidal energy? Are there enough incentives for investors?

The scope of this thesis is to discuss the obstacles and challenges for tidal energy to become a more trusted and invested source of green energy and puts the public's perception of tidal energy in Australia and Canada into focus. Some comparison between wave energy and tidal energy will also be made in order to highlight any possible confusion between the two. Other challenges than the ones arising from public perception will also be taken into account but in a more limited fashion.

The initial hypothesis was that respondents would have a positive but cautious approach to tidal energy as a viable source of green energy. Some confusion between tidal and wave energy was also expected.

# 3 Methodology

## 3.1 Literature Review

The study began with a literature review. This part of the research project focused on gathering a comprehensive picture of tidal energy and the challenges and the potential of tidal energy projects. The next step was to select relevant literature and previous research using the following criteria:

- Does the study have a multidisciplinary focus?

- Are public perceptions of tidal energy considered in the study?
- Did the study compare tidal energy to other sustainable sources of energy?
- Was there any explanation of the economic viability of tidal energy?
- Is there a clear conclusion or are the findings inconclusive?
- What is the geographical scope of the study?
- Was the study conducted and published in the last 10 years?

Google and Alma were used for finding literature. Search terms included: *"public perception tidal energy"*, *"tidal energy viability study"*, *"sustainability study tidal energy"*, *"tidal energy vs wave energy"*, *"multidisciplinary tidal energy" and "tidal energy economy"*.

The sources picked for this thesis were selected because of their relevance to the topic and their ability to help with discussing the results from the survey. These articles stood out by their in-depth understanding of both the potential of tidal energy and the issues that arise whilst finding solutions to various challenges.

## 3.2 Stakeholder contact

The French Électricité de France S.A. (EDF) was contacted for more detailed information on their current tidal power station in Brittany, France. They did not reply to this contact and request for additional information. Due to this and the general lack of relevant sources in English on the topic of public perception of tidal energy in France, this led to the research focusing its effort on other countries.

## 3.3 Survey Research

Since the goal of this research is to highlight public perception the chosen research method was a survey. The survey was distributed via online channels that were aimed towards people living in Australia and Canada since the scope was public understanding in these two countries. These were Australian focused subreddits, including city and state subreddits. Australian and Canadian focused Discord channels and Australian and Canadian focused Facebook groups. All survey

submissions were collected anonymously, and participants were informed their answers will be used in academic research.

The survey was structured in accordance with the academic survey principles outlined by Cowles and Nelson (2015). According to Cowles and Nelson, good survey questions are characterized by:

1. Specificity. This refers to the fact that successful questions are precise.
2. Clarity. The words, phrasing and concepts of the questions should be easy to understand for the respondents and do not leave room for vague interpretation.
3. Brevity. Good survey questions are short and straightforward. Superfluous words and convoluted phrasing are left out.
   (Cowles and Nelson 2015, 108)

Additional guidelines of how to order the questions are also given by Cowles and Nelson and attention was also given to these areas while constructing the survey. These additional guidelines are as follows:

1. Questions should be ordered by difficulty, starting with the easiest question. This is to not discourage the participant.
2. Questions should be ordered by how general they are, starting with the most general questions and ending with the most specific questions.
3. If there are questions that could be considered sensitive, these should preferably be placed at the end of the survey.
4. Interesting questions should be placed in the beginning of the survey and questions concerning demographics should be placed at the end. The reason is so the survey is able to engage the respondent from the beginning.

(Cowles & Nelson 2015, 121)

These principles constitute solid guidelines to ensure validity and reliability of responses whilst creating questions that were not only relevant but unlikely for respondents to misinterpret or make the respondent quit the survey before completing it. Furthermore, following these

guidelines ensured that the survey adheres to good academic practice and informs the respondents that the answers were confidential and that the participants could opt out at any point if they did not want to complete the survey.

Two surveys were constructed: one for residents of Australia and one for residents of Canada. The only difference between the two surveys was the first question to confirm the respondent was permanently residing in the relevant country. If the respondent answered that they were not permanently living in the country in question (for example, they were a tourist) the survey was immediately terminated, and their submission was not recorded in the results.

The questions included in both surveys were:

1. Is Australia your currently registered permanent country of residence? (for the survey targeting residents in Australia) *or* Is Canada your currently registered permanent country of residence? (for the survey targeting residents in Canada)

2. How "green" do you feel tidal energy is on a scale of 1 to 10? Where 1 is not at all and 10 is completely green. "Green energy" is defined as: "Energy resources which are renewable, meaning they're naturally replenished and readily available."

3. On a scale of 1-10 how important is it to you that your energy is "green"?

4. How expensive do you think tidal energy is to produce compared to solar and wind energy?

5. How maintainable do you feel tidal energy is as a source of energy? Where 1 is impossible to maintain and 10 is very easy to maintain.

6. How confident are you in knowing the difference between tidal energy and wave energy?

7. What are your THREE (3) major concerns regarding the implementation and use of tidal energy?

8. What do you think are the THREE (3) biggest challenges in implementing tidal energy?

9. Would you be interested in more coverage and discussion of tidal energy in the media such as television and web articles etc?

10. What is your sex?

11. What province of Canada do you live in? (for the survey targeting residents in Canada) *or* What state in Australia do you live in? (for the survey targeting residents in Australia)

12. What is the highest level of studies you have completed?

# 4 Results

## 4.1 Literature review

The initial literature review pointed to four dimensions of tidal energy that have impacted past and current tidal energy projects and most likely will impact future ones as well. The following are main challenges outlined by Husseini (2018) and by Khare et al. (2019):

- The impact of tidal energy on marine life and environment
- The cost of tidal energy, mainly its initial construction costs
- Technical challenges, for example efficient transportation of the energy
- Lack of research and knowledge in the field

A full picture of the various impacts tidal energy has on the marine environment has yet to be outlined. As of 2020, there is still research to be made to map the impact of tidal energy on marine life, the toxicity of paints and other substances used in the construction of tidal energy plants, alteration of currents and waves and the emission of electro-magnetic fields (EMF:s). (Husseini 2018)

The literature review showed that like all energy projects, tidal energy has a significant initial cost of development. In fact, it has one of the biggest up-front costs when it comes to energy. The cost of the proposed Swansea Bay Tidal Lagoon project in Wales, UK, is estimated at €1.5 billion. Whilst another, the Sihwa Power Station, completed with a cost of around €474 million. It is currently the world's largest plant and despite its heavy initial price tag, now produces energy at a rate of only 0.02 cents per kwh. Therefore, it is important to also take into account the economy and cost of electricity in the country where the tidal plant will be constructed.


**Figure 3 - MeyGen Tidal Energy Project, Scotland, the world's biggest tidal turbine power project in development. (Source: PowerTechnology)**

Green energy projects in Canada were cost estimated in 2019 with wind power ranging from 10 cents per kilowatt hour on land to 30 cents per kilowatt hour offshore, compared to tidal energy at around 66 cents per kilowatt hour. (Unwin 2019)

The literature reviewed here did not offer any conclusive method or theory of how to calculate long-term costs and return of investment. Segura et al. 2017 states that despite the fact that one can make estimations of the cost of a project in cent per kilowatt hour, it is still unclear what methodology should be used in calculating the exact long-term costs. It is therefore difficult to evaluate the cost efficiency of tidal energy.

Yet, tidal energy can be considered to be preferable over other sources of renewable energy in many aspects: availability, security of supply and possibly environmental impact. In short, it shows great potential as a fully sustainable form of energy. Johnstone et al. (2013) offers a deep analysis of the economic potential of current technologies of tidal energy. Based on their investigation into previous research, Johnstone et al. (2013) single out four mechanisms that reduces the costs of tidal energy and furthers its sustainability:

1. Concept design developments
2. Meticulous design optimisation
3. Economies of scale
4. Learning in production, construction, installation and operations and maintenance.

(Johnstone et al., 2013, p. 103)

Johnstone et al. (2013) identifies the next generation (or second generation) tidal turbines as promising. These new technologies can produce energy for a significantly reduced cost; this is made possible by the use of drive generators (which means no longer a need for a gearbox), the possibility of passively yawing with the current (resulting in no need for active monitoring and control of yaw or pitch) and the adaptation of flexible mooring for station keeping (and thus no need for a mono-pile) (Johnstone et al., 2013, p. 205). This brings light to multiple new opportunities for cost reduction that have been brought about by new technologies and efforts made in engineering.

Despite the favourable aspects of tidal energy (e.g. that it is renewable and the significant technological developments that have been made), the actual demand for tidal energy, and renewable energy sources in general, must also be taken into consideration. More recent literature brings up the Covid-19 pandemic as a potential cause of great change in global demand for energy (Abiad and Rosa Mia Dagli 2020). The International Energy Agency (IEA), predicts that the demand for oil and coal will fall radically, as much as –8% for oil and -7% for coal. Natural gas and nuclear energy are also likely to see a decrease in demand. However, according to these predictions, renewable energy will see a slight rise in demand, but only by +1% (IEA 2020). The uncertainties about future global energy demands are still many. The lack of important changes to municipal policies for dealing with and mitigating the environmental impacts of humans may also result in a return to non-renewable forms of energy and increased greenhouse gas emissions (Chowdhury 2020). According to IEA, the Covid-19 pandemic has brought about more disruption to the energy sector than any other factor in recent history. The IEA report stresses that the pandemic will have long-lasting impacts and that the energy sector and energy projects will experience these difficulties for years (IEA 2020).

Where tidal stream energy is concerned, there are also questions about another kind of uncertainty, for example the uniformity of the incoming tidal flow which can fluctuate heavily due to storms and hurricanes. Turbulence, eddies, wave-current interaction and harming environmental impact (such as the threat to biodiversity) are other issues mentioned

(Borthwick, 2016, p. 72). When it comes to tidal range power, the greatest challenges are the expenses. Although tidal range power presents a lucrative source for electricity, the construction is both lengthy and expensive in terms of capital and thus comes with a great investment disincentive. However, it is noted that recent breakthroughs can reduce both cost and environmental impact. (Borthwick, 2016, p. 73)

Another concern that researchers have also identified is the fact that the output of marine renewable energy sources depends on weather systems. Tides and waves are stochastic and subject to seasonal variability. Tides are also cyclic in nature and subject to fluctuation caused by the relative positions of the Sun and the Moon in relation to Earth. Thus, the question of energy storage becomes crucial to solve in order to amend the fluctuations in tidal energy output. Some solutions already exist, and some are being improved upon. Large volume storage technologies are being developed upon and some are under construction, for example pumped hydro-storage, hydrogen storage through electrolysis and compressed air energy storage. (Borthwick, 2016, p. 75)

Moreover, there is also the issue of ethical and legal concerns when it comes to marine renewable energy. These questions relate to ownership and whether MRE can be owned, a question which has philosophical, legal, cultural, and even religious dimensions. A further question is: if marine energy can be owned, *who* should own this resource? Is it legally acceptable and ethically justifiable for one party to capitalize on a resource that would otherwise be available to another party? These questions must be answered on a legal level, taking into consideration insights from ethics and moral philosophy. Borthwick illustrates how disputes may arise with an example from history: the 40 yearlong dispute between India and Bangladesh which started in 1974, revolving around the maritime boundary in the Bay of Bengal. India applied an equidistance principle, whereas Bangladesh applied an equity principle, leading to different, overlapping, and argued maritime boundaries. In 2014, the dispute was finally resolved by a United Nations Arbitration Tribunal. (Borthwick, 2016, p. 75)

As the literature on tidal energy shows, the possibility of disputes putting a stop to a tidal energy project are indeed a problem which often, if not always, requires legal actions and governmental

efforts. As the example showed, it can set back projects, installations and the possibility to harvest tidal energy for many years. It can also involve communities and countries having a negative effect on the public's perception of tidal energy or other forms of marine renewable energy (MRE).

## 4.2 Surveys

The results from the survey are based on the 64 respondent residents in Australia and the 40 respondent residents in Canada who answered the relevant survey. Both surveys were available for answer and ran for one week, from Monday 9th November 00:00 to Monday 16th November 00:00.

Both surveys had a majority of male respondents, with the survey for measuring the public perception among respondents in Canada answered slightly higher by males than the survey for respondents in Australia (Figure 4).

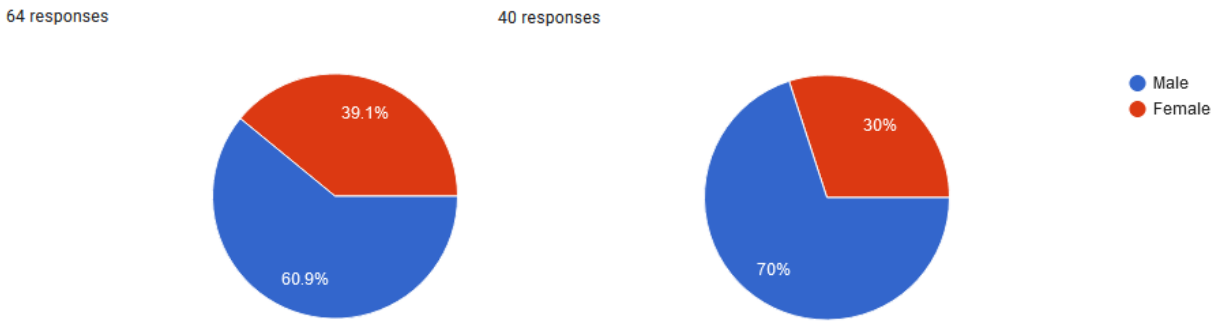


**Figure 4 – Pie chart 1 respondents in Australia, pie chart 2 respondents in Canada. Answers to: "What is your sex?"**

The complete list of the representation of the states in Australia is found below, with name of the state followed by the number of participants from that province and what that is as a percentage.

| | | |
|---|---|---|
| New South Wales | 27 respondents | 42.2% |
| Queensland | 11 respondents | 17.2% |
| Western Australia | 10 respondents | 15.6% |
| Victoria | 5 respondents | 7.8% |
| South Australia | 5 respondents | 7.8% |
| Australian Capital Territory | 4 respondents | 6.3% |
| Tasmania | 2 respondents | 3.1% |
| Northern Territory | 0 respondents | 0% |

**Table 1 – Number of survey respondents from each state in Australia**

The complete list of the representation of the provinces in Canada is found below, with the name of the province followed by the number of participants from that province and what that is as a percentage.

| | | |
|---|---|---|
| Ontario | 17 respondents | 42.5% |
| British Columbia | 5 respondents | 12.5% |
| Nova Scotia | 5 respondents | 12.5% |
| Alberta | 4 respondents | 10% |
| Quebec | 4 respondents | 10% |
| Saskatchewan | 3 participants | 7.5% |
| Newfoundland and Labrador | 2 respondents | 5% |
| Manitoba | 0 respondents | 0% |
| New Brunswick | 0 respondents | 0% |
| Prince Edward Island | 0 respondents | 0% |

**Table 2 – Number of survey respondents from each province in Canada**

Slightly more than half the respondents in Canada had completed high school whilst half of the respondents in Australia had completed a bachelor's degree. Furthermore, none of the respondents in Canada had finished a master's degree but 10.9% of the respondents in Australia had finished a master's degree (Figure 5).

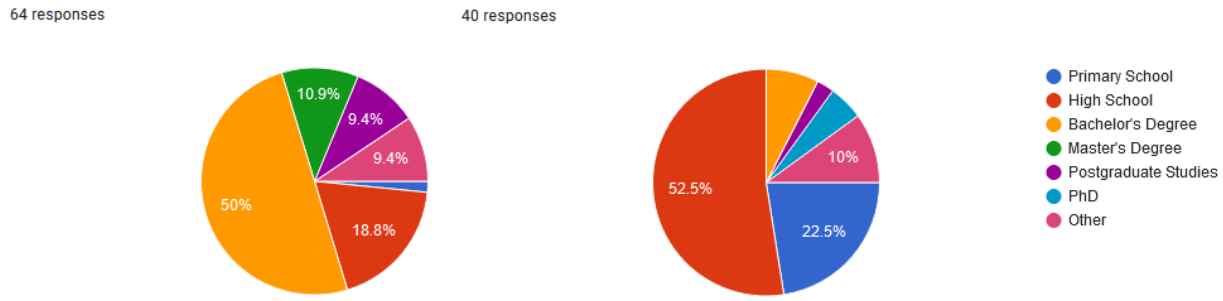


**Figure 5 – Pie chart 1 respondents in Australia, pie chart 2 respondents in Canada. Answers to: "What is the highest level of studies you have completed?"**

Respondents from both countries felt the cost of tidal energy was mostly higher or the same as wind and solar energy. When compared to respondents from Australia, a much greater number of respondents from Canada answered that tidal energy is less expensive than wind and solar energy. (Figure 6).

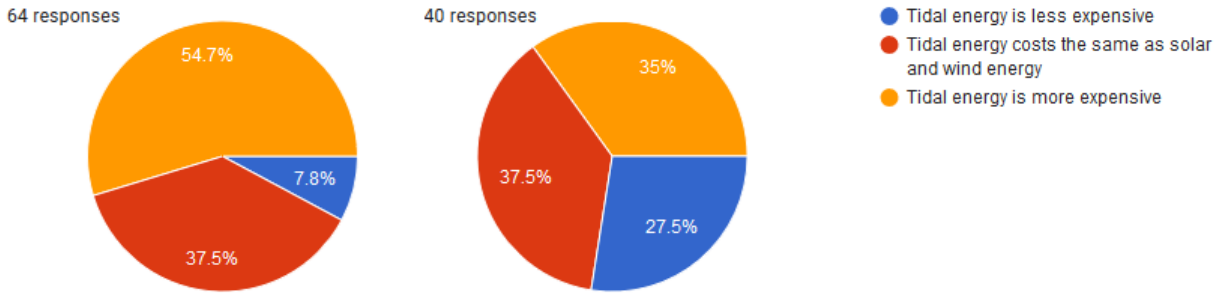


**Figure 6 – Pie chart 1 respondents in Australia, pie chart 2 respondents in Canada. Answers to: "How expensive do you think tidal energy is to produce compared to solar and wind energy?"**

Regarding the results of the survey, the challenges that most respondents in Australia and Canada had highlighted as their answers in the survey, are in line with those by Husseini (2018). Plant location, energy storage and public perception to tidal energy accounted for the majority of respondent's answers (Figure 7). This will be further discussed in the next chapter and a full list of the answers to this question from both surveys are available in the appendix.

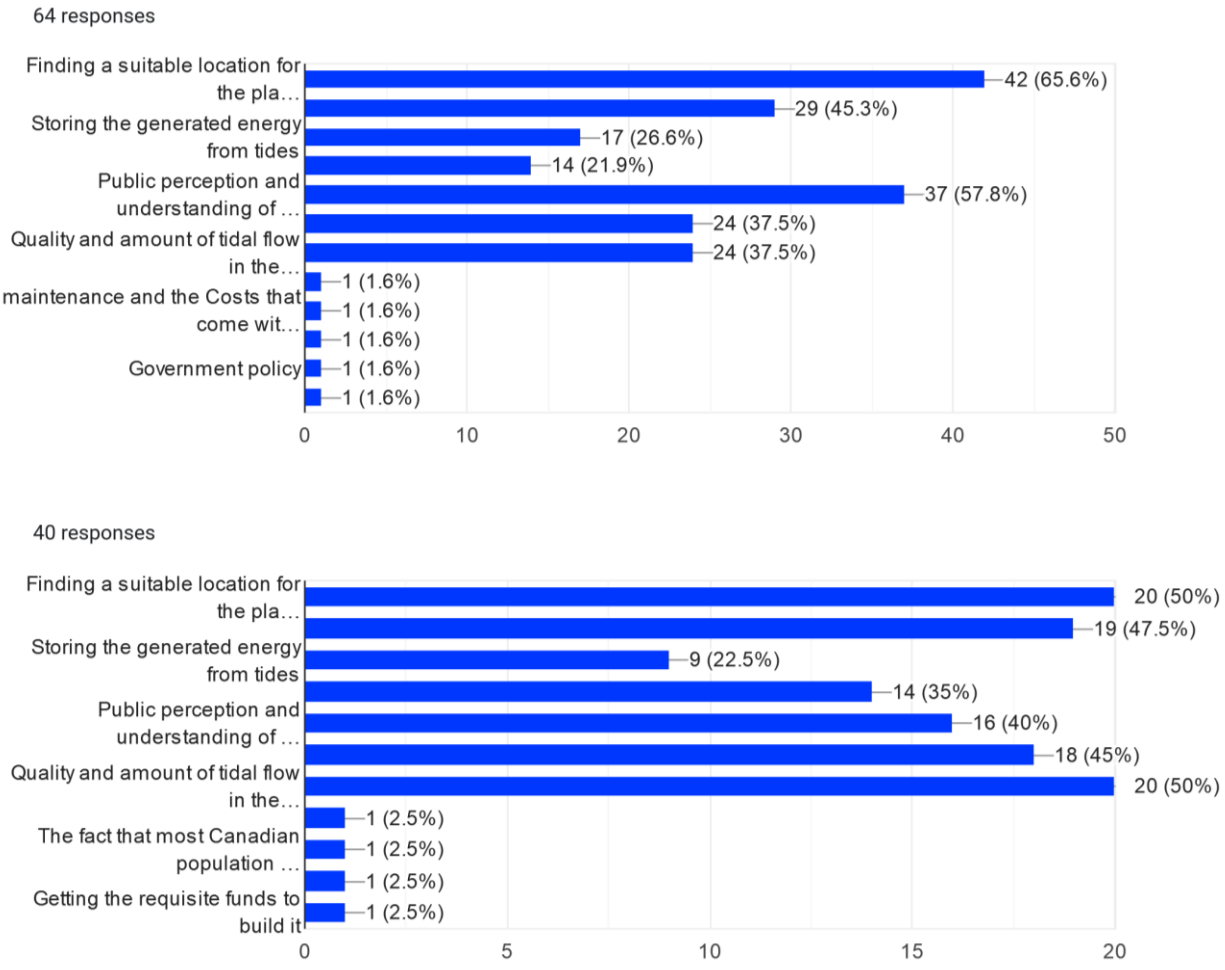


**Figure 7 - Graph 1 respondents in Australia, graph 2 respondents in Canada. Answers to: "What do you think are the THREE (3) biggest challenges in implementing tidal energy?"**

Similarly, disruption to wildlife, impact on land areas and their nearby environment and injury and/or death of wildlife were major concerns for respondents from both countries (Figure 8). This will also be further discussed in the next chapter and a full list of the answers to this question from both surveys are available in the appendix.

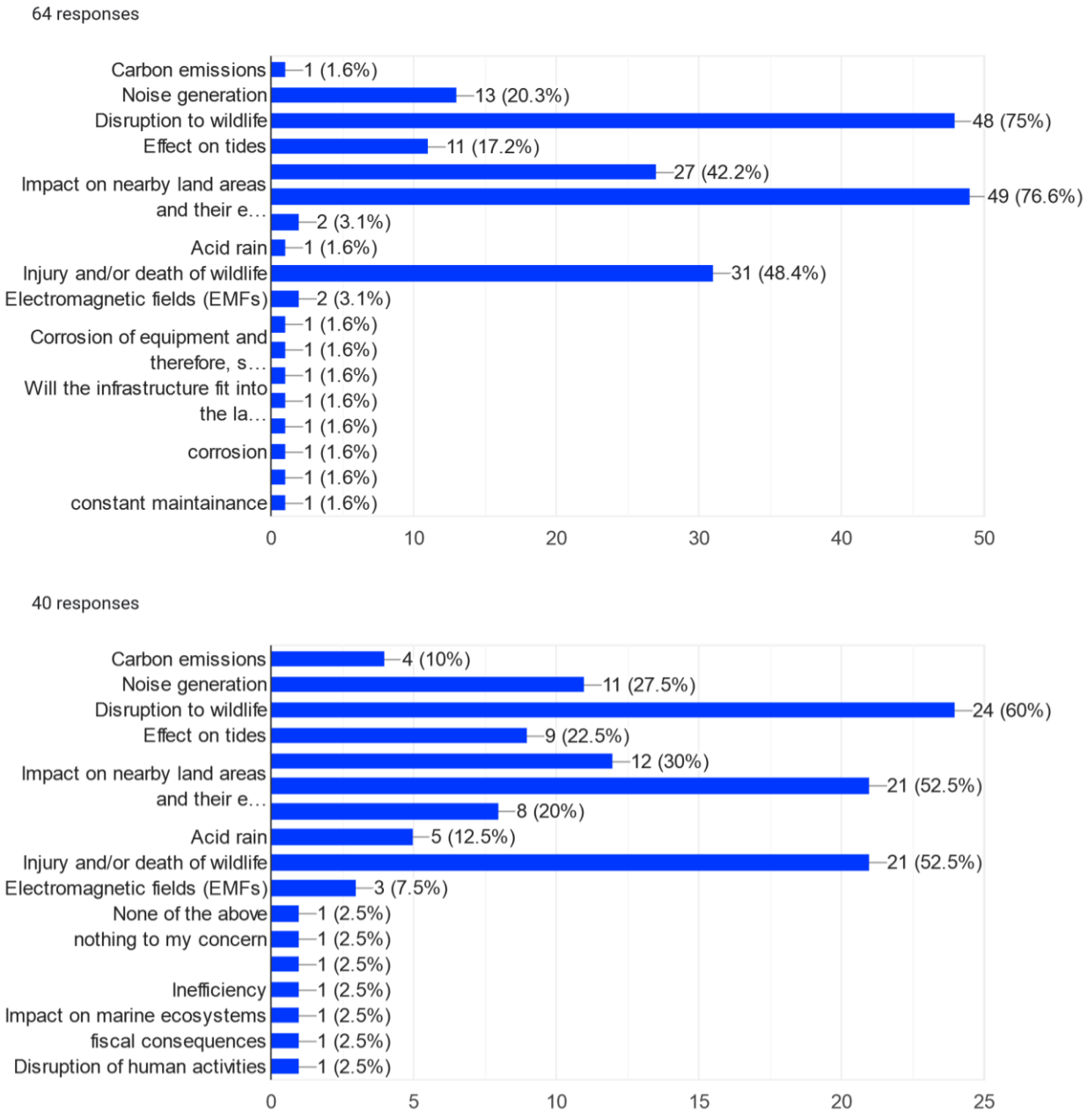


**Figure 8 - Graph 1 respondents from Australia, graph 2 respondents from Canada. Answers to: "What are your THREE (3) major concerns regarding the implementation and use of tidal energy?"**

Responses from Australia and Canada looked somewhat similar when respondents were asked about their confidence to tell tidal energy and wave energy apart (Figure 9). In both groups, most respondents picked 1, which stood for the least confidence. The average number among respondents from Australia was 4.6. The average among respondents from Canada was 4.2.

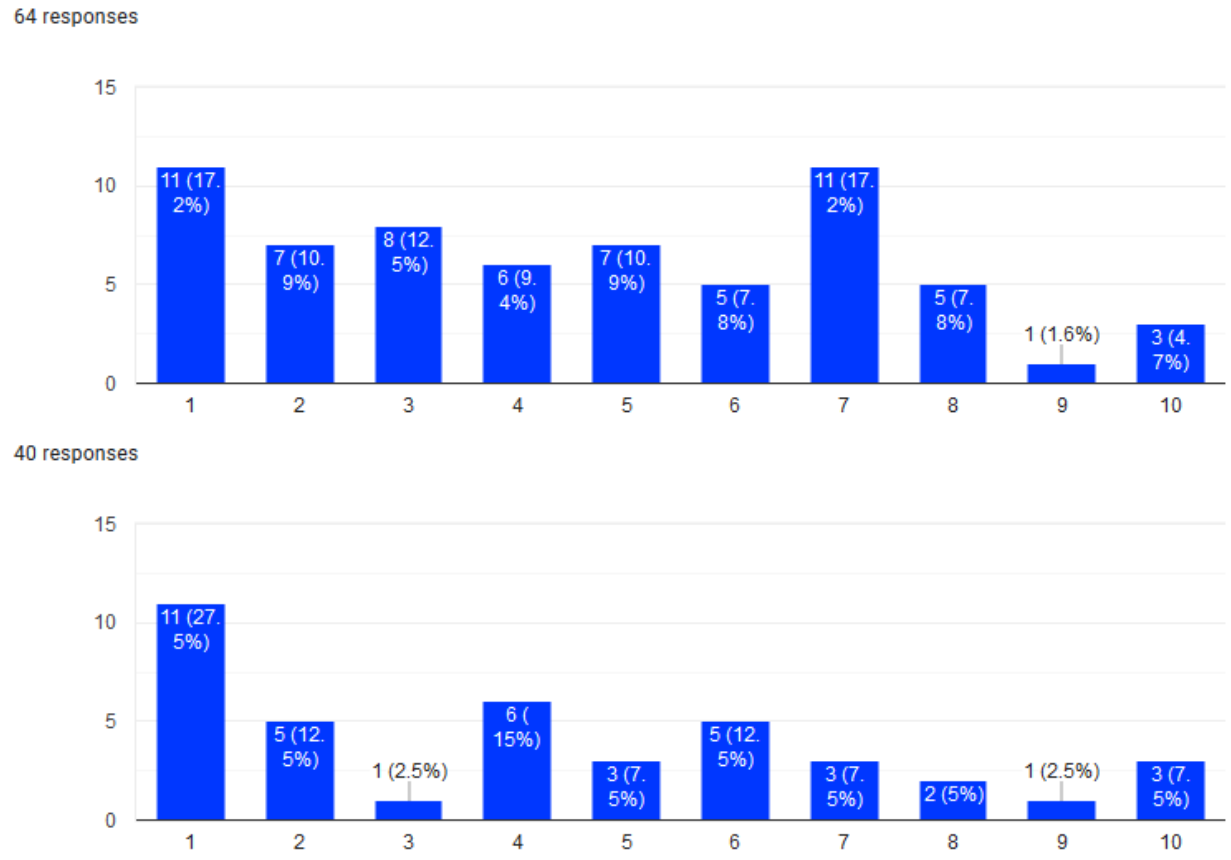


**Figure 9 - Graph 1 respondents from Australia, graph 2 respondents from Canada. Answers to: "On a scale of 1 to 10 - How confident are you in knowing the difference between tidal energy and wave energy?"**

When asked about the greenness of tidal energy, most participants from Canada gave it a score between 8-9 with the mode being 8 (where 1 meant they did not consider tidal energy green at all and 10 being they considered it completely green). The participants living in Australia were in general more confident in the "greenness" of tidal energy. The mode for the score that the participants from Australia gave the "greenness" of tidal energy was 9. None of the respondents from Australia gave it a score under 6 while amongst the survey participants from Canada, seven respondents gave it a score below 6. The average score was 8.5 among the respondents from Australia while the average among the respondents from Canada was 7.5.

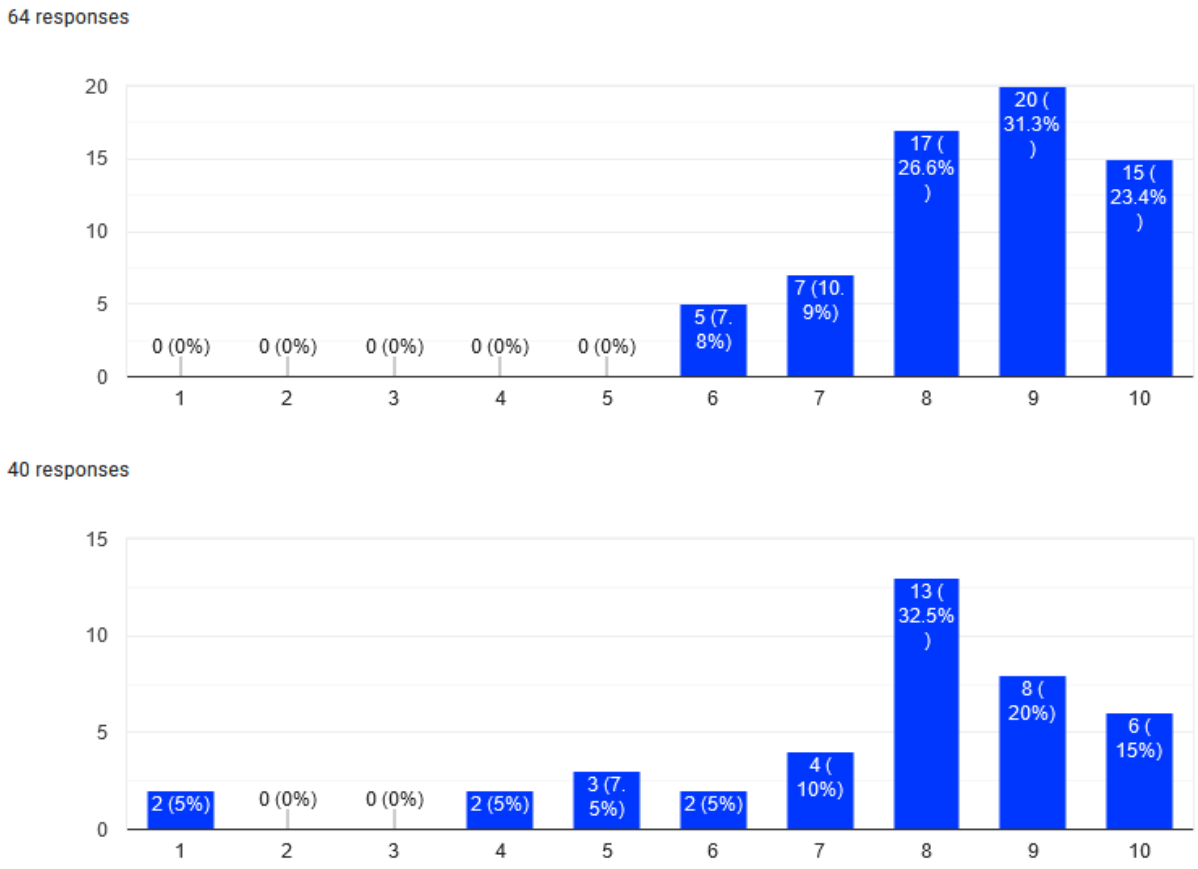


**Figure 10 - Graph 1 respondents in Australia, graph 2 respondents in Canada. Answers to: How "green" do you feel tidal energy is on a scale of 1 to 10? Where 1 is not at all and 10 is completely green."**

The respondents from Australia answered quite in unison that it is very important to them that their energy is green. 28 answered with a 10, i.e. the highest value indicating that it is of the highest possible importance to them. The answers from respondents from Canada varied more. The average score among the respondents from Australia was 8.5; the average among the respondents from Canada was 7.

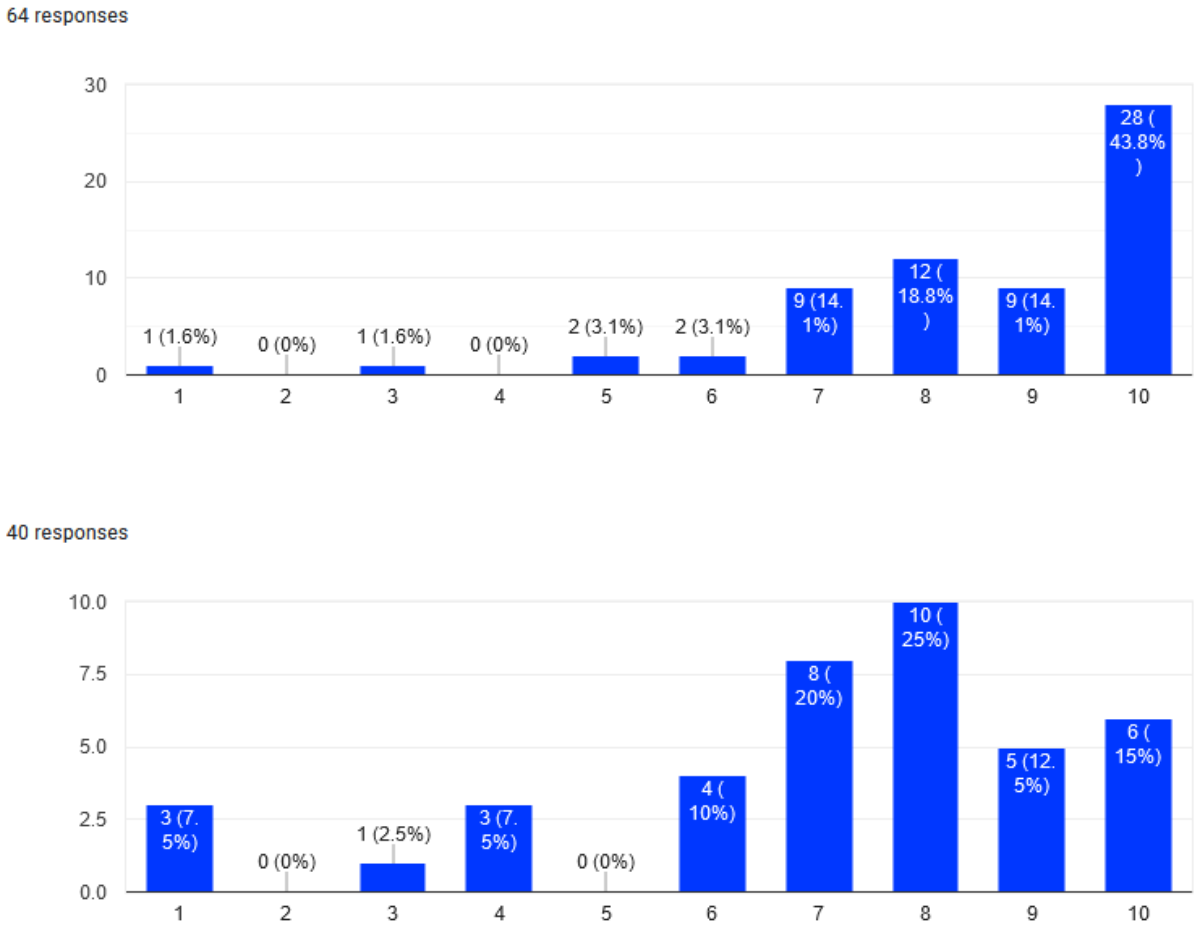


**Figure 11 - Graph 1 respondents in Australia, graph 2 respondents in Canada. Answers to: "On a scale of 1-10 how important is it to you that your energy is "green"?"**

When survey participants were asked if they would be interested in more media coverage of tidal energy, an overwhelming number of respondents from Australia answered 'yes' (Figure 12 Pie chart 1). From the participants in Canada, a third answered 'no' (Figure 12 Pie chart 2).

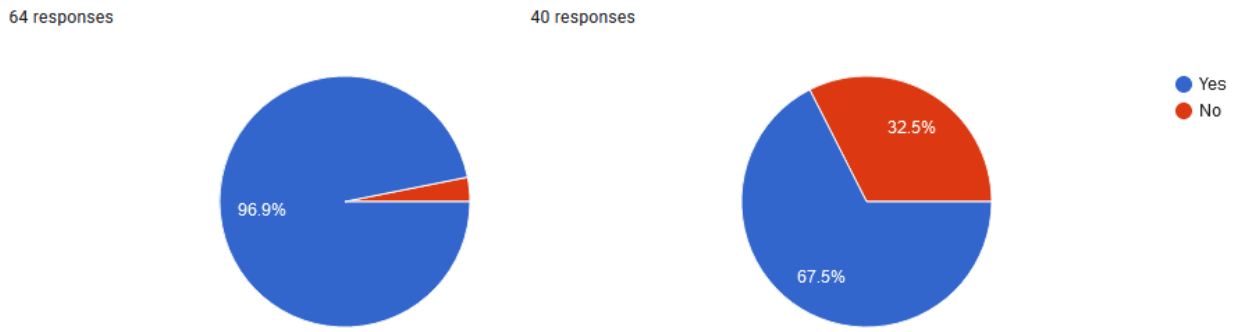


**Figure 12 – Pie chart 1 respondents in Australia, Pie chart 2 respondents in Canada. Answers to: " Would you be interested in more coverage and discussion of tidal energy in the media such as television and web articles etc?"**

The scores that the survey participants from Australia gave as an answer to the question "How maintainable do you feel tidal energy is as a source of energy?" were more evenly distributed. The mode among participants from Australia is 6. Among the participants from Canada, roughly a third answered with 7, which is the mode for this group. The rest of the results were evenly spread among the other scores. This survey thus points toward a perception of tidal energy as being easy to maintain (but not very easy) among the public in both Australia and Canada.

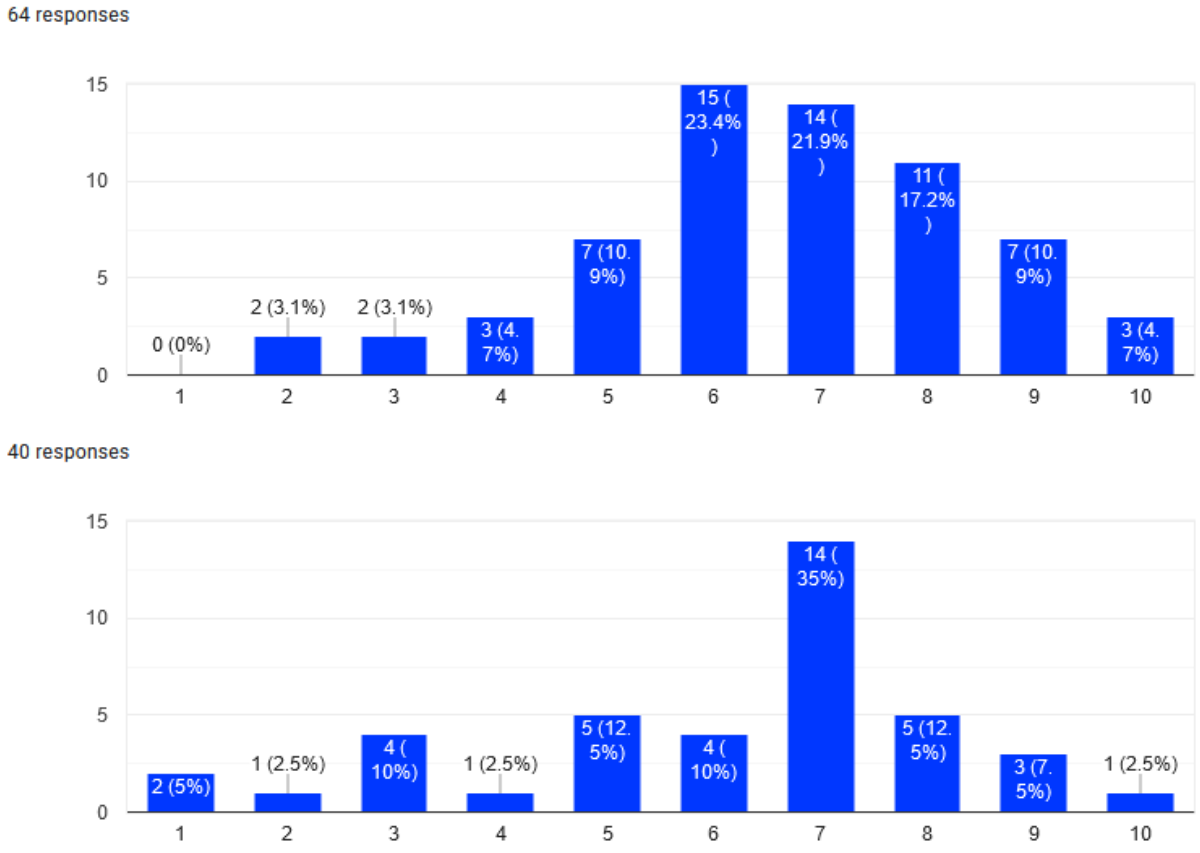


**Figure 13 - Graph 1 respondents in Australia, graph 2 respondents in Canada. Answers to: " How maintainable do you feel tidal energy is as a source of energy? Where 1 is impossible to maintain and 10 is very easy to maintain"**

# 5 Discussion

During the research process the following challenges were presented and dealt with.

Challenge 1: Settling on methodology and scope

The initial scope of the project included all tidal energy worldwide, this was quickly proven to be unmanageable and too complicated to research in a suitable timeframe. Moreover, the topic of tidal energy may not be that relevant to all countries in the world, as some places, due to location, could not even consider it as an energy resource. South Korea was chosen as the first country to compare with Canada, however it proved incredibly difficult to get survey responses from people living in South Korea, possibly due to language and cultural barriers. Ultimately the study focused on the public perception and challenges of tidal energy in two countries in different hemispheres, Australia and Canada.

Challenge 2: Challenges with survey-based research

The research encountered some obstacles concerning the distribution of the survey. The survey had to reach enough relevant participants to assure the validity and reliability of the research. The desired outcome was also to reach an equal, or close to equal, number of respondents from Australia and Canada.

Reddit, Discord and Facebook were chosen as the platforms of distribution since these were judged to be able to reach many possible participants, whilst also allowing the targeting of participants which had the highest likelihood of meeting the survey's permanent resident requirement. The first problem encountered with Reddit was the various restrictions for posts in the chosen subreddits and the moderators of some subreddits being unwilling to allow such a survey, even after being contacted in advance and informed about the nature of the research (and even in cases where it supported the subject matter of the subreddit in question). The limitations of this platform meant a lot of additional time had to be spent on the distribution of the survey and asking for permission to post the survey. Reddit was also the source of some

degree of negative backlash and a small amount of complaints were voiced about such a survey being allowed to be posed at all.

The second obstacle encountered during the research stage had to do with the length of the survey and the nature of the questions. The first survey did not generate enough responses (mainly from South Koreans) and a new survey with revised survey questions and a different target demographic was created.

The reason behind this setback is unknown but some assumptions can be made, one of them being language and cultural differences and the second in that the first survey was too long and time-consuming for the participant to feel motivated to finish whilst possibly not being distributed on enough platforms. Therefore, the second survey was made shorter and some of the open-ended questions, i.e. questions that would have been time consuming and may have accounted for a higher degree of dropouts, were removed.

The edited survey was posted on more subreddits and on additional platforms, Discord and Facebook, and successfully brought in an amount of responses that was judged sufficient for the kind of discussion planned.

Challenge 3: Making conclusions based on survey answers

There is always the possibility for errors and mistakes in survey answers. Additionally, there is also the possibility that survey respondents will give false information. Whilst the utmost care was taken to provide an unbiased and balanced survey with well-phrased, non-leading questions, some degree of survey submissions will have inconsistencies. The purpose of the survey as such is to be used as a guideline to highlight possible areas of improvement and identify key pain points regarding the topic of tidal energy. Survey answers should not be treated as pure fact or undeniable evidence of any of their related subject matter. Similarly, assumptions should not be made, and the survey should instead be compared with other similar surveys to help provide a bigger picture overall.

As the previous chapter showed, the survey did yield results, despite challenges, and based on these results, eight general statements about public perception can be made about the respondents living in Australia:

1. Respondents from Australia think of tidal energy as green (Figure 10).
2. Respondents from Australia were overwhelmingly concerned with their energy being green, much more so than the respondents from Canada (Figure 11).
3. Most respondents from Australia felt that tidal energy is not overly difficult to maintain (Figure 13).
4. More than half of the respondents from Australia had the opinion that tidal energy was more expensive than solar and wind and 40% thought that the cost was the same (Figure 6).
5. Like the respondents from Canada, the respondents from Australia were not confident in knowing the difference between tidal energy and wave energy (Figure 9).
6. The biggest concerns among this group of respondents were disruption and injury to wildlife and the impact on nearby land areas, i.e. respondents from Australia and Canada shared their biggest concerns (Figure 8).
7. The three biggest challenges that the respondents from Australia had were planning and construction of the plant, the location of the plant and public perception (Figure 7).
8. An overwhelming amount of the respondents living in Australia, 96,6%, wished for more media coverage of tidal energy (Figure 12).

The survey results from the survey that targeted people living in Australia are also overrepresented by participants residing in certain states. 42.2% of the participants reported to live in New South Wales. The second and third state with the most survey participants were Queensland and Western Australia. Northern Territory totalled zero, with no participant

reporting this as the state they live in (Table 1). Northern Territory is also the state with the smallest population in Australia (Australian Bureau of Statistics 2020). The states with the biggest population in Australia, New South Wales followed by Victoria and Queensland (Australian Bureau of Statistics), were also among the states that were picked by the biggest number of participants as the state they live in.

The general statements about the respondents living in Canada that can be made based on the survey are as follows:

1. Respondents from Canada think of tidal energy as green (Figure 10).
2. They were slightly less concerned with their energy being green than respondents from Australia (Figure 11).
3. Most respondents from Canada felt tidal energy is moderately easy to maintain (Figure 13).
4. They were split evenly between thinking tidal energy is cheaper, the same or more expensive than solar and wind energy (Figure 6).
5. Most respondents from Canada were not confident at all in knowing the difference between tidal energy and wave energy (Figure 9).
6. The biggest concerns among these respondents were disruption and injury to wildlife and impact on nearby land areas (Figure 8).
7. The things these respondents saw as the biggest challenges were planning and construction of the plant, the location of the plant and quality of the tidal flow (Figure 7).
8. Around half of the participants from Canada did not want more coverage of tidal energy in media (Figure 12).

What one must take into account is the fact that the majority of the participants form Canada had not completed a university degree (Figure 5). One should also be mindful of the fact that

some parts of Canada are more represented than others in the participants. Ontario had the highest number of respondents with 42.5% of the respondents living in Ontario, followed by respondents living in British Columbia which made up 12.5% of the respondents. Furthermore, there was no respondents living in Manitoba, New Brunswick or Prince Edward Island, which means that these provinces are not represented in the results in the results of this survey (Table 2). However, the respondents can still be considered representative of people living in Canada since the provinces where most respondents said they live in are also among the provinces with the biggest populations, according to Statistics Canada (2020) and the provinces not represented at all in the survey results are also among the smallest provinces in Canada. (Statistics Canada 2020).

These two summaries and the survey results outlined in the previous chapter are an indicator for some obstacles for a future for tidal energy in both Australia and Canada. On the other hand, there are also other aspects of the survey results that should be considered as being in favour of the future of tidal energy. This discussion highlights both sides and proposes solutions to obstacles.

Bonar et al. (2015) have identified the key social and socioeconomic dimensions of marine renewable energy (MRE). They observe that much research has been made on technological, economic and institutional obstacles for the future of MRE, but few attempts have been made to outline the social and socioeconomic dimensions of MRE. (Bonar et al. 2015, p. 487)

Although renewable energy is supported by the vast majority of people in Europe, there is still some reluctance to invest in it and every so often public opposition surfaces, especially regarding decisions on the site of installation. This remains a significant obstacle to the expansion of renewable energy in Europe (Bonar et al., 2015, p. 487). The results from the two surveys are an indicator of a reluctance among people living in Australia and Canada too, more so in the population of Canada than in the population of Australia. The participants from Canada did not report a huge concern for their energy being green and among them, tidal energy did not score high on its level of perceived "greenness". Looking at the average score and the mode, it did score on the higher end of the spectrum but a small percentage of the population of Canada still

gave it a considerably low score, which was not the case among the respondents from Australia. This indicates a bigger trust in the greenness of tidal energy among the Australian population.

These survey results speak for a possibility for the same kind of reluctance to invest in tidal energy in Australia but even more so in Canada that previous researchers have identified to be the case in Europe, even if there is a wide support and desire for green energy. People living in Australia or Canada may not be too willing to see big investments go into something that they do not feel is completely green, and may not even want investments or more investments to go into green energy; especially for people living in Canada, green energy does not seem to be a top priority at this point, even if it has some importance and value among those living in Canada.

Bonar et al. (2015, p. 487) identifies the uncertainty of what kind of impact an MRE project may have on the ecosystem as one cause for public opposition. The results from the surveys imply likewise. Disruption on wildlife was the most common concern among respondents from Canada and the second most common among the respondents from Australia (Figure 8). Impact on land areas was the most common concern among the respondents from Australia; this was the second most common among the respondents from Canada.

Two concerns which are not known to occur as a result of the operation of tidal energy plants were acid rain and ocean warming. These concerns were chosen by 5 (acid rain) and 8 (ocean warming) respondents from Canada, compared to only 1 (acid rain) and 2 (ocean warming) respondents from Australia (Figure 8). This could correlate to the previously mentioned difference in education levels measured between the two countries (Figure 5).

The overwhelming majority of respondents from both countries had little confidence in being able to tell tidal energy and wave energy apart (Figure 9), indicating a lack of confidence among both the population of Australia and of Canada. This result also suggests a lack of available information on both tidal and wave energy, at least in the states and provinces that had respondents. Education responses are most likely another reason for the answers of low confidence (Figure 5).

From this, it can be concluded that (1) more research on the impact of tidal energy and (2) communication with the public and affected communities are both needed. Good communication between project and residents in proximity to the site cannot be overlooked if tidal energy is to become the future. However, the public cannot be informed if the experts do not have the knowledge and insights and if they do not share them with the public. Informing the public appears to be the key here since research has in fact gathered *some* sound insights into the impact of tidal energy on the ecosystem (see for example Husseini 2018). However, more scientific research is needed, and clearer ways of communicating the insights that researchers have already gathered to the public are also needed.

A quick Google search shows that while the search term "tidal energy" nets 69 100 000 results, searching for "solar energy" nets 1 160 000 000 results and "wind energy" even more at, 1 190 000 000 results. Would more media coverage of tidal energy then be a possible solution? Is it possible there is a lack of coverage in Australia and Canada?

The survey respondents living in Australia wanted more coverage of tidal energy in the media (Figure 12). The desire for more coverage in the media was not as strong among the respondents from Canada, however. The media has previously heightened the public awareness of solar and wind power, which have dominated related news and documentaries. Could the same be done with tidal energy? The evidence for the media's influence on public opinion, politics and beliefs is abundant (Giles 2003, Scharrer and Comstock 2005, pp. 170-181) and this general insight into the power of media is also in favour for the hypothesis that communication such as media coverage would further the positive attitudes toward tidal energy. However, media saturation is still of concern here since more talk about tidal energy would still have to compete with everything else talked about in the media.

Some of the reasons why tidal energy is considered to be a promising form of renewable energy are the abundance of it and its reliability when it comes to supplying electricity, which sets tidal energy apart from other forms of renewable energy such as wind or solar (Devine-Wright, 2011, p 83). On the other hand, new ocean data-gathering campaigns are still crucial to provide the industry with quality data concerning factors such as seabed roughness, wave surface

elevations, currents, eddies and turbulence (Borthwick, 2016, p. 70). This data is required to develop the technology that can carry tidal energy into the future and guarantee and improve on its sustainability. The funding of this kind of data-gathering campaign could also gain from more coverage in media.

Both surveys showed varying concerns for obstacles for tidal energy. The obstacle that most respondents from Australia picked was the issue with (1) finding a suitable location, followed by (2) public perception and (3) planning and construction of plants. The challenges picked by the respondents from Canada were: (1) finding a suitable location, (2) quality and amount of tidal flow, and (3) planning and construction of plants, closely followed by (4) transportation of energy (Figure 7). One participant from Canada reported that they thought "Getting the requisite funds to build it" and another answered, "none of the above" (Figure 15). Transportation of the energy is in fact a big challenge identified by previous research too. Here, three aspects must be taken into account: transportation to shore, storing it, and transportation of it to the population. (Borthwick, 2016, p. 70)

In general, both the Australian and Canadian population rated tidal energy high on its maintainability but did not give it the highest score (Figure 13). In both groups, participants appeared to be hesitant to give it the highest score but still willing to rate it on the higher end, with most participants from Canada settling on a 7 and most participants from Australia settling on a 6. In other words, maintainability does not appear to be something that is perceived in Australia and Canada as a challenge or obstacle for tidal energy. If the public is of the opinion that tidal energy is an energy source that is easy to maintain, this is something that communication with the public could build upon. The public may feel more willing to see more tidal energy projects if their perception of its maintainability is enforced.

When it comes to societal issues already identified by previous research of the matter, one could talk about a so called "social gap". On the one hand, there is a wide-spread support for renewable energy, stemming from a handful of considerations. These include: the opportunities for local employment that people perceive in MRE projects, the hopes for cheaper electricity and dependable energy sources and lower carbon emissions, fewer other environmental impacts

and the wish to mitigate climate change. On the other hand, the public and especially residents in proximity to site may also take issue with:

- Possible visual impact of a construction
- Environmental impacts and the uncertainty of what impact an installation may have
- Harming effect on tourism
- Negative effects on navigation
- Damage to fisheries
- Negative effect on property values
- The possibility of hurting sites used for recreation
- Oceans turning into industrial zones

  (Borthwick, 2016)

Little or no engagement with the public may cause further opposition. This issue is best resolved through taking all the stakeholders into consideration and improving on communication. However, this takes time and results in a longer and more expensive process (Borthwick, 2016, p. 76). The general view is that a somewhat longer and expensive process will most likely have enough benefits to be worth it for the industry. Some respondents indeed raised the worry, both among participants from Australia and Canada, of land areas being affected by tidal energy, and both groups had respondents who were worried about noise, i.e. something affecting their own comfort (Figure 8). In other words, not wanting to have one's home environment and lifestyle disrupted is a factor that at least some of the population in Canada and in Australia are willing to admit to. However, this survey may not reflect how these participants and how the population of these two countries may react in reality, if a tidal energy plant were planned to be constructed close to their home.

It is possible to distinguish five different stages of public response to an offshore renewable energy project:

1. *Becoming aware:* What kind of place change will take place?
2. *Interpreting*: What are the implications of such a change for this place?

3. *Evaluating:* Will the effects be positive or negative?
4. *Coping:* How can I respond to these changes? How should I respond?
5. *Acting:* What can I do about it? What should I do about it?

(Devine-Wright 2011)

This model was put forth to correct the picture that the concept of "NIMBYism" and its negative connotations. Despite many previous surveys and opinion polls indicating strong support for renewable energy across Europe, projects have on many occasions faced heavy local opposition (Devine-Wright 2011, p. 83). This phenomenon is commonly known as 'NIMBYism', from the abbreviation of "Not In My Backyard" (NIMBY).

However, this label is problematic; it discredits the local residents and their opinions, which may indeed be well-founded and justified. Furthermore, it is too simplistic a description for a complex objections and support (Devine-Wright, 2011, p. 83). Devine-Wright founds his alternative concept on place theory and makes use of multidisciplinary literature, such as environmental psychology and human geography. Devine-Wright (2011) suggests that 'emplacement' also causes different settlements to have different opinions about a project. It is based on the understanding from psychology and social sciences that where you are influences who you are and how you perceive the world.

It has also been shown that even if two groups of people are living at similar distances from the site (but in different spots and communities) they are likely to have different attitudes and beliefs about the project and its impacts. This is the outcome of different perceptions of the 'symbolic fit' between project and place. This can be explained as the perception of how well (or how badly) the project fits in with beliefs and narratives the community hold about the ocean, for example to which degree it is regarded as 'special' and whether the project will threaten its status. (Devine-Wright, 2011, p. 84)

Residents are likely to associate a project with positive emotions such as enhanced placed-related pride and great self-esteem, if the project is perceived as 'unique', for example in the

sense of being cutting edge and being able to 'put the place on the map.' (Devine-Wright, 2011, p. 88)

As the literature review part of this research project has shown, it is rarely from technical or scientific factors that MRE meets its biggest obstacles but because of the human dimension (such as public opposition or legal disputes) and the responses received here are an important break-through and a step forward for tidal energy. Acting upon this insight can enable projects to get the public on their side. It highlights the importance of carefully studying the relationship communities have to the ocean, their sense of place and their beliefs about the ocean, the importance of communicating findings and insights to the public and affected communities.

Previous writers on the topic tend to agree upon the big potential tidal energy has as a green energy solution. However, the costs of tidal energy are big, and as a result tidal energy may never take the place of solar energy. Tidal energy requires big investments, both when it comes to money and time but the new technologies (new data-gathering equipment, drive generators, efficient storage and so on) leave researchers with no doubt about the superior sustainability of tidal energy and other types of offshore renewable energy. To have a secure future, tidal energy may need stronger presence in traditional media and social media. Even if most people from Canada or Australia think of tidal energy as green, some do not pay attention to, or care if their source of electricity is green or not. The survey pointed towards other challenges too with the public that tidal energy may encounter; the participants from Australia appeared to think of tidal energy as more expensive than solar energy and therefore may be reluctant toward it and unwilling to invest in it (Figure 6). Whereas the respondents from Canada appeared to be divided between thinking it is less, equally or more expensive than solar energy (Figure 6).

# 6 Conclusions

Tidal energy shows great potential as a sustainable form of energy and possibly as another green option with the power to mitigate climate change. Furthermore, new technologies are in development and more data is being gathered about tides, ocean climate, turbulence and other important elements to consider when it comes to securing a stable output of tidal energy. This results in a scenario where tidal energy is becoming a more reliable source of energy.

Tidal energy is still expensive and, unlike solar, will not offer the opportunity for a singular private home to invest in it. Tidal energy requires big investments, time and money wise. However, new technologies and rapid development are increasing the payoffs of tidal energy projects and there appears to be little doubt about the superior sustainability of tidal energy to other forms of renewable energy. Still, improvements cannot come to a halt if tidal energy is to improve on its sustainability and chances for the future. Development in the following fields is a precondition for the furthering of economic viability and sustainability for tidal energy: (1) Concept design; (2) Design optimisation; (3) Economies of scale; (4) Learning in production, construction, installation and operations and maintenance.

These are not the only challenges the tidal energy industry encounters. When planning a tidal energy installation, issues with public acceptance, engagement and misconceptions may present themselves. As a result, they become increasingly important factors to consider during policy making and when planning the tidal energy projects. The public may for example still feel apprehensive about a new form of green energy as it is still "young" and not discussed as much in traditional media and on social media as other forms of green energy.

Research has shown how to reduce negative attitudes toward tidal energy and MRE: communication and positive reinforcement, increasing the sense of the geographical site in question being 'unique' and 'of special value'. Dismissing concerns about how a tidal energy installation will affect the site is not a sustainable alternative; instead, the tidal energy industry must take into consideration and answer the worries especially of the residents in proximity, inform them about the different values tidal energy can bring (such as employment, secured

energy and so forth) to the community and society as a whole. In a best-case scenario, tidal energy installation projects can make the public perceive it as adding to the symbolic and psychological value of a place.

This survey-based research highlighted some of the possible challenges that could arise from the public in Australia and Canada. Both survey groups thought about tidal energy as green, with the respondents from Australia showing more concern about their energy being green (Figure 10). Neither group indicated that tidal energy is hard to maintain, but the participants from Canada were more apprehensive about the maintenance (Figure 13). Participants living in Australia, however, think of tidal energy as expensive in comparison to solar energy, while the answers among the survey participants from Canada varied (Figure 6). Both groups showed a big variation in concerns for the impact of tidal energy, with the biggest concern being how tidal energy may disrupt and injure wildlife (Figure 8). These answers could be used to give future researchers, developers and investors in MRE better insight into what social and economic areas should be focused on to reduce misconceptions about MREs and improve overall interest and understanding, especially in the areas highlighted in the surveys.

In both groups of survey participants, some resistance to tidal energy projects from the public must be anticipated and possibly managed if the two countries want to invest further into tidal energy. How big of a resistance, especially from communities in proximity, was out of scope for this thesis but a possible topic for future research.

When future research is concerned, similar surveys could be conducted in different parts of the world to enable more comparisons between populations of various countries. Regarding future surveys an additional question that could be asked would be "How far do you live from the nearest coastline?". The results form such a question would likely yield important results and comparisons between general public opinion, the residents in proximity to water and possible future tidal energy projects and people living further away from the coastline. Research could also be conducted to further uncover misinformation about tidal energy among the public so the possible obstacles that these misconceptions may form can be researched further, and possible solutions could be investigated and acted upon.

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# 8 Appendix

| |
|---|
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Injury and/or death of wildlife, Will the infrastructure fit into the landscape |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Injury and/or death of wildlife |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Effect on tides, corrosion |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Injury and/or death of wildlife |
| Disruption to wildlife, Injury and/or death of wildlife, maintenance costs. The sea likes to fuck everything. |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Ocean warming |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Injury and/or death of wildlife |
| Noise generation, Disruption to wildlife, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Injury and/or death of wildlife, Electromagnetic fields (EMFs) |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Noise generation, Impact on nearby land areas and their ecosystems, Acid rain |
| Disruption to wildlife, Effect on tides, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, constant maintainance |
| Carbon emissions, Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure) |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Noise generation, Disruption to wildlife, Effect on tides |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Injury and/or death of wildlife |
| Noise generation, Disruption to wildlife, Injury and/or death of wildlife |
| Noise generation, Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure) |
| Noise generation, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), These aren't really issues I think would be an issue |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Effect on tides, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Effect on tides, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Ocean warming |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Maintenance of the machinery |
| Noise generation, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Noise generation, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Noise generation, Effect on tides, Impact on nearby land areas and their ecosystems |
| Noise generation, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, I DO NOT HAVE ANY MORE CONCERNS |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Effect on tides, Injury and/or death of wildlife |
| Noise generation, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Electromagnetic fields (EMFs) |
| Disruption to wildlife, Effect on tides, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Effect on tides, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Effect on tides, Impact on nearby land areas and their ecosystems |
| Noise generation, Disruption to wildlife, Impact on nearby land areas and their ecosystems |
| Noise generation, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Injury and/or death of wildlife |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Effect on tides, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Corrosion |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |

**Figure 14 – Respondents in Australia. Answers to: What are your THREE (3) major concerns regarding the implementation and use of tidal energy?**

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| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Storing the generated energy from tides, Quality and amount of tidal flow in the area |
| Environmental legislation, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Environmental legislation, materials |
| Finding a suitable location for the plant, Planning and construction of the plant, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Storing the generated energy from tides, Transferring the energy from the plant to where it will be used |
| Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area, maintenance and the Costs that come with it. |
| Finding a suitable location for the plant, Planning and construction of the plant, Storing the generated energy from tides |
| Planning and construction of the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Storing the generated energy from tides, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Quality and amount of tidal flow in the area |
| Planning and construction of the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Environmental legislation, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Environmental legislation |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Planning and construction of the plant, Storing the generated energy from tides, Quality and amount of tidal flow in the area |
| Environmental legislation, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Environmental legislation, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Storing the generated energy from tides, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Storing the generated energy from tides, Government policy |
| Finding a suitable location for the plant, Planning and construction of the plant, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Storing the generated energy from tides, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Storing the generated energy from tides, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Planning and construction of the plant, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Planning and construction of the plant, Environmental legislation, Quality and amount of tidal flow in the area |
| Planning and construction of the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Storing the generated energy from tides |
| Finding a suitable location for the plant, Environmental legislation, Public perception and understanding of tidal energy |
| Storing the generated energy from tides, Environmental legislation, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Storing the generated energy from tides, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, I DO NOT THINK THERE ARE ANY OTHER CHALLENGES |
| Finding a suitable location for the plant, Environmental legislation, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Quality and amount of tidal flow in the area, Suitability of tidal energy as an energy source |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Storing the generated energy from tides, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Storing the generated energy from tides, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Environmental legislation, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Environmental legislation, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Environmental legislation, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Environmental legislation, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Planning and construction of the plant, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Storing the generated energy from tides, Public perception and understanding of tidal energy |
| Planning and construction of the plant, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Planning and construction of the plant, Quality and amount of tidal flow in the area |
| Planning and construction of the plant, Storing the generated energy from tides, Transferring the energy from the plant to where it will be used |
| Storing the generated energy from tides, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Planning and construction of the plant, Transferring the energy from the plant to where it will be used |

**Figure 15 - Respondents in Australia. Answers to: What do you think are the THREE (3) biggest challenges in implementing tidal energy?**

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| Disruption to wildlife, Injury and/or death of wildlife, Disruption of human activities |
| Effect on tides, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Effect on tides, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Noise generation, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Injury and/or death of wildlife |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Inefficiency |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Effect on tides |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Ocean warming, Injury and/or death of wildlife |
| Carbon emissions, Noise generation, Disruption to wildlife |
| Noise generation, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), None of the above |
| Effect on tides, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Noise generation, Acid rain, Injury and/or death of wildlife |
| Noise generation, Disruption to wildlife, Injury and/or death of wildlife |
| Disruption to wildlife, Ocean warming, Injury and/or death of wildlife |
| Carbon emissions, Effect on tides, Electromagnetic fields (EMFs) |
| Noise generation, Disruption to wildlife, Ocean warming |
| Carbon emissions, Disruption to wildlife, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Ocean warming, Acid rain |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Electromagnetic fields (EMFs), nothing to my concern |
| Noise generation, Disruption to wildlife, Injury and/or death of wildlife |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Noise generation, Disruption to wildlife, Effect on tides |
| Disruption to wildlife, Ocean warming, Acid rain |
| Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Noise generation, Disruption to wildlife, Injury and/or death of wildlife |
| Effect on tides, Impact on nearby land areas and their ecosystems, Ocean warming |
| Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife, Impact on marine ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Ocean warming |
| Effect on tides, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Acid rain |
| Noise generation, Acid rain, Electromagnetic fields (EMFs) |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Disruption to wildlife, Effect on tides, Injury and/or death of wildlife |
| Disruption to wildlife, Ocean warming, Injury and/or death of wildlife |
| Noise generation, Impact on nearby land areas and their ecosystems, fiscal consequences |
| Disruption to wildlife, Waste (e.g. decommission of plant and disposal of equipment and infrastructure), Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Effect on tides, Impact on nearby land areas and their ecosystems |
| Disruption to wildlife, Impact on nearby land areas and their ecosystems, Injury and/or death of wildlife |
| Carbon emissions, Disruption to wildlife, Injury and/or death of wildlife |

**Figure 16 - Respondents in Canada. Answers to: What are your THREE (3) major concerns regarding the implementation and use of tidal energy?**

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| Planning and construction of the plant, Quality and amount of tidal flow in the area, Getting the requisite funds to build it |
| Environmental legislation, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Environmental legislation, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Planning and construction of the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Storing the generated energy from tides, Public perception and understanding of tidal energy, Getting governments to invest may be difficult. |
| Finding a suitable location for the plant, Planning and construction of the plant, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Planning and construction of the plant, Storing the generated energy from tides, none of the above |
| Planning and construction of the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Quality and amount of tidal flow in the area |
| Storing the generated energy from tides, Environmental legislation, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Environmental legislation |
| Planning and construction of the plant, Environmental legislation, Quality and amount of tidal flow in the area |
| Storing the generated energy from tides, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Storing the generated energy from tides, Environmental legislation |
| Finding a suitable location for the plant, Storing the generated energy from tides, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Environmental legislation, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Storing the generated energy from tides, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Environmental legislation, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Environmental legislation, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Planning and construction of the plant, Quality and amount of tidal flow in the area |
| Planning and construction of the plant, Public perception and understanding of tidal energy, Transferring the energy from the plant to where it will be used |
| Finding a suitable location for the plant, Environmental legislation, Public perception and understanding of tidal energy |
| Finding a suitable location for the plant, Transferring the energy from the plant to where it will be used, Quality and amount of tidal flow in the area |
| Environmental legislation, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Finding a suitable location for the plant, Planning and construction of the plant, Environmental legislation |
| Storing the generated energy from tides, Public perception and understanding of tidal energy, Quality and amount of tidal flow in the area |
| Storing the generated energy from tides, Environmental legislation, Transferring the energy from the plant to where it will be used |
| Planning and construction of the plant, Environmental legislation, Public perception and understanding of tidal energy |

**Figure 15 - Respondents in Canada. Answers to: What do you think are the THREE (3) biggest challenges in implementing tidal energy?**