55 - City of Glens Falls

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City of Glens Falls
Glens Falls Community Microgrid
NYSERDA NY Prize: Project #67718
Stage 1: Feasibility Assessment

City of Glens Falls
42 Ridge St.
Glens Falls, NY 12801

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Glens Falls Community Microgrid
NY Prize: Project #67718
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Task 1: Description of Microgrid Capabilities

Project Introduction:

The proposed Glens Falls Community Microgrid (GFCM) will be anchored by expanded generation from an existing Finch Paper cogeneration plant, providing full requirements power from renewable energy sources for as many as four critical facilities in close proximity to the downtown area. The Finch supply source could potentially be augmented by output from an existing Boralex hydropower plant. Additional technology options, including photovoltaic arrays and stationary energy storage, could also be part of the final configuration. The resulting microgrid will provide the backbone of an energy network with the potential to include not only a number of critical facilities, but also a significant portion of the downtown Glens Falls area.

The existence of significant generation assets within a very short distance of downtown Glens Falls -- assets which include not only the Finch Paper cogen plant but also two substantial hydro facilities -- reduces the need for significant dark-sky energy storage to supplement intermittent sources, and provides extended emergency power for at least four facilities that either provide critical services or support vulnerable populations in the downtown Glens Falls area. The four facilities are:

- **Glens Falls Hospital** -- a non-profit, 410-bed facility, this facility is the largest hospital between Albany and Montreal; as such, it serves not only Warren and Washington counties, but also much of the southeastern Adirondack region, included significant portions of Hamilton and Essex counties. The Glens Falls Hospital is the largest medical facility in the expansive area between Albany and Montreal, serving a population of nearly 350,000, many of whom live in the remote reaches of the Adirondack Park.

- **Glens Falls Civic Center** -- a 4,800-seat, city-owned, multi-purpose facility, this has been proposed as a shelter for the entire tri-county (Warren/Washington/Saratoga) region;

- **Stichman Residential Towers** -- an 11-story, 81-unit apartment building operated by the HUD-funded Glens Falls Housing Authority, this complex houses more than 100 low-income seniors.

- **Glens Falls Municipal Wastewater Treatment Plant** -- like the hospital, this facility serves much of the surrounding region, including the Town of Queensbury (Warren County), Town of Moreau (Saratoga County) and the Village of South Glens Falls (Saratoga County), in addition to the City of Glens Falls. While this facility is powered by two electrical feeds, it does not have any back-up generation onsite. In the event of a serious threat to the grid which affects both feeds, then, the plant would lose 70% of their treatment capabilities.

Finch's current cogeneration plant uses wood waste and black liquor to produce approximately 16 MW of energy, all of which is used internally by the mill; this energy supplements an existing 15 MW Brookfield hydropower plant located in the Finch facility. By expanding the cogen facility using the mill's currently land-filled paper sludge, Finch believes that it can expand its generating capacity by approximately 10 MW. Finch is currently engaged in a number of significant energy reduction projects; upon completion of these projects and the expanded cogen facility, Finch projects that it will produce roughly 5 MW in excess of its own needs (see Appendix B for load profiles of off-taking facilities).

In order to establish a secure, resilient connection between Finch and the four facilities above, the GFCM will include underground transmission lines between the Finch cogen plant and two nearby substations: Henry Street Substation and Glens Falls Substation (see Appendix A). While underground lines already exist between the Henry Street Substation and Glens Falls Hospital, additional underground lines will be installed from the Glens Falls Substation to the Wastewater Treatment Plant, and from the Finch plant directly to the Civic Center and Stichman Towers, which are directly adjacent to the mill. (Although directly adjacent to the Civic Center, the Finch plant is currently connected to the electrical grid from a separate 115 kV transmission line).

The proposed microgrid described in this Feasibility Study constitutes Phase 1 of what is planned as a two-phase microgrid for the City of Glens Falls. Inasmuch as the Glens Falls and Henry Street substations described above also feed the Glens Falls Secondary Network, which in turn services much of downtown Glens Falls, the GFCM project team believes that the creation of the interconnections outlined above would enable Phase 2 of the GFCM, an expansion of the microgrid into the roughly-two-hundred customers served by the Secondary Network. Among these are City Hall, the Glens Falls Police Station, and the Ridge Street Firehouse, in addition to pharmacies, restaurants, a hotel, gas stations, St. Mary's Catholic School, and Cronin Towers, a second HUD-funded senior residential facility operated by the Glens Falls Housing Authority. While Phase 2 of the GFCM is outside the scope of the NY Prize -- largely due to commercial complexity and considerations surrounding the integration of Distributed Generation onto secondary networks -- the project team believes that the Phase 1 project supported by the NY Prize will enable eventual expansion of the GFCM into the Secondary Network (and beyond).

Sub-Task 1.1: Minimum Required Capabilities

Currently, electricity is delivered into downtown Glens Falls primarily through a number of transmission lines. One of these -- a 34.5 kV line into the **Henry Street substation** -- connects the nearby Boralex hydro plant (located on the south side of the Hudson, adjacent to the Finch Paper mill) to the Glens Falls Hospital, as well as to an underground Secondary Network (stepped down to 4160 v) covering much of the downtown area. This 34.5 kV line also connects to the **Glens Falls Substation**, where it then creates a parallel connection to the Secondary Network, and also connects to the Glens Falls Wastewater Treatment Plan via a dedicated 34.5 kV line.

A separate 13.2 kV transmission line supplies the Civic Center and Stichman Towers senior residential housing facility; as such, these two facilities do not connect to either the Henry Street or Glens Falls substation (see Appendix C for Interconnections Diagram). It should be mentioned that,

despite the various, disparate interconnects, all four of these facilities included in the GFCM are clustered on roughly adjacent parcels on the north side of the Hudson River near downtown Glens Falls, with a total distance between them of less than one mile. What's more, a secure ring bus encircles nearly all of Finch's property, and is thus relatively close to both the Henry Street and Glens Falls substations. This will minimize the distance over which transmission lines will need to be buried in order to create a resilient, severe-weather-resistant microgrid. Completed as described above, then, the result will be an island-able microgrid network in which the four off-taking facilities are powered by Finch on a continuous, 24/7/365 basis, using the mill's paper sludge waste-to-energy generators.

Although the Finch mill will constitute the primary energy source for the GFCM, the creation of the microgrid network will allow for the possible future inclusion of both additional sources of energy as well as additional off-takers. Possible capacity additions include a biomass digestion combined heat and power-energy facility at the Wastewater Treatment Plant, and photovoltaic generation at a number of as-yet-undefined locations. Any smaller solar installations will act as complements to a proposed 2.5 MW, NYSERDA-supported solar field that the City has contracted with Solar City to construct on city-owned land outside of the proximate microgrid area, which will operate under a remote net-metering arrangement. We are also examining possible battery storage options, primarily for the purposes of ancillary service support (voltage regulation).

Due to the fact that the primary power source for the GFCM is Finch Paper's existing cogeneration plant, supplemented by selective solar installations, maintenance schedules will follow existing protocols for the existing cogeneration facility. Given that this power is both durable and of sufficient capacity for the facilities in the GFCM, intermittent solar resources and attendant energy storage capacity will be utilized primarily for economic purposes, rather than for emergency power, thus obviating the need for energy storage beyond that selected for economic benefit, demand response, black-start requirements, or voltage regulation.

It should be reiterated that the Finch cogeneration facility currently operates at approximately 16 MW, or just under 60% of its nameplate (28 MW) capacity, and is currently fueled by wood waste and black liquor from mill operations. However, these fuels are insufficient for Finch to operate at full capacity; as such, Finch is enthusiastic about the possibility of expanding this facility to its full capacity through the expanded use of paper sludge, which is currently being sent to a Saratoga County landfill.

Communication between the existing generation assets (Boralex and Finch/Brookfield) and the local utility (National Grid) already exists; as such, no significant additional communication protocol would be necessary. Similarly, cyber security measures will adhere to existing SCADA protocols to ensure that communication between the GFCM and the larger grid remains both secure and confidential.

Beyond the Glens Falls Hospital, Civic Center, Stichman Tower, and Wastewater Treatment Plant, eventual connection to the Secondary Network -- either through the Finch plant, the Boralex hydro facility, or other new energy sources -- will expand the number of customers in the GFCM to several dozen, including City Hall, police and fire stations, a public library, a water-bottling facility, restaurants, hotels, multi-family residential complexes, houses of worship, a Catholic school, banks,

pharmacies, gas stations, and numerous smaller retail outlets. What's more, because the GFCM relies substantially on base load energy sources, the availability of sufficient energy for the GFCM would be nearly indefinite. In fact, from a technical (if not business-model) perspective, it is expected that the GFCM could demonstrably constitute an on-going, continuous 24/7 energy network. Islanding will be accomplished automatically, when the supply from the National Grid service is interrupted. Two things will occur: First, the send out to the 115Kv circuit will be reduced. Then, after a period of time, demonstrating that the system interruption will not be quickly resolved, the microgrid circuits will energize to deliver directly to Microgrid customers. This mode of operation, with full voltage and frequency control, can be sustained indefinitely until National Grid primary circuits are restored.

The project will connect the Finch plant to the critical facilities in the GFCM primarily via underground transmission lines, each facility of which is less than 500 meters from the point of generation. Buried transmission lines to the Henry Street substation will connect with existing underground lines from Henry Street to the Hospital, as well as to the existing Secondary Network. This will create a high level of resiliency for the entire GFCM in the event of severe weather, such as an ice storm, damaging winds, flooding, or heavy snow. Short of a natural disaster such as an earthquake that compromised the dam or a drought of such magnitude that the Hudson River itself could not maintain even nominal volumetric flow, the GFCM would thus be guaranteed an uninterrupted supply of power for an indefinite period of time. Resiliency on the Finch site comes primarily in the form of multiple fuel options for electric generation (hydro, biomass, natural gas). Historically the site has never been mal-affected by severe weather events. Onsite fuel storage will support full capacity operation for at least 15 days, after which load management and generation dispatch protocols will support full service to the microgrid for extended periods. The Finch site has a redundant 34.5 kV bus bar ring and can currently operate in islanded mode and provide black start.

Sub Task 1.2 Preferable Microgrid Capabilities

Although the GFCM will to a large degree retain the basic energy infrastructure that exists in Glens Falls today, the project partners plan to take several steps to ensure that the GFCM operates as smoothly, safely, and efficiently as possible. Given that one of the goals of the project is to provide opportunities for economical blue-sky operation, such steps will include the incorporation of Microgrid Logic controllers and digital relays, Smart Meters. Additional technology options could include load management and energy storage. Metering and control will be fully compliant with National Grid's interconnection standards. Additional technology options will be deployed to the extent that they are cost effective.

One initial step the City is taking is the process of pursuing energy audits for several municipal facilities. With support from NYSERDA, the City of Glens Falls recently joined the Climate Smart Communities program, and is seeking to provide updated energy information for several facilities in the proposed project, in order to develop strategies and employ technologies that minimize load requirements. Among these Demand Response strategies are the possible inclusion of Smart Meters and battery storage, ultimately done in order to best utilize generation from the Boralex plant which, as a run-of-river facility, is not able to impound water and thus generates excess night-time energy. In the GFCM, such low-cost energy would be directly available to facilities like the Hospital and Wastewater Treatment Plant, whose night-time demand is relatively high, but also indirectly available -- via battery storage -- to facilities like the Civic Center, an entertainment venue whose load profile

varies widely based on its schedule of events and activities. In looking at the expansion of the Finch Paper cogeneration plant or the inclusion of solar on one or more facilities, we are also considering the inclusion of battery storage as a means of voltage regulation for the GFCM.

All of the critical facilities to be included in the microgrid have active energy conservation initiatives. Additionally, the building control systems at the hospital and civic center and process controls at the Waste Water Treatment Plant can be configured, if needed, to support dynamic load management schemes that will be responsive to load-shedding through periods where demand approaches available supply, especially during black sky periods when the microgrid operates in Islanded Mode.

Depending on our ability -- either initially or eventually -- to incorporate the Boralex South Glens Fall hydro facility into the GFCM, and thus provide additional load to the GFCM, we plan to examine the possibility of creating a secure, resilient transmission line from the Boralex plant to the Henry Street Substation; this would insure power to the existing Secondary Network during a "black-sky" event affecting even local power lines. Currently, however, the Boralex facility has a Power Purchase Agreement (PPA) with National Grid in place until 2021; as such, incorporation of the Boralex facility into the GFCM prior to expiration of the PPA will require either the expiration or accommodation of that agreement.

The GFCM envisions the possibility of including energy storage capacity by keeping ample stored energy on hand that can be dispatched to desired Glens Falls facilities as an additional back-up to other security measures, staggering the use of such energy devices so as to simultaneously: a) peak-shave energy use to all municipal facilities; while at the same time b) maintain the above defined energy storage capacity, working with National Grid to assure real-time coordination of as much peak-shaving as National Grid determines to be optimal. It is as-yet-undetermined which facility or facilities might include such storage capacity.

The GFCM envisions a number of clean power sources, including hydropower, solar power, and large-scale cogeneration, which will be fueled by wood waste, black liquor and potentially paper sludge, which is now being sent to a Saratoga County landfill. However, a recent development that may revise and enhance the GFCM even further is the recent award of an $845,000 grant from the Adirondack Gateway Council to the City of Glens Falls (along with the Towns of Kingsbury, Queensbury and Moreau) to examine solid wastewater and solid waste disposal issues, and improve disposal of material such as restaurant grease and food waste. One possible component of that solution is an anaerobic co-digestion waste-to-energy facility at the Wastewater Treatment Plant, which would replace a current, obsolete Solid Waste Incinerator, provide an additional source of energy for the GFCM, and address regional needs for bio-solid disposal. This study is scheduled for completion in 2016.

The inclusion of the Glens Falls Hospital and Finch Paper in the GFCM means that the two largest employers in the City of Glens Falls stand to gain economically from a project that also improves the environment, which is consistent with the institutional goals of both organizations. Glens Falls Hospital has been considering the installation of a CHP system for several years and, given its importance as a regional health care facility, is enthusiastic about the possibility of securing

significant, economical, locally-generated power on demand. For its part, meanwhile, Finch Paper has been examining the expansion of its cogeneration facility for a considerable time, and views the development of the GFCM as the possible catalyst to realize its expansion plans, while allowing the mill to remove a significant waste-stream (paper sludge) from regional landfills. Finally, off-take agreements between Finch and the microgrid partners will serve to underwrite much of the cost of the project over time.

Regarding the possibility of incorporating tools and strategies that strengthen the surrounding power grid and increase the amount of actionable information available to customers -- providing a platform for customers to be able to interact with the grid in ways that maximize its value -- the City plans to work closely with project partner Johnson Controls to develop a platform to provide customers in the GFCM with access to information and technology that will enable them to maximize energy efficiency both during periods of grid stress and for purposes of economic benefit.

The Glens Falls Community Microgrid presents the possibility of providing continuous emergency power to several of the city's critical facilities and vulnerable populations. Facilities such as the Hospital, Civic Center, Wastewater Treatment Plant and Housing Authority stand to benefit not only from the availability of significant emergency power, but only from a source of economical power on a 24/7 basis. Beyond its value to the community during times of threat to the grid, however, the GFCM will also allow for much of the City's energy demand to be met with renewable energy, including significant energy from waste. This, in turn, will constitute a significant first step in the City's long-term goal to become a community that generates its entire electric demand from local, renewable sources.

Task 2: Develop Preliminary Technical Design Costs and Configuration

Sub Task 2.1 Proposed Microgrid Infrastructure and Operations

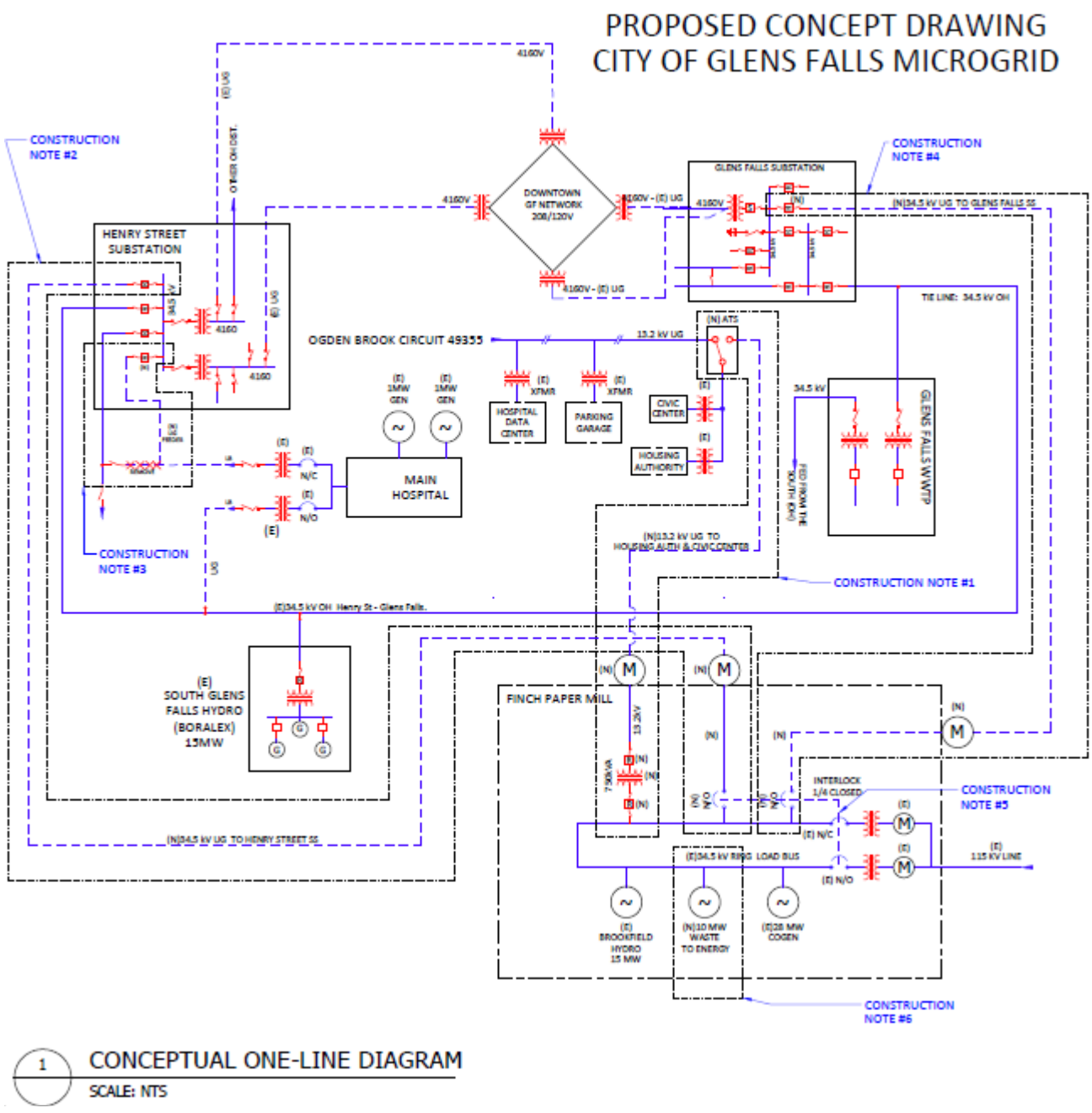
The proposed microgrid for the City of Glens Falls will consist of the addition of a new 10 MW waste-to-energy boiler and steam generator to be constructed at the Finch Paper Mill. This 10 MW plant will supply energy for Finch's own facility, and allow them to sell energy to the four critical facilities in the microgrid -- Glens Falls Hospital, Public Housing Authority, Civic Center and Wastewater Treatment Plant -- during both normal operation and in the event of an extended outage on the transmission system serving the area. This energy will be transmitted into the grid during normal operations through the existing 115 kV line, and directly to the microgrid off-takers during precipitating events. The microgrid project provides Finch with a firm off take agreement for the loads associated with the microgrid stakeholders. To the extent that the microgrid expands its off takers, Finch can continue to supply electric service to new loads. In the meantime, wholesale market transactions will be used for excess capacity not already committed to the microgrid. In the event that other sources of generation are introduced into the microgrid, or load reductions measures are pursued, this arrangement will provide Finch with the ability to supply additional off-takers under normal operations (via the 115 line), while simultaneously providing them with long-term off take agreements with the other facilities in the GFCM. In addition to the new generator, new distribution feeders and associated switchgear are required to provide the service and redundancy required.

The new 10 MW generation will be connected to Finch's existing 34.5 kV ring bus. A new feeder originating from the Finch Paper Mill 34.5 kV ring bus distribution system will be constructed to the Henry Street substation. Conductors will be run underground and across the canal to the substation. New switching devices will be added at Finch Paper Mill ring bus, as well as the Henry Street Substation. The new feeder to the Henry Street Substation will be energized in the event that the 115 kV transmission feeding the Finch Paper mill goes out of service.

Another new feeder emanating from the Finch Paper ring bus distribution system will provide a distribution connection to Glens Falls substation. Henry Street Substation and Glens Falls substation are the two main means of serving downtown Glens Falls.

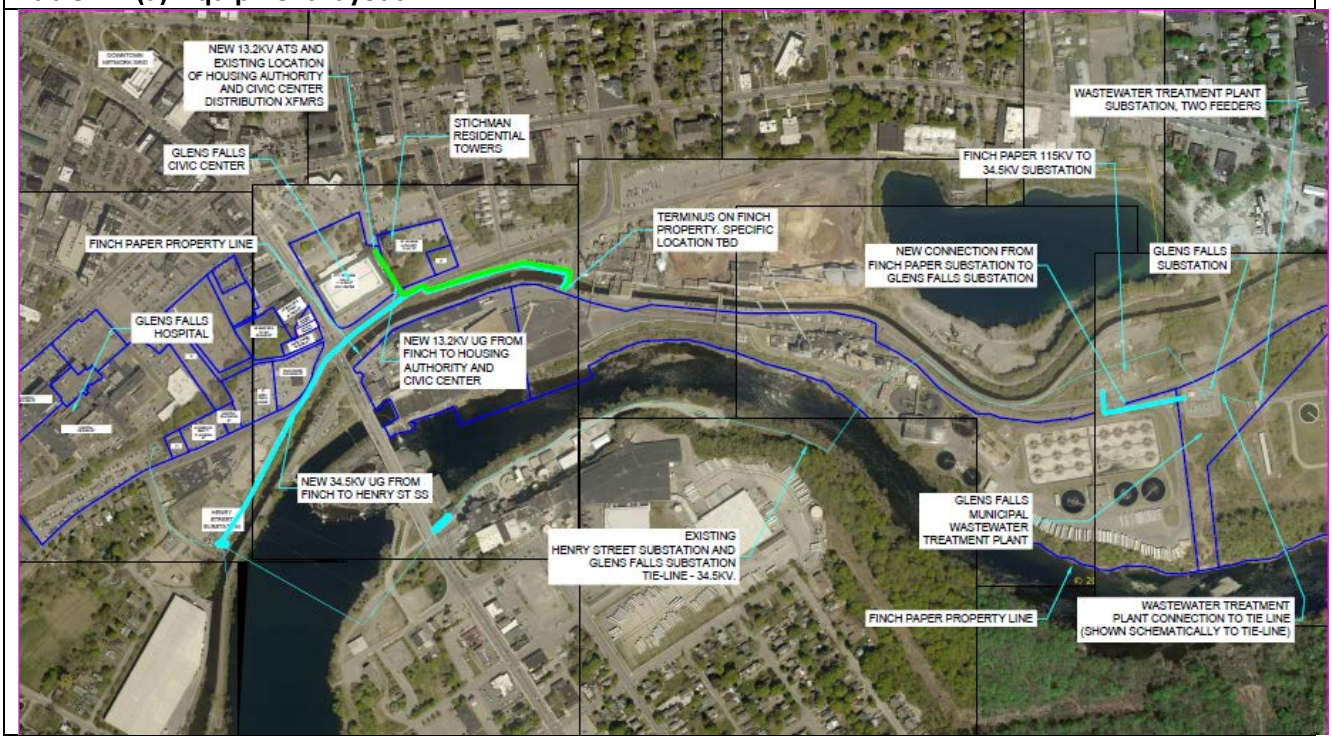
A new 13.2 kV distribution system will be established as a backup to the Ogden Brook feeder 49355 through a new Automatic Transfer Switch (ATS) co-located with existing National Grid transformers near the Housing Authority and Civic Center. Meanwhile, a portion of one of the feeders serving the hospital from the Henry Street substation will be relocated as an underground service, which should provide better reliability for the Hospital.

Table 2.1: One-Line Diagram with Location of Electrical Loads



Note: Phase 2 work is only implied by the supply connections to the secondary network. During Phase 1 there is insufficient capacity to energize the secondary network in full and the commercial model for phase 2 will require significant network upgrades that are not currently economically supportable. Connections to the secondary network currently exist and operational. Shown here for discussion purposes only.

Table 2.1 (a) Equipment Layout



Under normal conditions, there will be no change of operation with the exception that a new 10 MW generator will be operating at the Finch Paper Mill site. Normal conditions, in this case, are those in which the 115 kV transmission system is energized and interconnected to the Finch Plant, while the 34.5 kV interconnect between National Grid and the Finch Plant is open (de-energized).

Under emergency conditions - meaning that the 115 kV transmission system is out of service - the 10 MW generation system will supply three feeds: a 34.5 kV feeder will be energized to serve Henry Street Substation; a 34.5 kV feeder will be energized to service Glens Falls Substation; and a 34.5 kV feeder will be energized to serve a 750 kVA step down transformer that will energize a 13.2 kV feeder with limited capacity.

The energization of the line feeding the Henry Street Substation will be coordinated with the opening of Henry Street's switches and breakers such that the 34.5 kV bus will be energized, but only the feed to the Hospital will be utilized. All other breakers and switches serving other load will be opened and the feeders de-energized.

The energization of the line feeding Glens Falls substation will be coordinated with the opening of Glens Falls' switches and breakers such that the 34.5 kV bus will be energized by the new feeder, but only the feed to the Wastewater Treatment plant will be energized. All other breakers and switches serving other load will be de-energized. A reclosing circuit breaker on the tie line between Glens Falls and Henry Street substations will be opened as well.

The 34.5 kV feed through the 750 kVA step-down transformer to 13.2 kV will be coordinated with the opening of a new automatic transfer switch that will allow only the Civic Center and Housing Authority to be energized from the Finch ring bus.

Sub Task 2.2 Load Characterization

The microgrid will serve 100% of the electrical load requirements for all four of the off-takers, which include the Housing Authority, the Wastewater Treatment Plant, the Civic Center and the Hospital. During normal operations (parallel mode), electricity generated by Finch Paper will be sent for sale to the 115 kV transmission system. During emergency operations (islanded mode), automatic transfer switches will engage and will route electricity to directly serve the microgrid off-takers.

Table 2.2 illustrates the load characteristics of each of the off-takers. Initially, there will be no thermal load served by the microgrid, but there may exist an opportunity to serve thermal load as the microgrid expands to meet future opportunities. The Finch Paper facility has the ability to generate excess steam which could potentially be routed to serve the needs of the Hospital and the other off-takers.

Table 2.2: Peak kW, Average kW, and Monthly kW & kWh

Glens Falls Community Microgrid	Glens Falls Hospital		Glens Falls Civic Center		Glens Falls Housing Authority - Stitchman Towers		Glens Falls WWTP		Total kWh	Total kW
Month	kWh	kW	kWh	kW	kWh	kW	kWh	kW		
Jan-14	1,343,630	2,338	165,792	520	37,920	74	282,459	540	1,829,801	3,472
Feb-14	1,211,852	2,276	150,651	499	33,920	72	249,363	552	1,645,786	3,400
Mar-14	1,310,652	2,318	143,002	507	32,640	75	285,795	540	1,772,089	3,440
Apr-14	1,434,191	2,988	117,810	510	32,000	56	262,185	552	1,846,186	4,106
May-14	1,701,575	3,204	79,456	234	29,120	51	301,074	576	2,111,225	4,065
Jun-14	1,803,924	3,401	63,766	166	30,400	75	317,178	648	2,215,268	4,291
Jul-14	1,943,190	3,528	83,158	149	45,760	93	335,400	660	2,407,508	4,430
Aug-14	1,864,725	3,387	66,616	171	33,600	82	318,423	624	2,283,364	4,264
Sep-14	1,744,265	3,483	112,419	387	35,680	83	250,140	588	2,142,504	4,542
Oct-14	1,624,869	3,230	171,306	493	32,640	62	297,981	576	2,126,796	4,361
Nov-14	1,369,438	2,944	184,726	477	30,880	62	295,665	576	1,880,709	4,059
Dec-14	1,312,014	2,235	137,459	507	37,280	66	304,278	576	1,791,031	3,384
Total	18,664,325		1,476,161		411,840		3,499,941		24,052,267	
Peak kW		3,528		520		93		660		4,542
Average kW		2,944		385		71		584		3,984

See above Table 2.2 for monthly load profiles for each off taker. Hourly load profiles were not examined because the microgrid is sized to exceed 100% electrical requirements for all off-takers.

The sizing of the microgrid has evolved concurrently with Finch Paper's plan to expand its existing power generation capabilities. Finch Paper is planning to install a waste-to-energy power plant that will expand its generation capacity by 10 MW, while the loads served by the microgrid during emergency operations will be roughly 5 MW. Therefore, the microgrid will be sized to exceed 100% electrical requirements for all off-takers under an emergency state. During normal operations, the electricity will be used onsite at Finch to meet up to 100% of its onsite demand, with any excess electricity to be sold to an Electric Retailer or the NYISO wholesale market.

In the rare event that Finch's waste-to-energy plant experiences an outage during emergency conditions (loss of the 115 kV feed to the area), Finch would be able to allocate power from another existing cogeneration plant located on their site to serve the off-takers. In this event, Finch expects to be able to meet the demand of the microgrid by shedding load at the mill.

Sub Task 2.3 Distributed Energy Resources Characterization

NOTE: Please refer to the one-line diagram provided in Table 2.1 and equipment diagram in Table 2.1(a), which shows the DER and other resources to be installed.

Distributed Energy Resources (DER) will be in the form of electric generation assets that Finch Paper is planning to build, with existing assets available for redundancy. Finch is planning to install a waste-to-energy biomass boiler and associated condensing steam turbine to generate additional electricity that can be used to fully support the microgrid or on site at Finch's plant. This boiler will have the capacity to produce 10 MW of electricity.

The fuel to be used is paper sludge – a residual of Finch's paper making process – and biomass. Currently, the paper sludge is being land-filled. The new boiler will eliminate the land-filling process and utilize the paper sludge as fuel. Additionally, other waste biomass material will be sourced to supplement the paper sludge supply.

Finch's existing CHP assets include a 28MW extraction steam turbine, using steam produced by on-site steam-generating boilers (fueled by black liquor, waste wood, and natural gas). Additional electricity is available from a 15 MW run-of-river hydroelectric asset.

The existing DERs (backpressure turbine and hydro) collectively have served local plant loads reliably for over 40 years. The additional capacity from the 10 MW waste to energy asset will be operated to meet 100% of the microgrid loads under both normal and emergency operation.

The DERs that currently exist on site have not been materially impacted by forces of nature that are typical to the area. The proposed waste-to-energy DER will have a resiliency equivalent to the existing assets. In fact, with the addition of the waste to energy DER and the condensing electric generation cycle, the dispatch of the unit will support electric load following on the microgrid. This load following provides additional resiliency as the electric generation is not dependent on corollary steam loads.

Fuel sources for the existing generation assets include Black Liquor from Pulping Operations, waste wood from Finch's wood yard, and natural gas as a supplement, when needed. Brookfield's onsite run-of-river hydro asset is permitted for up to 15 MW and is impacted by seasonal water flow.

The proposed waste-to-energy asset will be fueled by both paper sludge that is generated by the paper mill and currently land-filled. Additional biomass waste wood will be sourced to supplement the paper sludge. Fuel supplies may vary slightly depending on paper mill operating capacity; however, fuel specifically for the microgrid load serving capabilities is expected to available for a 15-20 day onsite supply. This parameter can be extended based on commercial requirements which are yet to be established.

The plant currently exports several MW of electrical capacity and energy to the 115kV network and has black start capability. Voltage control, inside the plant, is accomplished using capacitor banks. When configured in emergency mode, the generation of the plant will be in load following mode – to meet full requirements of all connected microgrid customers. The feeder interconnection at 34.5 kV and 13.2 kV will be fully compliant with National Grid Interconnect requirements. Voltage and frequency regulation are currently operating to support the roughly 28 MW of energy currently being generated on the Finch site (which includes the Brookfield hydro facility). Distribution controls under microgrid service mode will be an extension of the current control scheme.

Sub Task 2.4 Electrical and Thermal Infrastructure Characterization

All of the described existing and new equipment will be required as part of the microgrid operation.

Finch Paper currently is fed from a 115 kV distribution at a customer-owned substation. The Finch Paper site has a 34.5 kV ring bus installed that currently has 28 MW of cogeneration installed. In addition, Finch currently has a PPA with Brookfield Renewable Energy for the output from Brookfield's hydro-electric facility, located in the Finch facility. Brookfield is connected to the Finch distribution and, by extension, to the 115kW distribution system. The South Glens Falls (Boralex) Hydro is connected to the 34.5 kV tie line.

The tie line between Glens Falls Substation and Henry Street Substation is an overhead line currently and would appear to be subject to outages. As a measure of resiliency, the planned system will allow for Finch Paper to island from the 115kV distribution system and connect to the 34.5 kV distribution at several locations. The first connection is at Henry Street Substation through a dedicated and new feeder switch. A second connection is through a new dedicated feeder connected at the Glens Falls Substation. A third will be through the installation of a 750 kVA transformer that will be 34.5 kV:13.2 kV and will serve the Civic Center and Housing Authority.

Dedicated Feeder for Civic Center and Housing Authority:
Upon loss of the 42355 13.2kV feeder, Civic Center and Housing Authority would transfer to the dedicated feeder established from 34.5kV Finch's distribution system through a 34.5kV to 13.2kV, 750 kVA transformer, and an Automatic transfer switch, which is located near the Civic Center / Housing Authority, will switch existing transformers.

Henry Street Substation (Located at 18 Basin Street, Glens Falls) – New Dedicated Feeder:
Henry Street Substation will have a new dedicated feeder circuit breaker installed on the substation location in order to provide for a method to connect to Finch Paper's 34.5kV ring bus. In the event of either loss of the 115 kV distribution OR loss at Henry Street Substation, Finch's 34.5 kV ring bus would be able to serve a portion of the Henry Street substation load. The Henry Street substation would open all breakers and then close into the feeder from the Finch Paper ring bus. The Henry Street substation would then energize the feeder to the Hospital only.
Henry Street substation will likely require upgrades of protection system components for existing feeders due to the dated protection systems currently in use at that substation.

Glens Falls Substation (Located at 6 Shermantown Road, Glens Falls) – New Dedicated Feeder:
Glens Falls Substation will have a new dedicated feeder circuit breaker installed on the substation location in order to provide for a method to connect to Finch Paper's 34.5 kV ring bus. The Glens Falls Substation is within 400 feet of a connection point to Finch's distribution and they are on adjacent properties. In the event of either a loss of the 115 kV distribution OR a loss at Glens Falls Substation, Finch's 34.5 kV ring bus will be able to serve a portion of the Glens Falls Substation load. The Glens Falls substation would open all breakers and then close into the feeder from the Finch Paper ring bus. The Glens Falls substation would then open a reclosing circuit breaker on the tie line between Glens Falls Substation and Henry Street Substation. The Glens Falls substation would then energize the feeder serving the WWTP.

Glens Falls substation will likely require upgrades of protection system components for existing feeders due to the dated protection systems currently in use at that substation.
As described above, there is a dual set of connections to the National Grid 34.5 kV distribution that connects through both Henry Street and Glens Falls Substations. The first level of redundancy is a tie line, which is overhead and is necessary for continuity of service to the downtown network. This tie line allows for redundancy of service for all the loads served by the Henry St. and Glens Falls substations. New underground feeder connections will be made at both Glens Falls and Henry Street Substations, offering additional resiliency in the event of a tie line outage associated with wind or icing events.

The time consideration for continuous operation support is not limited. The network will continue to deliver power to microgrid off-takers for the entire duration of an event. Inventories of fuel will be maintained in expectation of running the waste-to-energy plant for up to 20 days. Additional options for continued service exist due to the diversity of generation assets and fuels that are part of the facility's overall energy production. These options, and the degree to which any event affects paper productions on site, might well allow the microgrid to operate well beyond the 20-days of projected fuel inventory by shifting fuel currently allocated for plant operations to microgrid energy production assets.

Normal operation of the Finch Plant with 28MW of cogeneration and the additional 10 MW from the new DER will normally be connected the way it is currently, which is to the 115 kV distribution under an existing agreement for exporting power. These are the primary microgrid assets. However, when the 115 kV distribution system is down, Finch would have the opportunity to connect to the 34.5kV distribution, and if that distribution remains online, would be a second option for being grid connected.

Creation of the Glens Falls Microgrid and supply redundancy:
Glens Falls Substation Connection:
The connection from Finch's eastern electric substation, known as Finch Bank One, would be achieved by installing bus clamps on the 34.5kV conductors and installing a circuit breaker, with a means of disconnect on the load and line side. Five (5) utility poles would be installed and an additional circuit breaker, with a means of disconnect on the load and line side, would also be installed at the Glens Falls Substation. National Grid would be responsible for the connection from their 34.5 kV point of interconnect to the new disconnect switch.

Henry Street Substation Connection:

The connection from the Finch Paper Mill 34.5 kV Switch House would be achieved by utilizing a spare breaker in the switchgear, installing a disconnect switch, and routing the service north through the parking lot, continuing north across an existing trestle, and traveling underground to the west and terminating at a new circuit breaker, with a means of disconnect on the load and line side, in the Henry Street Substation. This requires crossing under Main Street and continuing underground through a parking lot owned by National Grid. Again, National Grid would be responsible for the connection from the 34.5 kV service to the new disconnect switch.

Operational and Protection Description:

The circuit breakers at Finch Bank One and Finch Paper Mill 34.5 kV Switch House would be normally closed. The circuit breakers at the Glens Falls and Henry Street Substations would be normally open. Communication from National Grid's existing yard equipment will be extended to the new circuit breakers. Upon loss of normal service, the new circuit breakers will receive a command to close. Upon restoration of normal service, the new circuit breakers will receive a command to open. All operational requirements will need to be coordinated with and approved by National Grid.

Sub Task 2.5 Microgrid and Building Controls Characterization

The microgrid control architecture will not interact with Building Energy Management Systems (BEMS). Automatic transfer switches will be used for converting from National Grid's normal operation service to emergency mode. Supply that meets the full requirements of the off-takers is anticipated while in emergency mode so there is no need for a load shedding scheme to be implemented by the BEMS.

The microgrid controller for Glens Falls will need to be coordinated with National Grid as substation breaker/switch/recloser operation will need to be closely coordinated and operations tested and approved by National Grid. Once in Island mode, the design of this particular project will not require load shedding or demand response schemes, but may do so to help monetize the investment for the City. Black start and load following capabilities are already present. The controller will be selected during phase 2, but, we are currently favoring the IPERC technology suite.

From a weather resiliency perspective, the microgrid controller will be located indoors and may be susceptible to a severe wind or tornado event.

Sub Task 2.6 Information Technology (IT)/Telecommunications Infrastructure Characterization

The resiliency and robustness of the communications architecture is dependent on two critical design factors: Medium and security. The preferred medium for maximum security is fiber optic cable, typically installed in underground conduit linking all critical loads, generations and assets. A cyber-security overlay is then added to the architecture via hardened networking equipment (routers, switches, etc.) to ensure proper directional flow of communications data, as directed by the microgrid control system. Ethernet cabling is also a reliable option to obtain greater data security, although not as robust as fiber, and is the preferred method for most urban and suburban microgrids. Final selection will rely on interconnection requirements with National Grid.

Resilient communications and power flow are the key to having the optimal, resilient microgrid control system. The ability to self-heal when communications are lost to a distributed controller is a highly sought feature of any microgrid control system. Self-healing is the algorithmic art of automatically reconfiguring a control network upon loss, or re-engagement, of a controller or asset. The ability to recognize a lost asset, and automatically re-balance load versus available generation is also a fundamental support requirement. When combined in a common distributed control system, not only are all single-points-of-failure eliminated in the architecture, but the control network is capable of adapting and overcoming any potential disruptive scenario, and thereby offering the optimal resilient solution. Communications systems will be developed with underground fiber optic communications with the new feeders being installed. The communications will be designed to interact with all coordinated assets on the distribution system. Connection to the National Grid operations center, as well as all system protection coordination and operations, will be done with complete coordination and approval of National Grid.

Task 3: Assessment of Microgrid's Commercial and Financial Feasibility

Sub Task 3.1 Commercial Viability – Customers

The critical facilities that would be incorporated into the Glens Falls Community Microgrid (GFCM) combine to serve a total population of approximately 347,000.

Glens Falls Hospital is a non-profit, 410-bed facility, and is the largest hospital between Albany and Montreal; as such, it serves approximately a population of approximately 347,000 in Warren, Washington, Essex, Hamilton, Northern Saratoga and Northern Rensselaer counties, along with much of the southeastern Adirondack region. Perhaps the most telling statistic regarding the Hospital's regional importance is that a total of 52,574 people came through the doors of the David S. and Janet R. Sheridan Emergency Care Center in 2010.

Glens Falls Municipal Wastewater Treatment Plant serves 25,000 people in the surrounding region, including the Town of Queensbury (Warren County), Town of Moreau (Saratoga County) and the Village of South Glens Falls (Saratoga County), in addition to the City of Glens Falls.

Glens Falls Civic Center is a 4,800-seat multi-purpose entertainment venue that is designated as an emergency shelter and triage facility for the Glens Falls Hospital. The Civic Center is also capable of serving as a shelter for the entire tri-county (Warren, Washington, Saratoga) region.

Stichman Residential Towers consists of two 11-story buildings with 81 apartments, and is operated by the HUD-funded Glens Falls Housing Authority. The vulnerable population served by this complex includes more than 100 low-income senior citizens.

The microgrid will supply wholesale market ancillary service support to the 115kV network during "normal" mode of operation. These services will be in the form of spinning reserve and frequency and voltage support. During emergency or islanded mode, the same services will be provided but on a much smaller scale. Certainly there will be some infrastructure upgrades that will be paid for as part of the microgrid project to support substation switching and automation.

Historically, the Finch Paper site has managed such services within its own plant. With the expansion of generation to provide regular export from the site to support microgrid service, the controls and regulation of hydro and thermal generation sources will be coordinated to meet grid power management for both on-site distribution at the Finch plant as well as provide proportionally required services when exporting to the 115kV transmission system in normal mode of operation and the 34.5kV distribution system in emergency mode.

During its initial phase, the microgrid is expected to have the following customers purchase electricity during both normal mode operation and emergency mode operation:

- Glens Falls Hospital
- Glens Falls Municipal Wastewater Treatment Plant
- Glens Falls Civic Center
- Stichman Residential Towers/Glens Falls Housing Authority

In addition the facilities listed above, the possibility exists for future expansion of the microgrid to serve a significant portion of the downtown Glens Falls area being currently being served by the Glens Falls Secondary Network, including City Hall, police and fire stations, a public library, a water-bottling facility, restaurants, hotels, multi-family residential complexes, houses of worship, a Catholic school, banks, pharmacies, gas stations, and numerous smaller retail outlets. While such expansion is outside the scope of the NY Prize, the generation capacity and interconnections resulting from the NY Prize project will enable future enlargement of the GFCM.

Other Glens Falls Community Microgrid stakeholders include:

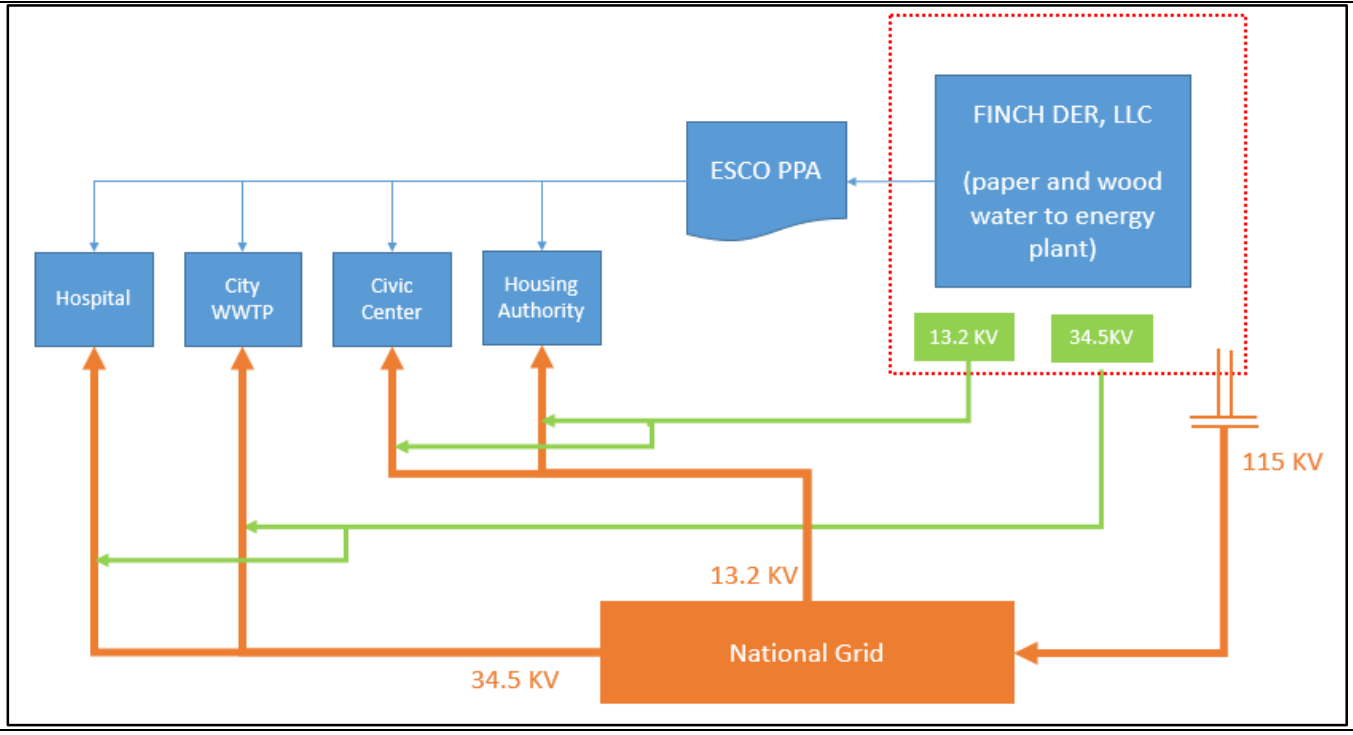
- City of Glens Falls - Applicant for NY Prize and owner of the Wastewater Treatment Plant and Civic Center
- Finch Paper - Owner of the DER providing power to the microgrid
- National Grid – local utility service that will own and manage microgrid transmission network
- Residents in the Glens Falls/Southern Adirondack region.

The approximately 347,000 residents in the Greater Glens Falls / Southern Adirondack region will benefit from the microgrid by ensuring that critical services provided by the Hospital, Wastewater Treatment Plant, Civic Center and Stichman Towers are available to the public during times of natural disaster or power outage.

As the city is a participant in NY's Climate Smart Communities program, the microgrid will also help the city to achieve its goals to reduce its greenhouse gas emissions and its environmental impact. The microgrid's use of renewable fuels will also enhance the city's image as a sustainable city and region as a good steward of the environment. The City and region will be further recognized as an environmentally-friendly place to live and do business.

The Glens Falls Community Microgrid will be established as a hybrid model. The City of Glens Falls will act as the Administrative "Owner". The physical infrastructure outside of the DER (such as lines, switching, controls, etc.) will be transferred over to National Grid under a sale transaction primarily for the purposes of ongoing maintenance and service. The sale transaction may be at a nominal value (i.e. $1) however the State will impute a sales/income tax associated with the transaction. The amount of tax due to the State will be addressed as part of the final regulatory and financial due diligence under Stage 2. Finch will own the DER and will sell power to an Electric Retailer, who in turn will sell power to the off-takers during both normal and emergency modes. The City of Glens Falls owns the Wastewater Treatment Plant and the Civic Center. The Housing Authority is independently owned and is operated by a 7-member board, 5 of whom are appointed by the Mayor of Glens Falls. The Hospital is independently owned and operated.

Table 3.1 Microgrid Ownership Model



During normal operation, it is anticipated that the four primary stakeholders - Glens Falls Hospital, Glens Falls Civic Center, Glens Falls Housing Authority and the Wastewater Treatment Plant - will purchase electricity produced by the DER. It will also be possible for other City-owned entities that are not connected to the microgrid, and potentially other unrelated entities, to purchase supplemental power produced by the DER during normal operation, enjoying the benefit of potentially reduced-price electricity. This arrangement would include additional sites owned by the Housing Authority, Hospital, and City of Glens Falls – that are outside the immediate delivery capability of the microgrid during emergency operation.

During emergency, or islanded mode, the microgrid will sell electricity to the four critical facilities only - Glens Falls Hospital, Glens Falls Civic Center, Glens Falls Housing Authority and the Wastewater Treatment Plant.

The current plan is to engage with an Electric Retailer as a strategic partner with the microgrid program. The framework of commodity supply contracting with the microgrid off-takers will conform to the standard terms of service associated with retail electric supply, excepting that the term of service will be for a period of years corresponding with the off-taking term from the Finch generation source. There may be additional language to allow for load growth or reduction over the term of the agreement, as would rights transfer considerations/ change of ownership provision. There may be additional features (riders) associated with standard structure that will address service premiums during emergency mode. However the details for those considerations will come during the Stage 2 design.

The critical and non-critical load purchasers will enter into contracts to purchase electricity with the Electric Retailer that is ultimately selected by the City. The City, as Administrator/Owner of the microgrid, will contract with an Electric Retailer, awarding them the rights to sell electricity to the microgrid off-takers and potential other city-owned facilities.

The Electric Retailer will also contract with Finch Paper, owner of the DER, to purchase power and distribute to the off-takers during both emergency and normal operating modes.

The Glens Falls Community Microgrid stakeholders have been meeting regularly and have all expressed interest, verbally and in writing, in participating in the microgrid project. These four strategic end-users represent 100% of the serviceable load during Emergency operations. It is expected that there could be additional end-use delivery points associated with the normal mode that will not be served during outage events. These additional sales opportunities will be used to build the secured sales block of power with the Strategic Electric Retailer and to provide a participating load of service, if and when the microgrid network expands, possibly to the secondary network in downtown Glens Falls. In addition to the primary off-takers of the microgrid, additional participants will be solicited during the NY Prize Stage 2, when the economic parameters and terms of participation are better defined.

The new DER waste-to-energy plant will also generate a new source of steam. Some of this steam will be utilized on-site by Finch, however, the potential exists to provide excess steam to the Glens Falls Hospital. This benefit would be further explored in Stage 2, and might possibly be handled as an ancillary agreement directly between Finch and the Hospital.

Sub Task 3.2 Commercial Viability - Value Proposition

The four off-taking participants in the microgrid (Glens Falls Hospital, Wastewater Treatment Plant, Civic Center and Stichman Towers) will benefit from the microgrid by having a continuous supply of electricity during times of natural disaster / power outages, enabling them each to remain operational.

Additionally, these primary off-takers will realize economic benefits by avoiding costly interruptions to their operations during emergency scenarios, and in the form of potentially lower-priced electricity during normal operations.

The approximately 347,000 residents in the Greater Glens Falls / Southern Adirondack region will benefit from the microgrid by ensuring that critical services provided by the Hospital, Wastewater Treatment Plant, Civic Center and Stichman Towers are available to the public during times of natural disaster or power outage. As the city is a participant in New York's Climate Smart Communities program, the microgrid will also help the city to achieve its goals to reduce its greenhouse gas emissions and its environmental impact. The microgrid's use of renewable fuels will also enhance the city's image as a sustainable city and region as a good steward of the environment. The City and region will be further recognized as an environmentally-friendly place to live and do business.

The primary benefit to the Utility (National Grid), associated with the installation of the microgrid, includes service resiliency between the two major 34.5 kV substations, along with switching and controls upgrades in the Henry Street substation. There may be some benefits associated with power

supply support to the 34.5 kV network during times of low hydro production associated with the winter and summery low-flow seasons, but the dimension of value will have to be determined through load flow analysis, which is a Stage 2 task.

The proposed business model starts with the generation of electricity at a waste-to-energy boiler to be located at Finch Paper. The boiler will be fueled by biomass (20% paper sludge/80% other wood biomass). Finch will sell most of the electricity produced to an Electric Retailer. The Electric Retailer will then sell the electricity to the microgrid off-takers (Hospital, Wastewater Treatment Plant, Civic Center and Stichman Towers). The Electric Retailer will provide billing services for those connected to the microgrid, utilizing existing National Grid meters. This model will operate similarly during both normal and emergency operations. It is anticipated that during normal operations, microgrid customers will receive electricity priced lower than existing market rates. The potential also exists to sell excess energy during normal operation to other city-owned entities, furthering the financial benefit of the project. The City, as the applicant/owner of the microgrid, will oversee the procurement of the Electric Retailer and will, in essence, award licensing rights to the Electric Retailer to serve the microgrid customers.

Table 3.2 - Glens Falls Community Microgrid - SWOT Analysis of Business Model

Strengths	Weaknesses
• Biomass fuel is environmentally friendly • Paper sludge fuel is sourced on-site, reducing current land-filling costs • Off-takers receive greater price certainty and/or lower-priced electricity during normal mode. • Selling electricity to microgrid provides additional and diverse revenue stream to Finch – largest employer in area • Dual connections to 115KV network and 34.5KV network provides seasonal optionality for wholesale market transactions to maximize economic value • All Stakeholders are strong credit-worthy entities • Full resiliency reduces need for expensive, small-scale, back-up generation • Close proximity of off-takers to the Waste-to-energy plant • Alignment with City of Glens Falls goals to be a "Green" City.	• Will require long term commitments from project stakeholders (suppliers and off-takers) • Various incentives required for economic viability of waste-to-energy plant (Renewable Energy Credits, Excelsior Credits for job creation and a public funding option (i.e., REDC)) • Waste-to-energy plant does emit minimal amount of particulate matter, compared to other clean energy sources (e.g. solar, wind), creating external costs
Opportunities	**Threats**
• Expansion of City purchases associated with properties other than Civic Center and WWTP to be served during parallel mode • Potential expansion of microgrid to the downtown Secondary Network, which includes numerous additional critical facilities. • Potential expansion of DER assets tied to microgrid could include Biogas cogen from Wastewater Treatment Plant, rooftop solar panels, distributed storage assets • Large added generation capacity creates possibility of new business models, such as community net metering	• Regulatory hurdles to be addressed: o Interconnection to National Grid delivery network o Retail wheeling considerations associated with parallel mode operations o Tariff riders for effective treatment of delivery costs during islanded mode operation o Tariff considerations for community beneficiaries for recovery of costs associated with islanded operations • Siting risks associated with the environmental permitting for the waste to energy plant • Energy source subject to ongoing viability of Finch Paper facility

While not unique, the microgrid will benefit from the utilization of a manufacturer that possesses the capability to operate a cogeneration power plant, and which utilizes one of its waste byproducts - paper sludge – as a fuel source. Additionally, the plant is in close proximity to the four critical facilities that will be served by the microgrid.

The project is not unique in that other areas within New York and across North America have similar attributes. The Glens Falls area has existing local generation sources and is in a state that has allowed for retail load to be served by companies other than the existing distribution utility. The utilization of the local generation source to provide other retail customers with energy and capacity in an emergency event (i.e. the loss of the regional transmission system) is one critical factor. Local load has to be matched to the amount of generation available. The capability to utilize the distribution system assets to deliver energy from the local generation unit(s) is also critical. The amount of modification of the distribution system assets through smart switching and other enhancements will need to be understood on a case by case basis with other communities. This project is scalable because there is a potential for adding additional generation capacity to serve a larger stakeholder community in the future. This includes excess capacity from the Finch site as well as additional local hydroelectric capacity (I.e. Boralex).

Having said that, it should be mentioned that Glens Falls does have several attributes that make this project uniquely beneficial. For one thing, the Glens Falls is a compact community with a large number of critical facilities and vulnerable populations in close proximity, all clustered near the downtown business district. As previously stated, however, the critical facilities in this area serve a much greater population. Perhaps more importantly, Glens Falls is the *de facto* hub of a very large area, much of which is located inside the Adirondack Park and thus lacks critical facilities. The proposed microgrid facilities currently rely on the same distant sources of power used by most New York State communities, meaning large percentages of natural gas and nuclear power, along with smaller amounts of coal, oil and renewables, delivered through the larger grid via substations and radial power lines.

While the City does have a Secondary Network which covers a section of the downtown commercial district, this only reaches a few of the City's most important emergency facilities; what's more, this Secondary Network is not connected to any dedicated source of reliable local power, rendering it vulnerable to service disruption in the event of a larger, regional threat to the grid, or a more localized one.

The area is vulnerable to heavy snows, ice storms, hurricanes, high winds, and falling trees, all of which have caused power outages in the past. During Hurricane Irene, the area experienced significant outages lasting several days, resulting from high winds and fallen trees; the Civic Center and Housing Authority experienced short-term outages. While most of the downtown area was spared the brunt of Irene's force, during 2014 and 2015 alone, National Grid indicated there were 21 outages on the 13.2 kV network, impacting parts of the Hospital, the Civic Center and Stichman Towers. Total duration for these outages was over 120 minutes (CAIDI).

The microgrid will utilize locally-generated power from the Finch Plant, which will eliminate potential outages due to other production facilities being knocked offline. In addition, the microgrid network

will be resilient to the hazards identified above with underground transmission lines. It is anticipated that the microgrid could supply electricity in emergency or island mode to the critical facilities for 15-20 days, based on projected on-site fuel supplies.

Glens Falls Hospital

The Glens Falls Hospital is the largest in the region between Albany and Montreal, serving a population of approximately 347,000. In the event of a power outage, the hospital utilizes diesel-powered generation that can power up to 60% of its facilities. Many critical services are curtailed during an outage, such as surgery, imaging, cardiac catheterization, gastroenterology, and more. These services can be essential to treating patients, and the possibility of them not being available severely impacts the quality of care patients would receive. From a financial perspective, this loss of services translates into an economic loss of more than $1,100,000 per day in an extended outage lasting 1 day or longer.

The microgrid would enable the hospital to maintain power during a prolonged outage and allow it to provide all of the critical services needed to its patients, likely saving many lives. Financially, the hospital would be able to avoid the economic impact associated with a loss of services. Additionally, being able to purchase lower-priced electricity during normal operating mode would provide tremendous financial relief to the hospital. Because the hospital maintains a roughly 10% operating margin, every dollar saved in operating expenses is equivalent to generating ten dollars in revenue. The implications of this are important because the operational savings allows for additional investment in other areas of operation that will increase revenues and/or improve patient care.

Glens Falls Wastewater Treatment Plant

Constructed in 1987, the Glens Falls Wastewater Treatment Plant serves approximately 25,000 residents in the City of Glens Falls, along with the neighboring towns of Queensbury, South Glens Falls, and Moreau. The facility is capable of treating 8.5 million gallons per day (MGD), and currently has an average daily flow rate of about half of that.

While the wastewater treatment plant is powered by two electrical feeds, it does not have any back-up generation on site. In the event of a power outage affecting both feeds, they would lose 70% of their treatment capabilities. In this scenario, raw, untreated sewage would be discharged into the Hudson River. Raw sewage could also overflow out of manholes and collection pipes that feed sewage to the wastewater treatment plant. When raw sewage is discharged into surface water, it carries with it bacteria and pathogens that can be a threat to public health and the ecology of the river. In addition to the threats to public health and the environment, the wastewater treatment plant would also be in violation of its State Pollutant Discharge Elimination System (SPDES) Permit, which could result in fines of $37,500 per day.

Furthermore, the offices at the wastewater treatment plant serve as the Emergency Response Center for the City of Glens Falls. Connection to the microgrid would provide the plant with the resiliency required to operate without interruption, avoiding the health and environmental hazards mentioned above. The plant would also avoid the potential financial penalties that could be incurred, and would be fully-functional as the City's Emergency Response Center. During normal operations, they would benefit from lower-priced electricity resulting from being connected to the microgrid.

Stichman Towers/Glens Falls Housing Authority

The residents at Stichman Towers are low income senior citizens with an average age of 74 years. Most residents are disabled physically and/or mentally in some way. During a power outage, their present plans provide for a standard policy of moving residents to a safe location nearby. However, if those nearby locations are not available due to the outage occurrence, their emergency evacuation plan becomes extremely compromised. Because of the vulnerability of this population, due to age, illness and economic position, moving them during a power outage subjects them to difficulties that could overwhelm their ability to survive. In the event of a long term power outage, these residents may need to shelter in place due to the difficulty in physically moving them to a powered location. The availability of a micro grid would not only provide options for Stichman Towers to address a large scale and/or long term power outage, it could free up the facilities presently in their plan for other community uses.

If this project was to come to fruition, the City of Glens Falls Housing Authority would be able to modify its present Emergency Evacuation Policy. This policy could be modified to allow for the sheltering in place of residents, which is less costly, safer and more beneficial, physically and emotionally, to them. Due to the fact that their current alternative shelter sites are nearby these apartment complexes, it's possible that they may not be usable if a large area, long term outage was to occur. The microgrid project would allow residents to shelter in place. This is a great benefit to the Agency, as substantial reductions in Federal funding for these complexes does not allow them to expand the size and capabilities of their existing generators, which only energize common areas and emergency infrastructure within the buildings.

During normal operations, they would benefit from lower-priced electricity resulting from being connected to the microgrid.

Glens Falls Civic Center

From an economic perspective, preventing a power outage would enable the Civic Center to avoid the financial impact associated with not being able to host scheduled events, along with the cost of losing and replacing ice in its rink. During blue-sky operations, they would benefit from lower-priced electricity resulting from being connected to the microgrid.

In the case of an extreme weather-related event, the Civic Center would remain committed to being part of the Glens Falls Hospital Emergency Response Plan. Additionally, the arena could support Warren County Emergency Services by acting as an evacuation center for local school systems. Additionally, in the recent meeting with both Warren County Emergency Services, it was discussed to see if the Civic Center met the criteria for being a FEMA disaster center, which can only be submitted during a disaster, so the preliminary workup is being done for when the opportunity arises. Additionally, the Civic Center is in discussions with the American Red Cross to be a certified Disaster Recovery site for them.

City of Glens Falls

Through its participation in the NY Prize Feasibility Study being conducted on behalf of the Glens Falls Community Microgrid, the City of Glens Falls acknowledges both the importance of energy security and resilience during times of emergency, as well as the fundamental role that energy does and will continue to play in the economic development and well-being of city residents. The City further

acknowledges that projects as impactful and potentially wide-reaching as the microgrid must include leadership by City officials.

From a macro-level perspective, the microgrid offers a number of advantages to the City. Most importantly, it renders the city much better able to withstand and respond to energy threats caused by severe weather, terrorism or stresses on the larger electric grid. Services that would benefit would include not only direct services, such as sewage treatment, emergency (police or fire) response, or public shelter (via the city-owned Civic Center), but also indirect ones, such as the Glens Falls Hospital. Although energy security for the critical facilities is an important consideration for the City, economic benefits play an equally important role. Due to the City's limited size (only 4 square miles) and space constraints (surrounded on 3 sides by the Town of Queensbury and on the 4th by the Hudson River), the City is burdened with relatively high property taxes, and must constantly pursue creative strategies to control costs and/or generate revenue. In the case of the microgrid, such economic benefits might be realized through the acquisition of low-cost, local energy to power any/all of the involved facilities.

Community

The approximately 347,000 residents in the Greater Glens Falls / Southern Adirondack region will benefit from the microgrid by ensuring that critical services provided by the Hospital, Wastewater Treatment Plant, Civic Center and Stichman Towers are available to the public during times of natural disaster or power outage.

The microgrid will also help the community to reduce its greenhouse gas emissions and its environmental impact. The microgrid's use of renewable fuels will also help to promote the region as being sustainable and a good steward of the environment. The City and region will be further recognized as an environmentally-friendly place to live and do business. This forward momentum would have the potential to encourage both residents and businesses to become more environmentally conscious, promoting further environmental benefits. Likewise, this recognition as a "green" community could help the region to maintain and/or attract new residents and businesses.

National Grid

The benefits to National Grid, the local utility company in the area, would include a reduction of stress on the existing electrical grid, the upgrade to infrastructure in the microgrid footprint, and improvements that are funded by sources other than the utility. National Grid is citing no service reliability impact. With CAIDI values of 2hrs, the service impact will be minimal. However, from a regulatory perspective and from a local government sustainability vision, this project will contribute substantially to precedent setting features that will enable growth of the model locally and replicability elsewhere in NYS. To the extent that this can happen with no economic impact to NG is a positive feature. Further, we have recently been given to understand the Henry St. Substation is subject to demolition. This was not previously revealed to us. In this circumstance the replacement of the Henry St Substation under any configuration can be facilitated in part with microgrid investment monies.

Finch Paper

Finch paper will benefit from the microgrid project in several ways: Supplying electricity to the microgrid and enabling the other stakeholders to provide their critical services without interruption will strengthen the community and generate goodwill for Finch.

The waste-to-energy cogeneration plant will provide Finch with the ability to completely offset current grid electricity purchases. In addition, selling electricity to the microgrid off-takers will provide a new revenue stream. The new waste-to-energy plant will create new jobs, benefiting the local economy.

Finch's pulping process results in a byproduct of paper residuals that is currently trucked to and disposed of at a landfill. The waste-to-energy plant will utilize these paper residuals as a fuel, eliminating the need for land-filling and putting the paper sludge to good use as a renewable fuel.

New York State

The microgrid project will benefit The State of New York environmentally, as the power produced from the waste-to-energy plant will be fueled by renewable energy sources – biomass and paper sludge. This renewable fuel source will displace commonly-used fossil fuels, which are carbon intensive and harmful to the atmosphere. The result will be fewer carbon emissions associated with the power consumption of the microgrid off-takers.

This project also supports NY State's REV (Reforming the Energy Vision) initiative in several ways: the project provides new means of investment recovery for improvements made to the power distribution system; the process will help to address reforms needed to reconfigure utility regulation; the project provides a platform for incorporating new distributed energy resources (DERs) into the existing power grid; and also provides a model for how Distribution System Operators can be enabled through regulatory, strategic and business model change.

Additionally, as the waste-to-energy plant will utilize renewable biomass and paper sludge as fuel, the project will support the goals of the Renewable Portfolio Standard/Clean Energy Standard, which seeks to increase the proportion of renewable electricity used by retail customers. This project would likely be considered a Main Tier Generator – providing power for onsite use and other customers.

It is anticipated that microgrid power purchasers will be able to purchase electricity at prices up to 10% below current retail market rates. The use of long-term PPA's will also provide price-certainty to the off-takers.

The project at Glens Falls has the opportunity to promote and demonstrate new technology. While the current plan is to serve the key local facilities from a local generating unit and through making some minor modifications to the utility distribution system, the application of energy storage may come into play either at each critical customer site or at the generating unit at some point in the future. While not included in the current project, energy storage could be a viable technology in the future especially as local hydro becomes available to supplement the energy supply model. Another application of new technology would be for sensing and switching operations that would automatically transfer customer load to the local generation system. The emergency event as

envisioned today would be that the system may lose power first, then be switched to the local generation system once the unit is ready for load. But enhanced sensing, switching, communication and generator control technologies will allow for automatic transfer with only momentary loss of power. The hospital interruption model will be no different than the interruption they currently experience when they switch over to emergency diesel generators.

Sub Task 3.3 Commercial Viability - Project Team

To develop ideas and build consensus around the project, the GFCM team has held regular stakeholder meetings involving elected and appointed city officials, executive leadership from the four primary off-taking facilities, executive leaders from Finch Paper along with technical leaders from Johnson Controls and other partners.

As the elected municipal authority for the City of Glens Falls, the Mayor and City Council monitor the operation and performance of city agencies, make land use decisions and oversee and approve the city's budget, as well as legislate on a wide range of other subjects that affect the wellbeing of Glens Falls City residents. For the purposes of the NY Prize, the following city representatives have been or may become involved in the development of the GFCM:

- Mayor Jack Diamond
- Councilman-At-Large Dan Hall
- Special Projects Committee -- Councilmen Jim Campinell, Jim Clark, Bill Collins
- City Engineer Steve Gurzler
- Fire Chief Jim Schrammel

In addition, each stakeholder developed a written Statement of Interest that outlines their support for the project.

As currently envisioned, we would have four parties each playing a critical role in the development of this sustainability initiative. Finch Paper, the Generation Owner would need to execute a capital plan for the expansion of the generating unit to serve the load. As part of the overall financing structure for the DER, there would need to be a Power Purchase Agreement (PPA) executed to provide long term supply contracting to the Microgrid Stakeholders. The Terms and Duration of this PPA will be addressed during the Stage 2 work and will require participation with an ESCO (Electric Retailer) that is currently registered as retail supplier in the National Grid service territory. The Electric Retailer would need to execute agreements with Finch, and each of the off-taking microgrid customers that serve as an energy supply contracts for both Parallel and Islanded modes of operation.

Essentially, the DER will be owned and operated by Finch. The Microgrid assets are expected to be developed under the project and ownership will be transferred to National Grid, for the purpose of system integration and long term maintenance. The commercial/Transactional rights associated with commodity supply will be the responsibility of the ESCO. Investments required at the Customer Interconnections will continue to be owned by the customer and subject to compliance with National Grid Interconnection standards.

In the technical definition of a P3 model, where private capital is used to support the long term operation of a public asset, there won't be a public/private partnership used in this project. In this

case, the DER is a private asset and will be built using private capital - only the Microgrid Networking and controls will be funded from public sources (IE: NYSERDA GRANT money or Regional Development Council loans) but that is outside the technical definition of P3. Conventional project financing is envisioned as long as the regulatory framework to support the microgrid is clearly defined and presents favorable options for expanding the scope of service going forward.

The City of Glens Falls has a strong credit rating of A2 as rated by Moody's Credit Rating Agency. Finch Paper Holdings LLC, who will own the power generation plant, has been in operation over 150 years and possesses an industry-leading balance sheet. The business is owned by Atlas Holdings, a diversified group of manufacturing, distribution, service and trading businesses that operate in the automotive, building materials, energy, industrial services, metals, packaging, pulp, paper, and tissue, and logistics, supply chain management and distribution segments. With $4 billion in annual revenue, their objective is to build strong companies that consistently outperform their peers and generate sustainably high returns on invested capital over the long-term. In addition, the Finch Paper Holdings ownership group includes Blue Wolf Capital Management, which invests in industrial businesses. Private capital can be considered for the microgrid investments, however the revenue model associated with the microgrid may not support direct investment. That is why the NY Prize funds are being sought, as a vehicle to incent the regulatory and financial models associated with the microgrid investments. At some point in the future, when the commercial and regulatory paths have been set, such investments will have less uncertainty and be financially self-supporting.

Jeffrey Flagg, Ph.D., Project Director -- Dr. Flagg has extensive experience in business, education and advocacy. Since 1999, Dr. Flagg has been the Program Director of the Saga more Institute, a non-profit cultural and environmental education center in Raquette Lake, NY. At Saga more, Dr. Flagg has developed and/or coordinated numerous projects, conferences and workshops aimed at increasing environmental awareness among North Country residents and communities, for organizations including the Sierra Club, NYS Council on the Arts, Appalachian Forest School, NYS Art Teachers Association, BOCES, and the Adirondack Mountain Club, along with numerous colleges and universities. Most recently, Dr. Flagg has developed a series of residential programs at Saga more called Living Simply, which introduce participants to the value of local perspectives on everything from sourcing food to energy conservation measures.
Dr. Flagg is currently a commissioner on the Glens Falls Zoning Board of Appeals, and has extensive contacts with the local Glens Falls business community, and with municipal government at the local, state and federal level, as well as relationships with key representatives at both National Grid and NYSERDA.

Donald Scherer, Ph.D., Energy Consultant -- Dr. Scherer has extensive consulting experience on projects involving energy conservation and development. Aware as an ethicist of how and in what circumstances fundamental values tend to come into conflict, he consistently articulates frameworks that allow teams of specialists to pursue strategies that avoid value clashes and soften tensions in ways that keep cooperating specialists pleased with emerging outcomes. From serious study of the history of energy sources and technologies, he analyses the energy supplies and demands so as continually to ground his recommendations both for softening the demand for energy through the adoption of imaginative energy conservation strategies and for engaging partners whose specialized

knowledge and experience allows them overcome tensions through their mixed choices of energy sources and strategies for energy storage.

Finch Paper LLC and parent company Atlas Holdings LLC have extensive experience with the operation of Distributed Energy Resources. Finch has operated a boiler plant for over 100 years and cogeneration via a steam turbine since 1987. In addition to Finch, Atlas owns and operates Detroit Renewable Energy LLC an energy-from-waste plant (EFW plant) that produces steam and electricity from municipal waste) and Detroit Thermal, LLC, (owns and operates the district energy underground steam system). These companies provide a long-term, cost-effective and eco-friendly supply of renewable energy from waste derived fuel to support the essential energy needs of Detroit's core business districts.
Also in the Atlas family is Hamtramck Energy Services, LLC, which operates the private industrial steam plants at five General Motors facilities. Recently, Atlas purchased a power plant in Greenwich, NY. Furthermore, Atlas operated dozens of industrial facilities that possess cogeneration capabilities.

Johnson Controls, Inc., Project Development and Management: The leading Performance Contracting Energy Services Company (ESCO) in North America, has executed over $800MM per year of energy efficiency retrofits for Customers in Schools, Universities, hospitals, Federal/State/and Local Government. In New York State, we are the leading provider of Performance Contracting services to School Districts (K12) and Municipalities. JCI is currently in the 15th year of a Performance Contract with the Glens Falls Civic Center.
Johnson Controls offers world class Energy Solutions to deliver on over $6 Billion of Guaranteed savings to customers, which has included Cogeneration, Solar PV, and Demand Management (Demand Response), amongst other offerings. JCI is a NYSERDA Flextech Consultant (NYSERDA CONTRACT NUMBER 29718) and has secured incentives and rebates from both NYSERDA and other Local Distribution Utilities for customers in New York State in excess of $3 Million annually.
Johnson Controls (JCI) will be primary system integrator, and will act on behalf of the City to develop, procure, and subcontract all elements (legal, regulatory, technical) of the delivery components for the microgrid. Finch Paper will take responsibility of the generation assets. JCI and Finch will collaborate to address the regulatory requirements to fulfill the vision of the microgrid.
Beyond the awards from New York State, it is anticipated that additional financing for the project will be secured by Finch Paper and/or the selected Electric Retailer, and/or public financing through an entity such as the Regional Economic Development Council.

The team is receiving legal and regulatory support from Allen & Desnoyers LLP and Four Corners Energy, LLC. Allen & Desnoyers is a full service law firm with offices in Albany and White Plains, NY. The partners of Allen & Desnoyers include two former Senior Assistant Counsels to the Governor, a former Division Director and attorney at the New York State Department of Environmental Conservation, and a former assistant counsel with the New York Power Authority (NYPA). The attorneys at Allen & Desnoyers LLP are experts in navigating and interpreting New York's regulatory framework, with specific subject matter expertise with regard to the legal and regulatory matters involved with this project.

Four Corners Energy is a full service energy consulting company, providing technical and regulatory expertise to its clients on all matters relating to energy. The principals of Four Corners Energy have a

combined 90 years of experience in the energy field in New York State. Four Corners Energy advises clients on all aspects of the New York energy environment. For this project, the principals engaged include a former member of the New York Power Authority's Energy Services Division and the former Executive Director of State Government Affairs for the New York Power Authority.

Sub Task 3.4 Commercial Viability - Creating and Delivering Value

The primary enabling technology is the waste-to-energy DER that is being proposed by FINCH paper. This will be developed with a condensing turbine that will allow full service requirements of the microgrid off-takers during both islanded and parallel operation. Metering, controls and communications to support operations will be applied to conform to all operating standards and to maximize the economic options to the DER owner and the Electric Retailer that are commercially responsible for the power delivery transactions.

The microgrid consists of an alignment of technology that has the most beneficial impact and ability to serve the loads of the primary stakeholder group. Finch had been exploring the viability of a waste-to-energy plant for its own use, and the load of the microgrid project makes the plant more appealing. In addition, the proximity of the plant to the off-takers makes this approach very appealing.

Potential challenges to the plant and distribution network include interconnection to National Grid's network, environmental permits that may be required for the plant, and city level permitting for installation. Finch Paper currently operates 38MW of on-site generation. The proposed DER asset will be new capacity that will supplement the existing assets. To that end, the existing assets already have black start capability and support Frequency Regulation (FR) and Voltage Regulation (VR) on the Finch Paper site, while interconnected to the 115kV transmission network. This existing capability will be highly leveraged to validate the operating confidence of the future state. Additionally, the Finch Paper site has an existing 34.5 kV ring bus that will be utilized.

Table 3.3

Generation Source	Rated Capacity (MW)
Existing Hydro-Electric	10
Existing CHP	28
Current Total:	**38**
Proposed DER to support MG Services	10
Proposed Total:	**48**

The proposed interconnections are relatively straightforward. Substations directly serve the larger microgrid off-takers, being the hospital and waste water treatment plant. The City of Glens Falls has permitting rights for local construction and installation.

The primary enabling technology is the waste-to-energy DER that is being proposed by Finch paper. This will be developed with a condensing turbine that will meet the full service requirements of the microgrid off-takers during both normal and emergency operation. Metering, controls and communications to support operations will be applied to conform to all operating standards and to maximize the economic options to Finch and the Electric Retailer that are commercially responsible for the power delivery transactions.

Balancing generation and load will be conducted by Finch using frequency and voltage regulation, which is currently done onsite while synchronously connected to the 115 KV network. There will be no change in this operation when the grid is down. The VR and FR features of the FINCH system, will continue to function to support the islanded mode of operation. This includes supply services to the interconnected microgrid off takers. The technology choice involves a waste-to-energy boiler generation that will meet full the full load requirements of the microgrid off-takers in both emergency and normal operating modes. Furthermore, the sizing of the plant will be such that it will allow for expansion of the microgrid.

We anticipate the project will need environmental permitting for the waste-to-energy plant, interconnection permitting for 34.5 kV service and 13.2 kV service, rights-of-way for underground service between Finch and connection points (e.g. substation feeder connections and dedicated feeder for the housing authority and civic center). Regulatory permission will be required to support the physical delivery model envisioned which will incorporate aspects of retail wheeling.
Any cogeneration asset will require environmental siting permission - this feature is not specifically unique. The emissions mix of the waste-to-energy DER may require alternate controls technology to satisfy the permit associated with particulate matter or other characteristics of the waste fuel combustion.

Development of the project will have several parallel paths. The primary task will be to create the final engineering for interconnecting the Finch Paper site with the National Grid infrastructure, specifically configured to support emergency service to the microgrid End-Users. This will require engineering designs, load flow analysis, metering and switching plans, and controls/communications technology models.

The secondary task will address the sizing, design, permitting and financial analytics around the DER. Several options for financing and operation of the DER will need to be resolved before enabling the third phase, which involves the long term off-take power purchase agreement with Finch and the Electric Retailer that will be the primary commercial agent for commodity supply to the microgrid off-takers. All necessary legal, regulatory, and operational issues between microgrid off-takers, Finch, and the Electric Retailer must be resolved to establish a commercial model for delivery of the microgrid energy.

Construction of the Network/Delivery assets will be under the oversight of the microgrid authority created by the City. Construction of the Finch assets will be under the oversight of Finch as they will finance the asset. There will be counter party agreements to support the fuel supply and operation of the DER and for the maintenance and operation of the microgrid delivery assets, which would have the close oversight and participation of National Grid.

The second stage of the NY Prize Program will lead to a more refined commercial model. At this point, the City of Glens Falls is considered the commercial lead for the microgrid delivery infrastructure, and Finch Paper is the commercial lead for the generation assets. A third party, which will be identified through competitive tender in stage 2, will be engaged to provide retail Electric Retail services to meet the regulatory and operational needs of the system.

Community benefits have short term and long term dimensions. In the short term, during an emergency requiring the use of the Civic Center as a place of refuge or hospital triage site, the civic center will have full requirements power supply. This will make the use of the Civic Center much more functional for these tasks. Current backup power minimally supports emergency lighting. Additionally, under such circumstances, the Hospital will also have full requirements service and not be limited to the minimal load support from their diesel generators.

Under the long term model, the community will recognize additional benefits through potential access to the microgrid delivery services as the network reach of the microgrid expands beyond the current 4 off-taker model.

It is possible that additional costs that may be incurred, such as the annual maintenance expense associated with the emergency mode network components. If so, it is expected that this cost will be passed along to the metered end-users within the regional tax districts that are considered primary users of the services that are connected to the microgrid. Subject to a final design model, based on total metered customers in the regional tax districts, this could be in the range of $0.50 per customer per month for all NG customers in the targeted region (not just stakeholders).

The greater Glens Falls community will benefit from the microgrid as follows:

- The ability to access the critical services provided by the Hospital and Wastewater Treatment Plant during times of power outages
- The ability to seek emergency shelter at the Civic Center during times of emergency
- The ability of the vulnerable population residing in Stichman Towers to shelter in place
- The microgrid is expected to provide some financial benefit to the involved stakeholders in the form of lower/stable utility costs and avoided costs currently incurred during power interruptions. The community will benefit indirectly from these financial benefits in that the stakeholders, who are also employers in the area, will have stronger financial bottom lines; this will enable the stakeholders to potentially stave off rate and tax increases and perhaps allow for investment in other areas that could benefit the community (e.g. – new equipment at the Hospital, public services from the city, etc.)
- During Stage 2, further analysis will determine if there is need to possibly implement a tariff rider for the community to help maintain and support the microgrid.

National Grid has been involved in providing insight and guidance throughout Task 1. It will be important for our project to conform to the electric and operational protocols for interconnection to the grid. It would be helpful to have their support in developing Tariff riders that are associated with the direct off-taking of load from the microgrid during both normal operating and emergency modes. Further, it will be beneficial for National Grid's support with the PSC related to tariff design for

community benefit charges that may be used to maintain and service the network components that are critical for emergency mode operation

All technology, electric generation (Waste-to-energy boiler) and controls will use proven, existing technologies and equipment. We envision using an IPERC technology (or similar) that's been in existence since 2004, and has been approved and utilized by the U.S. Department of Defense. The IPERC Controls have capability to coordinate switching devices, coordinate and control generation sources, and curtail loads, when needed.

The operation of the Finch Paper site currently includes nearly 40MW of self-generation capacity and synchronous interconnection to the 115 kV network, with periods of scheduled energy export. The proposed microgrid will continue to use the 115 kV network for normal mode delivery of energy to microgrid off-takers, at a higher and regular export capacity level. It is expected that the interconnection and send out to the 34.5 kV network will not be extraordinarily different from the 115 kV operation, but load flow modeling in stage 2 will be needed to provide confirmation.

While the final operational model will be further developed in Stage 2, the current vision involves the waste-to-energy plant being constructed and operated by Finch Paper. Utilizing Finch's existing 34.5 kV ring bus, the electricity produced will be fed to either the 115 kV network in normal mode, or to the microgrid in emergency mode. Various switching and controls, such as IPERC, will be utilized to manage the power distribution. National Grid will operate and control the microgrid network.

There will be a framework for retail supply to the off-takers, enabled through a traditional Electric Retailer, to support both normal operation and emergency events. The off-takers will need to make a long-term purchase commitment to the Electric Retailer and will benefit from cost savings on purchased electricity in normal mode. During an emergency event, it is possible that the off-taking customer may need to pay a premium – this will be further explored in Stage 2.

The final financial model is yet to be established, and will need to account for how much of the interconnection and construction costs will be covered by the NY Prize grant. The microgrid owner, being the City of Glens Falls, will select an Electric Retailer that will purchase electricity produced by the DER from Finch Paper, and the Electric Retailer will sell the electricity during normal and emergency modes to the off-takers. End-use metering with be done through the existing National Grid meters already being utilized.

This project certainly could be replicable in areas where there is close proximity of a given DER to off-takers. DER's could be other waste-to-energy plants, hydro plants, cogeneration plants, PV or Wind farms, etc. The scale of the DER is important, in that it would need to support the loads of the off-takers. In this particular case, Finch Paper has sizable existing infrastructure, which helps the viability and economics of the project. Replication may be constrained in areas where there is no existing DER.

Generally speaking, the barriers to entry are low for microgrid participants. The four identified off-takers simply need to make a long-term commitment to purchase power from the selected Electric Retailer. It could be said the barrier is higher for Finch, given the cost to construct the waste-to-

energy plant, however, initial analysis suggests that the project is economically viable. Other potential barriers could include figuring out how to extend benefits to a larger group of off-takers (e.g. – downtown secondary network). Also, during an event that requires emergency operation, the model incorporates retail wheeling, and current NY State regulations prohibit retail wheeling.

Perhaps the largest potential barrier is the cost for Finch to construct the waste to energy plant. Finch will require an economically sound plan to offset this cost. The plan will require long-term off-taking agreements with the Electric Retailer, and subsequently with the microgrid off-takers; Finch may also require the incorporation of Renewable Energy Credits and Excelsior Credits for job creation. They may also explore the possibility of using a public funding option (i.e., Regional Economic Development Council) for a portion of the upfront capital required install the waste-to-energy plant. Regulatory exemptions will be approached through a Public Service Commission (PSC) petitioning process in combination with support from both the City of Glens Falls and National Grid to allow the service interconnections that are required to fulfill both normal and emergency operating modes. There may be additional considerations placed before the PSC addressing microgrid service tariffs and electric retail services. These will be key dimensions of the Stage 2 design process.

Sub Task 3.5 Financial Viability

Finch, the Generation Owner, would place the unit into the wholesale market on a daily basis and have the upgrades required be paid for from the revenues from the wholesale market transactions.

The Electric Retailer is in business to create value for their retail customers and their shareholders by providing electricity contracts at or below existing default service electricity rates. Providing energy under an emergency or islanded event would be an enhancement to the service of any of its customers and would allow for greater revenue as well as marketing potential for the Electric Retailer.

The Distribution Company gets paid for service during an emergency event as well. As far as "fixed or variable" charges to the customers are concerned, the Electric Retailer may create a financial offer that could include both normal operating conditions and emergency operating conditions that would allow for savings from existing rates with an enhanced service.

The City, as the microgrid owner/administrator, could realize some economic benefit in the form of a payment from the Electric Retailer awarded the rights to distribute power to the microgrid off-takers.

From an incentive basis, the NY Prize award is important. But, perhaps more important to this project may be the Renewable Resource designation for the biomass waste-to-energy plant. Renewable Energy Credits (RECs) can be used to enhance the overall return on investment of the privately owned DER (anticipated annualized value $2.6mm for 10MW plant), and will allow for financially sustainable operation. Finch Paper, owner/operator of the plant, will require RECs. Additionally, Finch will likely solicit Excelsior Credits for job creation and a public funding option (i.e., REDC) for a portion of the upfront capital required install the waste-to-energy plant.
The categories and relative magnitudes of the capital costs that will be incurred to install the microgrid can be seen in the table below. There are two (2) categories of capital costs that include the microgrid interconnections and the microgrid distributed energy resource (DER). The

interconnections include substation upgrades, controls, and transmission lines. The DER consists of the installation of a paper process residual fluidized bed boiler and a condensing turbine and generator. The magnitude of capital costs totals $37.4M. We have proposed a hybrid ownership model, where the ownership of the interconnections will be National Grid and the ownership of the DER will be Finch Paper. Initial development and build-out of the interconnections will be a project responsibility. When complete, accepted for operation, ownership will be transferred to National Grid, for the purpose of life cycle maintenance

Table 3.4 – Anticipated Capital Costs

Capital Component	Installed Cost ($)	Component Lifespan (round to nearest year)	Description of Component
Distribution Interconnects Henry St Substation	$3,200,000	30	34.5 kV interconnect
Distribution Interconnects Glens Falls Substation	$1,200,000	30	34.5 kV interconnect
Distribution Interconnects Civic Center/Housing Auth.	$1,000,000	30	13.2 kV interconnect
Generation Sources Waste to Energy Boiler	$20,000,000	25	Paper process residuals fluidized bed boiler
Generation Sources Condensing Turbine	$12,000,000	25	Condensing turbine and generator

Operating costs that will be incurred by the microgrid include both fixed and variable expenses. The fixed O&M costs total $725,000 per year. This includes delivery, metering, SCADA, and generation/supply costs. This annual maintenance cost also factors in a minor turbine inspection every 3-4 years and a major turbine inspection every 9 years. Variable O&M costs are estimated to $43.96/MWh. This includes parasitic electric costs, transportations and disposal, transmission, labor, consumable, direct, and general and administrative costs.

Table 3.5 – Anticipated Operating Costs

Fixed O&M Costs ($/year)	What cost components are included in this figure?
$125,000	Delivery, metering, SCADA
$600,000	Generation/Supply

Variable O&M Costs ($/Unit of Energy Produced)	Unit	What cost components are included in this figure?
$43.96	$/MWh	Chemicals, consumables, labor, ancillary services.

Note: preliminary estimates from Finch; costs may decrease as scale increases.

The project is taking advantage of critical infrastructure that is already in place. There is a team that is capable of providing operation and maintenance already on site. The variable cost of increasing production is negligible from an O&M perspective. Also, the plan is to sell energy and capacity into the wholesale market on a daily basis. In the event of an emergency or islanded situation, the existing assets can be utilized to serve the greater good of the community and don't rely on revenues from such events. The revenue derived from such an event would be a very minor incremental amount and would not be planned for in the operating plan of the Generation Owner.

The project will likely gain project-based financing which would require some portion of equity by the Generation Owner supplemented with project-based debt. The debt service obligation would need to be covered by capacity and energy revenues from the wholesale market, and may be supplemented by Renewable Energy Credits from the combustion of biomass resource. The $5MM NY Prize award is the primary funding attribute for the microgrid (outside of DER). Recovery of the Distribution, Controls and Regulatory investments needed to deploy the microgrid model would burden the project to a level that would negatively impact its financial viability. That is why we are seeking NY Prize support.

Sub Task 3.6 Legal Viability

The proposed ownership structure is yet to be finally determined, but at this time, we expect that Finch Paper would hold the DER asset and receive project-based debt financing for the development and construction of the project.
The delivery assets will be initially developed by the Microgrid Authority under the purview of the City of Glens Falls and then transferred to an operational entity under a lease or sale agreement, for ongoing operations and maintenance. The final commercial model will be evaluated under the Stage 2 work.

We are proposing a hybrid ownership model, in which the DER is owned by Finch Paper and the substations, controls and transmission lines to off-takers are owned by National Grid. Grid will take title to the infrastructure, under an asset transfer that will be cost neutral to them. The ongoing O&M model for the assets will be covered from a regional rider that has been discussed previously. So, the 'benefit' to Grid is demonstration of a Microgrid model that is compliant with REV – and does not burden the Rate Making / Cost of service model outside of the service beneficiary population.

The City, as the applicant, would act as a sponsor and administrator of the project, coordinating contracts and assisting with procurement of the Electric Retailer.

The site for the generating asset is currently owned by Finch Paper. The rest of the microgrid is served by National Grid and easements are currently in place for the electric distribution system.
In its initial phase, the microgrid will serve only non-residential commercial, not-for-profit, or municipal customers, comprised of Glens Falls Hospital, Glens Falls Housing Authority, Glens Falls Wastewater Treatment Plant, and the Glens Falls Civic Center. The microgrid will protect the privacy rights of its customers consistent with the relevant provisions of Public Service Law (§65) and the Public Service Commission's (PSC) Uniform Business Practices (December 2015, and as subsequently amended) (Sections 4 and 5, as applicable). Moreover, should the State determine that microgrid operators should participate in the Green Button or Data Guard initiatives (or New York specific variations thereof) the microgrid will cooperate with the State in any such initiative.

There may be environmental regulations associated with the waste-to-energy cogeneration plant at Finch, which would likely include NYS SEQR impact assessment, emissions permits, local siting permits, possible amendment to FINCH's existing TITLE V permits. Certainly, as noted elsewhere, there is a major regulatory effort at the NY PSC to enable the fundamental features of the Microgrid and the retail wheeling aspects of the service. These, and any other regulatory hurdles, will be further vetted during phase two by Finch, Allen & Desnoyers, and Four Corners Energy.

Task 4: Develop Information for Benefit Cost Analysis - Draft

Sub Task 4.1 Facility and Customer Description

The Glens Falls Community Microgrid consists of four (4) stakeholders. The stakeholders include the Glens Falls Hospital, Glens Falls Civic Center, Glens Falls Housing Authority (Stichman Towers), and the Glens Falls Waste Water Treatment Plant. Each facility belongs to the Large Commercial/Industrial (> 50 annual MWh) rate class. The Hospital represents 78% of the total electrical load using 18,500 MWh/year, the WWTP represents 15% of the total load using 3,500 MWh/year, the Civic Center accounts for 6% of the total load, using 1,500 MWh/year, and the Housing Authority represents 2% using 412 MWh/year. The Housing Authority belongs to the "residential" economic sector, while the Hospital, Civic Center, and Waste Water Treatment Plant fall into the "all other industries" economic sector. See table 4.1 below for each facility's annual electricity demand (MWh) and peak electricity demand (MW). The Finch Paper waste-to-energy plant is designed to serve and support 100% electrical requirements during a major power outage and during a multi-day outage. During a multi-day outage, each facility would require electricity 24 hours/day from the microgrid.

Table 4.1 – Electricity Usage and Demand

Facility Name	Rate Class	Facility/Customer Description (Specify Number of Customers if More Than One)	Economic Sector Code	Average Annual Electricity Usage Per Customer (MWh)	Peak Electricity Demand Per Customer (MW)	Percent of Average Usage Microgrid Could Support During Major Power Outage	Hours of Electricity Supply Required Per Day During Major Power Outage
Glens Falls Hospital	Large Commercial/Industrial (>50 annual MWh)	Hospital	*All other industries*	18,500	3.5	100%	24
Glens Falls Waste Water Treatment Plant	Large Commercial/Industrial (>50 annual MWh)	Municipal Waste	All other industries	3,500	0.66	100%	24
Glens Falls Civic Center	Large Commercial/Industrial (>50 annual MWh)	Civic Center	*All other industries*	1,500	0.52	100%	24
Glens Falls Housing Authority (Stichman Towers)	Large Commercial/Industrial (>50 annual MWh)	Housing Authority	*Residential*	412	0.093	100%	24

Each facility stakeholder is a single ratepayer. The Glens Falls Housing Authority is a multi-unit apartment building where the building is fed by one master meter and the utilities are included in the rent.

Sub Task 4.2 Characterization of Distributed Energy Resources

The Distributed Energy Resource for the Glens Falls Community Microgrid will be a waste-to-energy power plant. Finch Paper will be expanding its existing power generation capabilities to include a 10 MW condensing steam turbine supplied by a waste-to-energy biomass boiler. The energy/fuel source for the biomass boiler will be paper process residuals – paper sludge – and other biomass materials. The estimated average annual production (MWh) under normal operating conditions is 61,995 (MWh). In the event of a major power outage, Finch Paper does not anticipate any production downtime. The average daily production (MWh/day) in the event of a major power outage will be 170 (MWh). The fuel consumption per MWh generated equals 6.56 (MMBtu/MWh).

Table 4.2 – DER Power Production

Distributed Energy Resource Name	Facility Name	Energy Source	Nameplate Capacity (MW)	Average Annual Production Under Normal Conditions (MWh)*	Average Daily Production During Major Power Outage (MWh)	Fuel Consumption per MWh	
						Quantity	Unit
Finch Waste to Energy Plant	*Finch Paper*	*Other – Paper Process Residuals*	*10.11*	*61,995*	*170*	*6.56*	*MMBtu/MWh*

** Primarily driven by MIcrogrid Stakeholder load variations. System is sized to meet annual peak loads. However there are seasonal low demand periods for stakeholders during which, full capacity dispatch of the DER may not be economically feasible. As such, the net operating load factor for the DER will run in the 70% range. Over time, it is expected that the capacity factor will increase, when the microgrid expands to support additional stakeholders.*

The proportion of wood biomass versus paper mill residuals will ultimately depend on the technology in the generation plant (up to 30% of the fuel source will be paper mill residuals). Biomass is a widely available, renewable resource. Finch has excess biomass material as a result of its current operations and furthermore, Finch's wood-basket is a net growth fiber state with a strong long-term outlook. Finch already employs a sophisticated forestry management division with professional foresters who can sustainably procure the biomass required for the new energy plant.

Sub Task 4.3 Capacity Impacts and Ancillary Services

The microgrid will provide 100% of the required load for its customers under both normal and emergency modes of operation. The primary generating source is a Waste-to-Energy boiler and condensing steam turbine. All peak load demands for the participating microgrid customers will be met.

Several of the microgrid stakeholders have participated or plan to participate in the Demand Response (DR) program sponsored by the NYISO. To the extent that such program participation continues to make sense under the microgrid-connected mode, then, that participation will continue. Where load shedding optionality exists for microgrid stakeholders, it may be deployed in response to operational optimization associated with balancing of microgrid DER supply with the net connected load. Facilities like the Civic Center, have some optionality for running their ice making system, and the Waste Water Treatment Plant has some optionality for pump and mixer dispatch. The use of load shedding may have more value under the microgrid model, as localized economic optimization, than it might as it relates to the broader network services under the NYISO program.

It is not clear that any transmission capacity would be avoided or deferred based on the increase in capacity at the generating station serving the microgrid. In theory, expanding the generation capability on the distribution system should free up transmission capacity, but, until the load flow modeling is completed on the 34.5 kV network, the full value of the interconnection to the 34.5 kV network will not be fully known. The primary benefits will likely fall in the seasonal LOW FLOW periods on the Hudson River hydro-electric system. It may be that both capacity and ancillary services values will be generated, during important load serving periods.

As noted above, it is not yet clear if any distribution capacity would be avoided or deferred based on the increase in capacity at the generating station serving the microgrid based on the fact that the generation would be utilizing the same distribution system that normally serves the critical customer load. At a future point in time, when the Glens Falls Secondary Network is being considered for connection to the microgrid Services, then there may be significant distribution level benefits.
The ancillary services provided by the microgrid installation would be for voltage support, reactive power support to increase power factor in the region as well as support for system restoration. This includes Black Start capabilities by the Finch site.

There are not any anticipated thermal energy savings at this time. However, there are scenarios that will allow Finch to displace grid purchases that they've historically made. There are also scenarios that involve steam sale transactions from Finch to the Hospital. In both circumstances, the magnitude and term of such transactions will be explored in Stage 2.

Finch anticipates the scope of the waste-to-energy facility will allow for a straightforward amendment to their existing Title V permit. Finch is MACT and RACT compliant for existing assets. All fuels utilized in the new waste-to-energy facility would be identical or similar to fuels already utilized at the Finch facility.

Table 4.3 – Emission Rates

Emissions Type	Emissions per MWh	Unit
CO2	13.863	lbs/mwh
SO2	0.016	lbs/mwh
NOx	0.251	lbs/mwh
PM 2.5	0.064	lbs/mwh
PM 10	0.072	lbs/mwh

Note: PM values used from EPA. See link to source. https://www3.epa.gov/ttnchie1/ap42/ch01/final/c01s06.pdf

Sub Task 4.4 Project Costs

The installed costs of the project can be broken down into two (2) main categories. The categories consist of building the Distributed Energy Resource (DER) and building the distribution interconnects to connect the DER to the stakeholders. There are (3) distribution interconnects that will be required to build the microgrid. They include interconnections from Finch Paper to the Henry St. Substation, the Glens Falls Substation, and the Civic Center/Housing Authority 13.2 kV distribution line.
The distribution interconnects at the Henry St Substation will include the creation of a redundant electrical supply from Finch paper to the Hospital. The work proposed involves connecting to the

incoming service at the Henry St. Substation from the Finch Paper 35kV Switch House to the Hospital Substation.

The distribution interconnects at the Civic Center and Housing Authority includes connecting from the Finch Paper 35kV Switch House to a step down transformer to be installed at Finch Paper. An automatic transfer switch will be installed near the National Grid transformers that service the Civic Center and Housing Authority with microgrid service at 13.2 KV.

The distribution interconnects at the Glens Falls Substation include the creation of a redundant electrical supply from Finch Paper to the Waste Water Treatment Plant. This work includes establishing a connection from Finch Paper Bank One at the 34.5kV level to the Glens Falls Substation. The generation source includes a paper process residual fluidized bed boiler that will be located onsite at Finch Paper, at an estimated cost of $20M. A condensing turbine and generator will also be installed at an estimated cost of $12M. Component lifespan of all equipment is expected to be 25-30 years.

Table 4.4 – Project Costs

Capital Component	Installed Cost ($)	Component Lifespan (round to nearest year)	Description of Component
Distribution Interconnects Henry St Substation	$3,200,000	30	34.5 kV interconnect
Distribution Interconnects Glens Falls Substation	$1,200,000	30	34.5 kV interconnect
Distribution Interconnects Civic Center/Housing Auth.	$1,000,000	30	13.2 kV interconnect
Generation Sources Waste to Energy Boiler	$20,000,000	25	Paper process residuals fluidized bed boiler
Generation Sources Condensing Turbine	$12,000,000	25	Condensing turbine and generator

Table 4.5 – Initial planning and design costs

Initial Planning and Design Costs ($)	What cost components are included in this figure?
$2,000,000	Engineering, environmental permitting, local permitting, legal/regulatory, marketing/public relations.

Note: includes an allowance of $750,000 for the DER asset as well as $1,250,000 for the engineering, regulatory and commercial transaction contracting for the Microgrid. Of $1.25 MM for microgrid, $250,000 would be cost shared, the balance of $1MM would be sourced from the NY PRIZE funding.

Table 4.6 – Fixed operations and maintenance (O&M) costs ($/year)

Fixed O&M Costs ($/year)	What cost components are included in this figure?
$125,000	Delivery, metering, SCADA
$600,000	Generation/Supply – mostly labor based, with additional non-capitalized maintenance. Does not include wood purchases.

Table 4.7 – Variable O&M costs, excluding fuel costs ($/MWh)

Variable O&M Costs ($/Unit of Energy Produced)	Unit	What cost components are included in this figure?
$43.96	$/MWh	Chemicals, consumables, labor, ancillary services.

There is no technical constraint to the maximum amount of time the DER would be able to operate in emergency mode. There is a potential for an operational de-rating after an event over 15 days. The reason is associated with fuel sourcing. However, onsite inventories can be allocated between paper production and electric generation based on commercial requirements.

Table 4.8 – Fuel Consumption

Distributed Energy Resource Name	Facility Name	Duration of Design Event	Quantity of Fuel Needed to Operate in Emergency Mode for Duration of Design Event	Unit
Finch Waste to Energy	Finch Paper	Indefinitely	100 tons/day	Other – Tons of paper process residuals

Sub Task 4.5 Costs to Maintain Service during a Power Outage

See table below for list and location of fuel/energy sources of each existing backup generator, nameplate capacity, percent operating capacity, average daily electricity produced (MWh) in the event of a major power outage, and one-time and ongoing operating costs associated with starting and operating the backup generators.

Table 4.9 – Existing Backup Generation

Facility Name	Generator ID	Energy Source	Nameplate Capacity (MW)	Standard Operating Capacity (%)	Avg. Daily Production During Power Outage (MWh/ Day)	Fuel Consumption per Day		One-Time Operating Costs ($)	Ongoing Operating Costs ($/day)
						Quantity	Unit		
Glens Falls Hospital	*Diesel #1 24001*	*Diesel*	*1.25*	*40%*	*12*	*1250.4*	*gallons*	*$ 500*	*$ 1,000*
Glens Falls Hospital	Diesel #2 24002	*Diesel*	1.25	40%	0				
Glens Falls Civic Center	Gen Set #1	*Diesel*	0.1	100%	2.4	139.2	gallons	$ 250	$ 100
Glens Falls Housing Authority (Stichman Towers)	Gen Set #1	Natural Gas	0.07	50%	0.84	14,112	cu.ft./day	$ 250	$ 100
Glens Falls Waste Water Treatment Plant	none								

Cost of Emergency Measures to Maintain Service while on Backup Power

If the Glens Fall Hospital lost power for more than 24 hours it would lose 40% of services including surgery, imaging, cardiac catheterization, and gastroenterology care. This would result in a $500,000/day loss in revenue. The Civic Center's generator is only connected to emergency lighting, and the generator's main purpose is to provide emergency lighting during an evacuation. If the Civic Center were operating on existing backup power for more than 8 hours, they would lose the ability to maintain their arena ice floor costing $6,000 per event. If power was lost during time of an entertainment event, the Civic Center would need staff to breakdown the floor that covers the ice, so that melting ice would not permanently damage the floor. This would cost $15,000 per event. If an extended outage occurred with catastrophic circumstances, the Civic Center would energize their site with a full capacity generator in order to act as a community shelter. This would cost $3,000 per day. If an extended outage occurred, the Civic Center would lose the ability to host regular events, at a loss of $20,000 per event. If an outage occurred greater than 12 hours, the Stichman Towers Housing

Authority would lose refrigeration in apartments, leading to spoiled food at a total cost of $20,000 per event.

Table 4.10 – Costs to Maintain Emergency Services on Backup Power

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When Required?
Glens Falls Hospital	*Ongoing*	*Loss of 40% of services including surgery, imaging, cardiac cath., GI*	*$ 500,000*	*$/day*	*Outage > 24 hrs*
Glens Falls Civic Center	*One time*	*Loss of Ice*	*$ 6,000*	*$/event*	*Outage > 8 hrs*
Glens Falls Civic Center	*One time*	*Breakdown floor*	*$ 15,000*	*$/event*	*Outage > 8 hrs & facility set up for entertainment event*
Glens Falls Civic Center	*Ongoing*	*Energize site with full capacity generator*	*$ 3,000*	*$/day*	*Extended outage with catastrophic circumstance*
Glens Falls Civic Center	*One time*	*Loss of revenue from inability to host event*	*$ 20,000*	*$/event*	*Extended outage with catastrophic circumstance*
Glens Falls Housing Authority (Stichman Towers)	*One time*	*Loss of refrigeration leads to spoiled food in refrigerators*	*$ 20,000*	*$/event*	*Outage > 12 hrs*

Cost of Emergency Measures to Maintain Service while Not on Backup Power

In the event of an extended outage where the facilities would not have service from any backup generators currently on-site, the Glens Falls Civic Center will act as an emergency services shelter. The cost per day for the Civic Center to act as an emergency shelter is $12,200. The Hospital would need to move people one time, from the Hospital to the Civic Center, at a cost of $10,000 per event. For ongoing security measures, it will cost the Hospital $1,000 per day to manage. The Hospital would then also lose 100% of operating revenue, at a loss of $1,250,000 per day. The Housing Authority would also need to move its residents one time to the Civic Center, at a cost of $1,000. In order to maintain security at the Housing Authority, ongoing costs would result in $250 per day.

Table 4.11 – Costs to Maintain Emergency Services Not on Backup Power

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When Required?
Glens Falls Hospital	*One time*	*Need to move people (410 bed)*	$ 10,000	$/event	*Extended outage with catastrophic circumstance where Civic Center acts as emergency shelter*
Glens Falls Hospital	*Ongoing*	*Secure building*	$ 1,000	$/day	Security, facility management
Glens Falls Hospital	*Ongoing*	*Loss of 100% services*	$1,250,000	$/day	Extended outage with catastrophic circumstance
Glens Falls Civic Center	*Ongoing*	*Act as Emergency Services shelter*	*$ 7,200*	*$/day*	*Extended outage with catastrophic circumstance where Civic Center acts as emergency shelter*
Glens Falls Civic Center	*Ongoing*	*Act as Emergency Services shelter*	$ 5,000	$/day	Food service, facility service, security
Glens Falls Housing Authority (Stichman Towers)	*One time*	*Move people to Civic Center*	$ 1,000	$/event	*Extended outage with catastrophic circumstance where Civic Center acts as emergency shelter*
Glens Falls Housing Authority (Stichman Towers)	*Ongoing*	*Secure building*	$ 250	$/day	Security, facility management

Sub Task 4.6 Services Supported by the Microgrid

Table 4.12 – Population Served

Facility Name	Services Provided	Population Served by Facility
Glens Falls Hospital	*EMS*	*30,000*
Glens Falls Hospital	*Hospital*	*347,000*
Glens Falls Housing Authority (Stichman Towers)	*Residential Facilities*	*87*
Glens Falls Waste Water Treatment Plant	*Wastewater*	*25,000*

Percent Loss in Service with Backup Power

The Hospital would lose 40% in services while on backup power. These services include surgery, imaging, cardiac catheterization, and GI. The Civic Center's backup generator only serves emergency lighting, so if the Civic Center operated on backup power it would lose 99% of services. If the Housing Authority were operating on backup power, only the boiler room, common areas, and elevator would operate. Electricity would be lost in all residential apartments (i.e. refrigerators) and the Housing Authority would lose 50% of services. The Waste Water Treatment Plant does not have a backup generator because the site is fed by a redundant utility service feed. If the Waste Water Treatment Plant lost power they would 75% of service. They would be able to support 25% through gravity settling.

Table 4.13 – Percent Loss in Services with Backup Power

Facility Name	Percent Loss in Services When Using Backup Gen.
Glens Falls Hospital	*40%*
Glens Falls Civic Center	*99%*
Glens Falls Housing Authority (Stichman Towers)	*50%*
Glens Falls Waste Water Treatment Plant	*75%*

Percent Loss in Service with No Backup Power

In the event of an extended outage where the facilities would not have service from any backup generators currently on-site, the Hospital, Civic Center, and Housing Authority would lose 100% of services. The Waste Water Treatment Plant would be able to maintain 25% capacity through gravity settling.

Table 4.14 – Percent Loss of Services without Backup Power

Facility Name	Percent Loss in Services When Backup Gen. is Not Available
Glens Falls Hospital	*100%*
Glens Falls Civic Center	*100%*
Glens Falls Housing Authority (Stichman Towers)	*100%*
Glens Falls Waste Water Treatment Plant	*75%*

The type of housing that the Glens Falls Housing Authority (Stichman Towers) provides is senior subsidized HUD housing. The number of residents at Stichman Towers that would be left without power during a power outage is 87.

Task 5: Final Report

I. SUMMARY OVERVIEW OF GLENS FALLS COMMUNITY MICROGRID

The City of Glens Falls relies on several existing assets that combine to make it an ideal candidate for a community microgrid, a small-scale-yet-expandable energy network that is not only fully resilient in the event of an emergency, but also green, dynamic and cost-effective during normal operation. The city's renewable energy resources, compact central city district, engaged and diverse stakeholder base, existing secondary network, and importance as a regional hub -- paired with an active, progressive local government -- all speak to our advantages as a first-tier community microgrid candidate.

The vision of the Glens Falls Community Microgrid (GFCM) began with an assessment and understanding of the city's energy assets -- both built and natural -- and its importance as a regional hub community. Geographically, Glens Falls is ideally suited for a community microgrid: the city's compact size (only four square miles) and location on the northern bank of the Upper Hudson River mean that available hydropower contributes substantially to the city's energy supply, if only indirectly at present. Much of Glens Falls -- including most of its critical services infrastructure -- lies within a very small radius, and is very close to two separate hydropower facilities: a 14 MW, grid-tied Boralex facility on the south shore of the Hudson, and an adjacent, 15 MW Brookfield facility located in (and fully utilized by) the Finch Paper mill.

Historically, of course, much of this energy was used by logging and paper mills, and Glens Falls today remains home to Finch, one of the largest paper mills in New York State. Finch has been operating since the Civil War, and over time constructed not only its own hydropower facility on the Hudson (the Brookfield facility referenced above), but also a cogeneration plant, which converts wood waste and black liquor from its operations into additional energy for the mill. This cogen facility currently generates approximately 16 MW of energy, all of which is consumed by the mill itself.

Meanwhile, over the course of the twentieth (and now the twenty-first) century, outside forces and circumstances have conspired to make Glens Falls an important critical-services hub for the entire southeastern Adirondack region. Its location on the southeastern boundary of the Adirondack Park -- a remote, rural area consisting of small scattered communities with few critical services -- has made Glens Falls an important regional gateway community for a vast area, providing commercial, municipal and critical services and support for most of the residents of Warren, Washington, Essex and Hamilton counties, along with many residents of northern Saratoga County as well.

Given these existing assets and the city's regional importance, then, the concept of the GFCM began with an idea to isolate and redirect energy from the nearby, grid-tied Boralex hydro facility across the Hudson, in order to harden existing connections into various facilities in Glens Falls. On the basis of both proximity and priority, several critical service facilities (hereafter referred to in this section as the "Microgrid Partners") were identified:

- Glens Falls Hospital
- Glens Falls Civic Center
- Glens Falls Wastewater Treatment Plant (WWTP)
- Glens Falls Housing Authority (Stichman Tower)

During the preliminary research phase of the Feasibility Study, however, the Project Team learned that Finch Paper was interested in expanding its existing cogeneration plant to include paper sludge created by the mill. This inert but voluminous waste material is currently being sent to a landfill, but Finch is seeking to add this to its current mix of fuels; doing so will not only allow the mill to achieve energy self-sufficiency, but also provide an energy surplus which Finch can sell to third parties (ostensibly, the Microgrid Partners themselves). Given the mill's location directly adjacent to the Microgrid Partners, then, primary source energy for the GFCM has shifted from existing hydropower to new capacity fueled by paper sludge and other biomass. (NB: It should be mentioned that, as of the conclusion of the Feasibility Study, Finch was still researching several options regarding its waste-to-energy facility, with potential capacity additions ranging from as little as 10 MW to as much as 25 MW. To the extent that such a determination has not yet been made, all of the assumptions and calculations provided in this Feasibility Study are based on the baseline figure. The Project Team is confident that any facility larger than 10 MW will simply enhance the viability of the GFCM.)

The GFCM meets several important criteria envisioned by NYSERDA in developing a microgrid: reliable energy production; durable generation; and resilient transmission infrastructure. In fact, the Glens Falls Community Microgrid is ideally-suited to meet all three criteria. For one thing, the use of large-scale, base-load, waste energy eliminates the need for costly emergency back-up generation facilities, or the need for significant energy storage. At the same time, the city's compact size and proximity to the Finch Paper mill reduce the need to construct extensive resilient (i.e. buried) transmission lines to the Microgrid Partners. But Glens Falls has an additional advantage in that it is one of only a handful of New York State communities to be part of National Grid's Secondary Network System. This secondary network has already created a *de facto* microgrid for the central business district of downtown Glens Falls – albeit one without a dedicated source of energy -- and forms the backbone of a much larger possible microgrid, one that might eventually include as many as a dozen of Glens Falls' and the region's critical service facilities, and which will be enabled by the development of the first-phase microgrid described in this Feasibility Study, funded by the NY Prize.

A second stated goal of microgrids as envisioned by NYSERDA is to "improve local electrical distribution system performance and resiliency in a normal operating configuration." Implicit in this goal is a desire to maximize Distributed Energy Resources (DER) -- especially renewable energy -- across New York State in ways that address greenhouse gas emissions and encourage economic development. With respect to the GFCM, the use of waste energy from Finch will result in no net greenhouse gas (GHG) emissions; in fact, the project will reduce GHG emissions overall, by eliminating transportation costs incurred in the current disposal of Finch's waste, displacing existing load that relies on fossil fuels, and replacing emergency back-up generation by the Microgrid Partners, which currently relies on diesel- and natural gas-powered back-up generators. In addition, the project will add capacity and diversity to New York's renewable-energy portfolio.

A further implication of this goal is the desire to develop microgrids that improve the energy security of the community being served, and add value to that community via the development of local clean-energy resources. The GFCM satisfies this requirement, as the added capacity will fully meet the demand load of the Microgrid Partners on a 24/7/365 basis, and at a reduced cost. What's more, expansion of the microgrid beyond the Microgrid Partners and into the Secondary Network and beyond will be not only possible but practical, utilizing either excess energy from the Finch mill, existing generation from one of the nearby hydro facilities, or via further capacity additions. One such latter possibility exists at the Wastewater Treatment Plant (WWTP) itself, which is currently conducting a study on the feasibility of producing energy from its own waste. Given the facility's inclusion in the GFCM and its proximity to Finch Paper, potential options for the

WWTP include providing its own solid waste to Finch as additional biomass fuel, or creating its own energy on site, perhaps through an anaerobic digestion system. A recent study suggesting that a typical WWTP could be redesigned to produce as much as nine times the energy that it consumes allows one to envision a scenario in which the GFCM expands with additional waste energy from the WWTP. While this prospect is outside the scope of the NY Prize, preliminary examination reveals that such a facility would contribute further to Glens Falls' portfolio of locally-produced clean energy and, like extension of the GFCM into the Secondary Network, is also enabled by the project described here.

Finally, in addition to serving existing users and enabling the expansion of local energy sources to a larger subset of consumers, the low cost of these various waste-to-energy initiatives will also create opportunities for new businesses and other commercial projects in the Glens Falls area. Preliminary research has suggested that data management, computer storage facilities and other technology firms looking to build near the Luther Forest Technology Campus in nearby Malta might be drawn to Glens Falls by the promise of a stable, reliable, economical energy supply. In fact, given the need for electric stability by technology during normal operations, it is not difficult to envision a scenario in which energy from the microgrid is delivered to Luther Forest facilities during normal operations, and diverted to the Glens Falls Secondary Network during times of emergency.

II. BASIC OPERATION OF PROPOSED GLENS FALLS MICROGRID

The Feasibility Study makes the following assumptions about the basic structure and function of the GFCM:

1. Finch Paper will create a minimum of 10 MW of new, clean energy, derived from its own waste along with other biomass;
2. Finch will consume approximately 5 MW of this capacity to achieve effective energy independence with respect to its own operations; this means that at least 5 MW of new capacity will be surplus energy for Finch, and thus available to off-takers;
3. During Normal ("blue-sky") operation, Finch will distribute its excess energy through an already-existing 115 kV line; this power will be purchased by the Microgrid Partners;
4. NY Prize funding will enable the construction of resilient feeder lines, which will connect Finch to the four Microgrid Partners, either directly, in the case of the Civic Center and Stichman Towers, or indirectly through the Henry Street substation (Hospital) or Glens Falls substation (Wastewater Treatment Plant);
5. During Emergency ("dark-sky") events, power will be redirected from the 115 kV line to the microgrid network through the installed feeder lines, and thus directly to the Microgrid Partners, providing continuous, indefinite power during an outage;
6. Depending on the capacity of Finch's expansion, Emergency power could also be potentially directed to the Glens Falls Secondary Network through the Henry Street and Glens Falls substations, in a future expansion of the currently-proposed microgrid; this would provide resilient, emergency power to much of the downtown area, including numerous additional critical facilities: the Police Department, City Hall, a Fire Station, the Glens Falls Public Library, a second high-rise, low-income senior residential complex, an elementary school, as well as several pharmacies, restaurants, gas stations and a hotel.
7. Depending on the capacity of Finch's expansion, energy will be available on an on-going basis to additional facilities in the City of Glens Falls beyond the Microgrid Partners, via the development of a Power Purchase Agreement (PPA), Community Distributed Generation (CDG) structure, or some other

contractual arrangement; member facilities might include those listed above on the Secondary Network, other municipal facilities, or other utility customers in the City of Glens Falls.

III. SUMMARY OF TASK 2: TECHNICAL CONFIGURATION

Although the GFCM will include substantial new DG capacity, the technical configuration of the microgrid itself is fairly straightforward, primarily because much of the infrastructure is already in place, and merely needs to be "linked together." Finch Paper already owns and operates a cogeneration facility producing approximately 16 MW; as a result, much of the necessary hardware, software, control systems and emissions controls that will be required for the DER component of the GFCM are already in place and operational. The reality is that, from the perspective of generation, Finch is simply looking to expand their current facility. Despite uncertainty about the plant's ultimate size, the existence of this support infrastructure not only provides the Project Team with a degree flexibility in the designing the project, but actually creates infrastructural boundaries which help to frame the scale and scope of the final facility.

Notwithstanding questions about the size of the additional capacity to be installed, Finch also has an existing 34.5 kV ring bus which circles its entire property, and runs within several hundred yards of both the Henry Street and Glens Falls substations. To create resiliency throughout the microgrid, underground feeders will be extended from this ring bus to the Henry Street and Glens Falls substations, and thus through to the Hospital and WWTP, respectively. Meanwhile, a separate, dedicated 34.5 kV feeder (stepped down to 13.2 kV) will connect Finch to the Civic Center and adjacent Stichman Tower. During Normal operations, power will flow out of Finch via an existing 115 kV line and into the grid. This energy will be purchased by the Microgrid Partners (and other potential users, depending on the capacity being generated). In the event of an Emergency, the 115 kV line will go offline, and energy will be supplied to the four Microgrid Partners through the connections outlined above. Once the Emergency is over and the larger grid is operational, the direct lines to the Microgrid Partners will be de-energized and Normal operation will resume through the 115 kV line.

IV. SUMMARY OF TASK 3: COMMERCIAL OPERATION AND FINANCIAL MODEL

Initial plans for the commercial model of the GFCM were informed by the premise that Finch would supply energy roughly sufficient to handle the load of the four Microgrid Partners on a 24/7/365 basis. Such a model most likely would have resulted in a simplified commercial model, in which Finch entered into separate, bilateral agreements with each of the Microgrid Partners. However, due to the range of capacity that Finch is planning to install (up to 25 MW, of which as much as 20 MW will be surplus), it will likely be necessary to export energy out to the larger grid via the existing 115 kV transmission line during Normal operations, at least in the short term; during an Emergency, the microgrid would shift to islanded mode and energize the 34.5 kV line, thereby powering the Microgrid Partners directly and indefinitely. While this shift in configuration does create the opportunity to indirectly power additional facilities beyond the Microgrid Partners in Normal operating mode, it also creates complexities in the commercial model.

As a result of this project variable, the Project Team determined that the most prudent and logical commercial model to adopt would be a "hybrid" model, in which Finch, the City of Glens Falls, National Grid and perhaps a third party coordinate the transactional operation of the GFCM. In one scenario, city officials enlist the service of an Electric Retailer or other service entity to participate in the GFCM as a strategic partner. The chosen entity, selected by city officials via a competitive bidding process, would develop,

execute and manage energy service contracts with all off-takers of Finch's available energy supply, most likely via a Purchase Power Agreement with Finch.

V: SUMMARY OF TASK 4: COST-BENEFIT ANALYSIS

Cost-benefit analysis for each NY Prize Feasibility Study was performed by Industrial Economics (IEc), in an attempt to maintain consistency in evaluating the financial viability of each NY Prize project. In order to determine the economic benefits of each proposal, IEc measured the costs and benefits of each project under two scenarios: Scenario 1 assumed no outages over a 20-year period, and thus assigned no economic value to the resiliency provided to the project's energy off-takers during an Emergency. Scenario 2 accounted for Emergency operations (power outage) and identified how long an annual outage would be necessary in order for the economic benefits of the project to exceed its costs. This section summarizes IEc's findings (the complete summary of which is included in this report as Appendix A).

Project Costs: Project costs for the GFCM will consist of both direct and indirect costs. Direct costs can be further broken down into capital costs, of both the DER assets and of the distribution assets. Direct costs for the generating assets are estimated to be approximately $32 million, including $20 million for the Waste-to-Energy (WTE) boiler, and another $12 million for the condensing turbine. Costs for the transmission assets, which primarily consists of the three interconnects needed to island the microgrid during an Emergency, are expected to total approximately $5.4 million.

Operating costs of the project will include fixed costs of $600,000 annually for generation supply, and another $125,000 for delivery, metering and SCADA, for a total of $8.2 million over the 20-year life of the project. Variable costs for labor and ancillary services are estimated at $43.96/MWh, or $2.7 million annually. Over the 20-year estimate life of the project, these costs would have a present value total of $30.9 million.
A final variable cost included in NY Prize projects is the cost of environmental damage caused by plant emissions. These costs can be either direct or indirect, depending on whether they are internalized (borne directly by the project developer) or externalized (borne by society, in the form of diminished environmental quality). Although the paper waste and other biomass to be used as fuel for the GFCM is both non-toxic and carbon neutral (and thus does not contribute any net positive GHG emissions), the biomass plant will create some emissions in the form of particulate matter (PM). In the case of the GFCM, the cost of this damage is estimated at $6.2 million over the project's 20-year life. However, the GFCM also benefits from a number of avoided costs, most notably the avoided cost of fossil fuel energy which at least some of Finch's biomass plant will displace for its consumers. It should also be noted that options to further mitigate the PM emissions will be evaluated in the stage 2 design. Combining all of the above costs yielded a total project cost of $84.7 million over twenty years.

Project Benefits: Aside from the indirect benefits mentioned above, other benefits identified in the BCA include avoided costs of $40.9 million from current energy suppliers, avoided costs to the grid of approximately $4.2 million, and power quality and reliability savings of roughly $5.4 million. Combined with avoided emissions damages estimated at $31.2 million, total benefits for the project are estimated at $81.4 million. Thus, under Scenario 1, in which the GFCM never experiences an outage, the GFCM runs a projected 20-year deficit of approximately $3.3 million, producing an estimated cost-benefit ratio of .96, where project benefits equal 96% of project costs, and the internal rate of return was 3.8%.

Under Scenario 2, the GFCM achieved a breakeven BCA of 1.0 after islanded operation of only 0.1 days (approximately 2.5 hours) per year and achieved an internal rate of return of 5.3%. One reason for these optimal figures is that costs for the GFCM remain constant during both Normal and Emergency operation. With the exception of load reduction protocols that Finch would likely have to engage in order to match its generation to the demand of the Microgrid Partners, nothing fundamentally changes in the operation of the Microgrid with respect to operational costs. Meanwhile, benefits are largely realized in actual cost savings of the microgrid over traditional back-up power (i.e. gas, diesel or natural gas-powered generators) along with avoided costs of an outage resulting from the assurance of full and continuous electrical service during an Emergency versus traditional, limited back-up services.

In summary, the GFCM is expected to operate at near-breakeven costs, even in the absence of any threat to the facilities in the microgrid. But although a Scenario 1 BCA ratio of .96 appears to be very competitive in and of itself, two items should be mentioned with respect to this figure. First, costs submitted to IEc were based on the smallest prospective biomass facility currently being considered by Finch Paper. It is reasonable to assume that if Finch chooses to install a larger waste energy facility, relative fixed costs incurred in the project -- including design-, capital-, and fixed-operating costs -- would decrease marginally. Second, although the biomass plant which Finch ultimately builds will include heat as an ancillary by-product, the generation scheme includes significant use of steam to dry the fuel feedstock (paper sludge & wet wood waste). Steam not used for fuel preparation will run through a condensing turbine. To the extent that underground lines are already going to be constructed between Finch and the Microgrid Partners, there is a possibility that if any unused heat is produced from the Finch cogeneration plant, it could be delivered to either the Glens Falls Hospital or Civic Center, thereby reducing their own heating costs. During this preliminary stage , there was no exception for excess heat available from the Biomass Boiler. As such, further consideration of the thermal services loop as part of the microgrid was deferred to Stage 2 engineering, when final sizing and duty of the Biomass system would be more complete. The addition of the thermal loop would provide optionality for the stakeholders for facility heating, but could also be used to support summer loads as well (in the form of Absorbers for the hospital's chilled water services or steam-driven chillers for ice production at the Civic Center). If there appears to be the possibility of excess thermal sources to support this thermal loop, then, there will be additional engineering investments to establish the economic deployment of additional assets to build the demand for steam during the non-heating season as well as the distribution loop investment.

Notwithstanding these immediate benefits that might accrue to the Project in the short term, it is worth identifying and emphasizing the enabling features of this project, with respect to the Glens Falls Community Microgrid as a longer-term, larger-scale energy network. Development of the GFCM envisioned in this document constitutes what the Project Team considers to be Phase 1 of a multi-phase, multi-year process, one that will eventually result in local energy supply for much of Glens Falls, if not the entire municipality. The ability to energize the Microgrid Partners through the existing substations that already energize the Glens Falls Secondary Network creates the possibility of eventually energizing the Secondary Network itself; this might be further extended into additional portions of Glens Falls, through existing underground transmission lines. Several challenges need to be overcome to make this vision a reality (see Section VIII: Observations, Analysis and Recommendation for more discussion). Still, while not reflected in the BCA for obvious reasons, extending the microgrid beyond the Microgrid Partners would not only enhance the City's ability to provide critical services to the region (by energizing second-tier services, such as restaurants, gas stations and pharmacies, in the event of an Emergency); it would also take significant load off of the larger grid itself, creating significant economic benefits identified in the BCA as "Avoided Costs to the Grid."

VI. SUMMARY ADVANTAGES OF THE GLENS FALLS COMMUNITY MICROGRID:

The GFCM would appear to possess a number of characteristic advantages among communities pursuing funding via the NY Prize:

1. The Finch Paper mill already produces significant power via its existing cogeneration plant and the Brookfield hydro plant; as such, the expansion of the existing cogeneration plant involves much less groundbreaking than a new, green-field facility would require, not to mention less permitting or other regulatory vetting.
2. Finch Paper has extensive experience creating and distributing energy, as well as the financial resources to help underwrite the project.
3. The amount of new capacity generated (10+ MW) is likely to exceed that of most other NY Prize project proposals, and will in fact exceed as many as 50 of the 70 Main Tier projects that NYSERDA has funded under the current NYS Renewable Portfolio Standard.
4. By using waste paper sludge from its papermaking operations, the GFCM not only reduces fuel costs (and thus the cost of generated energy), but also eliminates currently land-filled paper sludge from the solid waste stream.
5. Finch already has an existing ring bus which encircles the entire property and thus extends to within a few hundred yards of both the Glens Falls and Henry Street substations, thus reducing the amount of resilient (i.e. buried) transmission line that will have to be installed or hardened.
6. Connection to the Henry Street and Glens Falls substations will create the potential to eventually extend the GFCM into the Secondary Network, using energy from either the Finch cogeneration plant, the Brookfield hydro facility (located in the Finch mill) or the Boralex hydro plant just across the Hudson River Bridge.
7. Connection to the Glens Falls Substation, thus linking the Wastewater Treatment Plant, would enable the WWTP to potentially export its own surplus energy into the GFCM.
8. The variety of facilities included in the GFCM--including hospital, wastewater treatment plant, civic center and high rise residential building -- will provide NYSERDA with a wide range of energy profiles to examine for further energy savings or future microgrid projects.
9. The limited amount of new transmission infrastructure can be easily turned over to National Grid ownership. National Grid has indicated a willingness to assume these assets, pending regulatory relief regarding property and income tax liability (See Section VIII, Part B for a further discussion of this issue.
10. The limited initial size of the GFCM (Finch Paper and the four Microgrid Partners) allows for the development of a simplified operational model, while the existence of the Secondary Network allows for its expandability without significant capital expense beyond NY Prize funding.
11. The substantial cost of the GFCM ($30 million+) means that even full funding of the NY Prize in both Stage 2 ($1 million) and Stage 3 ($5 million) will be leveraged as much as 3-4 times or more.

VII: STRENGTHS, WEAKNESSES, OPPORTUNITIES, THREATS (SWOT) ANALYSIS

Based on the results of the Feasibility Study, the Project Team has identified the following Strengths, Weaknesses, Opportunities and Threats (SWOT) for the Glens Falls Community Microgrid:

Project Strengths:

- GFCM Includes diverse range of critical service off-takers from both public and private sector, two of which -- the Hospital and Wastewater Treatment Plant -- serve areas well beyond the city of Glens Falls.
- Provides additional and diverse revenue stream to Finch Paper, the city's largest taxpayer and second largest employer (behind Glens Falls Hospital).
- Finch has a long history of producing and -- on a limited scale, at least -- exporting energy.
- Off-takers receive greater price certainty (via the incorporation of a long-term PPA between Finch and off-takers) and/or lower-priced electricity during Normal operations. Long term stakeholder PPAs are needed to subordinate the PPA that the ESCO has with FINCH. The price certainty feature is beneficial to the off-takers, especially the hospital.
- Price certainty for utility services, with contract escalators, is much better for institutional budgeting and planning than historic market factors.
- Fuel for the GFCM consists entirely of environmentally-friendly biomass.
- Use of paper sludge as fuel component reduces waste, eliminating transportation and land-fill costs.
- Full resiliency reduces need for extended use of expensive, small-scale, back-up generation.
- All Stakeholders are financially strong, credit-worthy entities.
- Close proximity of Finch plant to off-takers (and substations) allow for full resiliency via underground transmission lines, thereby mitigating most likely weather-related emergencies.
- Project consistent with City of Glens Falls goals to be a 100% renewable energy community.

Project Weaknesses

- Project will require long term commitments from project stakeholders (suppliers and off-takers) to offset substantial capital investment costs.
- Various incentives will be required to ensure the economic viability of Finch biomass plant (Renewable Energy Credits, Excelsior Credits for job creation and potentially a public funding option (e.g. REDC)).
- Small size of microgrid relative to large generating capacity means that -- in the short- to intermediate term, at least -- during an Emergency, Finch may have to scale down energy production in order to level load with Microgrid Partners, depending on the eventual size of their plant.
- Although the waste-to-energy plant does not create any net greenhouse gases, it will produce marginally substantial emissions -- primarily in the form of particulate emissions -- relative to other clean energy sources (e.g. solar, wind), resulting in indirect social costs. Controls and equipment to mitigate emissions – perhaps through the installation of fabric filters or electrostatic precipitators (ESP) -- will be further explored in Stage 2.

Project Opportunities

- Expansion of City purchases associated with properties other than Civic Center and WWTP to be served during Normal operation offer prospect of additional savings to city taxpayers.
- Dual connections to 115 kV network or 34.5 kV network provide Finch with seasonal option to sell into wholesale market during normal operation in order to maximize economic value.
- Interconnects from Finch plant to Glens Falls and Henry Street substations will enable the addition of other generating capacity, including via the 15 MW Brookfield hydro plant, which is potentially stranded otherwise (plant currently runs through Finch infrastructure to existing 115 kV line).

- The Finch biomass plant will create excess steam that could be used by Microgrid Partners to support thermal load requirements.
- Large (minimum 10 MW) DER addition and connection to existing substations allows for seamless, organic growth of microgrid, and the possible creation of new business models, such as community net metering, or similar.
- Potential future expansion of microgrid to the downtown Secondary Network would provide resiliency to numerous additional critical facilities with little additional investment.
- Potential expansion of DER assets tied to microgrid could include Biogas cogen from Wastewater Treatment Plant, rooftop solar panels, and distributed storage assets.

Project Threats:

- As yet undetermined size and cost of Finch biomass plant requires use of conservative Cost-Benefit calculations.
- Project is dependent on Finch's long-term competitive viability.
- Use of paper sludge as fuel results in emissions absent in projects relying on alternative DER assets, such as wind or solar, thus creating competitive cost disadvantage.
- Project creates a number of regulatory complications (See Section VIII for elaboration):
    - Interconnection to National Grid delivery network: transfer of ownership of new microgrid transmission lines to utility will result in imposition of both local property taxes and state income taxes on National Grid.
    - Retail wheeling options may prove operationally complex during normal operations, given potential size of Finch generating assets.
    - Large scale of new generating capacity means that project may require tariff riders in order to provide effective treatment of delivery costs during emergency operation.
    - Regional importance of several Microgrid Partners -- particularly hospital and WWTP -- create tariff complications in attempts to assign costs to various community beneficiaries during emergency operations, especially with respect to System Benefit Charges (SBC)
- Waste-to-energy biomass plant may create siting risks associated with additional environmental permitting that may be required.

VIII. OBSERVATIONS, ANALYSIS AND RECOMMENDATIONS

While the GFCM is a relatively simple project given its large scale, the Project Team has identified a number of challenges which will need to be addressed in order to see the Project through to completion. The Project Team does not believe that any of these are insurmountable. These challenges can be broken down into three primary categories: Infrastructural, Regulatory, and Financial.

A. Infrastructural

As discussed in Section III, the GFCM is not a particularly challenging project, seen from a structural perspective. The project relies on one primary source of continuous power which, during Normal operation, will be transmitted through a 115 kV transmission line that is currently in use by Finch Paper (and, via Finch, the Brookfield hydro facility). Capacity of this line is not a technical obstacle. What complexities there are will occur only during the switch from Normal operation to Emergency operation, when power from the Finch plant will be rerouted directly to the Microgrid Partners, via three separate transmission lines: an underground, 34.5 kV line running from the eastern end of the Finch ring bus to the Henry Street substation; a second underground 34.5 kV line running from the western end of the Finch ring bus to the Glens Falls

substation; and a third underground 34.5 kV line running directly from Finch to the Glens Falls Civic Center and Stichman Tower; this last line will be stepped down to 13.2 kV through a transformer to be installed on the Finch property. Although none of these transmission lines in and of themselves will create any significant technical difficulties, each of these interconnects will require switching devices to allow the microgrid to transition into island mode during an Emergency. The primary structural challenge here is the level of energy that Finch produces, which may exceed the load of the Microgrid Partners, depending on the size of the DER. As a result of this potential load imbalance, Finch may need to develop load-leveling devices and protocols to match the plant's output to the load of the Microgrid Partners.

Another operational challenge is the potential impact that the microgrid will have on the two existing substations, which are also the feeder lines for the Glens Falls Secondary Network. Although it is hoped that Finch will eventually be able to energize the Secondary Network in the event of an Emergency, such accomplishment is outside the scope of this phase of the GFCM. One reason for this is that, to the extent that the size of the Finch biomass plant is not yet defined, we cannot determine whether the Finch plant will have the ability to fully energize the entire Secondary Network, which consists of approximately 290 meters and whose cumulative demand load ranges from 8-10 MW. This is a singular challenge because, although there are several critical facilities within the Secondary Network, at present it is not possible to direct power to specific meters within the Secondary Network selectively; as a result, load must be sufficient to energize the entire Secondary Network in order to function properly. Because of this uncertainty, it will likely be necessary to install automatic transfer switches at both the Henry Street and Glens Falls substations; at Henry Street, power will be directed to the Hospital and closed to the Secondary Network, while at the Glens Falls substation, power will be directed to the Wastewater Treatment Plant.

There are several options to address this problem, either in the short- or intermediate term. The simplest solution will occur should Finch elect to build a facility with enough capacity to energize the entire Secondary Network, in addition to the Microgrid Partners. Approximating very roughly, this would require Finch to install a biomass plant of perhaps 18-20 MW in capacity, to provide sufficient load for Finch's operations (5 MW), the Microgrid Partners (4-5 MW), and the Secondary Network (8-10). A second solution lies in the potential to extend the Glens Falls microgrid to include the Brookfield and/or Boralex hydro facilities. Doing so would provide sufficient energy for all of the above facilities, with significant capacity left over.

B. Legal and Regulatory

As with the infrastructural considerations outlined above, the Project Team does not believe that there are any insurmountable regulatory concerns regarding the GFCM. However, there are a number of regulatory and/or legal issues that will need to be addressed in Stage 2 of the NY Prize. In some cases, the issue at hand will require an exemption to current regulations; in other instances, unique circumstances will require unique, customized solutions.

Regulatory Exemptions and Tax Implications: The construction of a direct transmission line from Finch to the Glens Falls Civic Center will require interconnect exemptions from the Public Service Commission. More importantly, while National Grid has indicated a willingness to assume ownership of the GFCM's distribution assets, they have expressed concern over the status of taxes that would result from such a transfer of assets. Such taxes include local property taxes for land on which the assets are built, and state income taxes based on the future revenue generated by those assets.

Standby Rates: Another concern of the Project Team is the status of Standby Rates by National Grid. These are charges which utilities impose when DER projects go "offline," typically for scheduled maintenance or due to an unscheduled, asset-specific emergency. In the former instance, since Finch's biomass plant is designed to be a net exporter of energy, these charges should not affect Finch's costs adversely, since the mill can coordinate its maintenance schedule during periods of low energy demand. For this reason, demand changes should not be an issue, and all that will be required is a negotiated cost of energy supply to replace Finch's own production.

In a similar vein, since it is assumed that Finch will provide all of the energy needs of the Microgrid Partners, Standby Rates would have to be negotiated between National Grid and the Microgrid Partners in the event of a specific threat to the Finch biomass plant itself. Unless such an event coincided with an outage on the larger grid (which is extremely unlikely, in that both events would require separate precipitating catalysts), energy delivery reliability would not be affected, although in this case, to the extent that such an event occurred during periods of peak demand, Demand Charges might need to be included, along with Energy Supply costs.

Microgrid Wheeling Charges and Buy-Back Service Tariffs: To the extent that Finch provides its energy during Normal operations on a virtual (rather than direct) basis, the GFCM must address the possibility that National Grid would seek to impose a wheeling charge on either Finch or the energy purchaser. Conversely, Finch's production of export energy to the grid raises the question of whether Finch would be eligible for buy-back tariffs, and if so, how those would be valued.

Utility Cost Allocations: One additional area in which National Grid has expressed concern relates to the proper allocation of costs around the difficulty in assessing the (sometimes intangible) value of GFCM benefits, especially with respect to the SBC parameters. To the extent that microgrid benefits are local, there will need to be some discussion about whether and how these benefits should be paid for, and by whom. In this respect, although the development of GFCM will result in the development of significant clean energy assets in support of SBC priorities, the GFCM is perhaps a more complicated project than most, since several of the critical facilities that make up the Microgrid Partners serve large geographic areas. For example, the Glens Falls Hospital services a five-county region, while the Civic Center is currently being considered by regional emergency-service officials as potential three-county shelter. Meanwhile, the Glens Falls Wastewater Treatment plant serves not only Glens Falls, but also parts of the towns of Queensbury, Kingsbury, Moreau, and Fort Edward.

C. Financial

One of the great ironies of the Glens Falls Community Microgrid is that, paradoxically, the size and economic viability of this project as a green energy project also create the single biggest threat to its viability as a community microgrid. More specifically: because the project essentially consists of two largely discrete construction elements (the waste-to-energy facility on the one hand, and the separate interconnects to the Microgrid Partners on the other); because Finch already has existing infrastructure to connect to the larger grid via its existing 115 kV line; and because the GFCM comes very close to achieving "Blue Sky" viability using IEc's calculations (i.e. a Benefit-Cost ration of 1.0, assuming no outage over 20 years), it is logical to presume that Finch's waste-to-energy plant would be financially viable by itself. In fact, this is the implicit assumption of IEC's Benefit-Cost Analysis (BCA), since their calculations suggest that Glens Falls would require only a

nominal outage (approximately 2 hours per year) for the GFCM to "pay for itself." In other words, the entire GFCM is nearly cost effective even in the absence of emergency situations.

This conclusion suggests that, in the absence of further NY Prize or other outside funding support, Finch might be able to pursue construction of its waste-to-energy facility even in the absence of the microgrid infrastructure. The primary economic incentive for Finch to pursue the microgrid in such a case, then, is the opportunity for Finch to develop long-term contracts with the Microgrid Partners, providing pricing certainty for both Finch and its energy off-takers. However, while it might be possible for Finch to move forward without support from the NY Prize, doing so would very likely jeopardize any opportunity to leverage Finch's generating assets for a larger-scale community microgrid. A key element of the GFCM -- perhaps **the** key element --is the interconnects between Finch and the Henry Street and Glens Falls substations, because these two substations also connect directly to the Glens Falls Secondary Network. In the absence of NY Prize funding, Finch has no economic incentive to establish those connections, since it could access the energy market through the 115 kV line; however, failing to develop these resilient connections would not only eliminate the connections to the Microgrid Partners (and thus the opportunity for Finch to develop long-term contracts with the off-takers), but also the future opportunity to energize the larger Secondary Network during an Emergency.

This is an important point to understand, because it underscores the value of the GFCM within the larger context of REV, New York's visionary rethinking and restructuring of the state energy infrastructure. To the extent that a primary goal of REV -- and thus of the NY Prize -- is to "build a more resilient energy system" and reduce congestion on the larger grid either now or in the future, the construction of Finch's biomass plant helps to achieve this goal. By including the GFCM's substation interconnections, it is easy to imagine a near-term future in which all of Finch's excess energy -- and perhaps that from Brookfield's 14 MW and Boralex's 15 MW hydro facilities as well -- is delivered not through Finch's 115 kV line, but directly through local 34.5 kV lines. Doing so would eliminate the need for Finch to add load to the grid and would take the demand of any local off-takers off of the grid at the same time. In other words, the construction of the two short interconnects between Finch and the substations might well represent the long-term difference between adding roughly 5-15 MW of energy onto the grid (depending on the size of Finch's expansion), and taking as much as 40 MW off of it (Finch's additional power, plus the energy from the Boralex and Brookfield facilities, which would be sent directly to local off-takers).

In short, it is perhaps fair to say that, although the GFCM appears to be an eminently feasible project, NYSERDA support -- especially Stage 2 of the NY Prize -- also appears to be a critical element in leveraging Finch's increased capacity as a regional asset, primarily to the extent that a Stage 2 award would allow the Project Partners to fully examine the short-, medium- and long-term value components of the microgrid.

Another way of looking at the inherent value of the GFCM, and its potential to act as a value multiplier for REV, comes through an examination of New York's Renewable Portfolio Standard (RPS). Over the course of its ten Main Tier Solicitations, NYSERDA appears to have provided approximately $1.627 billion in funding for 2,471 MW of RPS capacity. This is, of course, an aggregate figure, one that covers projects ranging from 100 kW fuel cell projects to 321 MW wind farms. On average over the course of all funded projects, this works out to around $658,000 per installed MW.

In comparison, were the Glens Falls Community Microgrid project to be fully funded by the NY Prize, NYSERDA's maximum funding commitment is estimated to be $6 million ($1 million for Stage 2 and $5 million for Stage 3), in order to fund a project estimated to create 10-25 MW of new renewable energy, or between $240,000 and $600,000 per installed MW.

In other words, seen through the lens of New York's overall energy goals and perspective, one could argue that the GFCM is in many ways simply a NYS RPS Main Tier project -- and an inexpensive one at that -- with a free, expandable community microgrid thrown in. Or put slightly differently, it's an innovative NY Prize community microgrid project which happens to include 10-25 MW of RPS capacity at no additional cost.

Either way, it's a compelling project.

IX. SUMMARY CONCLUSION

While the concept of an eventual microgrid as large as 25-30 MW providing energy to a large portion of Glens Falls might seem overly ambitious among projects being funded by the NY Prize, the City of Glens Falls is uniquely positioned to leverage a NY Prize award in the pursuit of a project that will create energy security and economic benefits for a large section of upstate New York.

The NY Prize is an important piece of the puzzle for Glens Falls, but just as important as the benefits that this project will develop, are the possibilities that it will enable. Glens Falls is surrounded by significant generating assets, with nine hydro facilities generating as much as 280 MW of nameplate capacity located within a ten mile radius of downtown. While this energy is currently being used by consumers around the state – and perhaps across the nation – it is not difficult to envision a future in which the entire lower Adirondack region is directly connected to locally-generated clean energy. The addition of Finch's waste energy plant will not only add to and diversify this energy mix but, as new energy generated by a local business, will allow the GFCM to develop a financial model without the constraints of existing contracts or regulations.