Tackling the Challenge of Smarter Energy Design:

An Analysis of the New York State Microgrid Prize Competition
and a Case Study of the Village of Ballston Spa

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Abstract

Traditional power generation and distribution via the macrogrid is highly outdated, inefficient, and susceptible to outages from natural disasters. Microgrids present an opportunity to revolutionize New York's energy infrastructure. Microgrids are localized grid systems capable of producing their own energy through a combination of small-scale energy sources. Additionally, they are capable of disconnecting from the macrogrid and functioning independently, a feature which is particularly valuable during widespread outages and severe weather events. In response to the destruction caused by Hurricane Sandy, New York created the New York Prize Microgrid Competition to fund the development of microgrids throughout the state. In this paper, we will critically analyze to what degree the competition fostered innovation, inspired community engagement, and what role environmentalism played in the project. We analyzed the initial proposals of the communities participating in the competition to examine the technologies they incorporated and the stakeholders they partnered with. We also worked closely with the participating community of Ballston Spa as they developed a feasibility study during Stage 1 of the competition in order to produce a case study. In this case study, we identified the challenges, priorities and successes of funding the development of a microgrid proposal. In order to contextualize Ballston Spa and their experience as either an outlier or the norm, we sent a survey to the 83 participating communities. The results of our research indicated that the functionality, reliability and cost-effective design of a microgrid were more important to participating communities rather than environmental considerations. A local community attempting to design a microgrid will have to address a variety of obstacles including financial and technological challenges, along with lack of coordination and prior experience. These factors influence the level of innovation and community participation each project can attain. The prize model utilized by the NY Prize Microgrid Competition encouraged experimentation and innovation with different technologies. However, innovative and original ideas are not always the most cost-effective and feasible ones, and will not necessarily contribute to the success of a proposal. This being said, even the projects who do not succeed in the competition still provide a valuable service, because they pave the way in discovering what models do and do not work for microgrids.

Introduction

When Hurricane Sandy swept ashore in October of 2012, it left millions of east coast residents huddled in the dark, reliant on batteries and bottled water for days. The super storm initially knocked out power for approximately 8.5 million people, and rendered one of the nation's largest and most influential cities immobilized, (Wood, 2014). Schools and businesses could not open, gas stations could not be accessed, and even hospitals could not function due to outages.

What is the light in the dark? Microgrids.

Self-sufficient university microgrids in New York and New Jersey held fast during the storms, providing electricity, heat, and hot water to the campuses as the surrounding cities grinded to a halt. When much of Manhattan south of Midtown was blanketed in darkness, New York University's 13.4MW cogeneration system kept power flowing to 22 buildings and heat to 37 buildings, as it has since 2011 (Pyper, 2013). NYU's microgrid consists of two 5.5 MW gas turbines for producing electricity coupled with heat recovery system generators and a 2.4 MW steam turbine (Overton, 2014). Similarly, Princeton University is typically powered from both the local grid and an on-site cogeneration facility that supplies electricity and steam for heating. During Sandy, Princeton was able to switch off the grid and power 4,000 apartments, 35 high-rise buildings, townhouses, garages, three shopping centers, and six schools for nearly two days (Morgan, 2014).

The absolute paralysis that our economy and our country experiences during these prolonged and widespread outages exposes an extreme vulnerability in the electric grid. As climate change only continues to amplify the devastating effects of hurricanes and storm surges, the need to reduce susceptibilities of our power distribution system is apparent. The potential resiliency of microgrids was successfully tested during Hurricane Sandy when the NYU and Princeton microgrids islanded from the local distribution grids and continued to provide reliable power to the surrounding area. These two universities do not stand alone in their forethought. Since 2012, a number of states have taken action to promote the development of microgrids within their areas In the United States, 260 microgrid projects are either planned or operational, and 480 projects are running worldwide (Navigant Research, 2013). Alternative avenues of electricity production and distribution such as microgrids will promote security, efficiency and control of our power – qualities which are only becoming more relevant. As microgrids continue to garner increasing attention, we believe further investigation is required, which examines these potential benefits critically.

While research and investment in microgrids is expanding, the movement is still developing and technologies continue to evolve. Our research seeks to analyze the various factors that coalesce to support the implementation of an effective microgrid. We are particularly interested in the conceivable environmental advantages associated with the technologies that power a microgrid compared to traditional power production and distribution. Through participating in the efforts of Ballston Spa to design and implement a local microgrid, we will gain an understanding of the processes of microgrid development, including the priorities of stakeholders and the technologies incorporated. We will also explore the “prize model” approach utilized by The New York State

Energy Research and Development Authority (NYSERDA) and its relative effectiveness at encouraging substantial, lasting, creative innovation in the New York energy sector. Our guiding questions are as follows:

1. Microgrids have an array of potential economic, energy, technological, and environmental benefits. How important are environmental considerations in a local group's planning process? How central are environmental considerations in the plan?
2. What are the challenges for a local community seeking to implement a microgrid project?
3. The NY Prize Microgrid Competition was designed to foster creative and innovative solutions. How different and unique are the 83 communities' different proposals? Does the competition really foster innovation or do many areas design similar projects?

Microgrids present an opportunity to revolutionize the way the United States is powered. Microgrids are self-contained grid systems equipped with on-site power generation, like a combined heat and power (CPH) plant or a renewable resource like wind or solar. Energy demand is growing rapidly and the nation's aging infrastructure is increasingly ill-equipped to support that growth. As energy resources strain to meet increasing demand, environmental pollution will be exacerbated correspondingly. The environmental impacts of traditional power generation include asthma-inducing particulate matter, pollutants that cause acid rain and carbon dioxide that is primarily responsible for climate change (Twaite, 2011). The need to explore new approaches to generating and distributing electricity is apparent. Microgrids represent an emerging approach to energy production and distribution that mitigate a host of issues associated with the traditional electricity system.

Succinctly, a microgrid is an electric distribution system that is designed to interconnect to the traditional electric distribution grid at at least one point of common coupling. However, a microgrid is also capable of disconnecting from the grid and functioning independently. Microgrids can exist in many forms and models range from grids that operate in island mode constantly, to grids that are owned by utilities and never disconnect from the Macrogrid. Their benefits are also multifaceted. Microgrids are a way to improve system power quality, reliability and economics, while reducing environmental impact by allowing for small scale renewable integration (Morris, 2011).

Traditional Energy System- Macrogrid

The macrogrid is the infrastructure that currently provides the majority of energy to homes and businesses throughout the United States. The grid produces low voltage energy, Direct Current (DC), at generation facilities and then converts that energy into Alternating Current (AC). High voltage transmission lines transmit the energy to population centers, where the energy is converted back into low voltage and sent to residential homes and commercial buildings. The grid is an extensive piece of infrastructure that generates energy from 5,800 power plants and sends it to 120 million customers through 450,000 miles of transmission lines (U.S. Department of Energy, 2013). However, the grid's massive size, as well as America's complete dependence on it for power, has created vulnerabilities in the nation's energy system. Its interconnectedness means that when part of the grid needs to be repaired, everyone is affected.

The macrogrid is particularly vulnerable to severe weather events, which caused 679 blackouts between 2003 and 2010 and has cost between $18-$33 billion annually in grid maintenance. These annual costs spike dramatically during years where superstorms occur. Hurricane Ike resulted in $40-$75 billion of expenditures in 2008 and Hurricane Sandy resulted in $27-$52 billion in 2012 (U.S. Department of Energy, 2013). These costs are the aftermath of a combination of lost outages and wages, spoiled inventory, delayed production, inconvenience and damage to the grid. Blackouts also cause disturbances in supply chains, interfere with land and air traffic, as well as information being sent through the internet, and displace public safety as police and fireman are redirected from standard duties to address new problems.

Even when the grid is properly functioning as designed, power usage is extremely inefficient. Because the grid is built to accommodate large populations, it runs constantly at a set power level meant to provide for the times during the day when peak energy supply is needed. Throughout the remainder of the day, this energy is burnt and wasted because energy requirements are lower. There is currently no effective way to store energy for later use, nor is there a system to adjust the energy production to adapt to varying demand. Furthermore, while the grid is continuously expanding, the bulk majority of America's power plants, power transformers, and transmission lines are over 25 years old (U.S. Department of Energy, 2013). Older transmission lines waste more energy than new installations. Outdated automated sensor technology also delay information about mechanical difficulties and system failures being sent to grid operators. Older infrastructure is also more vulnerable to the effects of severe weather events and is therefore more likely to experience system failures (U.S. Department of Energy, 2013). As climate change increases precipitation in the global north, the rate of occurrence of extreme weather events is continuously rising; at the same time the grid infrastructure continues to age and becomes less equipped to handle damage.

What is a Microgrid?

Microgrids are unique in that there is no singular definition used to characterize this form of electricity distribution. Their uses and designs vary with location, population and geography. Many definitions of microgrids exist and currently there is no universally recognized definition for this emerging technology. The United States Department of Energy (DOE) describes a microgrid as a local energy grid that can work both in congruence and autonomously from the macrogrid (Hayden, 2013). A study by Securicon, a utilities security company, categorized microgrids by five distinct features:

1. Microgrids can operate as "islands" or in congruence the grid. "Islanding" refers to when a microgrid separates from the macrogrid automatically or manually, and therefore functions independently as an "island".
2. Microgrids consist of interconnected and co-located energy sources.
3. They can accommodate several different amounts and types of energy sources.
4. Microgrids are designed to meet the total energy needs of the islands they are producing energy for.

5. Microgrids are built to be operated separately from the macrogrid (Hayden, 2013).

Additionally, microgrids are locally controlled systems that have the ability to harness resources that otherwise may be too small or economically invaluable to the macrogrid.

General Structure of a Microgrid

Most microgrids connect to the macrogrid. The connection point is created using a substation. This substation is the key point of entry for energy either entering or leaving the microgrid. Depending on the formating of the microgrid, there might be more than one substation and point of entry into the macrogrid. The substation then leads to distribution lines. These distribution lines can connect to several different parts of the microgrid. The distribution lines will connect to every island in the microgrid, all of the energy generation systems, and the residential or commercial areas the microgrid is powering.

Markets of Microgrids

Currently the market for microgrids is small because the technology and potential applications are still developing and evolving. Despite this, there are several markets that are uniquely positioned to flourish with the implementation. These include institutional microgrids, off-grid microgrids, military microgrids, industrial microgrids, and community microgrids (Hayden, 2013).

The institutional microgrid is built for either a college campus or large institution of similar size. Currently, this is one of the fastest growing markets for microgrids. One reason for the fast growth in this market is because of the possibility of single ownership of property. Because college campuses and large institutions are often owned by only one entity, many logistical and regulatory obstacles are avoided with this model. These microgrids range in size from 4-40 megawatts of power (Hayden, 2013).

Off-the-grid microgrids are unique in that they do not operate in congruence with the macrogrid. These microgrids have no substation that connects to the macrogrid, meaning that they are always functioning independently. These microgrids are often used in situations where connecting to the macrogrid is to expensive or not technically feasible. These microgrids are highly applicable in developing countries, where national macrogrids are unreliable or non-existent (Bullis, 2012). Off-the-grid microgrids often produce the smallest amount of energy in comparison to all other forms of microgrids. Off-the-grid microgrids currently represent the largest market segment of microgrids (Hayden, 2013).

The military microgrid, is the third largest microgrid market segment, with huge potential for growth. The purpose of military microgrids is to make military bases independent of macrogrids in emergency situations. Military microgrids are strategically important, as it provides energy safely for military personnel and does not impact local energy supplies (Hayden, 2013). The Department of Defence (DOD) is currently investing about 30 million dollars into microgrid research, with a test microgrid base in Hawaii (Hayden, 2013).

The industrial microgrid is a recent development, without practical testing. The model is based around the idea that areas of high industrial activity will be able to coordinate energy usage and develop systems where they do not rely on the macrogrid. These types of microgrids are currently limited because of the regulatory issues that coincide with multiple owners and community members. Potential for market growth appears limited with industrial macrogrids.

Community microgrids are rarely found in the United States, and are often used in Europe. These microgrids consist of a combination of distributed and traditional sources of energy. Generally community microgrids connect to critical facilities such as a police station, hospital or fire station.

Economic Implications of Microgrids

Microgrids provide superior technical efficiency and resiliency than the macrogrid, resulting in both energy and monetary savings. The ability of microgrids to function as an "island" protects them from the system crash that a severe weather event may inflict on the greater grid, and allows them to continue to provide energy to the area they are localized to (Robinson, 2013). Furthermore, unlike the macrogrid, microgrids operators do not rely on outdated sensors for information of mechanical problems, and utilities do not have to wait for customers to report problems. Rather, microgrids are equipped with smart meters that both synchronize them to the grid under normal conditions as well as automatically disconnect themselves when necessary (U.S. Department of Energy, 2013). Smart meters send immediate alerts to utility companies when they are forced to island so that repair crews can be dispatched efficiently to the correct areas. Such immediate status updates of the grid help utility companies determine where and when to direct dispatches and to avoid unnecessarily and incorrectly deploying their resources (Vermont Law Review, 2012). This saves millions in total restoration costs (U.S. Department of Energy, 2013). Microgrids ability to function independently and incorporate efficient, modern monitoring tools helps prevent power losses from affecting customers. This dramatically cuts the costs that would normally burden customers.

Microgrids are also much more efficient than the broader electrical grid. Because the grid needs to transmit energy over long distances, it must convert DC to AC to move along transmission lines, and then back to DC for customer use (Singh & Shenai, 2014). This process wastes considerable energy in repeated conversion. Since microgrids operate in a localized context, they use only DC and thus avoid both conversion waste and the energy loss that inevitably occurs from moving electricity through aging power lines over long distances (Singh & Shenai, 2014). The DOE has predicted that microgrids will generate close to $1 billion annually both from savings during power losses and also from dramatic reductions in our use of the standard fossil fuels that power the electric grid. The localized energy provided from microgrids could lead to a 10% reduction in energy bills, which represents a savings of $360 million annually for customers (Vermont Law Review, 2012).

Environmental Implications of a Microgrid

While microgrid applications have the potential to provide significant economic and technological advantages, they also create environmental benefits by promoting the increased use of renewable power. The DOE predicts microgrid proliferation beginning in 2015 will provide 200 megawatts of renewable energy deployed within microgrids (Twaite 2011). Microgrids provide the opportunity for clean energy sources such as solar, hydro and wind to connect to the grid and manage their intermittency. Many renewable energies are not reliable or cost-effective enough to be implemented on a large scale. The flexible nature of microgrids makes them more suitable to the wider use of renewables. Combining two or more renewable energy sources can provide a stable energy supply. Thus, microgrids have the potential to displace coal-fired generation and other fossil fuel intensive ways of electricity production. Microgrids are therefore uniquely situated to take advantage of renewable technologies to meet substantial demand while still operating in small-scale applications; they mitigate the problems of intermittency while spreading their cost (Twaite, 2011).

Because microgrids lessen reliance on fossil fuel consumption by enabling the smooth incorporation of renewables into energy production, the technology has the potential to significantly reduce carbon footprint in the United States. As of 2013, 31% of total greenhouse gas emissions in the United States came from electricity production. That is the largest share of greenhouse gas emissions that any sector produces and amounts for about 2,068 million metric tons (EPA, 2014). The potential reduction of greenhouse gas emissions and other pollutants is sizable. The DOE estimate that widespread implementation of microgrids in the United States can eliminate 17.4 million tons of CO_2 emissions, 108,000 tons of SO_x emissions and 18,000 tons of NO_x emissions (Twaite, 2011).

A study conducted in 2012, by the Department of Electrical and Computer Engineering at the University of Waterloo analyzed and compared four different configurations of of electricity generation in order to determine the most favorable option for microgrid planning. The results from the study support the assertion that renewable integration into microgrids has the potential to significantly reduce emissions during electricity production. The study examined four different cases. In Case 1, the microgrid is supplied by an isolated network fed by diesel generators, as is the case for many power systems around the world that are dependent on fossil fuel to meet their demand. Case 2 considers that the microgrid is entirely based on renewable energy sources. Case 3 is a mixed configuration comprising of both diesel and renewable energy sources while in Case 4 the microgrid has the option of connecting and drawing energy from the external grid. The results displayed in Figure 1 reveal that the renewable grid made up of wind, solar PV, battery, micro-hydro and converter significantly reduces the total system emissions as compared to all other cases. Even Case 3, which emitted more than the purely renewable microgrid, was environmentally friendly when compared to the diesel microgrid (Hafez and Bhattacharya, 2012).

Case-wise Comparison of Emission

Pollutant	Emissions, ton/yr Case-1	Case-2	Case-3	Case-4
Carbon dioxide	6004.76	3.67	1078.4	1086.18
Carbon monoxide	14.82	0	2.649	0
Unburned hydrocarbons	1.64	0	0.293	0
Particulate matter	1.12	0	0.2	0
Sulfur dioxide	12.06	0.008	2.17	4.7
Nitrogen oxides	132.23	0	23.64	2.29

Figure 1: Case-wise Comparison of Emissions

In addition to decreased emissions from the integration of renewables in distribution systems, the localized nature of microgrids decreases the transmission distances of electricity. In the United States, transmission and distribution losses amount to about 7% (Singh and Shenai 2014). Hydroelectric generating stations, wind farms and solar-thermal power plants often require large installations in places that are far from population centers. That, in turn, demands the long-haul transmission and distribution of electricity to consumers, which results in energy losses (Singh and Shenai 2014). Having generators close to demand centers minimizes the losses not only associated with renewables but also with traditional energy production. Localized energy cuts down costs, but also achieves energy savings by reducing electricity loss.

Energy loss can occur during transmission as well as loss when electricity is converted from AC, that supports higher voltages, to DC for lower voltages appropriate for use in homes and businesses. In the traditional energy distribution system, the electricity flowing from photovoltaic panels mounted on the roofs of houses and commercial buildings is converted from DC to AC and then back to DC again just to generate power in the building. This wastes approximately a third of the total generated energy. Microgrids distribute DC energy directly and therefore prevent substantial losses in energy that result from going from DC to AC to DC back again (Singh and Shenai, 2014).

Barriers to Microgrid Implementation

Our review of relevant literature suggests that regulation is the largest barrier to the development of private sector microgrids. Currently, there is no national regulatory body dictating the development of microgrids. In New York, NYSERDA has created an outline for future development of microgrids (Saadeh, 2015). NYSERDA outlines how microgrid ownership should be merged with current macrogrid ownership, along with applicable ways to finance microgrids in both the public and private sector. The ideas in NYSERDA's outline are promising, but have not yet been implemented. Our initial primary literature review identifies five main barriers facing the development of microgrids. These barriers are: utility franchise rights, public utility regulation, issues with connecting to the macrogrid, working within building and zoning codes and effective energy storage methods (Saadeh, 2015).

Utility franchise rights is one of the primary barriers to the development of microgrids. Utility franchise rights are agreements made by the municipality and utility producer. The municipality charges the utility to use the public infrastructure and provide energy to residents. These franchise agreements are difficult for small independent energy producers like microgrids to attain because they require the construction of new energy infrastructure. Also, even if new energy infrastructure is built, larger utilities might sue microgrids for breaching or infringing upon previously existing franchise agreements.

Public utility regulation can also hinder microgrid proliferation. All major producers of energy in the grid are regulated by their state governments. This means that microgrid energy production could be treated like larger macrogrid energy producers. The state could control the price at which microgrids sell energy, the quality of energy microgrids sell, and the rate at which microgrids sell energy (Saadeh, 2015). These regulations could increase the cost of creating a microgrid. These cost increases from excess regulation could potentially make the construction of a microgrid cost ineffective.

Issues with connecting to the grid are problems that almost all microgrids will have. Private sector microgrids will run into issues regarding regulation of grid connection. Laws and regulations regarding connecting to the grid differ in every state. This makes it difficult for microgrids to develop nationally in the private sector as each project has different regulations about connecting to the grid (Saadeh, 2015).

While small private sector microgrids might face large regulatory barriers, large utilities have the potential to bypass all these regulatory issues (Saadeh, 2015). Large utilities can develop microgrids to help streamline the inefficient macrogrids for the 21st century. These enormous utility companies can afford to create microgrids, as they own more capital and can afford to adhere to the current rules and regulations required for energy producers.

Another major obstacle to microgrid construction, especially for industrial building and offices, are building codes. Codes were often designed to meet outdated needs, and may have voltage limitations on power generation in order to prevent fires and shock hazards (Singh & Shenai, 2014). Luckily, there are a few resources industrial and commercial buildings can access to work within these building codes. The largest of these is EMege Alliance, which closely examines the makeup of building and calculates how they can efficiently run a microgrid at a voltage level deemed acceptable by the United States National Electric Code. This organization also helps design simple wire systems that make handling microgrids as user friendly as possible (Singh & Shenai, 2014).

One of the major technological challenges in funding microgrids is that the standard lead-acid batteries that allow for on-site energy storage can only last for a few years before they need to be replaced. The replacement costs for the batteries are very expensive, and the ongoing funding for new installations needs to be factored into the budget of any microgrid plan (Bullis, 2012). However, a number of companies are currently working on new forms of storage that are technologically similar to the lithium ion batteries that are used in electric cars. While these batteries are typically high cost, they can be designed with cheap materials and can sell them for prices that are not exorbitantly high, and may even cost the same in many instances. Lithium ion batteries will last much longer than competitor brands, ultimately saving dramatically on replacement costs, as well as saving electricity that's typically used to continuously cool the lead acid batteries (Bullis, 2012). Even in cases when the batteries do cost more than the lead acid variants, a higher initial investment in longer lasting batteries will ultimately save money; however, the decision of whether or not to make this investment will generally vary based on the budget of each project.

Over the course of our research, we will seek to identify additional challenges that individual communities face when trying to establish regional microgrids.

Research Design

The microgrid movement has been slow to gain traction throughout the United States, with the majority of attention and investment happening in California, Maryland, Massachusetts, Connecticut, New Jersey and New York (John, 2014 & Wood, 2014). California stands out among this group of early adopters in their particular commitment to renewable energy. In 2014, the state dedicated $26.5 million to directly fund the development of renewable microgrids. $6 million was allocated specifically to microgrids that can connect to and power electric cars. However, California's commitment to clean distributed energy makes them the exception; most states investing in microgrid research are dedicating the bulk of their resources towards the construction of natural gas and diesel generators rather than solar, wind or hydro. States have generally chosen the "reliability first" model, which prioritizes microgrids' ability to provide back-up power over their ability to provide opportunities for clean technology development (John, 2014). It is no coincidence that aside from California, the states that have made the largest investments in microgrid research are all located in the northeast - the region of the U.S. that's the most geographically vulnerable to extreme weather events.

In response to the severe outages caused by Hurricane Sandy, in July 2013 Connecticut awarded $18 million to nine projects for the design and construction of microgrids. In March 2014, Connecticut followed their initial investment and offered $15 million for communities to bid on for microgrid development in their area (Wood, 2014). These actions made Connecticut the first state to make large-scale commitments to microgrids and currently places them as the leader in the United States in terms of installed capacity (Wood, 2014). New Jersey follows Connecticut closely in commitment to microgrids, also originally taking an interest in the movement during the recovery phase from Hurricane Sandy.

The NJ Transit is the third largest in the United States and provides the only public transport link between New Jersey and New York City. It is also uniquely and highly vulnerable to flooding (GreenBiz, 2013). In 2013, Governor Chris Christie commissioned a $1 million study to be carried out by the New Jersey Public Board of Utilities working with the DOE with the purpose of analyzing the capabilities of a 50 MW microgrid for their transit system. Consequently, New

Jersey committed a total of $200 million in 2014 to their Energy Resilience Bank for the development of microgrids and distributed energy throughout the state (GreenBiz, 2013 & Tweed, 2014). Massachusetts has adopted a more indirect route toward distributed energy, choosing not to pledge any funds directly towards microgrids. Instead, the state has required its utilities to design 10 year plans for their businesses moving forward. In order to be eligible for state funding, these plans must demonstrate a commitment and focus on smart grid modernization (Wood, 2014). Following in the footsteps of these other states, Maryland has created a task force with the sole purpose of studying the efficacy of microgrids in different areas throughout the state as in terms of relative electric demand and vulnerability to severe weather events (Wood, 2014).

While all six of these states are making impressive steps forward with distributed energy, our research will focus solely on New York. Similar to Connecticut and New Jersey, in New York public interest in microgrids was sparked following the disastrous effects of Hurricane Sandy. While two million people lost power in New York City, the New York University microgrid provided a consistent source of power for the Washington Square campus (Pyper, 2013). This incident exemplified the vulnerability of complete dependence on the traditional macrogrid while at the same time provided a powerful example of the reliability and advantages of microgrids in extreme circumstances. What followed was a new wave of attention from policy makers and public and private organizations towards the potential and need for distributed energy. In the wake of the storm, New York City Mayor Michael Bloomberg released his Special Initiative for Rebuilding and Resiliency postmortem report, which publicly called for an increase in the design and construction of microgrids. It called for 800 MW of the city's power to come from microgrids by 2030 (Pyper, 2013). The New York State Smart Grid Consortium praised Bloomberg's decision and began actively working to coordinate utility representatives, technology design specialists, property owners and policymakers to work together towards the installation of microgrids throughout the state. NYSERDA launched a year long study that analyzed the ability of microgrids to provide reliable backup power. The study was expanded in 2013, allocating $10 million to update the reliability and efficiency of New York's power delivery system (Pyper, 2013).

All this built toward June 2015, when New York Governor Andrew Cuomo released the Reforming the Energy Vision (REV) initiative to drive New York toward a clean, efficient and resilient state wide energy system. In response to New York's vulnerability to extreme weather events, as highlighted by Hurricane Sandy, REV largely focuses on modernizing the electric grid. The most significant step towards distributed energy outlined in REV is the New York Prize Microgrid Competition, created by Governor Cuomo and directed by NYSERDA. It allocates a total of $40 million to the development of microgrid projects throughout the state. Second to New Jersey's $200 million investment, this represents one of the largest sums of money dedicated to microgrid projects in the United States. Following the announcement of NY Prize, 130 communities in New York entered the competition to apply for REV funding to design and install a microgrid in their area (NYSERDA, 2015). 83 communities out of the 130 were awarded $100,000 each to complete feasibility assessments in June, 2015. They will submit their feasibility assessments in April 2016. In November 2016, approximately 10 communities of

83 will receive $1 million for the stage 2 design portion of the competition. In the fall of 2017, about 5 communities will proceed in the competition and receive $10 million for implementation (NYSERDA, 2015).

New York's program is unique compared to other states' in that it takes a bottom-up approach towards microgrid development, allowing communities to design their projects independently. This is in stark contrast to the New Jersey model, which focuses primarily on one specific model, the industrial microgrid, and how to integrate it with the public transit system. Every feasibility assessment and design will be carried out by the New Jersey State Department, working together with the DOE, using one form of design model: the Distributed Energy Resources Customer Adoption Model (U.S. Department of Energy, 2015). This is essentially the opposite of the design model created in NYSERDA's 2014 report that formed the basis for the New York Prize Microgrid Competition. In the report, NYSERDA specifically wrote that do not want New York to focus exclusively on campus style microgrids, such as the NYU microgrid, which have historically been the most successful for the longest period of time within the state (NYSERDA, 2014). NYSERDA acknowledged that different communities will require different models of microgrids based on their varying needs and unique geographical characteristics. As such, their report, and the New York Prize Competition, focuses on the overall ability of microgrids to provide back-up power to critical infrastructure in a wide range of different contexts, instead of specific model or one specific sector of public life (NYSERDA, 2014).

In this sense, New York's plan is more similar to Connecticut's than any other state. Connecticut also took a generally bottom-up approach by making funds available for a number of different organizations and locations, and also emphasized community-use microgrids over any one, location specific model (Bredenberg, 2013). This approach of making funds available for individual communities to do their own research and create their own designs saves the state government time and resources. It also ensures that more individual projects will ultimately be accomplished than if only government authorities were in charge of each and every infrastructure upgrade that happened within the state. However, the New York Prize Microgrid Competition stands apart from Connecticut's plan in that it created a separate stage of the bidding competition specifically for feasibility assessments. Each community that entered the Connecticut grant competition did so with a feasibility study already conducted, whereas New York provided feasibility funds for dozens of different locations, enabling communities to participate that would not normally have the funds to do so (Bredenberg, 2013 & State of Connecticut, 2014).

Furthermore, while only a few of the contenders will earn the final payoff to fund the majority of their project, many of New York's communities are projected to still complete their projects independent of REV funds. The initial $100,000 grant for the feasibility study mitigates one of the largest practical barriers to starting a microgrid project. Feasibility studies are perceived as high risk investments because they may reveal impracticalities in projects. By providing this funding, REV eliminates the risk associated with investing in research that normally would be impossible or costly to conduct. Additionally, locations that don't qualify for the final grant may still be able to attract outside investors once they have developed a thorough plan using initial funding. While Connecticut's pilot plan only provided the funds for nine different organizations, New York's plan may make it possible for many more microgrid projects to come to fruition. Because of the abundance of microgrid research enabled by state funding, the proper climate is also established in New York for further progress and development within the industry.

History of the Prize Model of Innovation

The Prize Model is: "an open innovation technique used to induce a desired innovation through the creation of a competition and recruitment of innovators in pursuit of the prize" (Innovation in the Crowd, 2012). The prize model dates back hundreds of years. Historically, governments have used philanthropic donations to promote innovation in a variety of fields.

The first modern prize project was initiated by the British parliament. In 1714, Britain had one of the largest navies in the history of the world, but no way of determining a ship's longitude while at sea. To solve this problem, the British government offered 20,000 pounds (the equivalent of $4.5 million), to the person who could create a simple solution to this problem (Lohr, 2011). Surprisingly, the clockmaker John Harrison, who had no previous naval history, produced the chronometer. The chronometer allows boats to determine their longitude at sea by using a precise timepiece. Harrison's invention is so effective that when modern boats are unable to use Global Positioning Systems, they still use chronometers. This quintessential example exemplifies the philosophy behind the concept of the prize model: there are innovative, original and specific ideas that will flourish if provided the appropriate motivation and funding, and if the opportunity was made available to a wider network of people. Encouraged and incentivized, John Harrison, an outsider, with no involvement in naval culture, created an ingenious and simple device that changed naval history.

Since 1714, the use of prizes to spark innovation has been on the rise. In the late 18th century, Napoleon Bonaparte utilized the prize model of innovation develop a way of preserving food. Consequently, modern canning techniques arose (Mckinsey and Company, 2009). In the early 20th century, the New York Hotelier Raymond Orteig, created the Orteig Prize, which offered a $340,000 to anyone who would cross the Atlantic Ocean using air power. As a result, Charles Lindbergh completed the first solo, nonstop flight across the Atlantic, and revolutionized transatlantic travel (Mckinsey and Company, 2009). The Orteig Prize was also significant because it began a movement of prize development by private financiers. The Nobel Prize, is now one of the most famous and well known private institutions that offers prizes in all fields of arts and science. History strongly suggests that prizes truly can stimulate new inventions. In 1995, Peter Diamandis created the Ansari XPrize which promised $10 million dollars to the first private organization that could build a functional spacecraft. Numerous organizations began independent efforts to gain the prize money and a huge amount of outside funds were invested in the project. In 2004, a team led by Burt Rutan won the competition and used the money to license the spacecraft the Virgin Galactic (Hendrix, 2014).

Despite the historical presence and success of prize model strategy, up through the 20th century, public policy goals and services were typically pursued through hierarchical government bureaucracy (Goldsmith & Kettl, 2009). However, in 2009, The Race to the Top (RTT) education initiative was developed as a modern utilization of the prize model of innovation in a new venue. RTT emerged as a part of the American Recovery and Reinvestment Act of 2009 and provides competitive awards to encourage innovation in education (McGuinn, 2012). Under RTT, states and individual schools develop innovative local education solutions and compete for a share of $4 billion from the U.S. Department of Education to implement them (Holstein and Phelps, 2013). The initiative represents a departure from relying purely on mandates and compliance culture to catalyze improvement, and instead focuses on collaborative work and incentives rather than sanctions to drive state reform (Russel et al, 2015).

Many cite the RTT education initiative as an overwhelming success. There is evidence that this federal policy has greatly influenced state legislative activity. For example, 29 out of 46 states that applied for RTT funding made policy changes creating statewide teacher evaluation systems. Of these 29, 16 states now require that student achievement data be used in annual teacher evaluations, a significant departure from the typical evaluation processes in schools. As this example illustrates, many of the changes launched by the requirements to be competitive for RTT funding have resulted in significant system changes that have the potential to influence teaching and learning in schools (Russel et al. 2015). Further, the competition attracted a tremendous amount of attention to the issue of school reform, ineffective state policies and helped create new political coalitions to drive reform. Significantly, RTT empowered new actors and organizations to create alliances committed to reform. In fact, RTT even galvanized a variety of private-sector actors including foundations, think tanks and private philanthropists on behalf of reform such as the Bill and Melinda Gates Foundation, the Center for American Progress, who used private dollars and expertise to support and extend efforts (McGuinn, 2012). This collaboration of various and diverse stakeholders around the cause was significant and impactful:

“A key to the success of the Education Race to the Top is the power held by those at the state and local level who witness, on a daily basis, the obstacles unique to their locality, and are therefore best equipped to design effective solutions” (Holstein and Phelps, 2013).

Therefore, an approach that takes the unique needs of individual communities into consideration to develop unique policies and technologies has been successfully tested as an avenue towards innovation.

We can garner valuable information about the realities of reform implementation through analyzing outcomes of the RTT program, which departed from reliance on traditional hierarchical approach to educational reform by engaging diverse coalitions of actors to work together toward improvement (Russel et al, 2015). Research on inter-organizational networks identifies the promise of this strategy as well as potential challenges (Goldsmith & Eggers, 2004; Provan & Kenis, 2008; Provan & Milward, 2001). Networks are particularly well suited for knowledge-intensive processes like innovation development, for example, because they can facilitate information exchange and interaction across diverse actors with varying expertise (Bryk et al., 2011; Goldsmith & Eggers, 2004). However, creating the conditions that support problem solving and knowledge exchange requires the right mix of partnering organizations, participation structures, and coordination mechanisms (Goldsmith & Eggers, 2004).These lessons concerning the implementation of a "Race to the Top" approach in education reform can then extend into energy reform, and provide insight into how this prize approach will function as part of NYSERDA's grant competition.

Prize Model of Innovation Applied to Energy

From Charles Lindbergh flying across the ocean in 1927 all the way to the Ansari XPrize funding spacecraft research and development in 1995, the prize model has helped major breakthroughs to be achieved from unlikely places. The value behind the prize model is that it offers powerful incentives towards wide scale innovation throughout a large population. This is in contrast to the traditional model of research grants or command and control regulation. Under command and control regulation, a government authority presents standards and targets that must be complied resulting in negative sanctions for non-compliance. Generally, research grants fund specific groups of people to conduct a project within set guidelines and achieves a much steadier pace of progress. (U.S. Chamber of Commerce Foundation, 2014 & The Department of Industrial Economics and Strategy, 2004). Additionally, traditional federal formula grant programs, such as the Elementary and Secondary Education Act, direct funds on the basis of demographics or educational need without regard for reform or achievement. On the other hand, the prize model of innovation only supports participants with strategic plans for innovation and a commitment to improve (McGuinn, 2012). The prize model sets a certain end goal and promises contestants reward money, public recognition, intellectual property rights and a large degree of freedom in their project design and research. Oftentimes the actual cash prize acts as the leverage point to initiate sponsorship and funding to go towards certain goals that would otherwise never be given attention. The Ansari XPrize demonstrates this. While the initial project promised only $10 million, altogether the contestants ended up investing more than $100 million of outside funds (Hendrix, 2015).

The NY Prize Microgrid Competition embodies the principles of the prize model by giving communities the freedom to design anything that's economically and technologically feasible. In theory, this will encourage innovation and diversity in the design of the different projects, and also encourage outside investors to help communities that do not win the grand prize to still develop their own microgrids. The NY Prize Microgrid Competition offers significant rewards at each of the three stages of the contest: $100,000 for the feasibility assessment, $1,000,000 for the design and $10,000,000 for the final implementation and construction. However, one of the key advantages of the competition is that it also offers non-monetary incentives to all participants (U.S. Chamber of Commerce Foundation, 2015). While traditional non-monetary driving reasons for entering a Prize competition might be prestige or an innate desire to win, the different townships and cities throughout New York have the promise of improvements in local energy resiliency to drive them. Every community in New York stands to gain from energy security and energy independence, especially when dealing with extreme weather events. Other possible considerations that could be of importance to the communities involved are the potential for more cost effective energy, greater efficiency in energy use and pro-environmental concerns and a specific interest in renewable technology.

We anticipate a few difficulties unique to prize model of development. Since the reward money necessary to actually build a microgrid is only promised at the end of the competition and many of the projects are dependent on outside investors, it is possible that some community efforts will fall short of gathering the funds they need. Failure of participants is not an obstacle in contests where the only goal is to generate the single best possible idea or solution. However, the stated goal of the NY Prize Microgrid Competition is widespread proliferation of energy security throughout the state, so it is to the benefit of NYSERDA for as many projects to succeed as possible. Furthermore, many of these projects rely upon grassroots collaboration, volunteer efforts from multiple partners and generous funding from outside sources, which could be an obstacle to many of the microgrid projects successfully being completed (U.S. Chamber of Commerce Foundation, 2015). Each of these projects will require large amounts of time and resources from many different people and organizations, many of whom will never have worked together before and some of whom will receive no financial compensation for their efforts. It is also true that even though each community is working independently, there are a limited number of electric utilities and major engineering and microgrid design companies in New York. If a wide number of the different communities end up working with the same partners, then many projects will share similar plans and technologies. This would potentially create homogeneity throughout the competition instead of fostering innovation and diversity.

Ballston Spa Case Study

Ballston Spa is a small, middle class village in Saratoga County, New York. The community is 1.6 square miles and contains 2276 households and 5,556 citizens (City Town Info & U.S. Census Bureau). The initial NYSERDA grant was awarded to the Ballston Spa School District to conduct a feasibility study. The project currently being directed by Edwin Martin, the Ballston Spa School District Coordinator of Facilities. In addition to the school district, the project involves over a dozen different members representing fields such as finance, engineering and construction. At the time we began coordinating with Ballston Spa, the team had composed a microgrids plan which identified six interconnected islands. The Ballston Spa team planned to base the first energy island near a dam on the Kayaderosseras Creek and run it using hydroelectric power. The remaining five were initially to be powered either by solar panels or by natural gas powered PureCell Fuel Cells and Cogeneration plants. While the bulk of the proposal is designed to be financed by REV funds, outside grant applications were currently being submitted for funds both for the solar panels and the natural gas fuel cells.

The Ballston Spa Proposal provides a relevant case study of the microgrid movement for a number of reasons. The Ballston Spa team faces unique challenges because of the technical complexity of the creating six interconnected islands and also because of geographical location. Ballston Spa is situated in upstate New York; however, the majority of NYSERDA funds will likely be concentrated in New York's most vulnerable area, New York City. These handicaps force the Ballston Spa team to assemble the most thorough feasibility study possible to compete with the other 82 communities, many of which are in storm-vulnerable locations throughout the city. In addition, Ballston Spa serves as a valuable case study because it involves many different organizations, which allows us to observe the interplay between actors representing vastly different fields. We will study, for instance, how a specialist in renewable finances works together with a specialist in engineering and energy storage to accomplish a goal built on both of their separate areas of expertise. Ballston Spa Proposal's is an informative case study because it utilizes both renewable energy sources, solar and hydro, as well as fossil fuel energy, in the form of natural gas. Their plan's incorporation of different forms of energy provides the opportunity to study the prevalence of renewable energy in the plan, as well as the stakeholder's interest in environmental protection in relation to convenience and price of power. We will consider the framing and presentation of different energy sources in addition to the rationale for choosing each energy source in order to assess the importance of the environment in Ballston Spa's microgrid project.

Methods

The purpose of our research is to investigate the success of the prize model of innovation in the New York Prize Microgrid Competition. We want to determine if the competition was successful in its goals of sparking innovation and community engagement. We also wanted to know what role environmentalism and renewable energy played in the competition. From our findings we will also identify the challenges, priorities and advantages that participating communities encountered during microgrid development.

A mixed-methods approach was utilized when conducting our research including both qualitative and quantitative process. Through direct participation we collected data during the the monthly meetings with the Ballston Spa Microgrid Team. Direct participation gave us familiarity with the Ballston Spa Microgrid Team, as well as inside knowledge of their specific practices. The Ballston Spa Project served as a case study to provide a detailed examination of how microgrids develop from inception to completion. We looked at who the stakeholders of each project are, how they interact, the obstacles they encounter and the technologies they choose to incorporate in their microgrid. In addition, we analyzed summaries of the initial proposals of each of the 83 different communities to discover what they believe their greatest priorities and obstacles to be in the competition, and to see how heavily renewable technology features in their unique plans. We looked at the technologies and strategic partnerships in each of the 83 proposals. We also sent out a survey to all of the 83 communities. The survey asked each community nine different questions about the innovation, community involvement, and sustainability initiatives in their microgrid proposals.

I: Ballston Spa Case Study

The first part of our data was collected through our correspondence with the Ballston Spa Microgrid team. This includes our attendance of their monthly meetings, a review of publicly shared data and semi structured interviews involving 10 different stakeholders. We attended four meetings from November 2015 through April 2016 when the microgrid proposal was finished and submitted. At each meeting the stakeholders in the project gathered to share their progress and their contribution to the project. Attendance ranged from 5 to 25 persons. The team shared developments, made personal presentations on their work, discussed complications and hurdles and set goals to be accomplished by the next meeting. Our participation in the meetings allowed us to observe how various stakeholders from different fields collaborated on the project. Through participant observation we assessed the role of environmental considerations in decision-making and how participants viewed the technical, economic and energy challenges facing the project.

We also conducted an archival analysis studying all relevant documents, plans and records related to the project. The majority of this information was recorded through a publicly shared Dropbox account that linked all of the stakeholders involved in the proposal. Whereas the meetings allowed us to observe the communicative and cooperative side of their project's development, the Dropbox acted as a source for which we could review data from each of the different elements of the project. The grant application process required complete transparency in each of the different proposals, so through the Dropbox we could review the PowerPoint slides from presentations delivered in the meetings and study the exact details of any side applications for funds that went into the final plan.

The final way we gathered information from the Ballston Spa team is through correspondence with the different stakeholders. We conducted a series of semi-structured interviews with eleven members of the project that lasted about an hour each. Through these interviews we could directly gauge each stakeholder's opinions on the project and the challenges it faced, and how prevalent they believed environmental considerations were in final proposal. These semi-structured interviews enabled us to obtain information that might not come up in the normal dynamic of the monthly meetings, and to observe if the different backgrounds of the stakeholders impacted the way they felt about the project and the role the environment in microgrid development.

II: Analysis of the 83 Communities

The second part of our research focused on drawing conclusions about the overall NY Prize Competition and was built upon data taken from each of the 83 communities involved in the competition. First we analyzed each community's initial microgrid proposal, which was available on NYSERDA's website. From these initial proposals we tallied and categorized every type of technology and energy source communities identified as part of their microgrids. This gave us a sense of what the most popular forms of energy technologies are. This will aid in our analysis of if the NY Microgrid Prize Competition was successful in fostering technological innovation.

We also recorded the different stakeholders that each community choose to partner with to determine which forms of partnerships are the most common. From this data we can make conclusions about who are the most widely used and most valued stakeholders. If environmental engineering organizations rank particularly high, for instance, this would suggest that environmental design may be of importance to many communities.This will aid in our analysis of the both the priorities of participating communities and also the success of the NY Microgrid Prize Competition in sparking community engagement.

III: Survey Study

We designed a short nine question survey that we sent out to the 83 participating communities. This survey will contextualize Ballston Spa as either an outlier or an average participant. Our survey asked communities questions including but not limited to obstacles they encountered, the goals they set for themselves, and the technologies the wanted to incorporate. We sent out these surveys to the representatives of each community and compiled the data of every project that responded. This gave us insight into the personal processes of developing microgrids across the state, and gave us data on the common trends between the different communities.

Results and Findings

Goals

Announced by Governor Andrew Cuomo in August 2014 and administered by NYSERDA, the NY Prize Microgrid Competition supports community-based grid planning and development as part of the Governor Cuomo's REV Initiative. On the NY Prize website, NYSERDA outlines the goals of the competition in a mission statement:

"The New York State Energy Research and Development Authority (NYSERDA), in partnership with the Governor's Office of Storm Recovery (GOSR) announce the availability of up to $40,000,000, under the three-stage NY Prize Community Grid Competition (NY Prize), to support the development of community microgrids. The objective of NY Prize is to promote the design and building of community grids that improve local electrical distribution system performance and resiliency in both a normal operating configuration as well as during times of electrical grid outages. NY Prize objectives include empowering community leaders, encouraging broad private and public sector participation including local distribution utilities, local governments and third parties, protecting vulnerable populations and providing tools to build a cleaner more reliable energy system."

The mission statement identifies the objectives of the NY Prize Competition as improving resiliency, reliability, distribution, and spurring innovation of energy production in New York. The competition also looks to ameliorate community partnerships with utilities, local governments and the private sector. This paper will define resiliency as the ability of power sources to withstand stress. It is most applicable to storm-induced outages in the context of the NY Prize Microgrid Competition. Also reliability refers to the consistency of power.

In NYSERDA's initial request for proposals (RFP) , "RFP 3044 NY Prize Community Grid Competition" guidelines they elaborate:

"Key NY Prize objectives include empowering community leaders, encouraging broad private and public sector participation, protecting vulnerable populations, expanding the use of locally distributed energy resources, engaging with private sector or third-party interests and providing tools for building a cleaner more reliable energy system."

Again, NYSERDA highlights community engagement, increasing resiliency and reliability, and adds the goal of "clean" energy. Resiliency and community engagement are even further emphasized through the entirety of the NYSERDA's original RFP. In fact, to ensure that communities are designing with resilience to storm outages and community partnerships in mind, the RFP stipulates that proposals must involve at least one critical facility such as hospitals, fire stations, police departments, and refuge shelters. Later in this paper, we will compare the goals outlined by NYSERDA with the priorities of participating communities, and the outcomes of our case study community Ballston Spa.

Requirements

Under the NY Prize Microgrid Competition Structure, NYSERDA is offering support for microgrid feasibility studies (Stage 1), audit-grade engineering design and business planning

(Stage 2), and project build-out and post-operational monitoring (Stage 3). Applications are judged against program requirements at each stage of the competition for which funding is requested. Cost share is required for Stage 2 and Stage 3 of the competition. Communities must raise $200,000 individually in order to progress into Stage 2 of the competition. The fund requirements for Stage 3 have not yet been announced. Proposals for Stage 1 were accepted until May 15, 2015. The Competition generated unprecedented interest from communities across the state, with more than 130 cities, villages, towns and municipalities submitting proposals for the competition's first stage. While NYSERDA only anticipated making up to 25-30 awards to support the development of feasibility assessments, the NY Prize Selection Committee approved up to $100,000 in funding for 83 feasibility studies across New York State in July 2015. At the feasibility stage, the applicant was expected to address certain issues such as but not limited to, the following:

- Identify site constraints and opportunities
- Select and appoint consultants to conduct work
- Preliminary assessment of the technical design and system configuration (resource options, appraisal and selection)
- Commercial and financial feasibility assessment
- Preliminary commercial terms/contractual relationships between project participants (project organization and operational control)
- Project value proposition to stakeholders
- Legal and environmental suitability and financial viability

- Net project benefits analysis
- Preliminary project design, management and operations plan, budget and schedule

(http://www.nyserda.ny.gov/All-Programs/Programs/NY-Prize/Competition-Structure)

Michael Razanousky, a project manager at NYSERDA working intimately with the Prize Competition was on the panel which selected the winning 83 communities. During an interview, he summarized that proposals had to meet three criteria in the selection process: Microgrid proposals needed to incorporate a critical facility. They needed to qualify as a community microgrid not just a campus microgrid. Finally, the community needed to have a well rounded team which includes but is not limited to utility involvement, building owners, and business and technology representatives. Razanousky was confident communities would rise to the challenge and be able to meet the goals of the NY Prize Microgrid Competition. The competition format was utilized because NYSERDA wanted to tap into individual community's experiences to gather information on the commercial viability of microgrids, raise awareness of distributed energy, and uncover barriers to microgrid implementation. This format would foster innovation and community involvement Razanousky described, echoing the NY Prize mission statement he had helped write. When pressed about how unique and innovative the winning proposals were, Razanousky asserted that they represented a wide range of diversity between cities, towns and villages.

When we began our research, the selected 83 communities were preparing Stage 1 feasibility studies which investigate the capability of installing a community microgrid. The feasibility studies were initially due by February 2016 but were extended to April 2016. Our research team identified these 83 communities to study further.

The 83 Proposals

To determine if the NY Prize Microgrid Competition was successful in meeting its goals of innovation and community involvement, we examined the proposal summaries released by NYSERDA. Specifically we looked at the technologies that each community planned to utilize as a measure of innovation, a marker of priorities, and from an environmental perspective. However, it is important to keep in mind that the 83 communities are not beholden to their initial proposal. Therefore, the technologies represented are subject to change.

Every different power source and technology that communities listed as part of their proposals and each power source and technology's popularity across the competition was recorded. Out of 83 proposals, 3 communities did not include a list of power sources and technologies in their project summary. The following statistics on Figure 2 below are therefore taken from a pool of 80 communities. In total, 20 separate power sources and technologies were mentioned in the 80 proposals. The majority of these technologies were used in under 5% of the proposals. Solar, cogeneration, energy storage and natural gas were respectively the most popular power sources communities initially planned to incorporate into their microgrids.

Technology/Power Source	% Of Communities with Technology
Solar	62.5%
Cogeneration/ CHP	62.5%
Energy Storage	47.5%
Natural Gas	25%
Biogas, Biomass, Fuel Cell, Diesel, Wind, Hydro	5%-15%
Tidal, Anaerobic Digestion, Back Up Generation, Hydrogen Station, Microturbines Powered by Wastewater, Waste Heat Recovery, Geothermal, Steam Turbine Generation, Steam Absorption Chillers for Cooling, Heat Recovery Generator	<5%

Figure 2: Technology/Power Source Distribution of the 83 Community Proposals

Secondly, we examined the extent of community involvement in each proposal below in Figure 3. We assessed the extent of community involvement by reviewing the partners and stakeholders each proposal listed in their initial submission. We separated partners into categories including but not limited to community businesses and organizations (hospitals, universities, police and fire stations), consulting and engineering organizations, environmental organizations , gas companies , electric utilities, and town and village councils. Unsurprisingly, almost every community partnered with some kind of utility. 78% of communities initially planned to partner with one of more community organization. 78% of communities also listed at least one Town/Village/County Council as partners. Engineering/Consulting Firms were also largely represented.

Type of Stakeholder	% of Communities that Partnered with this Type of Stakeholder
Utility	93%
Community Organization	78%
Town/Village/City Council	78%
Engineering/Consulting Firm	67%
Environmental Engineering/Consulting Firm	30%
Environmental Organization	22%

Figure 3: Percent of Communities that Partnered with this Type of Stakeholder

Survey Data

In order to enhance our understanding of the priorities, challenges and perspectives of the 83 participating communities and to contextualize our case study of Ballston Spa we sent out a 9 question survey to each community. We had a 35% response rate (n=29). The following graphs represent the responses to the survey.

Question 1:

Please rank the importance of the following goals to your microgrid on a scale from "Not At All Important" to "Extremely Important".

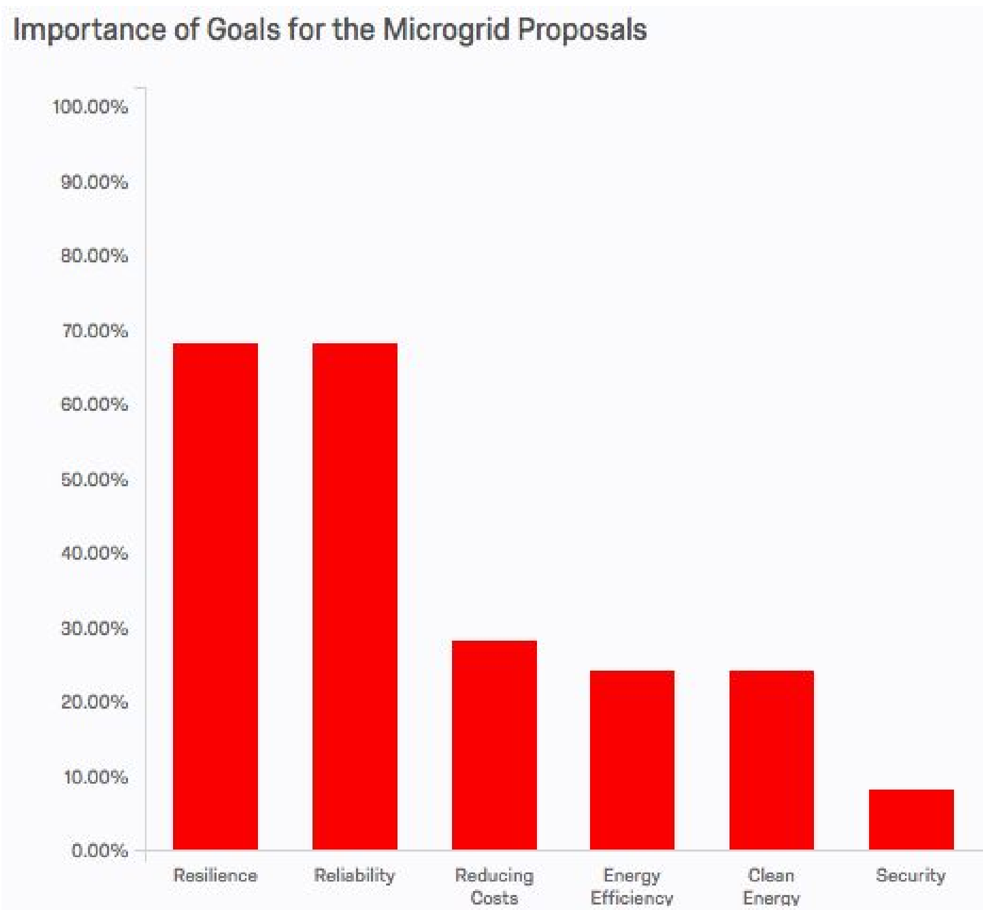

Figure 4: Importance of Goals for Microgrid Proposals

This graph shows the importance of various goals of the 83 communities during their microgrid development. This figure displays the percentage of communities who rated each goal as "extremely important". The data shows that resilience and reliability are the most important goals to microgrid development.

Question 2:

How important are the following technologies to the success of your microgrid on scale from 'Not at all Important" to "Extremely Important".

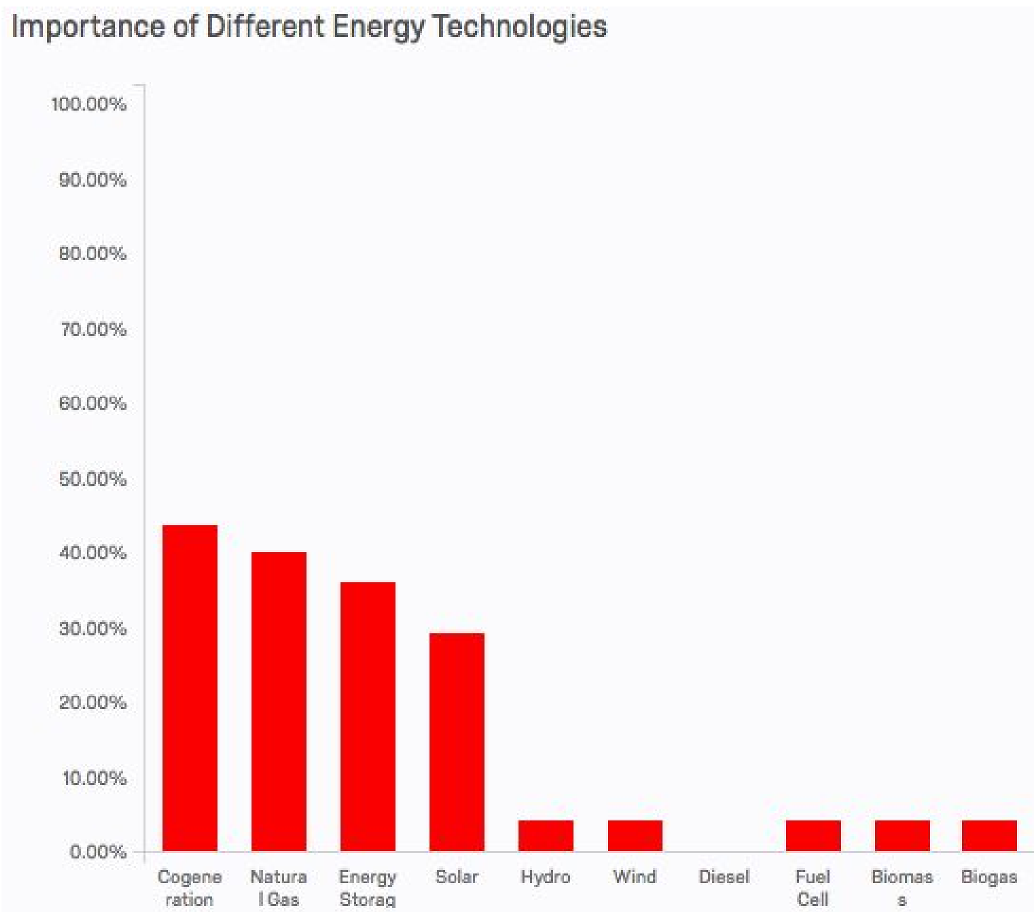

Figure 5: Importance of Different Energy Technologies

This graph displays the results from the survey question: “How important are the following technologies to the success of your microgrid on a scale of ‘Not At All Important’ to ‘Extremely Important’. This figure displays the percentage of communities who rated each technology as “Extremely Significant”.Cogeneration was seen as the most important energy technology used by communities and was ranked by 45% as extremely significant. 42% of communities perceived natural gas as the second most important technology. After natural gas, energy storage was the third most important technology and then solar. Hydropower, wind energy, fuel cells, biomass, and biogas were all deemed as not important technologies in microgrid development.

Question 3:

Please select all types of organizations your community has partnered with.

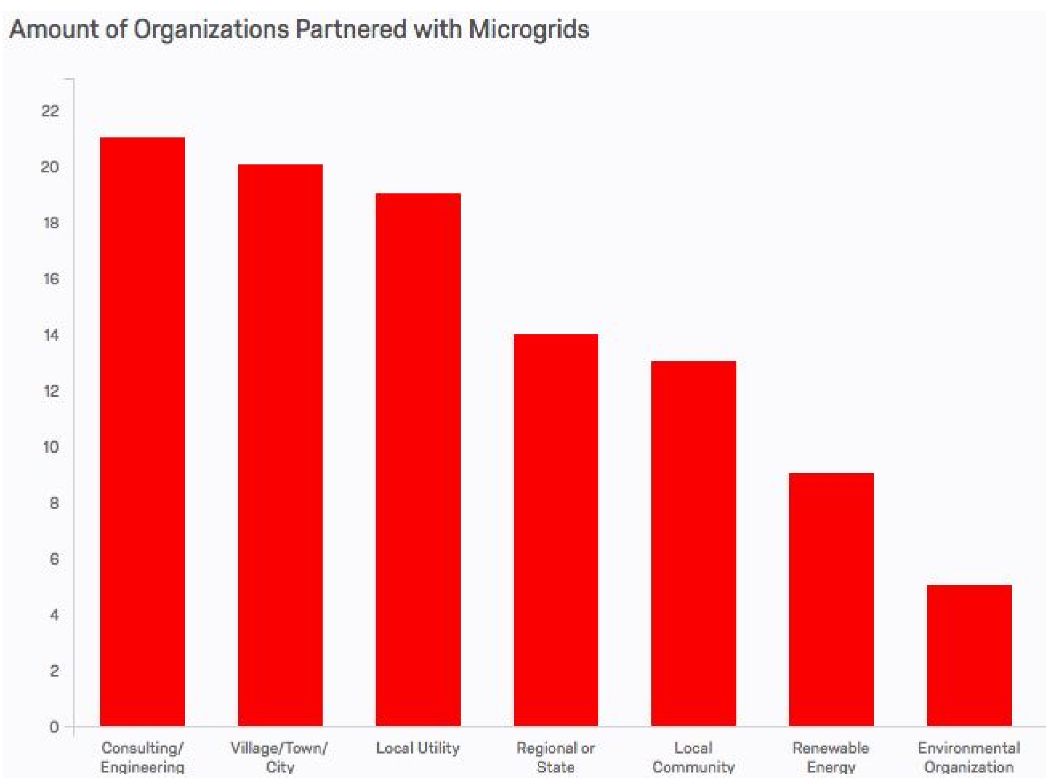

Figure 6: Amount of Organizations Partnered with Microgrids

Figure 6 displays the results from the survey question: "Please select all types of organizations your community has partnered with." Communities were asked to check off all that applied. Consulting and engineering organizations are the most represented among communities. Significantly, renewable energy and environmental organizations are the least represented amongst all communities. These responses differ somewhat from the data we collected in Figure 3. Community organizations are the fifth largest group of stakeholders for the 30% of communities we interviewed but are actually the largest group of stakeholders when you look at all 83 of the community's proposals together.

Question 4:

How significant are the following challenges to the development of your microgrid proposal on a scale from "Not at all Significant" to "Extremely Significant"

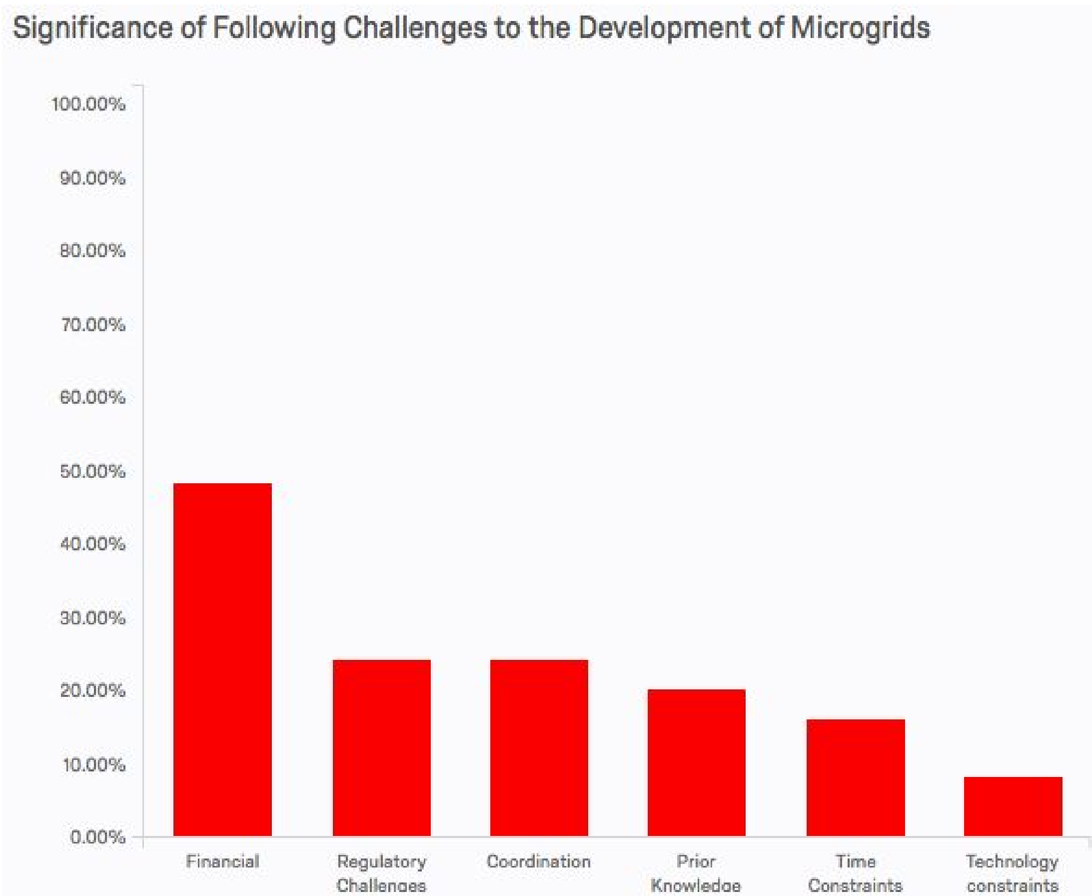

Figure 7: Significance of Following Challenges to the Development of Microgrids

Figure 7 shows what the results from the survey question: "How significant are the following challenges to the development of your microgrid on scale from 'Not at all Significant' to 'Extremely Significant'." This figure displays the percentage of communities who rated each challenge as "Extremely Significant" The largest challenge to microgrid development was financial obstacles. Financial challenges were primarily focused around raising enough capital to continue on to Stage 2 of the competition. The issue that was deemed the least challenging were technological obstacles.

Question 5:

How important were environmental considerations during the development of your proposal on a scale from "Not at all Important" to "Extremely Important".

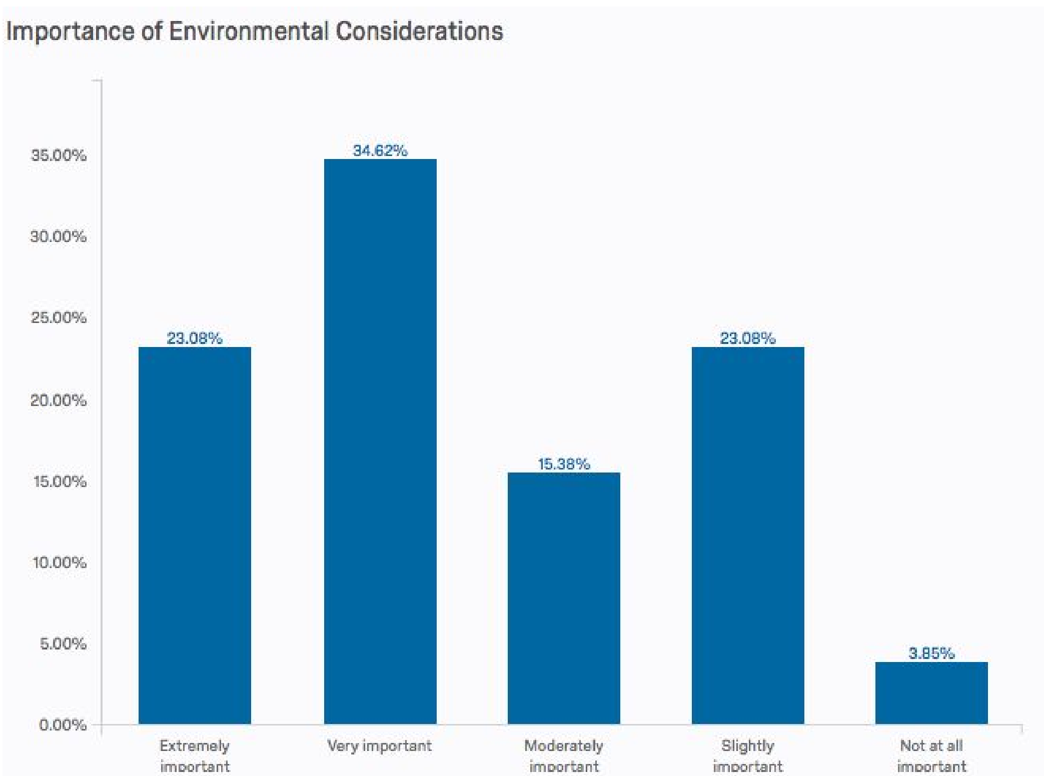

Figure 8: Importance of Environmental Considerations

Figure 8 displays the results from the survey question: "How important were environmental considerations during the development of your proposal?" This figure shows the percentage of communities that considered environmental considerations to be "Extremely Significant". Results varied widely across communities with 23% saying environmental considerations were extremely important, 34% saying they were very important while 15% said they were only moderately important and 23% were slightly important. Only 3% said that environmental considerations were not at all important.

Question 6:

In your opinion, how successful has the NY Prize Microgrid Competition been in bringing community organizations together on a scale of "Not at all Successful" to "Extremely Successful"

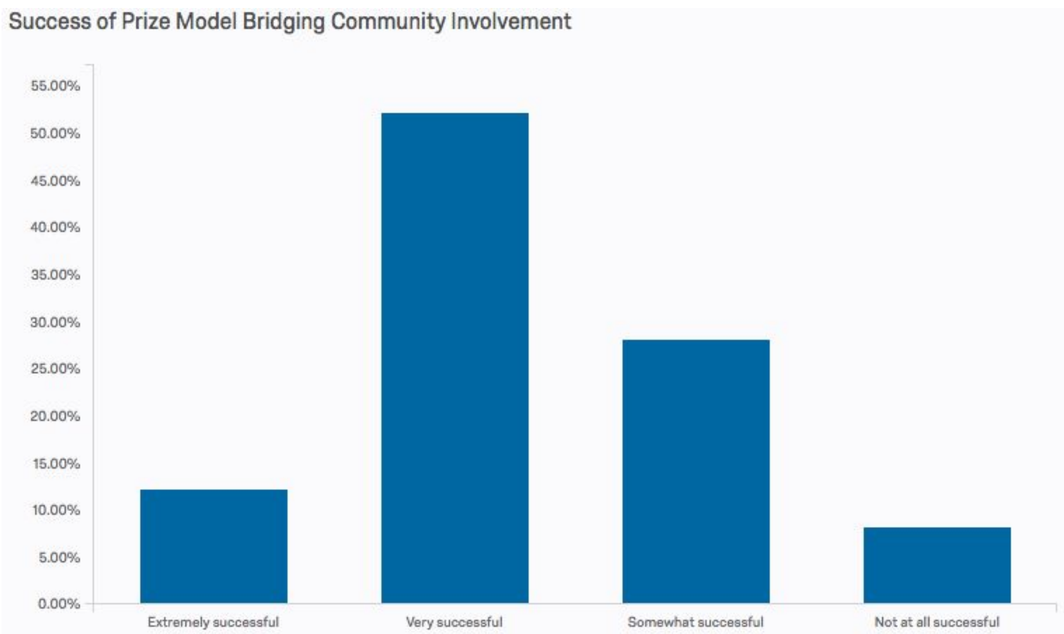

Figure 9: Success of Prize Model Bridging Community Involvement

Figure 9 displays how the results from the survey question: "In your opinion, how successful was the NY Prize Microgrid Competition been in bringing community organizations together?" Only about 10% of communities felt that the NY Prize Microgrid Competition was extremely successful in fostering community involvement, while half of all communities surveyed believed that it was very successful. About a quarter of the communities surveyed felt that it was only somewhat successful and only 8% of communities felt that it was not at all successful

Question 7:

In your opinion, how successful has the NY Prize Microgrid Competition been in fostering innovation on a scale of "Not at all Successful" to "Completely Successful"

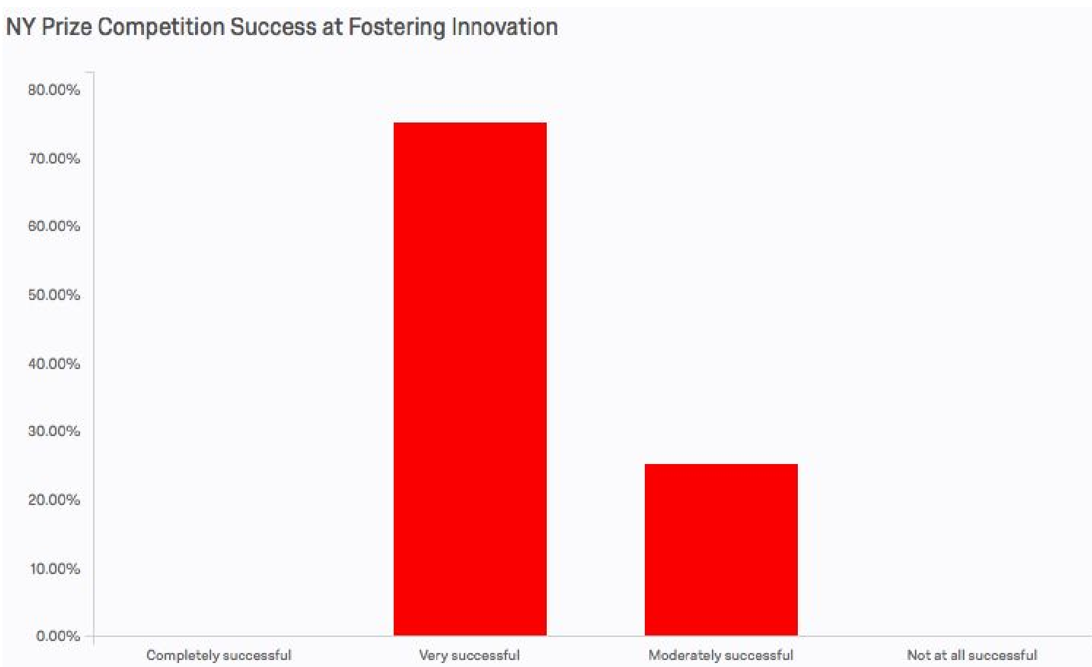

Figure 10: NY Prize Competition Success at Fostering Innovation

Figure 10 shows the results from the survey question: "In your opinion, how successful was the NY Prize Competition been in fostering innovation?" No communities felt that the NY Prize Competition was completely successful or not at all successful at fostering innovation while about 75% of communities believed that the competition was very successful. About 25% felt that the competition was only moderately successful.

Ballston Spa Case Study

Originally, the Ballston Spa microgrid proposal encompassed a cluster of local businesses and organizations located in the Village of Ballston Spa in Saratoga County. Ballston Spa had not experienced severe storm damage like other areas of New York State during the events of the past several years. However, the Ballston Spa team perceived the area as susceptible to such damage in the future and therefore, presented the community as a good choice for microgrid consideration.

In addition to the diverse facilities located in this cluster, there is significant existing on-site generation capacity present. Specifically, the Ballston Spa High School owns and operates a 900 kilowatt cogeneration plant in parallel with the local electric distribution, and the nearby nursing home also operates a cogeneration plant.

The basis for Ballston Spa's initial approach is to utilize existing generation capacity in a multi island microgrid environment that encompasses a diverse set of facilities within a well-defined electrical supply boundary. Ballston Spa augmented their base approach through the inclusion of other unique aspects to improve the resiliency of the cluster and to demonstrate, through field testing, the benefits and drawbacks of other technologies for future additions.

Ballston Spa's initial proposed critical infrastructure cluster included the following facilities:

- Ballston Spa High School / Middle School Complex (existing on-site cogeneration),
- Saratoga County Municipal Buildings,

- Community Emergency Corps,
- Ballston Spa Village offices,
- Police Department
- Public Works building and Water Department
- Local fire departments such as Union Fire Department and Eagle Matt Lee Fire Department,
- Zenith Care-Saratoga Center
- Saratoga County Court.

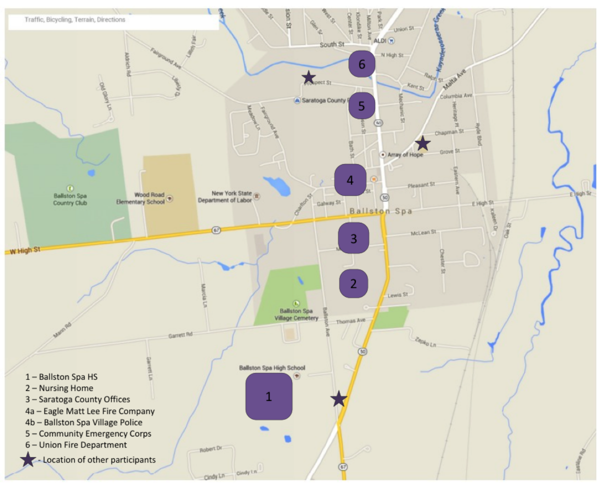

Figure 11: Locations of the six energy "islands" in Ballston Spa's initial proposal

As Ballston Spa continued to formulate their plan, these facilities were eventually changed. The initial mix of properties include municipal, government and privately owned entities are made available for public use to a large part of the local population within the Village and surrounding areas. The general locations of the facilities are shown on the map overlay above.

The technologies proposed to be utilized and investigated in Ballston Spa's initial proposal include:

- On-Site cogeneration at 2 sites
- Dispatchable electric capacity with alternate fuel existing at 3 sites
- Solar Photovoltaic
- Energy Storage – Pilot program by MTECH Laboratories, LLC
- Hydroelectric Power from the Kayaderosseras Dam
- Natural Gas Fuel Cell at 1 Site

The proposed public interest organizations and customers involved in the Project Team were initially outlined as:

- National Grid – Local Electric Distribution Company
- Saratoga County – Local Government
- Village of Ballston Spa – Local Government
- Town of Milton – Local Government
- Ballston Spa Central School District
- Saratoga Center Former County Nursing Home under Private Operation
- MCW Custom Energy Solutions, LLC – Consultant
- TecnerG, LLC – Consultant
- MTECH Laboratories, LLC – Consultant, energy storage technology
- CHA Consultants, INC. – Design Professional.

This list of organizations represents the stakeholders in the project and the makeup of the Ballston Spa Microgrid Project Team. After submitting their initial proposal for Stage 1, the Ballston Spa team was granted $100,000 to continue. It was at this point that we joined the Ballston Spa Microgrid Project Team. The team was scheduled to meet once a month and update the other stakeholders on progress and submit deliverables. Edwin Martin the Coordinator of Facilities and Security at Ballston Spa Central School and is the manager of the Ballston Spa microgrid project. His responsibilities include coordinating the various other stakeholders, managing the timelines and budgets, and assembling the structure and composition of the microgrid. He also sets the dates and agendas of the monthly group meetings. Martin directs these meetings, during which available involved parties give and receive updates on progress. We attended the monthly meetings in order to document the attendees and agenda and deduce how the proportion of environmental interests was represented in both the attendance and agenda. Our research team also used the content of these meetings to observe the relevance of issues, goals, obstacles, and successes of the Ballston Spa Microgrid Project.

I: Monthly Meetings

A. Attendance

The first meeting we attended was November 3rd, 2015. A breakdown of the attendees at each meeting appear in the appendix. The attendees are represented below as categorized by their different backgrounds:

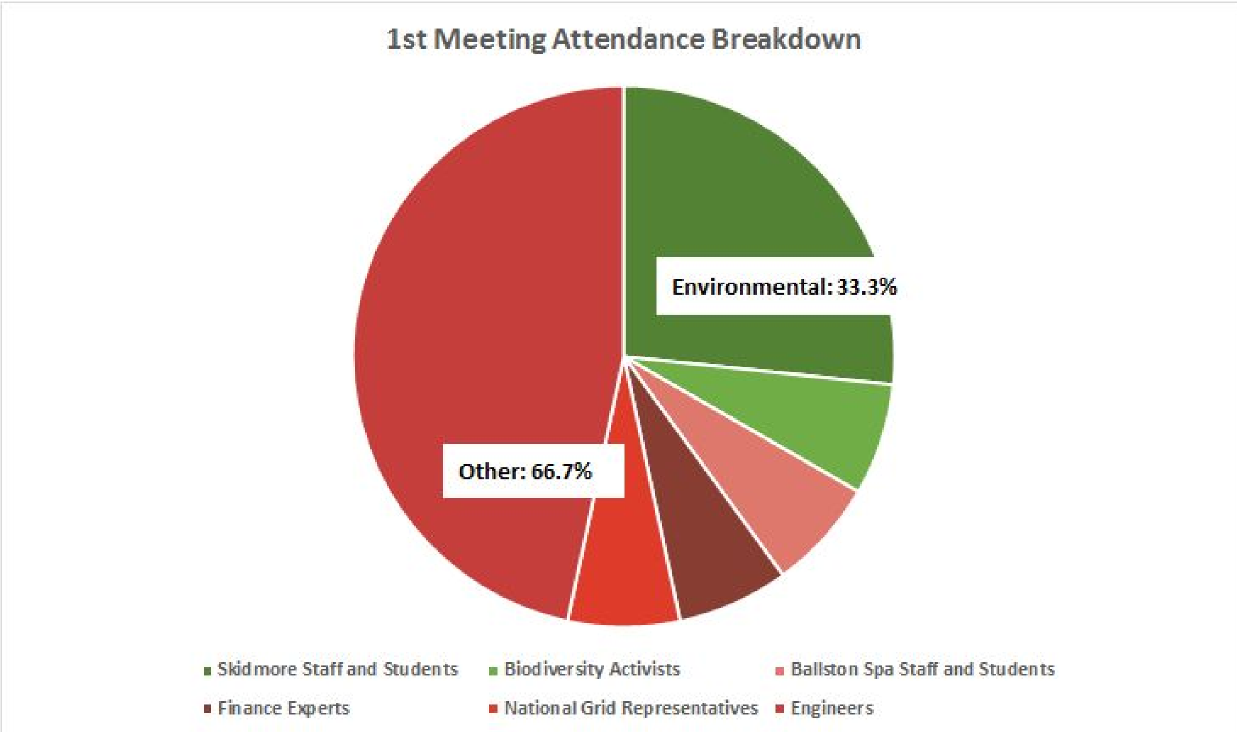

Figure 12: First Ballston Spa Meeting Attendance - 15 persons

The majority of attendees for the first meeting came from engineering and financial backgrounds, which are displayed in various shades of red. Environmental representatives made up almost exactly a third of the total attendance and are displayed in shades of green to contrast them to the other members of the meeting. However, our own Skidmore research team comprised four out of the five total attendees categorized as "Environmental". The remaining "Environmental" stakeholder was Larry Woolbright representing Friends of the Kayaderosseras. Woolbright is involved in the project because Edwin Martin anticipated Friends of the Kayaderosseras' interest in the process of restoring the Kayaderosseras Dam for microhydro power.

The second meeting took place only sixteen days later on November 17, 2015. The attendees are represented below as categorized by their different backgrounds:

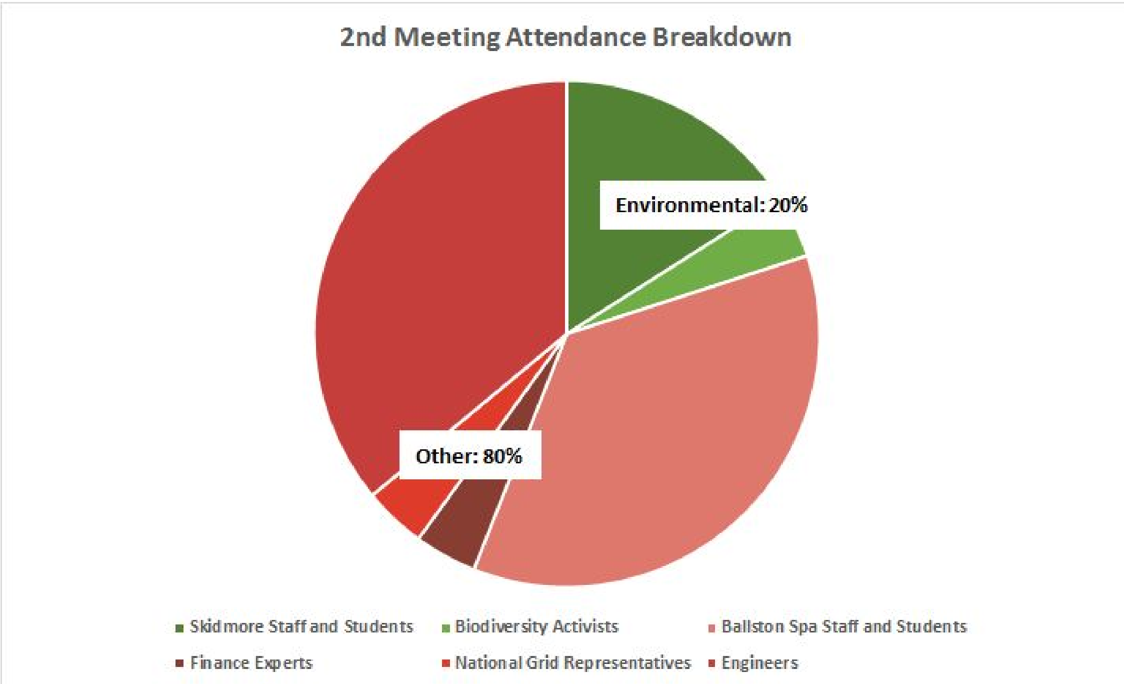

Figure 13: Second Ballston Spa Meeting Attendance - 25 persons

The number of attendees increased dramatically from 16 persons to 25 in the second meeting. This increase can be credited to the attendance of an additional five Ballston Spa students and two new staff members who were present for observational purposes. Therefore, Ballston Spa students and staff represent the largest percentage of stakeholders present at the meeting. However, aside from the new influx of persons from the school, the remainder of the attendance stayed similar to the previous meeting. The other new additions to the team were Jesse Hayes and Michael Koskon from Doosan Fuel Cell who came to the meeting specifically to give a presentation explaining the benefits of their fuel cell technology. While the percentage of environmental stakeholders seemed to have decreased dramatically from 33.3% to 20% from the first to the second meetings, this is only because of the increase in overall meeting attendance.

The actual environmental stakeholders are exactly the same as the first meeting: our research team and Larry Woolbright from Friends of the Kayaderosseras.

The third meeting took place on February 18th, 2016, about 3 months after the previous meeting. The attendees are represented below as categorized by their different backgrounds:

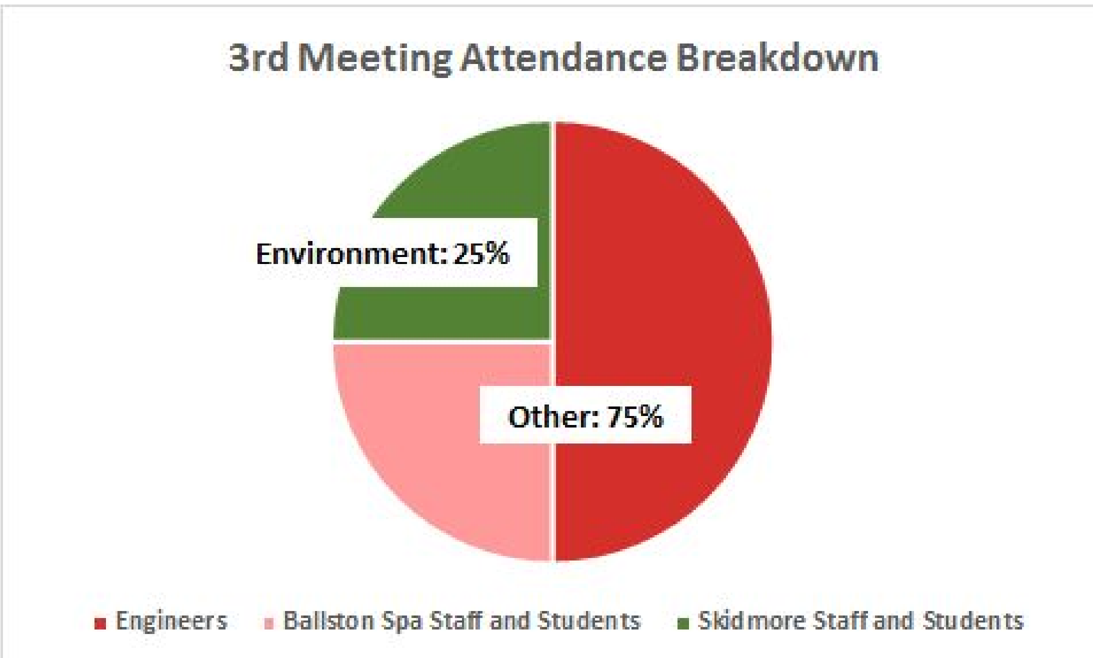

Figure 14: Third Ballston Spa Meeting Attendance - 8 persons

Only eight stakeholders were present at the third meeting, making it the smallest meeting thus far. Environmentalists represent 25% of the total attendance even though only two members of our research team were able to be present and Larry Woolbright left the project to complete research. However, this modest increase in the percentage of environmentalists is due to the fact that so many less engineers, Ballston Spa staff, and students came to the third meeting. None of the Ballston Spa students from the 2nd meeting made an appearance and Edwin Martin and Andrea Hall were the only Ballston Spa staff members present. Only four engineers were present, representing CHA, MTech Labs and TBS. While engineers still represented the largest percentage of the different stakeholders, realistically there were only two more members of their group than the environmentalists and the Ballston Spa staff. The National Grid, RPI and Doosan Fuel Cells were all unable to make the meeting. Bill Marzano's began working for a new organization so he was unable to continue to come to the meetings.

The fourth meeting took place on March 24th, 2016. The attendees are represented below as categorized by their different backgrounds:

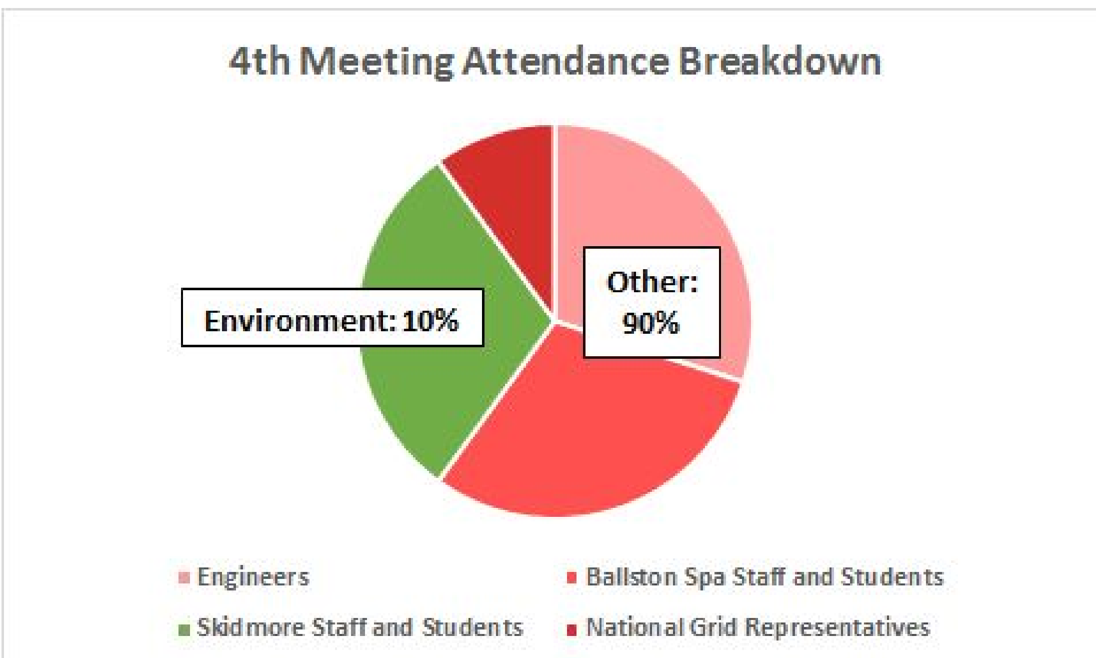

Figure 15: Fourth Ballston Spa Meeting Attendance - 11 persons

Eleven stakeholders were present at the fourth and final meeting, making it slightly larger than the previous month's meeting. As in the past, the only environmental members of the meeting was our team. Edwin Martin and Andrea Hall were accompanied by two more Ballston Spa staff members, giving them an equal percentage of the overall attendance as the engineers. National

Grid sent a new representative to the meeting to review new developments. All other organizations were not present at the meeting

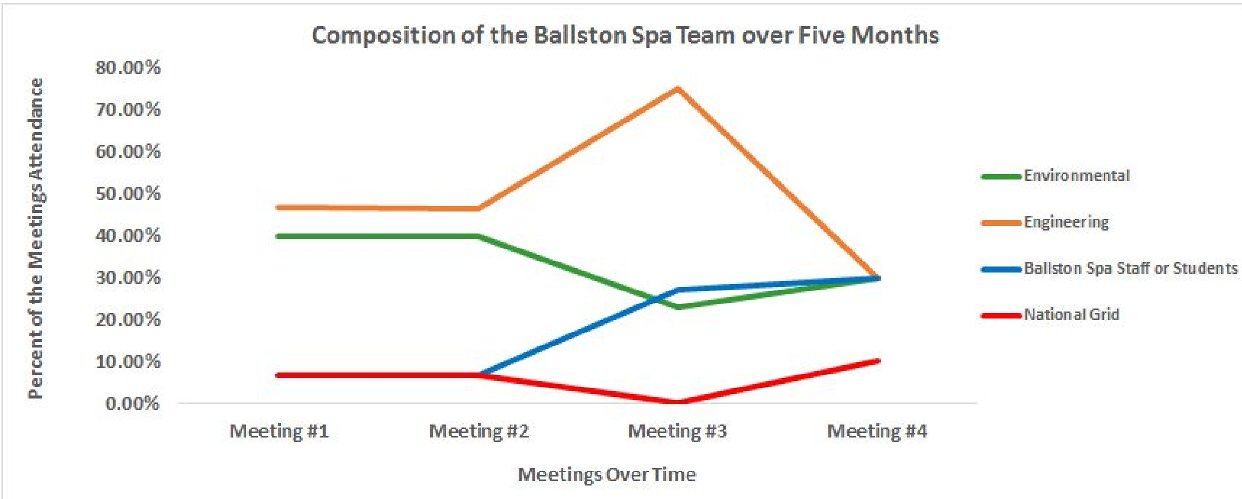

Figure 16: Distribution of the Different Backgrounds of the Ballston Team Members, Tracked Over Time by Their Participation in the Meetings

Figure 16 is a compilation of the meeting attendances of the four meetings we attended of the Ballston Spa Microgrid team. We separated attendees into four distinct categories depending on the industry they represented: Environmental, Engineering, Ballston Spa Staff or Students, and National Grid. Engineers were the largest group represented at the first meeting and remained the most represented throughout all four meetings. The environmentalist stakeholders are a substantial percentage of the first two meetings because our three person research team and Skidmore professor, Karen Kellogg, were counted in the attendance. However, our role was primarily observational and we were not responsible for contributing environmental suggestions to the project. The only environmentalist represented on the hired team was Larry Woolbright from Friends of the Kayaderosseras and by the third meeting both he and Karen Kellogg were unable to continue to attend.

National Grid was represented at the first two meetings and the last meeting. Ballston Spa steadily increased the number of staff and students at the meetings while at the same time the overall attendance of the meetings dropped. This caused Ballston Spa to become a steadily larger percentage of the overall attendance.

In the final meeting, only a few members of each different background attended. In the final meeting environmentalists, Ballston Spa staff, and engineers were all equally represented. However, it should be noted that the majority of the discussion was held between the engineers and Edwin Martin.

B. Agenda

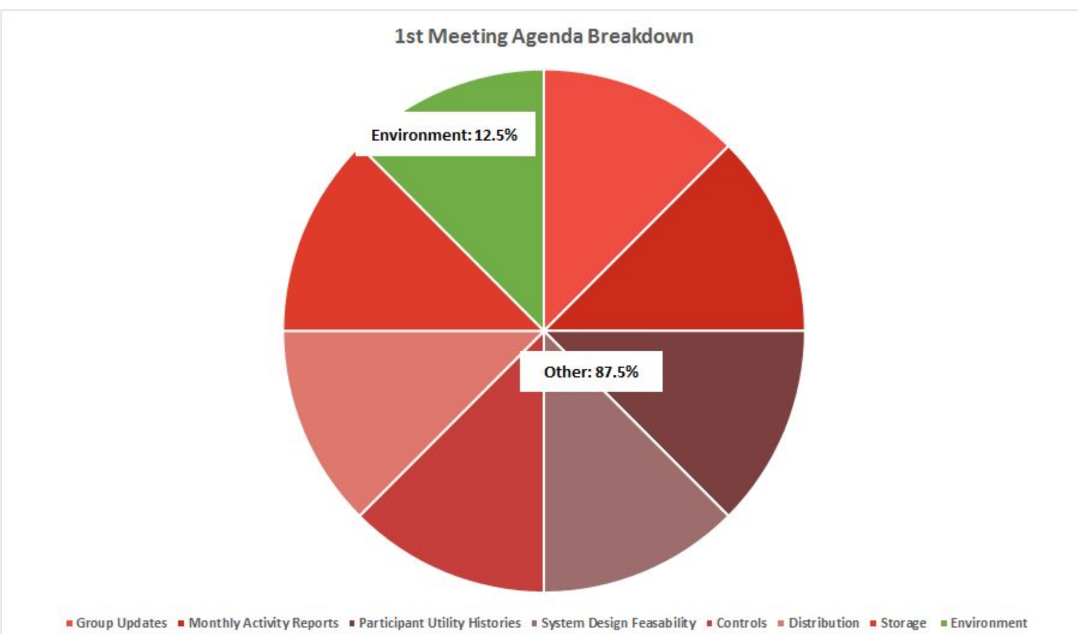

Figure 17: First Ballston Spa Meeting Agenda - 11/3/15

The first meeting was divided into eight major sections. The first two sections, "Group Updates" and "Monthly Activity Reports," were both dedicated to ensuring that the entire group had a sense of the status of the overall project and where each individual organization was in their personal contribution. The five following sections all related to different aspects of the engineering process behind the Microgrid. The last of the eight sections was reserved for the environment, represented in green on the graph. However, in the actual meeting this served only as a chance to introduce ourselves and the concept of our research capstone to the group.

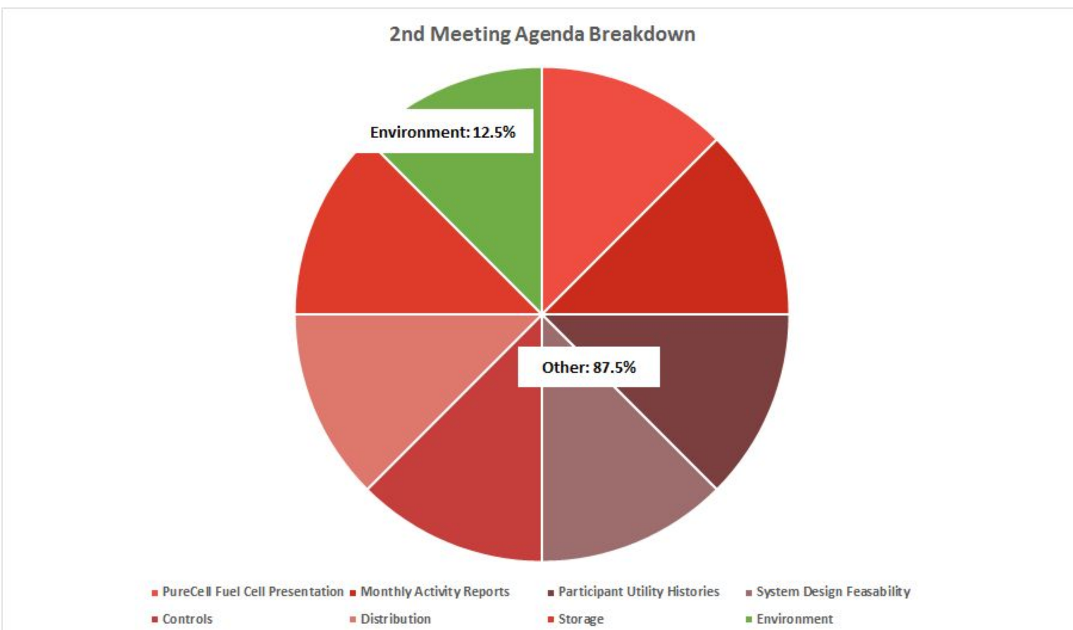

Figure 18: Second Ballston Spa Meeting Agenda - 11/17/15

The second was divided into eight sections in the same format as the first. The meeting began with the same monthly activity reports from the different members and then quickly moved into a presentation from Doosan Fuel Cell. Jesse Hayes delivered the presentation on the benefits of fuel cell technology and with the engineering specifics. Following the fuel cell presentation, the meeting moved through the same five sections as the first meeting on the different engineering aspects of the microgrid proposal. As with the first meeting, none of the stakeholders were allocated time to discuss the environmental impact of the project, although it was still given its own section on the agenda. This is possibly due to the fact that none of the stakeholders researched the environmental impacts of the project.

Figure 19: Third Ballston Spa Meeting Agenda - 2/18/16

The third meeting was divided into only four sections as opposed to the eight sections in the first two meetings. The monthly activity reports, group updates and general engineering specifics were all taken out of the schedule. Instead, the third meeting placed a large focus on the obstacles to completing the proposal. The group discussed two main concerns. The first concern was that Ballston Spa could no longer use the high school field to build solar panels. The Superintendent did not want to give up land that could be a potential development site. The second concern was that MTech's battery systems were not ready for commercial use. The group discussed that NYSERDA requires any community participating in the competition to raise $200,000 to move on to the next stage. Without solar panels and batteries, Ballston Spa's ability to raise these funds was uncertain. An entire section of the meeting was dedicated to figuring out where this money could come from. The meeting was closed by briefly discussing the status of the next meeting. In previous meetings the environment was given its own section on the agenda but no one was in charge of presenting on it or discussing its relation to the project, so its role in each meeting was largely superficial. In the third meeting, the environment was no longer listed on the agenda at all.

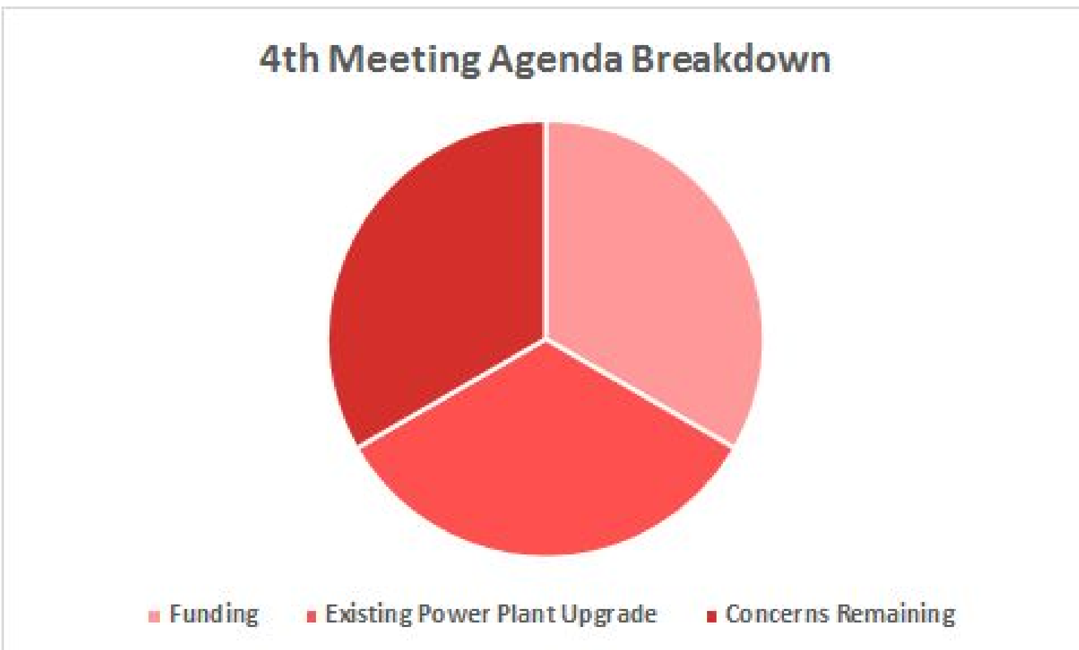

Figure 20: Fourth Ballston Spa Meeting Agenda - 3/24/16

The fourth and final meeting was divided into only three sections: Funding, Existing Power Plant Upgrade and Concerns Remaining. Edwin Martin opened the discussion by explaining that the U.S. Army had taken an active interest in seeing a pilot project of the Mtech superconductor battery functioning in a microgrid. To help this pilot happen, the U.S. Army asked the National Grid to help Ballston Spa by calculating the baseline energy use they needed for the feasibility study. Edwin Martin believed this would greatly help the success of the project. However, two of the islands that were originally involved never gave approval to use their baseline data, so they were removed from the proposal. Edwin Martin also explained that although he had lost the area to build solar panels on, Solar City had called him to say that he could still earn the same tax credit if he built the array on property in the Towns of Malta or Milton. He was looking into possible areas he could use in those towns, but implied that it would be unlikely for the town governments to allow him to build on their land in time for the Stage 1 deadline. The majority of the discussion took place between Edwin Martin, Tim Peer, and the Kim Ireland as they reviewed exactly what they needed for the feasibility assessment and discussed the possibility of a one week extension for the project. Edwin Martin also mentioned that he thought it was time to give up on the hydro facility at The Foundry, meaning that both hydro and solar, which constituted the only renewable components of the project, were removed from the proposal.

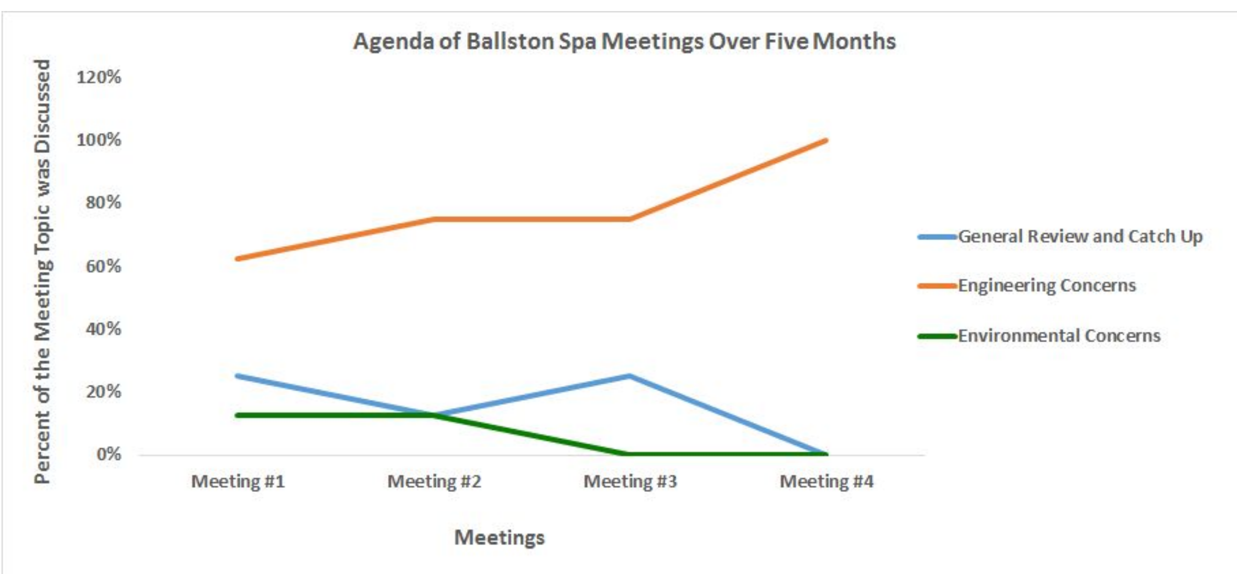

Figure 21: The Priorities of the Four Ballston Spa Meetings Mapped Over Five Months

Figure 21 represents a compilation of the meeting agenda focuses of the Ballston Spa Microgrid Team over the four meetings we attended. The lines display the percentage of the meeting agenda various issues took up. We separated the agenda topics into three distinct categories: General Review and Catch up, Engineering Concerns and Environmental Concerns. From the very first meeting, the majority of the agenda was dedicated to engineering concerns, with general team review constituting a much smaller section of time, and environmental concerns taking up the smallest portion of time in the meeting. As the project progressed, environmental concerns steadily decreased and by the third meeting they were no longer part of the agenda. General team review fluctuated for the first three meetings, but by the fourth and final meeting it had completely fallen off the agenda. Engineering concerns steadily climbed upward over the course of the five months and by the last meeting engineering concerns comprised 100% of the Ballston Spa Agenda.

Interviews

In addition to attending the monthly Ballston Spa meetings, our research team conducted semi-structured interviews with eleven relevant figures involved in the NY Prize Competition. Ten of these interviewees worked directly as part of the Ballston Spa team designing the feasibility study. One was a member of NYSERDA who worked on the creation of the NY Prize Microgrid Competition. The 11 people represented a range organizations and roles within the project, allowing us to study the competition from multiple perspectives and gather a wide range of data. We interviewed one facilities coordinator, seven members of engineering and consulting organizations, one National Grid representative, and one environmental representative. From these semi-structured interviews, we were able to identify the priorities and goals of Ballston Spa team members in terms of their microgrid proposal. In addition, we pinpointed challenges members encountered during their work on the feasibility study as well as their perceived successes. Analyzing this information in conjunction with our initial assessment of the 83 proposals and survey results will help us form conclusions about the successes and challenges of NY Prize Microgrid Competition in achieving its initial goals of sparking innovation and community involvement. We will also make conclusions regarding the role of environmentalism in this program.

I: Priorities

Microgrids offer opportunities for improved resilience, reliability, energy efficiency, security, cost reduction and clean energy generation. However, not each of these benefits were perceived as equally valuable to the communities participating in the NY Prize Competition. In fact, the main impetus behind Ballston Spa's participation was a desire to upgrade an existing cogeneration plant powering the village's local middle and high school. The NY Prize Competition was an opportunity to do a capacity and ability upgrade and replace aging equipment. The aging power plant at the high school was built in 1998 and cannot withstand power outages. Edwin Martin described the competition as a way to not only upgrade and replace the equipment, but also as a way to generate more energy as well, because currently the plant only generates two-thirds of the necessary power for the school. According to Edwin

Martin, creating a microgrid proposal through the prize competition would take care of those concerns while simultaneously providing community benefits. The community benefit he is referring to is the ability of a microgrid to run independently from the macrogrid, therefore, still providing the community with government and non government services in the case of emergency of power outage. Other members of the Ballston Spa team echoed a similar goal of increased resilience from the microgrid.

II: Resilience

Overwhelmingly, members of the Ballston Spa microgrid team cited resilience as one of the primary benefits of microgrids. Severe weather events threaten grid resiliency, demonstrated by the massive and prolonged power outages following Hurricane Sandy. Therefore, it is no surprise that the distinguishing ability of microgrids to operate independently from the macrogrid during times of severe weather is perceived as one of the most valuable benefits by the majority of interviewees. Stacey Hughes, the project manager at National Grid, explained:

"In correct application and location, microgrids can serve greater communities by providing resilient power and creating an area where critical services are offered. During our restoration work after Hurricane Sandy devastated New York City and Long Island, we saw how critical even small pockets of power can be".

Including Hughes, 64% of Ballston Spa team members we spoke to specifically cited improved resiliency as a goal of their plan.

III: Security

Because microgrids have the ability to operate independently from the grid, they can serve as countermeasures to the threat of cyber attacks and terrorist. Microgrids also provide alternative power to critical systems and facilities should the macrogrid become compromised. 18% of our interviewees described security as a problem that the microgrid will aim to solve.

IV: Reliability and Stability

Stability refers to continue supply of energy at any given time. It is the assurance that when you flick the switch up, the light will turn on. Reliability is most relevant when intermittent renewable energy technologies are introduced, such as solar and wind energy, because they cannot provide power consistently unless supported by energy storage, or combined with other technologies. Stability also comes into play during peak times during the year when energy consumption spikes. When demand spikes, the grid turns to rarely used and heavily polluting peaker plants as a resource of last resort. While stability was only mentioned by a little less than one-fifth of our interviewees, Tim Brock adamantly stated that "the number one reason for using a microgrid is to backup utilities in peak times." Microgrid technologies can help to provide necessary energy during peak consumption periods and lessen the need to turn on these expensive and polluting plants.

V: Cost Savings

Microgrids are viable solutions to costly electrical system upgrades. Combining newer technology within a well designed microgrid can defer or eliminate some utility upgrade expenditures. Microgrids benefit the consumer, by lowering peak demand and eliminating the need to build more costly power plants. Edwin Martin saw the NY Prize Microgrid Competition as a way to fund the upgrade the cogeneration plant in the Ballston Spa School System while generating additional community benefits. Additionally, generating on-site electricity inherently means pulling less energy from the macrogrid, resulting in lower energy bills for each participating island.

VI: Energy Efficiency

Traditional energy distribution is extremely inefficient. As discussed earlier in the paper, the macrogrid consistently supplies the maximum amount of energy needed in a day, even at 2:00am when energy demand is significantly lower. Combined with transmission losses and aging infrastructure, this makes the grid extremely inefficient. The technologies that microgrids can support can eliminate almost all of these efficiency challenges. Energy storage technologies allow the system to adjust to varying demand. Cogeneration technologies are extremely efficient because they utilize waste heat in a beneficial manner. Further, because energy is not traveling far distances, transmission losses in a microgrid are virtually eliminated. 18% of interviewed stakeholders from the Ballston Spa team cited energy efficiency as a goal of the microgrid.

VII: Renewable Energy

Incorporating renewable energy with the intent of reducing greenhouse gas emissions was not on the forefront of the Ballston Spa collaborators' minds. Many stakeholders mention that renewables would be welcome, but from an engineering standpoint they cannot generate energy levels that compete with fossil fuels. A further concern is the intermittency of renewable energy throughout the day. Many of those interviewed mentioned that proper energy storage could account for inconsistency in energy generation. However, energy storage technology was not perceived as being advanced enough to accomplish this yet. 36% of stakeholders shared this perspective. Notably, Larry Woolbright, Friends of the Kayaderosseras president, implied renewables were not equipped to handle the needs of the community:

"Most of us would like to move toward sustainable power sources in the long run but given the focus on microgrids in terms of emergency it might be a good idea to put in some fossil fuels".

Successes and Advantages

The Ballston Spa Microgrid has unique advantages that separate it from the rest of the 83 proposals in the NY Prize Microgrid Competition. Some of these advantages include the existing cogeneration plant, a diverse team and an advanced battery storage component.

I: Community Involvement

The Ballston Spa Microgrid succeeded in bringing a wide range of community stakeholders to develop the project. Traditionally, energy production is managed by a limited number of corporations. These energy companies often barely consult with the communities about the distribution of energy. The Ballston Spa Microgrid project allows for several private businesses, public resources, and a public utility to connect and produce energy locally. This represents a dynamic change in how energy is produced and distributed. It allows a more democratic decision making processes regarding energy infrastructure development.

II: Cogeneration

Ballston Spa High School already has an existing cogeneration power plant, which gives them a distinct advantages over many of the other 83 communities. The cost and difficulty of upgrading an existing cogeneration unit is significantly less than building a completely new one, which many other communities will be forced to do. Several members of the Ballston Spa Microgrid project, including Joe Weinschreider, Tim Brock, and Tim Peer emphasized the importance of a pre-existing cogeneration plant in making the Ballston Spa Feasibility Study stronger. Tim Peer, Tim Brock, and Bill Marzano also stated that NYSERDA was pushing the development of cogeneration, because it is a highly efficient technology that is well suited to microgrids.

III: Army, Department of Defense, and National Grid Interest in the Battery Storage

Battery Storage is another advantage of the Ballston Spa Microgrid. One of the tenets of the Ballston Spa Microgrid Proposal is to showcase the batteries produced by the company MTech Laboratories. MTech Laboratories is developing batteries that are hyper efficient, which are produced by cryogenically freezing the electrical currents. These batteries are not yet commercially available, but the U.S Army, Department of Defense (DoD), and National Grid are all interested in seeing a pilot project of the technology in action. This outside interest from the U.S. Army, DoD, National Grid gives the Ballston Spa Microgrid Project a distinct advantage.

Challenges

I: Financial

Financial challenges were cited as being the most relevant obstacle to the success of the Ballston Spa Microgrid by the majority of participants we interviewed: Edwin Martin, Tim Brock, Jerry Jannicelli, Larry Woolbright, Bill Wilson and Mike Hennessey and Tim Peer. Tim Brock stressed that from conference calls with different members of NYSERDA it had become very clear that New York did not want to pay the entirety of any given project. Each community conducting a feasibility study that failed to meet the $200,000 match would automatically be rejected from the next stage. Edwin Martin also described raising funds as his most difficult task as the director of the Ballston Spa Project. When the competition began, Martin had participated in a conference call with NYSERDA and the New York Green Bank in order to address ways to overcome this obstacle, but was unable to achieve the desired result from their interaction. He also reported that he felt the structure of the competition was designed to encourage the involvement of outside persons and organizations that would only participate in order to make a profit. Tim Brock also reported that the competition was structured to require the participation of private equity, which was particularly difficult because there is not a guarantee on a satisfactory return on investment. Edwin Martin's team, however, only involved nonprofit and public entities, which he felt was important for the integrity of the project but also a serious handicap to gathering funds.

Because the Ballston Spa team chose not to use private investors to help them reach their $200,000 goal, Edwin Martin chose to look to tax credits instead. Originally he believed he could meet the necessary $200,000 from a tax credit from the solar array that was intended to be built on the Ballston Spa High School field. However, the school Superintendent chose not to allow the field to be used for the solar array in case the school later wanted to develop on that land, effectively cancelling this source of funds. Edwin Martin reached out to the Town of Malta and the Town of Milton to see if he could use their property for the solar array, which would still qualify Ballston Spa for the necessary tax credit. However, neither of them agreed, most likely because allowing the Ballston Spa Solar Array to be built on their land would guarantee them neither energy or profit.

To compensate for this loss, Edwin Martin researched if the MTech energy storage system could be considered as a payment in kind and not as part of the overall cost of their project. The storage system would cost $4.5 million. If Ballston Spa could get that portion of their funds written off it would make their project look considerably more financially stable. While Martin was able to attract the interest of the U.S. Army and the National Grid, it remained unclear how the storage system was to be classified up until the deadline. This was further complicated by the possibility that the storage systems would not be ready for commercial use by the second round.

However, Jesse Hayes from Doosan Fuel Cell proposed another alternative: utilizing the NYSERDA $1,000,000 tax credit for the installation of natural gas fuel cells. Working together, Jesse Hayes and Edwin Martin wrote and submitted a grant proposal to NYSERDA. However, they weren't able to submit the application until a few days before the final Stage 1 deadline. While they requested another week extension, they essentially reached the deadline without actually having the matching $200,000 of necessary funds. The Ballston Spa Proposal had particular difficulties in raising their funds because they chose not to attempt to attract private investors and because they had to rely on tax credits, which required them to overcome the logistical hurdles of earning these credits.

In addition to the initial costs of developing and building a microgrid, the cost of upkeep and maintenance presents an additional obstacle. Because of the multiple parties involved in microgrids, assessing responsibility for maintenance can be difficult and costly. Stacey Hughes from the National Grid stressed that creating effective maintenance structures can be a challenge because each microgrid is unique in design and stakeholders. Therefore the traditional method of having one single utility develop and maintain microgrids is no longer applicable. At the time of the Stage 1 deadline, Ballston Spa had not yet figured out the financing behind the cost of upkeep and maintenance.

Edwin Martin made it clear that finances would either make the project or break it. If Ballston Spa were to be unable to make their feasibility study match NYSERDA's financial standards then they wouldn't move on to the next phase. Since the other five islands in the Ballston Spa

Proposal had no interest in self-funding their parts of the project, failure to pass on to Stage 2 would result in the project being scaled down to only upgrading the Ballston Spa High School Plant.

II: Technology

Ballston Spa encountered challenges related to the energy sources and technology that the team had originally planned to be included in their microgrid. Theses challenges resulted in a dramatic shift in the features of the proposal as the team progressed in their planning.

Originally the Ballston Spa Microgrid Proposal planned to build photovoltaic solar panels on an unused field on Ballston Spa High School property. However, five weeks before the deadline to submit the proposal, the superintendent of Ballston Spa decided that she wasn't comfortable giving up that plot of land for 20 years to the solar panels. Her primary reason was that it was possible the school would decide to build in that area. Solar PV was intended to bring in a large percentage of the $200,000 in outside funds that Ballston Spa was required to raise for the next stage of the NY Prize Microgrid Competition. Without a location for the panels to be built the school would be significantly short of the necessary funds.

Approximately a week before the date of the original deadline (which was then extended by a month for all 83 communities) Edwin Martin received a call from SolarCity telling him that if the school built a solar array on any plot of land, even if wasn't school property, then they would still receive a tax credit for their project. This information reopened the potential for solar power in the Ballston Spa proposal, so Martin followed up on their call by looking into property in Malta and Milton. This posed its own logistical obstacle, because for either Town Council to choose to give up their land for the Solar Array would essentially be a favor and wouldn't guarantee them neither energy of profit. By the time of the Stage 1 deadline, neither town had given an affirmative response. Solar panels had to be left off of the feasibility study because they had no plot of land to be built on.

At the third meeting, one month prior to the deadline for the next stage submission, RPI announced that the batteries they were contracted to design weren't ready for commercial use. They told the team that the model should be ready by the time of the deadline, but seemed unsure of the certainty of this. In the following months, the U.S. Army took an interest in MTech's concept of cryogenically freezing electricity and expressed interest in seeing a pilot project happening at Ballston Spa. The U.S. Army contacted National Grid and asked them to assist the Ballston Spa Project. Edwin Martin seemed confident in the energy storage system and reported that he was interested in continuing to work with MTech on the pilot project even if they didn't pass to the second round.

At the fourth meeting, Martin decided that it was time to officially remove hydroelectric power from the feasibility study.While Larry Woolbright and the Friends of the Kayaderosseras had given their approval to the revitalization of the dam, there were too many regulatory obstacles for the Ballston Spa Team to overcome.They removed the idea because its technical complexity and regulatory barriers made it too difficult to include in the feasibility study.

Tim Brock expressed concerns that fuel cells would be a very difficult technology to incorporate in the project because of their exorbitantly high cost, complicated upkeep and unproven reliability. Despite this, fuel cells became a central element of the project, largely because of the $1,000,000 NYSERDA grant available for fuel cell installation.

The original technologies proposed for the Ballston Spa Microgrid were combined heat and power, natural gas fuel cells, hydroelectric power, solar photovoltaic panels and energy storage systems. By the time of the first stage deadline the only technologies that were used in the feasibility study were combined heat and power, natural gas fuel cells and energy storage systems. Renewables dropped completely out of the proposal due to difficulties in finding land for the solar panels to be built on and difficulty overcoming the regulatory barriers of revitalizing a hydroelectric dam. The loss of hydro and solar did not seriously affect the power output of the proposal since the bulk of energy output was originally intended to come from combined heat and power and the natural gas fuel cells. However, the loss of solar meant a loss of a tax credit to help fund the project. The loss of renewable power in general did not seem to be viewed as a serious problem by the team, although it is possible that NYSERDA will view their feasibility study more critically because their community won't help New York State achieve its target goal of renewable energy outlined by the REV initiative.

While the original proposal included six individual energy islands that had their own sources of power generation; this was changed as well. In the final draft of the feasibility study, power will be generated exclusively at the Ballston Spa High School through combined heat and power and natural gas. Ballston Spa High School would still be connected by new power lines to each of the other five islands and would act as a sort of "small scale electric utility", capable of selling power to the different areas included on the mini grid.

III: Coordination

As the director of the project, Edwin Martin shouldered the responsibility of recruiting each of the different members and keeping track of their involvement. While he reported believing that the diversity of talent in his team was ultimately a strength of the project, it also required him to coordinate people from diverse backgrounds and translate their varying expertise and contributions into one cohesive study. This was further complicated by busy schedules of the different members and the fact that several of their organizations were based far away from Ballston Spa. In fact, the majority of participants were only working on Ballston Spa as a side project in addition to their primary jobs and responsibilities. Jesse Hayes, for instance, worked at Doosan PureCell in Connecticut and had to drive a considerable distance to each of their meetings. It is also of relevance that some of the members of the team were paid and some were volunteers, which may have contributed to varying levels of commitment to the project.

Several of the members dropped off as the project continued. Tim Brock and Bill Marzano, who were both experienced with the installation of power system and upgrades, left after they completed writing the original proposal. Tim Brock left because he felt that his contribution had been fulfilled and Bill Marzano had to leave the project because he started a job with a new company JW Danforth and no longer had the free time to contribute to the proposal design. Larry Woolbright from the Friends of the Kayaderosseras was also unable to continue to contribute to the project because his research took him to South America. Edwin Martin also originally had enlisted a team from Massachusetts to help with upgrade of the cogeneration plant. However, they stopped responding to his messages up to a month before the original deadline and had to be removed from the team.

Because each set of stakeholders represented their own organizations, they were generally concerned with their own responsibilities and only received information about the status of the other parts of the project at group meetings.There were only four meetings over a course of five months, so the different organizations were not generally up to date on each other's status or able to help each other out.Generally if something fell apart it became solely Edwin Martin's responsibility to find a solution, as the solar array situation demonstrated. Jesse Hayes in particular said that he felt it was necessary for the team to hold more regular meetings and attempt to appease the views of each organizations and entities in the group. This need for coordination, he believed, extended to the six different islands that the project was designed for, which rarely communicated with each other about new developments in the project. Up until a week before the deadline, none of the five islands outside of the Ballston Spa High School had supplied their utility baseline data, which was necessary for the feasibility study.

The Ballston Spa proposal was not ready by the deadline of February 28th. However, so many other communities also experienced difficulties completing their proposals in time that

NYSERDA extended their deadline until March. Jesse Hayes, Tim Brock and Tim Peer implied that this might be because many of the different communities were attempting to become microgrid experts themselves instead of hiring experienced professionals. As such, the projects as a whole suffered from a lack of expertise behind each proposal.

The Ballston Spa Proposal was not prepared by the March deadline because the actual specifics of the feasibility study could not begin until all the utility information had been provided. Because of the delay to retrieving this data, and because it was largely unclear whether solar and hydro would be involved in the study, Edwin Martin requested for another extension for Ballston Spa to complete their feasibility study. Two of the six islands involved in their project never volunteered their utility reports, so they were removed from the study. The final Ballston Spa project was handed in April. Edwin Martin reported that he did not believe this late entry would adversely affect their chances of continuing into the next stage of the competition.

IV: Experience/Prior Knowledge

While the vast majority of the Ballston Spa team is made up of engineers, almost none of them had prior experience working with microgrids. While many of them had experience with installing localized energy distribution systems, such as combined heat and power and fuel cells, only Bill Wilson and Mike Hennessey had previously been involved in building a microgrid. Most of the members reported that they had never worked with microgrids but many said that someone in their companies did have that experience. Tim Peer also had a unique role in that he was working with five other microgrids aside from Ballston Spa, but he had no experience with their construction prior to the competition. This created an interesting dynamic because the majority of the team had no prior experience with the overall project they were attempting to assemble. Jesse Hayes reported that he was suspicious that many of the people in all 83 of the different projects were similarly trying to make themselves microgrid experts and engineers overnight, and not consulting experts. NYSERDA gave an extension to the entire competition which indicates that many communities might be experiencing difficulties and suggests that he may be correct.

Considering that each project involved a variety of people from different backgrounds, lack of experience specifically with microgrids could be a serious obstacle to the coordination and progress of any given team. While Ballston Spa had a wide variety of experienced electrical engineers, it had very few members who had actually worked with microgrids, which may have posed an obstacle to the development of the microgrid.

V: Location

Without being able to review data on the which communities passed on to the second round, it is difficult to judge how important location is in the competition. However, almost every member of the Ballston Spa team we interviewed reported that they believed resiliency to be the most important benefit of a microgrid. Tim Peer stressed that a large part of the purpose of the competition was to protect the most storm vulnerable sections of New York, which would mean city centers, especially New York City, would have a distinct advantage in the competition. This makes sense considering the NY Prize Microgrid Competition was created in response to the mass power outages in New York City caused by Super Storm Sandy. If locational vulnerability to severe weather events is in fact considered in the NY Prize Microgrid Competition then Ballston Spa's secure location puts them at a disadvantage in the selection process.

Conclusion

Our review of the 83 Stage 1 proposals which included archival analysis and survey collection, combined with our in depth study of the Ballston Spa project have given us a sense of the priorities, challenges and successes of the NY Microgrid Prize Competition.

I: Guiding Question 1:

Microgrids have an array of potential economic, energy, technological, and environmental benefits. How important are environmental considerations in a local group's planning process? How central are environmental considerations in the plan?

Drawing from both the results of the survey, the summaries from the 83 communities, and our interviews and interactions with Ballston Spa, environmental considerations were not at the forefront of microgrid planning.

When asked to rank the most important goals in creating the microgrids from "Not At All Important" to "Extremely Important", 23% of the communities surveyed ranked " Clean Energy Generation" as "Extremely Important." Therefore, generating clean energy is the fourth most important goal listed on the survey, ranking behind “Resiliency” and “Reliability” and “Reducing Costs” and tied with “Energy Efficiency”.

We also asked how important environmental considerations were for the development of each proposal. Results varied dramatically throughout the different communities responses. 23% of respondents said that environmental considerations were extremely important, 34% reported that they were very important, 15% of respondents categorized environmental considerations as moderately important and 23% said that they were slightly important. Only 3% of respondents rated environmental considerations as not at all important. The wide variety in responses makes it difficult to determine exactly how prevalent environmental considerations were to different communities. It is also possible that while a given community may care about their environment, they still may not actually be designing a project with the environment as a serious part of the development process. Furthermore, it’s possible that some communities, like Ballston Spa, initially planned to use renewables but ended up having to remove them from their final feasibility studies. We turned to other survey responses and the review of the proposals to gain a more concrete picture of the role of environmentalism in the competition.

In our review of the technologies each of the 83 communities planned to use in their proposals, we found solar and cogeneration were equally popular, tied at 62.5%, and energy storage in third place at 47.5%. Natural gas was listed in 25% of the 83 communities’ proposals, while biomass, biogas, diesel, wind, fuel cells and hydro were all listed in between 5% and 15% of the communities proposals. The remaining technologies we recorded were all used in less than 5% of the communities proposals.

However, in the survey, when asked to rank which technologies were the the most significant in the development their microgrid, only 28% said that solar was " Extremely Important". By contrast, cogeneration was rated as " Extremely Important" by 45% of the communities surveyed, followed by natural gas, rated by 42% as being " Extremely Important," and Energy Storage, rated by 38% as being "Extremely Important".

Solar is the only form of renewable energy to appear in a major portion of the 83 proposals and while it is used by an equal percentage of communities as cogeneration, it is valued as being substantially less significant than cogeneration, natural gas, and energy storage. All other forms of renewables were used in less than 15% of the proposals and were ranked as being "Not At All Important" by the majority of the communities surveyed.

The prevalence of cogeneration in the different proposals and its perceived valued by the participating communities confirms Tim Brock's claim that cogeneration would be the primary focus of the NY Prize Microgrid Competition. The reason for this is that cogeneration is the only technology that will make a microgrid economically feasible: utilities in New York already charge fairly low rates for fossil fuels so in order for a microgrid to be worth the investment, it has to have a significantly higher efficiency rate than the grid can supply. Power generated and transmitted by the grid is only about 30% efficient, with the other 70% burned off as heat during generation and and lost in voltage conversion and transmission distances. Cogeneration, however, can achieve between 60% and 80% efficiency by capturing the excess heat that is normally burned off, making it the only technology with a high enough rate of efficiency to be worth the investment to generate energy independently from the grid. The reason natural gas likely also has been rated so high is that communities are planning on using natural gas as the fuel source for their cogeneration plants. We can conclude this with certainty because fuel cells, the other natural gas powered technology, were rated to be “Not At All important” by 50% of the communities surveyed.

The reason renewables play such a small role in the competition is that from an engineering perspective, they simply can not achieve an output of power and efficiency of generation that would make it logical to use them instead of a fossil fuel based technology. Renewables also often come with certain difficulties of use that fossil fuel based technologies do not have to deal with. Wind power only functions when the wind is blowing, and wind power is particularly difficult to install on a small scale with a high level of functionality. As we saw with Ballston Spa’s attempt at revitalizing a hydroelectric dam, hydro also requires overcoming a series of regulatory obstacles. Solar power can only create energy while the sun shines, which doesn’t provide for consumers night electricity needs. While energy storage technology exists that could solve the intermittency problems for renewables, the stakeholders we interviewed perceived that the storage technology was not yet developed to the point where it could fix this issue in microgrids.

It should be noted that solar can function well in combination with cogeneration because the rise and fall of potential solar power throughout the day runs parallel to the rise and fall of daytime energy use. Therefore during the day cogeneration can be used to cover the baseline, or average, energy use while solar power can provide for the peak energy loads. At nighttime, solar will stop running and cogeneration will take the full burden of energy output. This is likely the explanatory factor for why solar and cogeneration were both equally ranked as the most frequently used technologies used in the different proposals However, because cogeneration is providing the majority of the reliable power in that energy relationship, communities rated it as being more significant than solar in the survey. We saw an example of this attitude first hand when Ballston Spa realized that solar would not be available to them as an energy source for the feasibility study. They described the scenario only in terms of the loss of the tax credit to fund their project and did not view the loss of renewable energy production to be very relevant.

It is possible that NYSERDA may favor projects with higher percentages of renewables because those projects will contribute to the New York's goal of achieving 50% renewable energy by 2030. If so, this could be a contributing factor to the frequent inclusion of solar in proposals despite the fact that solar is perceived as supplemental and not of central importance to any microgrid. Furthermore, because New York State offers subsidies for solar installations, adding solar to a proposal could help communities raise the $200,000 needed to progress to the next stage of the competition. Other renewable technologies that don't have state subsidies play a significantly smaller role.

Our analysis of the summaries of the 83 proposals reinforces our findings regarding the prioritization of environmental concerns within the microgrid projects. The overwhelming popularity of community organizations listed as partners suggests that the Prize Competition was successful in fostering community involvement. Engineering and consulting firms were also very popular partners implying that engineering and technical abilities were highly valued. Contrastingly, from the relatively low representation of environmental engineering and consulting organizations, and standard environmental organizations we can infer that environmental concerns were not very salient when communities were choosing partnerships.

While environmental considerations are not the top priority in the NY Prize Microgrid Competition and come secondary to the functionality, reliability, and cost effective design of a microgrid, this is not to say there is no environmental benefit to microgrids. Inherently, a microgrid is a more energy-efficient and therefore sustainable system than the traditional macrogrid. Through the efforts of NYSERDA, microgrids will have a greater opportunity to live up to their sustainability potential.

II: Guiding Question 2:

What are the challenges for a local community seeking to implement a microgrid project?

Microgrid planning is an exceptionally difficult project with a series of technical, economic, administrative, energy, and logistical challenges. We found financial obstacles to be the most prevalent challenge that communities encountered when developing their proposals.

When asked which challenges were the most significant to the development of their microgrids, 48% ranked Financial Concerns as being “Extremely Significant”. “Coordination between Multiple Organizations and Partners” and “Regulatory Challenges” were both ranked by 24% of communities as “Extremely Significant”. 20% rated “Prior Knowledge” as an extremely significant obstacle. Only 8% of communities rated “Technological Challenges” as an extremely significant obstacle.

Financial Concerns were the most salient because NYSERDA required each community to raise $200,00 independently from the project in order to go on to the next stage, The competition was designed to encourage private investors to become involved to help raise the matching funds. However, attracting private investors to the Stage 1 feasibility study is particularly difficult because there’s no guarantee that they’ll be able to get a return on their money. The Ballston Spa team faced an additional handicap because of their decision not to use outside investors and only work with non-profit and public entities. Ballston Spa also ran into problems with coordination, time and lack of prior experience as only two members of their group had worked on a microgrid before, and every member communicated solely with Edwin Martin and not with each other. They were cut off from each other and meetings were held only semi-regularly. However, as Edwin Martin said: “the make-it-or-break-it factor for their project was being able to raise enough funds.”

The nature of the prize model requires people from a variety of different backgrounds to come together and synthesize their abilities, as well as maintain regular communication while holding day jobs.The fact that microgrids are a relatively new phenomenon means that it is very likely that many teams will be made up of members who do not have a background in building microgrids. This makes us suspect that many communities experienced similar challenges to

Ballston Spa. The fact that all 83 communities were given a one month extension on their final deadlines also suggests that there was universal difficulty in finishing by the deadline.

One possible reason technological obstacles were ranked as only a moderately significant challenge on our survey could be linked to the vast majority of communities using very similar proposals. Most communities used tried and tested technology combinations focusing on cogeneration, meaning that many communities probably considered the technological plan to be low risk. Regulatory obstacles likely ranked as moderately significant because for the most part the NY Prize Competition was structured to remove them. Other states competitions ended up running into serious regulatory obstacles in their design. The most notable case of this being when Connecticut utilities refused to let communities building microgrids use their power lines, severely interfering with their construction and functionality. However, New York demanded that utilities allow every community to use their power lines, thus removing the most serious regulatory obstacle in microgrid design. Furthermore, most communities chose not to use technologies such as hydro and wind which have difficult permitting process. This means most proposals were designed to use technologies that would have the least number of regulatory obstacles.

In conclusion, time, coordination, and previous experience with microgrids were all relevant challenges to the development of a microgrid. However, the financial obstacle of matching the $200,000 and attracting private investors to a project was by far the most significant challenge in the competition.

III: Guiding Question 3:

The NY Prize Microgrid Competition was designed to foster creative and innovative solutions. How different and unique are the 83 communities' different proposals? Does the competition really foster innovation or do many areas design similar projects?

The creators of the NY Prize Competition wanted to use the competition as a catalyst to explore many different paths and models of distributed energy and spark site-specific solutions. When asked how successful the NY Prize Microgrid Competition was in fostering innovation in our survey, 76% of respondents that it was "Very Successful" and 24% rated it was "moderately successful". No communities rated that it was "Extremely Successful" or "Not at All Successful". Looking solely at the range of technologies in the 83 communities' proposals, they do indeed represent a large variation. Twenty different technologies are represented across the the proposals. We see innovation in the anaerobic digestion plants presented in the Village of East Rockaway, Village of Malone, Town of Watertown, and the Village of Geneseo's plans. The geothermal energy considered by the Town of Kingston, the tidal proposed by the Village of Tarrytown and the Village of Sleepy Hollow, and the multiple communities utilizing hydro energy. These proposals display the creation of unique solutions that cater to and capitalize on individual location's existing resources in a way that only a prize model could.

While on the surface, it may seem like because more than half of communities are utilizing solar and cogeneration that the prize model did not spark innovation and was unsuccessful. However, it is possible that this uniformity is not a product of the prize model, but rather a result of financial constraints and New York state subsidies. The proliferation of solar is likely due to the fact multiple programs exist in New York State that provide tax credits which cover large portions of installation costs. These programs effectively provide the financial match each community is required to raise on their own to proceed in the competition. The popularity of cogeneration is likely due to the fact that it is a tried and true method that fits well into a microgrid model. Cogeneration has a proven history of working extremely well in microgrids due to its high level of efficiency of energy production. It is likely that these factors drove the seeming uniformity within the technologies chosen in the initial 83 proposals. The remaining, less popular technologies, represent experimentation that mark the innovation NYSERDA strived to generate. While many different technologies were experimented with, the high rate of cogeneration, solar and energy storage indicates that sometimes innovative creative solutions are not the most feasible and cost-effective ones.

NYSERDA had high hopes of building local partnerships within communities and spurring new models of energy production and distribution. While Ballston Spa's project changed substantially and may not continue on into stage 2, their inability to proceed in the competition does not represent failure. Elimination is inherent and expected in the NY Prize Microgrid competition. Those projects who do not proceed provide a valuable service because they have paved the way in discovering what models do and do not work for microgrids. Furthermore, many of the communities that won't make it to stage 2 may still be able to complete their projects independently with outside funds. By supplying the initial $100,000 for the feasibility studies, NYSERDA has opened the doors to the industry throughout the state. As programs like the NY Prize Microgrid Competition become more common, microgrids will play an increasingly more vital role in protecting and revitalizing the electrical grid and putting the power back into the hands of American communities.

Recommendations for Future Research

Our research focused solely on Stage 1 of the NY Prize Microgrid Competition. However, as the decisions are made about which communities progress to the Stage 2 and Stage 3, new data will become available. Future research on Stage 2 and Stage 3 should focus on the differences between communities that fail and communities that proceed. An analysis of what kinds of technologies and energy sources flourish and which are neglected during the remainder of the competition would provide a more thorough understanding the priorities and the innovation present in the competition. The communities that do not proceed in the competition may proceed on with the development separately from NYSERDA funds, or apply for different funding avenues. Future research may focus on the success of communities continuing to independently pursue their microgrid projects after the competition.   Future researchers can also analyze whether or not certain locations are favored over others in Stage 2 and Stage 3, which may show whether or not a community's vulnerability to severe weather events influences NYSERDA's decision to fund their project.

Appendix

Meeting #1 Attendance List:

1. Edwin Martin - Ballston Spa School District - Staff
    a. The Coordinator of Facilities and Security at the Ballston Spa Central School District
2. Katie Calhoun - Ballston Spa School District - Staff
    a. Administrative assistant to Edwin Martin
3. Martin Byrne - RPI
    a. The Associate Director of the Center for Future Energy Systems at Rensselaer Polytechnical Institute
4. Otward Mueller - MTech Labs
    a. A Senior Engineer at MTech Laboratories, died in December 2015 midway through the project
5. Michael Hennessy - MTech Labs
    a. President of MTech
6. Bill Wilson - MTech Labs
    a. Senior Manager at MTech Laboratories
7. Kim Ireland - National Grid
    a. Community and Customer Management at National Grid
8. Gerry Janicelli - TBS
    a. Owner of Technical Building Service Company
9. Bill Marzano - JW Danforth

    a. Project Development Engineer at John W. Danforth Company

10. Tim Peer - CHA
    a. Associate Vice President of CHA Consulting
11. Richard Rappa - CHA
    a. Senior Vice President of CHA Consulting
12. Larry Woolbright - Friends of the Kayaderosseras
    a. Retired Professor of Biology at Siena College
13. Kyle Downey - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College
14. Michaela Kerxhalli - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College
15. Sam Holmberg - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College
16. Karen Kellogg - Skidmore College - Staff
    a. Professor and Dean of Sustainability at Skidmore College

Meeting #2 Attendance List:

1. Paola Amezquita - Ballston Spa School District - Student
    a. High School Student at Ballston Spa
2. Benjamin Badaszewski - Ballston Spa School District - Student
    a. High School Student at Ballston Spa
3. Emily McClymonds - Ballston Spa School District - Student

   a. High School Student at Ballston Spa

4. Mariah McIntyre - Ballston Spa School District - Student
   a. High School Student at Ballston Spa
5. Kara Winslow - Ballston Spa School District - Student
   a. High School Student at Ballston Spa
6. Katie Calhoun - Ballston Spa School District - Staff
   a. Teacher at Ballston Spa
7. Andrea Hall - Ballston Spa School District - Staff
   a. Administrative Assistant to Edwin Martin
8. Edwin Martin - Ballston Spa School District - Staff
   a. The Coordinator of Facilities and Security at the Ballston Spa Central School District
9. Judy Selig - Ballston Spa School District - Staff
   a. A teacher in the Ballston Spa School District
10. Martin Byrne - RPI
    a. The Associate Director of the Center for Future Energy Systems at Rensselaer Polytechnical Institute
11. Michael Koskon - Doosan Fuel Cell
    a. Works with Jesse Hayes at Doosan Fuel Cells
12. Jesse Hayes - Doosan Fuel Cell
    a. Product Manager at Doosan Fuel Cell
13. Mike Hennessy - MTech Labs

    a. President of MTech

14. Otward Mueller - MTech Labs
    a. A Senior Engineer at MTech Laboratories, died in December 2015 midway through the project
15. Bill Wilson - MTech Labs
    a. Senior Manager at MTech Laboratories
16. Kim Ireland - National Grid
    a. Community and Customer Management at National Grid
17. Bill Marzano - JW Danforth
    a. Project Development Engineer at John W. Danforth Company
18. Tim Peer - CHA
    a. Associate Vice President of CHA Consulting
19. Richard Rappa - CHA
    a. Senior Vice President of CHA Consulting
20. Larry Woolbright - Friends of the Kayaderosseras
    a. Retired Professor of Biology at Siena College
21. Kyle Downey - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College
22. Michaela Kerxhalli - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College
23. Sam Holmberg - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College

24. Karen Kellogg - Skidmore College - Staff
    a. Professor and Dean of Sustainability at Skidmore College

Meeting #3 Attendance List:

1. Edwin Martin - Ballston Spa School District
    a. The Coordinator of Facilities and Security at the Ballston Spa Central School District
2. Andrea Hall - Ballston Spa School School District
    a. Administrative assistant to Edwin Martin
3. Mitch DeWein - CHA
    a. Mechanical/Engineering Tech
4. Mike Hennessy - MTech Labs
    a. President of MTech Labs
5. Bill Wilson - MTech Labs
    a. Senior Manager at MTech
6. Gerry Janicelli - TBS
    a. Owner of Technical Building Service Company
7. Sam Holmberg - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College
8. Michaela Kerxhalli - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College

Meeting #4 Attendance List:

1. Edwin Martin - Ballston Spa School District - Staff
    a. The Coordinator of Facilities and Security at the Ballston Spa Central School District
2. Andrea Hall - Ballston Spa School District - Staff
    a. Administrative Assistant to Edwin Martin
3. Katie Calhoun - Ballston Spa School District - Staff
    a. Teacher at Ballston Spa
4. Judy Selig - Ballston Spa School District - Staff
    a. A teacher in the Ballston Spa School District
5. Tim Peer - CHA
    a. Associate Vice President of CHA Consulting
6. Kim Ireland - National Grid
    a. Community and Customer Management at National Grid
7. Mike Hennessy - MTech Labs
    a. President of MTech Labs
8. Bill Wilson - MTech Labs
    b. Senior Manager at MTech
9. Kyle Downey - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College
10. Sam Holmberg - Skidmore College - Student
    a. Environmental Studies Major at Skidmore College

11. Michaela Kerxhalli - Skidmore College Student

    a. Environmental Studies Major at Skidmore College

Semi-Structured Interview Sheet

Interviews ranged in length from 15 minutes to an hour and each participant was asked the following questions:

1. What is your background, and your current job?
2. How and why did you get involved with the Ballston Spa project?
3. What is your role in the project? How much time have you put in?
4. What was your previous knowledge and experience with microgrids?
5. What do you hope accomplish with this microgrid?
6. What problems do you anticipate microgrids solving?
7. Do you see any obstacles the implementation of this microgrid?
8. What makes the Ballston Spa project unique and innovative? How is it catering specific to this community?
9. So if Ballston Spa doesn't get the next round, what happens to your project?
10. What technologies do you think are most applicable to microgrids?

Stakeholder Biographies

The eleven stakeholders interviewed are as listed below, with brief descriptions of their backgrounds and involvement in the competition.

Edwin Martin
Coordinator of Facilities and Security at Ballston Spa School District

Edwin Martin started working for Ballston Spa in 2000 and is currently directing the microgrid project. As the director of the project, Martin holds a large share of responsibility in the creation of the proposal. He recruits, directs and communicates with every party involved in the project, sets agendas and manages budgets.

Tim Brock
CEO, TecnerG, LLC

Tim Brock has spent the majority of his career working on holistic energy conservation projects, working specifically with solar and cogeneration upgrades for buildings. Currently as CEO of TecnerG, he works in microgrid and cogeneration consulting. His company built the original cogeneration plant for the Ballston Spa School District in 1998. While revisiting the plant, Tim introduced the NY Prize Microgrid Competition to Edwin Martin. Edwin Martin hired Tim Brock and Bill Marzano to put the original Stage 1 application together. Tim also brought in Joe Weinschreider from Energy Concepts to help and guided their organization through the creation of the application, making sure it was tailored to NYSERDA's requirements. Once the original application was submitted and approved, Tim's role in the project was completed. Consequently, he doesn't appear on the attendance lists for any of the feasibility study meetings.

Bill Marzano
Project Development Manager, JW Danforth

The majority of Bill Marzano's career has involved directing performance contracting for commercial and industrial centers. His company identifies potential energy savings and performs cost-benefit analysis to identify technology upgrades that represent financially sound decisions for his clients to invest in. Bill Marzano and Tim Brock worked collaboratively to write original application for the first phase of the Ballston Spa project. Bill specifically wrote the technical details of the form, basing them off of NYSERDA's original requirements for Phase 1. He also included the responsibilities, hours, and compensation of each organization involved in the proposal.

Bill Marzano was working for TecnerG with Tim Brock when the first application was written but he since has left and joined JW Danforth. Because of the time constraints of his new position, Bill Marzano was no longer able to help with the Ballston Spa proposal and doesn't appear on the attendance list after the first meeting. The responsibilities that TecnerG was originally in charge of, including the development design and using the utility bills to calculate the baselines of energy use for each island, were all shifted to the engineering organization CHA.

Tim Peer
Associate Vice President - Submarket Leader, CHA: Design and Construction Solutions

Tim Peer represents CHA and is charged with the design and engineering component of the Ballston Spa proposal. Tim Peer is working in the same role with five other communities involved with the NY Prize microgrid Competition. He is therefore the only interviewed stakeholder in the project working on additional microgrids, with the exception of Stacy Hughes.

Stacy Hughes
Product Manager, National Grid

Stacey Hughes has been working for National Grid for 33 years. She has worked as a meter reader, customer service, gas marketing, account executive, and currently as a project manager in the New Energy Solutions Group. She specializes in newer technologies and finding those technologies paths to the market. She is the Project Manager for the NY Prize Microgrid Competition. She is working with Ballston Spa and 22 different communities and their microgrid proposals. Her central responsibilities include managing the exchange of information, participating in the joint utility sessions, participating in meetings, and relaying information to NYSERDA, the NYS PSC, and the National Grid.

Jesse Hayes
Project Manager, Doosan Fuel Cell America

Jesse Hayes' background is in electrical engineering. He began working with fuel cells as an undergrad and after sixteen years of professional work in the field, he became a Project Manager for Doosan Fuel Cell. His role in the proposal is to provide the fuel cell technology and to ensure that it's both technically and financially feasible. He worked closely with Edwin Martin to apply for a separate, $1 million dollar NYSERDA grant made available specifically for for the implementation of fuel cells.

Joe Weinschreider
Associate, Mechanical Engineer and Project Manager, Energy Concepts

Joe Weinschreider worked as a mechanical engineer for fifteen years, working extensively with cogeneration and energy conservation. Tim Brock contacted Energy Concepts and brought Joe

Weinschreider in to review the existing cogeneration plant to determine the feasibility of upgrading the units. His responsibilities in reviewing the unit included checking electrical connections, hydraulic, exhaust and ventilation to see what could and should be changed. His involvement with the project was exclusively related to the cogen upgrade and his review of the unit took place before the second round of the competition, which is why he never attended any meetings.

Martin Byrne
Director of Business Development CFES at Rensselaer Polytechnic Institute

Martin Bryne is an employee of Rensselaer Polytechnic Institute (RPI). He works in the business development department of RPI. Bryne's job is to connect the business community of New York State with the innovate students and industries working at RPI. His program is funded by NYSTAR, which is a New York State funded program to bridge the gap between university work and business clients. Byrne became involved with the Ballston Spa Microgrid Project after meeting Edwin Martin at a Tech Smart Event. Bryne then offered the help Edwin Martin by allowing Ballston Spa to use RPI's distributed energy test bed, which can help with the development of microgrids. Edwin Martin wanted to have Bryne on the project because he wanted a third party proposal from the state.

Gerald Jannicelli
Owner of Technical Business Controls

Gerald Jannicelli has been working in building control systems for over 35 years. His specialty in the K-12, universities, and municipalities buildings. Ballston Spa has been a customer of TBS for over 30 years. Initially, Jannicelli's involvement with the Ballston Spa Microgrid Team was limited. His company TBS will not be involved in the project until the the physical proposal for the project is completed.

Larry Woolbright
Friends of the Kayaderosseras

Larry Woolbright is a retired professor of biology from Siena College. He has a PhD in ecology and was a professor at Siena for over 30 years. Woolbright is the president of Friends of the Kayaderosseras, which is an environmental organization focused on minimizing pollution and degradation to the Kayaderosseras. Woolbright's role in the microgrid was the to ensure that the proposed micro hydro dam would be environmentally friendly. The micro hydro dam project was eliminated from the microgrid proposal, meaning that Woolbright, the only representative from an environmental organization is no longer involved.

Bill Wilson
Manager, MTech Laboratories

Bill Wilson is the manager of MTech Laboratories. Wilson works at MTech to help develop the cryogenic batteries used in the Ballston Spa Microgrid. He works in accordance with Hennessy to develop the cryogenic batteries.

Michael Hennessey
Manager, MTech Laboratories

Michael Hennessey originally worked for G.E. on general intermagnetics. He worked with superconductor energy efficiency technology, primarily focusing on its potential to improve MRI technology. Currently he works on integrating superconductors to electronic systems of all kinds, partnering with a variety of organizations, including the U.S. Army, DOE, NASA and various different MRI companies. MTech is contributing to the Ballston Spa Proposal by calculating the energy storage requirements on the proposal and designing a magnetic energy storage system to accommodate Ballston Spa's needs. Their project is very advanced and the batteries they are using are not completely ready for commercial distribution yet. However, the U.S. Army has taken an interest in superconductor technology and they're very interested in seeing a magnetic battery storage unit built in Ballston Spa as a pilot project to test the technology.

Michael Razanousky
Project Manager at NYSERDA

Michael Razanousky has been working on microgrid development at NYSERDA since 2010. He attended Rensselaer Polytechnic Institute. Currently, Razanousky's focus at NYSERDA is on microgrids. He helped develop the New York State Microgrid Prize Competition with six other NYSERDA employees. Razanousky is a big proponent of the bottom up structure of the prize competition. Razanousky thinks that the prize structure will help NYSERDA determine the commercial viability of microgrids.

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