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Beaver Island and a Renewable Energy Future

Executive Summary

The objective of this project is to provide Beaver Island Sustainability Fair and the wider island with feasible courses of action to achieve a 100% renewable energy target from local sources. The project provides several possible courses of action for the island to pursue and achieve this goal as well as an analysis into previous case studies of renewable energy on islands, highlighting the case of the Samsoe island in Denmark and Isle au Haut in Maine as examples the demand further examination and provide effective models for Beaver Island. When examining culture and values on the island expressed through interviews, governmental objectives and available research data, this project argues that solar and geothermal is not only a feasible reality for Beaver Island but also best correlates with the island's values and life. It is recommended that Beaver Island pursue these two renewable energies by either becoming an electrical cooperative or public utility and using a Buy-All Sell-All method or Power Purchasing Agreements. However, before implementation, it is strongly encouraged that there should be public campaigns on energy efficiency to aid in the transition to renewables as well as further research into the energy possibilities and political structures that Beaver Island can seek to satisfy its renewable energy goals.

Introduction

Situated in Lake Michigan, 32 miles off the coast of Charlevoix, is an island that is unique to all others. Beaver Island, the largest island in Lake Michigan, prides itself as an oasis for residents, where times seem to slow and one can escape from the daily harassment of everyday life. This point is accentuated by the island's isolation, as it is only accessible by a three-hour boat ride or by plane. Beaver Island's seclusion, natural beauty, and recreational harbor make it a popular destination for tourists and seasonal residents as the island's six hundred year-round population almost doubles in the summer (Beaver Island, 2020). Its seclusion and limited population allow Beaver Island to maintain its cultural history and traditions which emerge from fascinating history and are integral to understanding the community's future plans.

In 1856, Beaver Island was home to the Mormon Kingdom. Claiming to be the only continuation of Joseph Smith's church, James Strang and his followers fled to Beaver Island to avoid prosecution and settled among the Irish immigrants already residing on the island (Beaver Island Net, 2020). In 1850, Strang proclaimed himself king of his religion, making Beaver Island the first and only kingdom in the United States (Beaver Island Net, 2020). His monopoly rule was marked by frequent and violent clashes with non-followers on the island and neighboring islands Lake Michigan. Many of the previous Irish immigrants who settled on Beaver Island fled to Mackinac island to avoid prosecution and even returned to take back the island but were fought off by Strang and his followers (Beaver Island Net, 2020). Eventually, Strang was assassinated and the kingdom's followers were eventually replaced by returning Irish fishermen. Despite the political upheaval that Beaver Island experienced, the island continued to foster an

independent and individual identity in contrast to the mainland. The island's isolation allowed this identity to further develop and today one is able to witness how community values and a desire for independence influences life on Beaver Island, including the island's energy market and desire for renewable energy.

Served by only one provider, Great Lakes Energy, Beaver Island is vulnerable to energy poverty both geographically and economically (Wang, a.l 2020). Its energy consumption is small in comparison to other areas that Great Lakes Energy services and its isolated location presents many technical challenges when the current energy servicing method is undermined. Beaver Island currently receives its electricity from an underwater cable, which some locals refer to as their umbilical cord to the mainland. This tenuous connection raises many concerns about energy security on the island. Beaver Island does have backup generators, renewed in the 2000s, that assist in peak energy times or provide power during blackouts or when construction on the underwater cable is necessary. Most Beaver Island residents also depend on propane as an energy source for heating and cooking, although many are dissatisfied with propane due to its higher prices than in other regions because of shipping costs. Relying on this source also raises concerns about its availability, as in one discussion, a worker tasked with supplying Beaver Island commented how recently he had to chain saw through ice on Lake Michigan as the oil tanker was frozen in the lake's treacherous winter conditions (Beaver Island Sustainability Interview, August 1, 2020). During that time, fuel had to be flown to the island, greatly increasing the costs and inconvenience for residents. In past years when this has occurred, islanders had to ration remaining fuel while the ships were being rescued (Beaver Beacon, 2008). Beaver Islands' low consumption and lack of interconnections mean higher energy costs than

other areas and reliance on tenuous connections. To increase their energy security, many islanders prefer indigenous, renewable sources (Notton, 2015). While some residents already use renewables on the island, such as small installations of solar or burning wood, there is a desire for the whole island of Beaver Island to be self-sufficient and rely solely on local renewable energy.

The purpose of this research is to provide Beaver Island with possible future energy multiple plans that match their community values and desires. Based on the values for independence and self-reliance, this research will examine the feasibility of renewable energy on the island and specifically the implementation of solar and geothermal, although wind power is briefly discussed. I hope that this study can be used as an educational resource to support future energy plans on Beaver Island and residents seeking renewable energy. This project will provide an analysis of renewable energy being implemented on island communities elsewhere, and outline possible courses of action for Beaver Island to implement solar and geothermal energy. This project will also provide an overview of energy efficiency and conservation as well as examining a variety of funding sources that residents can apply for to aid in the successful transition to clean energy.

Stakeholders

Developing and implementing renewable energy on the island is a complex process and involves a diverse group of stakeholders. This section will provide a description of each stakeholder and a contextual understanding of the relationships and motivations of the actors involved in this study.

Beaver Island Sustainability Fair

Beaver Island Sustainability Fair is a local organization, formed over five years ago and composed of permanent and seasonal residents concerned about environmental issues on the island and surrounding archipelago, focusing on promoting solutions in renewable energy, ecology, and local food systems. Their annual fair features local and regional green vendors, sustainability experts, and encourages the development of art music, environmental education, and action to promote Beaver Island as a regional sustainability leader. The organization and its annual fairs are rapidly growing in numbers and community involvement, which last year hosted over two hundred attendees and received a small grant for future events. This research project worked closely with this organization and will present its conclusions in January 2021.

Local Community, and Townships

Despite Beaver Island's small size, it is home to two townships. St. James township includes the town of St. James as well as the surrounding archipelago, while Peaine Townships extends to the lower half of Beaver Island. The island's population is around 600 permanent residents but has over 1,000 housing units, 73% of which are vacant for much of the year due to seasonal residency (Census Reporter, 2018). Beaver Island is 94% white with a median age of 62 and a household income of $56,000 (Census Reporter, 2018). Beaver Island is a tourist economy that prides itself on its natural landscape and beaches. Much attention is placed on maintaining that island's aesthetic for residents and tourists as reflected by community values expressed through interviews as well as the goals outlined in Beaver Islands 2017 masterplan.

Groundwork Center for Resilient Communities

Based out of Traverse City, Groundwork Center for Resilient Communities is a nonprofit that collaborates with citizens and local and state leaders on sustainability projects across Michigan. Their main objectives are building community health by improving food, energy, transportation, and the economy. Their focus on energy means supporting renewables, energy efficiency, and local energy production and input. One of the nonprofit's recent accomplishments includes its involvement in Traverse City's renewable energy transition plan. The organization has yet to be directly involved in any projects on Beaver Island, however their representative of Groundworks renewable energy department, Rick Evans, has been contributing to the preliminary renewable energy planning on Beaver Island. Rick Evans is also on the Great Lakes Energy representation board and has been an educational resource for the Beaver Island community. This relationship and further development of Beaver Island's renewable energy plans could lead to a later partnership with Groundwork.

Great Lakes Energy

Great Lakes Energy is the only utility available for Beaver Island. They are one of Michigan's largest energy cooperatives with elected representatives for each district and serving more than 125,000 member-consumers. The energy cooperative services nine districts within 26 counties, with Beaver Island belonging to the second district along with Charlevoix and Cheboygan counties and represented by Mark Carson. Great Lakes Energy does offer energy efficiency and renewable energy programs, although currently, none exist on Beaver Island. Their activity on Beaver Island is minimal compared to other districts due to the island's low population and seclusion from the mainland of Michigan. Great Lakes Energy provides Beaver

Island with power by the underwater cable which connects back to the mainland of Michigan, as well as their propane and internet services.

Methodology

The analysis of this project relies on insight from academic literature as well as interviews with the local stakeholders noted above. For the academic literature review, this research examined an enormity of publications on renewable energy, as well as energy on islands and case studies of renewable energy implementation on islands to provide a contextual understanding of Beaver Island and its desires for renewable energy. This section relied heavily on diverse research from domestic and international authors, as well as available federal and international organizations, nonprofit and governmental publications. This literature analysis also included a two year study on energy efficiency and renewable energy on Beaver Island in 1992 by Conrad Heins from the Jordan College Energy Institute and Tom Stanton from Michigan State University. While this is the only previous study conducted on Beaver Island that relates to this project and this project does utilize its conclusions, given it was published over twenty years ago, there is a need for updated information for a more accurate analysis. This review provided insights on microgrid energy, renewable energy on islands, the feasibility of renewable energy on Beaver Islands, as well as an overview of available resources and funding.

This project also interviewed a variety of local community members, energy experts, and public officials to understand Beaver Island's energy desires and needs. Prior to interviews, I conducted a preliminary literature review into public stakeholders and opinions to provide a theoretical framework to understand the values and ideas expressed by local community

members and other interviewees. This literature review focuses chiefly on the frameworks and theoretical perspective presented by Frank N. Laird in *Solar Energy, Technology Policy and Institutional Values* (2001) and Gordon Walker, et al.'s chapter "Symmetries, Expectations, Dynamics, and Contexts: A Framework for Understanding Public Engagement with Renewable Energy Projects," in Devine-Wright, P. (ed). *Renewable Energy and the Public: From NIMBY to Participation* (2011). The conclusions presented in these sources are utilized to understand the ideas that emerged from interviews as well as provide policy recommendations, highlighting the importance of utilizing forms of renewable energy that best fit the culture and life of Beaver Island. To contribute to this contextual understanding, this academic literature review also relied on Gordon Walker, et al, which focused on opposition responses to renewable energy and how community values impact the feasibility and location of energy projects. This reading stressed that opinions and values are not separate from each other but instead interact and influence each other. Instead of viewing, individuals are predisposed to oppose a project or opposition as constant, there should be an encouragement of local debate and discussion as all ideas are negotiable (Walker, et al. 2011). These two literature analyses present an integral framing of the values and stakeholder perspectives expressed by Beaver Islanders and others and provide an academic and practical structure for the island to continue pursuing renewable energies.

Interviews began in August 2020 and included a variety of local stakeholders, residents and renewable energy experts. Most interviews were conducted virtually, however in October, I had the opportunity to attend a Clean Energy Focus Group on Beaver Island. There I was able to interview local residents, employees and public officials and attend the focus group where I was able to present my working research as well as observe the islands first meeting on pursuing a

renewable energy goal. The event was largely successful, with over twelve individuals attending and allowed me key insight into the desires and aspirational goals of Beaver Island.

Results

From the interviews conducted, there were evident common themes and individual expressed ideology. To understand this, this section used Laird (2001) theory of positive (empirical) and normative (values) facts, and how the blurring of these two result in values being accepted as empirical statements and universal truths. This analytical lens was used to understand viewpoints expressed in interviews as well at the Focus Group as Laird (2001) revealed the influence of values and ideology on our perceptions of experiences and social and political life and a understanding of why some Beaver Islanders are choosing certain technologies that will encourage some forms of life while discouraging others (Laird, 2001). Additionally, to analyse the interviews and desires of Beaver Islanders, this project used Gordon Walker, et al. (2011) framework of cultural heritage and tourist economies influencing renewable energy perception and implementation practices. As the reading suggests and as interviews on Beaver Island reveal, renewable energy has been opposed due to conflicting values of landscape beauty and aesthetics as renewables are viewed as industrializing the area. However, Walker (2011) argues that connection to the heritage of the town allows for a recognition of the resilience of the community and the need to be self-sufficient, a characteristic offered by renewables. Strong values of Beaver Islands natural resources, tourist economy and cultural heritage was expressed by various interviewees, and evident in the island's Master Plan objectives for the island as well as in the cultural fabric on Beaver Island. Understanding this

theoretical framework will allow certain reservations and opposition to be circumnavigated and support certain conclusions.

Moreover, Laird's conclusions about energy policy should "tap into the intelligence of democracy" (2001) by incorporating perspectives from diverse participants to avoid large mistakes and provide feedback to improve policy, and continues to guide the purpose of this project to be a bottom-up approach and further local discussion and debate.

Challenges of COVID-19

Given the unprecedented challenges that COVID-19 has presented this year, it is important to note the impacts that the global pandemic has had on this study to provide context and some explanation for potential project shortcomings. Initial research began in spring 2020 when the pandemic was just beginning to unfold in the United States and Michigan. Due to Beaver Island's isolation from mainland life, and limited online presence, most information, and ideas from the Beaver Island community are by word of mouth only. Along with university constraints on travel, it was extremely challenging to obtain information from afar. As such, it was not until contacting Beaver Island's Sustainability Fair in late July 2020 that this project was able to gain insight and communication with island locals. This research must be in collaboration with local communities and reflect their hopes and needs to provide relevant and feasible conclusions. Unfortunately, due to the challenges of COVID-19, I was not able to interview all of the stakeholders originally identified. While I was able to visit the island for a Clean Energy Focus Group, I was not able to return to conduct more in-person analysis and interviews. While this project will still be able to be used as an educational resource as it was intended to, more

local discussion, participation, and research is needed to create a more comprehensive renewable energy plan for Beaver Island.

Microgrid Energy

Beaver Island is a rural island that can become a microgrid community. This section will define what a microgrid community is and discuss the drawbacks and benefits of microgrid and island communities as they relate to renewable energy production. Drawing on previous case studies of microgrids and renewable energy on islands this section will present the challenges and advantages Beaver Island will face in implementing renewable energy and transitioning to a microgrid.

Beaver Island; A Possible Microgrid

Traditional grids operate by connecting residences, businesses, and other buildings to central power sources while a microgrid can disconnect from the traditional grid and operate autonomously (Lantero, 2020). This allows microgrids to strengthen grid resilience and grants communities energy independence (Lantero, 2020). Although Beaver Island is powered by the underwater cable from Great Lakes Energy, and thus, not a microgrid, it has a backup generator on the island that allows it to be self-sufficient when the connection to the main grid is severed or needs repairs. In several interviews, islanders expressed desires to shed their energy connection to the mainland and become an energy-independent island as well as embracing renewable energy (interviews, 2020). Embracing a microgrid on Beaver Island would allow this transition to happen.

Compared to traditional gird, microgrids can be powered by various sources, making them the ideal grid to implement renewable energy resources (Lantero, 2020). Their flexibility allows the integration of intermittent energy sources, such as solar, and connects to local sources of energy that are considered too small or unpredictable for traditional grids to utilize (Lantero, 2020). Furthermore, microgrids have been shown to increase energy efficiency by reducing energy losses in transmission when using local energy (Energy.Gov, n.d). Beaver Island's geography presents many opportunities and challenges in meeting its energy needs. Given its isolation away from the mainland, Beaver Island has a history of flickering lights, loss of power, and large and expensive infrastructure projects that take years to complete to deliver power to the island. Many locals crave energy security and active participation in the sources and choices of their utility (interviews, 2020). Embracing microgrids cultivates democratic principles as public engagement is increased by their small scale and availability of use to commercial and residential building sites along with grid owners (Weng, et al. 2020).

Despite the various benefits that microgrids have to offer for Beaver Island, there are also serious drawbacks. To mitigate natural fluctuations of renewable energy, microgrids need to be specialized to the area due to the storage and the energy that that particular grid relies on (Weng, et al. 2020). This requires close attention to the demand, storage and transmission services on the island and possibly a need for some infrastructure to be strengthened or added on to ensure the microgrid efficiency and reliability. Additionally, microgrids with renewable energy have higher investment costs than traditional grids (Weng, et al. 2020). Mainly this is due to the extra

infrastructure that needs to be added beforehand. While this cost has steadily declined over the last few years, it can still pose a financial hurdle that deters some areas from implementing it.

Previous Case Studies of Renewable Energy on Islands

Beaver Island is not alone in its pursuit of island-based, renewable energy. Beaver Island is part of a larger movement of over a thousand island communities piloting renewable energy projects as a means to strengthen energy security and self-reliance (Gil & Simon, 2017). Many of Beaver Islanders' sentiments and energy plans reflect other islands' desires, and previous case studies illuminate the challenges and strategies that Beaver Island will likely experience. This section of the research project relies on an academic literature review of case studies of islands implementing renewable energy to provide a broader context of Beaver Islands energy movement and recommendations for courses of action.

Islands have been at the center of renewable energy pilot programs and are paving the way towards a clean energy future. Not only are islands at the forefront of climate change given their vulnerability to rising sea levels, coastal erosion, and extreme weather events (GSEII, 2020), but their heavy reliance on fossil fuels, due to their isolation and low energy consumption, leaves island communities exposed to market changes and increased prices (Energy.gov, n.d). In response, many island residents have turned to indigenous energy sources, hoping to diversify their energy resources and increase energy security and resilience (Notton, 2015). Many of these energy transitions have been a partnership between public and local government concern with renewable energy being implemented by governmental initiatives. In the global south, many island's renewable energy transitions have also been the result of international organization

incentives and advocacy or in response to the home countries incentivizations to pilot clean energy projects on islands before application on the larger country. For many island communities, renewable energy is a competitive and viable energy option due to the high prices of traditional energy sources (Duic, et al. 2004). However, there are still many difficulties and obstacles to the transition to renewables, both technical and social.

Islands present infrastructural and technical challenges to energy production given their isolation and unique economic circumstances. Most island economies are based on tourism, causing seasonal fluctuations in their energy demand. The energy system on the island must be able to meet the energy demands for the island throughout the year, accounting for expected and unexpected changes in demand (Notton, 2015). In the case of a microgrid island community or an energy-independent island, this must be accomplished without drawing on external sources. As such, the implemented energy system must be able to enhance energy security by matching energy demand. Failure to do so would only exacerbate energy issues on islands. Due to the island's natural limited population and average energy consumption, it is unnecessary to implement highly concentrated power plants because of the higher infrastructure costs and the excess of energy produced that the island does not need. Instead relying on renewables is less expensive, can be installed faster than a larger concentrated power plant and is still able to match demand without producing more than the island consumes (Notton, 2015). However, renewables natural intermittency requires careful implementation on islands as if located incorrectly, their fluctuations in energy could exacerbate the fragility of energy security on the island (Notton, 2015). To mitigate these issues, enough infrastructure needs to be created to meet peak energy demands and siting renewables needs to be done carefully. Small islands require a balanced

geographical distribution of renewables as concentration of renewable sources on islands can cause power fluctuations whereas multiple locations can allow power to still be generated when one area is under cloud cover for example (Notton, 2015). Additionally, storage technology needs to be integrated with renewables to provide power during intermittent periods. Unfortunately, storage technologies for intermittent energy such as solar and wind, are not yet technically feasible (Chen, et al. 2007). While research and innovation develops each day, many islands such as the Canary's, and Porto Santo have chosen to implement hydrogen storage technology, and infrastructure to mitigate this issue (Gil & Simon, 2017). Hydrogen storage is the process of splitting water molecules into their base components, both oxygen and hydrogen, and releasing the oxygen back into the atmosphere (Ellamoor, 2019). The hydrogen gas is then stored as a liquid and can be used for fuel (Ellamoor, 2019). This is a very heavy energy dependent process, however given its wide availability for islands and the necessity for islands to produce enough energy during peak demand, allows islands to use the excess energy produced by renewables to make this conversion (Ellsmoor, 2019). Beyond the technical and socio-economic concerns that islands pose, islands also present unique cultural challenges that need to be mitigated when transitioning to renewable energy.

As one research study concludes, islands' isolation can result in a stronger unity to the local cultures traditions and customs, as compared to other areas, their isolation limits their connection to outside ideas and variancy (Colmenar-Santos, et al. 2013). This study focused on several island communities including Cyprus, the Hawaiian Islands, the Canary Island, and Samsoe (Denmark) and clearly illustrated that despite the diversity of island cultures, renewable energy needs to coincide with the socio-cultural context on the island (Colmenar-Santos, et al.

2013). As such, renewable energies and energy infrastructure should be specialized in the region and best reflect the desires of the local community. As the researchers strongly advocate, public engagement is vital to the success of renewable energies on islands, best exemplified by the case of Samsoe successfully achieving 100% reliance on renewables from the strong involvement of the local public in development (Colmenar-Santos, et al. 2013). Despite the specialized approach that islands require for an energy transition, many islands have successfully embraced renewables and their success reveals a future pathway for Beaver Island.

While there are a plethora of case studies of renewable energy implementation on islands, this research paper will narrow its focus to two successful cases that best correlate to the circumstances of Beaver Island and provide the most evident recommended course of action that matches the theoretical framework of this project. This includes the case study of Denmark's Samsoe Island and the Isle au Haut in Maine.

Samsoe island is widely considered to be the leading island for renewable energy. While Samsoe has focused on wind energy when this project mainly concerns solar and geothermal, its public engagement and implementation strategy sets a precedent for Beaver Island. Today, Samsoe has 23 megawatts of offshore wind, enough to offset all car use to travel to the mainland (Lewis, 2017). Previously, Samsoe relied almost solely on imported oil as fuel (Colmenar-Santos, et al. 2013). This impressive transformation is highlighted by the fact that it took only 10 years mainly due to the strong public involvement and the investment strategy of the island (Colmenar-Santos, et al. 2013). The project cost roughly 50 million euros, 80% of which was financed by island inhabitants with support of the laws set by the government through

a community buy-in opportunity (Lewis, 2017). The distribution of ownership of the wind turbines allowed a variety of investors including private owners and investors, the local government, and local cooperatives who sell the energy produced to the regional distribution company (Lewis, 2017). This public engagement strategy allowed Samsoe to meditate community disagreement and negotiate with opposition groups, allowing the island to quickly integrate renewables (Lewis, 2017). While there are other renewables on the island, such as biomass for heating, and some residents still use the traditional heating method by burning wood or wheat, most of the island's energy needs are covered by wind (Biello, 2010).This strategy also correlated with the island's strong community values, and tourist based economy allowing the renewable energy implementation to coincide with the existing culture on the island as well as being advertised as a benefit to the local economy. This case study should serve as an example that highlights the power of public engagement and its necessity for renewable energy implementation. When beginning its renewable energy transition, Beaver Island should consider the strategies of Samsoe as a template. Its public engagement and participation allowed the accelerated implementation of renewables as well as correlating with the strong community values on the island which allowed renewable energy to cater to the existing culture and social fabric on the island.

While Samsoe serves as a successful policy management case for Beaver Island, Isle au Haut best correlates with the current energy circumstances on Beaver Island. Isle au Haut is a small island in Maine with a year-round population of 54, with 250 residents in the summer, and with most of the land composed of Acadia National Park (Isle au Haut Maine, n.d). Like Beaver Island, Isle au Haut currently gets its electricity from an underwater cable from the mainland

(Bouchard, 2020). Unlike Beaver Island who already had to pay for repairs on their underwater cable, Isle au Haut's underwater cable was only designed to last 15-20 years when it is now 36 years old (Isle au Haut Maine, n.d). If the cable fails, the island does have a backup diesel generator, but depending on this source would greatly increase the prices for residents (Bouchard, 2020). Instead of waiting for a catastrophe, Isle au Haut's Power Company, which is a private non-profit co-op, plans to transform the island into a microgrid and construct a 300kW solar array to become a 100% renewable-powered independent island (Bouchard, 2020). When other islands have pursued hydrogen storage technology, Isle au Haut choose to install 1,000kWh of supercapacitors (Isle au Haut Maine, n.d). According to the manufacturer, supercapacitors are electronic devices that store and release energy at a rapid rate without degrading as other batteries do (Bouchard, 2020). These batteries have a virtually unlimited life cycle and are safer compared to other battery storage methods (EEPower, n.d). While the underwater cable is still functioning, Isle au Haut plans on selling excess power to the mainland but once the cable fails, any excess power can be easily stored (Bouchard, 2020). In addition, the island plans on adding thermal storage in the form of heat pumps to replace costly propane (Isle au Haut Maine, n.d). This renewable energy strategy will be a fraction of the cost compared to replacing the underwater cable and grant them energy independence and self-reliance (Bouchard, 2020). Given the similarities between Isle au Haut and Beaver Island, Beaver Island should consider the former islands strategy to utilize the underwater cable as a transmission for selling excess energy to the mainland, and further investigating the use of supercapacitors to store solar energy. Beaver Island should also utilize the same cost comparison that the local government of Isle au Haut did for the service of underwater cable to justify the use of local renewable energy

and not only gain local support but local government action as well. These strategies could greatly aid Beaver Island in realizing their renewable energy goals.

Energy Perceptions on Beaver Island

Based on the opportunities and challenges presented to Beaver Island as a partial microgrid and island community, it is important to implement the right kind of energy that correlates best with islanders' values as it will be a sustainable energy source for years to come. This section of the research study will provide evidence to explain this project's focus on solar and geothermal energy for Beaver Island.

From research surveys conducted by the Yale Program for Climate Communication, over half of the residents in Charlevoix county, which includes Beaver Island and the township of Charlevoix, are worried about climate change (2020). Yet based on the interviews conducted with locals and Beaver Islands Sustainability Fair's renewable energy goals, transitioning to renewables are not motivated by climate change concern or action but instead as sentiments of environmental protection, which can possibly clash with renewable energy if it as seen as industrializing the natural landscape and self-reliance through energy independency (Interviews, August 19, 2020 and Clean Energy Focus Group, 2020). While there is a recognition for action to mitigate climate change as Beaver Islanders themselves are experiencing rising lake levels and coastal erosion (Interviews, October 15, 2020), it is not a primary motivator driving the community's desires for renewable energy. This phenomenon could be explained by the theoretical framework presented by Gordon Walker, et al. in the chapter "Symmetries,

Expectations, Dynamics, and Contexts: A Framework for Understanding Public Engagement with Renewable Energy Projects," in Devine-Wright, P. (ed). Renewable Energy and the Public: From NIMBY to Participation (2011). Walkers and other conclusions provide an alternative explanation, revealing that there is a strong connection to the relevance of one's town heritage and a tourist-based economy to the recognition of the need for resilience and self-sufficiency which renewables offer (2011). Beaver Island is a tourist-based economy and has a vibrant heritage which is not only reflected by interviews conducted for this project but Beaver Islands' 2017 Master Plan goals. Preference is placed on increasing tourism by expanding infrastructure and convenience on the island as well as preserving the cultural heritage and history (Beaver Island Masterplan, 2017). Using Walker et al.'s theoretical framework, these values better characterize the context for only just over half of residents concerned about climate change while 86% believe that we should fund research in renewable energy and allow incentives for solar and wind on private property (Marlon et al. 2020). This characterization coupled with the strong theme of energy independence and a strong desire for lower energy costs which is common for island communities (Gil & Simon, 2017) and expressed by multiple interviewees (Interviews, August 19, and October 15, 2020) best explain the pursuit of renewable energy goals on Beaver Island. Given this data this project will mainly focus on solar and geothermal as renewable energy options for Beaver Island. Geothermals individual installation and limited impact on the island coordinates with environmental protection values while also increasing energy security. While solar might be challenged by fears that it will industrialize the natural beauty of Beaver Island, its arguments for self-sufficiency and resilience as well as its appeal for lower energy costs, could override these concerns.

Additionally, there is already high interest in solar energy on Beaver Island, not only reflected in the Master Plan but recently in the installations at Mcdonough's Market in St. James township, from an energy efficiency study conducted on Beaver Island in 1992 (Heins & Stanton), as well as the two full-time resident islanders who have been off the grid for thirty plus years using mainly solar and some wind (Clean Energy Focus Group, 2020). Solar's ability to be installed locally has many islanders attracted to its independence and self-sufficiency qualities. While there are concerns about its intermittency which has been previously discussed in other solar energy implementation cases on islands, solar best correlates with the increase in energy usage during the summer and would still be able to provide enough energy for the smaller winter population . Given the energy usage on Beaver Island (discussed below) and its receptiveness to locals, it appears solar would be an appropriate renewable energy for Beaver Island.

Although geothermal is only briefly referenced in Beaver Island's Master Plan, there have been several implementations on the island including at the Holy Cross Catholic Church and increasing interest and awareness about its potential for the island (interviews, 2020). The successful examples of homes on the island using geothermal and the dramatically reduced heating costs, as well as its reliability, geothermal seems like an easily accessible and integrated energy system to use for more homes on Beaver Island. This is supported by research concluding that geothermal can very easily be integrated into existing power systems and requires fewer costs for homeowners as they do not need to replace large functioning equipment to be compatible with the new energy input (Duic, et al. 2003). As a reliable source for heat and at times energy, geothermal would be an appropriate source of energy coupled with solar for many full-time residents. In the winter, islanders use 8.7% more electricity, mainly for heating (Beaver

Island Master Plan, 2017). This increased energy demand could prove challenging as naturally, solar produces less energy in the winter. The addition of geothermal could meet this demand when solar struggles to do so without sacrificing comfort.

Despite the mention in Beaver Island Masterplan, this research study will not devote much of its attention to wind energy on Beaver Island. Walker et al. suggest strong values for natural resources and landscape aesthetics, which are evident on Beaver Island, can cause discord as some view renewables, especially wind as industrializing the area (2011). This conclusion is supported by some opposing views expressed by Beaver Islanders (Clean Energy Focus Group, 2020) as well as a study conducted by Michigan's Energy Office in 2013 and the large opposition and successful rejection of offshore wind turbines in Lake Michigan (Vuljevic, 2011). Given this backlash, it seems feasible and acceptable for solar and geothermal to be used instead.

Feasibility for Solar and Geothermal On Beaver Island

There has not been any location-specific feasibility study for geothermal and solar for Beaver Island, however, given the island's geographical location, certain conclusions can be drawn about each energy potential on the island by using certain case studies.

Geothermal is the technique of using the heat in the Earth's core for electricity and heating (EIA, 2020). Instead of analyzing traditional geothermal, this research paper will focus on a hybrid geothermal system called Well-Connect Geothermal. This type of geothermal energy was created by a company based out of Alpena, Michigan, and caters specifically to rural areas to lower energy costs without sacrificing comfort, making it the perfect geothermal technology

for Beaver Island. Well-connect geothermal is a hybrid heat pump that uses well water to heat and cool your home (Well-Connect Geothermal, n.d). It works by drawing water from the home's existing well up into the unit which can be easily placed in a basement, closet or crawl space, passing through a vapor compression process to heat or cool the home (Well-Connect Geothermal, n.d). This process is very similar to a refrigerators operating system. After the water passes through the heat exchange, it is safely returned to the ground and re-absorbed by the earth (Well-Connect Geothermal, n.d). To cool the home on summer days, Well-Connect draws the warm air from the home and moves it underground (Well-Connect Geothermal, n.d).

This hybrid geothermal system does not replace a home's previous heating system as it is compatible with existing structures. Unlike other geothermal methods, this system uses only a fraction of the water and functions with wells that only pump two gallons per minute (Well-Connect Geothermal, n.d). When discussing geothermal at Beaver Islands Clean Energy Focus Group in October 2020, there were some concerns from residents about geothermal water usage and possible depletion of wells. This new design eliminates these concerns and since it does not require a replacement of utilities and can run on the existing home infrastructure this type of geothermal is easier to install for many islanders and reduces the cost of upgrading and having to change appliances to be compatible with renewable energy sources (Well-Connect Geothermal, n.d). This feature, along with its limited noise and smaller size, and its design specifically for rural areas make this hybrid geothermal system a feasible and excellent addition to Beaver Islands energy sources.

Although Michigan is not characterized as a high solar irradiance region, its geographical latitude is similar to very successful solar implementation cases in Germany (Sengupta et al.

2018). It is much farther south relative to the highest concentration of solar in Germany, and given Germany's success from solar, Michigan would still be a great candidate for solar (Vermont Energy Investment Corporation, 2015). Furthermore, there has been an increase in utility large-scale solar development in Michigan in the past few years and despite not being in the southwest, these developments have been highly successful in generating sufficient energy. This includes the recent announcement of a $90 million solar panel project in Cheboygan County (Steeno, 2020). Focusing specifically on Beaver Island, solar radiation data can be drawn from the data for Traverse City Michigan, and Green Bay Wisconsin, which are two geographically close cities. Measured in watt-hours, Traverse city has a score of 3,153 and Green Bay a score of 3,676 (Solar Radiation Data, n.d). This data represents that for every square meter, Beaver Island solar panels will absorb between 3,153 and 3,676 of energy for one hour (Smart Business, 2019). This is only roughly one thousand less than the amount of energy a solar panel will consume in Tampa Florida, and a moderate input given the islands location (Solar Radiation Data, n.d). Additionally, with summer daylight lasting up to 16 hours on Beaver Island (Heins & Stanton, 1992) and successful cases of solar being used on Beaver Island, it is feasible for solar to be an effective renewable resource on the island.

While there are currently no specific solar and geothermal feasibility studies for Beaver Island, the specification of Well-Connect Geothermal for rural areas as well as successful implementation cases in Northern Michigan and Beaver Islands estimated solar radiation score illustrates that Beaver Island is capable of developing these energy sources on a large scale.

Current Energy Use on BI

Even though Beaver Island is a small community, it relies on energy to power all of its needs. This section examines the energy use on Beaver Island given by Great Lakes Energy for the whole 2019 year and its seasonal variances.

According to the data provided by Great Lakes Energy, Beaver Island used consumption of energy is expressed below.

- Full-time residential members use on average 826 kWh/month.
- Seasonal members use on average 314 kWh/month.
- Average usage for full-time residential members in July 2020 was 841 kWh/month and was 801 kWh/month in December.
- Beaver Island used a total of 10,929,893 kilowatts of energy for 2019

The total amount of energy that Beaver Island consumed in 2019 is a fair indicator of the target that should be satisfied when implementing renewable energy. Based on the data given and the population spike in the summer due to seasonal residents, more energy needs to be accounted for in the summer than will be consumed in the winter. Incidentally this increase of energy usage would best correlate with solar energy and the increase of electricity use in the winter (Beaver Island Master Plan, 2017) will be supplied by geothermal energy when solar is less powerful.

Given that Beaver Island consumed 10,929,893 kilowatts of energy for the 2019 year, enough solar and geothermal energy need to be created to match this annual expenditure as well

as meeting energy peak demands. Unfortunately, geothermal cannot be calculated to match this demand but instead needs to be specialized to each individual's home or building. However, the widespread use of geothermal can lower the acreage for solar needed to accommodate for Beaver Islands total energy expenditure as well as providing a more reliable source of energy.
For solar to match this total energy consumption, Beaver Island would need to install 9.1 megawatts of solar or roughly 50 acres of solar to offset that load (Rick Evans, 2020). That equates to roughly 24,270 individual solar panels with each being calibrated for 375 watts per panel (Rick Evans, 2020). As one can see, Beaver Islands' highest consumption of energy correlation in the summer when solar is most readily available.

While this appears like a daunting number, this is still a feasible plan for Beaver Island as solar can be broken up into several different locations on the island and coexist with other buildings and areas in use. During the Clean Energy Focus Group, there was a high interest and contribution from the community on possible siting locations for solar. There were suggestions for solar panels to be implemented over parking lots, at the airport, at an old landfill and co-locating it with grazing sheep and agricultural land (Clean Energy Focus Group, 2020). Despite Beaver Island's small land mass, solar's ability to be co-located and integrated in various environments was easily accepted by islanders and allows solar to be a feasible renewable energy source on the island.

Energy Efficiency and Conservancy

When implementing renewable energy, it is also important to implement energy efficiency and conservation practices to contribute to lower energy prices and aid in meeting

energy demands with intermittent sources. This section will provide a quick synopsis of energy efficiency and conservancy practices that should be encouraged and administered on Beaver Island before introducing renewable energy sources or in conjunction with their implementation.

In 1992 students and professors from Jordan College Energy Institute and Michigan State University conducted an energy audit of Beaver Island. Their conclusions supported that simple conservation measures could greatly cut the island's annual energy bill and support greater use of renewable energy sources to improve energy independence and economic development (Broder, 1992). Although this report is over 25 years old, their conclusions about energy efficiency are still valid. There are simple practices and habits that Beaver Islanders can integrate into their daily life to lower their energy bill and use less power.

According to Beaver Island's housing demographics, over 50% of beaver island homes were built between 1950 and 1989 (Beaver Island Master Plan, 2017). Additionally, the 1992 study discovered that most refrigerators were over 10 years old which generally, as the largest energy consumer in the household, greatly adds to the individual's monthly energy cost (Hein & Stonton, 1992). Simple energy efficiency changes such as changing household light bulbs to LED ones, as light amounts to 10% of residential electricity consumption (EIA, 2020), or air sealing your home in winter can compound and cause dramatic impacts (Direct Energy, n.d). Additionally, renewing outdated appliances and purchasing Energy Star appliances is the single most effective energy efficiency method (EnergySage, 2020). When preparing for solar energy to be the household's main power source and updating appliances, consumers should try to electrify appliances as much as possible (Rick Evans, 2020). This transition will prepare

homeowners for future dependence on renewables. Beyond implementing energy-efficient technologies and practices to limit energy consumption and lower pricing, simple behavior cost to save energy can also reduce the energy required to power Beaver Island. While Beaver Island has a limited full-time residence population, simple measures can still be set in place to limit Beaver Islands' energy needs and make the transition to renewable energy easier. These simple measures, such as turning off the lights when not in the room or using natural light as well as ensuring your home is properly insulated can make a contribution (Igs Energy, n.d).

Beaver Island should take advantage of state incentives for energy efficiency and host public campaigns to update appliances and increase energy efficiency on the island. Islands have already hosted such events which have been largely successful. For example on the St. Kitts and Nevis islands, there was an energy awareness week which coordinated with businesses, hotels, and homeowners to increase awareness about energy efficiency practices and appliances (Khattak, 2007). This week-long event was instrumental in St. Kitts and Nevis in increasing their energy efficiency and transitioning to renewable energy.

Pursuing Solar and Geothermal on Beaver Island

This part of the study will outline possible policy plans that Beaver Island can take in pursuing solar and geothermal energy. These plans will not revolve around specific timelines but instead allude to them and provide two courses of action that Beaver Island can follow, a decentralized or centralized approach. The decentralized plan outlined below follows individual

solar and geothermal implementation while the centralized provides several options in pursuing renewables at a larger scale.

Decentralized Approach

A decentralized approach to renewable energy can be classified as individual implementation, as it would not be an island-wide concentrated effort but instead rely on the individual choices of residents and public entities. This strategy would take longer to accomplish a 100% renewable energy dependence goal but instead, could be viewed as an alternative to increasing renewables on the island without a large-scale transition to meeting a certain renewable energy production percentage that the island sets.

Residents on Beaver Island could accomplish this by individually implementing geothermal as part of their homes' heating system, by taking advantage of certain tax credits to install solar on their homes for an additional power source, or work with Great Lakes Energy by buying a solar subscription. Individual implementation cases on the island exist for both solar and geothermal from the solar installation on the McDoughas market as well as the several uses of geothermal for residential homes across the island. These individuals' use of solar on the island was recently published by a video interview by Beaver Island Sustainability Fair in August 2020 and was discussed during the Clean Energy Focus Group in October, as more residents were curious about the use. Additionally, since the initial installation of geothermal, there has been a steady increase in island use (Interviews, October 15, 2020). According to the 1992 energy audit for Beaver Island, most residential homes have access to enough solar visibility that implementing rooftop solar is feasible for many residences and Beaver Island

businesses (Heins & Stanton). If one wanted to expand their use of renewable without having them being locally sourced, they have the option of buying a solar subscription through Spartan Solar which is operated through Great Lakes Energy (Spartan Solar, n.d). This method could be used in conjunction with residential solar or without as consumers would be able to buy a panel subscription that entitles them to a share of energy produced by Spartan Solar's utility-scale community solar array located on the mainland (Spartan Solar, n.d). This method would require the continued operation of the underwater cable to Beaver Island. This subscription does not require any maintenance or installation and subscribers can cancel any time (Spartan Solar, n.d). While this method does not satisfy the energy independence and renewable energy goals of Beaver Island, it can be used in place of an island wide energy movement if that goal is not widely accepted. While this is unlikely, it is not impossible and for precautionary measures is logical to have an alternative in that case.

Public buildings and Beaver Islands municipality can take this approach further. While there are already construction plans for solar panel installation on Beaver Islands community school and the successful case of solar on McDonagh Market, as well as the Holy Cross Catholic Church installation of geothermal, Beaver Islands' local municipalities can create and execute goals for public buildings to be powered by renewables, expanding the use of clean energy on the island without embracing more centralized approaches. Across Michigan, there are several cities and local municipalities that have begun their transition to renewable energy dependency but integrating it first on public buildings. Traverse City, Ann Arbor, and Petoskey have all initiated pilot programs of renewables infrastructure on public buildings (Perkins, 2020). Most of the municipalities are coordinating with third-party organizations for installations (Perkins,

2020). While this has been successful in various cases on the mainland, this strategy could incur higher investment costs for Beaver Island compared to its mainland cousins as the island isolation would cause higher transportation and installment costs (Chen, et al. 2007). This does not mean that Beaver Islands municipalities should not pursue this strategy, however, more analysis is needed to clearly define the costs of such a project. This strategy would make the transition to renewable energy easier as it symbolizes commitment and interest from the local government and could serve as successful examples if there is hesitancy from the larger public in embracing relying on renewable energy. However given that there is already interest for Beaver Island to pilot renewable energy projects on public buildings in the 2017 Master Plan, this strategy seems like a feasible future plan for the island.

Centralized Approaches

Community Choice Aggregation

Community choice aggregation (CCA) also known as municipal aggregation, is a program that allows the government to procure power on behalf of their residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from their existing utility provider (EPA, n.d). CCAs allow communities to have more control over their electricity sources, use more renewable energy than what was previously offered by their default utility, and can also lower residential retail prices for electricity up to 15-20 percent because of collective buying power (EPA, n.d). Communities that utilize CCA's can receive the same delivery and maintenance services from their local utility and are given negotiation power in their energy sources and services (EPA, n.d). Unfortunately, CCA

legislation has yet to be adopted in Michigan (Lean Energy, n.d). However, Ann Arbor is actively pursuing Community choice aggregation as a means to satisfy their A2Zero Plan which advocated for powering the community with 100% renewable energy (Stanton, 2020). If CCA legislation was adopted in Michigan it would be an opt-out program and allow all homes, businesses and municipalities to be eligible to participate (EPA, n.d).

Despite CCA legislation not being adopted in Michigan yet, CCA's could still be a viable option for Beaver Island given that transitions take multiple years and by the time when Beaver Island is ready for renewable energy implementation this strategy could be a viable option. This is based on that further research into renewables for Beaver Island as well as island discussion and campaigns for energy efficiency could take some time.

Beaver Island Becoming Its Own Utility

During the Clean Energy Focus Group held on Beaver Island October 2020, there was the discussion of Beaver Island becoming its own utility company. This idea caught fire among the participants and many were keen to learn more and follow this course of action. This section will examine the feasibility of this strategy and illuminate two possibilities that Beaver Island could pursue as its own utility entity; Buy-All Sell-All and Power Purchasing Agreements (PPAS). This section will define both and examine other case studies of islands that have utilized these as a means to implementing renewable energy.

A Beaver Island Utility and Buy-All Sell-All Option

If Beaver Island was to become its own utility it is suggested that it become an electric co-op rather than a private business or a public utility. Becoming either co-op or public utility would allow for more community engagement and participation and allow negotiations about energy sources, sitings and other issues. Additionally, there are case studies in Michigan of electric co-ops pursuing renewable energy and public utility examples on other islands which both serve as beneficials examples for Beaver Island.

Cherryland Electric Cooperative is one of these examples. An energy provider to six counties in Michigan, including Leelanau, Grand Traverse and Mainistee, this cooperative exemplifies democratic principles by being member controlled and hosting annual meetings for community input. A Beaver Island utility should model itself after Cherryland's operations and framework that Laird (2001) sets for public engagement. Given the values and tight knit community on Beaver Island, an electric co-op utility would better fit the island rather than a for-profit businesses model. Additionally, if Beaver Island was to pursue this model, it would be able to mimic similar implementation strategies on Samsoe Island which this research paper strongly encourages to do given the successful acceleration of renewable energy on the island.

For the example of Samsoe, there was a mix of public and private ownership of renewable energy, allowing different implementation strategies to be occurring at the same time on the island. This can be accomplished by following the Buy-All Sell-All the Cherryland Cooperative currently uses. This method consists of an individual installing a renewable energy system on their property and then the electric coop buying the electricity produced at an agreed price and agreement term (Cherryland Electric Cooperative, n.d). In the case of Samsoe, this

was achieved by individuals taking out loans or neighbors working together to set up an energy system to generate their power needs and the energy surplus being exported or bought by the local government to be used elsewhere on the island (Global 3000, 2011). For one cow farmer on Samsoe, his investment in wind turbines on his farm allowed him to make more money off of the energy that he sells than his agricultural business (Global 3000, 2011). Given that 45% of Beaver Islands land is dedicated to agriculture (Beaver Island Masterplan, 2017), this is a very feasible method for islanders to pursue as not only do they have the space but can also supplement their income by the addition of renewables. This Buy-All Sell-All example also allows individuals to be truly energy independent and become their own energy supplier to their utility company, in this theoretical case, to a Beaver Island electric co-op. However there are certain drawbacks to this renewable energy implementation model. Given individuals setting up renewable energy by themselves on their own property there are very high initial costs. In the case study of Samsoe, individuals pursuing this method were able to apply for bank loans to finance the project, however given that Denmark banks offer flare rate loans for wind and solar energy (Global 3000, 2011), this case maybe be more difficult in the United States if this is not a viable option. Additionally, there would need to be technical experts and engineers on Beaver Island who are able to install the renewable energy projects on an individual's land or assist in a Beaver Island utility outlining agreements and negotiating on selling price points. Beaver Island currently has a shortage of construction works and renewable energy experts to assist in maintenance and set up the metering systems that the theoretical utility company would use to measure the energy generated and the consumption rate. However, this is still a viable option as exemplified by the

case study of Samsoe, it just requires further examination and technical assistance to be part of the planning and execution of Beaver Island Buy-All Sell-All renewable energy strategy.

Since this method is an individual choice and investment strategy, there are other arrangements that a Beaver Island utility could pursue in implementing renewable energy on the island.

Power Purchasing Agreements

Beaver Island could also become a public utility and pursue Power Purchase Agreements to satisfy its renewable energy goals. Power purchasing agreements are a method to finance solar panel systems with leasing or "renting" systems (EnergySage, n.d). The solar company's finances would cover the cost to buy the necessary equipment and perform the installation (EnergySage, n.d) and in this case that would be a Beaver Island utility company. While the installation would be located on an individual's property, the company would own it and take care of any needed maintenance while the solar panels would generate power for that individual's home (EnergySage, n.d). The resident and the company would enter an agreement in which the owner of the system would set a rate for each kilowatt-hour for solar panel generation while the consumer agrees to the set rate and the installation on the property (EnergySage, n.d). PPA's differ from solar leases as their charges vary due to the production of that individual solar panel system, although the rate is lower than the previous price (EnergySage, n.d). This system correlates well with Beaver Island energy demands as peak demand is in the summer when the rates are higher due to the panels producing more energy than in winter. PPA's are more

affordable than other solar installation methods as the majority of residential solar PPAs require zero down costs (EnergySage, n.d). Although, PPA's lack incentive as such consumers are not able to apply for state and federal tax credits.

An alternative to direct PPA's with onsite power generation an offsite PPA which does not require the customer and project to be located in the same region (U.S Department of Energy, n.d). This would allow Beaver Island as a utility company to expand to mainland energy sitting if they choose to. In this case, the underwater cable would still need to be used as the agreement would pertain to the energy being sold to the local grid at market price while the actors involved in the contract have already agreed on a fixed price (U.S Department of Energy, n.d). The project owner would then proceed to send the customer funds in a settlement transfer for the difference between the energy sold and the agreed-upon fixed amount, allowing the customer to make habitual payments to its utility (U.S Department of Energy, n.d). This an intricate and at times confusing process but it allows for the expansion of renewables and encourages lower energy prices.

There are several cases of PPA's in Michigan and on island communities. In Michigan, for Consumers Energy alone there are currently four approved PPA's (Helms, 2019). Each of these agreements is to last for 20-year terms and vary in energy projects (Helms, 2019). Recently, there has been an increased interest for Power Purchasing Agreements to be set up on university properties, including Western Michigan University (Western Michigan Sustainability, n.d). For the case study of PPA's on islands, Hawaii's Public Utilities Commission that regulates Hawaii's electrical utilities recently enacted a power purchasing agreement (Hawaii State Energy,

n.d). One PPA example in Hawaii is an agreement between an independent power producer constructing wind and solar farms on public lands which is authorized by Hawaii's public utility. Given that 36% of Beaver Island is public, (Beaver Island Masterplan, 2017) sitings on public lands would best be negotiated by a public utility. While resources on PPA's in Hawaii is limited, and more research should be done before Beaver Island pursues this option, the case study can still serve as an example of expanding the use of renewables on the island and becoming a public utility company.

Funding Opportunities and Relevant Regulations

This section of the research paper is aimed at providing Beaver Island residents with information on possible funding opportunities and tax credits that they can receive while pursuing solar and geothermal energy.

Michigan's Renewable Portfolio Standard (RPS)

Michigan's renewable portfolio standard is a requirement that applies to all retail electric providers including investor-owned utilities, cooperative utilities, municipal utilities and alternative electric suppliers to have a certain percentage of their energy to come from renewable resources (Michigan.gov, n.d). Michigan's RPS increased from 10% in 2015 to 15% in 2021 with an intermediate compliance requirement set as 12.5% in 2019 and 2020 (Michigan.gov, n.d). If Beaver Island was to pursue a utility entity route, they would need to comply with these requirements.

Renewable Energy Investment Tax Credit

This incentive consists of a 26% federal tax credit available when purchasing and installing solar PV and small wind systems (EnergySage, 2020). This tax credit applies to both residential and commercial systems and currently there is not a cap on its value (Cecco, et al. 2016). This program is widely responsible for lowering the cost of solar energy and making it competitive with other energies on the market. Beaver Island residents and businesses could benefit from this tax credit and it could aid in the affordability of solar through a decentralized approach.

Net metering

Net metering is a service provided by utilities to electricity consumers in which any electricity generated by a customer (usually via renewable energy sources) is used to offset the electricity delivered by the utility during a specific billing period (Cecco, et al. 2016). In a highly productive environment this could also allow consumers to sell their excess generated energy back to the utility. The service is applicable to both residential and commercial consumers using solar, wind, or other renewable energies capable of generating electricity (Cecco, et al. 2016). With residents who individually install solar panels on their home on Beaver Island, they are able to reduce their energy bills by relying on the indigenous source of energy that they have installed.

Agriculture and Rural Communities Energy Incentive Program

The Agriculture and Rural Communities Energy Incentive Program offers financial incentives to farms, agribusinesses, public entities, and rural small businesses for energy related implementation projects (Michigan.gov, n.d). This program is best suited for energy audits and assessments. Given the last energy audit on Beaver Island was in the 1990's, an updated version is necessary for future energy planning. This program centers on agricultural and related entities as well as non-profits and small businesses with preference given to groceries and healthcare facilities (Michigan.gov, n.d). While this program would not provide an overall energy audit for the island, it can still be very useful to certain buildings and Beaver Island entities who are interested in energy efficiency and transition to renewables.

Community Energy Management Incentive Program

Michigan's Energy Services will offer financial incentives in 2021 to communities, public education K-12 schools and other entities for energy related implementation projects (Michigan.gov, n.d). The maximum rebate award is 15,000 dollars per applicant and preference is given to at risk communities, including rural areas (Michigan.gov, n.d). As this program aids energy efficiency and renewable energy implementation, the Beaver Island community as well as the Beaver Island school could greatly benefit from this program to realize their energy goals.

Michigan Energy Services Sponsorship Program

This sponsorship program could be directly applied to Beaver Island Sustainability's Fairs or the community at large as it offers financial assistance for workshops, training, conferences, or other events about energy efficiency, renewable energy and sustainability technologies (Michigan.gov, n.d). Implementing renewable energy on Beaver Island is a

multistep process which requires community engagement and education on energy efficiency and renewable energy. This program would allow Beaver Island to host public events that would increase the education and later acceptance of renewable energy on the island. Additionally, given this program could apply directly to Beaver Island Sustainability Fair, this program has the potential to allow this organization to realize its goal of Beaver Island becoming a regional sustainability leader.

Moving Forward

So far this project has provided an overview of renewable energy implementation on islands as well as possible opportunities that Beaver Island can pursue to realize its renewable energy goals as well as funding possibilities. This final section of the project will use these conclusions and provide recommended next steps of action for Beaver Island.

Regardless of the option that Beaver Island pursues to realize a 100% renewable energy goal, this transition will take some time. To continue effective action and maintain public engagement, Beaver Island should create intermediate goals and focus on smaller accomplishments that will eventually amount to the actualization of their larger objective. It is strongly recommended that the first two intermediate goals for Beaver Island should focus on energy efficiency, island educational workshops, and implementing the political structure for Beaver Island to pursue sustainability goals.

Energy efficiency should be prioritized before the implementation of solar, so the community is able to adjust to technological and habitual changes before a rude awakening of renewable energy use. Energy conservation and efficiency is necessary to renewable energy

implementation and unfortunately not readily available on island due to little or no energy audit services (Khattak, 2007). Island isolation can lead to overlooking news of technology innovations and designs. When implementing a relatively new technology, it is imperative that Beaver Island is updated on and updates to energy efficiency practices (Khattak, 2007). This goal can be achieved by energy efficiency workshops and educational events as previously demonstrated by the successful energy awareness week hosted on St. Kitts and Nevis islands (Khattak, 2007). Based on the success of Beaver Islands Sustainability Fairs event in August and their Clean Energy Focus Group, these events and promotions are perfectly feasible from their advocacy. Additionally, the successful addition of dark sky light for public street lighting piloted by the local government (Interviews, October 19th, 2020) serves as an example of possible future projects for energy efficiency and energy projects.

The second intermediate goal that Beaver Island should prioritize is instituting a political structure for renewable energy to be pursued. This depends on Beaver Islands implementation strategy, whether that is becoming its own utility, either a cooperative or publicly owned, using a Buy-All Sell-All method or Power Purchasing Agreements for renewables, or simply creating a renewable energy subcommittee on the islands Planning Committee which has been the technique used by other islands (Boston Harbor Islands Renewable Planning Guide, 2005). Regardless of the method, the necessary political structure needs to be incorporated in public engagement and in the policy process and implementation. Whatever Beaver Island chooses to do, the community's resilience and involvement must remain strong as it is the only way Beaver Island can realize its energy independence and renewable energy goals.

Conclusion

In conclusion, implementing the renewable energies of solar and geothermal on Beaver Island is a perfectly feasible possibility for the island's energy future. Based on previous cases studies and the values on the island, regardless of the strategy that Beaver Island decides to pursue, this process should include public engagement and participation and directly represent the values of the local residents. While there needs to be more research conducted on Beaver Island on energy efficiency, energy usage and the island's renewable energy possibilities, I hope this project was useful and be used as an educational resource. Beaver Island is a beautiful and unique place and it can easily pursue a renewable energy future and become the regional sustainability leader. More needs to be done, but the island has already taken the first steps toward a clean energy future and is becoming an inspiring example for others to follow.

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