Guide to a Clean Energy Future: Genesee-Finger Lakes

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Cover photo of Canandaigua Lake taken by Shawn Porter (http://sporterphoto.com/).

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The authors of this guide, pictured here, and Thomas Abdallah their faculty advisor

Executive Summary

The objective of this guide is to examine the efforts of the New York State Energy Research and Development Authority (NYSERDA) Clean Energy Communities Program and the Genesee/Finger Lakes Regional Planning Council (G/FLRPC) in advancing the region's clean energy transition thus far, to profile the Genesee-Finger Lakes region currently, and to highlight the opportunities available for the expansion of the clean energy transition. It also serves to provide insight into how sustainable energy technologies could impact the Genesee-Finger Lakes region's environment and local economy by identifying the realities inherent to the transition and by drawing comparisons to how communities in the United States and elsewhere are managing clean energy development, environmental protection, agriculture, and outdoor recreation. This guide will examine the region's economy, demographics, geography, and current sustainability systems and assess how the clean energy transition proposed would affect the region.

States, municipalities, and communities around the country are actively pursuing a variety of programs and initiatives to decrease their energy consumption, tap into renewable energy, and lower their carbon footprint. Some of these initiatives involve practical, common-sense solutions, while others are highly creative undertakings that feature out-of-the-box thinking and are tied to cutting-edge innovations. This guide takes a look into these tried-and-tested technological innovations, denotes the principles by which they operate, and discusses the parameters that aid in identifying how to use them symbiotically based on the local region. We've included case studies from six municipalities and regions that are making the clean energy transition and that share similarities to the Genesee-Finger Lakes region. The profiles highlight the challenges, success stories, and lessons learned from these clean energy pioneers.

This guide provides a road map to achieving a more sustainable Genesee-Finger Lakes region and addresses some of the common concerns often heard about renewable energy generation. By investigating and debunking these misconceptions, the guide shows that renewable technologies are not only safe, but they also can provide many benefits to the region in the form of financial rewards, health improvements, and mitigation of future climate change. Through extensive research our team has determined what we believe to be a highly effective and efficient way forward for the Genesee-Finger Lakes region to further transition to clean energy and become a leading model of sustainability.

The actionable steps resulting from our analysis include the following key take-aways:

- ❑ Future investment in partnership with local utilities and organizations should be focused on all energy sectors: generation, consumption, and transportation
- ❑ Distributed generation should be utilized to transition communities away from fossil fuels
- ❑ The region should look to Massachusetts, Michigan, and the Mid-Hudson region of New York when making the clean energy transition since their programs and best practices were primarily successful and always enlightening
- ❑ Educating the public about the benefits of the clean energy transition is vital to its success, and further education is encouraged, beginning with this guide
- ❑ This guide is not a solution but only a first step in a bright and clean future for the Genesee-Finger Lakes region

Glossary of Terms

Agrivoltaics	Co-located agriculture and solar photovoltaic (PV) infrastructure (NREL, 2019).
Albedo	A measure of how much light that hits a surface is reflected without being absorbed (North Carolina Climate Office, n.d.).
Anaerobic Digestion	A series of biological processes in which microorganisms break down organic material in the absence of oxygen (American Biogas Council, n.d.).
Azimuth	The direction of a celestial object from the observer, expressed as the angular distance from the north or south point of the horizon to the point at which a vertical circle passing through the object intersects the horizon (Merriam-Webster, n.d.).
Biogas	A fuel source composed mostly of methane and carbon dioxide. It is produced from biomass through the process of anaerobic decomposition (U.S. Energy Information Administration, 2019).
Biomass	Organic material that comes from plants and animals and is a renewable source of energy (U.S. Energy Information Administration (EIA), 2019).
Brownfield	A property whose expansion, redevelopment, or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (EPA, n.d., e).
Cadmium Telluride Solar	Photovoltaic solar cells based on CdTe represent the largest segment of commercial thin-film module production worldwide after crystalline silicon. It is considered a thin-film technology because the active layers are just a few microns thick, or about a tenth the diameter of a human hair (NREL, n.d., a).
Clean Energy Transition	A shift by the global energy sector away from fossil-fuel based systems of energy production and consumption, such as oil, coal, or natural gas, to renewable energy sources, such as wind and solar (Mintz, 2020).
Concentrating Solar Power	Generation plants that use mirrors to concentrate the sun's energy to drive traditional steam turbines or engines that create electricity (Solar Energy Industries Association (SEIA), n.d., a).
Ecotourism	Responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education (The International Ecotourism Society, n.d.).
Energy Benchmarking	Energy Benchmarking is a method used to determine whether a building is using more or less energy than its peer facilities with similar occupancies, climates, and sizes. Benchmarking is done by taking a buildings total energy

	use (typically converted to kBtu in the US and Watts elsewhere) and dividing by the building's total area (President and Fellows of Harvard College, 2015).
Global Horizontal Irradiation	Total solar radiation. The sum of Direct Normal Irradiance (DNI), Diffuse Horizontal Irradiance (DHI), and ground-reflected radiation (NREL, n.d., b).
Home Energy Rating System	A system for inspecting and calculating a home’s energy performance and the industry standard by which a home’s energy efficiency is measured (Residential Energy Services Network, 2019).
Hydroelectric	A process wherein falling water turns a propeller-like piece called a turbine, which then turns a metal shaft in an electric generator, which is the motor that produces electricity (USGS, n.d.).
Infrasound	Sound below a frequency of 20 Hz. It has sources in natural occurrences, industrial installations, low-speed machinery, etc. (Leventhall, 2007).
Intermittent Electricity	Electrical energy that is not continuously available due to external factors that cannot be controlled, produced by electricity generating sources that vary in their conditions on a fairly short time scale (Hanania, Stenhouse, & Donev, 2017).
Microgrid	A microgrid is a localized group of electricity sources and sinks (loads) that typically operates connected to and synchronous with the traditional centralized grid (macrogrid) but can disconnect and maintain operation autonomously as physical and/or economic conditions dictate (Berkeley Lab, 2019).
Nitrogen dioxide (NO_2)	An ozone-deteriorating gas into the atmosphere, which is emitted during agricultural and industrial activities, and during combustion of fossil fuels and solid waste (EPA, n.d., a).
Nuclear Energy	Energy generated from splitting atoms in a reactor, also known as fission, to heat water into steam, turn a turbine, and generate electricity (Nuclear Energy Institute, n.d.).
Nuclear Fusion	The process of nuclei colliding and fusing into heavier atoms, while releasing tremendous amounts of energy in the process (ITER, n.d.).
Particulate Matter	A mixture of solid particles and liquid droplets found in the air. This includes both organic and inorganic particles, such as dust, pollen, soot, smoke, and liquid droplets (EPA, n.d., d).
Passive House	A Passive House is a building for which thermal comfort can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions without the need for

additional recirculation of air (Theumer, 2018).

Photovoltaic Cell A single semiconducting element of small size that absorbs light or other bands of the electromagnetic spectrum and emits electricity (NREL, n.d.).

Power Purchase Agreement A financial arrangement in which a third-party developer owns, operates, and maintains a renewable energy system, and a host customer agrees to site the system on its property and purchase the electric output from the provider for a predetermined period of time (Solar Energy Industries Association (SEIA), n.d., c).

Smart Grid A network of transmission lines, substations, transformers and more that deliver electricity from the power plant to consumers and incorporates digital technology that allows for two-way communication between the utility and its customers, and sensing along transmission lines (Department of Energy, n.d., b).

Solar Array Combining several solar panels to collect solar energy (SunRun, 2018).

SREC Otherwise known as a Solar Renewable Energy Credit. One unit represents 1 MWH of solar electricity created. The SREC program provides a means for Solar Renewable Energy Certificates to be created for every megawatt-hour of solar electricity created. The value of an SREC is determined by the market and is subject to supply and demand constraints (SREC Trade, n.d.).

STEM An acronym used to group together the academic disciplines of science, technology, engineering and math (U.S. Department of Education, n.d.).

Sulfur dioxide (SO_2) A colorless gas with a strong odor, which is formed when fuel containing sulfur, such as coal and oil, is burned, creating air pollution (U.S. EPA, n.d., f).

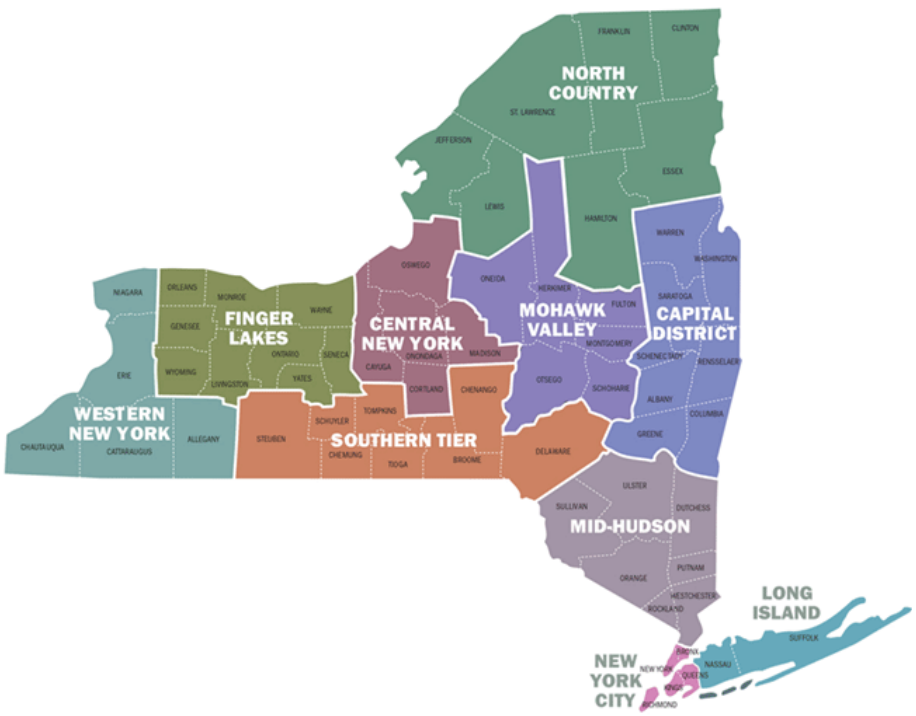
Swept Area The area through which the rotor of a wind turbine spins (Danish Wind Industry Association, 2000).

Introduction to the Genesee-Finger Lakes Region

Geography

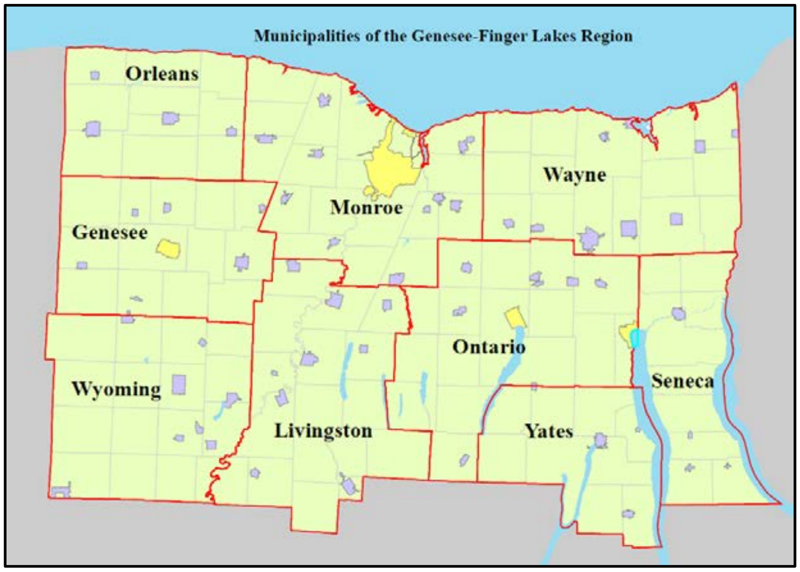
The Genesee-Finger Lakes region is located in Upstate New York about 250 miles northwest of Manhattan and bordering Lake Ontario. Over 1.2 million people reside in the region, which consists of nine counties: Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates. Sixty-two percent of the population lives in Rochester, or Monroe County, and its suburbs. Outside of the Rochester metro area the economy is primarily agricultural, with pastoral lifestyle values and economic well-being dependent on the wine, cheese, and dairy farming industries that exist on over 4,676 miles of resource-rich land (Office of the New York State Comptroller, 2017).

***Figure 1*. Map of Clean Energy Communities in New York State**



The climate in the region ranges from cloudy, cold, and snowy winters, when temperatures are near freezing from December to March, to warm, sunny, and humid summers, when temperatures rarely go above 80° F. The lake effect in the region provides rain every three to four days, keeping the area a few degrees cooler in the summer months than the rest of New York State. The same effect draws out the winter thaw, sometimes into late May, as cooler air sitting over the Great Lakes slowly burns off and permeates into the region’s sprawling hills and valleys, particularly from Lake Ontario (Levan, 2010).

Figure 2. **Map of Municipalities of the Genesee-Finger Lakes Region**



Demographics

The median household income of the region is lower than the state median of $64,894 (Department of Numbers, 2018). In 2015, of all nine counties, Ontario had the highest median income at $57,416, while Orleans county had the lowest at $46,359. The city of Rochester, which has a population of over 208,000, making it the most populated city in the region, has a median income of $30,960. Rochester also has a poverty rate of 33 percent, which is the highest of any city in the region (Deloitte, 2020).

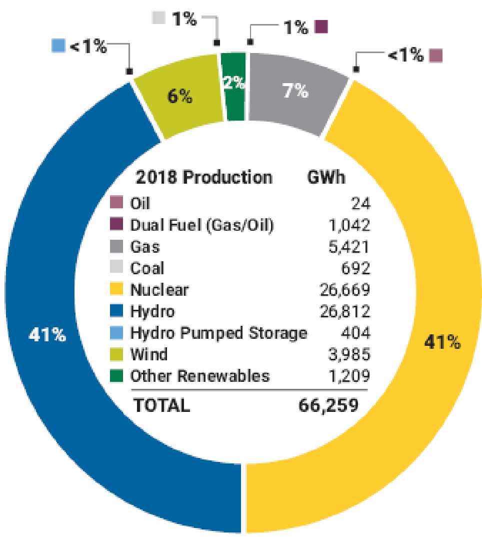
Unemployment rates have decreased in the Genesee-Finger Lakes area over the last 8 years, from 8 percent in 2012 down to 4.2 percent in 2019 (New York State Department of Labor, 2019). This is largely due to an increase in the tourism industry, as the area has become more frequented by visitors looking to indulge in the region's prosperous wine and cheese industries. Other prominent sources of economic revitalization are the universities in the region, which include The University of Rochester, Cornell University, Rochester Institute of Technology, Hobart and William Smith Colleges, and six others that collectively graduate nearly 19,000 students each year (Locate Finger Lakes, 2020).

Currently the largest employment sectors in the Genesee-Finger Lakes area are government and healthcare, accounting for nearly 30 percent of employed persons collectively and over 160,000 jobs. The manufacturing sector, which used to be a boon for job creation in the region, has dwindled since the downsizing of companies like Kodak and Xerox. However, manufacturing still employs 12 percent of the total of all industry hires, including many new and up-and-coming wine and brewery businesses. The region's wine and beer production accounts for over 50 percent of New York State's exports of beverage products and is one of the region's largest economic growth areas in both production and agricultural jobs for the crops barley, grapes, and hops (Office of the New York State Comptroller, 2017).

Current Energy Mix

The region's current energy mix is largely dependent on **nuclear** and **hydroelectric** generation. These two sources alone account for over 82 percent of energy generation in Upstate New York (New York Independent System Operator, 2019). Gas production accounts for 5 percent, wind energy for 3 percent, and all other generation types account for 1 percent or less.

***Figure 3*. Current Energy Mix of Upstate New York**



The geography of the region and market factors have the biggest influence on the mix of generation types used in Upstate New York to produce power. The abundance of land and water has enabled hydroelectric generation to become the prevailing generation type in the region and has led to New York State's position as the third largest producer of hydroelectric energy in the U.S. behind Oregon and Washington (U.S. Energy Information Administration (EIA), 2020). New York generates one-third of its energy from nuclear energy, which is considered a zero-emission resource and is among the energy sources that factor into the state's emission reduction goals for 2040. However, one of the state's four nuclear energy plants is scheduled for retirement in 2021 (U.S. Energy Information Administration (EIA), 2020), leaving hydroelectric power and other renewable sources to make up for the lost generating capacity. In Downstate New York, oil and gas generation are the primary energy mix drivers, most notably because over 85 percent of Downstate residents use public transportation, which runs on petroleum and natural gas (U.S. Energy Information Administration (EIA), 2020).

The Genesee-Finger Lakes region, with its abundance of lakes and land, has seen a notable increase in wind and solar power generation in the last 10 years. Both wind and solar energy can generate clean electricity, do not emit greenhouse gases, and come from a renewable, domestic source. Most of the best sites for generating electricity with wind and solar energy are found in rural areas, including farms and ranches, which makes the geography of the Genesee-Finger Lakes region ideal for this type of production (NYSERDA, 2019). At present, due to the irregular nature of wind and solar generation, these types of power can be used only to supplement hydroelectric energy in the state and are thus considered **intermittent electricity** sources. However, into the future as storage technology advances, they may indeed become reliable and substantial sources of clean, renewable energy.

Defining the Clean Energy Transition

Transitioning to clean energy has been discussed more and more as the next path forward for the world at large. A **clean energy transition** is considered a shift by the global energy sector away from fossil fuel based systems of energy production and consumption such as oil, coal, or natural gas, to renewable energy sources, such as wind and solar (S&P Global, 2020). This energy transition could not occur on the global scale without starting locally in towns, villages, and cities. In order to understand what needs to happen to make the clean energy transition most effective, the public needs to understand what it would entail. Wind and solar projects need to be implemented, from utility scale projects to rooftop solar, and fossil-fuel based facilities eventually need to be retired. However, it is not recommended to simply implement these projects without certain preparations for the changing energy mix of the region.

The transition to clean energy requires that certain preparatory actions be taken in order to have regions like Genesee-Finger Lakes ready to benefit from new renewable sources of generation. The guidelines proposed here regarding the clean energy transition have been taken from work that was started by the NYSERDA Clean Energy Communities program and supplemented by further research. Local solutions that can guide the clean energy transition include improving building energy efficiency, implementing electric vehicles, beneficial electrification, and more (Ferington, 2020).

Three Key Areas of Energy Use

The Genesee-Finger Lakes region has begun to make changes to prepare for the clean energy transition whether this involves figuring out its baseline energy use, making clean energy upgrades, or adopting renewable energy technologies for the generation of carbon-free electricity. However, the region still has work to do to fully transition to clean energy in the future. The changes that remain to be completed can be divided into three main areas.

The first area involves the generation and transmission of electricity across the region. There needs to be steps taken in the Genesee-Finger Lakes region in order for the region to change the nature of its energy assets. The three major categories of generation are fossil fuel based (coal, natural gas, and petroleum), nuclear energy, and renewable energy. Most electricity is generated with steam turbines but gas turbines, hydro turbines, wind turbines, and solar photovoltaics are also used as generation mechanisms (U.S. Energy Information Administration (EIA), 2020a). The Independent System Operator for electricity in the state discusses how important it is to have a diverse "fuel mix [that] affects both the reliability of the electric system and the price of power. A balanced array of resources enables the electric system to better address issues such as price volatility, fuel availability, and requirements of public policy," (New York Independent System Operator, 2019a). Fossil fuels do not currently, and should not, serve the majority of the region's energy needs into the future. Generation and transmission need to change in order to save money, balance fuel availability, and limit pollution across the region.

A second key area of the clean energy transition that requires focus is energy use, or the consumption of energy. Buildings make up a large percentage of energy used by the Genesee-Finger Lakes region. Energy efficiency programs in general are a part of a plethora of solutions that can reduce peak demand and moderate the growth of energy (New York Independent System Operator, 2019b). Building energy usage involves the mechanized heating and cooling systems that exist to climate control a building. It also involves lighting, appliance usage, and other electronics. Through the retrofitting of inefficient buildings and the new construction of building envelopes that are outfitted to be more energy efficient, building energy use can be reduced significantly. Consumption reduction can come from behavioral changes as well, but the focus of the clean energy transition is mainly involved with preparing the region for new technologies and systems.

The third key area of the clean energy transition is the transportation sector. This sector contributes the highest emissions out of all categories of energy usage including electric power generation, building energy usage, and industrial energy use, in New York State (New York Independent System Operator, 2019b). The transportation sector is rapidly changing across the world. Electric car deployment has been growing rapidly over the past 10 years, with the global stock of electric passenger cars passing 5 million in 2018, an increase of 63 percent from the previous year (International Energy Agency, 2019). There is a great opportunity to see a reduction in emissions through the electrification of the transportation sector and the replacement of fossil fuel sources in this area with electric vehicles powered by renewables.

Current Status of the Region

The Genesee-Finger Lakes region is part of a large contingent of cities, counties, and municipalities in New York State that are making the transition to clean energy. For the Genesee-Finger Lakes region, a clean energy transition means a move to solar and wind power generation in combination with energy efficiency technologies, battery storage, electric vehicles, and more. Organizations such as NYSERDA have worked to prepare the region for new renewable energy development that will make its constituencies more resilient, lower energy used by the area, and bring energy generation into the hands of local governments.

NYSERDA is an organization that brings information and a structural framework to the Genesee-Finger Lakes area, and New York as a whole, through a multitude of programs. One such program called NYSERDA Clean Energy Communities, running from 2015 to 2020, is specifically designed to prime the state for a clean energy transition going region by region. A Clean Energy Communities Coordinator was assigned to each of ten regions within New York to assist the communities with knowledge and resources in order to better understand the role they could play in a statewide energy transition.

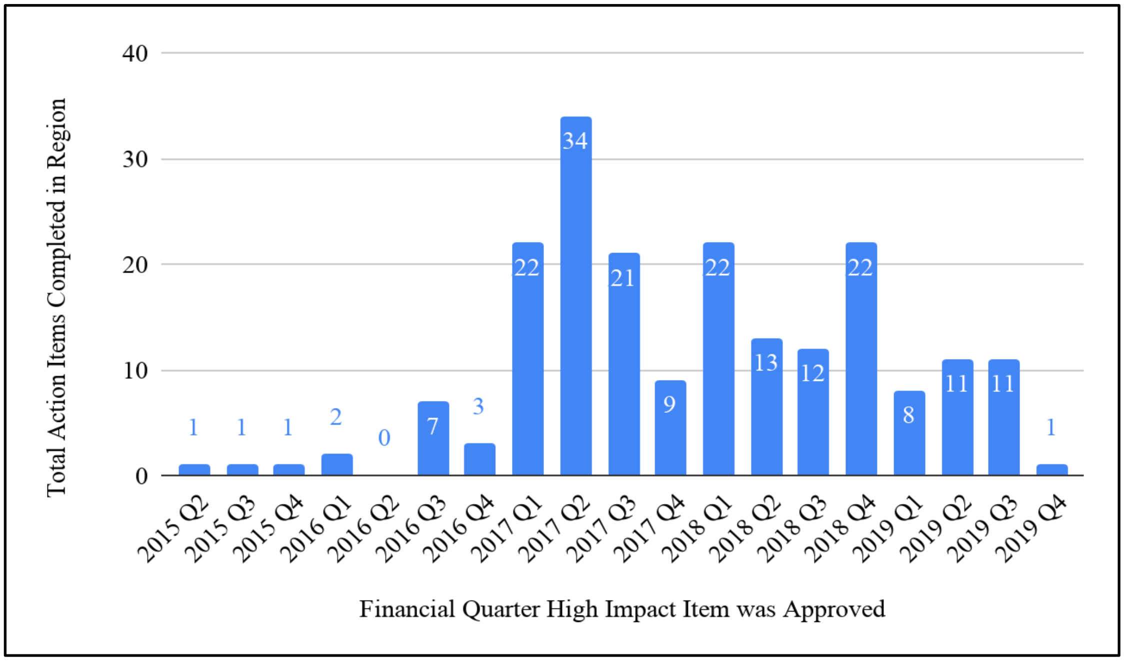
The key to earning a Clean Energy Community designation by the program involves municipalities taking part in four out of ten high impact action items. They are not limited to implementing only four, but four is the minimum number of items that need to be completed in order to receive that designation. Taking part in these projects involves completing items ranging from benchmarking energy used by buildings in municipalities to implementing a **community choice aggregation** program that allows communities across the state to begin to prepare for a regional clean energy transition (NYSERDA, n.d., h). Counties, cities, villages, and towns across the Genesee-Finger Lakes region took up the challenge to implement these action items. A breakdown of the number of municipalities that completed each of the high impact items can be seen in Figure 4.

Figure 4. **Number of high impact action items completed in the Genesee-Finger Lakes region, by category**

High Impact Action Items Completed	
Energy Code Enforcement Training	64
Unified Solar Permit	46
Benchmarking	40
Clean Fleets	23
LED Street Lights	9
Clean Energy Upgrades	8
Solarize, Clean Heating and Cooling, or Solar for All Campaign	5
Climate Smart Communities Certification	4
Energize NY Finance	2
Community Choice Aggregation Program	0
Grand Total	201

All nine counties that form the Genesee-Finger Lakes region participated in some way. The implementation of most of the high impact items took place between the first quarter of 2017 and the fourth quarter of 2018, as depicted in Figure 5. The second quarter of 2017 saw the most activity, when a total of 34 individual actions were taken by communities in the Genesee-Finger Lakes region. In the two-year period between 2017 and 2018, 155 individual actions were approved by 67 municipalities across all nine counties (NYSERDA Clean Energy Communities Program, 2020).

Figure 5. **The total number of Clean Energy Community High Impact Action items completed by the Genesee-Finger Lakes region by financial quarter.**



In some cases, even though work is done at the county level, actions can also be completed at the local level. For example, cities, villages, or towns can earn clean energy community status for the purpose of being prepared for the clean energy transition. Some action items were not completed by certain types of municipalities since some can only be done at the level of government that has the power to designate zoning and coding laws. For example, only cities and counties can enact PACE legislation for the action item that involves establishing a financing support system known as EnergizeNY (Ferington, 2020). Overall, the work that the NYSERDA CEC program has completed allows for a clear delineation of where the region currently stands in the clean energy transition and what work remains to be done.

Local Communities and the Clean Energy Transition

Identifying the Relevant Stakeholders

In the Genesee-Finger Lakes region there are many stakeholder groups who will be impacted by the clean energy transition. These include elected officials, the regional planning council, small businesses owners, homeowners, farmers, local and regional utilities, and various industries located in the region. Tourism particularly has become of increased importance to the economy and includes more than 70 different industries (New York State Department of Labor, n.d.). These include museums and other historical locations, wineries, sporting events, golf courses, outdoor recreation, and more. To understand how stakeholders feel about the clean energy transition, we connected with representatives of some of these groups.

Stakeholder Concerns

One of our conversations was with Shawn Grasby, a Code Enforcement Officer for Mt. Morris, and Grant Cushing, the CEO and Founder of Brownfield Group, a solar developer based in Upstate New York. Both are a part of stakeholder groups that actively push for the clean energy transition. They emphasized two main areas of improvement in order to help clean energy projects be developed faster and more often. First, education must be used as a tool (Grasby & Cushing, 2020). Essentially, if community members do not understand the benefits of clean energy, then there is a natural resistance to large-scale projects. Yet by debunking myths around clean energy and gaining community support, projects will move much faster. Grasby noted that municipalities still need more formal guidance around renewable projects (Grasby & Cushing, 2020). For example, there is limited language around battery storage for utility-scale projects in the region. This led Grasby to draft a code himself. Grasby and Cushing agree that there is still a lot of work to do towards furthering the clean energy transition, yet they will continue to push for more change. Through their experience, we can gain an understanding of how projects can successfully progress in the region. For example, a project located in the town of Mount Morris is cited as having no visual impacts on the nearby Letchworth State Park which is a win for stakeholders concerned about aesthetics of the projects (Grasby & Cushing, 2020). Additionally, by working with the town of Mount Morris and park officials, there could be potential for this installation to benefit tourism by creating a small visitor center (Grasby & Cushing, 2020).

The communities that host solar and wind project development are another key group of stakeholders of the region. Luckily, we were able to speak with Marion “Maz” Trieste of United Solar Energy Supporters (USES), a grassroots community of advocates with the shared goal of organizing communities in order to garner support for large-scale utility solar and wind projects. Trieste is focused on education in the region as well as getting the right people in the right industries speaking to each other. As developers grapple with the varying politics of the region and the misinformation that is often spread around renewables, Trieste is focused on educating younger generations. The promise of a clean future directly impacts the youth at a local level, so that is where she believes education programs should start (Trieste, 2020). Through Trieste’s experience in project support, she sees the mobilized voices of the vocal minority are often louder than that of the silent majority. Thus, she leads efforts to help support, educate, and unify the community to help override this small group of persons who have reservations about the clean energy transition.

When considering the voices of community groups in the Genesee-Finger Lakes region, we looked to the Rochester People’s Climate Coalition and their director, Abigail McHugh-Grifa.

As the largest city in the region, Rochester offers an interesting perspective on the clean energy transition. Like other stakeholder groups, the Rochester People's Climate Coalition is a driver of climate action in the region. Yet instead of focusing solely on renewable technologies like solar and wind, their efforts are on energy efficiency in heating systems and transportation. McHugh-Grifa works to organize and mobilize communities in support of a clean energy transition. Although education is an important aspect of these efforts, McHugh-Grifa emphasizes the need for policy as well (McHugh-Grifa, 2020). This includes updating building codes and financially incentivizing renewable energy sources. Through her nonprofit, she works to establish a collective impact initiative that can support and implement system level change (McHugh-Grifa, 2020).

We unfortunately were unable to speak directly with several other identified stakeholders in the region. Our initial plan was to travel to the region and spend several days meeting with community members, business owners, policymakers and more. Unfortunately, due to the COVID-19 pandemic, we were unable to physically travel to the region and instead conducted as many interviews as we could virtually. It is important to understand that a representative of the tourism industry, the agricultural industry, or an elected official may have had additional insightful thoughts to add to our discussion. As we can tell from the conversations we were able to have, this is a complex area with many varying opinions. When working towards the goal of clean energy in a region, it is important to consider all stakeholders.

Misconceptions about the Clean Energy Transition

There are common misconceptions that circulate around the clean energy transition and the myriad technologies that are commonly employed to hasten this transition. With some background research, however, these misconceptions can be debunked to bring clarity to a general audience and reassurance about these new resources. What follows are a few common misconceptions about clean energy technologies and the real story behind them.

Can proximity to windmills cause harm to people?

It is not true that being near windmills can cause harm to people. The original claim that windmills cause cancer, among other bodily issues, stems from a study originating with the Russian-born French scientist Vladimir Gavreau in the 1960's. He claimed **infrasound**, or sound that is very low in frequency, like that created by the turning of windmill turbines, could be causing nausea, sleep loss, and anxiety. The study in which he claimed to have proven this was flawed, however. It was missing a key component: a device that could measure infrasound in general. In all, this study did not make any definite conclusions about infrasound (Jaekl, 2017).

In 2009, the claim that windmills can cause bodily harm surfaced again when a pediatrician, Dr. Nina Pierpont, used Gavreau's flawed study as evidence to fight against the implementation of wind turbines in her community. Many people were galvanized by the thought that wind turbines could be causing deadly harm to them. There is no truth to the fact that wind turbines cause cancers or other bodily harm. Infrasound, the very phenomenon that people claim causes these symptoms, is present all around us; it is in the sound of waves, wind, our own heartbeat, fans, motors, and urban noise. There is no link between cancer rates, nausea, or other issues in the general population and proximity to wind turbines (Mühlhans, 2017).

Do wind turbines harm birds, migratory or otherwise?

To understand the effects that wind turbines have on bird populations, there needs to be some context given regarding the number of birds killed on a yearly basis by human influence. Figure 6, from the U.S. Fish & Wildlife Service, details the sources behind the median 3,324,184,012 bird deaths per year in the United States (U.S. Fish & Wildlife Service, 2018a; U.S. Fish & Wildlife Services, 2018b).

Figure 6. **Median number of birds killed annually by hazard**

Median Number of Birds Killed, Annually (2017)			
Hazard	**Deaths**	**Hazard**	**Deaths**
Cats	2,400,000,000	Collisions with Cell towers	6,600,000
Collisions with Glass	599,000,000	Electrocutions	5,600,000
Collisions with Vehicles	214,500,000	Oil Pits	750,000
Poison	72,000,000	Collisions with Wind Turbines	234,012

In terms of threats to birds, migratory and predatory birds being of prime concern to the Department of Fish & Wildlife Service, land-based turbines are the least harmful to birds out of other causes of mortality on this list. What may be surprising to many is the fact that 'Cats' (domestic and feral) are the number one cause of bird mortality in the U.S. Outdoor cats kill the greatest number of birds yearly at a median of 2.4 billion. ‘Building glass’ is ranked next with 599 million birds killed per year. Going down the list, causes such as ‘Collisions with Vehicles’ and ‘Poison’ tend to stick out at 214 million and 72 million bird deaths per year respectively (U.S. Fish & Wildlife Service, 2018a).

Figure 7. **Migratory birds and wind turbines**

At the bottom of this list is the hazard of land-based turbines, which kill around 234,512 birds per year. As the wind industry expands, this number is estimated to increase to around 1.4 million birds colliding with wind turbines per year. This number is not insignificant but is still a fraction of the number of bird deaths from electrocution yearly (U.S. Fish & Wildlife Service, 2018a). On the bright side, this number can be reduced through employing best practices when planning wind turbine placement. The Department of Fish & Wildlife Service recommends that wind turbines not be placed in high traffic areas for birds, near rivers, summits, and steep slopes, or in open habitat where birds tend to search for food. Regardless of hazard type, man-made structures do interrupt wildlife patterns in general and precautions need to be taken when building in fragile ecosystems. Wind turbines are not even close to the most harmful cause of death for birds in the U.S., and there are best practices that renewable energy developers can use to lower this number (U.S. Fish & Wildlife Services, 2018b).

Can solar be developed on agricultural lands?

Many people seem to think that placing **solar arrays** on agricultural lands is not possible, but there have been demonstrated cases of solar photovoltaic projects being implemented that have benefited farmers that choose to use their grazing land partly for solar generation. According to the Department of Energy’s Office of Energy Efficiency & Renewable Energy, there are many benefits to going solar. Farmers can reduce their electricity costs, increase the land’s ability to install high-value, shade-resistant crops, and potentially reduce water use and extend growing seasons (Department of Energy Solar Technologies Office, n.d.).

Figure 8. **Sheep grazing alongside solar panels**

There have always been misconceptions about solar modules, namely that they will damage the soil underneath or around them. In actuality, the nature of solar modules prohibits any leaching of trace metals into soil. Regardless of whether the modules are silicon-based, or **Cadmium Telluride** based, solar panels have a glass front that protects the PV cell and an aluminum and steel frame. Even during a fire underneath or around a photovoltaic panel, Cadmium Telluride panels do not release harmful substances and it is unlikely for silicon-based modules to release harmful substances as well (Fthenakis V. M., 2012). Solar panels tend to keep the air underneath them cooler during the day and warmer at night, which can diversify a grower's crop selection. Additionally, animals like sheep can graze around and under solar panels, reducing pesticide use and benefitting local shepherds. Sheep are well suited to graze in and around solar panels due to their lack of interest in photovoltaic wiring or equipment (Perez, Hain, & Fox, 2020). For this reason, solar panels will not harm animals that graze around them and more inquisitive animals can be accounted for through adjusting the height of the structures. Overall, solar can and should be developed side-by-side with cropland if that works best for landowners (Department of Energy Solar Technologies Office, n.d.).

Can solar panels cause harm to animals?

Since solar **photovoltaic** modules are less reflective than glass windows on buildings, it is highly unlikely that a bird will accidentally fly through them. In addition, ground mounted solar systems are low to the ground, also mitigating this risk. There is a slight risk for birds to run into the power lines, vehicles, and other equipment that is involved with the distribution of energy generated by solar modules, but this is the case for all electricity distribution as a whole (Department of Energy Solar Technologies Office, n.d.).

Do solar inverters cause noise pollution?

Solar panels themselves do not make noise while they generate electricity from converted sunlight (Martin II, 2013). Depending on the way that panels are mounted, for example being roof-mounted versus a standalone ground mounted system, some noise can be generated. With rooftop solar, the panels are installed on a racking system that is attached to the roof of the building on which it will be generating energy. Wind noise can happen from wind going in between the racking system and the roof but beyond that the setup will not generate noise. When it comes to the **inverter** for the solar system, otherwise known as the device that converts DC to AC electricity, there can be some level of noise heard that is akin to a monotone hum or buzz. This noise is typically around 60dB, which is around the amount of noise generated by a large air conditioner (Martin II, 2013). There are recommendations for the placement of inverters that allow the system to be far quieter for anyone living or working nearby, such as in an area that is not in direct sunlight that would heat up the inverter, making it work inefficiently. Overall, however, solar panels reduce noise pollution through their quiet operation and replace otherwise noisy energy assets (LG, n.d.). The noise that is generated from solar modules or inverters in addition to a building's noise is overall not overly disruptive.

Can solar panels cause cancer to nearby residents?

The process of energy generation from solar panels happens when photons from solar energy excite the electrons of the semiconductor and allow them to move freely (University of Bologna, 2006). The creation of an electric field from this process allows electrical generation to take place and energy to be used that has been generated by solar panels. Overall, the "collection" of any solar energy that falls on the panel does not interact in any way with the surrounding environment, aside from electricity moving into wires, converters, and the system at large. This process is passive and does not generate any carcinogens. Many who believe the falsehood that solar panels can cause cancer may be confusing the idea that UV radiation from the sun has been known to lead to skin cancers (Mancebo & Wang, 2014). The good news is that solar panels have nothing to do with this process, and the use of sunscreen, as well as coverings such as hats and other clothing, can do a lot to mitigate exposure to harmful UV rays. In summary, solar panels are not only useful clean energy options but they are also quiet and safe for everyone.

Can solar panels cause a distracting amount of glare?

The idea that solar panels can cause a large amount of glare is a common misconception about the technology. Solar PV systems can produce glint and glare at times, but in relation to other surfaces they are far less distracting. Indeed, they have less reflectivity than soil or wood shingles (Meister Consultants Group, 2014). For some time, it was commonly required that solar developers perform glare studies for nearby airports. This went out of practice when further research determined that the glare created was negligible (Day & Mow, 2018). An important point to remember about solar photovoltaic systems is that their main mechanism involves the absorption of light, not the reflection of light. This means that photovoltaic panels, usually dark blue or black in color, are typically sprayed with anti-reflective coatings and are made to absorb as much energy as possible, not reflect it (Meister Consultants Group, 2014). For this reason, photovoltaic solar panels do not cause any more glare than an organic surface like soil would. This is not the case for **Concentrated Solar Power (CSP)** systems, however, which work by reflecting light. These systems are most typically used in deserts and dry, remote areas, not in places where residential and commercial projects, such as those in the Genesee-Finger Lakes region, would be built. Thus, CSP systems are not relevant to this evaluation.

***Figure 9*. Solar panels are typically dark blue or black and have a low albedo**

Will wind or solar energy be depleted in the foreseeable future?

There is a misconception that sunlight or wind can be depleted by the operation of solar photovoltaic panels or wind turbines. There is no means by which these technologies can deplete the sources of their power. The astronomical scale of time that our sun will continue to be converting mass into energy is far past any human scale of time that we can comprehend. Sunlight reaches Earth through **nuclear fusion**, when lighter elements are forced together to become heavier elements and hydrogen is converted to helium at the core of the sun (Infrared Processing and Analysis Center at Caltech, n.d.). This solar radiation, emitted by the sun, is captured by photovoltaic panels and converted into electricity, or, in the case of solar water heaters, to heat (Department of Energy Solar Energy Technologies Office, 2013). Wind energy is more diffused and complicated to understand, but essentially wind is the motion of air molecules. Minute changes in air pressure, temperature, humidity, solar radiation, and the rotation of the earth, as well as barriers like mountains and large bodies of water, can result in changes in wind speed, direction, and more. The wind's direction and speed essentially determine how much or how little energy that wind turbines will generate through mechanical power (Department of Energy Wind Technologies Office, n.d.). The conclusion we can draw is that wind energy will never be depleted if Earth still has an atmosphere to contain the air that we breathe. In summary, these two power sources are called "renewable energy" because the sources of their energy generation will never, in our human lifetimes, be depleted.

Mitigating the Concerns of the Clean Energy Transition

Solar and wind energy are tremendous resources for generating clean and sustainable electricity without pollution or greenhouse gas emissions. However, these clean sources of energy, especially on a grand scale such as utility solar or wind, do not come without some minor negative environmental and economic impacts. There are several potential impacts associated with the clean energy transition if not mitigated especially during installation and decommissioning. Nevertheless, it must be noted that, compared to utilizing fossil fuel energy sources, which pollute our air with sulfur dioxide, harmful particulate matter, heavy metals, release greenhouse gases into the atmosphere, contaminate our water, and destroy environments and habitats during extraction and use, the benefits of deploying solar and wind technologies greatly outweigh their relative marginal concerns.

Land and Water Use Impacts

Depending on their location, larger utility-scale solar facilities can raise concerns about land degradation, deforestation, and habitat loss. Total land area requirements vary depending on the technology, the topography of the site, and the intensity of the solar resource. Estimates for utility-scale solar systems range from 3.5 to 10 acres per MW of electricity generated (Ong, Campbell, Denholm, & Margolis, 2013). Unlike wind facilities, there is less opportunity for traditional ground mounted solar projects to share land with agricultural uses. However, modern photovoltaic mounting structures are beginning to make it possible for grazing opportunities and some agriculture to be developed alongside solar. Generally, land impacts from utility-scale solar systems can be minimized by siting them at lower-quality locations, such as infertile and depleted land, **brownfields**, abandoned mining land, and existing transportation and transmission corridors. If solar developers are not financially incentivized to build on these lower-quality locations, they may choose to clear forested lands. Tree clearing within the region to protect the natural landscapes can be reduced by use of governmental restrictions and fees for cutting down tracts. Smaller scale solar photovoltaic arrays, which can be built on homes, parking lots, and commercial buildings, also have minimal to no land use impact.

The land use impact of wind power facilities varies substantially depending on the site. Wind turbines placed in flat areas like the Genesee-Finger Lakes region would typically use more land than those located in hilly areas. This is because wind making its way over hilly terrain recovers its power potential more quickly as it moves from turbine to turbine (Dorminey, 2012). However, wind turbines do not occupy all this land; they must be spaced approximately five to ten rotor diameters apart. Thus, the turbines themselves and the surrounding infrastructure, including roads and transmission lines, occupy a small portion of the total area of a wind facility (Ong, Campbell, Denholm, & Margolis, 2013).

A survey by the National Renewable Energy Laboratory of large wind facilities in the United States found that they use between 30 and 141 acres per MW of power output capacity (a typical new utility-scale wind turbine is about 2 MW). However, less than 1 acre per MW is disturbed permanently and less than 3.5 acres per MW are disturbed temporarily during construction. The remainder of the land can be used for a variety of other productive purposes, including livestock grazing, agriculture, highways, and hiking trails. Alternatively, wind facilities can be sited on **brownfields**, abandoned or underused industrial land, and other commercial and industrial locations, which significantly reduces concerns about land use (Ong, Campbell, Denholm, & Margolis, 2013).

Offshore wind facilities require larger amounts of space because the turbines and blades are bigger than their land-based counterparts. Depending on their location, such offshore installations may compete with a variety of other lake activities during construction, such as fishing, recreational activities, navigation, and aquaculture. Employing best practices in planning and siting can help minimize potential land use impacts of offshore and land-based wind projects (Ong, Campbell, Denholm, & Margolis, 2013).

***Figure 10.* A 2.56 MW solar project in Saratoga Springs**

Another concern around the deployment of solar is potential water scarcity or impact on water needs for the region. Solar photovoltaic panels do not use water for generating electricity; however, water may be needed for regular cleaning and washing down of the panels to maintain optimal output. This could tax local water resources, especially in areas with limited capacity; but for the Genesee-Finger Lakes region, an area with an ample supply of water and year round precipitation, the need for cleaning may be needed less than annually so this should not be a concern (Solar Energy Industries Association (SEIA), n.d., d).

Aesthetic Concerns of the Clean Energy Transition

An examination of recent environmental assessments for proposed utility-scale solar facilities around the country suggests that stakeholders are increasingly raising the potential negative scenic impacts of solar facilities as a concern, and some local governments are restricting commercial solar energy development specifically to protect these scenic resources. When looking at the primary components of a solar farm, which consists of photovoltaic panels, a possible method to mitigate the aesthetic concerns is to require a Visual Impact Assessment and screening (Department of Energy, 2013). This can be used to determine if the solar array will be visible from surrounding areas and where it might be a screen of trees maybe planted to hide it from view. Glare from solar photovoltaic panels is also commonly cited as a concern however, that is not the case for photovoltaic panels, which are designed to absorb light and actually create less glare than glass windows or bodies of water (Day & Mow, 2018). Visual impacts depending on the type of the scheme and the surroundings of the solar panels can be mitigated by strategically designed landscaping.

When it comes to aesthetics, wind turbines can elicit strong reactions. To some people, they are graceful sculptures; to others, they are eyesores that compromise the natural landscape (Good, 2006). Many people are concerned about the economic impact such structures may have on the tourism industry. The Genesee-Finger Lakes region, which has a vibrant tourism industry, also has similar concerns. Tourism impact studies around the world have found that villages near solar farms do not experience any decline in tourism. To the contrary, there is evidence that the local economy received a boost by the greater numbers of visitors who visit these facilities. Building educational centers to inform visitors about the transition can become an additional attraction for those looking to see firsthand how these facilities operate (Prinsloo, 2015).

Reliability and Inefficiency

Since solar energy relies on the sun and electricity cannot be generated during the night, solar is considered a variable source of energy generation. It requires either excess energy made during the day to be stored or to connect to an alternate power source, such as the local utility grid at night (Renewable Resources Coalition, 2016). On a residential and commercial scale buildings are always connected to the grid and typically systems can be sized to generate enough excess power during the day that can be sold and offset the cost of electricity consumed at night. Similarly the amount of energy produced can also be lower during overcast days due to less light reaching the system especially during winter months in regions like the Genesee-Finger Lakes, but solar systems can be designed to generate enough excess power to be sold during the summer to compensate for cost of electricity used when the sun is less available. Utility scale solar systems are interconnected directly to the grid and grid operators are experienced in handling fluctuating supply and demand of electricity through use of power electronics. In many cases grid operators can use solar assets to increase grid reliability and efficiency because inverters have the capability to adjust frequency and voltage on demand. Additionally, battery energy storage can help grid operators with solving peak capacity issues rather than building expensive fossil fuel peaker power plant assets and keeping them operating to meet those peak demands. Battery storage can also offer ancillary such as black start in power outages and provide other valuable grid support services denoted in the Identifying Suitable Sustainable Energy Technologies section of this report.

With respect to inefficiency, according to the Qualitative Reasoning Group with Northwestern University, most residential solar converts 14 percent of available energy into power and today's most efficient solar panels convert 22 percent of their available energy into power (Renewable Resources Coalition, 2016). While these values may seem low it must be noted that that efficiency percentage is based on the amount of free and abundantly available energy irradiated from the sun to an equivalent area of land to the collector area of the solar panel. To generate more power more land does need to be occupied by solar, but to put things into context, less than a quarter of Arizona (21,250 square miles of land) would be needed to power the entire United States (4 petawatt hours of electricity annually) (Nussey, 2018). Also, when comparing land use per gigawatt hour of energy generated, the land requirement for surface coal mining in the U.S. is 320 square meters per gigawatt hour compared to 310 square meters per gigawatt hour of energy generated by solar in the South Western U.S. (Earth and Environmental Engineering Department at Columbia University, n.d.). To overcome the reliability limitations, battery storage systems must be built as part of the solar farm in order to store the power for reuse.

Hazardous materials

While solar photovoltaic technologies provide the environmental benefit of zero emissions during their use, the heavy metals present in thin-film photovoltaic cells raises important health and environmental concerns regarding the end-of-life disposal of photovoltaic panels. Thin-film photovoltaic cells contain more toxic materials than those used in traditional silicon photovoltaic cells, including gallium arsenide, copper-indium-gallium-diselenide, and cadmium- telluride (Cyrs, et al., 2014). The majority of the industry does employ silicon photovoltaic panels, but the thin-film market share is expected to grow and the possibility of an accidental release of the chemicals from a thin cell solar cell module to the soil and groundwater may pose a threat to the environment (Thin Film Solar PV Market - Growth, Trends, and Forecast (2020 - 2025), 2019). There may be concerns with possible contamination from emergency fires and/or if they are not handled and disposed of properly because some materials used in thin-film photovoltaic technology could pose environmental and public health risks. According to a report by the United Nations International Renewable Energy Agency (IRENA) “there will be 60 million tons of cumulative solar photovoltaic waste by 2050,” (Brown, 2018). To date, there is no published quantitative assessment of the potential human health risk due to cadmium leaching from cadmium telluride (thin film) photovoltaic panels disposed of in a landfill. Thin-film solar manufacturers like FirstSolar build their panels with encapsulation that can handle extreme impacts like that from a landfill compactor and fires which seal any hazardous materials from leaching into the ground or air (The Virginia Center for Coal and Energy Research, 2019). Additionally, manufacturers have a strong financial incentive to ensure that these highly valuable and often rare materials are recycled using existing known processes rather than thrown away.

***Figure 11.* Solar panels can be disposed of improperly but there are specialty recyclers that know how to extract elements like silicon, silver and Copper.**

Given the potential costs of decommissioning and land reclamation, it is reasonable for landowners and local governments to proactively consider system removal guarantees. Often requiring a decommissioning bond, will guarantee that at the cessation of the energy producing activities or, at the end of the energy output life of a project, the panels are properly removed and disposed of. This way, an annual bond or multi-year prepaid bond can be in place to disassemble the energy project and restore the property to its original condition in the event that the developer does not do so as agreed either by state law, local ordinance, or as outlined in the original agreement with the lessor.

Heat Island Effect from Utility Scale Solar

The large-scale utilization of land by solar farms can also affect the thermal balance of the area by absorbing more energy than otherwise would be reflected by the surface of the Earth back to space (Lindeijer, 2000). Large-scale solar power plants are being built at a rapid rate and will inevitably use hundreds of thousands of acres of land surface. A concern that comes with this implementation is that more heat will be trapped in proximity to these farms. What should be the concerns, if any, of this situation? To answer this question, rigorous computational fluid dynamics (CFD) simulation capabilities for modeling the air velocity, turbulence, and energy flow fields induced by large solar farms are used to model the potential impacts of solar farms on local microclimate. Using the CFD codes Ansys CFX and Fluent, detailed 3-D simulations of a 1 MW section of a solar farm in North America were performed and the results compared with recorded wind and temperature field data from the whole solar farm. Both the field data and the simulations show that the annual average of air temperatures in the center of the solar photovoltaic field can reach up to 1.9°C (3.42°F) above ambient temperature, and that this thermal energy completely dissipates to the environment at heights of five to eighteen meters. The data shows a prompt dissipation of thermal energy with distance from the solar farm, with air temperatures approaching the ambient temperature at about 300 meters away from the perimeter of the solar farm. Analysis of eighteen months of detailed data showed that on most days, the solar array was completely cooled at night, and, thus, it is unlikely that a heat island effect could occur (Fthenakis & Yu, 2013).

High Electricity Prices

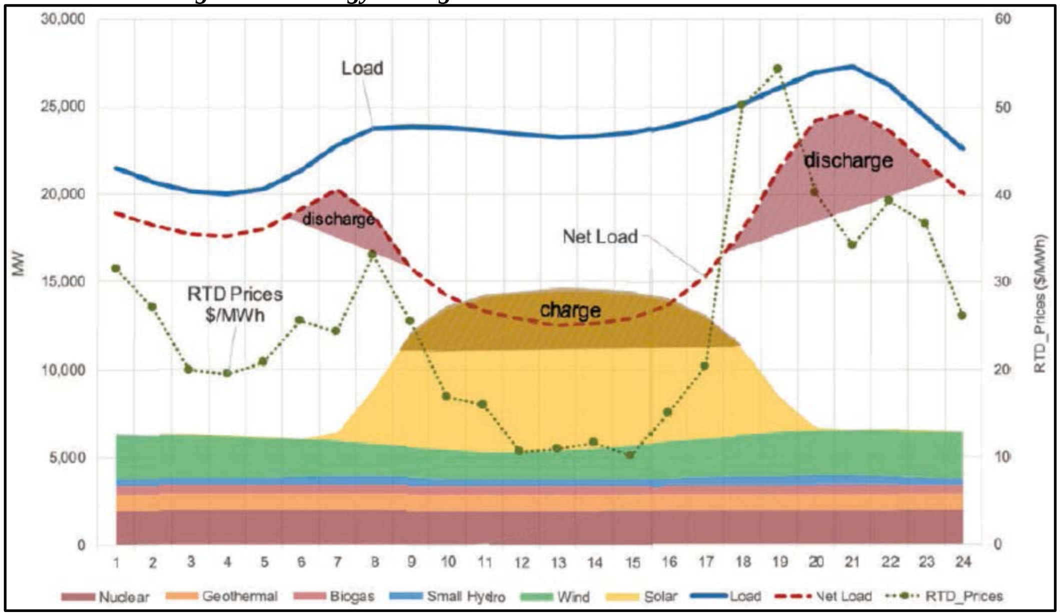
A common perception is that renewable energy comes from the sun and is therefore cheaper than fossil fuel generation plants. It is, in fact, a little more complicated than this. Between 2009 and 2017, the price of deploying solar panels per watt declined by 75 percent while the price of deploying wind turbines per watt declined by 50 percent. During this same period, the price of electricity in some places that deployed significant quantities of renewables seemed to have increased. For example, California electricity prices increased 24 percent during its solar energy build-out from 2011 to 2017 (Shellenberger, 2018b).

If the cost of deploying solar panels and wind turbines became so much cheaper, why did the price of electricity rise instead of decline? One hypothesis might be that while electricity from solar and wind became cheaper, other energy sources like coal, nuclear, and natural gas became more expensive, eliminating any savings and raising the overall price of electricity. But, again, that's not what seemed to have happened. The price of natural gas declined by 72 percent in the U.S. between 2009 and 2016 due to the fracking revolution. The price of nuclear and coal has remained constant during the same period and was mostly flat.

Another hypothesis might be that the closure of nuclear plants resulted in higher energy prices. Evidence for this hypothesis comes from the fact that nuclear energy leaders Illinois, France, Sweden, and South Korea enjoy some of the cheapest electricity in the world. Since 2010, California has closed one nuclear plant (2,140 MW installed capacity). Yet electricity in Illinois is 42 percent cheaper than electricity in California. But this hypothesis is undermined by the fact that the price of the main replacement fuels, natural gas and coal, remained low, despite increased demand for those two fuels in California. That leaves us with solar and wind as the key suspects behind higher electricity prices (Shellenberger, 2018a).

But why would cheaper solar panels and wind turbines make electricity more expensive? The reason is their fundamentally variable nature. Solar and wind produce more energy when demand is lower and often do not match up with demand when it is highest throughout the day. In order to shift the demand curve and keep electricity prices stable, energy storage deployment plays a vital role to make up for the loss in production when demand peaks towards the late afternoon into the evening and when solar production falls as the sunsets, otherwise known as the duck curve, see Figure 12 (Office of Energy Efficiency and Renewable Energy, 2017).

Figure 12. Energy Storage and How it Addresses the Duck Curve



Public Health and Community

Sound and visual impact are the two main public health and community concerns associated with operating wind turbines. Most of the sound generated by wind turbines is aerodynamic, caused by the movement of turbine blades through the air. There is also mechanical sound generated by the turbine itself. Overall sound levels depend on turbine design and wind speed.

Some people living close to wind facilities have complained about sound and vibration issues, but industry and government-sponsored studies in Canada and Australia have found that these issues do not adversely impact public health. However, it is important for wind turbine developers to take these community concerns seriously by following “good neighbor” best practices for siting turbines and initiating open dialogue with affected community members. Additionally, technological advances, such as minimizing blade surface imperfections and using sound-absorbent materials, can reduce wind turbine noise (Jeffery, Krogh, & Horner, 2013). Under certain lighting conditions, wind turbines can create an effect known as shadow flicker. This annoyance can be minimized with careful siting, by planting trees or installing window awnings, or by curtailing wind turbine operations when certain lighting conditions exist (Office of Energy Efficiency & Renewable Energy, n.d., c).

The Federal Aviation Administration requires that large wind turbines, like all structures over 200 feet high, have white or red lights for aviation safety. However, the FAA recently determined that if there are no gaps in lighting greater than a half-mile, it is not necessary to light each tower in a multi-turbine wind project. Daytime lighting is also unnecessary if the turbines are painted white (FAA, 2015).

Implementing the Clean Energy Transition

Identifying Suitable Clean Energy Technologies

Looking at the technologies involved in transitioning the Genesee-Finger Lakes region to clean, sustainable energy, our team broke down the region's energy dynamics into three major categories: Generation and Transmission, Consumption and Efficiency, and Transportation. Currently the majority of Upstate New York's power generation is derived from hydroelectricity and nuclear power. While both hydroelectricity and nuclear power are zero emissions technologies, nuclear can be controversial and hydroelectricity potential has already been mostly utilized, and both primarily provide baseload power.

For this reason, the focus of this report is on other alternative renewable energy generation technologies that may be able to transition intermediate and peaker power plants away from fossil fuel sources. In particular through the use of solar, but also with some insight into wind potential in the region as well as a discussion on how battery energy storage technology fits in. The report also discusses the use of biodigesters, a technology that could be complementary to the region's agricultural industry and the creation of a new source of biofuel. It then examines the importance of energy-efficient technologies like LED lights, EnergyStar appliances, and air- and ground-source heat pumps. The section concludes with a look at electrified transportation technology, such as electric vehicles (EVs) and EV charging stations.

Generation & Utility Grid Distribution

Photovoltaic Solar

Solar energy is renewable, available, abundant, non-polluting, low-maintenance, and does not emit greenhouse gases during operation. Photovoltaic solar energy involves the direct conversion of solar radiation into electricity. Photovoltaic solar systems are typically sized for residential scale around 10kW, commercial scale between 100kW-1MW, and utility scale less than 1MW applications. Concentrated Solar Power is another means of energy generation using solar radiation, but it is excluded from the guide as it is not relevant to this region.

Residential scale systems are usually installed on the roofs of homes to offset a homeowner's electrical usage (Department of Energy, n.d., a). There are many financing models available to homeowners to fund these systems, whether as cash rebates, loans, leasing agreements, **Power Purchase Agreements (PPA)**, and more. The wide array of financing allows people to shift their power consumption to solar energy via a method that is most suitable to their financial situation. Often homeowners can save and profit from having an array installed, though this depends on their local incentive programs, utility rates, and the physical constraints of their property's size.

Similarly, commercial, municipal, and industrial energy consumers can use larger, behind-the-meter interconnected systems to reap the financial benefits of solar. These are often installed in rooftop, ground mount, or carport configurations based on their available property (Solar Energy Industries Association (SEIA), 2015). Utility-scale systems frequently are built on larger land parcels, for instance on large residential, commercial, or federal property where the owners can lease or sell their land to a solar developer to build a system (Nextracker, 2016). These systems will usually interconnect in front of the meter directly into the grid and sell the generation either via a community solar program at a retail rate or straight to utility providers at a wholesale rate via PPA agreements or **SRECs**.

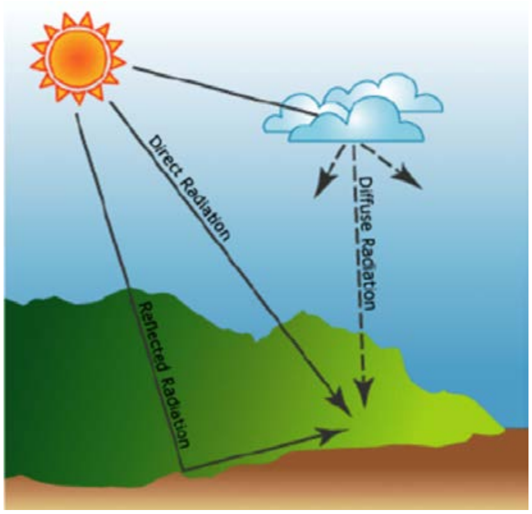
Figure 13. **Residential solar**

Figure 14. **Commercial solar**

Figure 15. **Utility-scale solar**

Some of the major geographical site conditions and parameters that are taken into consideration when planning a solar project are solar resource potential, weather, local environment, surface orientation, and landscape (Smalley, 2015). Solar resource potential is one of the most important variables to consider for site selection, since solar resource and power production are so tightly coupled. At a high level this is first measured as **Global Horizontal Irradiation (GHI)**, or the total amount of shortwave radiation received from above (the sun) by a horizontal surface. GHI encompasses three major components: Direct Normal Irradiation (DNI, direct line of site to the sun), Diffuse Horizontal Irradiance (DIF, scattered light through particles in the atmosphere like clouds), and ground-reflected radiation (often called **albedo**, it is the light that is reflected by surrounding surfaces) (esri, n.d.). See Figure 16 for a visualization of these processes.

Figure 16. **Direct, Reflected, and Diffuse Solar Radiation.**



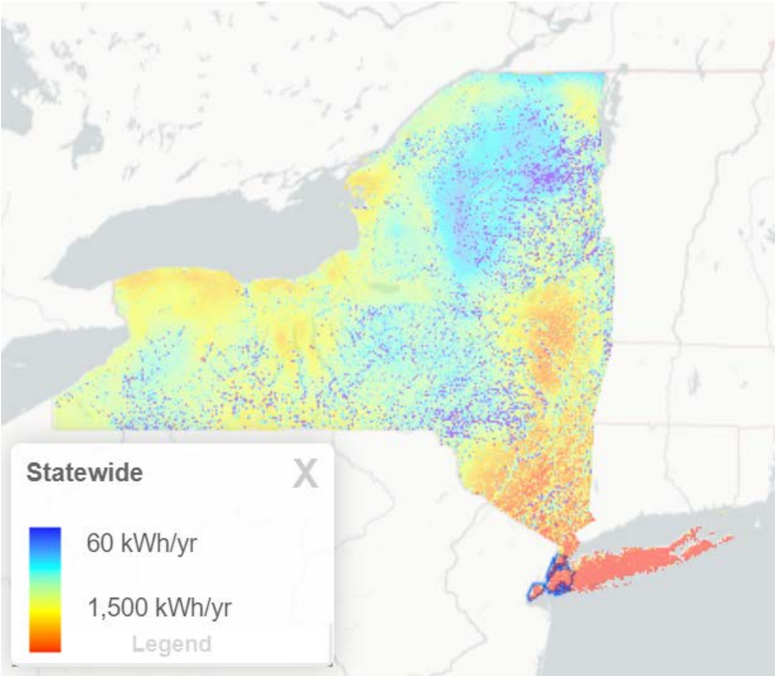
Weather & Regional Environment

Some major meteorological variables important to consider are ambient temperatures, cloud cover or fog, air density, wind, and snow or rainfall. At higher temperatures there is a drop in solar energy output because internal electrical resistance increases with higher temperature, so colder climates are better for solar production. Dense cloud cover and fog can diffuse sunlight and have a significant negative impact on annual solar production. Thin air is ideal for solar power since denser air scatters sunlight. Thus, sites at higher elevations rather than locations at or below sea level are better for solar production.

In the same respect to air particles from nature, clean air is also important because artificial air pollution can scatter light. Snow is a major weather factor to consider because a persistent thick layer of snow on the solar panels can impact solar production negatively. Additionally, regions with high accumulations of snow will have higher mounting structure costs associated with raising the panels so the lower panels are not covered by snow that has accumulated on the ground. However, small amounts of snowfall that melts off the panels rather than significantly accumulating on them while remaining frozen on the ground could be beneficial. This is because the amount of reflected light, or albedo, will aid production especially if bi-facial solar modules (modules with a photovoltaic backing in addition to its front side) are used, as reflected light is beneficial in the winter when there is less daylight. Rainfall also affects functionality, as frequent rainy weather will negatively impact solar production, although occasional rainfall may be beneficial because it reduces the operations and maintenance costs of seasonally cleaning the modules. Lastly, wind is also a factor to be considered. Mounting structures are designed to withstand regional uplift wind speeds of typically 80 mph or more but at higher wind speeds additional mounting structure engineering, procurement, and construction costs may be involved (Action AC, 2016).

Taking into account these weather and environmental factors, Figure 17, created through Sustainable CUNY's NY Solar Map utility, shows that the Finger Lakes region has typically greater than 1300 kWh/year solar potential and is one of the better areas within New York state for solar to be deployed (NY Solar Map, 2020).

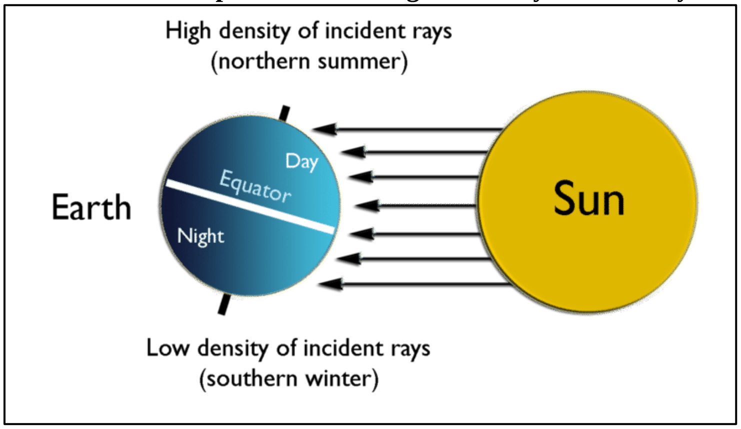
Figure 17. **Map of NY Solar Potential.**



Latitude, Slope, and Orientation

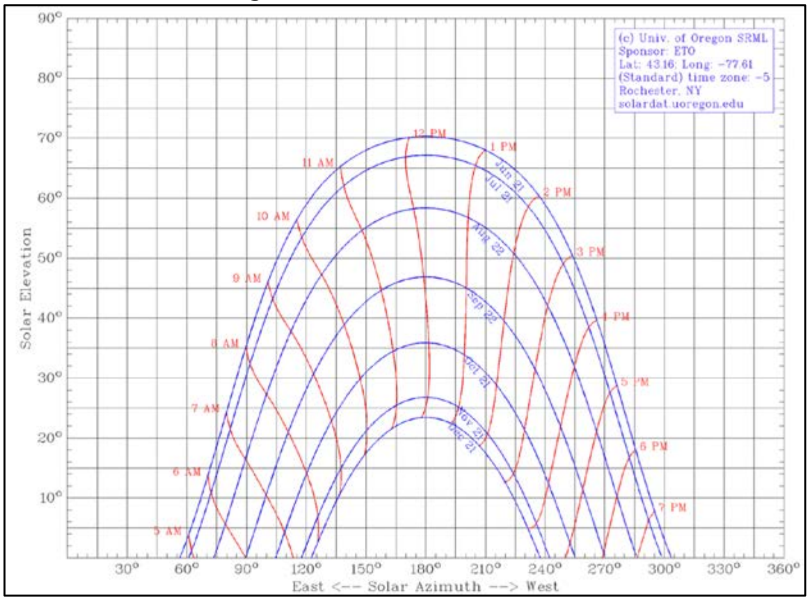
Latitude, slope, and orientation all play a major role in solar power generation. The latitude of a site has a significant impact on annual production because the total energy received each day at the top of the atmosphere dynamically changes with the orbit of the earth around the sun. The highest daily amounts of incoming energy occur in summer, when the days are long. This is because the northern hemisphere receives higher density incident rays during this time of year, which is advantageous since electrical consumption typically increases in the summer due to increased energy usage from air conditioning.

Figure 18. **The northern hemisphere receives higher density incident rays in the summer**



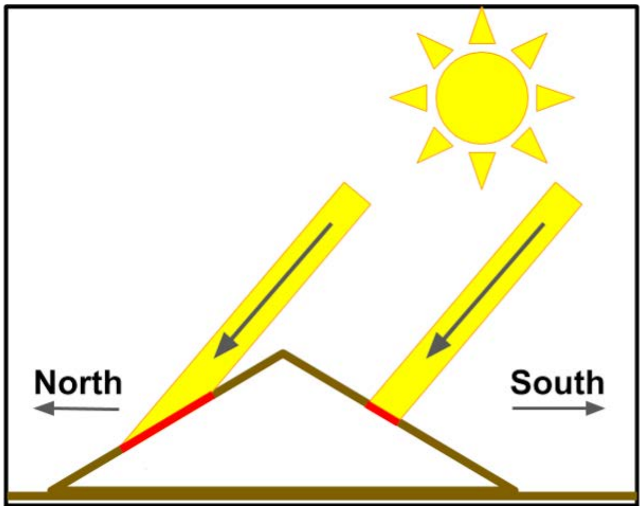
A common rule of thumb in the solar industry is to tilt modules as close to the degree of latitude as possible, which has less of an impact on production than **azimuth**. Since New York is at latitudes between 40°N and 45°N, this optimizes for annual DNI with respect to solar elevation, as demonstrated in Figure 18. Another general practice involves facing the module array as close to due south or 0° azimuth as possible, which has a higher impact on production than tilt does, to optimize for annual incident DNI at noon daily, when the sun is highest in the sky. This optimal azimuth direction is south in the northern hemisphere because the sun rises in the east and sets in the west on the southern half of the sky towards the equator. This is also depicted by the sun path in Figure 19, which has been generated specifically for Rochester, NY, using a tool created by the University of Oregon.

Figure 19. **Sun Chart for Rochester, NY**



Looking at these three major parameters, it is understandable that the Genesee-Finger Lakes region, with its plentiful south-facing slopes, is favorable to solar. Not only do the south-facing slopes aid in directing solar arrays in the optimal azimuth and tilt, but they also aid in reducing shading from the landscape. North-facing slopes get significantly less DNI and experience more shading.

Figure 20. **Solar DNI is more concentrated and has a lower horizon line on south facing slopes.**



Wind Energy

Wind energy is an alternative form of solar energy, as it captures the uneven heating of the atmosphere, variations in the earth's surface, and the rotation of the earth, all of which cause wind flow patterns. A wind turbine's propeller-like blades convert the kinetic energy in the wind to mechanical energy by turning a turbine rotor of a generator, which converts the mechanical energy to electricity.

Figure 21. **Internal components of horizontal-axis**

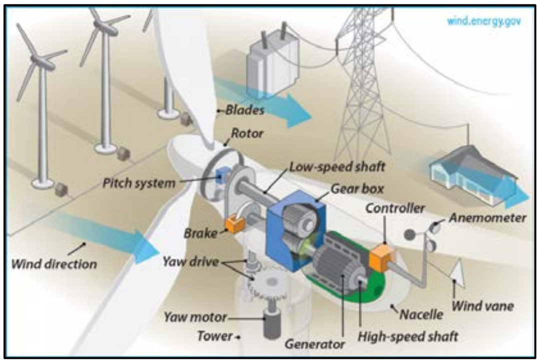
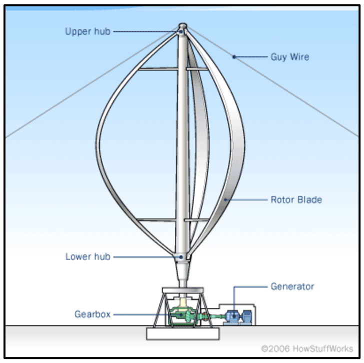


Figure 22. **Vertical-axis wind turbines.**



Two common types of wind turbines are horizontal axis turbines, which are most seen having three blades and directed to point into the wind, and vertical axis turbines, which come in several design varieties and are omnidirectional to the wind. Wind turbines can be built both on land and offshore and vary in size. Utility scale turbines can range from hundreds of kilowatts to several megawatts and are typically built offshore since there are less transportation challenges associated with moving their large components. The largest wind turbine model in the world as of 2019 is the GE 12MW Haliade-X, which has a rotor diameter of 220 meters in length. Large to medium wind turbines can also be grouped together into wind farms that can provide bulk power to the grid and can often be built on open farmland. Additionally, small wind turbines can be used for residential, agricultural, and small commercial applications and can aid in developing microgrids in remote off-grid locations, especially when paired with other distributed energy generation technologies like photovoltaics and energy storage batteries (Department of Energy Wind Technologies Office, 2020).

Figure 23. **Utility Scale offshore wind plant**

Figure 24. **Commercial Scale Wind Power**

Figure 25. **Residential Wind Turbine**

The three key factors involved in the amount of energy that a wind turbine can harness from the wind are wind speed, air density, and **swept area** of the turbine. Small changes in wind speed have a large impact on the amount of power available in the wind. Essentially the amount of energy in the wind varies with a cube of the wind speed, thus if the wind speed doubles there is eight times more energy available for wind turbines. The denser the air is, the more energy is available to wind turbines as well. Air density tends to vary with elevation and air temperature. Warm air is less dense than cool air and air gets less dense at higher elevations above sea level. Thus, lower elevations with cooler temperatures are optimal for producing wind power. A larger swept area, the area through which the rotor spins, allows the wind turbine to capture more energy. Since the area of a circle equates to pi times the radius of the circle, squared, a small increase in blade length can result in a large increase in the power available to the turbine (NREL, 2018).

Some of the major parameters involved in siting a wind farm development are wind resources, which are closely tied to wind speed and air density, distance from existing transmission lines with available hosting capacity, landscape geography and accessibility to the site, and available power purchaser markets. Factors very similar to solar, albeit unique to wind resources, make the Genesee-Finger Lakes area along the coast of Lake Ontario one of the better areas to develop wind projects, as shown in Figure 26 and 27 (Office of Energy Efficiency & Renewable Energy, n.d.).

Figure 26. **Average Wind Speed Heatmap across New York State**

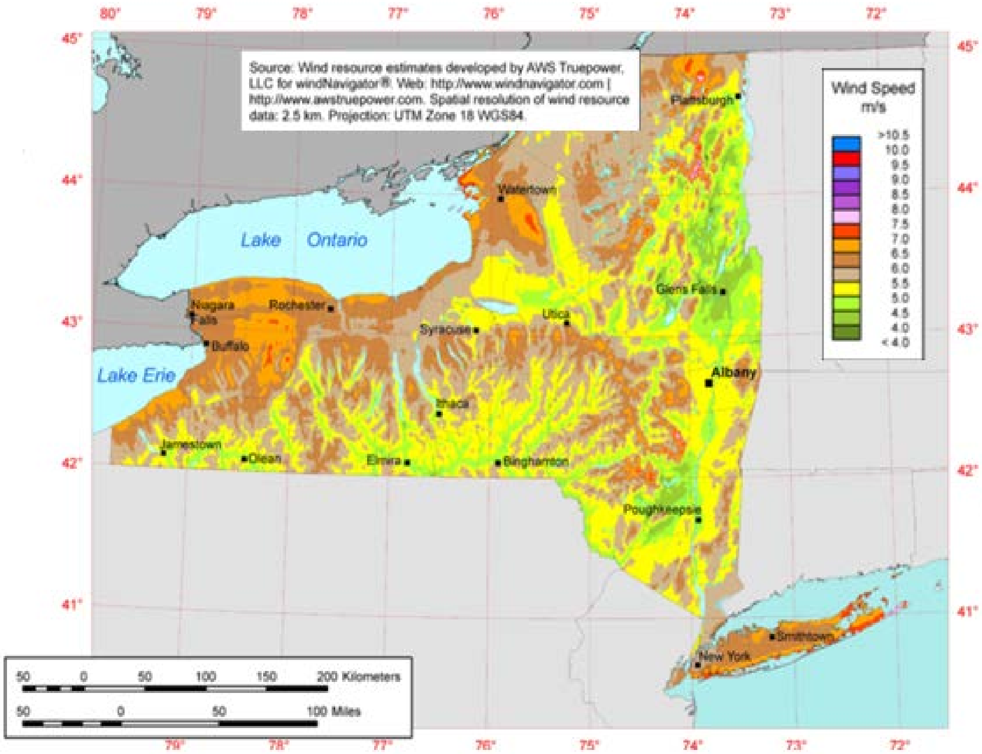
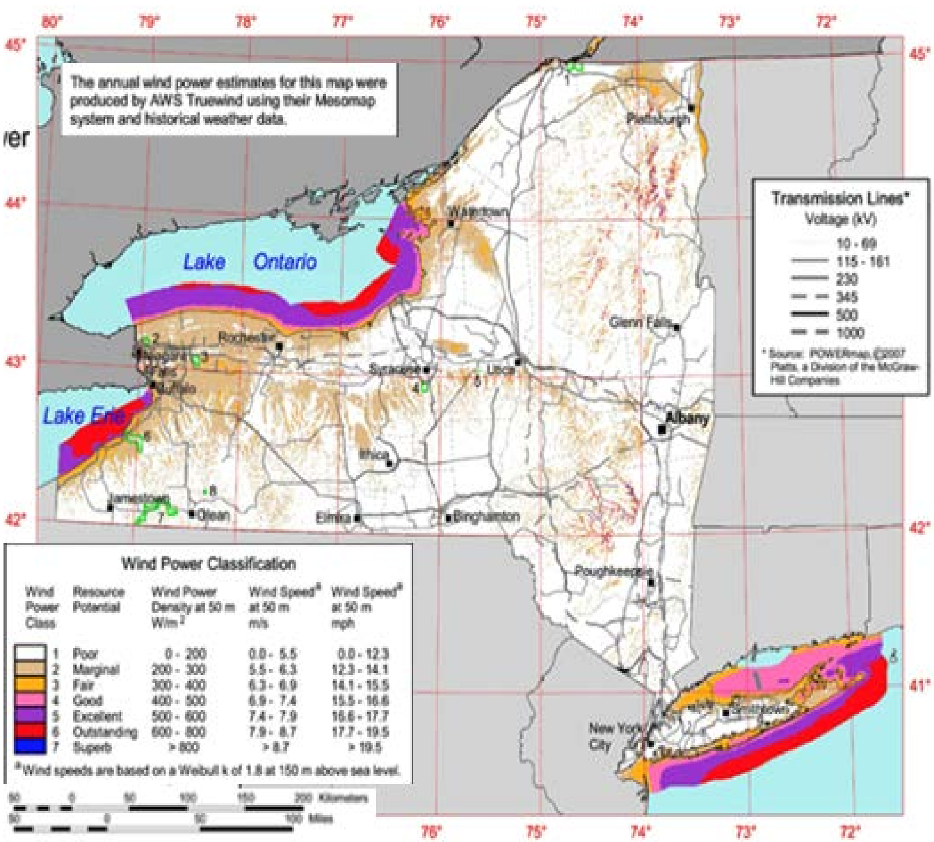


Figure 27. **Wind Resource Potential across New York State**

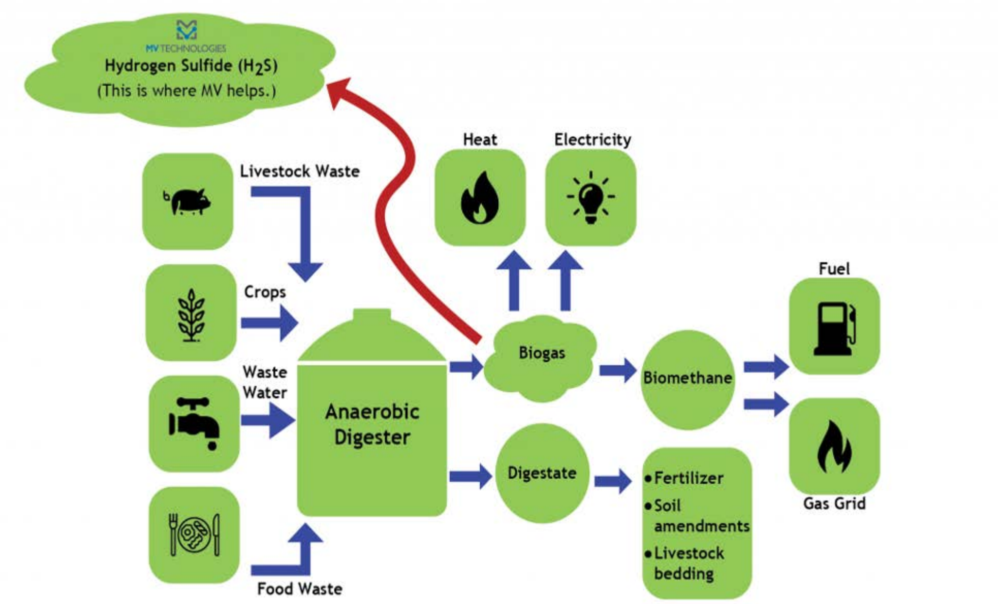


Anaerobic Digesters

New York is the nation's third-largest milk producer, and the Genesee-Finger Lakes region is home to many dairy farms. The more than 620,000 cows found in the state generate a large volume of waste, which currently is used for fertilizer for agricultural lands. Often, however, so much manure is produced that it gets washed away as runoff during rain storms or freezes in the winter, in both instances contaminating waterways. An alternative solution for waste manure is to repurpose it to produce a usable **biogas** in a process called **anaerobic digestion**.

Commonly used to breakdown sewage at water treatment facilities, anaerobic digestion is a naturally occurring process where, in the absence of oxygen, bacteria break down organic materials and produce biogas. It occurs in three steps. First, plant or animal matter is decomposed by bacteria into molecules, such as sugar. The decomposed matter is then converted to organic acids, which are then converted to methane gas, also called biogas. The by-products of the process include methane gas, organic solids, liquids, and small amounts of hydrogen sulfide (H_2S) gas. H_2S must be removed from the biogas before it can be used and sold as methane. Following this process, the biogas, the remaining organic solids, and liquids can be used in multiple ways, presenting both environmental and economic benefits. Figure 28 illustrates this concept as well.

***Figure 28*. Benefits and Uses of Anaerobic Digestion**



Energy Storage Systems (ESS)

The electrical grid that powers homes and businesses across the nation was initially built without a significant amount of energy storage. Instead, energy was produced at the instant that it was needed and was consumed as quickly as it was produced. Energy storage technologies have changed this and have made the adoption of renewable energy sources more cost efficient, while making the grid safer and offering several other benefits. Different energy storage technologies have traits suited for different power, energy, and discharge time applications, and there isn't really a single one-size-fits-all solution. In some situations, there are high power rapid response applications needed, while in others there are high energy and long duration needs, while some cases call for a blend of the two. See Appendix A for a visualization of this scale. However, there is a technology type available to fill all niche use cases. Energy storage can and should be deployed to improve the technical and economic performance, flexibility, and resilience of the electrical grid.

The most common energy storage technology associated directly with renewables is Battery Energy Storage Systems (BESS), a technology designed to store electrical charge using electrochemistry. Renewables and BESS systems are synergistic for the niche roles they can fulfill in the future energy grid. There are various types of batteries that can be used. Some of the most notable for grid-level, large-scale electrical energy storage are lead–acid, nickel–cadmium, nickel–metal hydride, sodium–sulfur, lithium-ion, and flow batteries, each of which have their own characteristic advantages and disadvantages, typically based around application. See Appendices B and C for further details.

BESS chemistry can be chosen based on the desired use case, as they can bring a vast array of value. This includes peak shaving and load leveling, which aid in balancing gaps in demand; ancillary services like voltage and frequency regulation, aiding grid stabilization; and providing emergency backup storage in the event of an outage, or even preventing one, and many other services as noted in Appendix D.

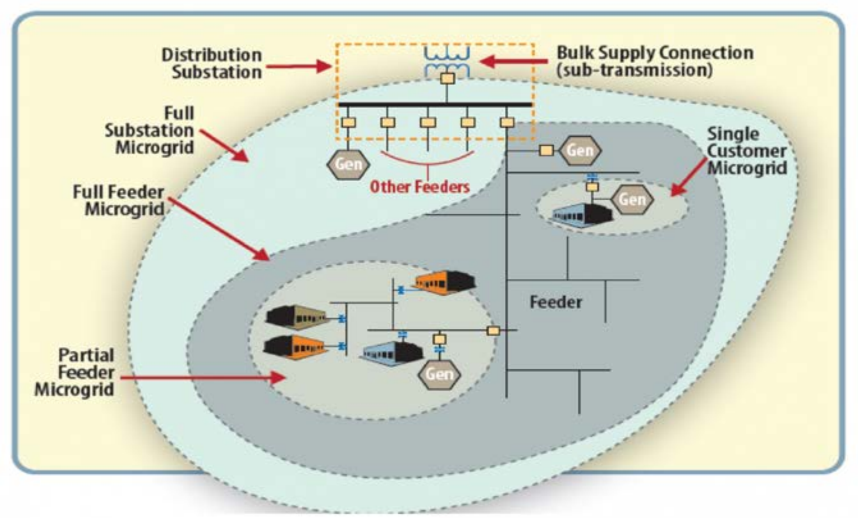
***Figure 29*. The State of Washington's Avista Utilities energy storage project involves a 1 MW, 3.2 MWh large-scale flow battery system**

Smart Grids & Microgrids

As renewable energy and energy storage technologies are added to the grid, there is an opportunity to add the additional necessary electrical equipment to prepare the transmission and distribution grid to be able to operate like a **smart grid** composed of tiers of **microgrids**.

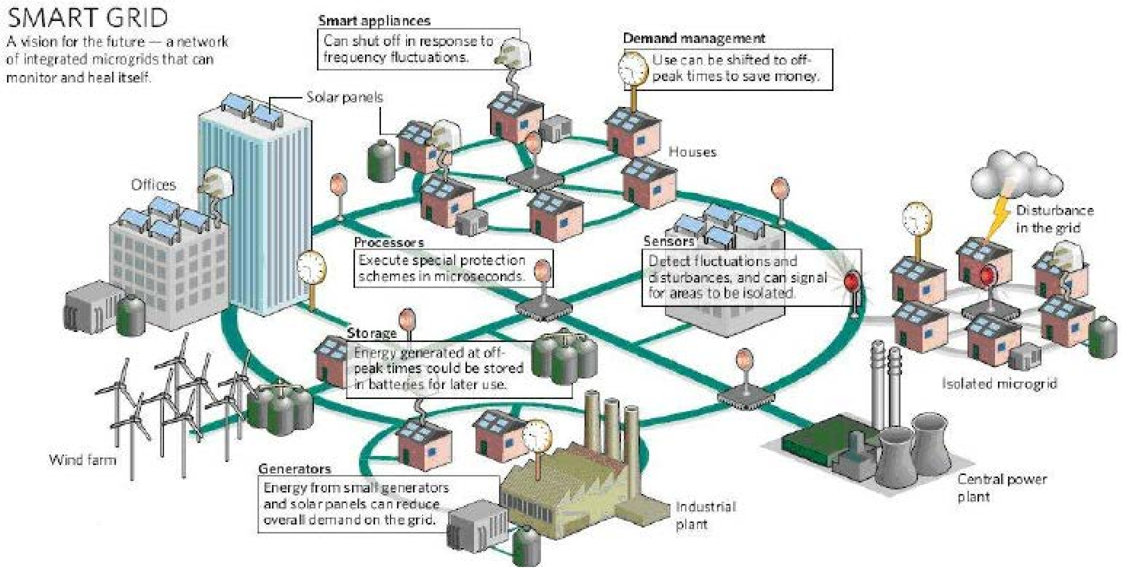
Microgrids are localized grids that can disconnect from the traditional grid to operate autonomously. Because they can operate while the main grid is down, microgrids can strengthen grid resilience and help mitigate grid disturbances as well as function as a grid resource for faster system response and recovery. Microgrids support a flexible and efficient electric grid by enabling the integration of growing deployments of distributed energy resources, such as renewables like solar. In addition, the use of local sources of energy to serve local loads helps to reduce energy losses in transmission and distribution, further increasing the efficiency of the electric delivery system. The additional resiliency of a smart microgrid can help communities better prepare for future weather events and aid the region in moving towards a clean energy future as renewable energy grid penetration increases (Office of Electricity Department of Energy, n.d.).

***Figure 30*. Example of Tiered Levels of Microgrids**



Smart grid technologies are made possible by two-way communication technologies, control systems, and computer processing. These advanced technologies include advanced sensors known as Phasor Measurement Units (PMUs). These sensors allow operators to assess grid stability as these advanced digital meters give consumers better information and automatically report outages. Relays that sense and recover from faults in the substation automatically are another key part of a smart grid. Additionally, automated feeder switches that reroute power around grid problems and batteries that store excess energy to make it available later to the grid, meeting customer demand, are integral to smart grid systems. Smart grids use a lot of network and communication equipment so care must be taken to protect against cyber threats (Office of Electricity Department of Energy, n.d.). As shown in Figure 31, a smart grid can be broken up into several microgrids which are then further layered as seen in Figure 30.

Figure 31. **How a Smart Grid made up of Microgrids operates**

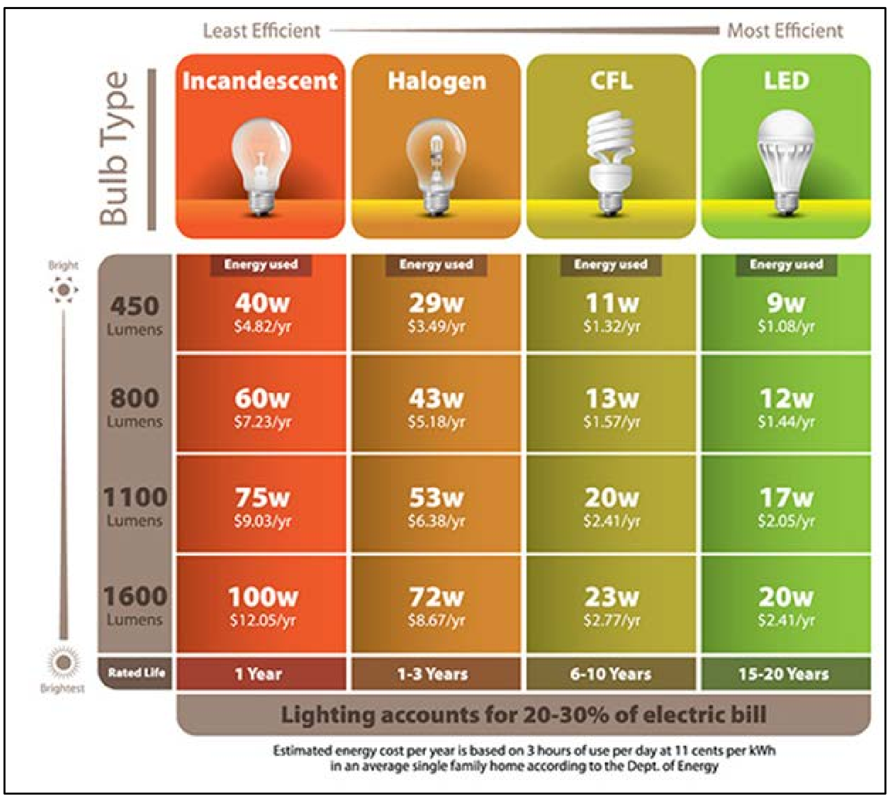


Energy Efficient Consumption

Moving onwards from generation and storage technologies that can aid the Genesee-Finger Lakes region in transitioning to a clean energy future, we look towards one of the most important parts that must occur in conjunction with renewable energy generation technologies: energy efficient consumption. Before adding new capacity, or while transitioning existing generation capacity, it is important to reduce the region's consumption demand through efficiency. Renewables and storage can be very effective at replacing antiquated fossil fuel technologies to power the community's energy needs, but less capital investments and new infrastructure need to be built to support those energy needs if they are upgraded to more efficient technologies, as the energy consuming apparatuses require replacement.

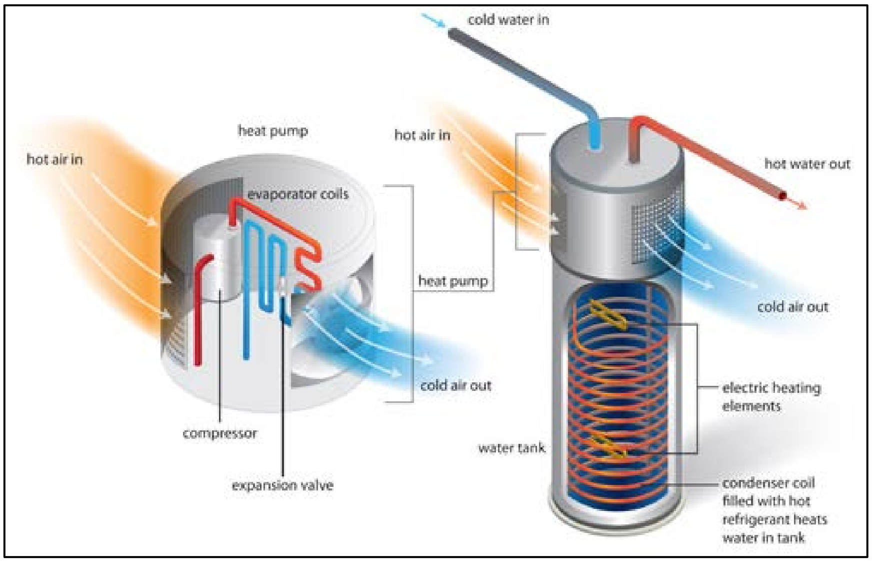
In terms of cost effectiveness, incandescent, halogen, and even fluorescent lighting can be upgraded to LEDs when they need to be replaced. This small change can have far-reaching energy efficiency and cost savings while reducing the frequency of bulb replacement and even providing a wider extent of functionality. LEDs can last up to 35 times longer than incandescent lights and 4 times as long than fluorescent lights. They also can produce more lumens per watt than either option; generate less waste heat; and can be dimmable, color programmable, and are designed to waste less light as they may be directed. Importantly, they do not contain mercury, which is a concern when it comes to the eventual disposal of these products.

Figure 32. **Lighting Technology Comparison**



Beyond lighting, energy intensive appliances, such as computers, refrigerators, dishwashers, heating and cooling systems, and televisions, can be upgraded to Energy Star-rated appliances when in need of replacement. Energy Star is a program run by the U.S. Environmental Protection Agency and the Department of Energy that provides information on the energy consumption of products and devices. Only products that meet criteria using standardized methods within their product category can carry the program's label. One example of a more efficient product is an air source heat pump water heater, as opposed to a purely electric or gas water heater that generates hot water at home. This product operates much like a refrigerator but in reverse: instead of sourcing all energy required to heat the water from electricity or natural gas, the heat pump takes heat from the ambient air and transfers it to water rather than using electricity to heat water. Air

***Figure 33*. Air Source Heat Pump Water Heater Heating Process**



source water heaters can be slightly higher in cost, but due to their higher efficiency, much like other energy efficiency technology upgrades, they generate significant savings over time.

Heating and cooling systems can be one of the most intensive uses of energy in a building. A geothermal or ground source heat pump can use the constant temperature of the earth as an exchange medium, as opposed to the external air temperature, making it significantly more energy efficient to alternative traditional heating and cooling systems. Depending on latitude, ground temperature tends to range from 45-75° F. This temperature is cooler than the air above it in the summer and warmer than the air above in the winter, and thus can be taken advantage of by using a ground heat exchanger. This is accomplished by pumping a thermal liquid solution that is carried via pipes called loops from the ground into a heat pump to move the heat to the desirable location, whether that be into the building from the ground or vice-versa from the building into the ground.

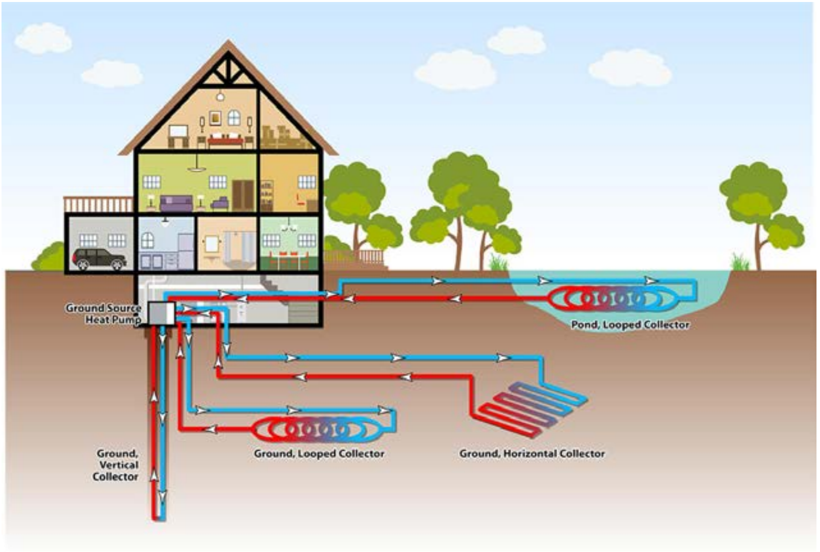
***Figure 34.* Cost Comparison of Common Water Heater Types**

Water Heater Type	Efficiency Rating	13-Year Cost
Conventional Gas Storage	0.60	$5,394
Condensing Gas Storage	0.86	$5,170
Conventional Elec Storage	0.90	$6,769
Elec Heat Pump Storage	2.20	$4,125
Tankless Gas	0.82	$4,925

Closed loop systems are typically vertical and require a 100 to 400-foot depth pit drilled down. These are usually in commercial applications, where land is not as widely available. If there is a wide area of land available where four to six-foot-deep pits could be dug to bury the loop, then the depth is not required. This system is often used in residential applications. Finally, the system could be established within a pond or lake eight feet below the surface. This system is the lowest cost. The heat pump, using the thermal liquid in its loops, transfers energy between the ambient temperature in the building and ground, equilibrating the two. The energy can be transferred into an existing standard central heating and cooling air duct system or be transferred throughout the building using a more advanced and efficient radiant heating distribution system.

Geothermal heat pumps last upwards of 25 years and are on average four times more energy efficient than conventional HVAC systems. In a well-insulated home, such a system can pay itself off in 5 to 10 years through energy cost savings (ComfortPro, 2014). New York state is a particularly good region to develop these ground source geothermal heating and cooling heat pump systems because of the available land for horizontal closed loops and drillable ground for vertical closed loops. There are companies currently working to bring a simplification of financing and installation of this system, so it is more available to the public starting with New York state (Dandelion Energy, n.d.).

Figure 35. **Ground Source/Geothermal Heating & Cooling Heat Pump System**



Since water heating and climate-control heating and cooling are using ground and air source heat pumps, which are powered by electricity, it may be possible to entirely abandon the need for fossil fuels. There essentially would not be a need to use natural gas if both heating and cooking were electrified by these different technologies. Essentially, energy-efficient technology paired with onsite renewable energy generation paves a way for buildings to become a **passive building** and incur little to no utility costs, especially when new construction is built with energy efficient insulation materials and windows.

Electrifying Transportation

The third large sector of the energy dynamic where adoption of modern technology plays an important role towards making the clean energy transition is transportation. Conventional Internal Combustion Engine Vehicles (ICEVs) require the continual use and replacement of crude oil products and fossil fuels, which are known to be environmentally hazardous substances that can harm humans and ecological life alike. Among these substances are engine oil, radiator fluid, brake fluid, power steering fluid, and transmission fluid. ICEVs also generate tailpipe emissions, including air pollutants such as hydrocarbons, nitrogen oxides, and particulate matter, along with carbon dioxide greenhouse gas emissions that are given off during operation. In addition, they require constant maintenance and replacement of many moving mechanical parts that experience wear and tear.

Electric Vehicles

Electric vehicles play a crucial role in transitioning towards a clean energy economy. They can obtain all their energy from renewables, whether from the grid or from an onsite renewable energy generation source. They also require minimal maintenance, using little to no substances that are consumed through operation or that need to be replaced, like timing belts, fuel filters, spark plugs, and emissions checks. The current electric vehicle market leader, Tesla, claims its technology has battery packs that can last upwards of 500,000 miles and can be replaced for $5,000-$7,000 dollars. Their vehicles also have a drivetrain that is designed to last an incredible 1,000,000 miles and battery coolant that lasts for the life of the vehicle. With so few mechanical parts that experience friction, impact, or combustion, these vehicles require little more than air filters, tires, suspension, brake fluid, and AC servicing, all significantly less frequently than that required by ICEVs. Amazingly, assuming normal use, it is claimed due to regenerative braking (where the energy to stop the vehicle charges the battery) that the brakes will not need to be replaced for the lifetime of the vehicle (Lambert, 2019).

***Figure 36*. ICEV vs EV Cost of Ownership Comparisons**

5 Year Cost of Ownership	Tesla Model 3	Toyota Camry LE	Audi A5
Purchase Price	$38,900	$24,600	$44,200
Financing	$2,765	$486	$3,180
Tax, Title and License	$3,025	$2,050	$5,405
Insurance	$5,640	$6,060	$8,080
Fuel/Electricity	$2,250	$8,140	$9,910
Maintenance/Repairs	$1,200	$4,000	$8,000
Total	$53,780	$45,336	$78,775
Resale Value	($18,988)	($8,905)	($18,564)
Total	$34,792	$36,431	$60,211
Cost Per Mile	$0.46	$0.49	$0.80

To put it more simply, an EV has around 20 moving parts in comparison to the 2000+ moving parts in an ICEV (Raftery, 2018). This directly puts the reliability and cost of ownership of EVs ahead of ICEVs and reduces their lifetime environmental impact. These advantages are only expected to improve over time with battery technology evolving as the capacity increases, EV costs falling, lifespans lengthening, and these vehicles becoming lighter and more powerful.

Additionally, the battery packs of EVs, once cycled to the point of having 80 percent capacity, where their use in an automotive application is diminished, can be reused at a discount for second-life stationary storage applications. These are mentioned in the grid scale energy storage applications section of Appendix D, and after that can still be recycled by means of closed loop supply chains.

Electric Vehicle technology can go beyond private passenger vehicle uses. There are already plug-in electric commuter buses, last-mile transportation, and scooters to electrify community level public transit, as well as commercial level utility electric vehicles. Expanding the use of electricity in public transportation can yield similar benefits to the private and public sectors as it could for individuals and families while simultaneously aiding the entire community in making the clean energy transition. EVs save money, reduce transportation's impact on the environment, and increase the quality of life for everyone in several ways, among them reducing the need to use personal vehicles, providing rapid forms of transit for short distances, and reducing traffic and noise, to name a few. EV applications can be expanded to delivery vehicles and ridesharing applications as well, creating new jobs. For example, in New York City there has been a boom in the use of EV bicycles, which has expanded to the restaurant take-out and delivery business.

A fleet of personal, commercial, and municipal EVs can directly compliment a renewable energy infrastructure on the grid to support it by reducing the need to build additional stationary energy storage systems to support them. While EVs are not in use (i.e. when people are working and their cars are not being used or at night when public transit and commercial vehicles are under less use) they can be plugged into the grid to support its demands and earn revenue for their owner and can be charged at times when electricity is cheaper autonomously.

Electric Vehicle Charging Stations

Among the stigmas surrounding electric vehicles are that they require a long charge time, have a short driving range, and lack a robust charging infrastructure to keep them charged. While many of these points may have been true when EVs were first introduced, the technology has come a long way since then, although there is still room for significant improvement. An example of the marked improvements that electric vehicles have gone through is the current Tesla Model S. This vehicle can fully charge for a range of 300 miles in 6 to 9 hours using a home charger or in 1 hour at a supercharger station, charging 80 percent in 30 minutes. The continually expanding supercharger infrastructure in 2020 includes 1,870 stations with 16,585 chargers conveniently located at commonly trafficked areas and point of interest corridors near helpful amenities like coffeeshops and travel plazas (Tesla, n.d.). Traditional car companies like GM are also making huge investments in EV technology and infrastructure, spending $20 billion in the next five years developing a next-generation fleet of all-electric vehicles (Wayland, 2020) and partnering with Bechtel to build thousands of EV charging stations across the United States (Valdes-Dapena, 2019).

***Figure 37*. Tesla Supercharger and Destination Charging Stations**

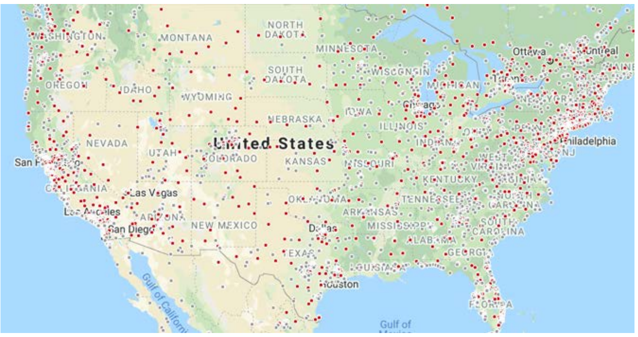


***Figure 38*. Logged Existing Public Charging Stations (excluding Tesla)**

Public transit buses also have substantially comparative metrics. They can already operate for 24 hours on a single charge, with battery packs of 550kWh. A fully loaded 40-foot electric bus can travel an average of 155 miles with air conditioning running. In regions without the need to use air conditioning a 60-foot articulated bus that can transport 120 passengers can travel 200 miles on a full charge (Austin, 2015).

When renewable energy technologies like solar, battery energy storage, and EV charging stations are combined, it may be possible to build charging stations that can optimize around solar availability and electricity prices to generate the highest return on investment and payback time. It may even be possible to construct completely off-grid charging stations as the technology evolves.

***Figure 39.* A Photovoltaic Solar and Battery Energy Storage System Electrical Vehicle Station**

Implementation Process

When it comes to sustainable energy technologies there is no silver bullet. Their implementation often requires careful attention to the local environment, economy, and community. Using the vast arsenal of technology available, a localized plan catering to the area's situation should be developed after careful analysis of what the energy needs of the community are, what natural resources are available, and which technologies will best solve and improve the lives and financial standing of the people who will be using them. Some regions might have abundant solar resources while others might have high wind potential or agricultural waste at their disposal. There may be open, unused lands in one area and not in another, a local grid might be facing congestion and could use energy storage to alleviate it, or a small town road routed to a city center might be heavily trafficked and could use EV public transit. Even within energy storage technologies alone there are varying options with niche applications, including electrochemical and mechanical, some types might be able to shift electrical load throughout the day to reduce the cost of electricity while another might be used to stabilize the grid to provide more stability and resiliency.

One might use multiple technologies simultaneously. Take, for example, agricultural land that a farmer is not making enough money from. There might be the opportunity to build an **agrivoltaic** solar farm over the land that the farm's sheep graze on, allowing the farmer to get dual uses out of it. The farmer could even add an irrigation system to the mounting hardware. Taking it a couple steps further, the farmer could get creative, adding battery energy storage to the solar array and biodigesters to their land to potentially make use of the waste from their livestock, providing additional revenue streams without compromising their livelihood or the local environment.

Ultimately, we envision that when we combine these technologies it can be possible to achieve true energy independence from a grid-based system by employing a more localized microgrid system that is not reliant on price fluctuating fossil fuel technologies while still using existing infrastructure to remain interconnected as needed. Global oil prices make no difference to a region that is sourcing all its energy needs from localized renewable sources that can be used to power its energy needs, be it heating and cooling of buildings, cooking, transportation, or other things. The transition doesn't have to occur in a step-by-step fashion. If these ideas are simultaneously implemented where it makes sense whether on a residential, commercial, or utility scale the transition will naturally occur, as many of these technologies symbiotically work with each other. The most important part in allowing the transition to happen is to remove political and financial barriers so that the technical upgrades, changes, and investing can occur to bring the clean energy transition to fruition.

Benefits of the Clean Energy Transition

Transitioning to a clean energy economy will ultimately provide health benefits, financial rewards, and mitigation of future climate change. Internal combustion engines will be heavily minimized over the next decade and inevitably displaced. Diversifying to alternative fuels is important to reduce fuel price volatility in order to sustain economic growth. **STEM** job opportunities such as atmospheric scientists and software developers for renewable energy companies are on the rise due to the urgency of climate change and will continue to grow especially as the economy continues to shift away from traditional fuel sources. Renewable energy paired with energy storage together are also able to provide energy independence, stability, and resilience towards building a sustainable future grid.

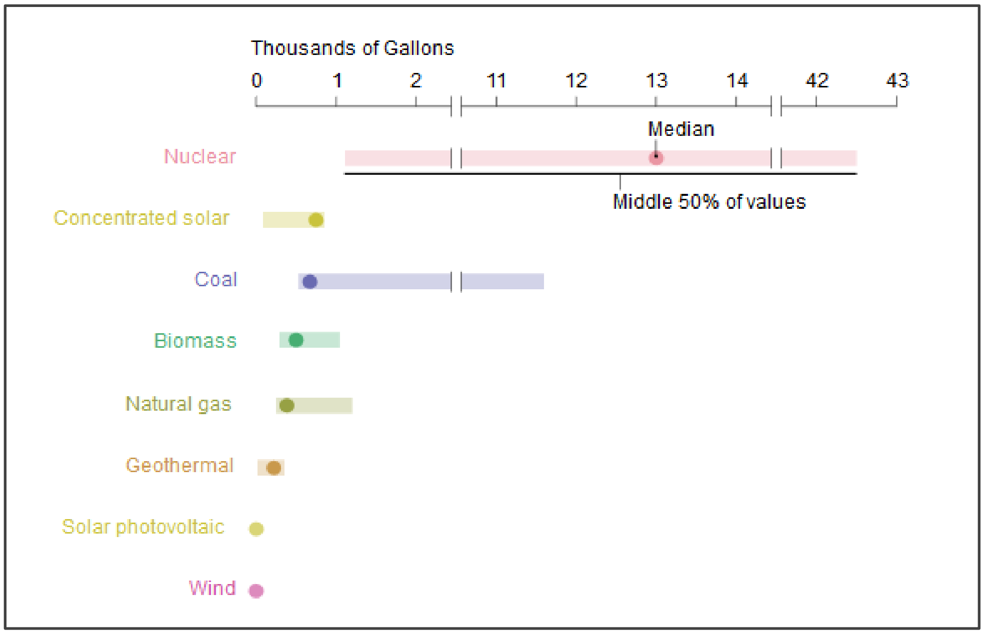
Environmental and Social Benefits

A clean energy economy built on renewable energy reduces air pollutant emissions, including those from greenhouse gases. In turn, this delivers health benefits such as reducing the burden of respiratory diseases while providing financial relief to national healthcare programs. The cost of transitioning the United States to clean energy may also be offset by the savings of not having to buy into fossil fuels any longer. Programs like NYSERDA Clean Energy Communities, among others, help to manage the financial and deployment costs of these burdens in order to overcome and give inertia to the transition.

Solar and wind energy deployment has increased significantly over the past decade and has simultaneously reduced carbon emissions and **sulfur dioxide**, **nitrous oxides**, and fine **particulate matter**. The Environmental Markets Policy Group estimates that wind and solar have helped the U.S. prevent 8,000 deaths from 2007 to 2015 and saved $60.5 billion from avoided air pollution, as well as saved over $30 billion in costs related to climate change (Millstein *et al.*, 2017). In the Southwest US and California, solar has provided more benefits than wind, but this is the reverse for the rest of the country. Generally, it depends on factors specific to these regions whether either solar or wind will best fit. The Genesee-Finger lakes region, as previously mentioned, is ripe for solar and wind projects based on its unique characteristics.

Solar and wind not only contribute to cleaner air but also conserve water compared to other forms of electrical generation. In 2010, over 43 percent of water drawn from natural resources was used to temper fossil fuel sourced power plants and nuclear reactors, also known as thermoelectric power plants (Castillo *et al.*, 2018). This water usage far exceeds that of public consumption and more than water withdrawal for irrigation purposes. Water usage for solar and wind generation is minimal at best compared to those of its energy counterparts, see Figure 40 for more details.

Figure 40. **Water withdrawn to produce 1 MWH of electricity**



Besides the renewable initiatives, we have seen greater expectations by cities like New York City with its path to reach carbon neutrality by 2050 set out in the 2015 Paris Agreement (NYSERDA, 2020a). These initiatives include requirements for buildings over 25,000 square feet to cut climate emissions 40 percent by 2030. By 2050, New York state is targeted to reduce greenhouse gas emissions by 85 percent from 1990 levels. Furthermore, the United State Climate Alliance, a bipartisan coalition of 24 states and Puerto Rico representing 55 percent of the U.S. population, is committed to uphold the objectives of the Paris Agreement (U.S. Climate Alliance, 2019). The combined efforts of these 25 governors were able to reduce emission by 14 percent from 2005 to 2016, which was 3 percent more than the rest of the country and continue to outpace the states not a part of the alliance.

Economic Benefits

When it comes to solar, it is important to distinguish between rooftop solar and community solar. Although solar energy is 100 percent renewable and releases no harmful emissions into the atmosphere, the costs between rooftop versus community solar can be quite different. Rooftop solar, as it sounds, requires installation of leased or purchased solar panels on the roof of an individual home, while community solar allows residents in a specific region the option to access a local pool-financed solar power supply. This type of financing helps spread risk. Some of the first states to deploy these types of programs were California, Colorado, Massachusetts, Utah, and New York, each of which has seen a gain in popularity of the programs.

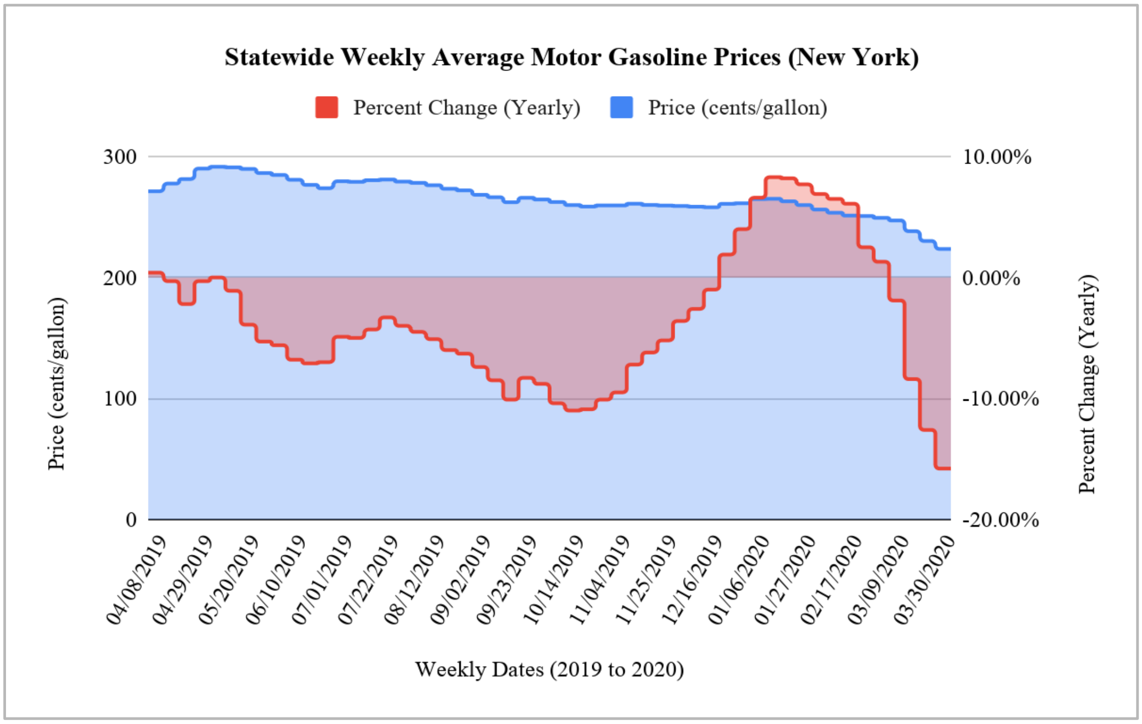
While electric vehicle growth has not lived up to its expectations so far, due to limited battery technology and a lack of charging-infrastructure investments, global electric-light vehicles continue to make solid growth in sales and they are expected to pick up in growth into the future. In 2018, China's EV sales accounted for 51 percent (or 1.1 million units) of the entire global market, which was about three times the size of either the European or U.S. markets (Hertzke *et al.*, 2019). With the combination of power grids transitioning toward clean energy and the use of EVs expanding, greenhouse gas emissions will be reduced drastically. With two-thirds of petroleum consumed through the transportation industry in the United States, EVs can help the

U.S. obtain a more diverse mix of fuel choices available for all forms of transportation through electrification (Department of Energy Office of Energy Efficiency & Renewable Energy, 2020).

Figure 41. **Electric Vehicle Charging Stations**

With the volatility in oil and gas prices seen over the last decade, especially during the most recent COVID-19 pandemic, renewables offer the ability for a community to produce its own energy, providing protection against pricing volatility as well supply disruption. It is difficult to forecast fossil fuel prices, which puts consumers and providers at risk from fluctuating energy rates. See Figure 42 for an example of price fluctuations for New York State specifically.

Figure 42. **Gasoline prices tend to fluctuate frequently**



On March 31, 2020, for example, New York state saw an average drop of 41.9 cents per gallon, or a 15.8 percent drop, in cost from 265.5 to 223.6 cents per gallon, where the nine-month average prior to the pandemic saw a reduction of only less than 15 cents per gallon (NYSERDA, 2020b). During a crisis, utility shut offs due to inability to pay bills or sudden blackouts can affect us all, particularly the elderly and those with disabilities using medical equipment to live a normal day-to-day life. Unlike fossil fuels, renewable energy resources do not require purchased fuel, therefore, the operating costs over time are much more predictable, except for **biomass** (Lieberman, *et al*, 2008).

The benefits of leasing of land for solar or wind use are primarily financial, which would have rewards for any unused abandoned land that qualifies for these projects. There is a risk in taking on a conversion of any agricultural land since it will be considered non-agricultural until the project is decommissioned and reconverted. Because the landowner is not the owner of the renewable project, they also will not receive tax incentives tied to the project itself and if there is a failure to report a land conversion to non-agricultural use, a fine of up to five hundred dollars can be levied against the landowner (NYSERDA, 2016). However, land lease rates vary across the country, ranging in the hundreds to north of ten thousand dollars annually per acre and to lease your land for solar can be quite lucrative in certain situations. For the Genesee-Finger Lakes, with as high a solar potential that it has, solar may provide greater opportunities. Rates can also depend on “the location (whether they are near a three-phase transmission hub or not), local power demand and rates, state and federal incentives, installation costs, site accessibility, and the amount of land available nearby,” (Metz, 2020) so other factors should be taken into account as well. Typically, solar projects may require between 10 to 30 acres per project. Depending on the type of technology, a utility-scale solar power plant may require between 5 and 10 acres per MW of generating capacity (Solar Energy Industries Association (SEIA), 2020), while most wind farm projects require at least 60 acres of land per MW produced (Landmark Dividend, n.d.). If excess power is produced, though, electricity can be sold back to the grid for the profit of the lessor. Massachusetts is leading the pack in agrivoltaics where the dual-use method of solar energy production and crop growth around the panels creates a win-win situation for farms. Currently, economic incentives for New York are not on the same level as Massachusetts (Agricultural Stewardship Association, 2019) but there is potential in the future for this to change.

Ecotourism and the Clean Energy Transition

Ecotourism as an industry is increasingly embracing renewable energy and using it as a tool for achieving sustainability in tourism. As tourists continue to seek sustainable lifestyles, environmental awareness becomes more prevalent in the newer generations. Reputations rely on consistent quality and oftentimes off-grid getaways can have unreliable power sources, which can negatively impact guest experiences (USAID, 2008). With the appropriate storage systems, renewable energy sources in more remote locations provide not only dependable energy access, but also improve local air quality that is often diminished by diesel generators. This helps resorts become more self-sufficient and less reliant on fossil fuel imports that will not be available through a pipeline. This also helps protect the natural and cultural heritage of the regions in which the ecotourism operates (The International Ecotourism Society, n.d.). As mentioned earlier, the Genesee-Finger Lakes area over the last eight years has seen a growth in employment, primarily through the tourism industry, so ecotourism could add another layer of positive opportunities.

Job Growth in the Renewables Industry

Over the next decade, the U.S. Bureau of Labor Statistics estimates a spike in job growth for wind-turbine technicians and solar panel installers (U.S. Bureau of Labor Statistics, 2019). See Figure 43 for further details on current job growth in these careers as well as their annual median pay currently. Besides careers as installers or operators, lucrative careers such as atmospheric scientists, geoscientists and software developers for renewable energy companies are expected to skyrocket through 2026 (Kiersz and Akhtar, 2019). These "green" STEM careers can typically start near six-figure salaries or beyond, which is at least double the salary of solar technicians and installers. These increased opportunities arise from the urgency and harmful effects of climate change, especially as the economy continues to shift away from fossil fuels. According to the National Solar Job Census, the solar workforce added more than 5,600 jobs throughout the U.S. (United Solar Supporters, 2020).

Figure 43. **The Fastest Growing Occupation and their 2018 annual median pay**

Occupation	Growth Rate	2018 Annual Median Pay
Solar Photovoltaic Installers	63%	$42,680
Wind Turbine Service Technicians	57%	$54,370
Home Health Aides	37%	$24,200
Personal Care Aides	36%	$24,020
Occupational Therapy Assistants	33%	$60,220
Information Security Analysts	32%	$98,350
Physician Assistants	31%	$108,610
Statisticians	31%	$87,780
Nurse Practitioners	28%	$107,030
Speech-Language Pathologists	27%	$77,510

One prime example is the first two offshore wind projects by NYSERDA started in 2019 which are expected to total nearly 1,700 megawatts. These will be the first step in achieving 9,000 megawatts of offshore wind by 2035. The wind projects will create enough energy to power over one million homes representing the single largest renewable energy procurement by any state in U.S. history. With a combined economic activity of $3.2 billion across the State, this helps position New York as the hub of the nation's offshore wind industry with these opportunities stimulating more than 1,600 jobs. This shows the rewards that renewables can offer in terms of economic growth. To create a resilient and distributed grid, the expected 1,500 megawatts of energy storage by 2025 is estimated to double to 3,000 megawatts by 2030. This will potentially employ over 30,000 in the energy storage sector. These employment opportunities are expected to strengthen socio-economic resiliency in New York during its transition to its own state goal, particularly in low-income and disadvantaged communities. Another point to mention is that the economic output of the states and territories in the United States Climate Alliance grew by 16 percent, which was two percent higher than the rest of the country. This shows the importance of how "climate leadership and economic growth go hand-in-hand" (U.S. Climate Alliance, 2019).

There is a wide array of benefits that will reveal themselves through this transition, some of which we have yet to discover. Some benefits work on a large scale impacting the entire U.S. economy while there are some more local benefits that make local impacts. It is important to understand that not all benefits are created equally and not all regional landscapes are identical.

Much of these benefits will depend on multiple factors such as state and local policies, land quality, weather, and budget, to name a few. We absolutely understand that there will be substantial opportunities available for the Genesee-Finger Lakes region because of the clean energy transition

Sustainable Future Grid

Clean energy resources and technologies such as wind and solar paired with energy storage can provide sustainability benefits to the grid as well. Renewable energy sources and storage can be implemented to form microgrids keeping the lights and power running at critical needs facilities especially in the wake of natural disasters where supply routes for fossil fuel may be compromised, providing an extra measure of grid resiliency as they are less prone to disruption. Microgrids made up of renewable energy technologies are still connected to the centralized grid infrastructure but are flexible and capable of islanding blocks, streets, individual buildings, as may be necessary during natural disasters such as hurricanes, blizzards, floods, other extreme weather events, etc. Additionally, while renewables are commonly flagged as intermittent resources that cause grid instability modern smart inverters that convert the DC generated power to AC power now have electronics that can use power factor to filter, regulate, and adjust their outputs into the grid which can actively and instantaneously provide grid stability services reducing the need to operate idling mechanically based fossil fuel plants which are slower to respond to the fluctuating demands of the grid. They make the grid more efficient and resilient to brown and black outs (Zipp, 2015).

The Difficulties of the Clean Energy Transition

There are numerous pieces of the clean energy transition that need to fall into place for it to be successful for the Genesee-Finger Lakes region. The solutions we have identified need to be implemented in a certain way, but as the current status of the region and the state stands, some hurdles exist for this to be implemented. Developers, utilities, regulatory bodies, and community leaders all have a role to play in overcoming these hurdles.

To best gauge the means by which renewable projects are implemented in the region, we spoke with solar site originator Travis Scott at CVE North America, a solar development and Independent Power Producer (IPP) firm. From the solar developer perspective, there are many reasons that suggest looking to agricultural regions like Genesee-Finger Lakes makes sense. The region’s south-facing slopes, abandoned agricultural lands, and relatively flat areas are prime reasons to develop in this region (Scott, 2020). Another draw to the region includes its numerous brownfields, which are hazardous spill remediation areas that are extremely competitive sites for solar development due to the limitations of other property development on them (Scott, 2020). However, there exist many challenges for solar developers like CVE North America who want to develop land in this area into solar farms and help residents access the benefits to participating in this clean energy industry.

Updating Transmission Infrastructure

One physical obstacle in the way of the clean energy transition and distribution progressing for the Genesee-Finger Lakes region is the current state of transmission infrastructure in New York State. Scott commented on this problem as well, stating that it is vital to locate projects near three phase electrical distribution lines that have available hosting capacity for the interconnection of the system. Renewable energy developers are being asked to bear the costs of upgrading the distribution grid in order to interconnect their systems which often results in them forgoing desirable lands to build on (i.e. clear abandoned agricultural parcels, brownfields, large industrial rooftops etc.) and local regions that may want to see renewable energy development. These utility upgrade costs can often make or break project finances sometimes reaching upwards of several million dollars upfront which equate to large fractions of the total project cost. These costs are used to upgrade the utility’s distribution lines over dozens to hundreds of utility poles and even entire electrical substations. For this reason, without proper incentives it is often at times difficult for a developer to pursue projects even when locals might be interested in having them built. Providing incentives targeted around transmission and distribution upgrades may open the doors to large scale renewable development. Additionally, outdated utility infrastructure not only impacts costs but also timing, utilities must go through rigorous impact studies to determine how adding distributed generation will affect the distribution and transmission grid to determine what these upgrades need to be. This often leads to project queues with the utility to perform impact studies between multiple distributed generation developers that can take years to get through before even realizing what the costs of upgrade are during which time a developer needs to pay options on to maintain the land lease while they just wait.

New York’s current aged transmission and distribution network places a limitation on the extent to which distributed generation capacity can be added to the grid. For the boom of renewable energy projects in the Finger Lakes Region to continue and for the clean energy transition to be fully implemented in this region, it is necessary to bring transmission infrastructure up to more modern standards. Much of the infrastructure in New York State dates to the early to mid-1940s, during the time of New Deal public improvement projects, and quite a lot is no younger than sixty years old. It is in desperate need of repair to accommodate the generation sources that will be added to the grid, the novel means by which energy will be channeled, and the additional demand that electrification will bring to the grid (NYPA, n.d., a).

Some of the symptoms of this aged infrastructure include power outages, which inconvenience electricity consumers and increase energy inequity for electric customers whose community does not benefit from more attention to the system. Transmission infrastructure in New York is in constant need of repair. Many of the transmission lines are still supported by outdated wooden poles that are due for an upgrade to steel monopole structures, for example (T&D World, 2017). The physical aspect of transmission infrastructure itself is certainly an issue, but there are other aspects of transmission in New York that are not conducive to managing a modern grid. For example, data is not as widely available for much of the grid's operations since mechanisms are not in place to provide deep, real-time information about the system (NYPA, n.d., a). New York State's transmission infrastructure needs an upgrade for the clean energy transition to progress and so that consumers can save money, energy, and reduce stress related to energy access.

Projects are underway to complete much-needed distribution infrastructure improvements as well. One project being developed by NY State Electric & Gas, a utility that has some territory in the Genesee-Finger Lakes region, involves replacing electric cables that were originally submerged in Seneca Lake in 1942 (Christensen, 2019). This infrastructure is currently leaching certain contaminants into the lake due to its age and the components involved, and it also does not have the capacity to serve the new needs of the region. Distribution improvement projects like this one are key to paving the way for more generation capacity in this part of the state's energy grid.

New York Power Authority operates a third of the transmission lines in New York State, serving as the base for electric power distribution. Alongside utilities, public-benefit corporations like NYPA, and the New York Independent System Operator, many groups work to improve New York's grid and ensure that it is ready for the clean energy transition. This includes the Genesee-Finger Lakes region (NYPA, n.d., b).

Figure 44. **Wooden H-frames like these pictured need to be updated to steel monopoles to improve aging transmission infrastructure in New York**

Education and Public Awareness

For the clean energy transition to be successful in the Genesee-Finger Lakes region, the public needs to be educated and aware of the changes that are happening in their communities. The NYSERDA Clean Energy Communities program has begun the process of bringing these projects to the general public along with other organizations such as United Solar Energy Supporters and many clean energy advocacy organizations. The difficulty is that public perception of the clean energy transition is currently being pulled in two directions. The first is from lobbyists in the fossil fuel industry. Renewable deployment is generally advocated against by competitors in the opposing industry for fear of competition from the booming renewable energy industry and increasingly lower energy prices that this industry can provide (Massaro, 2012). These groups tend to spread falsehoods about the implications of the clean energy transition and thus are often considered bad actors in the energy sector (Sane Energy Project, 2018). The second is by clean energy advocacy organizations and renewable energy developers who have pushed the clean energy transition in the Genesee-Finger Lakes region and beyond (Fitzgerald, 2018). These groups have worked to educate the public on the benefits of the clean energy transition as well as advocate for increased regulation and incentives in the region to further push for the transition's success. The public's attention has been split in the Genesee-Finger Lakes region, but this contrasts with community leaders of the region who have internalized the need for clean energy to become more of a focus and have worked to make changes happen in their municipalities. Developers can attest that there exists a constant push and pull of the public perception that needs to happen for these projects to be perceived positively by the community (Grasby and Cushing, 2020; Scott, 2020).

According to the Clean Energy Communities Market Evaluation Final Report, wherein state representatives of New York State were interviewed about their interest in, and knowledge of, bringing clean energy to their given localities, representatives generally perceive clean energy as a medium to high priority. About one-third of interviewed representatives reported clean energy is a high priority in their community and another third reported it was "medium-high," while the same number of representatives described it as a "medium" priority in their community when compared to other initiatives. Two communities reported clean energy was between a low and medium priority. Communities that reported clean energy was not a high priority noted that infrastructure projects related to public health and safety, such as water and sewage, were higher priority items for their government (Research into Action, 2019).

Communities are generally motivated by cost savings: about two-thirds of representatives reported they pursued energy efficiency to save energy and money for both their municipalities and constituents (Research into Action, 2019). Some representatives noted they only pursued clean energy projects if it was economically viable in the long-term, providing them an economic return. Three representatives were interested in clean energy because it saves their constituents tax dollars and keeps their electricity rates low. Two communities also reportedly pursued clean energy projects to lower long-term Operations and Maintenance costs.

Figure 45. **David Zorn from NYSERDA informs City of Batavia officials about the Clean Energy Communities Program**

Financial Motivations of the Clean Energy Transition

Travis Scott of CVE North America has experienced situations in his career where “there are a bunch of farmers that want to do solar farms on a part of their property… and there are a bunch of developers that want to work with these farmers… [but] the town [says] no [since]... the land was too valuable,” (Scott, 2020). From the perspective of these towns, solar projects despoil the aesthetic value of a lush, verdant farm. However, towns are not taking into consideration the financial needs that farmers have when considering leasing the grazing or cropland that may lie fallow for some time, and the positives that leasing land for solar energy generation could bring. Overall, municipalities and concerned citizens tend to try to protect farmland from being developed into solar farms to keep the character of their villages, towns, or cities, but the farmers or landowners often want to sell it for solar development to make a higher revenue stream. The cultural conflict can often result in the developers and farmers not getting what they want.

The motivation to transition certainly is there for many municipalities, but in order to get the public on board, community advocacy needs to happen on a wide scale. Misconceptions about the clean energy transition are often generated by fossil fuel opponents of the transition and, thus, work towards correcting these falsehoods is key. Scott discussed one way to mitigate the concerns of municipalities and get a solar project successfully completed. When it comes to avoiding a disturbance of the beautiful aesthetics of regions like the Genesee-Finger Lakes, the key is to develop plans with the municipality and concerned community members during the project’s development and implementation. This involves discussing techniques that can reduce the impact that solar projects have on the view of these landscapes. One technique involves screening solar projects to block their view from the road using tree planting on berms. The onus also usually falls to solar developers to develop these protocols with the landowners and present them to municipalities, and they can involve a decent amount of lead time to be properly implemented (Scott, 2020).

Regulatory Reform

In order to overcome the obstacle of permitting in these areas, developers can work with the municipality on crafting solar laws that make the process easier for both future development for the town and for solar project developers that want to work in that area. Developers and municipalities can also use utilities as a resource to figure out utility interconnection logistics (Scott, 2020). One of the 10 High Impact Action Items, the Unified Solar Permit, was a push in the right direction towards getting municipalities to rethink their relationship with solar project developers and best prepare for the clean energy transition. The Unified Solar Permit is a permit application designed to streamline the approval process for installing solar in the community. This standardized permit essentially intended to cut costs by creating a uniform permitting process in municipalities across the state (NYSERDA, n.d., h). The Unified Solar Permit can be referred to as a guide for a new permitting process for municipalities that may not have the expertise, or a mobilized team available to create one.

To implement clean energy generation in the region there needs to be changes made to the regulatory structure of permitting these projects in the state level overall as well as increased regulations. Another hurdle that developers need to overcome is finding municipalities that are amenable to creating solar laws or that already have solar laws in place. The lack of, or unwillingness to consider, solar permitting laws is a typical reason why projects fail in the first two months of development. Without solar laws or permitting processes in place for the municipality to have guidance, projects will simply not move forward. According to Travis Scott, towns don't always have the legislation needed in place or a plan for this legislation to be put in place to make this happen. A lot of legwork needs to happen on the developer side for projects to go through the pipeline in towns, villages, and other municipalities (Scott, 2020).

One specific regulation that is considered a barrier to solar development is Article 10, which regulates the means by which major electric generating facilities larger than 25 MW are sited (NY State Board on Electric Generation Siting and the Environment. n.d.). This comprehensive law provides guidance to the New York State Board on Electric Generation Siting and the Environment about authorizing construction and operation of major electric generating facilities.

There are several positive points to the existence of Article 10. It streamlines the application process for developers while providing a rigorous process for local input and ensuring environmental and public health laws are followed. The public can participate in its decision-making process by offering support, voicing concerns, or asking questions about public health, safety, the environment, and other factors. This process begins during the initial planning of the facility and continues throughout the siting review, construction, and operation. However, there are aspects of the law that can be onerous to solar and wind developers who want to quickly and effectively begin projects in the state.

Developers are required to implement public involvement programs in the communities that they want involved in their project five months before submitting a scoping statement to the siting board. As our interviews with brownfield developer Grant Cushing and solar site originator Travis Scott have shown, there is certainly a great deal of front loading of work that needs to be done in order to convince communities of the benefit of the project. Environmental mitigation measures among other planned work for the development of the project also needs to be worked out by the developers. A formal application must be submitted to the siting board, which requires detail for the developer to implement. Finally, within 12 months of the date of application completion, the siting board will make its final decision about whether to issue or deny a certificate.

This law is not robust or flexible enough to allow for the implementation of clean energy resources at the rate that is needed for the Genesee-Finger Lakes region, let alone the state. Article 10 is a law that encompasses approvals of all new, repowered, or modified electric generating facilities and is a vast improvement over the requirements of applying for numerous state and local permits, but it still exists as an obstacle for developers who need projects deployed quicker to meet the needs of communities across the region. It will be up to the New York State Senate to decide whether improvements to this process will occur to meet the needs of the state.

Environmental Factors & Challenges

As with almost any kind of development that involves construction there are several environmental factors that need to be considered when building renewable energy projects, some with the intent of protecting the environment and others which are generally constructability challenges. For example, for a solar project there are civil permitting stages during the development of a project which account for doing detailed survey work for topography, hydrology, wetland delineations, endangered species, and geotechnical analysis to name a few. Often unanticipated steep slopes and buried boulders can take a project which initially looks desirable to pursue suddenly uneconomical to build or construct because so much grading and earthwork may be required that it becomes infeasible. Or related to the prospective land parcel’s topography the proposed project may change the hydrology so much that unexpected expenses using swales and culverts may be required to maintain appropriate stormwater runoff on the site.

Another common challenge in the snowier regions of NY state is performing wetland delineations as the ground is covered in snow and frost for most of the winter preventing the delineation surveys from being performed which can dramatically delay project timelines and generate situations where an expected solar project system footprint and size can suddenly shrink a project in half or less which can come to the surprise of a developer, landowner, and/or town that has spent months to a year working on a project. Endangered species migration or habitats can also play a significant role on project construction timelines and footprints as proper care must be taken to avoid disrupting them. This goes for both animals (maybe nesting during certain seasons) and plants (if replanting cannot use invasive species and if clearing cannot cut down protected species, typically botanists must be hired to do an evaluation). Another major factor that must be accounted for are ground content and quality which can be analyzed through geotechnical studies which will determine what kind of structural footings might be desirable for the project, for example for a landfill solar site the surface cannot be punctured with piles. Also, frozen ground during winter can also make it difficult to drive structural piles into the ground during construction so weather so care also needs to be taken to plan around weather.

A lot of these environmental factors and challenges that need to be considered during the development of renewable energy projects must be planned for ahead of time and communicated appropriately with all involved parties in order to meet the timing, financial, and general expectations. To avoid frustration and being blindsided by such environmental factors requires experience on the part of the developers and towns especially who may need to include steps to account for them in their permitting processes.

Resources Available to Make the Transition Work

Several resources are available at the federal and state level to support local governments and businesses transition to clean energy. This section does not comprehensively cover resources that include step-by-step instructions and tools to guide the implementation of clean energy, permitting processes, property taxes, siting, zoning, and more. Rather, it is intended to give readers an insight into some available financial incentives and supportive policies that can be harnessed by local governments, communities and businesses when investing time and resources in transitioning to clean energy. Specifically, the material focuses on tax credits, grants, loan programs and policy initiatives for clean energy technologies identified earlier in the guide. The latter half of the section is intended to draw best practices from similar regions in the country that can potentially be considered by federal or state authorities to accelerate transition to clean energy.

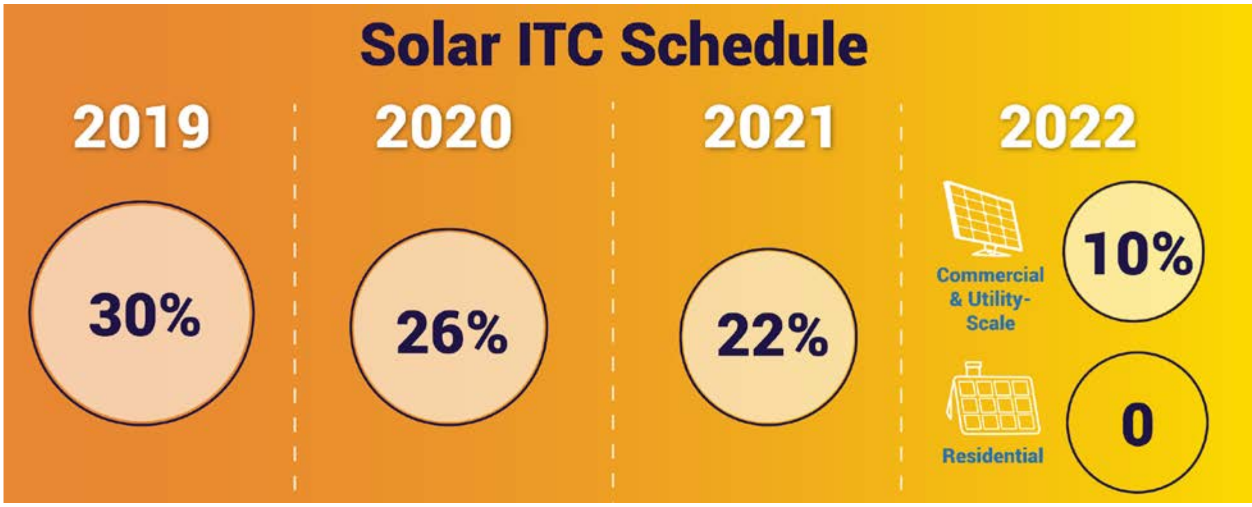
Federal Support for Clean Energy Projects

Several federal government tax credits, grants, and loan programs are available for qualifying renewable energy technologies and projects. The federal tax incentives, or credits, for qualifying renewable energy projects or equipment include the Renewable Electricity Production Tax Credit (PTC), the Investment Tax Credit (ITC), the Residential Energy Credit, and the Modified Accelerated Cost-Recovery System (MACRS). Grant and loan programs may be available from several government agencies, including the U.S. Department of Agriculture, the U.S. Department of Energy (DOE), and the U.S. Department of the Interior. Most states have some financial incentives available to support or subsidize the installation of renewable energy equipment.

The federal Renewable Electricity Production Tax Credit (PTC) is an inflation-adjusted per-kilowatt-hour (kWh) tax credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person during the taxable year. The duration of the credit is 10 years after the date the facility is placed in service for all facilities placed in service after August 8, 2005. The tax credit amount is $0.015 per kWh in 1993 dollars for some technologies and half of that amount for others. The amount is adjusted for inflation by multiplying the tax credit amount by the inflation adjustment factor for the calendar year in which the sale occurs, rounded to the nearest 0.1 cents (DSIRE USA, 2018).

The Investment Tax Credit (ITC) is currently a 26 percent federal tax credit claimed against the tax liability of residential (under Section 25D) and commercial and utility (under Section 48) investors in solar energy property. The Section 25D residential ITC allows the homeowner to apply the credit to his/her personal income taxes. This credit is used when homeowners purchase solar systems and have them installed on their homes. In the case of the Section 48 credit, the business that installs, develops and/or finances the project claims the credit (Solar Energy Industries Association (SEIA), n.d., b). A tax credit is a dollar-for-dollar reduction in the income taxes that a person or company would otherwise pay the federal government. The ITC is based on the amount of investment in solar property. Both the residential and commercial ITC are equal to 26 percent of the basis that is invested in eligible solar property which has begun construction through 2019 (Solar Energy Industries Association (SEIA), n.d., b).

Figure 46. **Multi-year Extension of ITC Schedule passed by the Congress in 2015.**



If energy-saving improvements are made in homes by installing Earth-friendly energy sources, The Residential Energy Credit can be claimed for a percentage of the total cost. In order to qualify for the credit, the energy-saving improvements must have been made in a home located in the United States. Solar water heaters, solar panels, and small wind turbines are the different products that qualify for the credit (eFile, 2020).

The Modified Accelerated Cost-Recovery System (MACRS) is a depreciation system used for tax purposes in the U.S. MACRS depreciation allows the capitalized cost of an asset to be recovered over a specified period via annual deductions. The MACRS system puts fixed assets into classes that have set depreciation periods (Kagan, 2019).

State Support for Clean Energy Projects

NYSERDA's Clean Energy Communities program helps local governments earn recognition and grant funding to demonstrate their clean energy leadership and to implement clean energy actions, save energy costs, create jobs, and improve the environment. In addition to providing tools, resources, and technical assistance, the program recognizes and rewards leadership for completing clean energy projects. The Clean Energy Communities program provides local governments with a simple, but robust and flexible, framework to guide them through implementation of high-impact clean energy projects (Costello, 2018).

The program is designed to provide grants to a total of 163 communities. Grant funding with no local cost share is available to support clean energy projects. Participating municipalities can earn up to $250,000 each for large communities (+40,000 population) and up to $100,000 for small/medium communities (0-39,999 population). Grants are awarded to the first 18 communities in each of the state's 10 Regional Economic Development Council regions. Within each region, funding is set aside for large and small/medium-sized communities so communities in each region are only competing against those of similar size in their region (Costello, 2018).

To help local governments prioritize and implement the high-impact actions and navigate the program, a Clean Energy Communities Coordinator is assigned to each region to provide expert guidance, at no cost to the local government. The Coordinators are funded by NYSERDA and are based at regional planning organizations that have long-standing relationships with local governments in their regions. Their services include meeting with municipal staff, answering questions, preparing LED street light cost-benefit reports, aiding with software for tracking municipal energy use, and identifying grant opportunities for electric vehicles and charging infrastructure (Costello, 2018).

Article 23: A New Permitting Regime for Large-Scale Renewables

A significant overhaul of renewable energy project permitting since the enactment of Public Service Law Article 10 manifested in the form of the newly proposed "Accelerated Renewable Energy Growth and Community Benefit Act" (the Act), put forth as part of the annual budget (Hodgson Russ, 2020).

Article 10 required that electricity generation projects of 25 megawatts (MWs) and larger made their way through a multi-staged and multi-year permitting process before the New York State Board on Electric Generation Siting and the Environment (Siting Board). However, it was recognized that Article 10 is ill-fitted to help the state reach its ambitious renewable energy and climate targets set forth in the 2019 Climate Leadership and Community Protection Act (CLCPA). In response, the Act was proposed to not only create entirely new permitting processes and the state entities to implement them, but also to invest significant state resources in the cause of getting large-scale project sites "build ready," (Hodgson Russ, 2020).

Highlights include:

- Allowing large-scale renewable energy to avoid the arduous permitting process under Article 10 of the Public Service Law, in favor of a new, more streamlined process under Article 23 of the Economic Development Law
- Reducing the MW threshold of projects that may seek a permit at the State level, as opposed to through local zoning and a State Environmental Quality Review Act (SEQRA) process, from 25 MWs to 10 MWs
- Directing the New York State Energy and Research Development Authority (NYSERDA) to develop "build-ready sites" – including site control, interconnection and tax agreements – for the construction and operation of renewable energy facilities
- Requiring municipalities and industrial development agencies (IDAs) to consult with NYSERDA in setting payment in lieu of taxes (PILOT) amounts
- Providing a more uniform real property value assessment methodology for solar and wind projects
- Authorizing a power grid study and investment plans for distribution and transmission infrastructure needed to meet the CLCPA's goals
- Amending Article 7 of the Public Service Law to allow for expedited regulatory review of major transmission utility projects

Eligible renewable energy systems are "solar thermal, photovoltaics, on land and offshore wind, hydroelectric, geothermal electric, geothermal ground source heat, tidal energy, wave energy, ocean thermal, and fuel cells which do not utilize a fossil fuel resource in the process of generating electricity (Hodgson Russ, 2020). Note that Article 23 seems to preempt local authority in some instances which is likely to provide for more efficient permitting of renewable energy projects but extra care may need to be taken in part of the local community to assure their local interests are still met through the development of these projects within their locale. For example, the noted jurisdiction over PILOT amounts gets set by NYSERDA rather than the local municipality or county level IDA which impacts the local level property taxes that can be collected from such projects. The PILOT agreements per a statement from Carson Weinand, Business Developer NY & Mid-Atlantic of CVE North America, Inc. can have crucial impacts on solar project development in NY:

> "In 2014 the New York State Department of Taxation and Finance enacted RPTL 487, which states that solar energy systems are exempt from taxation for 15 years. That said, it also included the option for local taxing jurisdictions (such as townships, school districts, and counties) to "opt-out" and tax solar energy systems at full property tax rates. Many local jurisdictions have done so and, in those cases, solar developers are forced to circumvent the local entities and execute PILOT agreements with the applicable county IDA. The IDA has the authority to supersede the taxing authority of the local jurisdictions, in an effort to promote economic activity. The IDA lists their specific terms for solar taxation and PILOT agreements in a document called the UTEP (Uniform Tax Exemption Policy). Generally speaking, solar projects upstate can secure PILOT agreements ranging from $3,000 / MWp / year - $9,000/MWp / year. Without the RPTL 487 exemption or the PILOT agreement from the county IDA, the economics of solar projects in New York State would not be feasible," (Weinand, 2020)

Article 23, may bring significant change to these existing rules and will require careful attention from all parties involved, the community, municipalities, developers, etc.

State Financing for Clean Energy Projects

According to the Database of State Incentives for Renewables (DSIRE), there are about 124 different program types available to the state of New York, including 12 grant programs, 49 Rebate Programs (the greatest number of all programs), and a few Property-Assessed Clean Energy (PACE) financing programs, which have become quite popular. The following are a selection of state financing vehicles available for assistance in the clean energy transition for Genesee-Finger Lakes.

PACE financing effectively allows property owners to borrow money primarily to pay for energy improvements, but also includes disaster resiliency improvements, water conservation measures, and renewable energy installations. It is not limited to residential property; therefore, it can also help fund commercial and industrial property owners. A downside to the loans is that they can often be more expensive than home equity loans.

Grant programs are typically the most desirable type of funding since these funds do not have to be repaid (Office of Energy Efficiency and Renewable Energy, n.d., a). Of interest to the region due to the large number of farms located there is the Rural Energy for America Program (REAP), which provides opportunities for agricultural producers and rural small businesses. Grants obtained through REAP funding cover up to 25 percent of total eligible project costs, with the remaining amount funded through loans, which do require repayment with interest. To qualify for the program, agricultural producers must have at least 50 percent of their gross income coming from agricultural operations or small businesses in eligible rural areas (DSIRE, n.d.).

NYSERDA provides several clean energy financing and assistance for a range of different projects. The C&I Carbon Challenge is a grant competition for large businesses (those with a 12-month average electricity demand of 10 MW) to unlock highly cost-effective carbon reduction opportunities. NYSERDA awards up to $10 million, ranging from $2 million to $5 million per successful proposal. Awardees continue to work with NYSERDA to update, refine, and implement their carbon reduction strategies over three years (NYSERDA, n.d., a). NYSERDA also provides technical assistance and funding opportunities for implementing an energy storage system (NYSERDA, n.d., e).

For local governments, NYSERDA provides incentives and technical assistance to install and manage energy storage in their facilities. NYSERDA offers a single up-front payment at a fixed incentive amount per kilowatt hour (kWh) of usable energy storage for projects up to 5 megawatts (MW). Incentives vary throughout the state; the amount by region can be found in the energy storage incentive dashboard. NYSERDA's Energy Storage Guidebook contains information, tools, and step-by-step instructions to support local governments across the state that are managing battery energy storage system development in their communities. The Guidebook provides local officials in-depth details about the permitting and inspection process to ensure efficiency, transparency, and safety in their communities. NYSERDA also works with local governments, including first responders, on a one-on-one basis to better understand, plan for, and site energy storage systems. As needed, NYSERDA can draw upon a network of independent subject-matter experts who can work directly with local permitting agencies on specific questions or concerns (NYSERDA, n.d., f).

Businesses can also receive assistance from NYSERDA. The organization offers a single up-front payment at a fixed incentive amount per kilowatt hour (kWh) of usable energy storage for projects up to 5 megawatts (MW). As with those for local governments, incentive amounts vary by region throughout the state and can be found on the energy storage incentive dashboard. Financing is also available through Commercial Property Assessed Clean Energy (PACE) financing programs. PACE uses authority given to a municipality to offer financing for commercial property owners to fund energy efficiency and renewable energy projects, including energy storage on existing commercial structures. Incentives for all retail storage projects are provided through a network of participating contractors approved under the Energy Storage program To receive the energy storage incentive, businesses must work with a participating contractor, who will apply for the incentive on their behalf (NYSERDA, n.d., g).

The $1 billion NY Green Bank (NYGB) acts as a supplement to other ratepayer-funded programs by leveraging private investment for energy efficiency and clean energy. NYGB alleviates barriers and gaps in clean energy financing by providing financial products that make it possible for lenders to close greater numbers of credit-worthy deals. In addition, it fosters scalable, replicable clean-energy projects and financial solutions by promoting standardizations of contracts, installation and servicing practices, and credit underwriting methods.

NYGB's current active energy efficiency portfolio includes numerous proposed transactions in various clean energy sectors. For example, the NYGB has recently retrofitted Northpoint School District; installed a combined heat and power (CHP) system at Hebrew Home for the Aged in Riverdale, NY; retrofitted numerous NYC Housing Authority developments; and funded an energy software company called Sealed, Inc. that finances residential efficiency improvements. In June 2017 Governor Cuomo announced that NYGB had turned a $2.7 million profit (ACEEE, 2019).

The Green Jobs Green New York (GJGNY) program provides residential, small businesses, not-for-profit, and multifamily building owners with access to energy assessments, installation services, low-cost financing (currently for residential customers only), and "green jobs" workforce training. For residential customers, NYSERDA's Home Performance with Energy

STAR program offers loans of up to $13,000 per household, or up to $25,000 if the project meets higher cost-effectiveness standards, and has repayment periods of 5, 10, or 15 years. Programs for small businesses, nonprofits, and, in the near future, multifamily building owners can finance energy efficiency upgrades with low interest payments conveniently built into one energy bill and offset the payment with the savings earned over the year (ACEEE, 2019).

Solar Development

State solar tax credits and accelerated depreciation are also available for the cost of installation. In some financing arrangements, these credits are taken by the contractor, and in others, they are taken by the building or business owner (NY-Sun, n.d., k). The New York solar tax credit can reduce state tax payments by up to $5,000 or 25 percent of the total solar energy expenses, whichever is lower. The advantages of the Solar Equipment Tax Credit are twofold: first, a system does not have to be purchased to claim the credit -- it is applicable even for those with a lease or PPA -- and second, if the tax liability isn't large enough to claim the entire credit in the first year, it can be rolled over into the next year (EnergySage, n.d.).

The NY-Sun Initiative is an umbrella program for a number of solar industry support mechanisms in New York State, including, but not limited to, the Megawatt Block Incentive Structure. NY-Sun, in conjunction with NYPA, also provides the backbone for the state's Community Solar and K-Solar programs (EnergySage 2020). For communities and local governments, NY Sun provides them with resources and guidance on implementing solar. The Solar Guidebook provides tools and resources for local officials to encourage solar energy development in their communities, (NYSERDA, n.d., h) and the organization also provides local officials with one-on-one assistance to help implement the guidelines of the Solar Guidebook (NYSERDA, n.d., h).

There are also Solarize campaigns that help homes and businesses in the same area go solar through locally organized community outreach (NYSERDA, n.d., j). For businesses, NY-Sun partners with private-sector financial institutions to offer loans for small and large businesses, as well as not-for-profit organizations. They offer three options for loans: small business or not-for-profit on-Bill Recovery loans, small commercial participation loans, and large commercial/industrial loans through Energize NY (NYSERDA, (n.d., b).

The Megawatt Block Incentive Structure, New York's Megawatt Block Incentive, is a direct, generous incentive for solar energy available under New York's ambitious NY Sun Initiative. The program provides an up-front dollars-per-watt ($/W) rebate for both commercial and residential solar panel systems. The size of the subsidy depends on how much solar energy is already being produced in the area and could be as high as $1/W.

The Municipal Solar Procurement Toolkit provides guidance and resources for communities seeking to develop solar projects on underutilized properties, such as landfills and brownfields, and supports recent revisions to the NY Sun-Megawatt Block Program, which provides financial incentives for developing solar projects in those areas (NYSERDA, n.d., j). The incentive program is divided into three regions across New York: the LIPA/PSEG-Long Island service territory, the Consolidated Edison service territory, and Upstate. The incentive is reduced over time based on market activity by sector and region. The program was revised post-launch to encourage the development of new projects by accelerating payments and providing new, higher, financial incentive "adders," such as development in limited-use areas and projects built on brownfield or landfill sites, on rooftop or parking canopies in Con Edison territory, and on affordable housing (Misbrener, 2018).

Electric Vehicles

Charge NY is a collaboration between NYSERDA, the New York Power Authority (NYPA), and the New York State Department of Environmental Conversation (DEC). Charge NY offers car buyers who purchase a plug-in hybrid or battery-powered vehicle the Drive Clean Rebate of up to $2,000 for new car purchases or leases, which can be combined with a Federal Tax Credit of up to $7,500 (NYSERDA, n.d., d).

Energy Efficiency Initiatives

National Grid residential electric customers in Upstate New York are eligible for several incentives. Rebates are available for heating and cooling equipment and the improvement of multifamily residential units. Incentives may be available to multifamily property for residents or building managers of apartment or condominium complexes with 5-50 units per building. The program provides free energy audits and free installation of low-cost energy efficiency equipment (DSIRE, 2019b).

National Grid's Non-Residential Program is for electric business customers in Upstate New York. Incentives are available for both small commercial and large commercial customers. Large commercial customers are eligible for prescriptive rebates on lighting, controls, vending equipment, refrigeration equipment, compressed air measures, and custom projects. All equipment purchased must meet minimum program efficiency requirements. Commercial customers with an average demand of 100 kilowatts or less per month qualify for the Small Business Program. National Grid provides a free energy audit and report of recommended energy efficiency improvements. Eligible energy efficient equipment includes lighting upgrades, energy efficient time clocks, occupancy sensors, programmable thermostats, walk-in and reach-in cooler measures, and other site-specific custom projects. Customers can view more information for both small and large commercial projects online at the website listed above (DSIRE, 2019a).

State Level Policy Framework for Clean Energy Projects

New York is a member of the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade program for reducing GHG emissions in North America that began its compliance period in 2009. Capping CO_2 emissions from the power sector, the program aims to reduce emissions by 45 percent below 2005 levels by 2020 and by an additional 30 percent by 2030 (ACEEE, 2019). BuildSmart NY is a statewide initiative to accelerate energy efficiency in State buildings while incorporating broader state policy goals to foster cost-effective investment, stimulate the clean energy marketplace, advance energy security and resiliency, and protect the environment and public health. At the center of BuildSmart NY is Executive Order 88, requiring a 20 percent improvement in energy efficiency at state owned and managed buildings by the year 2020. While this requirement does not mandate localities to comply with the requirements, localities are encouraged to do so and some, among them New York City, have adopted their own requirements (NYPA, n.d., a). The New York Power Authority (NYPA) was tasked to finance approximately $800 million in cost-effective energy efficiency projects between then and 2017. The financing provided has already helped reduce energy consumption in state buildings by over 16 percent and will be directed towards the largest and most inefficient buildings. Since the program's initiation, NYPA has implemented 95 BuildSmart NY projects that are yielding an annual $49 million in savings for state agencies (ACEEE, 2019).

The NYPA has been offering its Energy Services Program for 25 years. Between 1987 and 2018, NYPA financed and invested over $2.3 billion across 4,000 facilities within New York State. Under the Energy Services Program, NYPA provides services that include developing feasibility studies, engineering design, life-cycle cost analyses, procuring equipment, contractor labor, hazardous waste disposal, managing projects/construction, and financing projects. Measures include lighting retrofits, building envelope-related improvements, HVAC modernization, including energy-efficient chillers, boilers, and controls, high-efficiency motors, variable-speed drives, energy management systems, process controls, and distributed generation. These installations, and many more, have been performed throughout the NYPA customer base. New York State governmental entities, municipalities, school districts, public housing authorities, wastewater treatment plants, prisons, hospitals, museums, zoos, and public colleges are all continuing participants in the NYPA program.

In 2014, NYPA initiated approximately $240 million in energy efficiency projects across over 260 public buildings statewide. The programs are implemented without performance guarantees that are traditionally offered by energy service companies. NYPA has been steadily expanding its program services and is on track to exceed $300M in 2018, the latest year figures are available. The Dormitory Authority of the State of New York also is authorized to support performance contracting, and many municipalities and K-12 schools issue their own procurements independently to obtain performance contracting services (ACEEE, 2019).

Net metering, or net energy metering is a utility rate structure and billing mechanism that allows consumers with alternative energy systems, such as solar and wind, to transfer electricity they do not use back into the grid in exchange for credits on their utility bills. As of March 2017, the Public Service Commission (PSC) has adopted a new rate structure to credit solar projects for the benefits they provide. This new methodology takes the first step in moving beyond Net Energy Metering (NEM) to a more accurate valuation and compensation of Distributed Energy Resources. VDER factors include the price of the energy, the avoided carbon emissions, the cost savings to customers and utilities, and other savings from avoiding expensive capital investments and is being implemented in two phases (Department of Energy, n.d., b).

Case Studies of Communities Making the Clean Energy Transition

States, municipalities, and communities around the country are actively pursuing a variety of programs and initiatives to decrease their energy consumption, tap into renewable energy, and lower their carbon footprint. Some of these initiatives involve practical, common-sense solutions, while others are highly creative undertakings that feature out-of-the-box thinking and are tied to cutting-edge innovation. What are other, similar regions to the Genesee-Finger Lakes doing to solve for this issue? Following is a look at six of them from the state of Massachusetts on the East Coast to Washington state on the West, and the challenges, success stories, and lessons learned in their quest for clean-energy solutions.

Mid-Hudson Clean Energy Communities

The Mid-Hudson Clean Energy Communities encompasses seven counties in the lower Hudson Valley. According to Carla Castillo, Deputy Executive Director and CEC Coordinator for the Hudson Valley Regional Council, “There was a rush for the money initially - communities were very interested in the program. . .. When the Block 1 and 2 grants ran out, Block 3 grants of $5,000 statewide kept the program alive” (Castillo, 2020). In addition, when the Block 1 and 2 grants were no longer available Castillo found that Climate Smart Communities Certification attracted more communities (Castillo, 2020).

Most of the communities that participated in the program chose high impact action items that are sometimes perceived to be the “low-hanging fruit” of the program—Energy Code Certification, Clean Energy Fleets, Unified Solar Permit, and Benchmarking (Castillo, 2020). Of the 202 communities that make up the Mid-Hudson region, 147 actively engaged in the program and completed 69 actions (Castillo, 2020). Among the 147 communities that participated, one community completed eight actions, one completed seven actions, two completed six actions, and five completed five actions (Castillo, 2020). The remaining communities completed four actions or less. Peer motivation was a big factor in spurring the Mid-Hudson communities on to achieve designation.

Castillo found that there is skepticism surrounding some of the 10 high impact action items, which may affect their implementation. For instance, communities often wanted to know what the cost savings would be to switch to LED streetlights and voiced concern over how the cost savings would affect jobs at the local utility. The issue of maintenance also prevented a lot of communities from considering LEDs. To counter this resistance, Castillo built a cost benefit analysis and used it to encourage communities to take a real look at cost savings. She also created a cash flow analysis of LEDs and did targeted presentations to communities. In addition, the CEC helped put together a maintenance program through a company that installs LEDs.

Clean Energy Upgrades was another of the high impact items that was rarely chosen in the Mid-Hudson region. Castillo concedes that this is probably the most difficult action item to pursue and attributes this in part to the short time frame that some elected officials are in office and the shortsighted planning model this brief period causes. In the words of Castillo, “There was not a business model mentality of long term, there was a political model mentality of short term” (Castillo, 2020). She also found that communities fixated on needing grant money in order to make these upgrades, which feeds into a catch-22, as New York does not offer many state grants for the upgrades. To help counter this wariness Castillo encouraged communities to think about using money saved from other actions, for instance from installing LED streetlights, to make these upgrades.

There was not a lot of interest in solar and wind within the Mid-Hudson CEC region. The comment Castillo heard most often with regards to these two energy sources was how can communities manage preservation of land and reduce clear cutting of trees. There was also a strong objection to putting solar on prime agricultural soils, as people feel that would hurt the state in the long run. Instead, when discussing the possibilities of renewable energy, Castillo emphasized placing solar on landfills, **brownfields**, or rooftops of large buildings, such as schools and businesses.

Castillo says that the biggest challenge the Mid-Hudson CEC faced in her five years overseeing the program was "the amount of interest and meeting the demand for grant money. It was overwhelming and difficult to manage" (Castillo, 2020). In terms of the high impact action items themselves, benchmarking was the most challenging according to Castillo, which is surprising since it is among the most frequently adopted of the impact items. In Castillo's experience, communities find setting up the benchmarking process to be difficult, and it has required her to hold two and three in-person training sessions in some cases. She also feels that it was a mistake to count the benchmarking action item as completed when communities pass the resolution to commit to it – she feels that this should happen after communities upload their information to the computer, which can happen much later in the process. One of the things Castillo would like to do moving forward is to develop a benchmarking training webinar that specifically addresses how to do the benchmarking. She feels that this would cut down on the number of in-person training sessions needed to complete the action item.

One of the biggest successes that Castillo highlights is the collaborative group learning model that she developed in Ulster County. Once a month, representatives from eight communities came together to work on different aspects of sustainability and clean energy. Together the group fielded the many questions their communities had, provided tips and tricks on addressing different issues they encountered, and helped each other craft climate action plans. The result was so successful that Castillo plans to replicate this aggregated learning model in Dutchess and Westchester counties soon, a prime example of the best practice that we learn best when we learn together.

Energize Connecticut's Clean Energy Communities Initiative

New York's eastern neighbor, Connecticut, also operates a Clean Energy Communities initiative that is overseen by Energize Connecticut, a state-run program "dedicated to empowering Connecticut to make smart energy choices, now and in the future" (EnergizeConnecticut, 2020). The program's main focus is to promote saving energy in Connecticut homes and businesses through rebates, financing, and services for energy efficiency and clean energy improvements. Revamped in 2012, the reworked Connecticut CEC program required communities to complete three steps in order to be designated as a Clean Energy Community and be eligible for "Bright Idea Grants" for energy-saving projects:

- Commit to the "Clean Energy Communities Municipal Pledge" to reduce energy consumption in municipal buildings by 20 percent by 2018
- Fulfill the Clean Energy Communities Municipal Pledge by taking actions to save energy
- Earn energy efficiency points by participating in Connecticut Energy Efficiency Fund programs. CEC communities must earn 100 energy efficiency points and are then eligible to receive grants ranging from $5,000 to $15,000 that can be used toward energy-saving projects in CEC communities (EnergizeConnecticut, 2020)

Among the communities that have achieved a 20 percent reduction are Wilton, Hamden, North Haven, Bridgeport and Woodbridge. Energy-saving initiatives included a light-bulb exchange; subsidizing the co-payment for home energy assessments; participating in the CT Solar Challenge, which offers residents and businesses solar arrays at a discounted rate; and a God is Green program to reduce energy consumption in houses of worship. Through the CEC program Energize Connecticut also partners with Technical High Schools through Connecticut to operate the E-House Initiative, which creates hands-on learning in the areas of sustainability, energy efficiency, and renewable and green buildings and helps to promote a green workforce (Energize Connecticut, 2019).

Palmer, Massachusetts's Clean Energy Community Resilience Initiative

Massachusetts, another neighbor to the east that shares a border with New York, also offers a robust array of clean energy initiatives. The state's Clean Energy Community Resilience Initiative is a $40 million grant program that enables cities and towns to use clean energy technologies to protect citizens from service interruptions caused by severe weather due to climate change (Massachusetts Department of Energy Resources, 2020).

The state also sponsors a Green Communities Designation and Grant Program, which helps communities find clean energy solutions to reduce costs and strengthen their local economy. They can also receive technical help and financial support for local initiatives that improve energy efficiency. The municipality of Palmer, a community of 12,200 (Green Communities Division of Commonwealth of Massachusetts, 2015) located among the rolling farmlands and green hills of the Pioneer Valley of Western Massachusetts, was one of the first communities to receive the Green Communities designation. Through its efforts to become more energy efficient the municipality has reduced its energy consumption by 37 percent, saving its constituents around $5,500 a year (Massachusetts Department of Energy Resources, 2015). Its Town Planner and Economic Development Director, Linda Leduc, has coordinated the effort from the beginning.

Since 2010 the municipality has received five grants to upgrade its buildings, including its Town Hall, where the HVAC system and boiler were replaced with more energy efficient equipment, and its wastewater treatment plant, which was retrofitted with LED lighting and a smaller, more efficient aeration blower that lowers energy consumption. Palmer also installed LED lights in the municipality's three schools and is in the process of switching to LED streetlights. While $600,000 in grants secured through Massachusetts' Department of Energy Resources (DOER) funded a portion of these upgrades, municipal funding, rebates through the statewide Mass Save® program, and money from the Massachusetts School Building Authority also supplemented these grants (Massachusetts Department of Energy Resources, 2015).

Although the program has been generally well accepted within the community, the municipality has encountered some resistance along the way. In the early stages of designation, the local construction industry objected to the stretch building code that all Green Communities were required to adopt as part of the designation process. In another instance, the local utility was not supportive of the municipality's efforts to install LED streetlights.

Leduc found ways to counter this resistance and to create buy in. To sway builders' concerns that the stretch code, which were building energy codes that a town had to commit to in order to earn designation, would cost more money, she utilized the sales pitch that the building code was due to be updated in two years anyway and that the **Home Energy Rating System (HERS) Index** that new builds would receive as a result of the stretch code would increase the sales value of the new houses. For the LED streetlights, the municipality ultimately purchased the lights themselves and hired an independent third-party company to install and maintain them.

Leduc attributes the overall success of the Green Communities program in Palmer to having dedicated staff to direct the efforts, as well as a regional planning agency to serve as an active partner for technical advice and information (Leduc, 2020). She believes that saving money has been the biggest motivator in convincing the community to adopt the measures that Palmer has taken to increase energy efficiency and decrease their carbon footprint. In the words of Leduc, "everyone wants to get on the bandwagon" when they hear that you can save money (Leduc, 2020).

Figure 47. **Table reproduced from *A Toolkit for Community Clean Energy Programs, Tips on Effective Messaging for Clean Energy Programs***

Tips on Effective Messaging for Clean Energy Programs	
Widely Applicable Messages	**Other Potentially Effective Messages (Audience Dependent)**
• Saving money (or reducing energy service bills) • Improving comfort • Improving indoor air quality or occupants' health or productivity	• Restoring the value of one's home • Controlling energy use (self-reliance) • Environmental improvement • Social norms (what should be done; what the mainstream does)

Grand Rapids, Michigan and Landfill Solar Development

With a goal of 100 percent renewable energy for municipal energy usage by 2025, the elected officials of Grand Rapids, Michigan, were looking to do something fast and big. In 2014, this city of 200,000 inhabitants located 30 miles east of Lake Michigan settled on a plan to build a solar array on Butterworth Landfill, a former Superfund site, to generate electricity for a wastewater treatment plant. After issuing an RFP and selecting a developer, the project ran into trouble. The first hurdle was a technical issue – the wastewater treatment plant was located across the Grand River from the landfill and required expensive engineering technology to deliver the energy across the river. Then the developer who had been awarded the project went bankrupt (Oliveira, 2020).

The project was shelved for a few years before being reassessed by Grand Rapids' current Sustainability and Performance Management Officer, Alison Sutter. This time around the plan was to use electricity generated by the solar array on the former landfill to power city-owned buildings, streetlights, and traffic lights (the City of Grand Rapids has its own distribution system and owns the substations used to bring power to its network). The City planned to enter into a Power Purchase Agreement with a developer to avoid upfront costs, which would be significant.

Based on studies conducted by the National Renewable Energy Laboratory, Grand Rapids determined that the planned solar system on Butterworth Landfill would produce 15 to 18 megawatts of power (Oliveira, 2020). It was at this point that the City ran into its next hurdle with the project: The current distribution system does not allow for this capacity – it only allows for 3 megawatts – and to upgrade the system to 15 megawatts would require a large amount of money.

Because the City of Grand Rapids is one of the largest consumers of energy from the local utility, the utility did not have an interest in building and operating the system, as they knew it would impact them financially. A local climate action group was also against the idea of the utility owning and operating the system, and pushed back against the idea (Oliveira, 2020). According to João Oliveira, the Energy, Climate, and Performance Management Specialist for the City, it has been challenging to find the balance point of how to use the electricity generated by the Butterworth Landfill solar array. The City is now looking at using it to offset energy usage in its buildings that are not in the City-owned distribution system.

Although Grand Rapids was expecting more capacity from the solar array on Butterworth Landfill, the 3 megawatts it will generate will add 6 percent renewable electricity to their current usage, increasing the energy derived from renewables from 36 percent to 42 percent (Oliveira, 2020). Grand Rapids is planning to release a new RFP for the Butterworth Landfill solar array by the end of March 2020 so that they can take advantage of federal tax credits for solar, which are due to be reduced from 26 percent to 22 percent after this year.

Oliveira concedes that some of the most important lessons learned from the project are ones that people might not want to hear – that it's important to have the utility, developers and regulators in on the conversation; that you need to be intentional in your planning; and that every project is a challenge.

Wisconsin and Washington: Harnessing Ingenuity and Innovation

Wisconsin and Washington, two states with similar geographic and economic profiles to the Genesee-Finger Lakes region, are tackling the clean energy transition through ingenuity and innovation. In 2010, Wisconsin employed a practical, though creative, method to help its citizens adopt energy-saving measures. It developed an energy efficiency program that trained energy advocates to interact directly with program participants. The advocates would explain the benefits of energy efficiency, assist with paperwork, discuss how behavioral changes could save energy, and provide and install compact fluorescent lamps, faucet aerators, and low-flow showerheads (Berry, 2013). According to the *Toolkit for Community Clean Energy Programs*, published by Western Resource Advocates, "program staff and program participants viewed the energy advocates as central to the success of an energy efficiency program (Barry, 2013).

Washington state is using innovation to help move the needle on the clean energy transition and advance its mandate that all utilities self-generate 100 percent clean energy by 2045. To this end, the state-run Clean Energy Fund, which provide grants, matching funds, and other assistance for the development, demonstration, and deployment of clean energy technology (Washington State Department of Commerce, 2019), created the Dairy Digester Enhancement program to aid in the development of applicable dairy digester projects.

Milk is a major contributor to the economy in Washington – the state ranks tenth in the nation for milk production – and only apples are more valuable as an agricultural commodity (Washington State Department of Agriculture, 2011). Through the Dairy Digester Enhancement program close to $1 million in grants will be awarded to enhance the viability of dairy digester projects.

Dairy digesters convert manure into methane gas through the process of **anaerobic digestion**. Like natural gas, the methane gas produced by the digester is used to provide power to the farmstead, or it can be sold as electricity to the grid. Likewise, the solid byproducts of the process can be used onsite for compost and bedding, or they can be sold to other dairies or commercial enterprises.

Currently, Washington has eight dairy digesters in operation, with a ninth in development (Washington State Department of Agriculture, 2011). Both FPE Renewables and George DeRuyter & Sons Dairy, two of the earliest dairies in the state to install digesters, have created revenue streams from the process in the form of electricity, Renewable Energy Credits, carbon credits, tipping fees, and the sale of solids (Washington State Department of Agriculture, 2011). According to the report “Washington Dairies and Digesters,” published in 2011 by the Washington State Department of Agriculture, George DeRuyter & Sons originally used the separated solids onsite for bedding or compost, but in 2011 they began selling them to Organix, a company located in Walla Walla, Washington, that produces a peat moss substitute called RePeet™ out of the solids (Washington State Department of Agriculture, 2011).

The Environmental Protection Agency states that there is currently a total of 254 anaerobic digester projects in operation nationwide, 107 of which have been awarded grants by the (EPA, n.d., a.). While the monetary benefits of low or no electricity costs and a possible external revenue stream are enticing, there is also another benefit to the digesters: They help to reduce greenhouse gas emissions from the release of methane into the atmosphere. In “Washington Dairies and Digesters,” the Washington State Department of Agriculture noted that “on an annual basis, Washington’s dairy digesters capture 2,500 tons of methane, equivalent to more than 50,000 tons of carbon dioxide that would otherwise be released during conventional manure management” (Washington State Department of Agriculture, 2011). With the addition of more dairy digesters in the state since the publication of the report nine years ago, this figure has only increased. The challenge now is to develop the technology to make digesters practical on a large scale. Washington state, through its Dairy Digester Enhancement program, is harnessing innovation as it endeavors to meet this challenge.

Wrap-Up

There is much that these cases of successful transition can teach us about what the Genesee-Finger Lakes region can do to move towards their own clean energy future. Bringing these lessons learned all together, there are a few clear best practices for the clean energy transition, summarized in Figure 48.

Figure 48. **7 Best Practices for the Clean Energy Transition**

7 Best Practices for the Clean Energy Transition
❑ Adopt a business model mentality of long term, as opposed to a political model mentality of short term
❑ Saving money is perhaps the most powerful motivator to convince people to make the transition
❑ Have a dedicated staff to direct the transition efforts
❑ Make sure that you are intentional in your planning
❑ Harness innovation and promote ingenuity
❑ Every project is a challenge
❑ Collaborative group learning is a highly effective way to solve for individual challenges

Conclusion

By participating in the NYSERDA Clean Energy Communities program, the Genesee-Finger Lakes region has demonstrated its willingness to reduce energy consumption and drive clean energy use in its communities. This official commitment is the first step of many up the ladder that leads to a clean energy transition. During the five-year duration of the NYSERDA CEC program, great strides have been made by the regional counties. In fact, all nine counties in the region have acted in one form or another to work towards a clean energy transition. The implementation of most of the program-required high impact items occurred between the first quarter of 2017 and the last quarter of 2018. During this two-year period, 155 individual actions were taken by 67 municipalities across all nine counties in the initial moves toward transitioning to clean energy. Nevertheless, more remains to be done for the region to continue its forward path to a clean energy future.

Fortunately, because of its geography and topography, the Genesee-Finger Lakes region is uniquely positioned to make a measurable impact in addressing the future regional energy challenges should it fully commit to transitioning to clean energy. Bordering Lake Ontario, it sits on ample southern-facing land and has abundant water resources. Additionally, because of its current energy mix, centered around hydro and nuclear power, it possesses the necessary power grid infrastructure that will enable the future adaptation of other types of sustainable power sources, such as solar, wind, geothermal, and energy storage systems.

We understand the transition to clean energy will not be easily achieved. To that end, we have, to a large extent, laid out the challenges as minimal as they may be. Large renewable energy projects require a significant amount of space. And sometimes projects are proposed on farmland or in wildlands that have other important uses: wildlife habitat, pristine landscapes, and areas of cultural importance. At times, it may seem like an impossible conundrum. However, in the long run it is a worthwhile cause. The region is primed for renewable energy, which will make for a cleaner, more sustainable future. But we also need to protect rich wildlands and wildlife for future generations. The good news is that we can do both with careful planning, smart policies, and mitigation that offsets environmental impacts.

To help lead this process, this team has done extensive research and determined the most effective and efficient ways forward for the Genesee-Finger Lake region.

Actionable steps have been laid out, which are summarized below in four key takeaways:

- ❑ Future investment in clean energy generation should be focused on renewable energy technologies, such as solar, wind, geothermal, in partnership with local utilities and organizations.
- ❑ The benefits of transitioning to clean energy would provide financial rewards, health benefits, and mitigation of future climate change in the region.
- ❑ Massachusetts, Mid-Hudson, and Michigan should serve as model examples of how the region should structure their clean energy.
- ❑ Educating the public about the benefits of the clean energy transition is vital to the success of the transition, and further education should be employed in some manner, beginning with this guide.

Furthermore, with abundant farm waste, animal waste from dairy farms, and the growing beef industry, the region can take an additional step towards reducing its environmental footprint by mitigating greenhouse gas production through the deployment of bio-digesters.

In closing, by adopting this guide, the Genesee-Finger Lakes region can continue to move along the path to clean energy adoption that it began when it joined the ranks of NYSERDA's Clean Energy Communities. We do not make the claim that this guide is the solution; however, it does bring effective, efficient, and actionable steps that will turn Genesee-Finger Lakes into an exemplary model for sustainability that can be replicated by other communities seeking to achieve energy independence.

Authors and Contact Information

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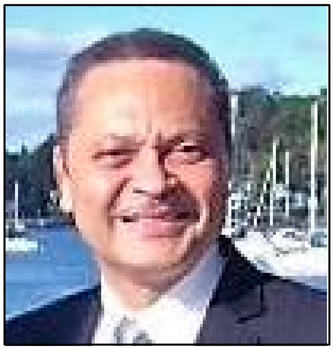
Danielle Shtab is an Efficiency Coordinator at ICF, an international consulting firm that works with utilities, governments, and more. She has experience in the non-profit, public, and private sectors, having worked at Underwriter's Laboratories and the Community Choice Aggregation program Westchester Power, as well as the Bronx River Alliance. Danielle has a passion for urban ecology, especially in the New York City area, and is excited about the renewable energy transition that is happening now around the world. She earned a Bachelor of Arts in Environmental Policy from Fordham University with a Minor in Urban Planning.

Deputy Project Manager – Mehul Dalal

Mehul is a graduate from Rutgers University with a Bachelor of Science in Materials Science and Engineering concentrated in energy storage & conversion. His past experiences include working for the Obama Administration's White House Council on Environmental Quality as an Energy & Climate Change team intern as well as working at Tesla as a Photovoltaic & Energy Storage Design Engineer. He currently works as a Solar Solutions Engineer for CVE North America, a renewable energy project developer based out of France. Mehul is an avid proponent of utilizing engineering and technology to solve climate change challenges, especially those affecting underserved populations. His interests include sustainable energy policy, design, engineering, and construction.

Yves-Leo Dejoie



Leo is a New York and New Jersey State registered Professional Engineer, with more than thirty years of Engineering Design Experience, specializing in all aspects of MEP/FP/FA engineering design, commissioning, inspection, project and construction management services in the public and private sectors. He is a specialist in the engineering field for a wide range of educational, laboratory research, commercial, industrial, pharmaceutical and health care facilities. Presently, he works for Columbia University's Facilities & Operation department as Director of Design Standards & Professional Services. In his current role, in addition to generating the design standards for the University, he supervises outside design consultants who work for the University as part of their staff augmentation program. Additionally, he assists and guides the Facilities Operations staff with troubleshooting mechanical issues on Campus. He also reviews and critiques Consulting Engineers MEP construction documents and specifications for accuracy, constructability and adherence to existing Columbia University Standards.

Jensen Hodge

Jensen is an ESG and Impact Analyst at TriLinc Global, an LA-based Impact Investment firm, where he conducts industry and company research and performs environmental and financial impact valuation in order to effectively evaluate each deal in the firm's investment pipeline. Jensen also spent three years working for Bank of America Merrill Lynch, first as a rates sales analyst, followed by working directly for the Global Banking and Markets Chief Operating Officer as a member of his Strategic Initiatives team. Matriculating at Georgetown University as an undergraduate in 2015, Jensen has a passion for sustainable finance and impact investing, with the belief that the finance industry must adjust for changes to our climate and that through impactful and ESG-guided capital investment significant environmental recovery is on the horizon.

Lauren Hood

Lauren is the Sourcing and Sustainability Manager at Mara Hoffman, a contemporary women's wear brand committed to implementing more sustainable and responsible practices. Lauren started her career working in production for a large teen retailer. Feeling disillusioned and disconnected with the vast amount of product being produced, she made the decision to leave for a smaller, more thoughtful brand. Lauren worked her way up through the Production department at Mara Hoffman and has recently taken on the first full-time sustainability role at the brand. Her goals are to continue moving the brand toward more sustainable practices in every area from initial fiber source to final packaging. Lauren received her undergraduate degree from the University of Wisconsin-Madison and an Associate degree from the Fashion Institute of Technology.

Kevin Kwok

Kevin leads development of Fixed Income Environmental, Social and Governance (ESG) Research as Vice President at MSCI. He chairs the Fixed Income Committee and sits on the award-winning Bloomberg Barclays MSCI Global Green Bond Index Selection Committee. MSCI ESG Research is the largest provider of ESG Ratings and analytics to global institutional investors.

Prior to joining MSCI, Kevin was most recently an Associate Director in S&P Global Ratings' Energy, Materials, and Commodities practice and a member of its Sustainable Finance Team. In private equity, he advised and raised capital for small to midsize energy companies. He was also a former Corporate Trust CDO Manager at The Bank of New York Mellon. He has a Bachelor of Arts in Economics from The University of Texas at Austin and an Energy Finance MBA from University of Houston. Kevin also served in the Peace Corps in Mali, West Africa.

Karen Schimmel

Karen Schimmel came to sustainability in a roundabout way, having worked as a writer and editor in New York City for many years. Currently she works at Columbia University's School of Professional Studies as an Associate Director of Events Management. She is interested in sustainability through a nonprofit lens, particularly in the area of education, and is Vice-President of the Women & Sustainability student organization at the School of Professional Studies. For several years before beginning her studies she volunteered at the Wild Bird Fund, a nonprofit organization in Manhattan that rehabilitates injured birds and other wildlife with the goal of rereleasing them into the wild once they are healed.

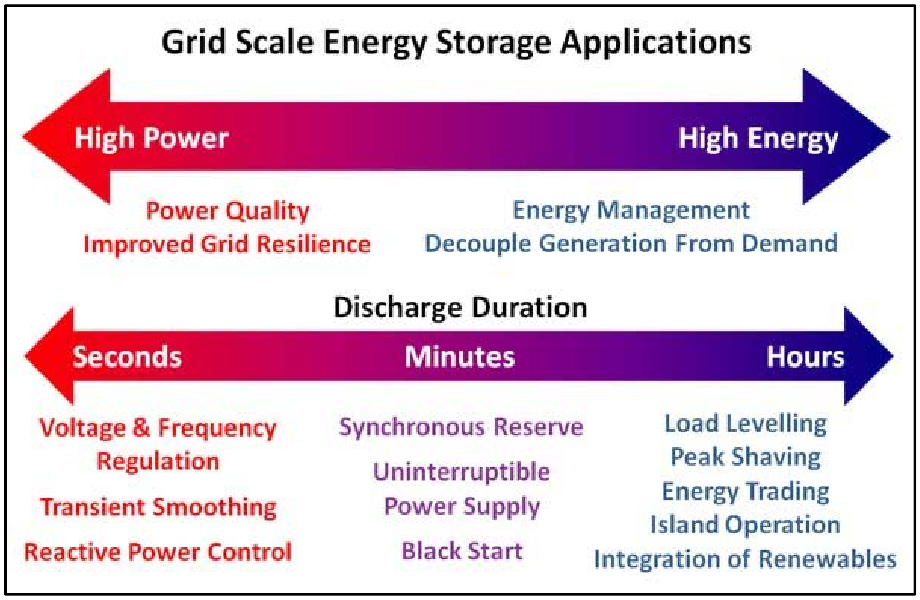
Tejaswini Thethi

Tejaswini holds an undergraduate degree in Architecture from M.S. Ramaiah Institute of Technology in Bangalore, Karnataka, India. Tejaswini has worked with Total Environment Building Systems, a design-and-build firm focused on high-end residential projects with sustainability as a core function. In her role as a Customization Manager, she tailored spatial layouts to customer needs, and prepared cost estimates and working drawings for the proposed layouts. Tejaswini was also involved with the waste management sector in India, undertaking internships with NGOs, startups and a public interest collective. She is an advocate of data-driven design and technology-enabled sustainable development. Her key interest areas include circular economies, smart and sustainable cities, system design and social entrepreneurship.

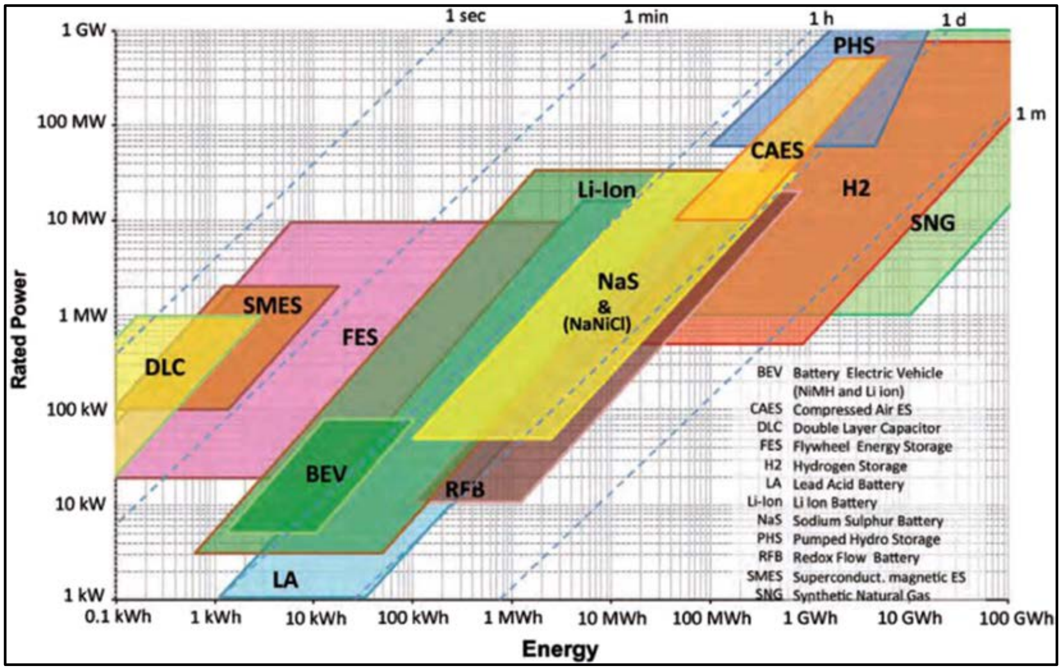
The authors are all students enrolled in the Columbia Sustainability Management Program, a joint Master of Science Program administered by the Earth Institute and School for Professional Studies.

Appendix

Appendix A: Energy Storage Use Cases and their Characteristics



Appendix B: Power, Energy, and Discharge Times of Energy Storage Technologies



Appendix C: Inherent BESS Characteristics & Potential Application Comparisons

Energy Storage Technologies Compared				
Storage Technology	**Main Advantage (relative)**	**Disadvantages (relative)**	**Power Application**	**Energy Application**
Flow Batteries	High Capacity, Independent Power and Energy Ratings	Low Energy Density	Reasonable for this application	Fully capable and reasonable
Sodium-Sulphur Batteries	High power & Energy Densities, high efficiency	Production cost, safety concerns (addressed in design)	Fully capable and reasonable	Fully capable and reasonable
Li-ion Batteries	High power & Energy Densities, high efficiency	High production cost; requires special charging circuit	Fully capable and reasonable	Feasible but not quite practical or economical
Other Advanced Batteries	High power & Energy Densities, high efficiency	High production cost	Fully capable and reasonable	Feasible but not quite practical or economical
Lead-Acid Batteries	Low Capital Cost	Limited life cycle when deeply discharged	Fully capable and reasonable	Feasible but not quite practical or economical
Flywheels	High Power	Low Energy Density	Fully capable and reasonable	Feasible but not quite practical or economical
Pumped Hydro	High Capacity, low cost	Special Site Requirement	Not feasible or economical	Fully capable and reasonable
Compressed Air Energy Storage	High Capacity, low cost	Special Site Requirement, needs gas fuel	Not feasible or economical	Fully capable and reasonable

Appendix D: Defined Energy Storage Applications and Their Corresponding Needed Durations & Market Value

Applications of Utility-Scale Energy Storage			
Application	**Description**	**Duration of Service Provision**	**Typically Valued in U.S. Electricity Markets?**
Arbitrage	Purchasing low-cost off-peak energy and selling it during periods of high prices	Hours	Yes
Firm Capacity	Provide reliable capacity to meet peak system demand	4+ hours	Yes, via scarcity pricing and capacity markets, or through resource adequacy payments
Operating Reserves • Primary Frequency Response	Very fast response to unpredictable variations in demand and generation.	Seconds	Yes, but only in a limited number of markets
• Regulation	Fast response to random, unpredictable variations in demand and generation	15 minutes to 1 hour	Yes
• Contingency Spinning	Fast response to a contingency such as a generator failure	30 minutes to 2 hours	Yes
• Replacement/ Supplemental	Units brought online to replace spinning units.	Hours	Yes, but values are very low
• Ramping/Load Following	Follow longer-term (hourly) changes in electricity demand	30 minutes to hours	Yes, but only in a limited number of markets
Transmission and Distribution Replacement and Deferral	Reduce loading on T&D system during peak times.	Hours	Only partially, via congestion prices
Black-Start	Units brought online to start system after a system-wide failure (blackout).	Hours	No, typically compensated through cost-of-service mechanisms

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Appendix B. Power, Energy, and Discharge Times of Energy Storage Technologies. Reprinted from sciencedirect.com. Retrieved from https://www.sciencedirect.com/science/article/pii/S1364032116308218

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Figure 5. The total number of Clean Energy Community High Impact Action items completed by the Genesee-Finger Lakes region by financial quarter. Recreated from NYSERDA CEC Internal Data

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Figure 11. Solar panels can be disposed of improperly but there are specialty recyclers that know how to extract elements like silicon, silver and Copper. Reprinted from weforum.org.

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Figure 20. Solar DNI is more concentrated and has a lower horizon line on south facing slopes. Reprinted from eoas.ubc.ca Retrieved from https://www.eoas.ubc.ca/courses/atsc113/snow/met_concepts/07-met_concepts/07h-aspect-effects/images-07h/sunAspect.png

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