

The Future of Energy: Climate Change Adaptation in Cleveland
Michael Kay
ND-GAIN Urban Adaptation Assessment Ambassador Case Study
29 August 2017

Bio:

Michael is a junior from Cleveland, Ohio studying Electrical Engineering and pursuing an Energy Studies Minor. He is passionate about the role of energy in the climate change conversation and the increasing role of renewable energies in the world.

Abstract:

Many climate related threats face the city of Cleveland from rapidly rising temperatures and extended heat waves to increased prevalence of extreme weather events. Facing these threats requires a response to protect those vulnerable from these impacts as well as ensure the lessening of the extent to which these impacts continue to grow. One approach to mitigation of future impacts and adaptation to current situations is investing in renewable energy technology as well as supporting the regional grid with smart technologies to avoid outages or other catastrophes that can strengthen the issues faced due to climate change. The details of the Cleveland Climate Action Plan and its Advanced and Renewable Energy focus area provide a route through which to explore adaptation, with the goal of an offshore wind industry and growth of individual renewable energy generation on homes integral to forwarding the energy agenda in Cleveland. This case study explores the role of the Icebreaker Wind project, led by the Lake Erie Energy Development Corporation (LEEDco.), in the climate action plan of the city of Cleveland. The aspect of renewable energy for individual households is explored by evaluating the willingness and understanding of various energy related programs in the Duck Island community, a local community in Cleveland focused on sustainable living. This includes evaluating the feasibility, need, and emphasis these projects and the larger scope of renewable energy in a smart, robust grid have in the broad scope of climate change reform. This will entail investigating the Cleveland Climate Resiliency Plan and Urban Opportunity Plan, the Duck Island community itself, and detail the efforts of LEEDco and its partners in establishing offshore wind in the Cleveland area. By investigating the current efforts and focus areas of the city as whole, the role of adaptation in Cleveland's energy industry can be evaluated in the context of climate action needs of the city.

Introduction:

The city of Cleveland is witnessing firsthand the impacts of climate change. The region is currently entering another summer season in the midst of a heat wave highlighted by consecutive record setting extreme heat days while facing continued threat of severe weather activity. The sustained heat requires a raised baseline level of energy usage throughout the area with even higher peaks in energy needs throughout the course of a single day, the length of a heat wave, or the duration of these summer months. The threat of severe weather continues to intensify as impacts

such as increased flooding and damage to homes and businesses are seen as results. Given this combination, the current state of the energy industry in Cleveland faces a challenging future. Two main obstacles are continually increasing energy demands and a higher threat of damage to the power grid. The power grid is necessary to protect and support functioning of the city itself. A reliable grid can serve to spur regrowth and avoid vulnerability to the effects of climate change already experienced in the region. Along with this, continued use of fossil fuels as the main energy sources powering the grid will serve to increase greenhouse gas (GHG) emissions which, in turn, perpetuate the climate change effects, continuing a cycle that leads to an increasingly dire situation that requires a new approach.

Facing these impacts of climate change, the city of Cleveland began developing strategies in 2009 to guide leaders in taking action that would assist the attempt to establish a sustainable economy. The basic framework set a foundation for general goals to reach by 2019 focused on environmental health, economic prosperity, and social vitality as explained in the Sustainable Cleveland 2019 Action and Resource Guide. Based on these goals, a climate action plan was formed to establish formal goals in sectors such as energy, urban green space development, and green transportation. The Cleveland Climate Action Plan report, written in 2013, served to break down the current situation and emphasize six areas of focus to reduce emissions and establish the sustainable economy hoped for in the initial guidelines. Each area of focus was highlighted by multiple actions intertwining adaptation to the present state with mitigation of future impacts from climate change. The area of advanced and renewable energy offered various actions from installing distributed renewable sources and utility aggregation plans to the establishment of an offshore wind industry in conjunction with LEEDco. This attempt to develop a new industry is a large component of the renewable energy efforts in the climate action plan. LEEDco's Icebreaker Wind project represents a specific case through which to evaluate the effectiveness of focusing on renewable energy standards as a means to offer adaptation and mitigation in the face of impactful climate change effects. An increasingly smart grid is critical to protecting future public health. Development of smart grid technologies and the focus on renewable energy provides a definite route to investigate the role of adaptation in climate change countering efforts in Cleveland.

Background on Climate Change Impact:

Cleveland, founded in 1796, was built into a thriving city through industrial innovation. As the largest city in Cuyahoga County, Cleveland is the main contributor to the high GHG emissions in Cuyahoga that ranks fourth among counties in the United States (Turner). Cleveland's role in the emission levels is evident. According to the Cleveland climate Action Plan report, the starting emission level at the time of the proposed climate action plan was 13 million metric tons of carbon dioxide equivalents annually. The breakdown of GHG emissions by sector is shown in Figure 1 and the GHG emissions by fuel source are shown in Figure 2, both found in the 2013 Cleveland Climate Action Plan. The largest contributors to these emissions in both cases align with the industrial nature of the city as over 60% of total emissions come from the industrial sector while 16% of fuel source emissions are due to industrial electricity generation. This electricity

production overall accounts for over 25% of the total GHG emissions from fuel sources. This singular issue presents a need to establish new sources of energy to continue powering industrial and residential sites while reducing the amount of emissions expended by such activities.

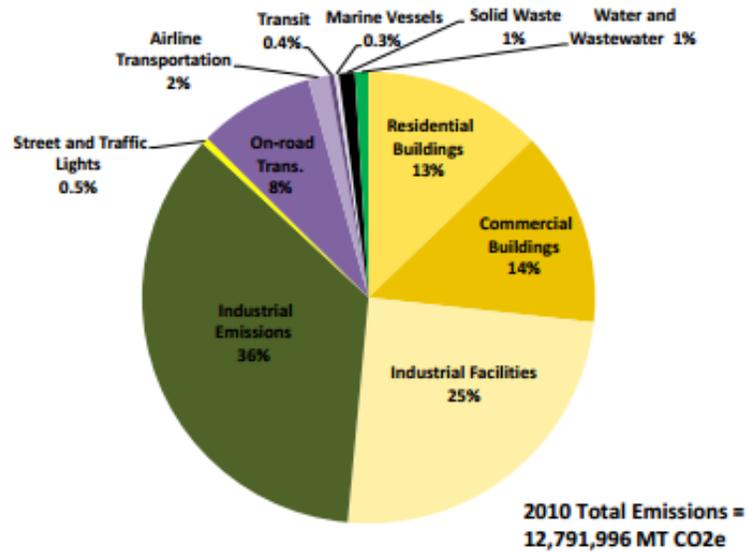


Figure 1: GHG Emissions by Sector

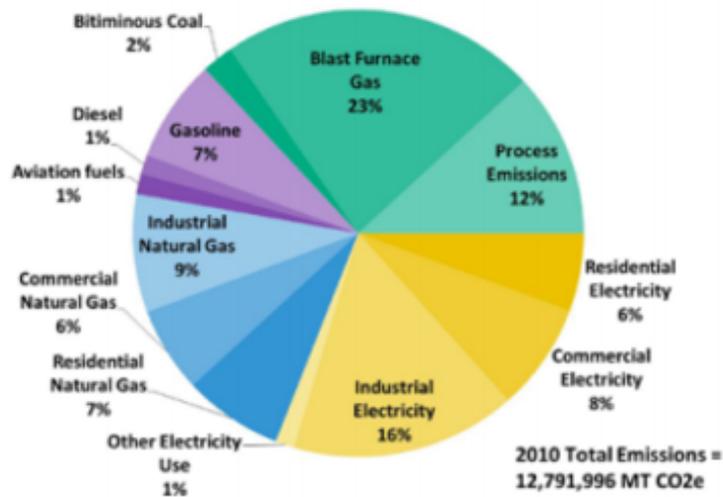


Figure 2: GHG Emissions by Fuel Source

The impacts of continued high levels of GHG emissions include effects on public health, sustained warmer temperatures, and destruction of natural habitats, environments, and local species. Climate change impacts also include detrimental effects on air and water quality which, combined with hotter temperatures leads to public health risks while impacting the food systems in the area. Altered farming seasons and decreasing agricultural productivity due to higher temperatures and prevalence of extreme weather events lead to decreased and abnormal yields.

Extreme weather events, as they pertain to Cleveland, include severe storms, increased flooding, lake effect snow, and erosion or landslides. The increased temperatures can lead to more frequent and intense events such as these. The temperature increase has been steady from the mid twentieth century through the present with the average annual temperature rising 2.4 degrees Fahrenheit. Also, there has been increased precipitation in this time with annual precipitation records increasing 25.8% in the area over the same timeframe as the temperature rise as referenced in the Climate Resilience and Urban Opportunity Plan. With the multitude of impacts from climate change affecting the city, a plan was necessary to combat the growth of more dire issues of greater intensity and breadth.

Background on Cleveland Climate Action Plan:

The Cleveland Climate Action Plan was established in 2013 in a report that presented six focus areas related to both the mitigation of and adaptation to climate change. The climate action plan came as an extension to the Sustainable Cleveland 2019 Action and Resource Guide developed in 2009. This guide establishes general goals of developing a sustainable economy, which is detailed as an economy that supports prosperity, quality of life, healthy communities, and the creation of good jobs. The Action and Resource Guide offers three fundamental outcomes from this concept: economic prosperity, environmental health, and social vitality. Economic prosperity entails building a resilient local economy building prosperity over time quantified by increased opportunities for all, higher employment, and reduced income disparities. Environmental health relates to the results of reducing emissions, energy use, and waste while preserving quality of life and aspects of the environment such as air and water. Finally, social vitality refers to the establishment of a diverse and inclusive community in which everyone has access to resources and opportunities for success. This outcome is measured by reduction in educational and health disparities, increased safety and community involvement, and a regeneration of the urban core of communities. These basic outlines for future goals lay the foundation for the 2013 CAP report that details specific routes through which to reach these outcomes of a sustainable economy focused on climate change adaptation and mitigation.

The six focus areas of the Cleveland Climate Action Plan include Energy Efficiency and Green Building, Advanced and Renewable Energy, Sustainable Mobility, Waste Reduction and Resource Management, Land Use and Clean Water, and Community Engagement and Public Health. Each focus area includes multiple objectives divided into specific actions aimed at achieving certain goals within each area. The full list of areas and their objectives are displayed in Appendix A. The Advanced and Renewable Energy focus area provides the most insight into the adaptation and mitigation efforts in the energy industry. The specific goals of this focus area, detailed in the Cleveland Climate Action Plan, include a 2.1 million metric ton of carbon dioxide equivalents reduction by 2030, a 25% renewable resource presence in the energy mix by 2030, and a minimization of brownouts during heat waves and extreme weather events with on-site generation efforts and storage systems. Included in these explicit goals is an attempt to diversify

the energy supply and include distributed generation of power in Cleveland to protect against both outages and volatile pricing of fuels such as gas and coal.

There are three objectives involved in establishing renewable energy as a part of this plan. The first is an emphasis on widening the use of renewable energy by residents and businesses. This objective is approached through the installing more distributed energy projects, also known as distributed generation (DG), and incorporating more renewable energy in the Cleveland Electricity Aggregation Program. This is a program offered by Constellation Energy Services that currently serves 65,000 households and small businesses in Cleveland. Constellation provides increased buying power and lower pricing to those in the program, purchasing energy through their service at group rates rather than as individual customers. This program offers competitive rates on utility plans that ensure the power purchased is generated by 100% renewable sources at \$0.07429 per kWh. Advanced energy technologies include anaerobic digestion and the use of low-carbon fuel sources to power heating and cooling systems in the city. Anaerobic digestion turns organic waste into energy in such locations as the 1.3MW Collinwood BioEnergy Plant on the east side of the city of Cleveland. As detailed in the Advanced and Renewable Energy Primer, this process produces carbon dioxide yet remains carbon neutral by capturing carbon dioxide as the plants grows to balance that which is released when the waste is used as a fuel.

The final objective of this focus area emphasizes the use of local projects to meet the renewable energy portfolio standards set. The standards established set the goal at 25% of energy production to come from renewable sources by 2030. The actions in place to reach this standard involve the use of vacant lots and other urban areas to install DG projects. Also included is the act of utility investment in other established renewable sources to meet the set standards. The final piece of establishing renewable energy projects is the development of offshore wind projects in Lake Erie. The pioneering project in this budding industry is the Icebreaker Wind Farm led by LEEDco and its local governmental and private partners.

Included in the Energy Efficiency and Green Building focus areas is an emphasis on smart grid technology integration in the city. This is present in the attempt to establish distributed generation locations in vacant space and on homes. An organization called Solarize Cleveland has begun this approach to climate change adaptation by installing solar panels on individual homes that can be used to power the home and sell excess power back to the grid, utilizing the net metering technology as part of the beginning of smart grid installations (O'Brien). Consumers can purchase home systems for \$10,000 to \$20,000. Along with these smart metering technologies, FirstEnergy and its main utility provider, The Illuminating Company, have implemented programs to install Advanced Metering Infrastructure in thousands of homes in the area as noted in the Cleveland Climate Action Plan. These technologies offer a glimpse into the future of the power grid. Combined with renewable energy on both large and small scales, this system provides a robust and adapted model for energy generation, transmission, and use.

Background on Climate Resiliency:

The city of Cleveland has also developed an analysis of practical solutions, programs, and goals to build more resilient and educated vulnerable communities. The Cleveland Neighborhood Progress, an organization focused on revitalizing the city's many neighborhoods through funding projects, training leaders, and creating programs, developed the Cleveland Climate Resilience and Urban Opportunity Plan in 2015. This plan advocates taking an assets-based approach to adapting to climate change by utilizing the strengths of community. Assets include community bonds, strong leadership, and vacant spaces available for renovation to develop programs and agendas through which to revitalize more communities. The study used four neighborhoods currently working to develop programs to combat climate change effects in the Cleveland area.

This plan noted the many impacts of climate change and drew conclusions on ways to use these strengths to combat negative effects such as higher temperatures and severe weather as well as detriments to food systems, air and water quality, energy usage, and public health. The study established physical factors that contributed to climate-related vulnerability. These physical factors include:

1. Land coverage/impervious surface
2. Land coverage/tree canopy
3. Buildings constructed before 1939
4. Flood zones

The study also identified social factors of climate-related vulnerability and these include:

1. Residents without a high school diploma
2. Residents over age 65
3. Non-white residents
4. Households below poverty level
5. Living in rental property
6. Households without a vehicle

The study evaluated these vulnerabilities alongside the assets tabulated in communities containing these challenges and developed combined solutions. For example, the study notes, "if socio-economic vulnerability is clustered in an area with low amounts of vegetation and high amounts of asphalt, an appropriate strategy might be to start a street tree-planting program to create jobs and shade pavement that contributes to the urban heat island effect. If these areas also have low levels of car ownership, solutions might point to increasing public transportation and opening cooling centers during extreme heat events" (Climate Resilience and Urban Opportunity Plan).

Specific actions of interest from the Cleveland Climate Action Plan as numbered in Appendix A were included in this plan. These include:

- Action 1: Support programs and policies to retrofit residential buildings.
- Action 8: Increase distributed energy installations.
- Action 20: Make biking and walking easier and safer.
- Action 27: Develop and implement an urban tree plan to grow the canopy.
- Action 29: Implement green infrastructure to capture storm water on-site.

Action 32: Recognize capacity of neighborhoods and community groups to implement climate mitigation and adaptation initiatives.

Action 33: Conduct climate change vulnerability assessment and integrate projected impacts into existing plans.

The only action listed that is addressed in the Advanced and Renewable Energy focus area of the climate action plan is Action 8: Increased distributed energy installations. This action is to be addressed by installation of renewable energy projects in vacant spaces along with added green spaces in similar areas as well as on homes themselves in line with the attempts of Solarize Cleveland. However, these actions require resources and funding not available to populations in vulnerable conditions thus making it imperative to establish funding opportunities and programs that can be effective in all situations.

The top three priorities from this conclusion are protecting residents from flooding and extreme weather, reducing the increased heat-related mortality, and reducing household energy costs. Each of these benefit from a foundation of education on the dangers and challenges of climate change. Following from these are programs encouraging active participation by communities such as tree planting programs and senior citizen health monitoring programs. Home weatherization and retrofitting homes to be more energy efficient also assist those low income vulnerable populations. A full list of current programs is shown in Appendix C. With these programs in place, the vulnerabilities and their magnifying effect on climate change issues become manageable and provide a foundation for the city's communities to focus on climate change adaptation and mitigation.

Background on Icebreaker:

Icebreaker Wind is an initial offshore wind installation project. Construction is to begin in 2018 and this project has rallied support from organizations on the local, state, federal, and international level. Each component requires a network of corporations and public entities to execute this project. Areas of focus range from physical turbine construction, energy transmission, and grid connection to funding efforts, raising public awareness of the goals, and passing regulation and acquiring permits. Those groups at the core of the efforts are the Lake Erie Energy Development Corporation (LEEDco) and Fred. Olsen Renewables USA. LEEDco is a nonprofit regional corporation developed in 2009 and backed by private enterprises, the City of Cleveland, and Cuyahoga and Lorain County. The purpose of LEEDco is to launch the Icebreaker Wind project and lead the way in establishing an entire freshwater offshore wind industry. The long term goals of this industry are to generate 1500-5000MW through wind farms on Lake Erie. The plans include stimulating both the local Cleveland economy and the economy of the state of Ohio. A developing offshore wind industry will prove to create thousands of new jobs in the state ranked second in wind turbine manufacturing and development. Fred. Olsen Renewables is a Norwegian company with experience in constructing offshore wind farms in the UK, Sweden, and Norway. They have agreed to construct Icebreaker Wind and foresee a bright future of offshore wind in Lake Erie provided this pilot project is successful.

The supply chain of the project, from manufacturing to assembly, includes many opportunities for individual, local companies to join this project. The Great Lakes Wind Network (GLWN) considers itself a leader in the charge to find regional companies interested in supplying components, systems, equipment, material, and services for this project and growing industry. The Cleveland chapter of the Emerald Cities Collaborative, a national nonprofit organization focused on developing sustainable environments based on just and inclusive sustainable economies, also plays a role in gathering firms to contribute to this project. These groups are working with local organizations such as the Port of Cleveland to establish an area to assemble turbines and transport materials and Cleveland Public Power who has agreed to connect the wind farm through one of their substations and purchase 25% of the power generated. They have contracted with MHI Vestas Offshore Wind as the company providing the turbines, Universal Foundation as the provider of the seabed foundation system, and Fred. Olsen Windcarrier as overseer of marine operations including the assembly, transportation, and maintenance as well as the vessels and other equipment needed to perform these roles. The united effort of those organizations representing the wind farm and bringing together other companies to perform specific tasks displays the desire to establish this project as the first ever freshwater offshore wind farm in the United States.

The final project specifications detail six Vestas V126-3.45 wind turbines, provided by MHI Vestas Offshore Wind. Each turbine has a power generating capacity of 3.45MW, yielding a total of 20.7MW of generation for this initial project, enough to power 7,000 homes. The turbines are 479 feet tall with a rotor diameter of 413 feet and thus regulations and studies were conducted to site the farm out of the path of migrating birds and away from controlled airspace. The site for the turbines is 8-10 miles offshore in waters sixty feet deep. The six turbines will be anchored to the seabed using a Mono Bucket Foundation system developed by Universal Foundation that uses a pressure difference mechanism to sink the base into the seafloor using its own weight as a force as water is pumped out from beneath. The turbines will be in a line with transmissions cables connecting each one and a final 34.5kV export cable under the seafloor connecting the wind farm to a Cleveland Public Power 20MW substation. From here, the generated power will be connected to the regional grid for purchase. Appendix B includes projected setup of the wind turbines and cable connections to the power grid. The construction and implementation of these specifications requires the work of each corporation gathered and the effort of government and consumer interest.

The City of Cleveland and surrounding suburbs and counties have expressed support for the project, citing interest in being industry leaders, developing a special tourist attraction due to the wind farm location, and aligning with renewable energy and climate change efforts in the area. LEEDco. began a survey of the region in 2013 asking customers what they would pay for this energy to supply their homes and the results yielded a commitment to paying an extra \$12.72 per billing cycle. This commitment is a reality for the first ten to fifteen years of operation as the companies look to repay construction debt. However, given the renewable, fuel-less nature of wind, the prices will drop below market value after this time as power continues to be generated and connected to the grid at no cost beyond maintenance of the turbines themselves (Funk).

The growth of the industry from this initial project offers environmental benefits with almost no negative impacts. The reduction of emissions due to use of clean energy is a direct impact as a single wind turbine can displace a large quantity of carbon dioxide and other greenhouse gas emissions from the atmosphere. Along with this, studies have been conducted to analyze the impact on aquatic life and migrating bird populations due to the growth of an offshore wind industry development. The impact is positive for some species in the lake as the turbines act as artificial reefs. The impact on other wildlife is far less direct than the effect of GHG emissions on the same populations as noted in multiple environmental studies conducted and distributed by LEEDco. The effect of increasing levels of emissions and the results of these impact the wildlife directly as the Climate Resiliency and Urban Opportunity plan states, “the effects of increased heat stress, flooding, drought, and late spring freezes on natural and developed ecosystems may be magnified by pest prevalence, increased competition from non-native or opportunistic native species, ecosystem disturbances, and land-use change.” The positive impacts and reduction of such negative impacts makes this a desirable project and industry to pursue in the region.

The Duck Island Community

The Duck Island community’s focus is best stated on their webpage: “Duck Island Development Collaborative is an urban redevelopment effort implementing sustainable community enhancement in Duck Island, a traditional neighborhood that is perfectly situated for mixed-use, transit-oriented living. The Collaborative is a private-sector-led effort utilizing shared resources to improve the quality of life for the current future residents of Duck Island.” The community is located directly outside of downtown Cleveland and consists of a few blocks in the revitalized town known as Tremont. The households are a mixture of new inhabitants who have purchased energy efficient housing and home owners who have been in the area for many years. The location of the community creates a focus on sustainable living mainly oriented toward energy efficiency and sustainable transportation such as biking and public transportation. The community is therefore open to sustainable living habits such as incorporating renewable energy into their lives. Thus, a survey of various environmental topics and energy areas relating to the individuals was disseminated and taken by about twenty households. Some notable conclusions included the fact that many households sought to explore home solar generation yet were wary of the cost it would require. This observation, along with general observations on understanding of the utilities that served them and current initiatives around them, led to the development of an overall conclusion and fact sheet to educate the neighborhood, shown in Appendix D. The output fact sheet offers a small scale solution to educating and involving community members in the discussion of energy as well as raises awareness of various climate topics and local programs focused upon in the Cleveland Climate Action Plan.

Conclusions, Ideas, and Further Research:

The city of Cleveland lies on Lake Erie, one of the five Great Lakes that make up the largest bodies of freshwater in the world. The potential for offshore wind production in these

bodies of water is second only to the capacity offered by ocean waters. The position of Cleveland in the discussion of climate change is interesting as it pushes to erase this history of high ranking emission levels and catastrophic impacts such as the Cuyahoga River catching on fire. Seeing this magnitude of impact first hand has led to the implementation of vast climate change reform. Lofty goals have been set to adapt to the already impacted climate and mitigate further effects caused by high volumes of industrial activity and dirty power generation. In this landscape, the discussion of steps to take to combat climate change must include the significant role of the evolving energy industry, both in Cleveland and throughout the country. With emphasis on renewable energy as a part of a sustainable environment and economy, ensuring the energy industry both adapts and lessens its impact on the environment is necessary.

Cleveland has an opportunity to combine efforts in both the governmental and business sector of this industry with consumer involvement to form a dual purpose industry powered by a robust, smart regional grid. To address this two part solution, the side of adaptation must be brought to the forefront. Currently, the efforts of LEEDco. and its partners are leading the way by making local large scale renewable energy sources a reality. Their pilot Icebreaker Wind project is set to be constructed in 2018 and be generating energy directly for the power grid for the foreseeable future. This commitment made by various private companies and by the city itself to remain positive and invested in this project displays a need for this foundation. Going forward, the support shown for this project and the impact it can have on the city, generating 600 jobs and stimulating the local economy, can be seemingly exponentially increased. The goal of 5000MW, or the smaller goal of 1500MW of generated power, is feasible and economical. The establishment of an entire offshore wind industry powered by local interest groups, companies, and supporters will develop the area into an industry leader in clean energy and build toward the original goal of a sustainable economy. This industry contributing to a sustainable economy boasts environmental health and economic prosperity locally. However, the social vitality must also be considered for this solution to fully be realized and impactful.

The development of an offshore wind project and an entire offshore wind industry greatly addresses the need for mitigation of climate change effects and GHG emissions. The need to adapt to the current challenges faced by the residents of the communities must also be present in this consideration. The Cleveland Climate Action Plan listed the offshore wind project as a purely mitigating action, yet, combined with efforts currently being made by individual homeowners and companies it can become a concrete adaptive measure. These efforts must be focused on implementing smart grid technologies throughout all communities. Utility companies such as The Illuminating Company and organizations such as Solarize Cleveland have already begun programs to address this need. By offering Advanced Metering Infrastructure installation in homes, The Illuminating Company is making it more realistic to power large amounts of homes and businesses with electricity from renewables as demand can be more regularly monitored and its fluctuation limited. Solarize Cleveland's efforts to provide distributed generation to individuals offers a supplemental energy integral to the smart grid by making consumers into producers. These measures are intensive, small steps to a fully smart grid as industry leaders must change structures

to provide pricing that aligns with the fluctuation of energy production from variable renewable sources such as wind energy. This may require a change in government policy on pricing or a modification in business model with the utilities focused on selling energy efficiency and smart products rather than large sums of energy at standard prices. In establishing these, the smart grid can go from mitigating climate change effects through adding renewables to adapting to the current climate change situation by providing ensured use during extreme heat days and extreme weather events. By having backup strategies and flow of data to both customers and energy providers, a more robust system of transmission with fewer outages can be manufactured.

The main catalyst for change in implementing a smart power grid based on renewable resources are local residents. This was specifically seen in the Duck Island community. In surveying the community in regards to their views on climate issues and, more specifically, energy initiatives, it was evident that households were interested in what they could do on a small scale. In terms of renewable energy, this relates to choosing utility plans focused on renewable energy or being involved in programs that offer opportunities to increase energy efficiency. This also includes personal interest in renewable energy for an individual home. The distributed generation of solar power for houses in this community could offer an added level to the sustainable living focus of the community. The main need in attempting the introduction of initiatives such as these is education on routes through which to explore these programs, and education on the existence of such opportunities.

On the contrary, it is difficult, given the results of the Climate Resilience and Urban Opportunity Plan, to decree a focus on renewable energy and smart grid technology. The upfront expenses of smart metering systems, distributed generation from renewables, and purchasing electricity generated by renewables are large and not plausible for the vulnerable populations addressed in the study. The plans to involve communities included more fundamental approaches to climate change adaptation such as turning vacant lots into urban tree canopy or retrofitting homes to be more energy efficient and drive down energy costs for these residents. With these as steps to both address the impact of climate change on vulnerable populations and educate those on the need for adaptation, the emphasis on advanced and renewable energy is far down the road. This reality of vulnerability in the present impacting plans to reduce vulnerability in the future causes a need to reconsider the imperative measures to focus on in the present and those which can be continued, though not made forefront presently.

A next step would be further research into the discrepancy of advancing climate change reforms and inhibiting factors stopping this forward motion. There is need to consider whether energy industry changes, reform, and advancement are necessary components of an adapted city given prevalence of vulnerability. However, pursuing research into ways to make these additions in the energy industry more affordable, both on the production side with offshore wind and the consumption side with smart grid technologies and distributed generation, would be appropriate as well. The starting point with this plan would be implementing smaller scale examples in those households and businesses that can afford to handle higher expenses in the near future. Proving success with these programs and educating these populations, as done with the Duck Island

community, on the power of renewable energy in mitigating climate change effects, coupled with smart grid technologies adapting to the current state of the areas would be the next step in widespread, affordable implementation of an integrated grid based on clean energy. Therefore, understanding the position of those most able to take on the implementation of new frameworks for the energy industry is also important. This step can be undertaken to understand the issues and options residents have and the role they are willing to play in developing this industry to align with extensive changes in structure and operation

Appendices:

Appendix A:

Focus Area	Objective	Sectors	Climate Change Impact	Action	Reduction Potential by 2030 (MT CO ₂ e/yr)
ENERGY EFFICIENCY & GREEN BUILDING	Retrofit and renovate existing buildings		M A	Action 1. Support programs and policies to retrofit residential buildings	430,000 8%
			M	Action 2. Support programs and policies to retrofit commercial and industrial buildings	1,300,000 24%
	Implement neighborhood-level solutions		M A	Action 3. Incentivize new construction to exceed existing building codes	1,500 0.03%
			M	Action 4. Make utility data easily accessible for residents and businesses	n/a
			M	Action 5. Expand use of smart grid and advanced meter technologies	120,000 2%
			M	Action 6. Expand energy and green building challenges	290,000 5%
			M A	Action 7. Build on existing green school initiatives in the City	n/a
ADVANCED & RENEWABLE ENERGY	Accelerate renewable energy use by Cleveland's residents and small businesses		M A	Action 8. Increase distributed energy installations	25,000 0.6%
			M	Action 9. Incorporate renewable energy into municipal aggregation	340,000 6%
	Use local projects to help meet or exceed the utility renewable energy standards		M	Action 10. Become national leader in reusing vacant land for renewable energy projects	23,000 0.4%
			M	Action 11. Develop a pilot offshore wind farm	67,000 1%
			M	Action 12. Utilities invest in additional projects to meet renewable energy standards	1,100,000 20%
	Implement advanced energy technologies		M	Action 13. Accelerate conversion of organic waste to energy using anaerobic digestion	52,000 1%
			M	Action 14. Switch to low-carbon fuel sources for district heating and cooling systems	120,000 2%
		M	Action 15. Support Cleveland businesses to reduce industrial process emissions	390,000 7%	
SUSTAINABLE MOBILITY	Reduce congestion and vehicle emissions		M	Action 16. Develop and promote policies and programs that encourage more efficient vehicles	150,000 3%
			M	Action 17. Encourage anti-idling citywide	8,500 0.2%
			M	Action 18. Expand use of carpooling and car sharing	8,700 0.2%
			M	Action 19. Increase the use of public transit through incentives and system improvements	84,000 2%
	Create Complete and Green Streets		M	Action 20. Make biking and walking easier and safer	2,000 0.05%
			M A	Action 21. Develop a streamlined process to implement complete and green streets policy	n/a

Figure 1: Cleveland Climate Action Plan Focus Areas

Focus Area	Objective	Sectors	Climate Change Impact	Action	Annual Reduction Potential by 2030 (MT CO ₂ e/yr)
WASTE REDUCTION & RESOURCE CONSERVATION Annual Emissions Reduction by 2030 = 77,000 MT CO ₂ e (1% of total GHG reduction)	Significantly reduce the amount of waste sent to landfills		M	Action 22. Implement programs and policies to encourage waste reduction and diversion by residents and businesses	56,000 1.0%
			M	Action 23. Develop a cost-effective approach to deconstructing and recycling demolished buildings	n/a
			M	Action 24. Develop and implement a sustainable integrated waste and energy plan for the City of Cleveland	21,000 0.4%
LAND USE & CLEAN WATER Annual Emissions Reduction by 2030 = 130,000 MT CO ₂ e (2% of total GHG reduction)	Encourage vibrant downtown and neighborhoods		M, A	Action 25. Green the zoning and land use codes to encourage sustainable development	1,500 0.03%
			M, A	Action 26. Prioritize sustainability and rightizing in City infrastructure upgrades and improvements	n/a
	Restore and regenerate the natural environment		M, A	Action 27. Develop and implement an urban tree plan to grow the canopy	110,000 2%
			M, A	Action 28. Scale up the local food system	n/a
			M, A	Action 29. Implement green infrastructure to capture stormwater on-site	1,000 0.02%
			M, A	Action 30. Increase water conservation and efficiency	9,300 0.2%
COMMUNITY ENGAGEMENT & PUBLIC HEALTH Annual Emissions Reduction by 2030 = 800,000 MT CO ₂ e (15% of total GHG reduction)	Organizations, neighborhoods, and individuals become climate leaders		M	Action 31. Promote leading local businesses striving to meet energy and carbon reduction goals	800,000 15%
			M, A	Action 32. Recognize capacity of neighborhood and community groups to implement climate mitigation and adaptation initiatives	n/a
	Improve public health and resiliency to climate change impacts		A	Action 33. Conduct climate change vulnerability assessment and integrate projected impacts into existing plans	n/a
Total Estimated Annual Reduction by 2030 (MT CO ₂ e/yr) =					5,500,000
KEY (XX%) Percent contribution of each action (and total of all actions) to meeting overall GHG reduction goal of 40% reduction below 2010 baseline by 2030 TBD Analysis/results that will be included in the final CAP but is not yet available n/a Actions for which GHG reductions and costs are not be quantified as part of the CAP Sectors: At Home At Work In The Community Climate Change Impact: Mitigation Adaptation					

Figure 2: Cleveland Climate Action Plan Focus Areas Continued

Appendix B:

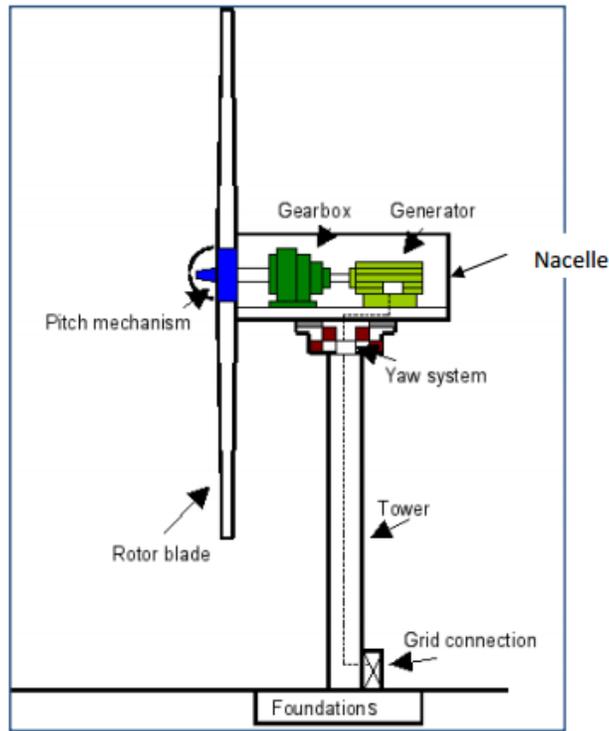


Figure 1: Components of a Wind Turbine

6 Vestas V126-3.45 turbines

8 – 10 miles offshore

Water depth ≈ 60 feet

20.7 MW capacity

Power for 7,000 homes

Mono Bucket foundations

**Grid connection at CPP
Lake Road substation**

**Port of Cleveland
staging & assembly site**

**Construction planned to
begin in 2018**



Figure 2: Icebreaker Wind Project Specifications and Siting

Cabling runs from each turbine to the next until they reach the turbine closest to shore. From there, cables will be buried together in trenches several feet deep on the lake bottom. As the cables approach shore, they will pass under the breakwater and combined disposal facility and connect at the Cleveland Public Power Lake Road Substation.

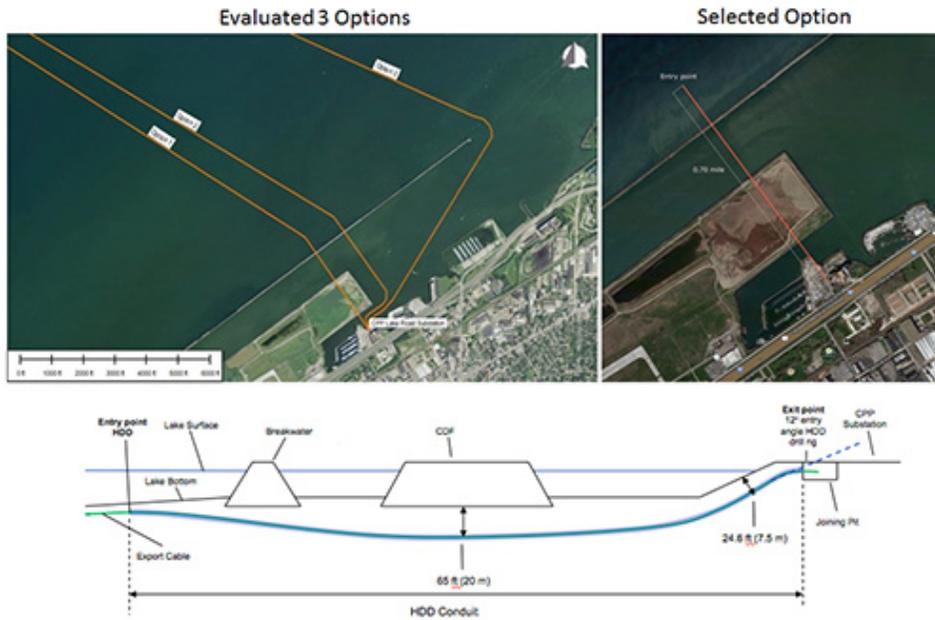


Figure 3: Underwater Transmission Cables

Appendix C:

FLOODING, INCREASED PRECIPITATION, AND EXTREME WEATHER

- *Climate Fairs:* Work with community development corporations and climate ambassadors to develop regular educational and community-building programs that emphasize accessible, hands-on education. Climate fairs would include face-to-face contact with climate action program coordinators, leadership development program intake, green job training intake, emergency response training stations and giveaways, and skill-building tutorials in urban agriculture and home weatherization. We will also focus on grassroots neighbor-to-neighbor outreach, finding trusted spaces for events, and providing free childcare, free transportation, and free lunch.
- *Green Party Crasher Program:* Bring outreach efforts to places where people already gather. Climate ambassadors would attend neighborhood celebrations and events to share information about climate change and community resilience in a fun and accessible way. This would bring the content of the Climate Fairs to new audiences.
- *Local Climate Documentaries:* Provide technical assistance, a camera crew, and film editing support to enable ambassadors to conduct interviews with Cleveland residents and public officials that shed light on Cleveland-specific climate impacts and actions. The documentaries would feature residents speaking about why climate change matters, to help make these concepts real and relevant for more Clevelanders. Documentaries will be broadcast on websites, via social media, and at events.
- *Vacant Land Care Skill Share and Co-Op Program (Slavic Village/Detroit-Shoreway)* Connect neighborhood volunteers with vacant land reuse projects through a co-op program. Participants would be trained on how to access vacant land, and construct and maintain various landscape treatments. They could then sign up for shifts to take care of vacant lots. The program will help activate and maintain shared green spaces that foster social cohesion, provide micro cooling effects, and manage stormwater.
- *Green Infrastructure Investments* Develop programmatic ties to the Northeast Ohio Regional Sewer District's green infrastructure grants initiative, which is currently oriented toward market-driven development. Determine whether the grant program can be expanded to incorporate neighborhood-scale climate resilience efforts.
- *Changing flood zones* Identify new/anticipated flood plain areas based on patterns of increased precipitation and develop a land use overlay and/or a land bank screening tool to discourage new construction in existing and expanded flood plain areas. A program could be created to install retrofits for houses that are prone to flooding.
- *Headwaters Reforestation* Concentrate neighborhood reforestation efforts on vacant parcels in the higher areas of Cleveland's watersheds (headwaters areas) to capture stormwater runoff and reduce flooding risks at low places in the watersheds.
- *Re-imagining a More Sustainable Cleveland* Establish a no-build zone over buried streams and culverts, to be created by designating land in the city/county land banks as 'non-buildable' if a buried waterway runs below the site. Neighborhood-scale greening efforts on vacant sites that align with buried waterways can become part of a comprehensive climate adaptation strategy.

HEAT-RELATED MORTALITY

- *Climate Emergency Dramatizations:* Most people don't prepare for climate emergencies because they're not aware of potential dangers or they don't feel a sense of urgency about what could happen at some point in the future. In order to make climate emergencies seem more real and immediate, some of the climate ambassadors would like to imagine

future climate scenarios (i.e. blackouts, heat waves, food shortages) and act them out in short video productions. The ambassadors stressed that these videos should not be heavy-handed or frightening. People are more likely to absorb the information if it is presented in a straightforward yet humorous way. The videos would be shown at community screenings, movie nights, and in the schools to spark community dialogues.

- *Intergenerational Landscaping Program (Glenville)* Adapt the existing Cleveland Youth Landscaping lawn care and snow shoveling program as a means to check on, monitor and connect seniors to support systems and resources to ensure their safety, health and well-being in the face of extreme weather. Through this program, young people will be trained and paid to provide lawn care and snow shoveling to low-income seniors.
- *City of Cleveland's Department of Aging's World Health Organization Age Friendly City Initiative* Collaborate on this existing initiative which is aimed at creating an inclusive and accessible environment for older adults with varying needs and capacities. This initiative will produce an Age Friendly Plan of Action. We will coordinate the climate resiliency aspects into the plan.
- *Mold Prevention* Provide public education about mold hazards, especially impacts on infants and children. Develop guidelines and educational materials about what to look for and where mold growth most frequently occurs. Provide tips for preventing mold growth before it starts, through waterproofing, ventilation and dehumidifiers; and for catching mold early, before it spreads. Provide information about who to call for help (City/County Health Departments).
- *Cooling Center Communication Network* Establish block-club-based mechanism to extend existing robo-call service to new neighbors and those who do not have landlines and therefore do not get notice of the cooling center locations and hours.
- *Complete and Green Streets:* Align implementation of the city's Complete & Green Streets ordinance and Typologies Plan (Appendix M) to help mitigate urban heat island effects and improve accessibility and thermal comfort for pedestrians, bicyclists, and transit riders in the city. Adopt climate resilient design guidelines (Appendix L) for new streetscape projects in the city.

REDUCED ENERGY USAGE AND COST

- *Home Weatherization* Focused expansion of home weatherization programs to low-income neighborhoods. Expand home weatherization efforts and investments in high-risk areas, as identified in the vulnerability mapping (Appendix E). Focus on insulation and air sealing, combined with operable windows, as a cost effective way to achieve comfortable interior temperatures in summer and reduce energy costs in winter. We will need to develop low cost security measures that will make residents more comfortable having operable windows.
- *Strategic Reforestation Efforts* to restore the urban tree canopy, especially in those neighborhoods most susceptible to urban heat island effects.
- *Coordination with Community Development Corporations on Neighborhood Plans* to achieve better land use choices that reduce energy demand, foster social cohesion, and make optimal use of the city's growing inventory of vacant land.
- *Climate-Ready Renters Training (Central-Kinsman)* Develop targeted programs and resources to help renters negotiate effectively with their landlords for home weatherization, energy efficiency upgrades, mold elimination, and other climate-related concerns. This initiative will also teach renters how to increase their comfort, protect their health, and prepare for climate challenges even if their landlord is unresponsive to their concerns. Empower Gas and Electric, the provider for the Cleveland Energy Saver program, will be piloting an energy efficiency program geared toward landlords which is a potential partnership for this action item.
- *Green Retrofit Model House (Any of the four neighborhoods where capacity exists)* Work with Environmental Health Watch and the Cleveland Housing Network to profile an acquisition and rehabilitation project as a showcase for cost effective sustainability strategies (e.g., water conservation, energy efficiency, etc.). Ideally, the model property would serve as a venue for hands-on workshops, seminars and educational sessions for community members.
- *Energy Saving Trees Program* In conjunction with the city's soon-to-be-completed tree plan, develop a tree planting strategy and online interface so residents can see the energy savings they could get with additional trees, to help increase public support for the restoration and maintenance of Cleveland's urban forest. The Arbor Day Foundation is a potential collaborator on this action item.
- *Transit-oriented development* Cleveland's more than 20,000 vacant lots create opportunities for urban greening and real estate development. Concentrating new development near existing transit may reduce overall household energy usage, provide mobility options in the event of energy shortages and power outages, and help foster social cohesion through walkable, transit-friendly neighborhoods.

LIVING A SUSTAINABLE LIFE WITHIN THE DUCK ISLAND COMMUNITY

Cleveland Climate



The number of extreme heat days, over 90°F, that occurred in Cleveland this summer. A few extreme heat days came back-to-back causing multiple heat waves.

Climate Action

The most popular focus areas noted by the Duck Island community were:



2017- Vibrant Green Space



2013- Renewable Energy



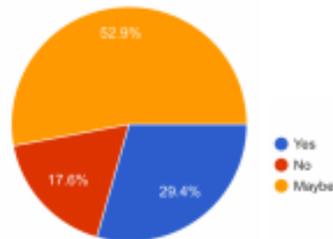
2015- Clean Water

These are all critical sectors for a community with the opportunity of continued growth.

Learn more about sustainability in Cleveland, such as programs to get involved in | sustainablecleveland.org

Renewable Energy

Responses about paying extra each month to use renewable energy were not exceptionally positive:



Yet, when given specific ranges of added monthly costs, on average, there is a willingness to pay an extra...

\$10.74/MONTH

Utility Options

Cleveland Public Power

CPP offers comprehensive energy and cost saving snapshots, as well as information on connecting home solar to the CPP electric grid | cpp.org

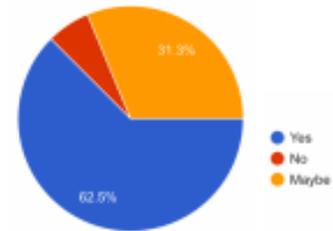
FirstEnergy & Illuminating Company

FirstEnergy offers insight into many programs, including appliance turn-in and an energy analyzer for your home offered by the regional provider, Illuminating Company.

Both utilities offer detailed home energy analysis with account login information | firstenergycorp.com

Quantifying Solar

Based on the survey, interest in solar power for individual homes is extremely high:



Estimated cost of a 7.29kW solar panel system through Solarize Cleveland is...

\$15,785

This includes the federal tax credit, allowing a homeowner to deduct **30% of the cost of install.**

Average estimated annual return and savings on a 7.29kW solar system:

Generation	Money Saved
8,850	\$1,007

The payback period on the example above is about 15 years and energy production continues long after.

Investigate Solar

Solarize Cleveland

Enter home location to determine upfront solar cost | geostellar.com

PV Watt

Enter home location to determine estimated annual energy generation & monetary return | pvwatts.nrel.gov

References:

American Wind Energy Association:

“Comparative Air Emissions of Wind and Other Fuels.” *Lake Erie Energy Development Corporation*. n.p., n.d. Web. 7 June 2017.

<<http://www.leadco.org/images/stories/documents/AWEA-Emissions-Comparison.pdf>>.

Advanced and Renewable Energy Plan:

“Advanced and Renewable Energy Primer.” *Sustainable Cleveland*. VOXARA with NationBuilder, n.d. Web. 31 May 2017. <http://www.sustainablecleveland.org/action_areas>.

Cleveland Climate Action Plan 2013 Report:

"Cleveland Climate Action Plan." *Sustainable Cleveland*. VOXARA with NationBuilder, n.d. Web. 31 May 2017. <http://www.sustainablecleveland.org/climate_action>.

Cleveland Electricity Aggregation Program:

“City of Cleveland Electric Aggregation Program.” *Constellation: An Exelon Company*. n.p, n.d. Web. 4 June 2017. <<https://www.constellation.com/solutions/for-government/governmental-aggregation/ohio-aggregation-programs/city-of-cleveland.html>>.

Climate Resilience and Urban Opportunity Plan: http://www.clevelandnp.org/wp-content/uploads/2015/11/Final-Implementation-Plan_CNP.pdf

Cuyahoga Emissions Rank:

Turner, Karl. “Two Ohio counties rank among worst in nation for greenhouse gas emissions.” *Cleveland.com*. Advance Digital. 25 April 2008. Web. 14 June 2017.

<http://blog.cleveland.com/metro/2008/04/two_ohio_counties_rank_among_t.html>.

Duck Island Development Collaborative: <http://www.duckislanddevelopment.com/>

Emerald Cities Collaborative Site: <http://emeraldcities.org/cities/cleveland>

Fred. Olsen Renewables Involvement:

Funk, John. “Norwegian Wind Company to build LEEDCo off-shore turbine project.” *Cleveland.com*. Advance Digital. 7 December 2015. Web. 16 June 2017.

<http://www.cleveland.com/business/index.ssf/2015/12/norwegian_wind_company_to_buil.html>.

Fred. Olsen Windcarrier Website: <http://windcarrier.com/>

Great Lakes Wind Network Website: <http://www.glwn.org/>

LEEDco Website: <http://www.leedco.org/>

MHI Vestas Offshore Wind Website: <http://www.mhivestasoffshore.com/>

Solarize Cleveland:

O'Brien, Erin. "First residents jump into Solarize Cleveland." *Freshwater Cleveland*. FeedBurner. 18 May 2015. Web. 17 June 2017.

<<http://www.freshwatercleveland.com/devnews/solarizecleveland051815.aspx>>.

Sustainable Cleveland 2019 Action and Resource Guide:

"Sustainable Cleveland 2019 Action and Resources Guide." *Green City Blue Lake*. FORM, n.d. Web. 7 June 2017. <<http://www.gcbl.org/files/resources/sc2019executivesummary9sep10.pdf>>.

Universal Foundation Mono Bucket Explanation Site:

"Suction Bucket or Caisson Foundations." *4COffshore*. n.p, 7 January 2016. Web. 31 May 2017.

<<http://www.4coffshore.com/windfarms/suction-bucket-or-caisson-foundations-aid11.html>>.

This case study reflects the opinion and sole research of the author, an Urban Ambassador who participated in ND-GAIN's pilot program. Published August 2017.