A Comparative Case Study of Instream Tidal Energy Siting Locations

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A thesis

Submitted in partial fulfillment of the

requirements for the degree of

Master of Marine Affairs

University of Washington

2017

Committee:

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Program Authorized to Offer Degree:

School of Marine and Environmental Affairs

University of Washington

Abstract

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Instream tidal energy is a form of renewable energy that is at an early stage of development compared to other forms of energy generation. A comparative multiple-case study was conducted to evaluate stakeholder group perceived concerns and benefits about the siting of commercial instream tidal energy projects. Based on their history of experience with instream tidal energy and their dissimilarity of population and grid connectivity Puget Sound, Washington State and Igiugig, Alaska were chosen. Interviews were conducted with key stakeholders in both locations to understand perceptions of project development. Perceived concerns and benefits were ranked; interviews were transcribed and coded to extract themes about project development. Providing local renewable energy, advancing science and technology, and environmental awareness were some of the top perceived benefits of the technology, while negative environmental impacts, conflicts with other uses, and unintended consequences were some of the top perceived concerns of the technology. The two locations varied in the type, number, and complexities of stakeholders involved in project development. Support or opposition about a project was

justified by promoting the wellbeing of the affected stakeholders. There was overall more support in smaller communities isolated from municipal power sources, that had a demonstrated need for energy.

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1.0 Introduction/Background

Renewable energy technology has the potential to contribute to the worlds energy supply while producing less emissions and having less environmental impact than traditional sources of energy such as coal or fuel power plants, nuclear power plants, and hydroelectric dams. Despite little utilization, instream tidal energy is a form of water-based renewable energy that has the potential to provide clean energy with less environmental impact. This paper explores stakeholder groups' perceptions of instream tidal energy to identify what perceived concerns and benefits are held about the technology. This information is useful for identifying ways that development of the technology can move forward.

1.1 Renewable Energy

Renewable energy is derived from powerful natural processes that continually and infinitely replenish (Borthwick, 2016). Harnessing the natural power of the sun, wind, and oceans provide sources of renewable energy that have the potential to significantly contribute to the world's energy supply without emitting greenhouse gasses (Denny, 2009; Borthwick, 2016). Currently, onshore wind and solar photovoltaics are the most common types of new installed commercial renewable energy projects (IEA, 2016). These technologies are helping reduce greenhouse gas emissions. A single wind turbine can eliminate 2,500 tons of carbon dioxide emissions annually (Ledec et al., 2011; MEOEEA, 2017). Despite the advantages of these technologies, there can also be downsides. These technologies are variable; they are dependent on energy from natural weather patterns (i.e. the sun and the wind), which are difficult to predict (Denny, 2009). Furthermore, wind turbines can kill birds and bats (Ledec et al., 2011) and solar energy production is reduced outside of noon and not received at night (Skipka & Theodore, 2014). These devices are also placed terrestrially and can lead to public concern over visual impacts (Bailey et al., 2011).

To achieve reductions in carbon from the energy sector several types of renewable energy likely need to be used. Instream tidal energy conversion is a renewable energy technology that has low emissions, is

predictable, and not land based. Instream tidal energy can play an important role in future low emission energy generation.

1.2 Instream Tidal Energy Conversion

Instream tidal energy utilizes the natural ebb and flow of Earth's waters to generate clean, renewable energy. Instream tidal energy devices can be situated in any area with fast moving water, such as ocean channels, narrows, inlets, rivers, or streams where the velocity of moving water is great. The energy of the moving water can be converted to a rotational motion and subsequently converted to electricity (EPRI, 2007).

Instream tidal energy is advantageous because unlike other forms of renewable energy, instream tidal generation can be forecasted over long time periods because of the consistency of tides and river flow (Denny, 2009) giving a predictable and reliable source of energy. Additionally, the ability to locate devices in diverse environments and different parts of the water column maximize the scope of potential sites of use while minimizing the visual impacts of local communities (EPRI, 2007). When compared to energy produced by the combustion of fossil fuels not only do instream tidal energy projects produce significantly less emissions, projects can also be located near energy demand, reducing security of supply concerns and transmission costs (O Rourke et al., 2010; Hartnett, 2014).

One of the challenges facing the industry is finding appropriate locations for siting tidal energy turbines that balances other marine and aquatic uses. Balancing these negative societal effects such as the reduction of access to space for users of the marine environment will be important when discussing the siting of projects. (Uihlein and Magagna, 2015). For example, one of the challenges facing the development of a tidal energy project in Massachusetts has been the existing uses of the area for commercial and recreational fishing (Barrett, 2013). By understanding the perceived benefits and concerns of stakeholders regarding in-stream tidal energy, we can identify ideal locations to incorporate tidal energy into our marine and aquatic environments to utilize this clean, renewable energy source.

1.3 Instream Tidal Energy Applications

Instream tidal energy has the potential to contribute to the electric grid in both a large-scale commercial capacity as well as in small-scale remote settings (Bergmann et al., 2008). To date, the technology remains largely at a pre-commercial capacity (Kasper et al., 2016). Harnessing enough energy to power urban areas, a project would need to be built at commercial scale with multiple instream tidal turbines. To achieve energy generation at that level, multiple turbines can be placed in areas of high current near one another, which reduces installation and operation costs (Fraenkel, 2002). At this scale of production turbines must be near a power facility that can receive the power and distribute it to the electrical grid (Fraenkel, 2002).

In addition to dense, urban areas, instream tidal energy has the potential to serve more rural populations and support small energy distribution systems called microgrids (Suberu et al., 2013; Mooney, 2015). Remote communities tend to have low population densities, limited conventional energy sources, lack of infrastructure, low levels of economic activity, physical access constraints, and are typically located long distances from external markets (Hanley & Nevin, 1999). These challenges make a small-scale instream tidal energy project a potentially viable option for their energy needs in remote communities located near a dynamic water source.

Proven in pilot projects around the globe, instream tidal energy is viable in both small-scale and large-scale applications. Moving beyond pilot projects and into full scale production is the goal of those looking at the future of tidal energy. Further research on barriers to permanent implementation, such as overcoming stakeholder environmental impact concerns, can help identify solutions to achieve broader applications of these technologies. When framed with the multitude of benefits provided by tidal energy and with solutions to overcome obstacles to achieve implementation, a vibrant future of tidal energy is possible.

1.4 Social Implications of Instream Tidal Energy

Instream tidal energy is receiving greater attention globally from scientists, industrialists and politicians (Behera & Tkalich, 2014) which has translated to national governments funding research in the technology. Although many instream tidal projects have been proposed, few commercial-scale devices have moved beyond the planning stages to construction and testing (Borthwick, 2016). Taking a closer look at why these tidal energy projects do not make it to implementation, it appears that social factors rather than technical limitation have stood in the way (Conway et al., 2013) However, few empirical social studies have been conducted to look at the social issues around tidal energy technology and how those issues can be overcome (Devine-Wright, 2011; Uihlein & Magagna, 2016). Additionally, looking beyond the logistical and environmental challenges, there needs to be an understanding of the social and economic impacts to the surrounding community (Henkel et al, 2013; Denny, 2009; Stagonas et al., 2011).

Existing studies that have been conducted on tidal energy implementation often overlook social considerations (Abundo, 2012). The societal challenges of tidal energy projects such as the competing uses of the area, increased consumer electrical pricing, and fear of environmental impacts have all caused challenges for instream tidal energy development. This research aims to identify the socio-economic issues that surround tidal energy projects by exploring how key stakeholders view the technology and how their concerns about the technology can be addressed. Lessons learned from this study can be used to promote the implementation of tidal energy technologies and help identify the scale and location of new instream tidal energy projects throughout the world.

1.5 Stakeholders and Instream Tidal Energy

Instream tidal energy stakeholders are a diverse group of citizens, environmentalists, government officials, and tribal groups including any person, group, or organization that has a link to the development of a tidal energy project. Stakeholders can affect or be affected by the actions taking place prior to, during, or after the development of a project. Stakeholders can also affect or be affected by objectives and policies associated with project development (Stagonas et al., 2011). Early and frequent stakeholder

engagement is an important aspect of any project to ensure the goals and ideas of these diverse groups are identified, discussed, and balanced to get large scale community buy in for the project (Stagonas et al., 2011; Jansujwicz & Johnson, 2015). Examples of direct stakeholders for tidal energy projects could include turbine manufacturers and utility companies. Examples of indirect stakeholders could include national agencies, conservation associations and local energy consumers. Examples of stakeholder groups include industry, national government, state government, municipalities, non-governmental organizations, and local rate-payers.

Each instream tidal energy project will have different types and amounts of stakeholders (Howell & Drake, 2012). Lessons from other marine renewable technologies have shown that even local individuals can cause project delays or cancellations (BWEA, 2002). Instream tidal energy is developing and is faced with significant challenges including how stakeholders perceive projects (Jansujwicz & Johnson, 2015). It is crucial to understand how stakeholders perceive instream tidal energy in different locations and scales to help identify places where projects can successfully be sited.

1.6 Research Questions

This study aims to address three fundamental questions about instream tidal energy projects, and how they relate to different project scales:

1) How do stakeholders perceive of a commercial instream tidal energy project in their location?
2) What are the perceived benefits and concerns of a commercial instream tidal energy project?
3) How do stakeholders want their top perceived concerns about a commercial instream tidal energy project to be addressed?

By focusing on two fundamentally different locations, one large, urban area and one small, remote area, this research aims to explore unique perspectives on commercial instream tidal energy projects, especially how they may vary between urban and rural settings. Through extensive stakeholder interviews, this research examines the two cases to gain firsthand stakeholder perspectives about the potential for instream tidal energy. First, this research is important in determining where potential instream tidal energy projects can succeed based on stakeholder community and industry perspectives. Second, it

shows potential approaches and framing opportunities for outreach to stakeholders by those developing and promoting instream tidal energy. Finally, it shows how stakeholders would like their concerns addressed so that instream tidal energy projects and the overall instream tidal energy sector can move forward. This research is vital to the future of renewable energy, as we identify stakeholder concerns we can outline solutions and locations to move forward and implement tidal energy projects that promote the benefits of this clean, reliable energy.

2.0 Selecting locations for a comparative case study

Due to their history with in-stream tidal energy, two locations were chosen for this comparative case study examining the societal environment around tidal energy projects. A comparison between the potential urban tidal energy projects of the Puget Sound, WA with a rural location in Igiugig, AK should yield diverse perspectives on differences and similarities among stakeholders involved in separate projects with differing circumstances.

The first location considered is Puget Sound, WA, which is an approximately 240 km fjord estuary that connects with the Pacific Ocean in the Northwestern United States (Polagye, et al., 2009). The area has a significant population of more than 4 million people as many towns and cities line the Puget Sound shorelines including Seattle (USCB, 2012). Local history with tidal energy projects and the large population overlapping with suitable tidal energy locations make this an ideal study location. In the north of Puget Sound the Snohomish County Public Utility pursued the installation of an in-stream hydrokinetic pilot project beginning in 2006. The second location considered is Igiugig, AK, a small primarily Native American village in southwestern Alaska on the Alaska Peninsula. The village is situated on the southwest corner of Lake Iliamna at the mouth of the Kvichak River. The local history with tidal energy projects and its rural location provide an excellent comparison to the Puget Sound. In 2014, Ocean Renewable Power Corporation (ORPC) installed a pilot project in the Kvichak River adjacent to the village of Igiugig. Both locations have capacity for commercial scale instream tidal energy (Polagye et al., 2009; TerraSond, 2011) and a history with pilot projects. Their differences in waterbody type, nearby population, and stakeholder involvement in pilot projects provide an opportunity for comparison.

2.1 Puget Sound, WA

Puget Sound is the second largest estuary in the United States. Connected to the Pacific Ocean by the Strait of Juan De Fuca, Puget Sound has 19 different river basins and has tidal influence to allow the mixture of fresh and salt waters. With 4,000 kilometers of shoreline, Puget Sound supports a population of nearly 4.5 million people including 118 incorporated cities and 15 American Indian tribes. The Sound has an average depth of 140 meters and a maximum depth of 285 meters. 211 fish species, 100 sea bird species, and 13 marine mammals reside in the region (WADOE, 2017)). Concern has been voiced that instream tidal energy projects may have negative impacts on these species (Tarantino, 2013).

Hydroelectricity, obtained through the damming of rivers, is the primary source of power for Washington state, providing 65% of the state's electricity. While, the remaining power primarily comes from coal and natural gas (Bonlender, 2015), there is support for renewable energy in the region with more than 16,000 customers of Seattle's public utility company voluntarily paying more on their electricity bills to promote the use of renewable energy (Seattle City Light, 2016; Dreyer et al., 2017; Polis et al., 2017). In 2006, the state passed an initiative requiring large utilities to obtain 15% of their electricity from renewable resources. Excluded from the definition of eligible renewable resources was power generated by fresh water making the state's existing dammed rivers an ineligible source of renewable power (WA, 2006). An instream tidal energy project located in Puget Sound would count towards a utility's renewable energy requirement.

2.1.1 Puget Sound, WA history with tidal energy

A tidal energy demonstration project was pursued by Snohomish Public Utility beginning in 2006 (SnoPUD, 2006) but by 2015 the project was eventually abandoned. The project called for the deployment, operation, and monitoring of two 6-meter open-center turbines in an area of Puget Sound known as Admiralty Inlet. During peak tidal currents, the project could generate as much as 300 kilowatts of energy. The two turbines were to be placed in 58 meters of water and 1 kilometer from shore. Underwater transmission cables would bring power from the turbines to a power substation. A removable, gravity-based foundation was designed so that all equipment could be removed for maintenance or at the

conclusion of the pilot project. Despite extensive outreach and numerous public meetings the long development process was abandoned due to escalating costs in 2015 (Collar, 2015). Municipalities, federal and state agencies, non-governmental organizations, Indian Tribes, and industry all voiced their opinions about the project.

2.2 Igiugig, AK

Igiugig is a small village with a population of less than 70 people that are of mostly Yup'ik Eskimos, Aleuts, and Athabascan Indians. The Kvichak River has one of the largest sockeye salmon runs in the world. The closest villages to Igiugig are Iliamna 48 miles to the southwest and King Salmon 56 miles to the northeast. There are no roads to the village; the only way to access Igiugig is by boat or plane (Igiugig, 2016). Due to its location, it is nearly impossible for electricity from a commercial scale power generating facility to be transported to the village. Instead Igiugig primarily relies upon deliveries of diesel to fuel the village's generators. This requires diesel to be barged in when the weather allows and the lake has cleared of ice, usually during the summer months. If fuel cannot be barged in it needs to be delivered by plane (Igiugig Village Council, 2014). A commercial instream tidal energy project potentially could provide cheaper energy while being predictable and produce less emissions than burning diesel.

2.2.1 Igiugig, AK history with tidal energy

To demonstrate the feasibility of their technology, with the support of the Igiugig Village Council ORPC installed their "RivGen Power System" as a pilot project in the summer of 2014. A cross-axial turbine was installed in the Kvichak River adjacent to Igiugig and removed before the coming winter due to concerns of ice flow down the river. Turbines were modified and deployed again in the summer of 2015, sending power to the village. The turbines were placed in the deepest location in the area and situated to allow vessel traffic. During peak operation, the refined system could provide one-third of the village's electrical load or 25kW (ORPC, 2016; Igiugig Village Council, 2014). Local resources have been used to support the project. The project has been well received by Igiugig residents. The local village council, villagers, municipalities, industry, federal agencies, and state agencies were all involved in Igiugig's pilot project.

2.3 Igiugig, AK and Puget Sound, WA

Igiugig, AK and Puget Sound, WA provide an excellent opportunity for comparison for reasons that go beyond just the fact that both have pursued an instream-tidal energy project. First, the two different projects had similar stakeholder groups that engaged in project development such as federal agencies and municipalities; however, some of the stakeholder groups were different such as non-governmental organizations having a presence in only Puget Sound. Second, the projects were in vastly different locations with vastly different population sizes; one remote with a small population and the other more urbanized with a sizable population. Finally, the two projects had different outcomes; one was successful in having a pilot project while the other was not.

3.0 Methods

To achieve the research objectives, a descriptive, multiple-case, holistic case study design was chosen because of its ability to comprehensively examine and compare diverse situations in real-world context. A multiple-case study is appropriate when there are multiple sources of evidence and a descriptive case study is appropriate when the study describes an event in its real-world context where the environment is not manipulated. As opposed to embedded case studies that have multiple units of analysis, a holistic study has one unit of analysis (Yin, 2014). This methodology allows the study to interpret real-world events and incorporate stakeholder beliefs and concerns to provide a holistic understanding of the social context in a situation. By focusing on in-stream tidal energy projects only, the cases support one another. This helps strengthen external validity and makes the study's findings more generalizable to other areas pursing tidal energy (Yin, 2014). Stakeholders were grouped together based on wider encompassing categories (e.g. federal government, Indian Tribes, industry) and are the unit of analysis.

To identify perceived benefits and concerns of tidal energy stakeholders, a preliminary assessment was conducted with instream tidal energy researchers from diverse fields of study (e.g. applied physics, engineering, fisheries, oceanography, and marine affairs) at the University of Washington before this study took place. During interviews researchers were asked to name what social concerns and benefits they saw from the development of instream tidal energy technology. The 10 most common perceived

benefits and concerns mentioned by researchers were gathered and provided to participants in this study (Table 1). Even if concerns or benefits appeared related to one another (e.g. economic and low cost benefits) they were still included in the list because enough researchers saw them as distinct. Participants were encouraged to add perceived benefits and concerns that were not provided and then rank their perceived benefits and concerns.

Table 1. 10 Concerns and 10 Benefits Provided to Interviewees

Concerns	Benefits
Conflict with other uses of the water	Provide local renewable energy
Negative environmental impacts	Provide jobs
High cost	Provide a sense of pioneering for the community
Informing public accurately about projects	Low cost
Public perception of project	Culturally appropriate
Difficulty with project permitting	Advancement of science and technology
Variability of power production levels	Predictability
Unintended consequences	Economics
Impact on industry	Energy independence
Loss of access to space	Environmental awareness

Comments, interventions, and correspondence submitted to or by the Federal Energy Regulatory Commission (FERC) for pilot tidal energy projects in Igiugig and Puget Sound were used to directly identify a preliminary list of tidal energy stakeholders that played a major role in the respective projects (Tables 2 and 3). Interview guides used to facilitate conversation were identical regardless of the stakeholder or location with only the words “Puget Sound” and “Igiugig” interchanged based on the site in question. Identified stakeholders were contacted and interviewed in-person. Snowball sampling, a type of data collection that uses a small pool of initial informants to nominate additional participants based on study criteria (Morgan, 2012), was used to subsequently identify other key informants. Example questions can be seen in Table 4.

Table 2. Comments by Source for the Proposed Snohomish Public Utility Instream Tidal Energy Pilot Project

Stakeholder	Number of Comments
US Department of the Interior	8
Tulalip Tribe	8
Orca Conservancy	6
PC Landing Corp	6
U.S. Department of Commerce	6
Washington Department of Natural Resources	4
North American Submarine Cable Association	3
Squamish Tribe	3
Washington Department of Fish and Wildlife	3
American Waterways Operators	2
Federal Safety and Homeland Security Bureau	2
PUD Snohomish	2
S'Klallam Tribe	2
U.S. Army Corps of Engineers	2
Department of Ecology	1
Environmental Protection Agency	1
Federal Energy Regulatory Commission	1
GCI Communication Corp	1
National Oceanic and Atmospheric Administration	1
Office of Regulatory Assistance	1
Pacific Whale Watch Association	1
Point No Point Treaty Council	1
Robert Cinq-Mars	1
Swinomish Tribal Community	1
Washington State Department of Transportation	1
Washington State Ferries	1
Whidbey Environmental Action Network	1
Garret B. Ferguson	1
Suquamish Tribe	1
U.S. Congress	1

Table 3. Comments by Source for the Proposed Village of Igiugig Instream Tidal Energy Pilot Project

Stakeholder	Number of Comments
Igiugig Village Council	4
Department of the Interior	1
Alaska Department of Fish and Game	1
Alaska Energy and Engineering Inc.	1
Federal Energy Regulatory Commission	1

Table 4. Example Interview Questions

Example Questions
If a commercial tidal project were to be developed in Puget Sound (Igiugig) would it affect [stakeholder group] interests?
Please rank the mentioned concerns from that of greatest concern to that of least concern.
You mentioned that _____ was a concern of yours. How could your concern be addressed to your satisfaction, if a commercial-scale tidal energy project were to be developed in the Puget Sound/Igiugig?
If your top 3 concerns were addressed to your satisfaction, would you be supportive of a tidal energy project?
How could the project be structured to ensure the top identified benefits?
What about Puget Sound/Igiugig makes it a good or bad location for a tidal energy project?

3.1 Data collection

A semi-structured interview methodology was chosen to elicit an environment for open discussion of stakeholder opinions, concerns, and feelings. In a semi-structured interview, the researcher has control over the topics of the interview but is structured to allow for an open-ended response (Ayres, 2012). Interviewees could openly share their thoughts and ideas through prompted questions to target discussion on areas this study wanted to target, such as perceived project concerns and benefits. A total of twenty-three interviews were conducted between July and October of 2015. These twenty-three semi-structured interviews with tidal energy stakeholders from Igiugig and Puget Sound serve as the primary source of data. When possible, and in most cases, interviews were conducted in person at the stakeholders' place of employment or residence. In-person interviews provided the opportunity to build rapport with the interviewee, creating an environment where the interviewee was open and willing to share in an unfiltered

manner. The interview data was pure and genuine. In rare instances, important stakeholders were unable to meet in person and a phone interview was conducted. Interviews lasted approximately 35 minutes. The interviews began by having interviewees describe their background with instream tidal energy and to describe and rank their perceived benefits and concerns of a commercial instream tidal energy project. They were also asked to describe their interests in their respective area, how concerns could be alleviated, and what makes the area good or bad for a commercial tidal energy project. Measures were taken to ensure confidentiality which improved participation and promoted an honest and open environment for quality data collection. Interviews were recorded to ensure all aspects of the interview were captured and transcribed for subsequent data analysis. Before the start of data collection, the Human Subjects Division at the University of Washington gave exempt status to the interviewing procedures. Transcripts of the interviews were compiled and organized by topic and area to create a logical canvas for data analysis.

3.2 Data analysis

When dealing with qualitative data it is important to limit interference from the researchers pre-existing biases (Yin, 2014). To remove any bias the analytical method grounded theory was used. First, interviews were transcribed and imported into MAXQDA 12, a software program used for qualitatively analyzing data. The software allows data to be systematically analyzed line by line. Selected portions of the transcripts were then coded using the open, axial, and selective coding techniques. The goal of open coding is to break down qualitative data into discrete parts (Benaquisto, 2012). During axial coding these discrete parts are developed into specific categories that are then selectively coded to form themes to explain the phenomenon (Benaquistio, 2012). This grounded theory method requires the researcher to remain open to all possibilities that are exposed in the data and constantly compare sets of data to other data (Oktay, 2012) to allow concepts and theories to inductively emerge. This approach is distinct from alternative methods where concepts are known before data is collected (Charmaz & Bryant, 2012). By using this methodological approach, more than 900 unique coded segments were analyzed to find common themes across the different stakeholder groups and locations.

Interviewees were provided a list similar to Table 1 and asked to rank their perceived benefits and concerns of an instream tidal energy project from greatest to least. The greatest perceived benefit or concern received a 1, the second greatest received a 2, etc. Sometimes interviewees added benefits and/or concerns to the ten benefits and concerns listed. To allow comparison of results by stakeholder and location, values were assigned for each ranking that was provided on the original list (i.e. items added to the list were not included in the ranking exercise since they weren't provided to all interviewees). The value used for analysis was assigned by taking the ranking (e.g. 1, 2, 10, etc.) and subtracting it from the greatest number of responses by any interviewee (i.e. 10) plus one (i.e. 11) so that a ranking of 10 (i.e. lowest possible rank) would be assigned a 1 and not a 0. For example, if an interviewee said that their second top perceived benefit was "Predictability" (i.e. "Predictability" had a rank of 2), the value would be 9 (i.e. 11 minus 2). Table 5 provides examples of how ranks were calculated. Concerns and benefits that did not factor in for an interviewee were not ranked (i.e. ranked 0).

Table 5. Example Ranking Calculations

	Example 1	Example 2
Step 1. Original	4th greatest benefit was "Low Cost"	9th greatest concern was "High cost"
Step 2. Number assigned	4	9
Step 3. Number of provided concerns/benefits	10	10
Step 4. Number of provided concerns/benefits plus 1	11	11
Step 5. (Number of provided concerns/benefits plus 1) - (Number assigned)	7	2
Final assigned ranking	7	2

Because the same number of individuals were not interviewed in each stakeholder group, rankings were normalized by combining the values assigned for each benefit or concern within a stakeholder group and dividing by the number of interviewees in the stakeholder group. Furthermore, for the sake of comparison, concerns and benefits that were added to the list were not included when creating figures summarizing concerns or benefits for a location due to the fact that in no instance did an interviewee add a concern or benefit that was the same as that added by another interviewee. Added concerns and benefits were noted. After running this analysis, the main concerns and benefits that stakeholders involved in tidal

energy have floated to the forefront and we are able to gain insights into stakeholders' perceptions of instream tidal energy projects.

3.3 Analyzing the Federal Energy Regulatory Commission Data

FERC plays an important regulatory role by approving project permits. An interview was conducted with the agency, however, because the agency is a regulatory gatekeeper, it was not considered a unique stakeholder group. The interview was used to generate themes while applying grounded theory but was not included in the ranking exercise. The interviewee representing the FERC was not differential to either of the projects and maintained that the FERC takes the same approach regardless of project location.

4.0 Results

4.1 Stakeholder Groups

The total number of stakeholder groups that emerged in Igiugig and Puget Sound were different and some, but not all, of the stakeholder groups were present in both projects. From FERC comments for the Snohomish Public Utilities proposed pilot project and from snowball sampling of key stakeholders, six stakeholder groups arose in Puget Sound (Table 6). These stakeholder groups include municipalities, Indian Tribes, industry, federal agencies, non-governmental organizations, and state agencies.

In Igiugig, there were some similarities among the stakeholder groups with those in Puget Sound as well as some stark differences and opinions that were absent from the Puget Sound discussion. A total of six stakeholder groups arose from discussions on the Igiugig tidal energy project in Alaska. Stakeholder groups included federal agencies, state agencies, industry, municipalities, the village council, and village residents (Table 6). State representatives were contacted in Igiugig however requests for interviews did not receive a response.

Table 6. Count of Interviews by Stakeholder Group

Stakeholder Group	Puget Sound (Count)	Igiugig (Count)
Federal Agency	3	1
Industry	2	3
Municipality	1	2
NGO	1	
State	1	
Tribes	2	
Village Council		1
Village Resident		4
Total	*10*	*11*

Of these stakeholder groups, federal agencies, state agencies, tribes, and municipalities/regional agencies were present in each of the case studies.

4.1.1 Stakeholder Group Difference

Individual stakeholders and stakeholder groups as identified through the FERC commenting process were more numerous in Puget Sound than in Igiugig likely due to the vast population size difference between the two communities. In Puget Sound 51 unique stakeholders, consisting of individuals or organizations, expressed opinions through the commenting process while only 8 unique stakeholders expressed opinions in Igiugig. Non-governmental organizations and federal agencies/industry (i.e. national laboratories) were not involved in the comment process or snowball sampling in Igiugig. With a goal of 10 interviews in each location snowball sampling led to residents in Igiugig but remained with organization representatives in Puget sound, also likely due to the vast population size difference between the two communities and the number of interested and involved parties as exemplified by the FERC comment process. The stakeholders of these two tidal energy projects provide an informed study group to uncover the perceived benefits and concerns around these tidal energy projects. By investigating and ranking the results we will be able to derive themes that can inform decision makers and project staff, as well as identify solutions to overcoming perceived issues with tidal energy.

4.2 Ranking Results

4.2.1 Benefits

4.2.1.1 Puget Sound Benefits

A total of 13 perceived benefits from a commercial instream tidal energy project were identified by interviewees in Puget Sound. Three new identified benefits were added to the list of 10 original benefits provided to interviewees (Table 1); the perceived benefit of contributing to a diversified energy portfolio, being “low carbon,” and finding ways to reduce environmental impacts. Creating environmental awareness by providing all stakeholders with the opportunity to learn about the site’s local environment and the role of the marine renewable technology was one of the greatest perceived benefits among all stakeholder groups in Puget Sound along with the advancement of science and technology, providing local renewable energy, and the ability to provide jobs (Figure 1). The NGO stakeholder group did not see any perceived benefit from a project since project development could impact their environmental interests and any benefit from a project was not worth the environmental impact risk in their view.

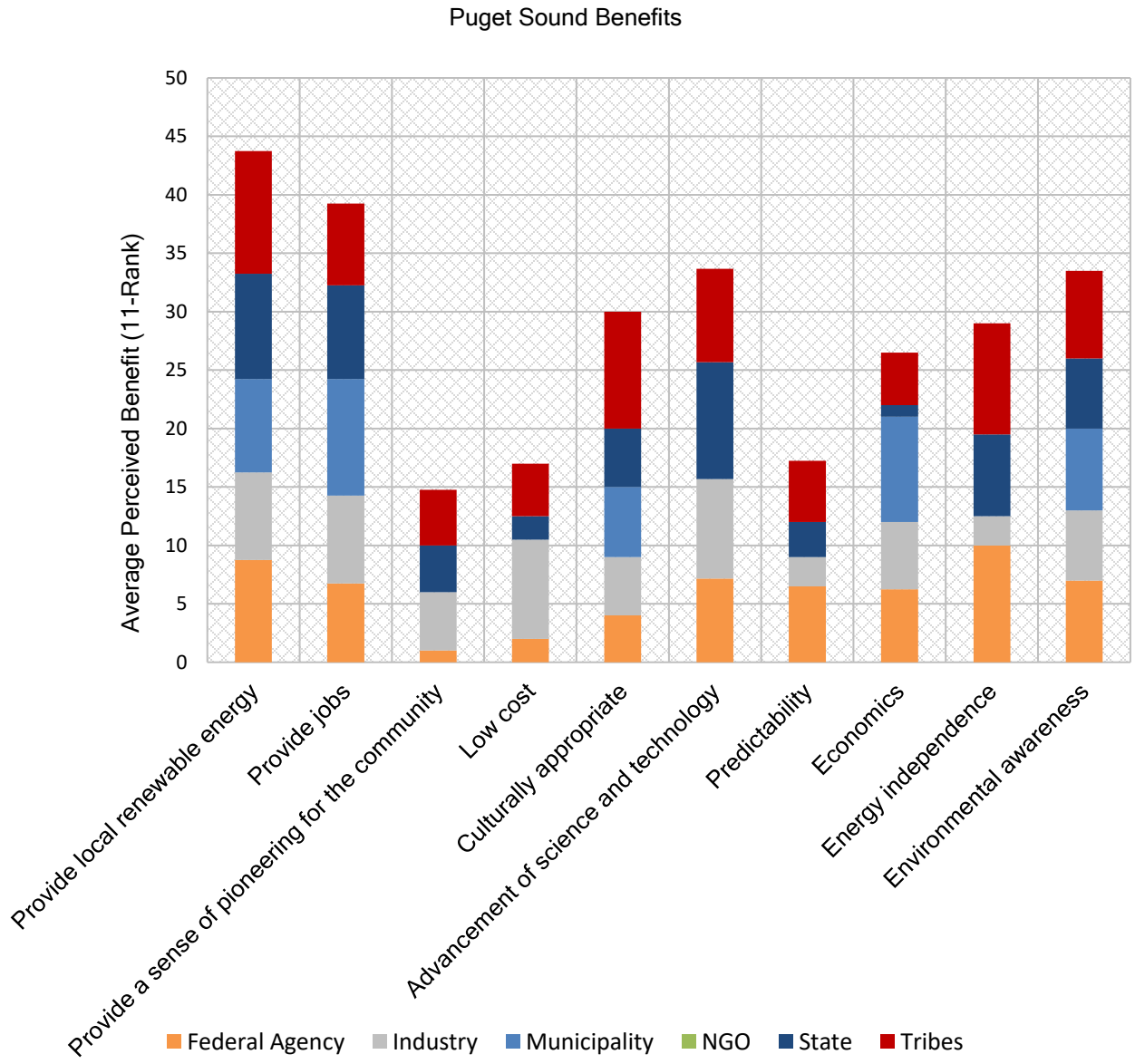

Figure 1. Ranked and Averaged Perceived Benefits by Puget Sound Stakeholder Groups

4.2.1.2 Igiugig Benefits

A total of 12 perceived benefits from a commercial instream tidal energy project were selected and identified by interviewees in Igiugig. Two new benefits, both identified by village residents, were mentioned in addition to the 10 benefits originally provided to interviewees (Table 1); the perceived benefit of providing professional development opportunities, and the ability to educate the community. Perceived economic and predictability benefits were the lowest ranked among interviewed stakeholder groups. By a

wide margin providing renewable energy was the highest ranked perceived benefit of stakeholder groups with energy independence and the ability to advance science and technology also highly ranked perceived benefits (Figure 2). The lowest ranked benefits were economics and predictability. The federal agency stakeholder, who is involved in land management, responded that project development would negatively impact their normal operations and therefore saw no benefit from a new project.

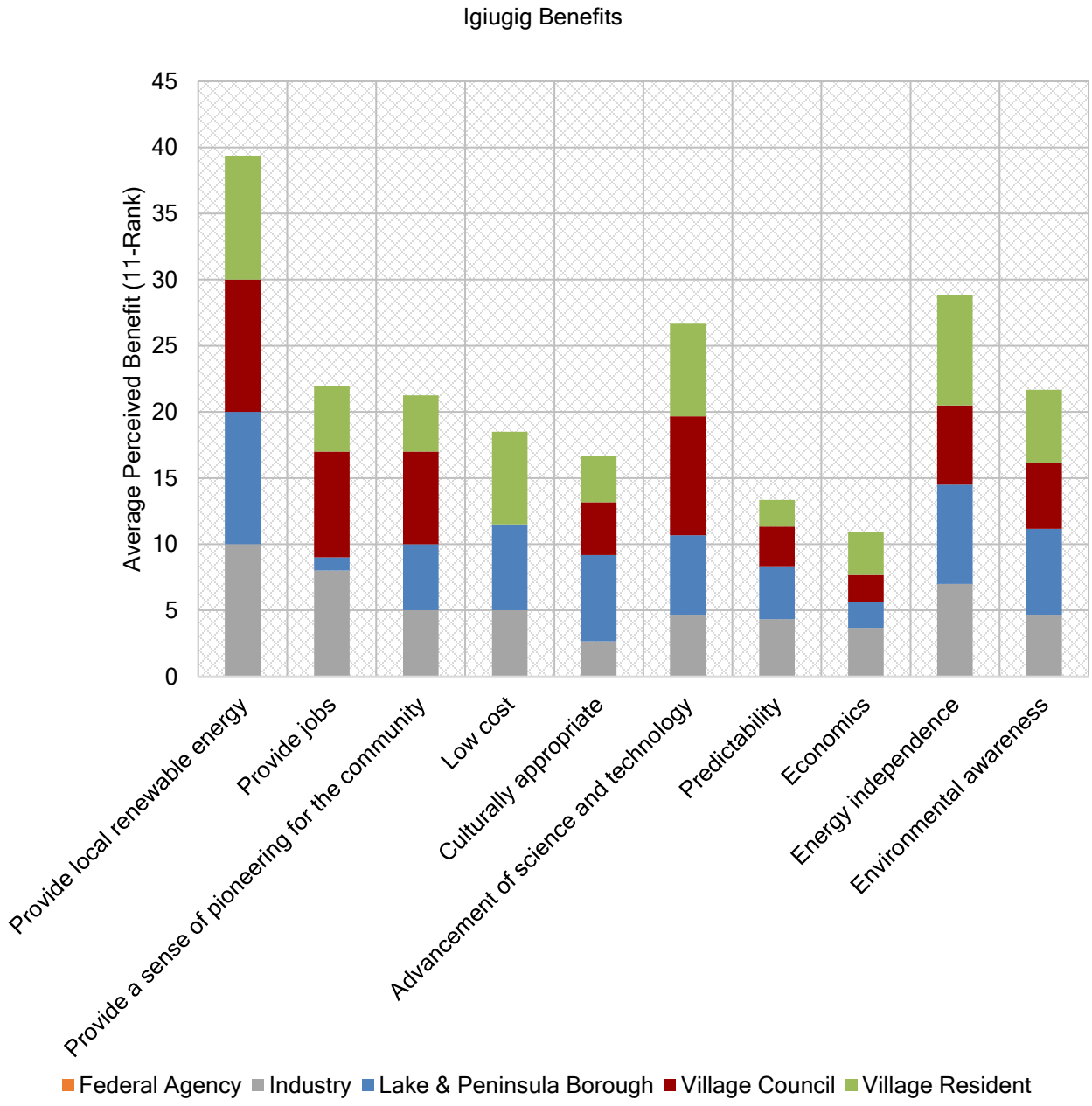

Figure 2. Ranked and Averaged Perceived Benefits by Igiugig Stakeholder Groups

4.2.1.3 Benefit Framing Opportunities

In trying to present the merits of a project, it can be useful to know what types of benefits get stakeholders excited about a project. Table 7 describes the perceived benefits ranking results for each stakeholder group for Puget Sound. Table 8 provides the same results for Igiugig. When addressing a particular stakeholder group it may be useful to highlight some of the top 3 identified benefits while staying away from benefits that were not seen as beneficial. “Other perceived benefits” can also be used to gain support for a project.

Table 7. Perceived Benefits by Stakeholder Group in Puget Sound

Puget Sound Benefits	Top 3 Perceived Benefits	Not A Perceived Benefit	Perceived Benefit Added by Stakeholder
Federal Agency	Energy Independence, Provide local renewable energy, Environmental awareness		Low carbon
Industry	Low cost, Advancement of Science and Technology		Diversified energy portfolio
Municipality	Provide jobs, Economics	Provide a sense of pioneering for the community, Low cost, Advancement of Science and Technology, Predictability, Energy Independence	
NGO		Of the 10 provided options, none were considered benefits	
State Agency	Advancement of science and technology, Provide local renewable energy, Provide jobs		Finding ways to reduce environmental impacts
Tribes	Provide local renewable energy, Culturally appropriate, Energy independence,		
FERC	Of the 10 provided benefits, all were considered equal		
*If the third greatest perceived benefit was ranked equal to the 4th it was not included in the "Top 3 Perceived Benefit" field.			

Table 8. Perceived Benefits by Stakeholder Group in Igiugig

Igiugig Benefits	Top 3 Perceived Benefit	Not a Perceived Benefit	Perceived Benefit Added by Stakeholder
Industry	Energy Independence, Provide local renewable energy, Provide Jobs		
Regional Agency	Energy Independence, Provide local renewable energy		
Village Council	Energy Independence, Advancement of Science and Technology, Provide Jobs	Low cost	
Federal Agency		Of the 10 provided options, none were considered benefits	
Village Resident	Energy Independence, Provide local renewable energy		Professional development opportunities, Community education
FERC	Of the 10 provided benefits, all were considered equal		

*If the third greatest perceived benefit was ranked equal to the 4th it was not included in the "Top 3 Perceived Benefit" field.

4.2.2 Concerns

4.2.2.1 Puget Sound Concerns

A total of 13 perceived concerns from a commercial instream tidal energy project were identified by interviewees in Puget Sound (Figure 3). Four concerns were added to the list of 10 original concerns provided to interviewees; interfering with treaty rights, scientific uncertainty, ability to obtain environmental data, and the durability of the technology. Of the ten originally provided concerns, the variability of power production were the lowest ranked concerns. Among all concerns negative environmental impacts was the highest ranked perceived concern with unintended consequences and conflicts with other uses of the water also of high concern.

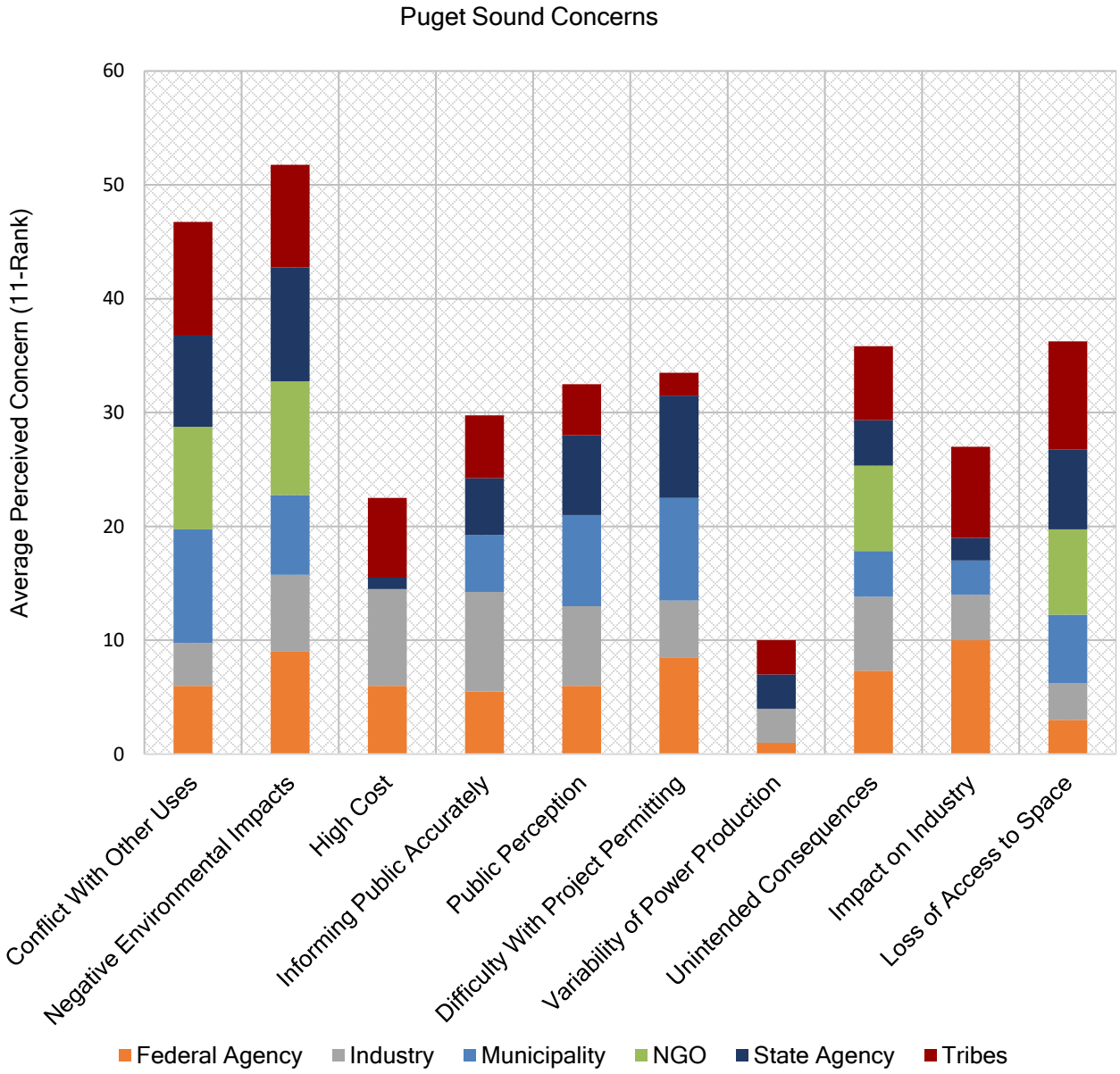

Figure 3. Ranked and Averaged Perceived Concerns by Puget Sound Stakeholder Groups

4.2.2.2 Igiugig Concerns

A total of 12 perceived concerns from a commercial instream tidal energy project were identified by interviewees in Igiugig (Figure 4). Two concerns were added to the list of 10 original concerns provided to interviewees; insufficient study scoping and the concern of changing the character of the community. The highest ranked concerns included negative environmental impacts, unintended consequences, informing

the public accurately about projects, conflict with other uses of the water, and loss of access to space. The lowest ranked concerns were public perception, variability of power production and loss of access to space.

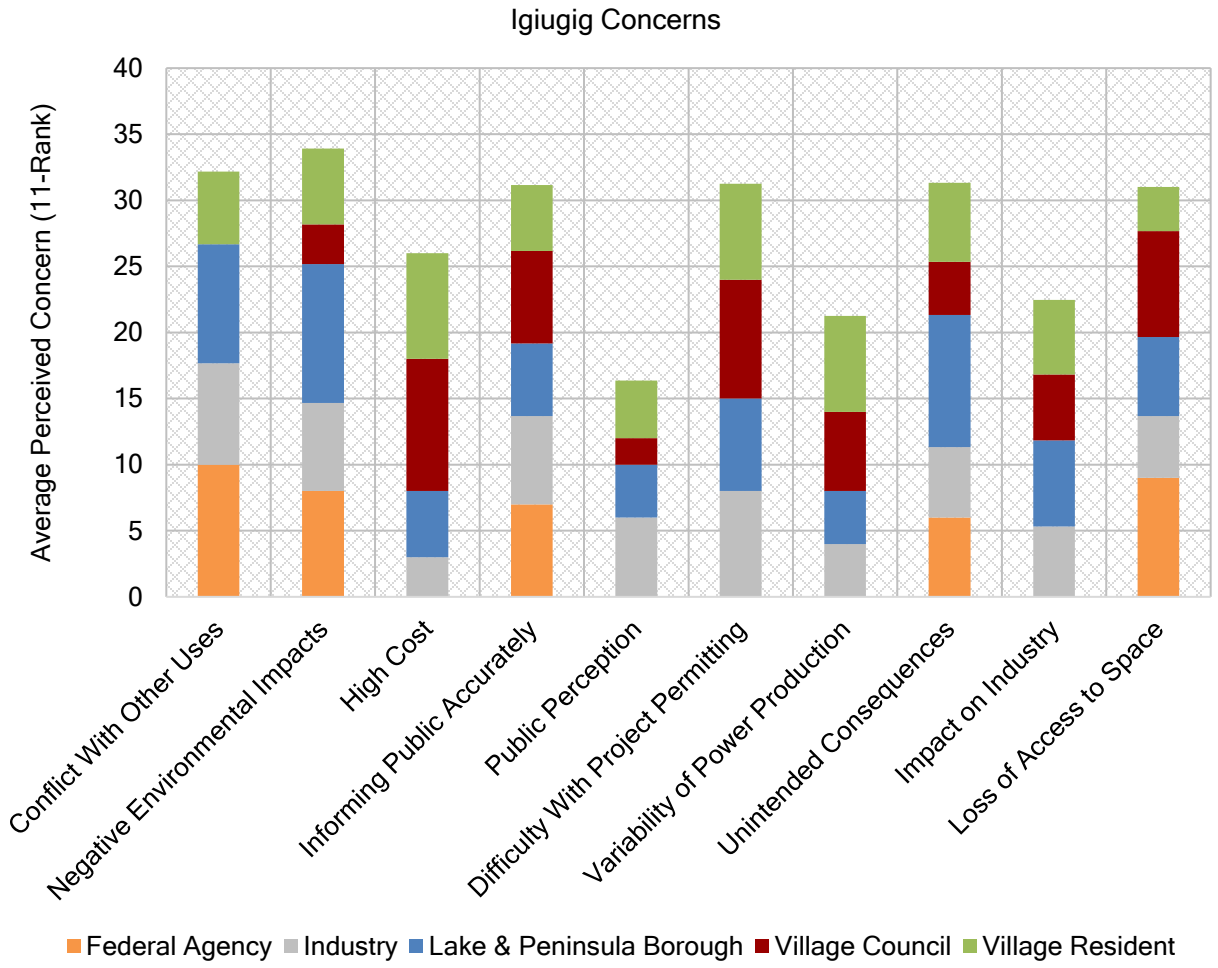

Figure 4. Ranked and Averaged Perceived Concerns by Igiugig Stakeholder Groups

4.3 Themes

4.3.1 Theme 1: Asymmetric Stakeholders

The first theme that emerged from the text analysis was that the stakeholder groups in each location differed by both the degree of support for an instream tidal energy project and type of stakeholder groups in each location. In Puget Sound, snowball sampling to 10 interviewees led to the inclusion of non-governmental organizations while non-governmental organizations did not appear in Igiugig. In Puget

Sound, the non-governmental organization stakeholder group in Puget Sound had a great amount of concern about instream tidal energy development and saw no benefit of a potential project. This organized opposition was not present in Igiugig and a greater voice was given to residents.

To get a clear perspective of the extent of concern that interviewees had, after interviewees were asked several questions reflecting on their greatest concerns of an instream tidal energy project, interviewees were asked "If your top 3 concerns were addressed to your satisfaction, would you be supportive of a tidal energy project?" In Puget Sound, all interviewees were either supportive of a project or could be supportive of a project depending on the project details except for two interviewees from two different stakeholder groups; Indian Tribes and non-governmental organizations. In Igiugig, all interviewees including village residents, were either supportive of a project or were conditionally supportive of a project depending on project details. Despite assurances that their top concerns would be addressed to their satisfaction tribal and non-governmental representatives remained opposed to a commercial instream tidal energy project in Puget Sound.

The non-governmental organization spoken with in Puget Sound summarized their concern:

> *… I have concerns about the spinning aspect and whether or not that can be physically damaging to underwater species. And then I always have the concern that whenever we humans do something in an environment, we tend to disrupt habitats and often displace critters. And so those are always going to be concerns for … … as far as trying to weigh the benefits of human use versus nonhuman use and the differences, we kind of hold the power in the voice and they don't. So somebody has to keep that in mind as we go forward on these projects.*

The staunch opposition to instream tidal energy projects voiced by non-governmental organizations in Puget Sound cannot be compared to non-governmental organizations' opinions in Igiugig because non-governmental organizations were not active in Igiugig. Sampling with a goal of 10 interviews did not lead to interviews with residents in Puget Sound. While residents would become involved in development of a

commercial instream tidal energy project in Puget Sound, their voice could potentially have less weight than the voice of residents in Igiugig. The ultimate fate of a Puget Sound tidal energy project might turn on the views of organized NGOs, while the ultimate fate of a comparable Igiugig project might rest with what influential community members think.

4.3.2 Theme 2: Wellbeing Justification

The second theme that emerged is that for a stakeholder group to support an instream tidal energy project they will likely need to be able to justify that the project will promote their members' wellbeing. Igiugig and Puget Sound both had stakeholder groups emerge that were representative of indigenous people. In Puget Sound this was composed of several different tribes located across the region, and in Igiugig, it was the Village (i.e. Tribal) Council. In both cases these stakeholder groups seek to oversee tribal members' general wellbeing and continued existence (Igiugig, 2016). Despite having similar interests, the Village Council in Igiugig was supportive of a commercial instream tidal energy project, if their concerns could be addressed, while those in Puget Sound were not.

Indian Tribe representatives spoken with in Puget Sound were concerned about losing access to usual and accustomed harvest areas and fishing rights. When asked if they would be supportive of a project if their concerns were addressed to their satisfaction, one Indian Tribe representative said that:

> *There's really no way to mitigate that* [their concerns]. *You could potentially site it to an area that's not fished as heavily as others. But there's really no way to prevent the interference from happening.*

When pressed further to see if there was any way a project could move forward, uncertainty of accurately knowing the impact of devices was raised:

> *And the other problem is to just be able to monitor doesn't tell us what the impacts are, because they're working in such a harsh environment. Monitoring techniques they're using are as experimental as the project itself. Maybe even more experimental, because it's just never been done before. And so we're not even sure how good the data would be coming*

> *out of the monitoring. Somehow we've got to be able to monitor the projects in a way that gives us good data to actually assess what the impacts are.*

The Indian Tribes in Puget Sound did not see a commercial project being feasible:

> *For a utility-sized project, a couple of 500 kilowatt or 1 megawatt turbines is really meaningless to a utility. They're literally have to put hundreds of those out there to be of any real benefit to the utility. You just can't take up that much marine space without being an impact to the commercial fisherman that make their living off of it.*

Meanwhile, the Village Council in Igiugig was extremely supportive of the project. The council saw a potential commercial project as an opportunity to displace the use of diesel, provide economic opportunity, bring employment possibilities to villagers, and instill a sense of pride in the community. It was the Village Council that applied for grants to fund the project.

Even though both the Indian Tribes of Puget Sound and the Village Council of Igiugig value natural resources that use the space where a commercial instream tidal energy project would be placed, they reached vastly different conclusions on their support of a project. What remains consistent about these stakeholders is that they justify the rationale behind their decisions as acting to support the wellbeing of their members. Both indigenous groups need to ensure that their members have access to energy, a clean environment, and employment opportunities. Despite any risk that a commercial project might put on the world's greatest sockeye run, the Igiugig Village Council saw that the benefits of this project outweighed any perceived environmental impact risk (which, in their view, was little to no risk). The Igiugig Village Council desired sustainable electricity generation for the welfare of their members. Indian Tribes of Puget Sound saw potential conflict with their right to fish usual and accustomed places and were vocal protesters in Snohomish Public Utilities' attempt to install a pilot project. Indian Tribes of Puget Sound were concerned about impact to their commercial and subsistence fisherfolk and were seeking to maintain their fishing ability. The Indian Tribes did not see the potential benefits of instream tidal energy

as worth the potential risk to their fisheries. Both stakeholder groups expressed opinions that promoted the wellbeing of their tribe members, however their positions on instream tidal energy were contradictory.

With both the Igiugig Village Council and Indian Tribes of Puget Sound seeing the development of an instream tidal energy project as a way to have a dependable access to energy, having a clean environment, and providing employment opportunities, only the Igiugig Village Council was interested in the development of a commercial instream project. With fewer employment opportunities in a remote community like Igiugig than a more populous region like Puget Sound it is logical that potential work would be valued more greatly in the village. As pointed out by an interviewee, a community leader can increase community wellbeing by having a commercial instream tidal energy project that allows them to fly less diesel in for power generation and decrease fuel spillage, emissions, and noise. With established sources of energy in Puget Sound there is not an incentive for the Indian Tribes to introduce environmental impact questions into their fishery resources. Views supporting and views opposing a project were both justified as promoting their community's wellbeing.

4.3.3 Theme 3: Siting Based on Stakeholder Interests; A Short Chain is a Strong Chain

The third theme that emerged is that in Puget Sound there were both more and varying interests that made project development more complicated from a stakeholder perspective, and fewer and less diverse interests present in Igiugig. These differences provide a clearer path forward for project development in Igiugig than Puget Sound. Despite there already being readily available inexpensive electricity available in Puget Sound, interviewees still saw Puget Sound as good place for a commercial instream tidal energy project. The tidal resource was seen as strong and predictable. The great depths of Puget Sound allow for device placement away from shipping and fishing and the greater-Seattle region was seen as being rich in resources to support the industry with a confluence of manufacturing, maritime experience, and research. However, when interviewees were asked to reflect on how their stakeholder group's interests would be affected by the installation of a commercial instream tidal energy project in Puget Sound the answers covered a wide range of topics. For example, one representative of a state agency reflected that

> *There's a lot going on in the Sound as far as fishing and traveling and barges and, you know, you name it. So putting something below that*

possibly could be hit by an anchor or what have you is a high concern. I know for us, specifically, you know salmon migration corridor is very important. And that also affects orcas.

The list of affected interests mentioned by the state in the preceding interview excerpt brings up potential concerns that other stakeholder groups such as the resource conscious non-governmental organizations or fishing dependent Indian Tribes would have. Other stakeholder groups in Puget Sound also referenced a wide range of ways their interests would be affected by a commercial instream tidal energy project. Municipalities would be required by law to become involved in the permitting process to comply with Washington's Shoreline Management Act. Industry was interested in the opportunity to further study the technology and develop local clean renewable energy.

Reflecting on their past experiences in Puget Sound all of the governmental organization stakeholder groups (municipalities, state agencies, and federal agencies) saw that there were such a great number of interests in Puget Sound that it would be difficult to appease everyone when developing a commercial project. One municipal interviewee perceptively described their vision of the complications with installing a commercial instream tidal energy project in Puget Sound:

"…whenever you propose something new, in a place where established and moneyed interests already have a bunch of stuff, they're going to default to objection. Even if they're not sure whether or not they have an objection, they may not be sure they have an objection, but they're sure they have an interest, and so they're probably just going to default to objection.

And it's...the more links that you have in your chain, the more apt your chain is to fail. A strong chain is a short chain, and when you start working in all these stakeholders, it's like herding cats. And it really only takes one to do something you didn't expect to derail your whole process. Puget Sound is a very obviously heavily utilized area, and there's a lot of stakeholders in there, and to do anything new in Puget

Sound, you're going to have to get all of them in a row, or you're going to have to fight down the ones that don't agree. And there are people who are simply going to oppose because...not even because they necessarily object, or because they have certainty that this is going to damage them. They may be opposing just because you're introducing uncertainty into their business model.

The vast and varying interests in Puget Sound can make it a difficult place for project development due to different stakeholders' actions taking the development process its varying interests (Koontz et al,, 2004), Igiugig with its lack of stakeholders may be a more favorable place for project development due to its relative lack of stakeholders. When speaking about the interests in Igiugig one Village Council member noted that the Igiugig was a "clean slate" and its lack of development, both physical and from a stakeholder perspective, provided opportunity for instream tidal energy.

When comparing the "chains" of Igiugig and Puget Sound, Igiugig had both a stronger and shorter "chain" than Puget Sound. When you compare the number of stakeholder groups in the two locations, there were more in Puget Sound (7) than Igiugig (6). When you compare the amount of support for the installation of an instream tidal energy project after stakeholder group's top concerns were addressed, there was more support in Igiugig than Puget Sound. All stakeholders would conditionally be supportive of a project if their concerns were addressed to their satisfaction in Igiugig, while two stakeholder groups remained unsupportive in Puget Sound even if their concerns were addressed to their satisfaction. With instream tidal energy in its early phases of development, the technology is inherently going to bring uncertainty along with project development. Locations with shorter and stronger "chains," such as Igiugig, may be primed for successful commercial instream tidal energy projects.

4.4 Addressing Concerns

Of the 10 concerns provided to interviewees and additional concerns that they mentioned, five of the provided concerns were consistently among the highest concerns in both Puget Sound and Igiugig. This

section looks at how great a concern each was in each location and how various stakeholder groups proposed that their concern could be addressed to their satisfaction.

4.4.1 Negative Environmental Impacts

After combining all of the rankings for all stakeholders by concern negative environmental impacts was the greatest combined concern in both Puget Sound and Igiugig. In particular, federal and state agencies, municipalities, non-governmental organizations and Indian tribes were especially concerned about negative environmental impacts. Several stakeholders mentioned concerns about fish and mammal strikes by turbine blades being a primary concern.

Starting with a small project and slowly scaling up while monitoring the devices was seen as one path forward towards addressing this concern. Nearly all stakeholders referenced some type of device monitoring. Others built upon using monitoring by establishing mitigation plans and using adaptive management to improve the project as it is implemented. As a representative of the FERC mentioned:

> *Well, there's a number of tools for dealing with potential environmental impacts, including - well first of all, if you start early with moving the project slate to avoid these potential impacts. If there's a way to mitigate for them that would prevent them on site, you mitigate for them. And then if there's uncertainty, you can get into the adaptive management and schemes. You know, we write all sorts of conditions into the licenses that are there to protect the environment.*

While negative environmental impacts were the greatest cause of concern for all stakeholders, it is also the concern with the most research and experience addressing. The Indian Tribes and NGOs of Puget Sound remained opposed to instream tidal energy development based on negative environmental concerns even if their concerns were met. Significant work has been completed evaluating a host of environmental concerns including collision risks for animals, sound impact on animals, changes caused by energy removal, electromagnetic field impacts, and changes in habitats (Copping et al., 2016). Tools such as providing adequate resources, using adaptive management, and extensive stakeholder

engagement have been used and suggested for addressing these conflicts. Attempts could be made to use these techniques to appease reticent stakeholder groups (Jansujwicz & Johnson, 2015; Scottish Environment LINK, 2010) such as some of the research that has looked at how adaptive management can be applied to the difficulties navigating an uncertain instream tidal energy permitting process (Jansujwicz & Johnson, 2015). Almost any development project is going to have some negative environmental impacts and there is a lot of experience addressing these impacts through mitigation and continued adaptive management.

4.4.2 Conflict with Other Uses

Conflict with other uses of the water where a commercial instream tidal energy project potentially could be located was the second greatest concern in Puget Sound and the fourth greatest concern in Igiugig. In particular, municipalities, non-governmental organizations, Indian Tribes, industry and federal agencies saw this conflict as particularly concerning. Industry saw improvements and clear navigational signage as a way to prevent issues when transiting near devices. Several different stakeholders saw clear communication with communities that use the area in question and early and often engagement with stakeholders using the area as a way to address this issue. Addressing conflict with natural resources could be alleviated by placing devices in areas of inferior habitat quality. Another view was more focused on stakeholders saying that the location of a project should be decided by those that use the area to find a location where there would be less conflict. One federal agency suggested that adaptive management could be used as a tool to resolve conflicts as they arise. Broad siting scoping, adaptive management, and extensive, early and often stakeholder engagement were identified by interviewees as ways to prevent and address conflicts with other uses of the area. Some of these approaches may cause greater conflict. For example, wide project scoping combined with early stakeholder engagement could bring in additional powerful stakeholders into negotiations and there have been experiences with other marine renewable technologies where even though stakeholders were engaged in consultations they weren't given any involvement in the decision-making process. Nevertheless, each one of these approaches or a combination of these approaches can be considered to help address conflicting uses of a project area and should be considered within the specific regulatory, economic, and political climate (Reilly et al., 2016; Jansujwicz & Johnson, 2015; Scottish Environment LINK, 2010).

4.4.3 Unintended Consequences

Unintended consequences was the second greatest concern for stakeholder groups in Puget Sound and the third greatest concern among stakeholder groups in Igiugig. For some interviewees unintended consequences pertained to unintended environmental consequences while for others unintended consequences included other social factors. Some stakeholders suggested doing exhaustive background research on any potential conflict that could come with the installation of an instream tidal energy devices. In particular, federal agencies, municipalities, non-governmental organizations and national laboratories were especially concerned about unintended consequences. Most stakeholder groups mentioned having a method to monitor and a way to respond quickly or immediately to problems that arise with the device. One stakeholder went as far as requiring any new project to ensure that habitat was returned to its original condition should any potentially harmful unintended consequences arise.

4.4.4 Loss of Access to Space

Loss of access to space was the fourth greatest concern in Puget Sound and the fifth greatest concern in Igiugig among stakeholder groups. While it may appear that loss of access to space is the same concern as conflict with other uses both of these two concerns emerged from preliminary interviews with university researchers where the list of concerns provided to interviewees were created. Many interviewees saw loss of access to space and conflict of use as different concerns. Other interviewees saw these two concerns as the same, in which case they were ranked the same. In particular, federal agencies, Indian Tribes, and non-governmental organizations were concerned about losing access to space. One Indian Tribe representative suggested making sure that devices were placed in areas that were not usual and accustomed fishing areas while another member suggested that this really isn't possible. A representative of a federal agency suggested ensuring a reasonable relationship with any people that previously used the area to explain why the project is taking place, and that their concerns were acknowledged and attempted to be resolved to the best of the project lead's ability. Project-centric development approaches like this have brought up issues of when stakeholder engagement should occur and how stakeholder issues can be resolved to their satisfaction (Ounanian et al., 2012).

4.4.5 Informing Public Accurately

Informing public accurately about the project was the third greatest concern in Igiugig and the fifth greatest concern in Puget Sound among stakeholder groups. In particular, industry, federal agencies, and national labs were concerned about how the public was informed about projects. One industry representative suggested that the project developer be proactive in providing timely and accurate information about the development and status of the project. Other industry representatives suggested having engagement early and often with the public while also acknowledging that they may not have all of the answers. Another industry representative has had great success holding public meetings at various times and locations to provide as much accurate information as possible directly. They stated, “I think fear about a project development like this comes from a lack of understanding.”

With early and often engagement through public meetings, newspaper announcements, open houses, newsletters and much more, getting the message out and providing the public and stakeholders an opportunity to gather information and comment can happen. Nevertheless, not all stakeholders will have the same idea of what is a proper level of engagement and who should be involved. Furthermore, some stakeholders may want to be more engaged than by just being included in public comment periods. Tools and frameworks to address this issue such as Strategic Environmental Assessment (SEA) can be used to foster appropriate levels of engagement. A SEA considers environmental, economic, and social policy consequences and allows for them to be addressed at the earliest stage of decision making (Howell, 2012). A SEA used in the Bay of Fundy for instream tidal energy development successfully engaged stakeholders from geographically isolated areas and increased stakeholder involvement. Excluding important or powerful stakeholders can impact project development and efforts should be made to decrease fear by promoting understanding of a project.

5.0 Discussion

This research fills the gap in the literature targeting the social implications of instream tidal energy technology and how those perceptions can be addressed in order to move forward to wide-spread implementation of this technology. Previous work exploring the siting of instream tidal energy devices has

overlooked factoring in perceptions of the technology by stakeholders (Abundo, 2012) despite policy holders becoming increasingly concerned with acceptance of renewable energy projects (Devine-Wright, 2011). There has been a demonstrated need to explore the role of the location of instream tidal energy projects and their relative levels of acceptance (Devine-Wright, 2011). Results from this comparative case study can be used to promote the implementation of instream tidal energy technology and help identify the location of potential new instream tidal energy projects throughout the world.

The 10 perceptions of tidal energy presented to interviewees adequately captured the majority of their perceived concerns and benefits of the instream tidal energy within their respective geographic areas. Interview participants added additional perceived benefits that they felt were not directly captured by the original ten perceptions. These added perceptions provided additional detail or specificity to the perceived concerns outlined by the originally provided ten benefits and concerns.

Not included in the original ten concerns provided to interviewees was the concern of an instream tidal energy project interfering with treaty rights. While arguably this concern could fall under other concerns such as loss of access to space, environmental impact, or conflict with other uses, one tribal stakeholder group representative felt that in their view it was strong enough of a concern to have it listed as its own entity. The fact that this concern was not identified and included by the collection of researchers whose input was used to generate the original ten stands out. A potential reason for this omission could be that they saw this concern was adequately captured by other listed concerns that addresses potential tribal issues.

Themes derived from the grounded theory analysis may potentially help identify “hot beds” of opportunity for the initial successful siting of instream tidal energy projects. While a project location would not need to have all three identified themes (i.e. having stakeholders that have a favorable opinion of the project compared to other locations, a strong wellbeing justification, and a “short chain”), if a project were to have aspects of one or more of these themes it may be more likely to succeed when evaluated from a social perspective. Not only the extent of stakeholder groups and stakeholders that are either impacted or interested in a project, but also the amount and organizational power of stakeholder groups and

stakeholders needs to be considered during outreach to stakeholders, and when framing these discussions around tidal energy projects.

From a developer perspective, it could be advantageous to consider multiple potential places for project development to identify locations where there are favorable social factors. When doing so both the the types of stakeholder groups, levels of support from stakeholders, and the short chain theme should be taken into account. Distinguishing one location among many where there are fewer stakeholders, more supportive groups of stakeholders, and greater support from stakeholders may lead to an opportunity for smoother development. These locations could potentially have less resistance and allow for project developers to more effectively address stakeholders concerns.

Places that can justify the project as improving the wellbeing of stakeholders may be set up for success. On a microscale, for the wellbeing justification to be fully utilized, individual stakeholders and stakeholder groups should be presented with a project in such a way that it not only addresses their concerns, but frames the benefits in such a way that it promotes their wellbeing. Meanwhile on a macroscale, project development opportunities should be pursued where a greater number or percentage of stakeholder groups can readily see a wellbeing improvement from project development. Fostering and identifying locations with improved stakeholder group wellbeing from project development may lead to greater instream tidal energy project success.

This research takes a solid approach to understanding the perceptions of instream tidal energy projects but could be enhanced with expansion in the number of interviewees. Due to resource and time constraints, this was not possible. Unfortunately, state agency representatives that were involved in the Igiugig FERC pilot project commenting process and a vocal industry dissenter that was involved in the Puget Sound FERC pilot project commenting process did not respond to requests for interviews. The inclusion of these representatives would have provided further insight into the stakeholder group dynamics in the two locations. However, this work soundly depicts perceptions of instream tidal energy in the two locations.

6.0 Conclusion

This paper presented two cases to better understand what stakeholder groups perceived benefits and concerns were about the development of an instream tidal energy project. While both locations used similar technology, they varied vastly in their population size and degree of isolation from traditional, municipal power sources. Providing local renewable energy, advancing science and technology, and environmental awareness were some of the top perceived benefits of the technology, while negative environmental impacts, conflicts with other uses, and unintended consequences were some of the top perceived concerns of the technology. Outside of this work, research, frameworks, and tools exist to address these concerns with stakeholders and should be considered when considering project development. Some of these approaches included adaptive management, strategic environmental assessment, and marine spatial planning (Jansujwicz & Johnson, 2015; Doelle, 2009; Alexander et al., 2012). Identified benefits can be used to market this technology and used as a basis for discussion across stakeholder groups to illustrate the positive influence tidal energy projects could have for a community and our planet. The findings suggest that across all stakeholder groups, stakeholders are encouraged about making efforts to reduce emissions from electricity generation on the local level. Also, despite negative environmental impacts being the greatest concern, the benefit of environmental awareness ranked towards the top of the provided benefits. This may provide an opportunity to address environmental concerns by framing projects as opportunities to learn more about the location where devices are placed through practices such as monitoring or baseline studies. It was found that there was overall more support in smaller communities isolated from municipal power sources, that had a demonstrated need for energy.

Marine renewable energy and instream tidal energy technology continue to evolve. To have the first commercial instream tidal energy project developed in the United States, and to further promote the technology world-wide, human dimensions must be placed at the forefront of the conversation about any new project development. For each new tidal energy project location, unique stakeholders will emerge and consideration of their opinions is necessary. As the case studies in Puget Sound and Igiugig have demonstrated, there are locations that may be more prone to project success, such as places that have

‘shorter chains’ of stakeholder groups that more easily provide the opportunity for the concerns of all stakeholders to be addressed, and places that can adequately justify a project as promoting a community’s wellbeing. While further social research will aid instream tidal energy development, this research has demonstrated that small communities that will see their member’s wellbeing improve with project development may provide a location for the first commercial instream tidal energy project in the US and the spark that is needed to ignite further development.

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