60 - Town of Watertown

Notice

Jefferson Community Microgrid
Task Five Report
Agreement No. 64566

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Introduction

Project No. 64566

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SECTION ONE NARRATIVE

1.1 Project Scope

The Jefferson Community Microgrid (JCM) study assesses the feasibility of a community microgrid in the Town of Watertown, NY that encompasses the Jefferson County Industrial Park, Jefferson Community College, and the Town of Watertown District 3 Fire Station. This application is sponsored by the Jefferson County Local Development Corporation (JCLDC).

The JCM incorporates a diverse mix of critical public facilities, privately owned commercial and manufacturing facilities in an easily defined geographical area. It addresses existing problems with system outages in the project area, and provides additional benefits for the environment, energy generation and delivery, and especially the local economy.

1.2 Project Background

The Town of Watertown and Jefferson County are in the heart of New York's North Country. The entire area endures some of the harshest winter conditions in the Country, which impact power quality and reliability. The Microgrid feasibility study explores a mix of distributed energy resources such as solar, wind, hydropower, and biomass renewable sources as well as natural gas for CHP applications at the members manufacturing sites. We are focusing on providing power to Watertown's Fire District Station 3, the Jefferson County Community College, and five manufacturing sites located in the Jefferson County Industrial Park.

In keeping with the New York State energy plan, Reforming the Energy Vision (REV), the Jefferson Community Microgrid (JCM) would be a self-sustaining, independent local energy system. It would utilize a variety of Distributed Energy Resources (DERs) from both renewable and non-renewable energy sources. These DERs would be diversified energy components such as Combined Heat and Power (CHP) through natural gas, Photovoltaic Solar (rooftop and ground mount), Hydropower, Biomass, and Battery Storage. The three major components of Generation, Storage and Demand Response would be managed by a controlled network, which may or may not be connected to the utility grid provided by our utility partner, National Grid. The JCM would have a Point of Common Connection (PCC) with the utility grid allowing it to import or export electricity as commercial or technical conditions dictate.

1.3 Opportunities and Potential Benefits

Currently, several industrial park occupants (identified in the photo) are encountering above average energy costs and regular system outages and brown outs due to an unreliable energy infrastructure. We have been told by the clients they experience several outages per year and possibly some brown outs. Depending on the time of day, these outages can cause productivity delays and retooling of equipment which can take three to four hours at a cost of $5,000 to $7,500 per hour. The latest power outage for the Industrial Park occurred on Thursday, May 12th which last approximately two hours. This event also included a power spike which destoyed IT servers at one of the members location.

The JCM has the opportunity to eliminate power quality issues for these participants by providing secure, sustainable, reliable, and resilient energy an affordable price. The JCM can maintain critical loads from the Distributed Energy Resources (DER) while adjusting others and shedding non-critical demands. It is also well suited to match intermittent low-carbon renewables with a wide range of demand requirements. This combination of reduced losses and lower energy costs would increase company profitability and the potential for business growth and its associated new jobs, benefitting the local, regional, and state economy.

A unique opportunity ties into Jefferson Community College's plans to add an on-campus learning lab to enhance its renewable energy programs. This project would enhance the study of grid connectivity and monitoring as an element of the program's curriculum. By enhancing Jefferson Community College's renewable energy program, the project would support the growth of a renewable energy workforce in the region. In turn, the availability of this workforce would support the growth of renewable energy systems and related business growth in the region. In addition, for this publicly supported institution, the microgrid offers the obvious benefit of reducing energy costs associated with the operation of its instructional, administrative, and residence hall facilities.

Preliminary estimated data for the JCM in annual energy demand and use assessment is:

- Annual Electric Usage – estimated 9,100,000 kWh/year;
- Annual Electric Peak Demand – estimated, assuming average Load Profile of 44%: 2,300 kW or 2.3 MW;
- Annual Average Electric Demand – estimated: 1,032 kW;
- Annual Heat Usage – estimated: 26,400 MMBtu or in kWh 7,740,000 kWh; and
- The coincidence of heat/fuel and electricity usage would be determined from additional site/building/operations information.

The JCM would benefit the environment in reducing CO2 emissions by shifting energy generation towards renewables and low emission fossil fuels. Through smart energy management, demand can be shifted to carbon-free generation, like solar and wind, to produce or store power. Technologies like Combined Heat & Power (CHP) would significantly reduce carbon emissions as proven in the widely publicized NYU study on Sustainability Progress from 2013. In the occurence of an event that shuts down the main grid, the JCM would provide a secure back-up energy source to several critical infrastructure facilities.

1.4 Consistency with Local and Regional Planning Documents

In addition to New York's REV, this project supports the goals of the Jefferson County Comprehensive Economic Development Strategy for workforce development, renewable energy deployment, and manufacturing growth. It also advances similar goals of the North Country Regional Economic Development Council's strategic plan and the North Country Cleaner, Greener Community Sustainability Plan. It addresses a key cost of doing business in the North Country by decreasing the cost and improving the reliability of power.

1.5 Development of Microgrid Capabilities

Critical Facilities

The JCM contains two critical facilities, the Jefferson Community College (JCC) and the Watertown District Three (WD3) fire station. In the event of a disaster, the JCC serves as a shelter to service the community and to the 4,442 students. The buildings housing these activities, Building 4, which has the Gym and Cafeteria, and the adjacent Residence halls, can also be a shelter. The new building under construction is equipped with its own generator and can be used as a shelter. Each of these buildings would be tied directly into the microgrid and electric service would be available to them.

The same services would be available to the Watertown District Firehouse. The firehouse covers the western portions of Watertown population and serves as backup to the other fire districts. It supports other local volunteer agencies in the surrounding area as well.

Diesel Generators

The six of the seven members of the JCM do not have any diesel generation at this time. The JCC does have diesel generation and it is utilized only in emergencies. The JCC does not currently participate in any demand response programs with National Grid.

Combination of resources for grid-connect and islanding

The preliminary design would provide for both – grid connection and islanding. The JCM would connect through its own small substation/switchgear to distribution lines connected to the National Grid Coffeen Street substation infrastructure, located directly across from the industrial park.

The preliminary design also includes the running of underground transmission lines on easement property owned by the Jefferson County Industrial Development Agency (JCIDA). We would be locating DER on the member sites for usage and sharing of all members.

Discussions have been underway with the legal team, Harris Beach, on the legal documentation needed for these implementations. Preliminary meetings are continuing with the Town of Watertown planning board and we see no barriers at this time.

Formation of an intentional island

The preliminary design utilizes equipment from Eaton Corporation that would permit intentional islanding for the members of the JCM. This would be an automated process utilizing Eaton SMP gateways, switchgear and transformers. Automated controls would be implemented for both the above ground DER and the underground distribution equipment. The JCM would automatically separate from the grid upon loss of utility resources and return to the grid after normal power is restored.

The JCM would include 24/7 capacity and maintenance from both JCM and Eaton Corporation. JCM, through Eaton's control environment would monitor and operate the system on a 24-hour basis. Eaton would supply the service portion. There services are currently supplied in New York State for utilities such as National Grid, NYPA and NYSEG and other utilities throughout the US.

Follow the load – voltage and frequency

The Eaton CL-7 regulator control is specifically designed to meet the need for the JCM Smart Grid-infrastructure with an array of communications options. These regulators integrate with Eaton's Cooper Power Systems Yukon™ enterprise software and other advanced controls to meet system control and data acquisition requirements. Power saving Smart Grid advancements such as Integrated Volt/VAR Control (IVVC) and Conservation Voltage Reduction (CVR) are implemented with industry leading voltage regulating apparatus, control and communication interfaces.

The speed of the Quik-Drive™ tap-changer along with the unique Voltage Limiter capabilities of the control enable the fastest response available for extreme voltage swings. Eaton's Cooper Power Systems voltage regulator apparatus and control are designed to operate together, with industry exclusive features such as Duty Cycle Monitor (DCM), Preventative Maintenance Tapping (PMT™) and motor trouble diagnostics are available to alert users to a need for maintenance.

The Eaton's Cooper Power Systems CL-7 multi-phase control, another major advancement from the industry's leader in innovation, enables operation of up to three voltage regulators with a single control. New multi-phase control options include true three-phase metering and innovative gang-operation strategies.

Eaton's Cooper Power Systems offers CYME™ engineering analysis software to assist with, the proper coordination of, voltage regulators and capacitors on your distribution system. This would help to minimize losses, improve voltage profiles, and balance loads between feeders.

Optimize energy savings, power quality, and asset management while minimizing power interruptions. Eaton's Cooper Power Systems voltage regulators are part of a comprehensive power management portfolio, an integral element in your Smarter Grid operation, and backed by expert technical support.

Two-way communication with control center

Most of what we would be proposing in technology and equipment is for supporting and stabilizing existing weak grid infrastructure. We would be installing equipment specifically designed to utilize a minimum amount of control center support. Our energy flows, frequency, and reactive power capabilities are specifically designed in response to the same. That being said, wherever necessary, our equipment would function as described in the following paragraphs.

JCM would utilize the latest equipment deployed in today's microgrids including inverters, capacitors, meters and control systems. These devices employ a mix of industry standard communication interfaces and protocols. We would design and build the system that interconnects these devices for monitoring and controlling the network in real-time. This infrastructure would incorporate a combination of physical and wireless interfaces. The devices that do not support wireless technology would be connected primarily through Ethernet. There would be exceptions when legacy equipment is necessary in the new architecture requiring the use of standard RS-232 serial connections.

For wireless, it is our plan to build an intelligent mesh network based on the IEEE 802.15.4 standard. A standard used by low powered internet enable devices such as electric meters. Using the latest internet protocol (IPv6), our mesh network would be able to support the most recent advances in technology for deploying and maintaining today's microgrids. This would also furnish the foundation for implementing future developments in the industry including the deployment of the 'Internet of Things (IoT)'.

There are many advantages of using a mesh network including eliminating any single point of failure. Our devices would have inherent 'smart capabilities' to 'self-heal' themselves in an event of a device failure. This protocol would allow us to easily communicate real-time information to Jefferson County and to the members of the JCM through ubiquitous devices such as personal computers and mobile phones. In addition, it would provide us the ability to integrate with our customer's on premise industrial equipment and HVAC components that possess standard IP communications capabilities. Lastly, it would provide the JCM the capacity to deliver more accurate and timely information to National Grid than the majority of other Distributed Energy Resources (DER) currently attached to their infrastructure.

The JCM serves a diverse group of customers ranging from office environments to educational facilities to heavy-duty manufacturing sites. These sites would vary in energy usage and energy demand. For example, one member has a very high demand on Sunday evenings while the office park members would see peak usage Monday through Friday from nine to five.

We have built preliminary building profiles for each member and have analyzed their usage. Although not final until further audits and assessments are complete, these profiles serve as the JCM's unique design of DER and storage.

Uninterruptible fuel supply or one week on-site

The fuel supply for the CHP would be handled by the current gas pipeline infrastructure providing an uninterruptible fuel supply for the base system load. We are also investigating the ability to have local storage for either Compressed Natural Gas (CNG) or Liquid Natural Gas (LNG) on site.

Resilient to the forces of nature

System resiliency is inherent and a top priority in the JCM design. The preliminary design calls for our own underground transmission infrastructure, unable to be damaged by the forces of nature. We investigated the legal and financial implications of the underground transmission network to be separately owned and funded by the County, not the JCLDC.

Black start capabilities, if needed, would be supplied by the power generation of the CHP units. These require no electrical grid feeds, only natural gas.

Our grid would always support its own waveform, i.e., frequency, and maintain a “spinning reserve” with generation or batteries.

1.5 Preferred Microgrid Capabilities

Customer interaction with the JCM grid would be available through packaged or customized user interfaces (UI). The entire system is being designed with smart devices, so conceptually; all JCM grid utilization metrics and controls could be available to the end user. As with all complex Information Technology (IT) systems, many user and operational levels would be determined as the project progresses and the appropriate UI and security/operational levels would be implemented.

The network control system would be a cloud-based environment consisting of multiple products and services. The preliminary design is based on two utility grade products – the Eaton Foreseer system and the Eaton/Cooper Yukon system. These two products would be improved by an Eaton toolkit currently under development and further enhanced by an analytical overlay.

Once implemented, the control system would optimize demand and supply on the microgrid. These optimizations would be built around usage profiles, which are not yet finalized.

Several members implemented energy efficiency projects over the past few years. One member has completed new boilers in several buildings. New High efficiency lighting in all building and parking lots. Ice storage HVAC system for cooling building four. It has had such good success with this ice storage, that they are cooling their new building and retrofitting another building with this technology. In addition, they have updated their BMS system in all buildings except building six. It is their long-term plan to equip every building, but it is very costly.

Another member has implemented high efficiency lighting with automatic on/off sensors in their warehouses and office space. Currently, none of the members are enlisted in any demand response programs with the local utility – National Grid.

As previously stated, the JCM would be operated through an underground transmission line network utilizing all smart devices. This would provide connectivity to all DER and CHP units on the network. We have probable locations for grid connectivity but cannot determine the exact locations until we receive further information from National Grid.

We have followed the REV vision in the entire design of the JCM. The following are highlights of the coordination between our JCM and the visions sited in REV:

Enhanced customer knowledge and tools that support effective management of their total energy bill.

The JCM members would have a complete set of managerial tools at their disposal and an advanced set of energy analytics. These tools would permit them to see their energy profiles as well as methods of enacting energy efficiency measures.

Market animation and leverage of ratepayer contributions

The JCM would be a critical component of the newly envisioned REV environment. The platform would inherently serve ratepayers as a mechanism to support DER generation while connecting to the greater transmission platform supported by the utilities. Integration between the JCM platform and the utility would be the vision of the future and allow the utility to develop products and services for the ratepayers.

System-wide efficiency

The JCM would incorporate advanced efficiency measures based on the user profiles. All components would provide energy to the infrastructure and the controls would store or dispense energy based on the most efficient use on a daily basis. The JCM would also provide a balance between the utility's bulk energy generation and local generation provided by the local DER.
Cost savings are an integral part of the JCM solution. We are anticipating a 10 to 15% reduction in the cost of energy to the JCM members.

Fuel and resource diversity

The JCM would provide energy diversity in terms of natural gas fired CHP components and PV solar. It would contain energy store facilities in terms of batteries. We are currently investigating the addition of a hydropower facility, but that component would be for a Phase II of the project.

System reliability and resiliency

The JCM is being designed with system reliability and resiliency from the ground up. Islanding is a major component of the design. Base load and backup equipment, CHP units, are being studied and would be implemented as part of the design strategy.

Reduction in carbon emissions

The JCM would reduce the carbon emissions in the area but the exact statistics are unavailable until the final design is understood and implemented.

Tangible community benefits:

One of the main objectives of the JCLDC is to keep local jobs in the Watertown area while providing a mechanism to attract new jobs to the area. By providing this new and innovative energy infrastructure, current members of the industrial park would have a low-cost energy infrastructure with predictable budget stability in the future. It would also have the new marketing moniker of being a green and sustainable energy environment.

Provides for resilience and reliability during serious weather related events or grid interruptions.

- **Blizzard of 1977 -** January 28th to February 1st paralyzed region for many weeks. Peak winds of 69 MPH creating snow drifts of 40 feet or more.
- **Microburst of 1995 -** thousands without power, homes and businesses damaged.
- **Ice Storm of 1998 -** catastrophic Ice Storm and flood event of January 1998. One half a billion dollars in damage according to US Commerce Department. Hundreds without power for weeks. 36,000 power lines were downed and roads made impassable.
- **Ice Storm of December 2013 -** 23,000 people without power. Flooding occurred, roads closed. Shelters opened to house those without power

Increased use of local energy sources as the base load for the network thereby reducing dependency on energy sources outside the area and outside the Country.

Strengthen the surrounding power grid in the Watertown area by providing less strain in critical times on the current National Grid environment.

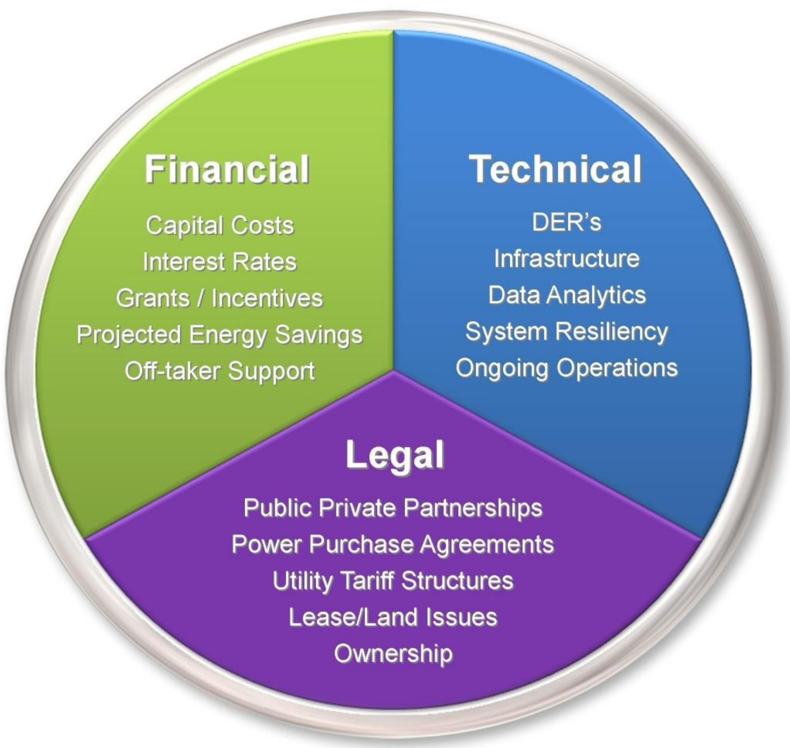
It is our understanding that the current power grid supplied by National Grid is in an "opportunity zone" and designated as a critical area. We are now waiting on a definition of this aspect from National Grid.

As for innovations to customers, this would be a total reversal of their current energy environment. All of the members are paying a high price for their energy and have no window into utilization analytics or consumption profiles. Only one member, with large commercial usage, was given an interval meter and unfortunately, it was never installed to register usage.

1.6 Project Topography

The JCM team understands the complexities of developing a project of this magnitude. For internal purposes, we are deploying three fundamental practices in conjunction with the NYSERDA worksheets. They are described below:

The JCM team understands these three concepts are fundamental to a successful microgrid. We believe the financial and legal components are just as important as the technical solution. Believing in this three-dimensional approach gives us a solid understanding of the client. As such, we have spent much time in all three pieces of the proverbial pie – outlining action items and processes not only in the technology area but in financial and legal manner as well.



Legal

Over the past few months, we have seen the legal structure have an impact on the financial structure in terms of credit rating, overall interest rates and low customer capital. Questions have arisen on grid ownership and the ability for the grid owner to sell energy to its members, as most New York governmental entities are not permitted to sell energy, which means the surviving entity has to comply with these regulations. Other involvements are easements and right of ways, ownership of meters and accounts for net metering, property leasing, locations and site issues, and many other situations.

Financial

The JCM team has spent time working on the financial modeling and the costs involved in the base project. We are investigating various methods of reducing the infrastructure costs such as a separate bonding component. We are also having discussions with grant and incentive sources such as the Department of Energy and the US Department of Agriculture. Any cost reduction in terms of funding and interest rates can make a sizable difference.

We are also seeking some answers of the National Grid SC-7 charges. These would play an important part in the overall ongoing cost structure. We would consider these when determining the islanding model. These are all real world issues of today's microgrids in New York State.

The second critical piece of our financial assessment is the off-takers of the energy generation. For in essence, this group of users would be paying for the project over the next 20 years. They have to be real, solid entities or replaced with guarantees or set offs.

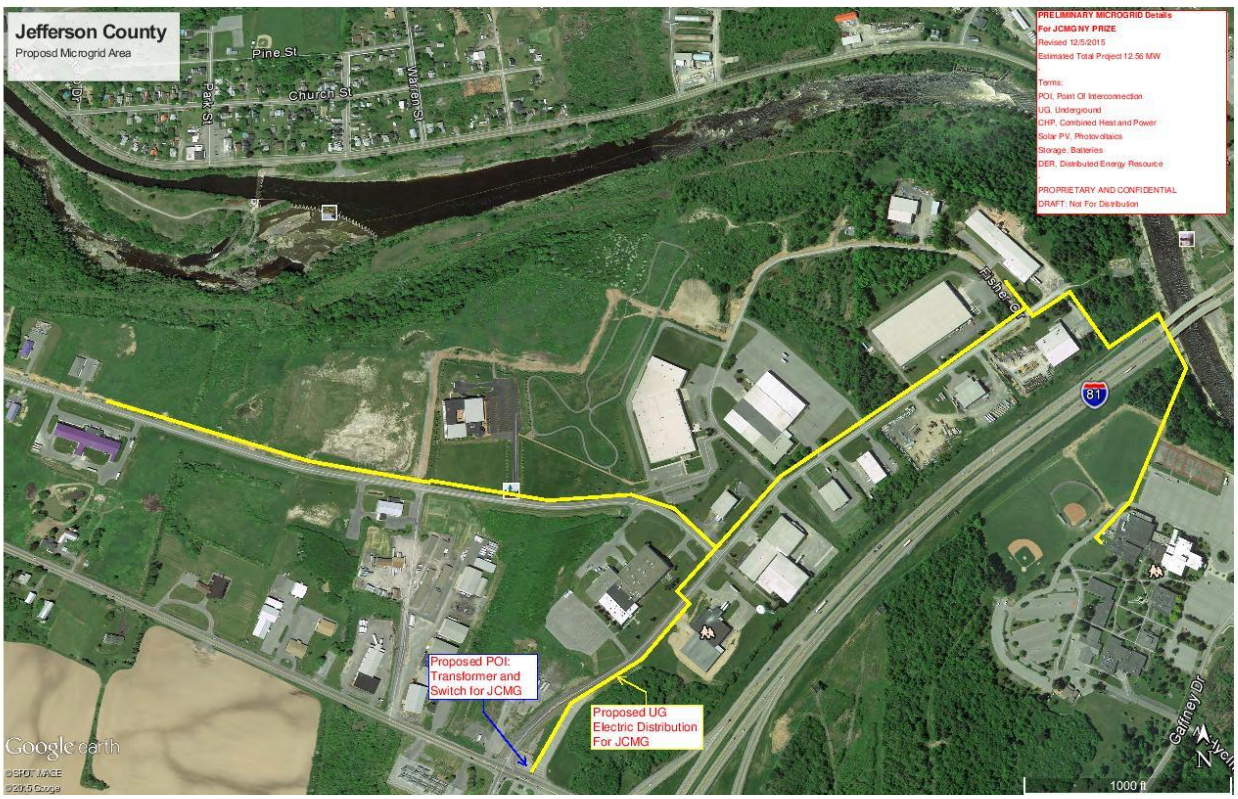
The JCM is attempting to leverage private capital in many different methods. We have engaged the capital markets by splitting the underground infrastructure and the DERs. The concept behind this strategy is that the underground infrastructure would be utilized by not only this project, but for many projects to come. There should be a separate ownership of the transmission infrastructure, one in which the infrastructure can receive grants or low interest loans from the USDA rural financing arm. This would drastically reduce the cost of this component.

Many funding entities including banks, funds and home offices are reviewing the DER infrastructure, the associated Investment Tax Credits, and the structure of the PPA's. We are currently discussing issues with the Green Bank on topics such as minimum monthly payments and "off-taker" insurance (what happens if a member moves or relocates).

2.1 Develop the Preliminary Technical Design, Costs and Configuration

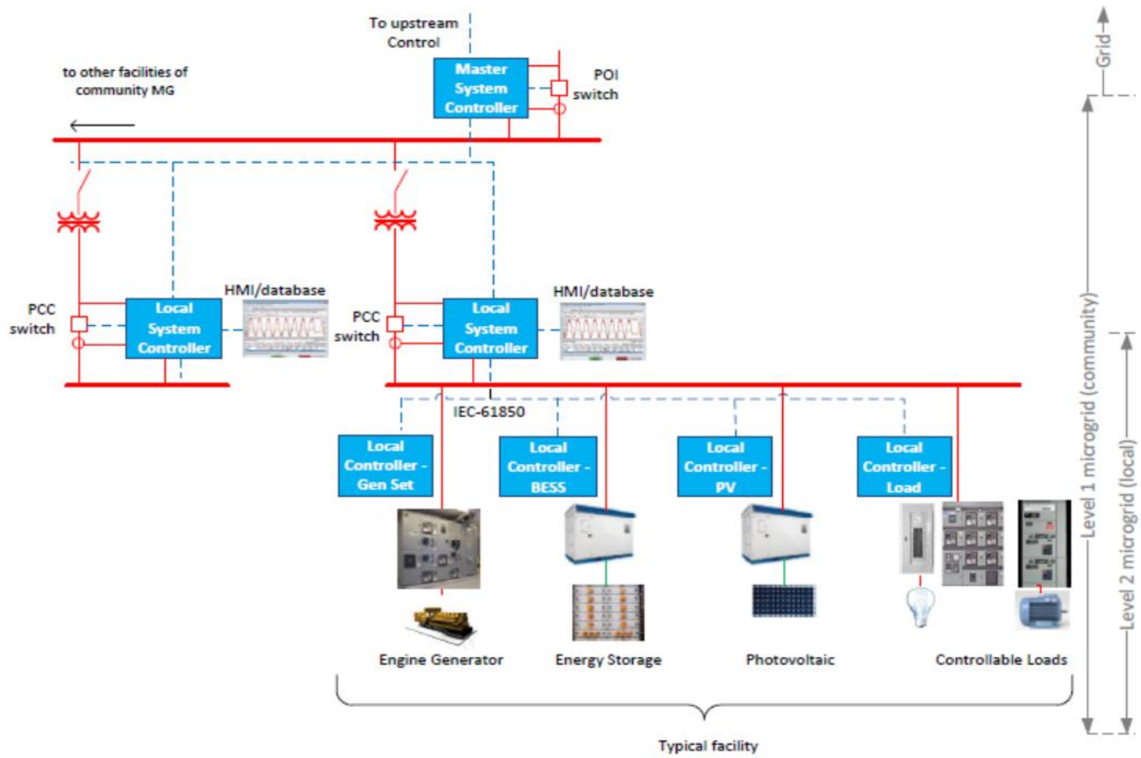
Proposed Microgrid Infrastructure and Operations

The JCM preliminary layout with Distributed Energy Resources (DER) and National Grid Interconnection point is shown below a simplified one-line diagrams.



JCM would provide the JCM 15kV underground backbone distribution electrical cable system. There would be power transformers at each of the client locations, and although not yet determined to be necessary, we have included automatic transfer switches at each client where National Grid (NGRID) existing feeder lines can be switched with the JCM feeder cable. There would be a single POI (Point of Interconnection) with one Eaton-Cooper recloser.

One Microgrid system master controller would be provided communicating with wireless local facility client controllers that in turn communicate with individual DER assets and distribution equipment as well as meters at the POI and PCCs (Point of Common Coupling). Below describes the definition of Level 1, community, and Level 2, local, microgrids and depicts a portion of the system.



LOAD CHARACTERIZATION

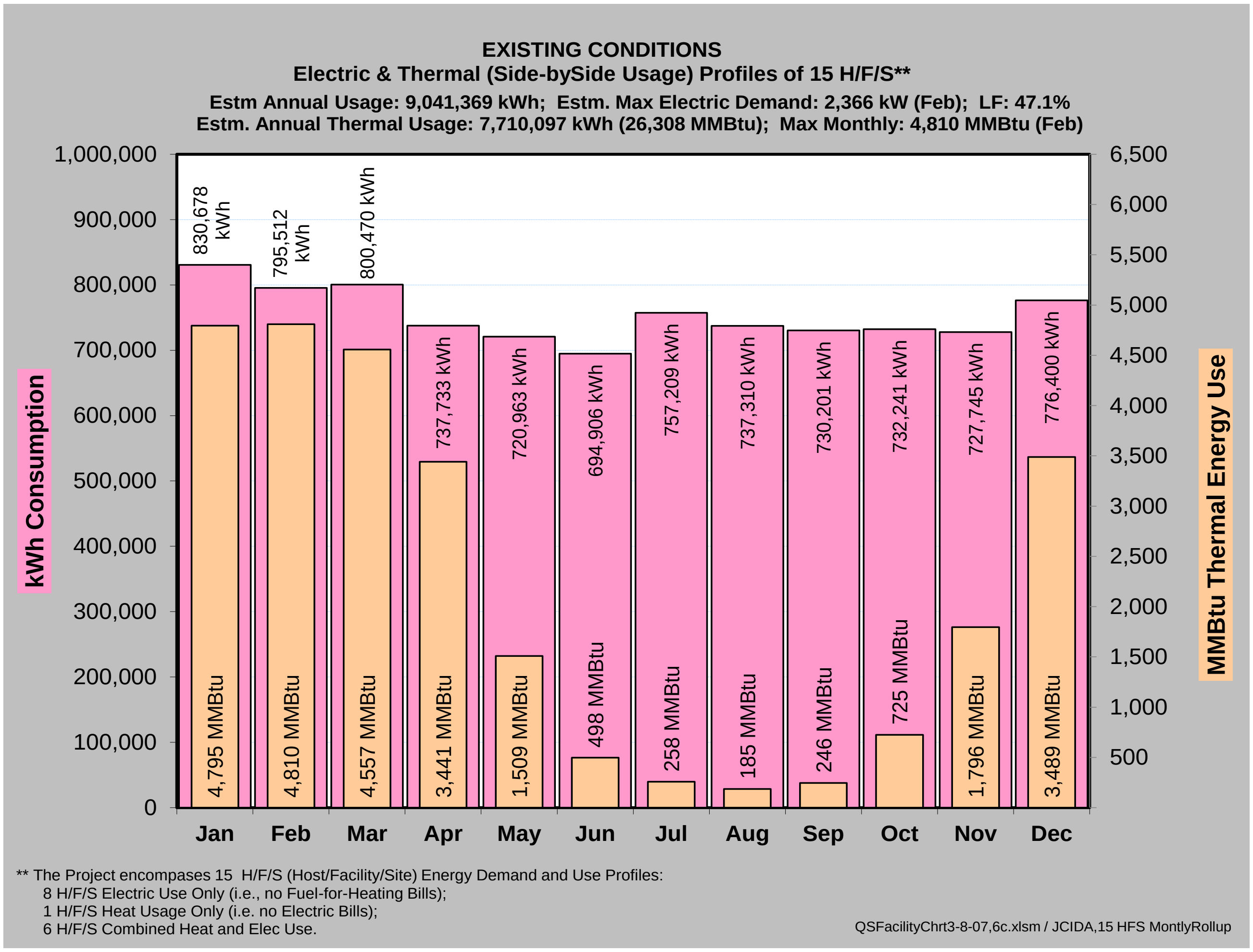
The electrical and thermal loads served by the microgrid when operating in islanded and parallel modes are listed below. The diagram includes estimated current usage, peak demand kW, and annual kWh identified by the location of the electrical loads.

	Estimated and Current			Proposed		
	Project Statistics/Totals			Distributed Energy Resources (DER)		
	Estimated	**Peak**	**Micro Grid**	CHP	SOLAR	Storage
Facility	**Current Usage***	**Demand**	**Production**	kW	kW	kWh
Member 1	233,120	66	242,000	-	220.0	-
Member 2	982,334	560	1,560,000	300.0	600.0	400.0
Member 3	2,165,976	569	3,640,000	400.0	800.0	800.0
Member 4A	680,614	292	1,040,000	200.0	400.0	400.0
Member 4B	820,443	296	1,450,000	300.0	500.0	400.0
Member 5	2,781,940	773	2,600,000	500.0	1,000.0	1,200.0
Member 6A	1,126,800	246	1,450,000	300.0	500.0	400.0
Member 6B	900,112	212	1,040,000	200.0	400.0	400.0
Member 6C	1,823,456	524	1,640,000	400.0	500.0	800.0
Total (kW)				2,600.0	4,920.0	4,800.0
Total (kWh)	11,514,795	3,538	14,662,000	7,800,000	5,412,000	

The existing side by side electrical and thermal loads of the current JCM members are listed below. These loads would be served by the JCM when operating in islanded and parallel modes. Additional member loads have been estimated based upon analysis of their building structure and discussions with management regarding company workloads and other characteristics.

In most cases, hourly profile data was not available but requests for new interval meters have been made by the members to National Grid. We have developed a proprietary interpretive model for generating hypothetical hourly profiles from monthly (actual) data sets. By using a hypothetical profile specific to a building usage, i.e., manufacturing, office, retail, etc., we can interpolate hourly profiles in the context of a Phase One feasibility study.

Listed below is the electric usage profiles determined for the JCM. These profiles were used in determining the sizing of the loads to be served by the microgrid, which include redundancy analysis.



DER sizing is based on an Electrical Demand following basis. Optimization of thermal output from CHP has been estimated, but would be better optimized for process heat, space heating and absorption chilling for air conditioning purposes. System sizing is based on hourly estimates of capacity, availability and dispatch ability of the individual DER systems, and the estimated usage and demand of the individual host sites.

Ongoing iterations would provide more detailed optimization and may result in modifications to the proposed DER capacity requirements. All designs provide for full islanding capabilities utilizing:

Battery storage systems to provide:

- Resiliency
- Frequency Regulation
- Voltage Support
- Backup Power

CHP Generation to provide:

- Baseload Power and Energy Needs
- Resource Adequacy
- Demand Response
- Spinning reserve

Solar PV to provide:

- Daytime Peak
- Frequency Regulation and Reactive Power through Smart Inverters
- Summer Peak Shaving

DISTRIBUTED ENERGY RESOURCE CHARACTERIZATION

The following are the Distributed Energy Resources (DER) and thermal generation resources that are current considered as part of the JCM:

	Energy	CHP	SOLAR	Storage
Facility	**Type**	kW	kW	kWh
Member 1	CHP, Solar	-	220.0	-
Member 2	CHP, Solar, Storage	300.0	600.0	400.0
Member 3	CHP, Solar, Storage	400.0	800.0	800.0
Member 4A	CHP, Solar, Storage	200.0	400.0	400.0
Member 4B		300.0	500.0	400.0
Member 5	CHP, Solr, Storage	500.0	1,000.0	1,200.0
Member 6A	CHP, Solar	300.0	500.0	400.0
Member 6B		200.0	400.0	400.0
Member 6C	CHP, BioGas	400.0	500.0	800.0
Total (kW)		2,600.0	4,920.0	4,800.0
Total (kWh)		7,800,000	5,412,000	

These DER and thermal generation resources are part of the JCM and are located on space provide to the JCM by its respective members. Typically, solar would be placed on the members roofing structure. CHP and battery storage units would be placed adjacent to the buildings in containers designed specifically for this purpose, varying slightly from manufacturer to manufacturer. Final locations would be determined after the Phase I feasibility project is complete.

The adequacy of the DERs and thermal generation resources to continuously meet electrical and thermal demand in the microgrid is based on known performance characteristics of established CHP, Solar and Storage DER products. Currently peak demand and redundancy generation is supplied by multiple CHP and excess capacity proposed in both CHP and energy storage configurations. See the attached Appendix items and associated DER equipment specifications.

The CHP and battery units would not be exposed to the forces of nature or extreme weather events for they are housed in containment platforms specifically for this reason. The solar panels would be exposed to weather events such as snow storms and icy conditions. These factors have been taken into consideration in the load designs for the JCM.

Fuel source for the CHP units is natural gas supplied by National Grid. There is currently no history of any gas supply events and the amount of time for continuous operation of the microgrid is unlimited. That being said, we are investigating the ability of the JCM to store limited amount of LNG for economic and catastrophic reasons. This would be studied further in the next phase of the program.

The JCM DER systems are controlled by a Master Control System, the generation resources provide power, energy and thermal output based on the monitored client demands. This project is always self-sustaining with regard to energy requirements and is capable of full operations of the host facilities at all times regardless of the status of the Local Utility Grid. The following characteristics are listed specific to the DER type.

Solar PV System Characteristics

- Meet interconnection standards
- Reactive Power
- Peak load generation and energy offset of CHP

Combined Heat and Power

- Black Start capable
- Synchronous Operation
- Load following
- Maintain voltage
- Maintain frequency
- Ride through capability
- Meet interconnection standards

Battery

- Black Start
- Load following
- Maintain voltage
- Maintain frequency
- Ride through capability
- Meet interconnection standards

2.2 Microgrid Electrical, Thermal, Infrastructure & Control Characterization

Distribution System

A 3 foot deep electrical trench would begin at Point of Interconnect (POI) to all members, then cross Hwy 81 under the overpass bridges using the bridges as a means to support the conduit, and terminating at the Jefferson College campus. The estimated total length of trenching and conduit is 13,500 ft.

- There would be a single 5 inch conduit with 3 – 1C 15kV, 133% insulated, Cu 500MCM cable plus 1 – 4/0 bare ground cable within the trench.
- JCM member building loads to be reconnected, by others, from existing utility service entrance feed to the individual ATS and from the ATS to the LV bushings of the new pad mount transformers.
- There would be eight (8) pad mounted oil filled transformers up to 1500 kVA typical on a 6 inch thick concrete pad to step from 13.2 kV down to 480/3/60 utilization voltage.
- One (1) 15 kV class NOVA pad mounted recloser with a recloser controller to act as the POI point of separation between the utility and the new islandable microgrid.
- Provisions for synchronization would be completed at the POI. Connection of the recloser to the utility POI by others.
- One (1) NEMA 3R free standing enclosure to house microgrid controller and network switch. Controller to receive DNP3 communication from utility. Provisions for compliance with utility IT requirements for interface with utility SCADA.
- Startup and commissioning testing for the recloser, transformers, and cable.

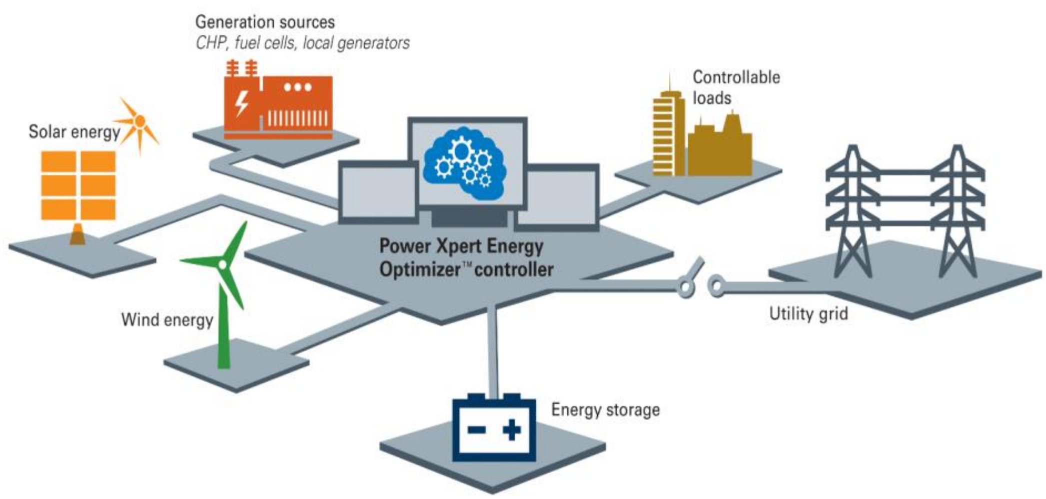
Control System

SMP4250 and/or SMP4 controller in 19 inch rack for coordination of CHP gen set, PV inverter, and BESS to coordinate power at each participating facility that would be connected via a dedicated cable feed to form a local “Level 2” microgrid. Each Level 2 DER would have an OEM supplied dedicated controller for routine control of CHP generator, PV array inverter, and BESS inverter. Additional control mechanisms could include:

- DER asset devices would synchronize with other generating devices and utility. The controller would interface with the DER asset controllers to provide system status, set point values, alarming, and data historian.
- DER assets would have their own black start capability.
- Eight (8) 2000A ATS, open transition (one at each of the eight clients) to be fed by existing utility and new Microgrid line.
- HMI software.
- Server with SQL data base and historian.
- Managed network switch to communicate with CHP gen set, PV inverters, and BESS inverter at each participating facility location. The managed network switch would communicate with a wireless transceiver at each building location to form a microgrid LAN.
- Local net metering with communication to be mounted in/with ATS for each building.
- Analysis would be conducted for system dynamics, arc flash, load flow, device coordination, device evaluation, short circuit, harmonic analysis and grounding.
- A single line of the system would need to be developed after approximately 80% design completion.

Proposed General Component Infrastructure

Power Xpert Energy Optimizer™ Controller-General Description



Introduction – Controller

The description below is a general description of the Eaton technology architecture and would be modified to suit for the Jefferson County Microgrid.

The Eaton Power Xpert Energy Optimizer™ controller is an integrated, modular distributed control architecture, scalable to a variety of applications including energy storage, photovoltaics, and microgrids. Primary components of the integrated control system include:

- **Local Controllers:** A local controller is used at each controllable client site. The local controller provides semi-autonomous, fast device control, maintaining operation within connected equipment limits, providing local sequencing and alarm management, and includes an integrated sequence of events recorder. The local controller scales, normalizes, and manages control, operational and monitoring data flow to the upstream system controller. The local controller hardware, hardened and without moving parts, has broad environmental ratings and is suitable for mounting in a NEMA 3R enclosure. Testing, commissioning, and troubleshooting at the local controller can be performed independent of the upstream control. Critical control communications with the upstream System Controller is via industry-standard IEC-61850 protocol. In addition to the controlled devices, local metering and other communicating IEDs may be connected to facilitate control & monitoring. Local controllers are configured for specific applications as described below.

- **Energy Storage Local Controller:** The energy storage local controller interfaces with and coordinates the operation of a PCS (Power Conversion System) and associated BMS (Battery Management System), providing sequencing, mode selection, and dispatching while maintaining operation of the PCS within battery current, voltage, and SOC limits. Communication complies with the MESA standard for PCS and BMS.

- **Photovoltaic (PV) Local Controller:** The PV local controller interfaces with and coordinates the operation of one or more PV inverters, providing sequencing, curtailment, and reactive power control. The controller can also serve as a gateway for routing PV monitoring data (weather, irradiance, etc.). Communication complies with the SUNSPEC standard for inverters.

- **Generator Local Controller:** The generator local controller interfaces with and coordinates the operation of a standard communicating engine-generator control, providing generator sequencing, mode selection, and dispatching.

- **Load Local Controller:** The load local controller interfaces with a variety of controlled (sheddable) loads, monitors status and load information, and coordinates disconnection / reconnection of loads.

- **System Controller*:*** One system controller interfaces with upstream SCADA and optimizes and coordinates the operation of controllable assets (sources & loads) through the downstream local controllers. The system controller can support various system-wide applications such as optimal source dispatching or demand control, and applications for specific sources such as renewable firming, etc. The algorithms within the system controller are adaptable to the status of the downstream local controllers and associated devices, modifying setpoints and sequencing to compensate for devices which are offline, underperforming, or under local control. The system controller provides remote access to the control system via a secure communication network (as defined by IEC 62351-3). The system controller also interfaces with external devices such as meters and protective relays for monitoring and control; for example, the POI (point of interconnection) breaker is controlled for islanding applications.

- **Real Time Control:** All real-time control functions are implemented in the combination of the system and local controllers. All controllers utilize embedded operating systems and implement cyber security regarding access, operation, configuration, firmware revision and data storage and retrieval.

- **Server with local HMI & Historian:** The Eaton Power Xpert Energy Optimizer™ controller's HMI provides system configuration, device monitoring and application control functionality. The integrated historian continuously monitors system operation and performance and collects detailed operational history. While the server-based HMI is a significant element of the control system, the balance of the control system can continue to operate independent of the server (during server upgrade, maintenance, or outage).

Control Functions

- **System Sequencing and Coordination:** The Eaton Power Xpert Energy Optimizer™ controller coordinates sequencing for the controlled system in response to user commands, system status, limits, or faults.
  - Connect / Disconnect system and/or individual sources & loads - includes ramping of sources and sequencing. Specific conditions (faults, etc.) may also result in commanding sources & loads to physically disconnect from the power system.
    - Start/Stop –
    - Permit Reconnection

- **Black Start:** includes sequencing, mode control, and setpoints for sources and loads from an unpowered condition when isolated from the utility.

- **Mode control selection for system and individual sources & loads**
  - Operational Mode Selection
  - System Status (Black Start, Islanded, Grid Connected)

- **Coordination and dispatching of sources:** commands to individual sources are coordinated to achieve the desired total system output, based on several considerations including:
  - Manage energy storage to maintain optimal state of charge; limit charge/discharge rate to remain within equipment limits, and adjustable user-entered limits (maximum and minimum).
  - Limit total system power import/export to remain within system programmed limits and adjustable user-entered limits (maximum and minimum).

  - Optimize sources based on efficiency, cost of fuel, run time, and other considerations

- **Black Start:** combines sequencing and coordination described above to re-power the microgrid from an unpowered condition when isolated from the utility.

- **Islanding:** combines sequencing and coordination described above to balance sources and loads to a zero import/export condition, disconnect from the utility, and continue independent operation as an independent island, maintaining voltage and frequency.

- **Reconnection:** combines sequencing and coordination described above to synchronize microgrid to the utility, reconnect, and transition to grid-connected active control.

Active Control Functions:

The Eaton Power Xpert Energy Optimizer™ controller provides multiple modes of operation. The following functionality is an example, but not limited to:

- **Manual Dispatch - Real & Reactive Power:** Each controlled source is adjusted to match user-supplied values.

- **Real Power – Follow setpoint:** Total system import or export follows a dynamic user-supplied reference value (via communication interface – SCADA or other). Typical applications include:
  - Frequency Regulation service
  - Automatic Generation Control

- **Real Power – Load Limiting:** Total imported real power, as measured at POI, is limited to a user-supplied value (via HMI or communication interface – SCADA or other). Source output is varied to compensate for load exceeding the setpoint; load shedding is employed if needed. Typical applications include:
  - Peak Shaving
  - Demand Management
  - Load Leveling

- **Real Power – Generation Limiting:** Similar to Load limiting, the total exported real power, as measured at POI, is limited to a user-supplied value. Energy storage system charge power is varied to compensate for generation exceeding the setpoint. Typical applications include:
  - Generation Leveling
  - Renewable Integration

- **Power Factor Regulation:** Source reactive current is varied to achieve a system target power factor, as measured at POI. The target value is user-supplied (via HMI or communication interface – SCADA or other).

- **Reactive Power Regulation:** PCS reactive current is varied to achieve a system target reactive power, as measured at POI. The target value is user-supplied (via HMI or communication interface – SCADA or other).

- **Voltage Regulation:** PCS reactive current is varied to achieve a system target voltage, as measured at POI. The target value is user-supplied (via HMI or communication interface – SCADA or other).

- **Source Optimization:** dispatching of sources to optimize operation based on one or more of the following considerations:
    - System stability (for unintentional islanding event)
    - Efficiency / fuel consumption / cost of fuel
    - Run time limitations
    - Total cost of operation
    - Maximize renewables

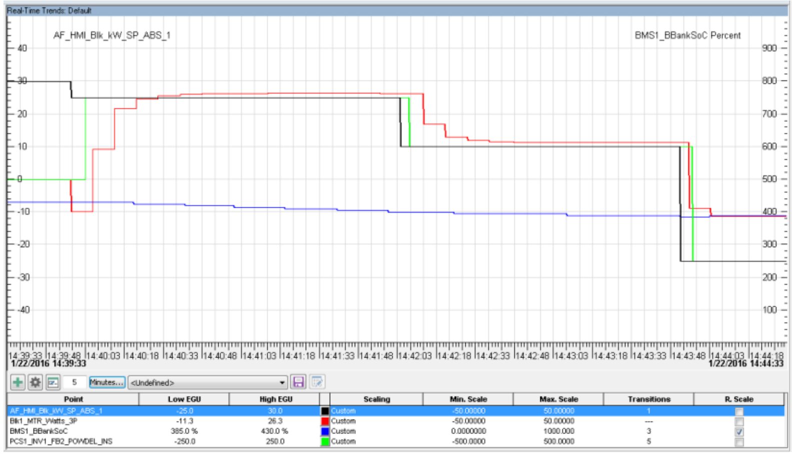
- **Islanded operation:** set modes and dispatch sources & loads in island mode based on one or more of the following considerations:
    - System stability
    - Efficiency / fuel consumption / cost of fuel
    - Run time limitations
    - Total cost of operation
    - Maximize renewables

Local HMI, Historian:

Eaton's Yukon™ Visual T&D™ is integrated into the Power Xpert Energy Optimizer™ controller, providing scalable, pre-configured smart monitoring and control functionality. It continuously monitors system operation and performance, and collects detailed operational history. The HMI and historian reside on the local server and interfaces with all elements of the Power Xpert Energy Optimizer™ controller.

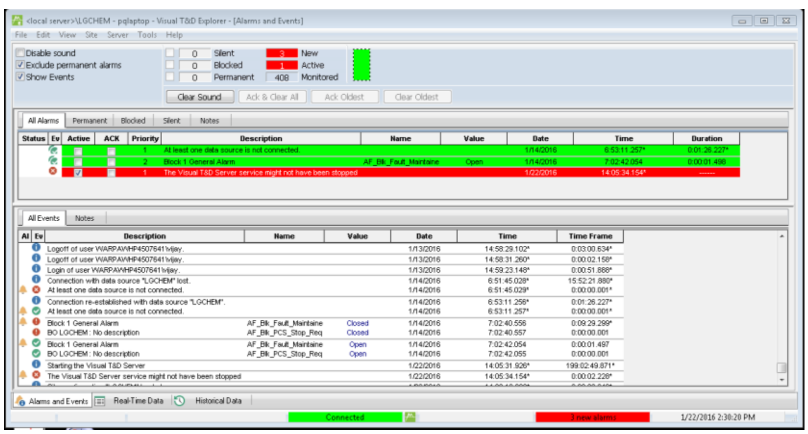
Data Logging: The data log is a true historian, providing a complete record of all system data, alarms, operator actions, and events. The high-performance historian is based on industry-proven PostgreSQL and Microsoft SQL Server databases. Millisecond time tagging. Data can be viewed immediately in real-time, in a variety of formats.

Table Views provide a spreadsheet-like display of the real-time values of selected data points



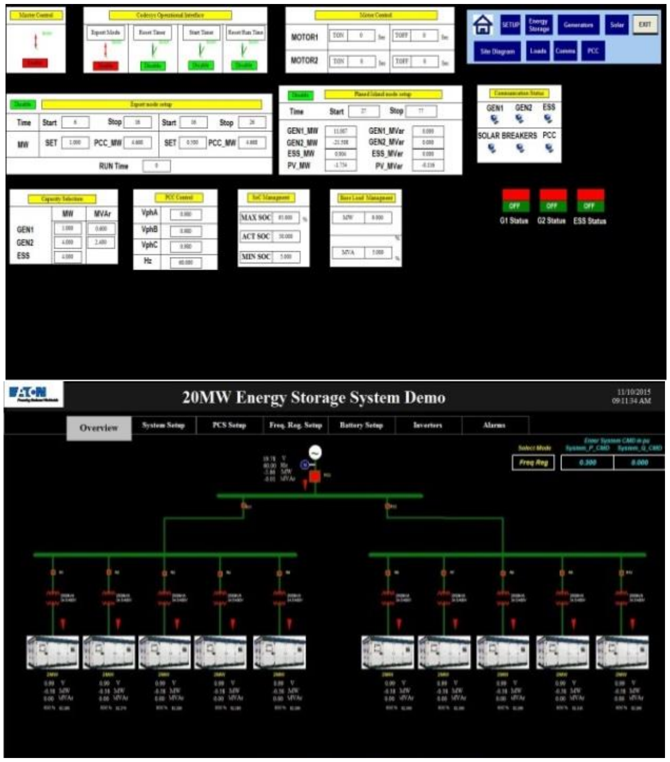
Trending Views plot the value of any data point, in real time.

Alarm and event management: Provides comprehensive alarm and event processing: alarms and events are available via HMI, and remotely via web browser. User notification of significant alarms and events by email, SMS of pager may also be configured.



Alarms and events view via HMI: Includes Events tab (chronological list of recent events and alarms), and Alarms tab (separate color-coded list of all current alarms)

Graphical System Display & Control: Includes interactive diagrams to monitor and operate the system: the graphical diagrams display real-time values, use animation / colors to indicate operational status or alarm conditions. System setpoints, modes, and other operator-initiated actions are directly accessible from the graphic display, and control privileges can be limited to specific users.



Additional components include:

- Secure remote pass-through access: Allows owner to grant other users secure access to specific device(s) connected to the Power Xpert Energy Optimizer™, while prohibiting access to all other devices. For example, in storage applications, this feature may be used to allow the battery supplier to access the BMS. The remote access would be enabled on demand by the owner. The owner may disable remote access when not in use.
- Automatic retrieval and processing of event files from digital fault recorders and relays
- Integration and secure configuration management of all connected IEDs.
- Enhanced secure pass-through access to connected IEDs through server: adds session logging, automatic password login, and role base access.
- DNP3 with Secure Authentication V5 between System controller and upstream SCADA.

2.3 Grid Interconnection

There would be a single point of connection to the grid, POI, which would have automatic isolation functions and have remote and local reconnection capability. There would be a separate isolation transformer and/or substation built at the POI to perform these functions. All of the items below are functions of the master control and monitoring capabilities of the communications and control systems.

The controls have operational characteristics that allow for default operations independent of remote monitoring and controls. All communications systems within the microgrid are powered locally at each host through a primary function of the BESS (batteries). Therefore, weather disruptions of the microgrid operations are isolated from outside conditions at all times.

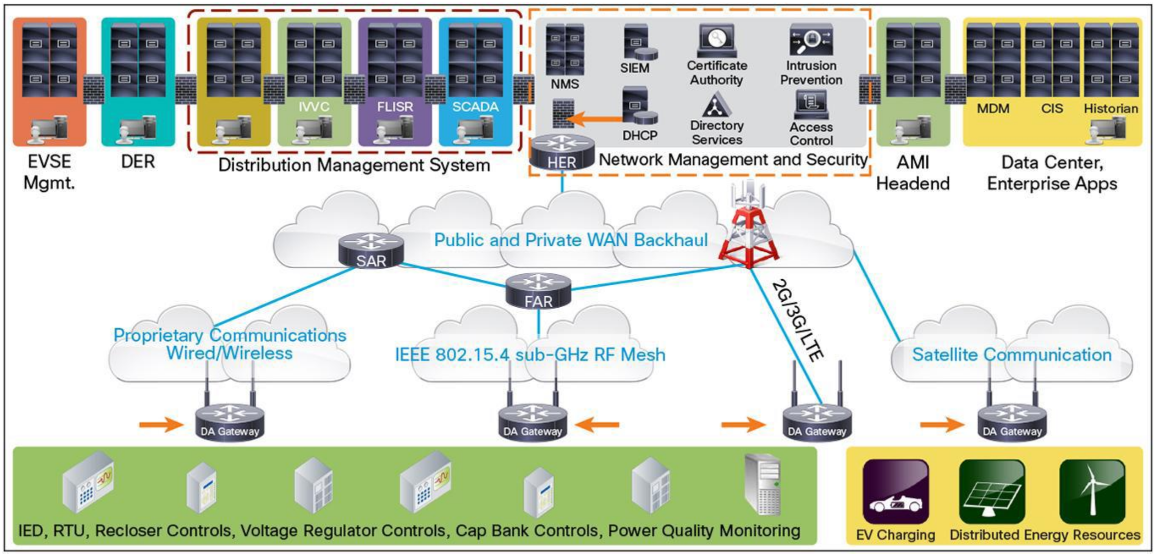
2.4 Information Technology / Telecommunications Infrastructure Characterization

JCM would utilize the latest equipment deployed in today's microgrids including inverters, capacitors, meters and control systems. These devices employ a mix of industry standard communication interfaces and protocols. The design and build of the system interconnects these devices for monitoring and controlling the network in real-time. This infrastructure would incorporate a combination of physical and wireless interfaces. The devices that do not support wireless technology would be connected primarily through Ethernet. There would be exceptions when legacy equipment is necessary in the new architecture requiring the use of standard RS-232 serial connections.

For wireless, the JCM plan builds an intelligent mesh network based on the IEEE 802.15.4 standard. A standard used by low powered internet enable devices such as electric meters. Using the latest internet protocol (IPv6), the mesh network would be able to support the most recent advances in technology for deploying and maintaining today's microgrids. This design would also furnish the foundation for implementing future developments in the industry including the deployment of the 'Internet of Things (IoT)'.

There are many advantages of using a mesh network including eliminating any single point of failure. Devices would have inherent 'smart capabilities' to 'self-heal' themselves in an event of a device failure. Also, this protocol would allow us to easily communicate real-time information to Jefferson County and to the members of the JCM through ubiquitous devices such as personal computers and mobile phones. In addition, it would provide the ability to integrate with our customer's on premise industrial equipment and HVAC components that possess standard IP communications capabilities. Lastly, it would provide the JCM the capacity to deliver more accurate and timely information to National Grid than the majority of other Distributed Energy Resources (DER) currently attached to their infrastructure.

JCM would not make use of any telecommunication infrastructure currently in place in the Industrial Park. All new equipment and telecom services would be installed and configured to the unique needs of JCM. Below is a high-level diagram of our standard network.



The Field Area Network or FANs allows enabling communications, monitors networks and improves control of our energy distribution network. Based on energy usage information gathered at customer sites, the network would improve load management, offer new services to our customers, and help to build a more efficient microgrid with a lower carbon footprint. We are also aware of real-time grid conditions to help improve system responsiveness and management. Our grid-connected network supports these requirements and provide:

- Security to protect customer and utility information
- Ruggedized equipment to handle harsh weather conditions
- Strong network management capabilities to help collect and administer large data
- Notifications in case of emergency and support for disaster recovery

3.1 Commercial Viability – Customers

The Jefferson County Industrial Park and the adjacent Jefferson Community College are vibrant community participants of Watertown, New York. These manufacturers and educational institutions or JCM members have been impacted by local weather and utility-related energy events, causing a loss in their ability to provide services to their customers, employees and students. This loss of electrical services impacts the community in general, and as an example, one lost day of productivity at the college has a financial effect on the community of approximately $100,000. The JCM customers and the individuals impacted are listed below:

- JCC has 300 dormitory residents, 415 employees and 4,100 students
- 5 Member total of over 625 employees
- Fire District Station 3 has 10 volunteer firemen

The JCM, just with its initial members, contains 1,040 jobs for the Town of Watertown. These jobs are extremely important to the local economy and comprise 2.4% of all jobs in the entire County of Jefferson!

These JCM members would receive improved energy operations and cost savings. These improved energy operations would provide direct benefits to the members, but also indirect benefits of peak demand reduction to National Grid and to the New York Independent System Operator (NYISO).

All but two members of the microgrid are located in the Jefferson County Industrial and Corporate Park, which has been designated by National Grid as an "Opportunity Zone". The information provided to us by National Grid shows a large number of events in the Coffeen Street substation area, which, in our opinion, directly impact the member's power resilience and power quality. Other information available to us via the National Grid/PSC websites show over 20 events in 2014 and 15 thus far in 2015.

The JCM consists of seven members, which could be extended to ten or more members. All of the current members are seeking reliable, quality power from the JCM and would purchase power directly from the JCM. The exact amount of power purchased has not yet been determined but it is envisioned that all seven members would purchase approximately 80 - 100% of their peak power from the microgrid on a full time basis. Power would be available during both normal operations and islanding modes.

Besides the JCM members, there are additional stakeholders who would indirectly benefit from the JCM. They are the County, Town and City of Watertown and the local community. Their positive effects are summarized below:

1. Keep local businesses in Jefferson County by providing quality, affordable power;
2. Keep local businesses in Jefferson County by providing green, clean, renewable power; and
3. Attract new businesses to the area by providing #1 and #2.

The JCM would be a collaboration between the public and private sectors - a true Public Private Partnership (PPP). The JCM is progressing with the concept that the Distributed Energy Resources (DER's) would be owned by a private Special Purpose Entity (SPE) consisting of the prime system energy integrator and the funding entities. The County (or County agency) would own the transmission infrastructure and that would be lease back to the SPE.

The JCM has met with all seven members and discussed in general, the signing of a multi-year Power Purchase Agreement (PPA). The PPA would serve both critical and non-critical loads of the members. The PPA's are being formulated by our team member Harris Beach LP.

The meetings with members have specific, individualized plans in place that include the PPA, easements, placement of DER's and other legal discussions regarding the microgrid deployment. The PPA's contain multiple DER's including solar, Combined Heat and Power (CHP) and batteries along with various financial implications.

We have discussed some critical collateral aspects of the program with the Green Bank. These topics include critical JCM members leaving the project in the infancy of the payback years. Additional meetings would be scheduled when further financial aspects of the project are complete.

3.2 Commercial Viability - Value Proposition

The JCM has enormous value to its members, the community at large, the local electric distribution utility and the State of New York.

There are multiple benefits associated with the community at large with some realized in the construction and operation of this project. They are:

- Additional jobs during the construction phase;
    - The project would consist of a twelve-month construction phase employing local tradesmen, engineers and laborers.
- Scalability models for deployments at other County and North Country locations;
    - The JCM model could be utilized in multiple locations within Jefferson County.

- Energy cost reductions;
  - Based on our initial studies, there would be a true cost savings for all members in terms of kWh usage and kW demand.
- Better power quality;
  - Power quality would be both improved with brown outs and voltage sags eliminated
- Enhanced resiliency;
  - The JCM is designed with local DER at all of the locations providing for onsite generation for its members
- Natural disaster power production;
  - The JCM has been designed with "islanding" capabilities
- Ability to feed and house the community.
  - Once in an "islanding" mode during a disaster, the JCC would shelter and feed up to 600 residents from the community, based on its agreement with the local Red Cross.

The JCM benefits the local utility by reducing congestion and deferring upgrades to the local infrastructure. It is our belief that National Grid would be able to defer upgrades to some of the local feeders at the Coffeen Street Station taking power strain from the local lines.

All DER's would be behind the member's meter causing no increase or additional cost components to the utility's infrastructure.

The project would include the placement of a new energy infrastructure throughout the Industrial Park and to the JCC via an easement from the Town of Watertown under Interstate Highway 81. All the DER proposed would be connected via the County (or County agency) owned transmission lines. This whole energy environment would be at no cost impact to the utility.

The JCM business model is a standard PPA with each member utilizing the energy generated as well as shared energy from other DER as required. The model allows each member to produce its own renewable and non-renewable energy in a cost effective manner. It also provides for a stable, predictable energy budget for the life of the PPA. The following is an analysis of strengths, weaknesses, opportunities and threats (SWOT) for the proposed business model.

- Strengths – this would be a self-supporting, bankable project full of the benefits we have outlined in the previous sections.
- Weaknesses – Like all new ideas, people are cautious of change and because the sponsor is a County government or local County agency, there would be many people who want to keep to the status quo and reject new ideas and change.
- Opportunities – These are endless, but the highlights would be scalability and the opening of commerce to Jefferson County and other communities in the North Country who do not have access to clean, quality energy sources. The project would also provide a

working model for educating others and improving future receptivity to the potential of microgrids.

- Threats – some of the funding aspects such as insurance and the ability to fill a hole in bank payments if a member leaves the microgrid without a replacement. We are also cautious of regulatory changes not currently established by the PSC or local utility.

The JCM has many unique characteristics, both in its location as well as the technology it would utilize. The site consists of contiguous parcels corralled by a County owned easement. This unique layout is perfect for a microgrid and the availability of land/rooftops for PV solar is ideal.

The technology considered would include leading-edge products and services for generation, storage, controls, information technology (IT), automated and smart metering infrastructure (AMI), along with a cloud-based energy command and control center.

Future energy sources such as hydropower and a compressed natural gas (CNG) site are being explored and future members, including a wastewater treatment plant, are contiguous and would be consideration in the coming phases of JCM deployment.

Another special aspect of the JCM is its ability for scalability and replicability. Its design and components are replicable for other corporate and industrial parks and the component of adding natural gas storage allows them to operate as a standalone in any environment. Further, the development of an IT cloud-based control center provides for operations and monitoring from any place on the planet.

The JCM is designed to withstand disruptive weather phenomenon and other forces of nature that are especially harsh in the North Country area. Watertown, which is just north of the Tug Hill Plateau, has some of the toughest weather conditions in the State. The transmission lines would be buried underground and each member's facility would be modular and self-supporting during a time of crisis and severe weather event. CHP units either would be indoors or encapsulated in their own housing isolating them from the weather.

Other important aspects that allow the JCM to remain resilient to disruption caused by such weather phenomenon as the duration of an event would be unlimited due to the natural gas feed CHP units and the future consideration of adding CNG and LNG systems to the microgrid.

The project's overall value proposition to each of its identified customers and stakeholders, including the electricity purchaser, the community, the utility, the suppliers and partners, and NY State are as follows:

- Customer – better quality power at a less expensive price
- Community
  - More jobs and a cleaner environment
  - Access to operational critical facilities during power failures
- Utility – less stress on their network
- Supplier – additional projects to sell their products
- Partners - additional projects to sell their products
- NY State – fulfillment of the PSC REV policies

The JCM provides additional revenue streams and savings for the member power purchasers with direct cost savings in their daily power purchases and by indirect cost savings in keeping the manufacturing in operations during utility events, thus reducing waste and lost time caused by brown-out events.

The proposed JCM project promote state policy objectives (e.g. NY REV, Renewable Portfolio Standard (RPS)) with the development of microgrids utilizing renewable energy technologies, Implementation of remote net metering opportunities and decentralization of power production causing less expense on the upgrades to the current utility infrastructure.

The JCM promotes new technology including, generation, storage, controls, and Information Technology. They are:

- Exact products have not been determined but classes of products and services are being quoted for the project.
- Team partners are currently developing a cloud-based operations center with redundancy, specifically for the needs of microgrid users and local government utilizing Eaton's core solutions.

3.3 Commercial Viability - Project Team

The project team is led and sponsored by the Jefferson County Local Development Corporation (JCLDC). This local county agency is pivotal in the success of the JCM. Over the past two years, JCLDC, the project team and members have established a working relationship and have jointly promoted the JCM to other County officials, local cities and towns and local customers. Here are some of the activities that have accomplished thus far:

- Two outreach sessions and luncheon meetings to update stakeholders on project status to seek their member feedback and input;
- Introduction of the microgrid to the local Town of Watertown Planning Board;
- Project description in the local newspaper many times over the past 24 months; and
- Project visibility through the NY Prize marketing campaigns.

Team partners/suppliers have not been finalized but the following companies have been identified in the JCLDC NY Prize application and have since contributed time and effort in support of the JCM initiative.

- Jefferson County Local Development Corporation – sponsor and award recipient of the NY Prize application.
- Jefferson County government/agency – proposed owner of the in-ground transmission infrastructure at the JCM location.
- Entecco - project management and energy systems integrator
- Eaton – infrastructure design and deployment (The infrastructure designs would be by Eaton engineers and specified with Eaton equipment, under the direction of JCM)
- Tecogen and Kraft - CHP Providers
- Eaton and Cisco - operations, network controls and operations
- Capital Innovations – financial advisor

The JCM initiative is built around the concepts of a PPP. This is a true example of government, the private sector, and the local community working together for the benefit of all.

The applicant of the JCM is the JCLDC. The final and ongoing structure of the legal entity has not yet been determined but listed below are the core team members and their respective strengths:

- JCLDC
  - The Financial strength of the Applicant is demonstrated by its FYE 9/30/2015 Statement of Net Position. The Agency is showing Total assets of $11,877, 173, and Total Liabilities of $329,803, giving the Agency a Net Position of $11,547,370.
  - Current Assets are $11,877,173 compared to Current Liabilities of $119, 481. For a Current Ratio if 99-1 (For every dollar we owe currently we have 99 dollars in assets)

- SPE/Special Purpose Entity
  - There are multiple investment funds identified and interested in financing this project as well as one super regional bank. All with assets well over $300 million.

- Core technologies would be provided by industry leading electrical supply companies.
  - Eaton has designed and deployed electrical infrastructure for over 100 years. They are a $25 billion public company with microgrids deployed in Federal locations.

- Core integration, management and ongoing operations would be provided by JCM which has managerial integration experience of over 30 years in complex integration deployments and over 60 MW of solar/renewable energy deployments.

- Core IT products and services would be provided by Eaton, Coopers and Acadia Energy. Acadia provides network controls and operations as well as innovative, new infrastructure controls based on Eaton's proven product line.

- JCM infrastructure, the in ground transmission lines, would be supported by a separate 3rd party and in all probability financed through low-cost energy related bonding.

The legal and regulatory advisors on the team are Harris Beach LP and Allegiance Energy Systems respectively. Harris Beach is a leading NY State law firm which provides energy services to a host of municipal and commercial entities. Allegiance and its founder Mark Ranalli have consulted and advised on distributed generation projects around the world for over 25 years. We have also been engaging regulatory issues directly with our utility partner, National Grid.

3.4 Commercial Viability - Creating and Delivering Value

The JCM team has been assembled based on proven technologies, prior integration capabilities and customer requirements. The process started with assessing the energy profiles of the JCM members and the reliability and quality of their power. Meetings were established and site visits with the interested participants. These usage analytics enabled our team to build preliminary usage, demand profiles, peak demand times, and site characteristics.

Once these preliminary profiles were determined, team engineers began the next step of determining the sizes and placements of the grid components. These grid components were analyzed to structure the transmission needs and the point of integration with National Grid.

Some of the specific microgrid technologies under consideration are listed below:

- Transmission infrastructure – quality, proven network
- PV Solar – quality, proven products
- SMA Inverters - quality, proven products
- Combined Heat and Power Generators - quality, proven products
- Batteries – new technology, challenges and longevity are unknown
- Grid Controls - quality, proven products

All core members of the team were engaged in similar projects and deployments regarding technology integration and energy deployments. Most of the products and solutions considered for this deployment have been utilized in other microgrid installations or projects of similar size and scope. The JCM team brings together every asset that is necessary for a PPP microgrid and ongoing support and operations. Team engineers have spent months ensuring the design and analyzing loads and system balances.

The JCM has been presented to the local planning Boards and at this time, and see no impediments with respect to local permits and/or special permissions for this project.

Based on project approvals, financing and NYSERDA/NY Prize awards, the proposed approach for developing, constructing and operating the project is as follows:

- Continued Project Development throughout 2016
- Infrastructure construction in late 2016
- DERs in late 2016 and early 2017
- Operations would begin after the DERs are in place

In conjunction with the development schedule listed above, the members and the JCM would need to submit the following applications to National Grid:

- Standard SIR Applications and behind the meter approvals would be required.
- POI documents would be required for grid connectivity to the network.

The JCM team has taken technical, financial, transactional and decision-making steps in our operational scheme to ensure that the project operates as expected. Some of the steps include the following:

- Technical - All components are smart technology components already in use at other locations;
- Financial – the solution would be bankable, able to stand alone as an independent, revenue producing project;
- Transactional – it would be expected that all members pay for energy in the same manner they pay it now, transactional based on usage, paid in arrears within 30 days of billing;
- Decision-making responsibilities would be based on algorithms currently used in the core application products in use by utilities

.

The JCM members would be charged for the energy they consume from the microgrid. These charges would be for electric usage/demand and the thermal residual from the CHP units. Each member site would have local revenue grade meters and real time demand metering.

There are business commercialization and replication plans for the JCM. The County envisions not only local corporate park locations as possible replication site but additional sites throughout the North Country. These sites would mimic the JCM structure and may also include CNG components.

3.5 Financial Viability

Initial analysis shows a very strong case for the financial viability of the JCM. The overall blended rate of the members is above $.10kWh. Based on the project cost, Federal and State incentives and the prospect of a 3rd party transmission infrastructure, we believe the JCM would be a cost saving endeavor for the members and a true financial benefit to the community. We also believe the project would provide additional "soft" benefits for the town and community at large.

Our analysis shows fixed and variable revenue streams for JCM. Initial member payments at 100% utilization would be approximately $1.1 million per annual growing at an industry recognized rate of 3.45% per year. Revenue streams associated with weather or utility based events – if just once a year, would add another $150,000 per daily event to this amount.

The JCM would be dependent upon incentives from the Federal and State governments and the project has reflected those incentives in our current financial analysis. That being said, we are currently seeking additional incentives from other government sources in an effort to further reduce the cost of the project.

The current project costs, within 30% as requested by NYSERDA, are development costs of approximately $7 to $8 million for the transmission infrastructure and $25 to $30 million for the DER. Based on these amounts, and the usage determined in the customer profiles, we envision the project to be a financial success and profitable.

3.6 Legal Viability

The JCM would be owned by the SPE and the ownership structure has not been finalized at this time. It is envisioned that participants would be the funding entity and JCM and could also include some of the team members.

The JCM property locations would be primarily owned by the members with the transmission lines existing on the County's easements. DER positioning would be on the member's sites and the PPA's would include the necessary rights of way and easements for the implementations of the components.

Individual member privacy would be accomplished through separate metering and sensory components. Privacy and network security would be of utmost concern. No member data would be shared with other members. Data would be secured through the cloud based analytics and reporting system.

Potential regulatory hurdles that would need to be evaluated and resolved for this project to proceed are as follows:

- SC-7 charges for utility back up has been addressed
- RNM regulations would need to be assessed for cross technologies like PV Solar and CHP;
- Regulatory questions regarding battery storage would need to be identified.

SECTION FOUR NARRATIVE

4.1 Facility and Customer Description

The following facilities would be served by the microgrid with these attributes. All of these locations are single rate payers and do not include any multiple ratepayers:

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
Member 1	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	233	66	100%	8
Member 2	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	982	560	100%	16
Member 3	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	2,165	569	100%	8
Member 4A	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	680	292	100%	8
Member 4B	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	820	296	100%	8
Member 5	Large Commercial/Industrial (>50 annual MWh)	Multiple metered educational facility	All other industries	2,781	773	100%	15
Member 6A	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	1,126	246	100%	8
Member 6B	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	900	212	100%	8

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
Member 6C	Large Commercial/Industrial (>50 annual MWh)	Individually metered manufacturing facility	Manufacturing	1,823	524	100%	8
Member 7	Small Commercial/Industrial (<50 annual MWh)	Individually metered manufacturing facility	All other industries	186	50	100%	8

4.2 Characterization of Distributed Energy Resources

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
DER PV Solar 01	Member 1	Solar	.22	2.53	0*	0	MMBtu/MWh
DER CHP 02	Member 2	Natural Gas	.300	2365	6.5	12.6**	MMBtu/MWh
DER PV Solar 03	Member 2	Solar	.600	6.90	0	0	MMBtu/MWh
DER Storage 04	Member 2	Other - please specify - storage	400 kWh	n/a	.40***	0	MMBtu/MWh
DER PV Solar 05	Member 3	Solar	.800	9.20	0	0	MMBtu/MWh
DER CHP 06	Member 3	Natural Gas	.400	3154	8.6	12.6	MMBtu/MWh
DER Storage 07	Member 3	Other - please specify - storage	800 kWh	n/a	.8	0	MMBtu/MWh
DER CHP 08	Member 4A	Natural Gas	.200	1577	4.3	12.6	MMBtu/MWh
DER PV Solar 09	Member 4A	Solar	.400	4.6	0	0	MMBtu/MWh

Distributed Energy Resource Name	Facility Name	Energy Source	Name plate Capacity (MW)	Average Annual Production Under Normal Conditions (MWh)	Average Daily Production During Major Power Outage (MWh)	Fuel Consumption per MWh	
						Quantity	Unit
DER Storage 10	Member 4A	Other - please specify - storage	400 kWh	n/a	.4	0	MMBtu/MWh
DER CHP 11	Member 4B	Natural Gas	.300	2365	6.5	12.6	MMBtu/MWh
DER PV Solar 12	Member 4B	Solar	.500	5.75	0	0	MMBtu/MWh
DER Storage 13	Member 4B	Other - please specify - storage	400 kWh	n/a	.4	0	MMBtu/MWh
DER PV Solar 14	Member 5	Solar	1.000	11.5	0	0	MMBtu/MWh
DER CHP 15	Member 5	Natural Gas	.500	3942	10.2	12.6	MMBtu/MWh
DER Storage 16	Member 5	Other - please specify - storage	1,200 kWh	n/a	1.2	0	MMBtu/MWh
DER Generator 26	Member 5	Diesel Generator	.250	0	4.5	286	Gal/Day
DER Generator 27	Member 5	Diesel Generator	.300	0	5.4	336	Gal/Day
DER CHP 17	Member 6A	Natural Gas	.300	2365	6.5	12.6	MMBtu/MWh
DER PV Solar 18	Member 6A	Solar	.500	5.75	0	0	MMBtu/MWh
DER Storage 19	Member 6A	Other - please specify - storage	400 kWh	n/a	.4	0	MMBtu/MWh
DER CHP 20	Member 6B	Natural Gas	.200	1577	4.3	12.6	MMBtu/MWh
DER PV Solar 21	Member 6B	Solar	.400	4.6	0	0	MMBtu/MWh
DER Storage 22	Member 6B	Other - please specify - storage	400 kWh	n/a	.4	0	MMBtu/MWh
DER CHP 23	Member 6C	Natural Gas	.400	3154	8.6	12.6	MMBtu/MWh
DER PV Solar 24	Member 6C	Solar	.500	5.75	0	0	MMBtu/MWh
DER Storage 25	Member 6C	Other - please specify - storage	800 kWh	n/a	.8	0	MMBtu/MWh
DER Generator 28	Member 6A&B	Diesel Generator	.300	0	5.4	336	Gal/Day

Distributed Energy Resource Name	Facility Name	Energy Source	Name plate Capacity (MW)	Average Annual Production Under Normal Conditions (MWh)	Average Daily Production During Major Power Outage (MWh)	Fuel Consumption per MWh	
						Quantity	Unit
None	Member 7	N/A					MMBtu/MWh

*Net Metered Solar may have production if automatic isolation relays are used at microgrid POI. CHP have black start and UL1547 inverters. Solar Array inverters have reactive power capability if wave form is generated by CHP generators.
**Rate of consumption is the same for ALL CHP Units Storage charging is from CHP generation,
***Note: All CHP is assuming 90 Availability, 100% Capacity and includes charging for storage.

The intent of the conceptual design represented above is to develop a demand load following generation project. Some of the designated CHP capacity would be dedicated chillers for summer peak cooling loads. Phase two of this design process would optimize and refine the mix of DER requirements in a more dynamic process. The overall generation capacity is capable of fully islanded operations. All Communication and controls are isolated and power continuously through the BESS systems are located at each host site.

4.3 Capacity Impacts and Ancillary Services

The JCM estimates of the following services/value the microgrid as follows:

Distributed Energy Resource Name	Facility Name	Available Capacity (MW/year)	Does distributed energy resource currently provide peak load support?
DER PV Solar 01	Member 1	.22	No
DER CHP 02	Member 2	.300	No
DER PV Solar 03	Member 2	.600	No
DER Storage 04	Member 2	480*	No
DER PV Solar 05	Member 3	.800	No
DER CHP 06	Member 3	.400	No
DER Storage 07	Member 3	560*	No
DER CHP 08	Member 4A	.200	No
DER PV Solar 09	Member 4A	.400	No
DER Storage 10	Member 4A	280*	No
DER CHP 11	Member 4B	.300	No
DER PV Solar 12	Member 4B	.500	No
DER Storage 13	Member 4B	280*	No

DER PV Solar 14	Member 5	1.000	No
DER CHP 15	Member 5	.500	No
DER Storage 16	Member 5	1,120	No
DER Generator 26	Member 5	.250	Yes
DER Generator 27	Member 5	.300	Yes
DER CHP 17	Member 6A	.300	No
DER PV Solar 18	Member 6A	.500	No
DER Storage 19	Member 6A	280*	No
DER CHP 20	Member 6B	.200	No
DER PV Solar 21	Member 6B	.400	No
DER Storage 22	Member 6B	280*	No
DER CHP 23	Member 6C	.400	No
DER PV Solar 24	Member 6C	.500	No
DER Storage 25	Member 6C	560*	No
DER Diesel Generator 28	Member 6A&B	.300	Yes
None	Member 7		N/A

- Based on discharge over one hour

Ancillary services to the local utility (e.g., frequency or real power support, voltage or reactive power support, black start or system restoration support) are as follows:

Ancillary Service	Yes	No
Frequency or Real Power Support	X	☐
Voltage or Reactive Power Support	X	☐
Black Start or System Restoration Support	X	☐

Estimates of the projected annual energy savings from development of a new combined heat and power (CHP) system relative to the current heating system and current type of fuel being used by such system

The current profiles are not complete with regards to thermal loading and CHP thermal offsets. Additional detail is being developed to better understand the dynamic consequences of staging multiple units. The current offset / savings is estimated at approximately $166,000.00. This is not a complete total as several hosts have increased hours of operations and added physical space since initial records were made.

Environmental regulations mandating the purchase of emissions allowances for the microgrid (e.g., due to system size thresholds)

There are currently no environmental regulations currently impacting this project.

Emission rates of the microgrid for CO_2, SO_2, NO_x, and Particulate Matter (emissions/MWh).

Emissions Type	Emissions per MWh	Unit
CO_2	.57 Tons/MWh	Choose an item.
SO_2	n/a	Choose an item.
NO_x	1.5LB /MWH	Choose an item.
PM	n/a	Choose an item.

4.4 Project Costs

The fully installed costs and engineering life span of all capital equipment is:

Capital Component	Installed Cost ($)	Component Lifespan (round to nearest year)	Description of Component
CHP Units	$7,150,000	25 years	CHP Units
Solar PV Systems	$11,808,000	25 years	PV Solar Implementations
Energy Storage Units	$1,152,000	20 years	Storage Systems
Distribution Infrastructure	$7,910,000	50 years	Transmission Infrastructure
Grid Interconnection	$750,000	50 years	Coffeen Street Substation

Phase II planning and design costs are $750,000 to $900,000, depending on whether additional members and buildings are added to the current project.

Fixed operations and maintenance costs begin at $251,375 per year and increase at 1% per year.

Variable O&M costs, excluding fuel costs are $.96/MWh for CHP units and $15/MWh for the microgrid operations.

The maximum amount of time each DER would be able to operate in islanded mode without replenishing its fuel supply and the fuel each DER consume during this period is listed below:

Distributed Energy Resource Name	Facility Name	Duration of Design Event (Days)	Quantity of Fuel Needed to Operate in Islanded Mode for Duration of Design Event	Unit
DER PV Solar 01	Member 1	Indefinitely	0	Choose an item.
				Choose an item.
DER CHP 02	Member 2	16 Hours	3.4*	MMBTU/HR
DER PV Solar 03	Member 2	Indefinitely	0	Choose an item.

DER Storage 04	Member 2	Indefinitely	0	Choose an item.
DER PV Solar 05	Member 3	Indefinitely	0	
DER CHP 06	Member 3	8 Hours	4.5	MMBTU/HR
DER Storage 07	Member 3	Indefinitely	0	
DER CHP 08	Member 4A	8 Hours	2.3	MMBTU/HR
DER PV Solar 09	Member 4A	Indefinitely	0	
DER Storage 10	Member 4A	Indefinitely	0	
DER CHP 11	Member 4B	8 Hours	3.4	MMBTU/HR
DER PV Solar 12	Member 4B	Indefinitely	0	
DER Storage 13	Member 4B	Indefinitely	0	
DER PV Solar 14	Member 5	Indefinitely	0	
DER CHP 15	Member 5	15 Hours	5.7	MMBTU/HR
DER Storage 16	Member 5	Indefinitely	0	
DER CHP 17	Member 6A	8 Hours	3.4	MMBTU/HR
DER PV Solar 18	Member 6A	Indefinitely	0	
DER Storage 19	Member 6A	Indefinitely	0	
DER CHP 20	Member 6B	8 Hours	2.3	MMBTU/HR
DER PV Solar 21	Member 6B	Indefinitely	0	
DER Storage 22	Member 6B	Indefinitely	0	
DER CHP 23	Member 6C	8 Hours	4.5	MMBTU/HR
DER PV Solar 24	Member 6C	Indefinitely	0	
DER Storage 25	Member 6C	Indefinitely	0	
DER Diesel Generator 26	Member 6C	8 Hours	0	
None	Member 7	Not Applicable		

- *Energy Content
- Approx. $5.50 /MMBTU

4.5 Costs to Maintain Service During a Power Outage

The JCM facilities are listed below along with the backup generation capabilities for each site:

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 ($)	Ongoing Operating Costs ($/Year)
						Quantity	Unit		
Member 5	Unit 1	Diesel	.250	75	4.5	286	MMBtu/ Day	0	957
Member 5	Unit 2	Diesel	.300	75	5.4	336	MMBtu/ Day	0	1,033
Member 6A	Unit 1	Diesel	.250	75	4.5	286	MMBtu/ Day	0	957
Member 6B	Unit 1	Diesel	.05	75	.9	64	MMBtu/ Day	0	246

The following are additional backup generation costs for to provide 100% of each sites energy requirements:

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Member 1	One-Time Measures	Hooking up additional portable generator	$2,050	One Time	Upon installation of each portable generators (1)
Member 1	Ongoing Measures	Renting additional portable generators to run the facility at 100% - 250 kW required	$3,830 per week	One unit required	In the event of a widespread power outage.
Member 2	One-Time Measures	Hooking up additional portable generator	$4,100	One Time	Upon installation of each portable generators (2)
Member 2	Ongoing Measures	Renting additional portable generators to run the facility at 100% - 350 kW required	$5,842 per week	Two units required	In the event of a widespread power outage.
Member 3	One-Time Measures	Hooking up additional portable generator	$2,050	One Time	Upon installation of each portable generator (1)
Member 3	Ongoing Measures	Renting additional portable generators to run the facility at 100% - 500 kW required	$6,412 per week	One units required	In the event of a widespread power outage.

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Member 4A	One-Time Measures	Hooking up additional portable generator	$4,100	One Time	Upon installation of each portable generators (2)
Member 4A	Ongoing Measures	Renting additional portable generators to run the facility at 100% - 350 kW required	$5,842 per week	Two units required	In the event of a widespread power outage.
Member 4B	One-Time Measures	Hooking up additional portable generator	$2,050	One Time	Upon installation of each portable generators (1)
Member 4B	Ongoing Measures	Renting additional portable generators to run the facility at 100% - 250 kW required	$3,830 per week	One unit required	In the event of a widespread power outage.
Member 5	One-Time Measures	Hooking up additional portable generator	$14,350	One Time	Upon installation of each portable generators (7)
Member 5	On-Going Measure	Renting additional portable generators to run the facility at 100% - 3,300 kW required	$44,884 per week	Seven units required	In the event of a widespread power outage.
Member 5	Ongoing Measures	Emergency Food 300 residents – Red Cross rate $2/meal	$1,800	$/day	Year-round, necessary seven days per week
Member 5	Ongoing Measures	Emergency Shelter 300 residents – Red Cross $12.50 per night	$3,750	$/day	Year-round, necessary seven days per week
Member 5	Ongoing Measures	Emergency Food 600 homeless – Red Cross rate $2/meal	$3,600	$/day	Year-round, necessary seven days per week
Member 5	Ongoing Measures	Emergency Shelter 600 homeless – Red Cross $12.50 per night	$7,500	$/day	Year-round, necessary seven days per week
Member 6A&B	One-Time Measures	Hooking up additional portable generator	$8,200	One Time	Upon installation of each portable generators (4)
Member 6A&B	Ongoing Measures	Renting additional portable generators to run the facility at 100% - 1,800 kW required	$25,648 per week	Seven units required	In the event of a widespread power outage.
Member 7	One-Time Measures	Hooking up additional portable generator – 250 kW required	$2,050	One Time	Year-round, but only necessary five days per week
Member 7	Ongoing Measures	Renting additional portable generator – 250 kW required	$3,830 per week	One unit required	Year-round, but only necessary five days per week

4.6 Services Supported by the Microgrid

The JCM contains two critical facilities, the Watertown Fire District 3 and the Jefferson Community College.

Watertown Fire District 3:

The estimated population served by the fire district is approximately 9,000 residents. Should there be a power outage at the site, the station would be able to service the public but the station itself would be totally shut down and incapable of operations.

Jefferson Community College:

The estimated population served by the Community College is as follows:

- Number of employees is 415
- Number of Resident is 300
- Number of total enrollment is 2,800 full time equivalents
- Number of residents the college provides for during an emergency and part of their contract with the Red Cross is 600 people.

The proposed microgrid includes the Jefferson Community College. The average annual added income due to the activities of JCC and its former students equals $121.8 million. This is approximately equal to 1.8% of the total Jefferson and Lewis counties economy. These statistics comes from a recent 2009-2010 Economic survey. Additionally, the value of services lost per day during an outage are approximately $100,000 per day. This was given to us from a study done by the College.

The value to the community in terms of total effect - Altogether, the average annual added income due to the activities of JCC and its former students equals $121.8 million. This is approximately equal to 1.8% of the total Jefferson and Lewis counties economy. This comes from out 2009-2010 Economic survey that was done.

5.1 Observations

- There is a critical need for energy infrastructure upgrades in the Watertown area. As outlined in the previous sections, encounters considerable power outages and fluctuations throughout the year causing considerable hardship to the business community.
- There are abundant energy resources in the North County which can be capitalized upon for the greater economic and environmental good of each community. In the area surrounding the JCM and Industrial Park there are:
    - Biomass renewable energy in surplus from Fort Drum; and
    - Hydropower potential on the adjacent Black River.
- The Tug Hill Plateau region has some of the worst weather conditions in the US.
- The upstate New York region has been in constant economic decline and is in dire need of keeping existing jobs and creating an environment to create new jobs.
- The entire region is a low income area and falls below the median income for NY state.
- Most Counties in upstate region have the same needs as Jefferson County.

5.2 Findings

- Technology exists to build the microgrid in the Industrial Park
- County properties and easements provide a perfect geographical layout with easy access to additional members and new renewable generation sources.
- All 7 members are anxious to proceed and receive energy cost savings and power resiliency and reliability
- There are potential regulatory hurdles that would need to be evaluated and resolved for this project to proceed are as follows:
    - SC-7 charges for utility back up has been addressed
    - RNM regulations would need to be assessed for cross technologies like PV Solar and CHP;
    - Regulatory questions regarding battery storage would need to be identified.

5.3 Recommendations

- The JCM should proceed as a bankable solution with additional incentives currently available under NY Sun and NYSERDA incentives.

- The JCM should be in multiple phases with ownership to the Special Purpose Entity (SPE)
    - DERs – SPE owned and operated
    - Infrastructure – 3rd party owned with SPE lease for usage including operations

- New members should be added in the future for additional cost savings to community businesses ensuring job creation.

- The PSC should eliminate the National Grid SC-7 charges. These would play an important part in the overall ongoing cost structure. These are all real world issues of today's microgrids in New York State.

- A critical piece of our financial assessment is the off-takers of the energy generation. For in essence, this group of users, through a PPA, would be paying for the project over the next 20 years. We have begun discussions with the Green Bank in terms of "off-taker" insurance and its effect on the overall funding sources.

- These models are new and banking entities want low risk environments to utilize their capital. The Green Bank should provide help in building models suitable for microgrid funding.

- There should be a specific NYSERDA PON available for the building of the ensuing microgrid infrastructure. These grids are building the energy network of the future and there are currently no subsidies available for this transmission infrastructure.

- There should be a specific NYSERDA PON available for the control of smart component of microgrids. As stated above, these grids are building the energy fabric of the future and there are currently no subsidies available for these components.

- It must be pointed out that a large amount of SBC dollars are going to support residential solar programs and only a small percentage to create jobs and promote business in NY State for these new, important microgrids and their components.

- There needs to be better accessibility for energy programs generated by the utilities.

- The IEC model should be adjusted to consider the needs of smaller communities.

5.4 Results

Public Private Partnerships

The JCM will be a collaboration between the public and private sectors - a true Public Private Partnership (PPP). JCLDC and the JCM team have worked in conjunction for over 2 years to make this project a reality. This is a true example of government, the private sector, and the local community working together for the benefit of all.

JCLDC – Sponsor Agency

The applicant of the JCM is the JCLDC. The final and ongoing structure of the legal entity has not yet been determined but the JCLDC and various 3rd parties will be involved. This is a replicable model not only for further microgrid implementations in Jefferson County but will serve as a solution for the 187 other IDA's throughout the state to keep and encourage businesses in NY.

JCM infrastructure, the in ground transmission lines, will be supported by 3rd parties and in all probability, financed through low-cost energy bonding or USDA loans and guarantees.

The project includes the placement of a new energy infrastructure throughout the Industrial Park and to the JCC via an easement from the Town of Watertown under Interstate Highway 81. This whole energy environment would be at no cost impact to the utility and fiscally neutral to the County and its agencies.

There are currently no impediments with respect to local permits and/or special permissions for this project.

Special Purpose Entity

The JCM is progressing with the concept that the Distributed Energy Resources (DER's) will be owned by a private Special Purpose Entity (SPE) consisting of the prime system energy integrator and the funding entities.

The SPE will insure individual member privacy and cyber security will accomplished through separate metering and sensory components. Privacy and network security will be of utmost concern. No member data will be shared with other members. Data will be secured through the cloud based analytics and reporting system.

Power Purchase Agreements

The JCM business model is a standard Power Purchase Agreement (PPA) with each member utilizing the onsite energy generated as well as shared energy from other DER as required. The model allows production of onsite renewable and non-renewable energy in a cost effective manner. It also provides for a stable, predictable energy budget for the life of the PPA. The JCM members will be charged for the energy they consume from the microgrid. These charges will be for electric usage/demand and the thermal residual from the CHP units. Each member site will have local revenue grade meters and real time demand metering.

The PPA’s will include the easements and placement of DER’s and other legal discussions regarding the microgrid deployment. The PPA’s contain multiple DER’s including PV Solar, Combined Heat and Power (CHP) and batteries. Additional renewable resources are being considered such as hydropower, wind and biomass.

Creating and Delivering Value

Based on project approvals, financing, NYSERDA and NY Prize awards, the proposed approach for developing, constructing and operating the project is as follows:

- Project Development is continued and currently underway
- Construction will begin in 2016 with the deployment of the infrastructure
- DER deployment in late 2016 and early 2017
- Operations will begin after the DERs are in place

In conjunction with the development schedule listed above, the JCM and its members will need to submit the following applications to National Grid:

- Standard SIR Applications and behind the meter approvals will be required.
- POI documents will be required for grid connectivity to the network.

There are business commercialization and replication plans for the JCM. The County envisions not only local corporate park locations as possible replication sites but additional sites throughout the North Country. These sites would mimic the JCM structure and may also include LNG or CNG components.

Cost Justification

Initial analysis shows a very strong case for the financial viability of the JCM. The overall blended rate of the members is currently above $.10kWh. Based on the project cost, Federal and State incentives and the prospect of transmission infrastructure bonding and loan guarantees, we believe the JCM will be a cost saving endeavor for the members and a true financial benefit to the community. We believe the IEC analysis is slanted towards larger cities and towns and does not give proper credence to the smaller governments in upstate New York.

Our analysis shows fixed and variable revenue streams for JCM. Initial member payments at 100% utilization would be in excess of $1.2 million annually growing at an industry recognized rate of 3.45% per year. Revenue streams associated with weather or utility based events – if just once a year, would add another $100,000 per daily event to this amount.

The JCM would initially be dependent upon incentives from the Federal and State governments and the project has reflected those incentives in our current financial analysis. We are currently seeking additional incentives from other government sources in an effort to further reduce the cost of the project.

The current project costs, within 30% as requested by NYSERDA, are development costs of approximately $7 to $8 million for the transmission infrastructure and $20 to $25 million for the DER. Based on these amounts, and the usage determined in the customer profiles, we envision the project to be a financial success.

The current profiles are not complete and do not include thermal loading and CHP thermal offsets. Additional detail is being developed to better understand the dynamic consequences of staging multiple units. The current offset/savings is estimated at approximately $166,000 annually. This is not a complete total, as several hosts have increased hours of operations and added physical space since initial records were made.

5.5 Conclusion

Findings and Assumptions

NYSERDA, in partnership with the Governor's Office of Storm Recovery (GOSR) announced the NY Prize Community Grid Competition to support the development of community microgrids. The purpose of this competition is to solicit proposals to design and build community grids that improve the local electrical distribution system performance and resiliency in both a normal operating configuration as well as during times of electrical grid outages. The competition was developed in response to the Governor's New York RISE initiative recognizing the use of microgrids as a means of minimize the impacts due to power outages associated with emergencies, natural disasters, and other events. Communities that:

- Continue to remain vulnerable to future storms,
- Have historically not benefitted from energy grid optimization,
- Are associated within a utility service territory designated as an "Opportunity Zone" and
- In potential need of utility grid reinforcements.

The Town of Watertown is such a community in need and the JCM is the answer.

The JCM further possesses key NY Prize objectives including the empowering of community leaders, the involvement of private and public sector participation, the protection of vulnerable, low-income populations, and expanding use of local DER's. The JCM also includes private sector and third-party funding while providing tools for building a cleaner more reliable energy system.

The JCM is a true community microgrid which encompasses local critical facilities that provide life-threatening services to the public. The JCM is connected to multiple, uniquely owned buildings that as a group of interconnected loads and distributed energy resources, lie within a clearly defined electrical boundary and act as a single controllable entity, which can connect and disconnect from the surrounding utility grid and operate in both grid-connected or island mode.

The JCM fulfills the following PSC's identified policy objectives as well:

- Enhanced customer knowledge and tools to support effective management of their total energy bill
- Market leverage of ratepayer contributions
- System wide efficiency
- Fuel and resource diversity
- System reliability and resiliency; and
- Reduction of carbon emissions

The JCM also satisfies the REV order instituting a proceeding to improve system efficiency, empower customer choice, and encourage greater penetration of clean generation and energy efficiency technologies and practices.

Benefit - Cost Analysis Summary Report

Site 60 – Town of Watertown

PROJECT OVERVIEW

As part of NYSERDA's NY Prize community microgrid competition, the Town of Watertown has proposed development of a microgrid that would serve ten facilities within the Town, including:

- Eight manufacturing facilities;
- Three buildings at Jefferson Community College; and
- The District 3 Fire Station.

The microgrid would be powered by 25 new distributed energy resources (DERs): nine photovoltaic arrays with capacities ranging from 0.22 MW to 1.0 MW; eight natural gas-fired combined heat and power units with capacities ranging from 0.2 MW to 0.5 MW; and eight storage units ranging from 0.112 MW to 0.56 MW in capacity. The town anticipates that the natural gas units and photovoltaic systems would produce electricity for the grid during periods of normal operation. In contrast, the diesel generators and storage units would produce power only during an outage, when the microgrid would operate in islanded mode. The system as designed would have sufficient generating capacity to meet average demand for electricity from the ten facilities on the microgrid circuit during a major outage. The project's consultants also indicate that the system would have the capability of providing ancillary services to the grid, including frequency regulation, reactive power support, and black start support.

To assist with completion of the project's NY Prize Stage 1 feasibility study, IEc conducted a screening-level analysis of the project's potential costs and benefits. This report describes the results of that analysis, which is based on the methodology outlined below.

METHODOLOGY AND ASSUMPTIONS

In discussing the economic viability of microgrids, a common understanding of the basic concepts of benefit-cost analysis is essential. Chief among these are the following:

- *Costs* represent the value of resources consumed (or benefits forgone) in the production of a good or service.
- *Benefits* are impacts that have value to a firm, a household, or society in general.
- *Net benefits* are the difference between a project's benefits and costs.

Table 1. Proposed Location and Capacity of Distributed Energy Resources

FACILITY NAME	DISTRIBUTED ENERGY RESOURCE	NAMEPLATE CAPACITY (MW)
Member 1	PV Solar 01	0.22
Member 2	Natural Gas CHP 02	0.3
	PV Solar 03	0.6
	Storage 04	0.28
Member 3	PV Solar 05	0.8
	Natural Gas CHP 06	0.4
	Storage 07	0.56
Member 4A	Natural Gas CHP 08	0.2
	PV Solar 09	0.4
	Storage 10	0.28
Member 4B	Natural Gas CHP 11	0.3
	PV Solar 12	0.5
	Storage 13	0.28
Member 5	PV Solar 14	1.0
	Natural Gas CHP 15	0.5
	Storage 16	0.112
Member 6A	Natural Gas CHP 17	0.3
	PV Solar 18	0.5
	Storage 19	0.28
Member 6B	Natural Gas CHP 20	0.2
	PV Solar 21	0.4
	Storage 22	0.28
Member 6C	Natural Gas CHP 23	0.4
	PV Solar 24	0.5
	Storage 25	0.56

- Both costs and benefits must be measured relative to a common *baseline* - for a microgrid, the “without project” scenario - that describes the conditions that would prevail absent a project’s development. The BCA considers only those costs and benefits that are *incremental* to the baseline.

This analysis relies on an Excel-based spreadsheet model developed for NYSERDA to analyze the costs and benefits of developing microgrids in New York State. The model evaluates the economic viability of a microgrid based on the user’s specification of project costs, the project’s design and operating characteristics, and the facilities and services the project is designed to support. Of note, the model analyzes a discrete operating scenario specified by the user; it does not identify an optimal project design or operating strategy.

The BCA model is structured to analyze a project's costs and benefits over a 20-year operating period. The model applies conventional discounting techniques to calculate the present value of costs and benefits, employing an annual discount rate that the user specifies – in this case, seven percent.[1] It also calculates an annualized estimate of costs and benefits based on the anticipated engineering lifespan of the system's equipment. Once a project's cumulative benefits and costs have been adjusted to present values, the model calculates both the project's net benefits and the ratio of project benefits to project costs. The model also calculates the project's internal rate of return, which indicates the discount rate at which the project's costs and benefits would be equal. All monetized results are adjusted for inflation and expressed in 2014 dollars.

With respect to public expenditures, the model's purpose is to ensure that decisions to invest resources in a particular project are cost-effective; i.e., that the benefits of the investment to society would exceed its costs. Accordingly, the model examines impacts from the perspective of society as a whole and does not identify the distribution of costs and benefits among individual stakeholders (e.g., customers, utilities). When facing a choice among investments in multiple projects, the "societal cost test" guides the decision toward the investment that produces the greatest net benefit.

The BCA considers costs and benefits for two scenarios:

- Scenario 1: No major power outages over the assumed 20-year operating period (i.e., normal operating conditions only).
- Scenario 2: The average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under Scenario 1.[2]

RESULTS

Table 2 summarizes the estimated net benefits, benefit-cost ratios, and internal rates of return for the scenarios described above. The results indicate that if there were no major power outages over the 20-year period analyzed (Scenario 1), the project's costs would exceed its benefits. In order for the project's benefits to outweigh its costs, the average duration of major outages would need to

[1] The seven percent discount rate is consistent with the U.S. Office of Management and Budget's current estimate of the opportunity cost of capital for private investments. One exception to the use of this rate is the calculation of environmental damages. Following the New York Public Service Commission's (PSC) guidance for benefit-cost analysis, the model relies on temporal projections of the social cost of carbon (SCC), which were developed by the U.S. Environmental Protection Agency (EPA) using a three percent discount rate, to value CO_2 emissions. As the PSC notes, "The SCC is distinguishable from other measures because it operates over a very long time frame, justifying use of a low discount rate specific to its long term effects." The model also uses EPA's temporal projections of social damage values for SO_2, NO_x, and $PM_{2.5}$, and therefore also applies a three percent discount rate to the calculation of damages associated with each of those pollutants. [See: State of New York Public Service Commission. Case 14-M-0101, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision. Order Establishing the Benefit Cost Analysis Framework. January 21, 2016.]

[2] The New York State Department of Public Service (DPS) requires utilities delivering electricity in New York State to collect and regularly submit information regarding electric service interruptions. The reporting system specifies 10 cause categories: major storms; tree contacts; overloads; operating errors; equipment failures; accidents; prearranged interruptions; customers equipment; lightning; and unknown (there are an additional seven cause codes used exclusively for Consolidated Edison's underground network system). Reliability metrics can be calculated in two ways: including all outages, which indicates the actual experience of a utility's customers; and excluding outages caused by major storms, which is more indicative of the frequency and duration of outages within the utility's control. In estimating the reliability benefits of a microgrid, the BCA employs metrics that exclude outages caused by major storms. The BCA classifies outages caused by major storms or other events beyond a utility's control as "major power outages," and evaluates the benefits of avoiding such outages separately.

equal or exceed 17.4 days per year (Scenario 2). The discussion that follows provides additional detail on these findings.

Table 2. BCA Results (Assuming 7 Percent Discount Rate)

ECONOMIC MEASURE	EXPECTED DURATION OF MAJOR POWER OUTAGES	
	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2: 17.4 DAYS/YEAR
Net Benefits - Present Value	-$26,800,000	$342
Benefit-Cost Ratio	0.5	1.0
Internal Rate of Return	-12.4%	6.9%

Scenario 1

Figure 1 and Table 3 present the detailed results of the Scenario 1 analysis.

Figure 1. Present Value Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate)

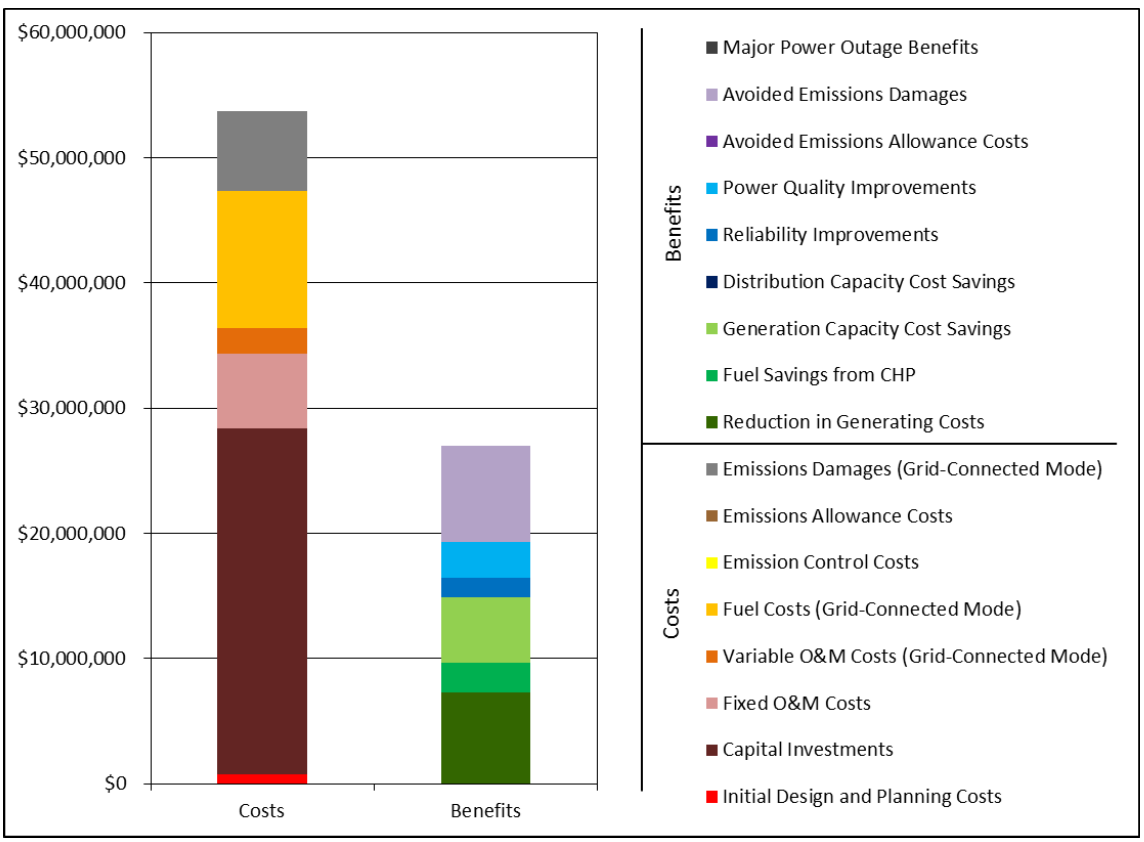


Table 3. Detailed BCA Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$750,000	$66,200
Capital Investments	$27,700,000	$2,160,000
Fixed O&M	$5,920,000	$522,000
Variable O&M (Grid-Connected Mode)	$2,040,000	$180,000
Fuel (Grid-Connected Mode)	$11,000,000	$966,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$6,440,000	$420,000
Total Costs	**$53,700,000**	
Benefits		
Reduction in Generating Costs	$7,310,000	$645,000
Fuel Savings from CHP	$2,340,000	$207,000
Generation Capacity Cost Savings	$5,200,000	$459,000
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,600,000	$141,000
Power Quality Improvements	$2,860,000	$253,000
Avoided Emissions Allowance Costs	$3,830	$337
Avoided Emissions Damages	$7,650,000	$499,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$27,000,000**	
Net Benefits	**-$26,800,000**	
Benefit/Cost Ratio	**0.5**	
Internal Rate of Return	**-12.4%**	

1. Fixed Costs

The BCA relies on information provided by the project team to estimate the fixed costs of developing the microgrid. The project team's best estimate of initial design and planning costs is approximately $750.000. The present value of the project's capital costs is estimated at approximately $27.7 million, including costs associated with grid operations; equipment for a substation that would be used to manage the microgrid; the transmission infrastructure for the microgrid; and the new natural gas units, photovoltaic arrays, and storage systems. Operation and maintenance (O&M) of the entire system would be provided under fixed price service agreements, at an estimated annual cost of $522,000. The present value of these O&M costs over a 20-year operating period is approximately $5.9 million.

2. Variable Costs

The most significant variable cost associated with the proposed project is the cost of natural gas to fuel operation of the new gas-fired combined heat and power units. To characterize these costs, the BCA relies on estimates of fuel consumption provided by the project team and projections of fuel costs from New York's State Energy Plan (SEP), adjusted to reflect recent market prices.[3] The present value of the project's fuel costs over a 20-year operating period is estimated to be approximately $11.0 million.

The analysis of variable costs also considers the environmental damages associated with pollutant emissions from the distributed energy resources that serve the microgrid, based on the operating scenario and emissions rates provided by the project team and the understanding that none of the system's generators would be subject to emissions allowance requirements. In this case, the damages attributable to emissions from the new natural gas generators are estimated at approximately $420,000 annually. The majority of these damages are attributable to the emission of CO_2. Over a 20-year operating period, the present value of emissions damages is estimated at approximately $6.4 million.

3. Avoided Costs

The development and operation of a microgrid may avoid or reduce a number of costs that otherwise would be incurred. In the case of the Town of Watertown's proposed microgrid, one significant source of cost savings would be a reduction in demand for electricity from bulk energy suppliers, with a resulting reduction in generating costs. The BCA estimates the present value of these savings over a 20-year operating period to be approximately $7.3 million; this estimate assumes the microgrid provides base load power, consistent with the operating profile upon which the analysis is based. Cost savings would also result from improvements in fuel efficiency provided by the new CHP systems. The BCA estimates the present value of fuel savings over the 20-year operating period to be approximately $2.3 million. The reduction in demand for electricity from bulk energy suppliers and for heating fuel would also curtail emissions of CO_2, SO_2, NO_x, and particulate matter from these sources, yielding emissions allowance cost savings with a present value of approximately $4,000 and avoided emissions damages with a present value of approximately $7.7 million.[4]

In addition to the savings noted above, development of a microgrid could yield cost savings by avoiding or deferring the need to invest in expansion of the conventional grid's energy generation or distribution capacity.[5] Based on estimated available capacity for the solar and natural gas generators and the capacity of the storage units, the project team estimates the project's impact on demand for generating capacity to be approximately 6.12 MW per year (the team estimates no impact on distribution capacity). Based on this figure, the BCA estimates the present value of the

[3] The model adjusts the State Energy Plan's natural gas and diesel price projections using fuel-specific multipliers calculated based on the average commercial natural gas price in New York State in October 2015 (the most recent month for which data were available) and the average West Texas Intermediate price of crude oil in 2015, as reported by the Energy Information Administration. The model applies the same price multiplier in each year of the analysis.

[4] Following the New York Public Service Commission's (PSC) guidance for benefit cost analysis, the model values emissions of CO_2 using the social cost of carbon (SCC) developed by the U.S. Environmental Protection Agency (EPA). [See: State of New York Public Service Commission. Case 14-M-0101, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision. Order Establishing the Benefit Cost Analysis Framework. January 21, 2016.] Because emissions of SO_2 and NO_x from bulk energy suppliers are capped and subject to emissions allowance requirements in New York, the model values these emissions based on projected allowance prices for each pollutant.

[5] Impacts on transmission capacity are implicitly incorporated into the model's estimates of avoided generation costs and generation capacity cost savings. As estimated by NYISO, generation costs and generating capacity costs vary by location to reflect costs imposed by location-specific transmission constraints.

project's generating capacity benefits to be approximately $5.2 million over a 20-year operating period.

The project team has indicated that the proposed microgrid would be designed to provide ancillary services to the New York Independent System Operator (NYISO). Whether NYISO would select the project to provide these services depends on NYISO's requirements and the ability of the project to provide support at a cost lower than that of alternative sources. Based on discussions with NYISO, it is our understanding that the markets for ancillary services are highly competitive, and that projects of this type would have a relatively small chance of being selected to provide support to the grid. In light of this consideration, the analysis does not attempt to quantify the potential benefits of providing these services.

4. Reliability Benefits

An additional benefit of the proposed microgrid would be to reduce customers' susceptibility to power outages by enabling a seamless transition from grid-connected mode to islanded mode. The analysis estimates that development of a microgrid would yield reliability benefits of approximately $141,000 per year, with a present value of approximately $1.6 million over a 20-year operating period. This estimate is calculated using the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, and is based on the following indicators of the likelihood and average duration of outages in the service area:[6]

- System Average Interruption Frequency Index (SAIFI) – 0.96 events per year.
- Customer Average Interruption Duration Index (CAIDI) – 116.4 minutes.[7]

The estimate takes into account the number of small and large commercial or industrial customers the project would serve; the distribution of these customers by economic sector; average annual electricity usage per customer, as provided by the project team; and the prevalence of backup generation among these customers. It also takes into account the variable costs of operating existing backup generators, both in the baseline and as an integrated component of a microgrid. Under baseline conditions, the analysis assumes a 15 percent failure rate for backup generators.[8] It assumes that establishment of a microgrid would reduce the rate of failure to near zero.

It is important to note that the analysis of reliability benefits assumes that development of a microgrid would insulate the facilities the project would serve from outages of the type captured in SAIFI and CAIDI values. The distribution network within the microgrid is unlikely to be wholly invulnerable to such interruptions in service. All else equal, this assumption would lead the BCA to overstate the reliability benefits the project would provide.

5. Power Quality Benefits

The power quality benefits of a microgrid may include reductions in the frequency of voltage sags and swells or reductions in the frequency of momentary outages (i.e., outages of less than five minutes, which are not captured in the reliability indices described above). The analysis of power quality benefits relies on the project team's best estimate of the number of power quality events

[6] www.icecalculator.com.
[7] The analysis is based on DPS's reported 2014 SAIFI and CAIDI values for National Grid.
[8] http://www.businessweek.com/articles/2012-12-04/how-to-keep-a-generator-running-when-you-lose-power#p1.

that development of the microgrid would avoid each year. The Watertown team estimates that on average, 12 such events would be avoided annually. The model estimates the present value of this benefit to be approximately $2.9 million over a 20-year operating period.

6. Summary

The analysis of Scenario 1 yields a benefit/cost ratio of 0.5; i.e., the estimate of project benefits is approximately half of project costs. Accordingly, the analysis moves to Scenario 2, taking into account the potential benefits of a microgrid in mitigating the impact of major power outages.

Scenario 2

1. Benefits in the Event of a Major Power Outage

As previously noted, the estimate of reliability benefits presented in Scenario 1 does not include the benefits of maintaining service during outages caused by major storm events or other factors generally considered beyond the control of the local utility. These types of outages can affect a broad area and may require an extended period of time to rectify. To estimate the benefits of a microgrid in the event of such outages, the BCA methodology is designed to assess the impact of a total loss of power – including plausible assumptions about the failure of backup generation – on the facilities the microgrid would serve. It calculates the economic damages that development of a microgrid would avoid based on (1) the incremental cost of potential emergency measures that would be required in the event of a prolonged outage, and (2) the value of the services that would be lost.[9,10]

As noted above, the Town of Watertown's microgrid project would serve a number of manufacturing facilities, as well as a fire station and a portion of Jefferson Community College. The project's consultants indicate that at present, only two buildings in Member 4 and Member 6A and Member 6B are equipped with backup generators; these units can support the ordinary level of services at these facilities. Operation of the existing backup generators at Member 4 costs approximately $2,900 per day; the daily cost of operating the generators at Member 6A and Member 6B is approximately $1,700 combined. These costs also include estimates for the cost of diesel fuel used to power the generators, calculated based on fuel price forecasts and the heat capacity of diesel. The fire station, the six other manufacturing facilities, and the remaining building at Member 4, are not equipped with backup generators but could maintain service by renting portable units; Table 4 lists the associated costs. In the absence of backup power – i.e., if the backup generators failed and no replacement was available – all facilities would experience a 100 percent loss in service capabilities.

[9] The methodology used to estimate the value of lost services was developed by the Federal Emergency Management Agency (FEMA) for use in administering its Hazard Mitigation Grant Program. See: FEMA Benefit-Cost Analysis Re-Engineering (BCAR): Development of Standard Economic Values, Version 4.0. May 2011.

[10] As with the analysis of reliability benefits, the analysis of major power outage benefits assumes that development of a microgrid would insulate the facilities the project would serve from all outages. The distribution network within the microgrid is unlikely to be wholly invulnerable to service interruptions. All else equal, this would lead the BCA to overstate the benefits the project would provide.

Table 4. Backup Power Costs and Level of Service, Scenario 2

FACILITY NAME	ONE-TIME COST OF MAINTAINING SERVICE WITH PORTABLE GENERATOR ($)	ONGOING COST OF MAINTAINING SERVICE WITH PORTABLE GENERATOR ($/DAY)[11]
Member 1	$2,050	$996
Member 2	$4,100	$1,463
Member 3	$2,050	$1,814
Member 4A	$4,100	$1,463
Member 4B	$2,050	$996
Member 6C	$8,200	$6,896
Member 4	$12,300	$10,064
District 3 Fire Station	$2,050	$1,215

The information provided above serves as a baseline for evaluating the benefits of developing a microgrid. Specifically, the assessment of Scenario 2 makes the following assumptions to characterize the impacts of a major power outage in the absence of a microgrid:

- The two buildings at Member 4 equipped with backup generators and Member 6A and Member 6B would rely on their existing backup generators to maintain 100 percent of their service capabilities. If the backup generators fail, the facilities would experience a total loss of service.

- The remaining facilities would rely on portable generators, experiencing no loss in service capabilities while the units are in operation. If the portable generators fail, the facilities would experience a 100 percent loss in service.

- In all cases, the supply of fuel necessary to operate backup generators would be maintained indefinitely.

- At each facility, there is a 15 percent chance that the backup generator would fail.

The economic consequences of a major power outage also depend on the services the facilities of interest provide. The analysis varies by facility, as described below:

- For the fire station, the analysis calculates the impact of an outage on property losses, lives lost, and injuries suffered due to fires, due to an anticipated increase in response time. The methodology assumes that the population normally served by the non-functioning fire station would rely on the next-closest provider able to serve this population. In Watertown's case, the nearest alternative provider is seven miles away.

- For Member 4, the value of service provided during an outage is estimated at $107,000 for the two buildings that are equipped with backup generators. This figure is based on the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, and an assumed 15 hours of microgrid demand per day during an outage.[12] The third building at the college would function as a shelter, supporting 300

[11] These costs include fuel costs associated with running the portable diesel generators; costs were estimated assuming the same price estimations and consumption rate provided for the existing diesel generators.
[12] http://icecalculator.com/.

residents and 600 homeless in the event of an outage. The value of this service is estimated at $45,000 per day, using standard Red Cross rates for the cost of providing food and shelter.[13]

- For Member One, Member 4A, Member 4B, Member 3 and Member 6C combined, the value of service is estimated at approximately $362,000 per day. This figure is based on the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator and an assumed eight hours of microgrid demand per day during an outage.[14]

- For Member 3, the value of service is estimated at approximately $131,000 per day. This figure is based on the U.S. Department of Energy's ICE Calculator and an assumed 16 hours of microgrid demand per day during an outage.[15]

- For Member 6A and 6B combined, the value of service is estimated at $137,000 per day. Again, this figure is based on the U.S. Department of Energy's ICE Calculator, and an assuming eight hours of microgrid demand per day during an outage.[16]

Based on these values, the analysis estimates that in the absence of a microgrid, the average cost of an outage for all facilities is approximately $166,000 per day.

2. Summary

Figure 2 and Table 5 present the results of the BCA for Scenario 2. The results indicate that the benefits of the proposed project would equal or exceed its costs if the project enabled the facilities it would serve to avoid an average of 17.4 days per year without power. If the average annual duration of the outages the microgrid prevents is less than this figure, its costs are projected to exceed its benefits.

[13] http://www.redcross.org/images/MEDIA_CustomProductCatalog/m30240126_FY14FundraisingDollarHandles.pdf.
[14] http://icecalculator.com/.
[15] *ibid*.
[16] *ibid*.

Figure 2. Present Value Results, Scenario 2 (Major Power Outages Averaging 17.4 Days/Year; 7 Percent Discount Rate)

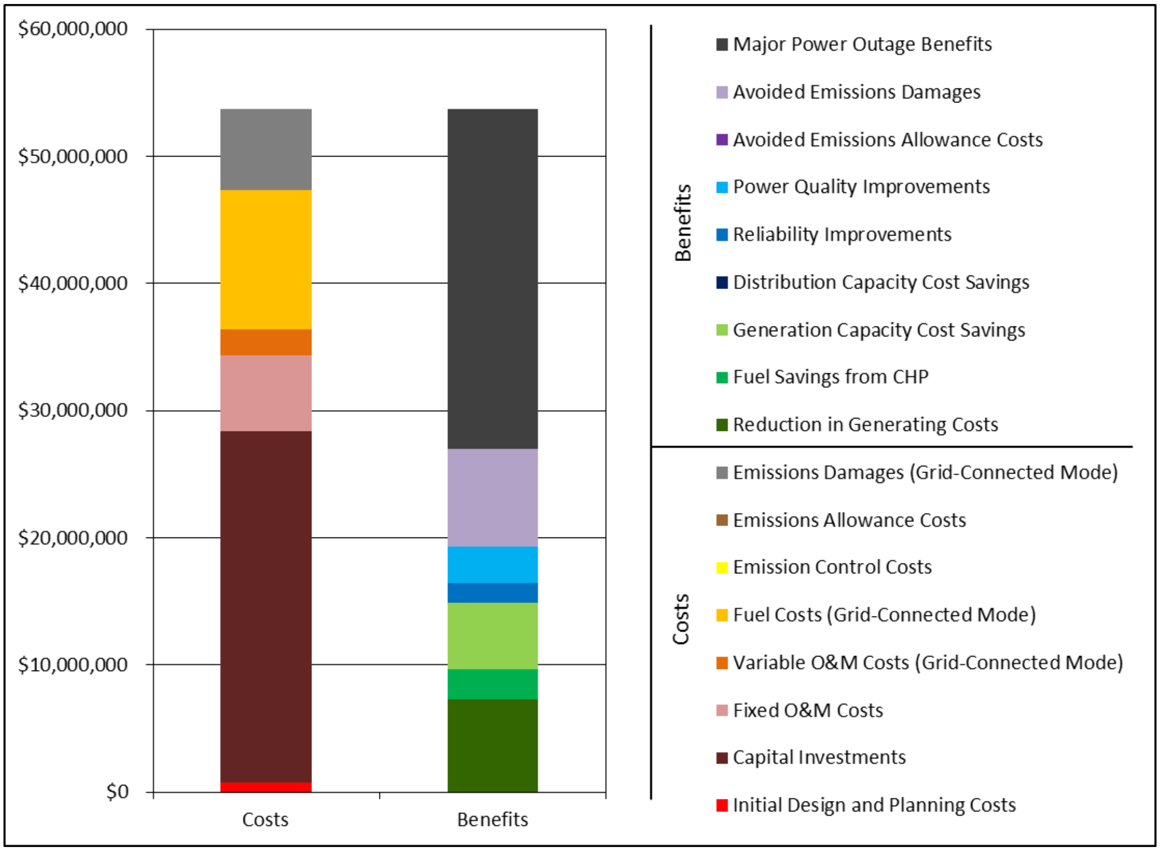


Table 5. Detailed BCA Results, Scenario 2 (Major Power Outages Averaging 17.4 Days/Year; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$750,000	$66,200
Capital Investments	$27,700,000	$2,160,000
Fixed O&M	$5,920,000	$522,000
Variable O&M (Grid-Connected Mode)	$2,040,000	$180,000
Fuel (Grid-Connected Mode)	$11,000,000	$966,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$6,440,000	$420,000
Total Costs	**$53,700,000**	
Benefits		
Reduction in Generating Costs	$7,310,000	$645,000
Fuel Savings from CHP	$2,340,000	$207,000
Generation Capacity Cost Savings	$5,200,000	$459,000
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,600,000	$141,000
Power Quality Improvements	$2,860,000	$253,000
Avoided Emissions Allowance Costs	$3,830	$337
Avoided Emissions Damages	$7,650,000	$499,000
Major Power Outage Benefits	$26,800,000	$2,380,000
Total Benefits	**$53,700,000**	
Net Benefits	**$342**	
Benefit/Cost Ratio	**1.0**	
Internal Rate of Return	**6.9%**	

APPENDIX B – Backup Charts and Diagrams

EXISTING CONDITIONS - ROLL-UP – MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Electricity and Thermal (and Fuel) Demand and Usage Tables

			Typical Annual	Typ Jan	Typ Feb	Typ Mar	Typ Apr	Typ May	Typ Jun
	Typical Elect Demand & Use Profile	Typ-Mo kWh	**9,041,369 kWh**	830,678 kWh	795,512 kWh	800,470 kWh	737,733 kWh	720,963 kWh	694,906 kWh
		Typ-Mo kW	Max Dmnd (useless)	566 kW	591 kW	551 kW	617 kW	657 kW	543 kW
	For WeightedAvgLF:	LF%	43.6%	49.2%	50.0%	52.2%	47.6%	44.4%	46.4%
	PLUG	Plugged LF							
TOTAL H/F/S Roll-up	Modelled LF:			49.2%	50.0%	52.2%	47.6%	44.4%	46.4%
	CalcPkDemand:	Calcd kW	2,365.7 kW	2,269 kW	2,366 kW	2,061 kW	2,151 kW	2,184 kW	2,080 kW
		NoDys:	365 Dy	31 Dy	28 Dy	31 Dy	30 Dy	31 Dy	30 Dy
		AvgDmd:	1,032 kW	1,117 kW	1,184 kW	1,076 kW	1,025 kW	969 kW	965 kW
		Typ Blended $/kWh:							
	Typical Heat Use Profile	Typ-Mo MMBtu	**26,308 MMBtu**	4,795 MMBtu	4,810 MMBtu	4,557 MMBtu	3,441 MMBtu	1,509 MMBtu	498 MMBtu
		in kWh:	7,710,097 kWh	1,405,354 kWh	1,409,689 kWh	1,335,441 kWh	1,008,516 kWh	442,198 kWh	145,920 kWh
	Typical Fuel Use Profile	Typ-Mo MMBtu	**30,239 MMBtu**	5,512 MMBtu	5,529 MMBtu	5,238 MMBtu	3,955 MMBtu	1,734 MMBtu	572 MMBtu
		in kWh:	8,862,180 kWh	1,615,350 kWh	1,620,332 kWh	1,534,990 kWh	1,159,214 kWh	508,273 kWh	167,725 kWh
	Effective Overall Boiler (i.e., Heating System) Fuel-to-Heat Eff.			87%	87%	87%	87%	87%	87%
	What-if Boiler Fuel-to-Heat Eff. of:	87%	**30,239 MMBtu**	5,512 MMBtu	5,529 MMBtu	5,238 MMBtu	3,955 MMBtu	1,734 MMBtu	572 MMBtu

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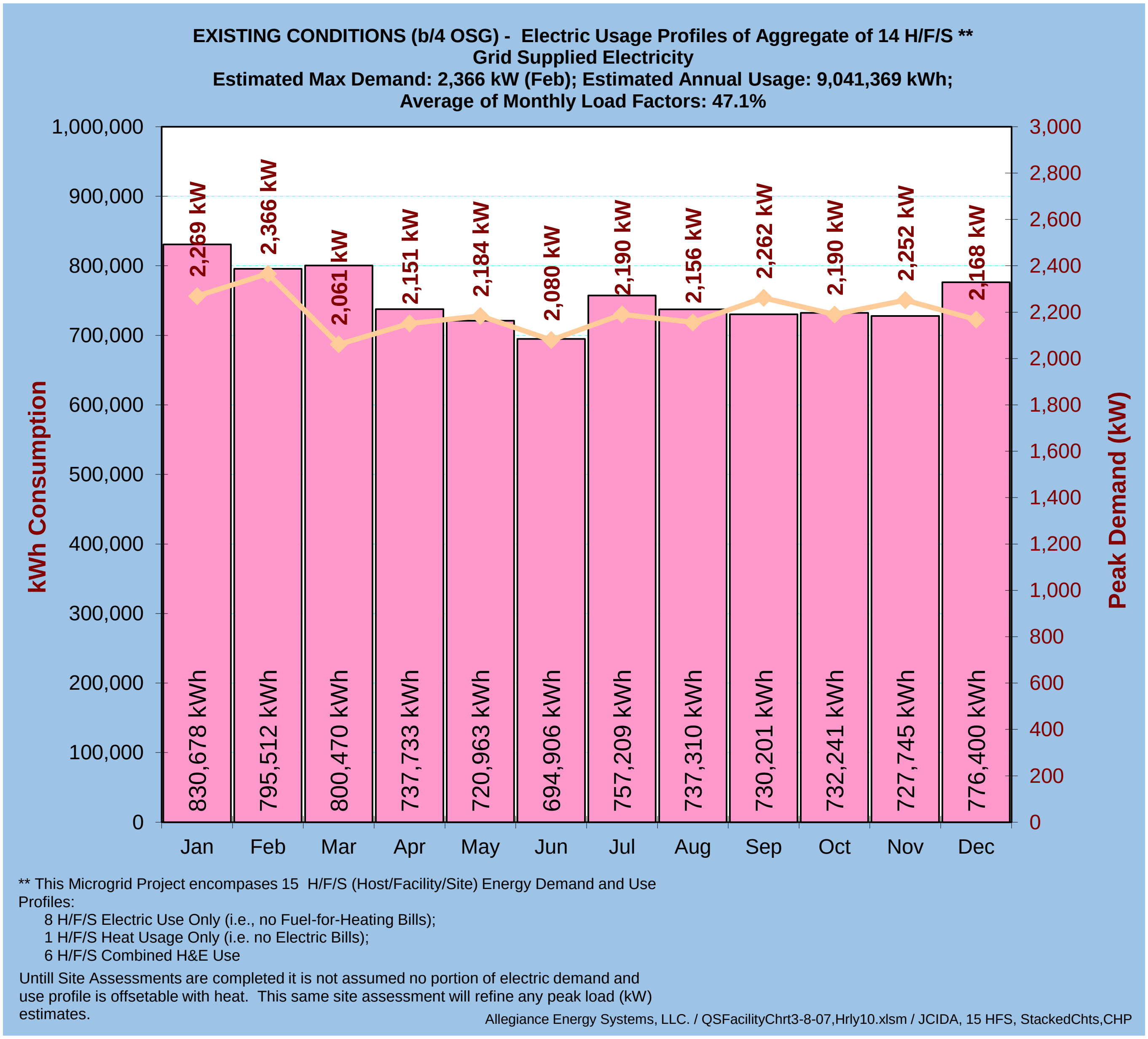
			Typical Annual	Typ Jul	Typ Aug	Typ Sep	Typ Oct	Typ Nov	Typ Dec	
	Typical Elect Demand & Use Profile	Typ-Mo kWh	**9,041,369 kWh**	757,209 kWh	737,310 kWh	730,201 kWh	732,241 kWh	727,745 kWh	776,400 kWh	**9,041,369 kWh**
		Typ-Mo kW	Max Dmnd (useless)	543 kW	549 kW	614 kW	570 kW	586 kW	564 kW	
	For WeightedAvgLF:	LF%	43.6%	46.5%	46.0%	44.8%	44.9%	44.9%	48.1%	
	PLUG	Plugged LF								47.1%
TOTAL H/F/S Roll-up	Modelled LF:			46.5%	46.0%	44.8%	44.9%	44.9%	48.1%	
	CalcPkDemand:	Calcd kW	2,365.7 kW	2,190 kW	2,156 kW	2,262 kW	2,190 kW	2,252 kW	2,168 kW	**2,365.7 kW**
		NoDys:	365 Dy	31 Dy	31 Dy	30 Dy	31 Dy	30 Dy	31 Dy	
		AvgDmd:	1,032 kW	1,018 kW	991 kW	1,014 kW	984 kW	1,011 kW	1,044 kW	1,183.8 kW
		Typ Blended $/kWh:								
	Typical Heat Use Profile	Typ-Mo MMBtu	**26,308 MMBtu**	258 MMBtu	185 MMBtu	246 MMBtu	725 MMBtu	1,796 MMBtu	3,489 MMBtu	**26,308 MMBtu**
		in kWh:	7,710,097 kWh	75,472 kWh	54,360 kWh	72,004 kWh	212,366 kWh	526,211 kWh	1,022,565 kWh	7,710,097 kWh
										4,810 MMBtu
	Typical Fuel Use Profile	Typ-Mo MMBtu	**30,239 MMBtu**	296 MMBtu	213 MMBtu	282 MMBtu	833 MMBtu	2,064 MMBtu	4,011 MMBtu	1,409,689 kWh
		in kWh:	8,862,180 kWh	86,749 kWh	62,483 kWh	82,763 kWh	244,099 kWh	604,840 kWh	1,175,362 kWh	
	Effective Overall Boiler (i.e., Heating System) Fuel-to-Heat Eff.			87%	87%	87%	87%	87%	87%	
	What-if Boiler Fuel-to-Heat Eff. of:	87%	**30,239 MMBtu**	296 MMBtu	213 MMBtu	282 MMBtu	833 MMBtu	2,064 MMBtu	4,011 MMBtu	

QSFacilityChrt3-8-07,Hrly10.xlsm / JCIDA,15 HFS MontlyRollup

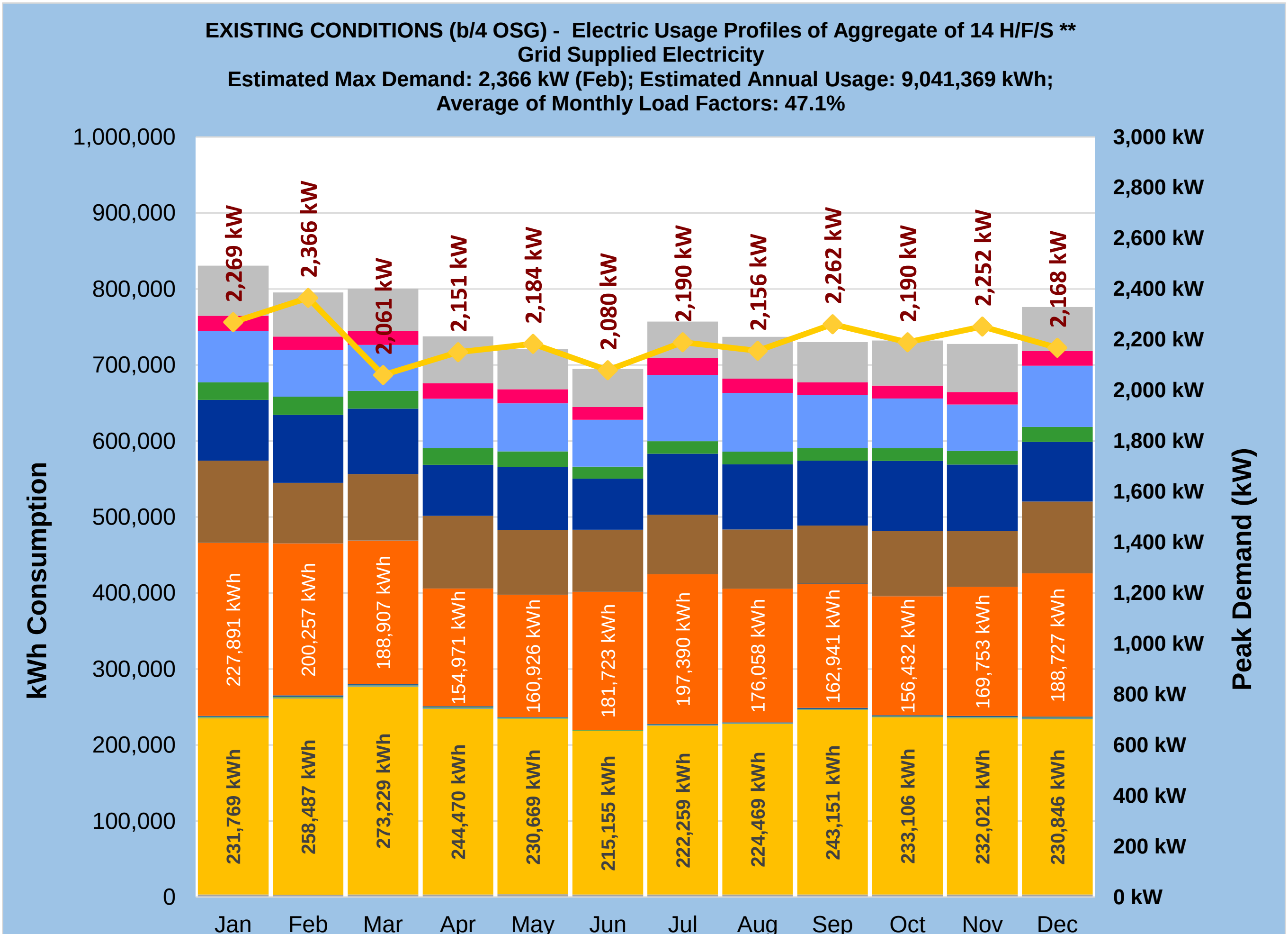
EXISTING CONDITIONS - ROLL-UP – MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE (CONTINUED)

Electricity Demand & Usage Chart



EXISTING CONDITIONS - ROLL-UP – MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE (CONTINUED)

CHARTS - KEY H/F/S'S CONTRIBUTING TO THE ELECTRICITY DEMAND USE PROFILE



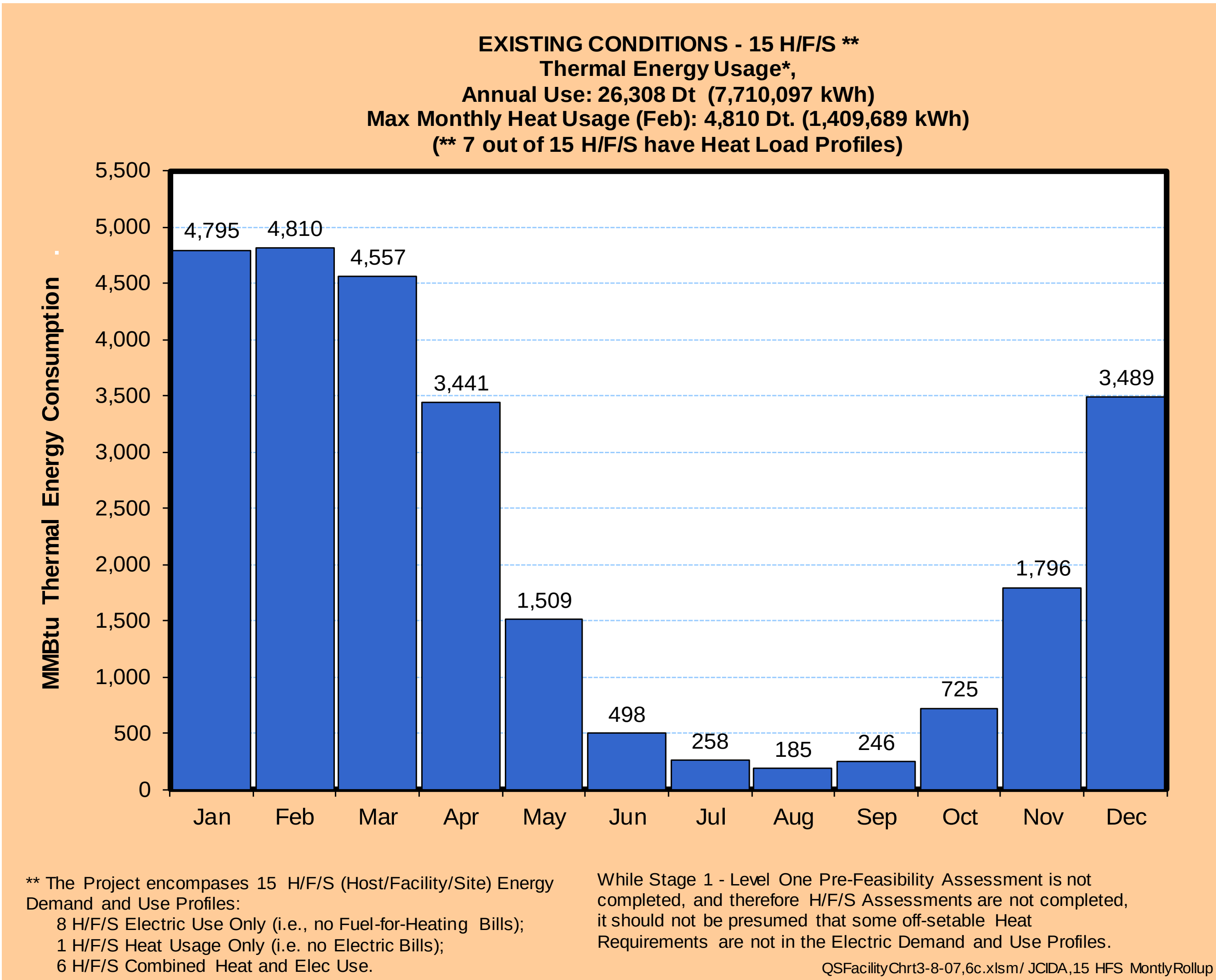
LEGEND:

/ Facility / Profile Type			Pk Dmd	Annual Usage (kWh)	Estm. LF %
H/F/S	1	ElecONLY	292 kW	680,614 kWh	29%
H/F/S	2	CHP	68.8 kW	221,600 kWh	42%
H/F/S	3	CHP	296 kW	820,443 kWh	37%
H/F/S	4	CHP	65.6 kW	233,120 kWh	42%
H/F/S	5	CHP	560 kW	982,334 kWh	25%
H/F/S	6	CHP	203 kW	1,020,800 kWh	60%
H/F/S	8	CHP	569 kW	2,165,976 kWh	50%
H/F/S	12	ElecONLY	773 kW	2,839,631 kWh	51%

Allegiance Energy Systems, LLC. / QSFacilityChrt3-8-07,Hrly10.xlsm / JCIDA, 15 HFS, StackedChts,CHP

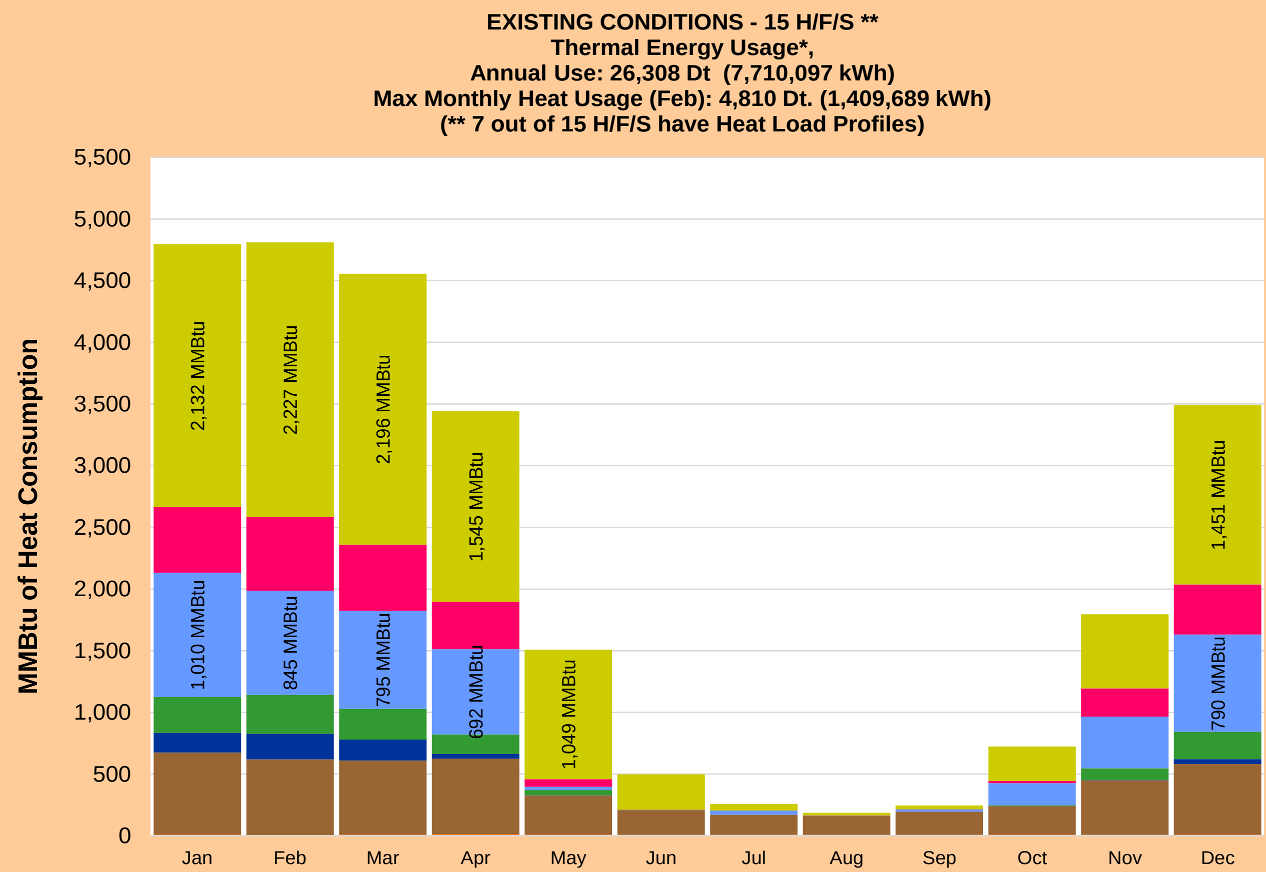
EXISTING CONDITIONS - ROLL-UP – MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Thermal Usage Chart



EXISTING CONDITIONS - ROLL-UP – MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

THERMAL USAGE CHART - KEY H/F/S'S CONTRIBUTING TO THE HEAT USE PROFILE



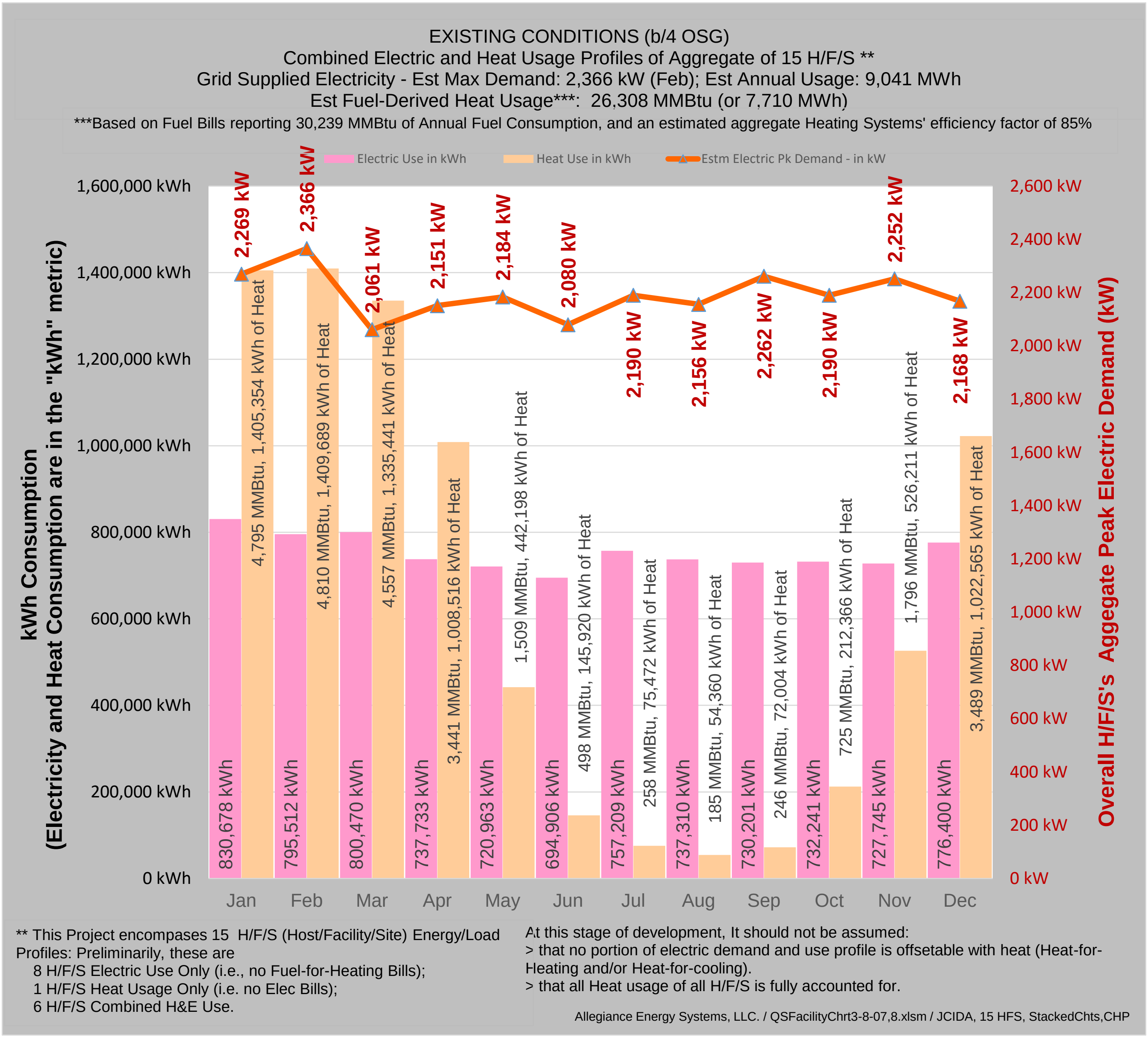
LEGEND:

/ Facility / Profile Type			Annual Heat Usage (MMBtu)	Electric Energy Demand & Use: Pk Dmd	Annual Elect Usage (kWh)	Estm. LF %
H/F/S	2	CHP	2,766 MMBtu	69 kW	221,600 kWh	42%
H/F/S	3	CHP	4,811 MMBtu	296 kW	820,443 kWh	37%
H/F/S	4	CHP	1,382 MMBtu	66 kW	233,120 kWh	42%
H/F/S	5	CHP	614 MMBtu	560 kW	982,334 kWh	25%
H/F/S	6	CHP	4,760 MMBtu	203 kW	1,020,800 kWh	60%
H/F/S	8	CHP	103 MMBtu	569 kW	2,165,976 kWh	50%
H/F/S	14	HeatONLY	11,872 MMBtu	773 kW	2,839,631 kWh	51%

Allegiance Energy Systems, LLC. / QSFacilityChrt3-8-07,8.xlsm / JCIDA, 15 HFS, StackedChts,CHP

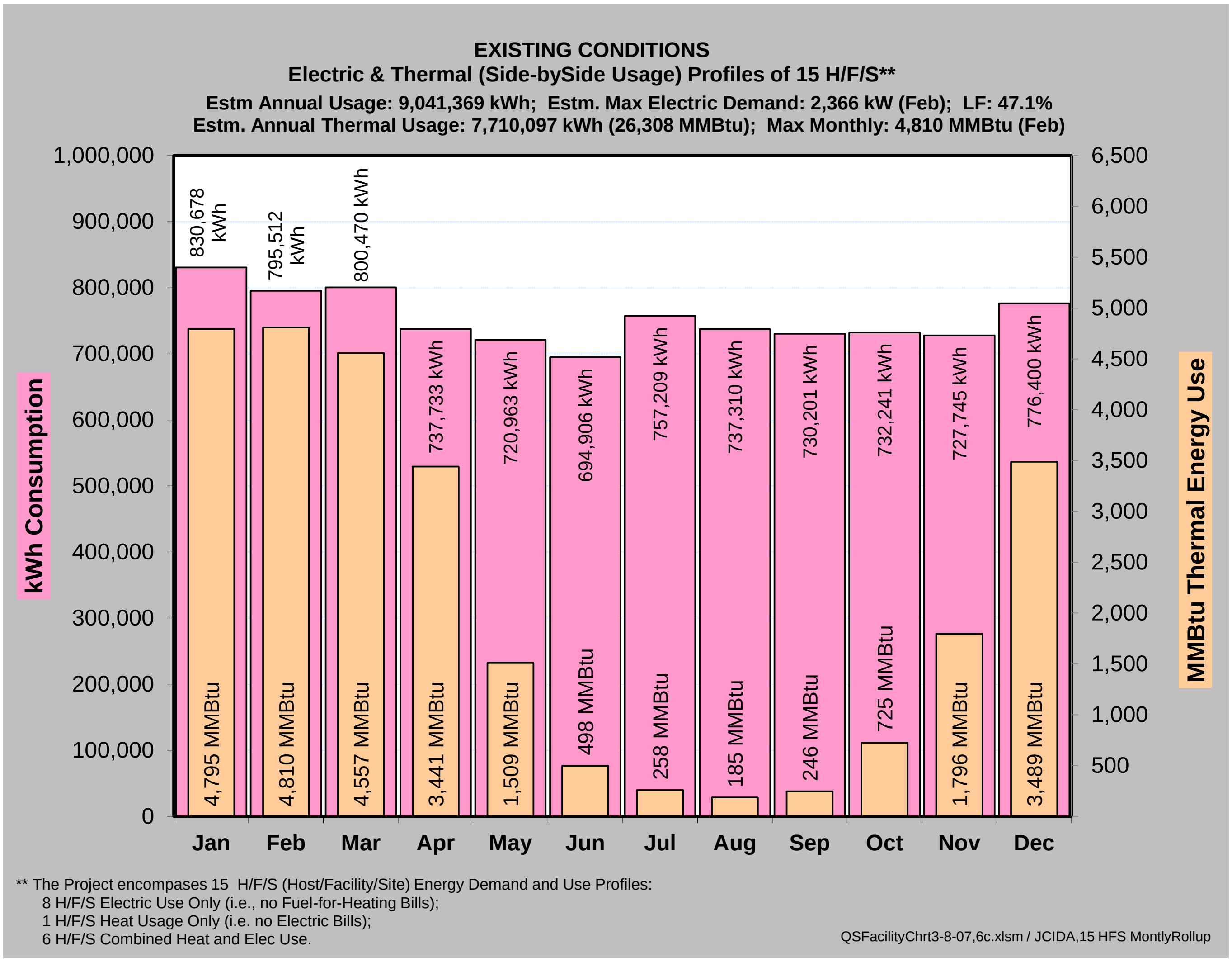
EXISTING CONDITIONS - CHP – COMBINED HEAT AND ELECTRICITY MONTHLY USAGE

- Perspective 1.



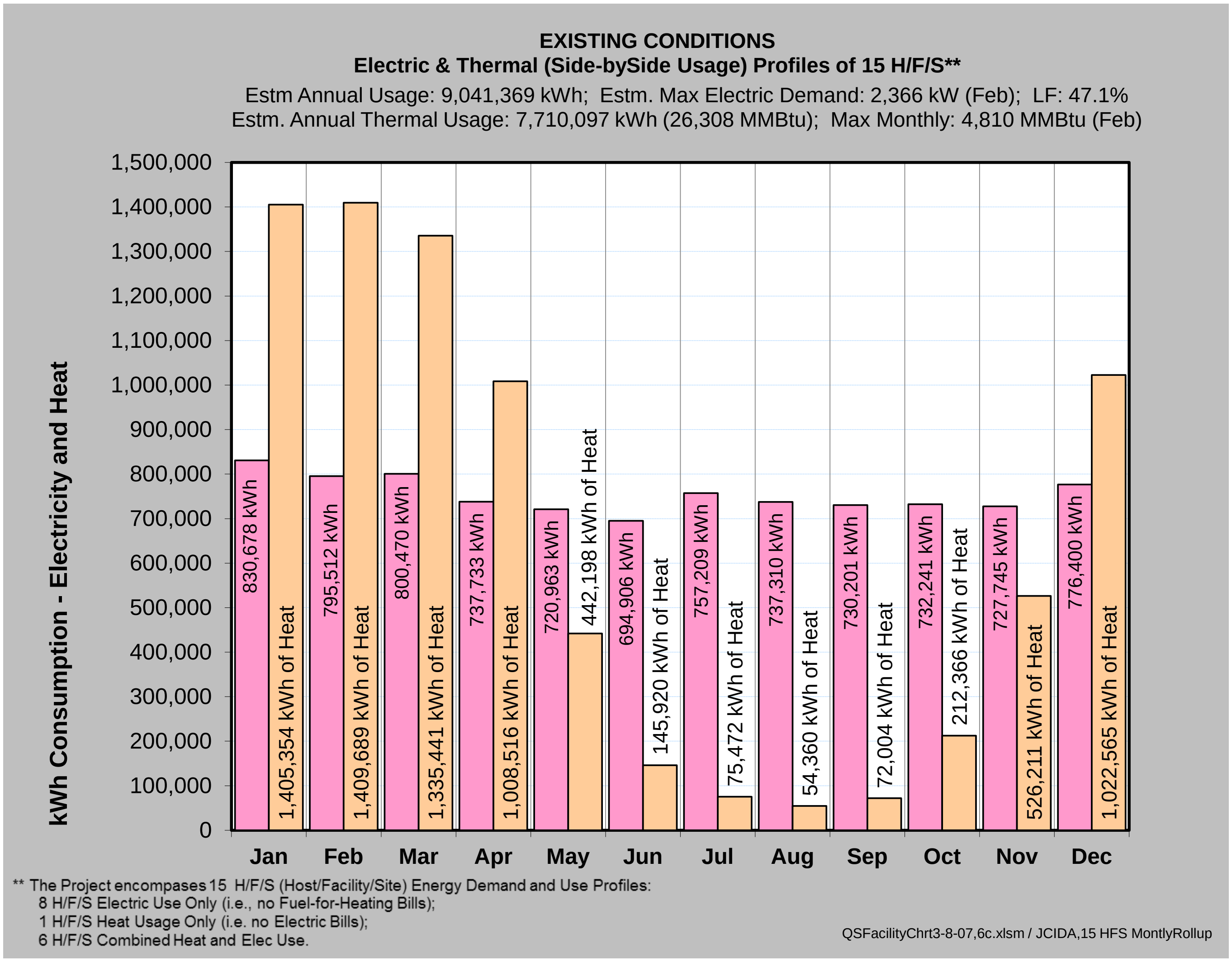
EXISTING CONDITIONS - CHP – COMBINED HEAT AND ELECTRICITY MONTHLY USAGE (CONTINUED)

- CHP Perspective 2.



EXISTING CONDITIONS - CHP – COMBINED HEAT AND ELECTRICITY USAGE (CONTINUED)

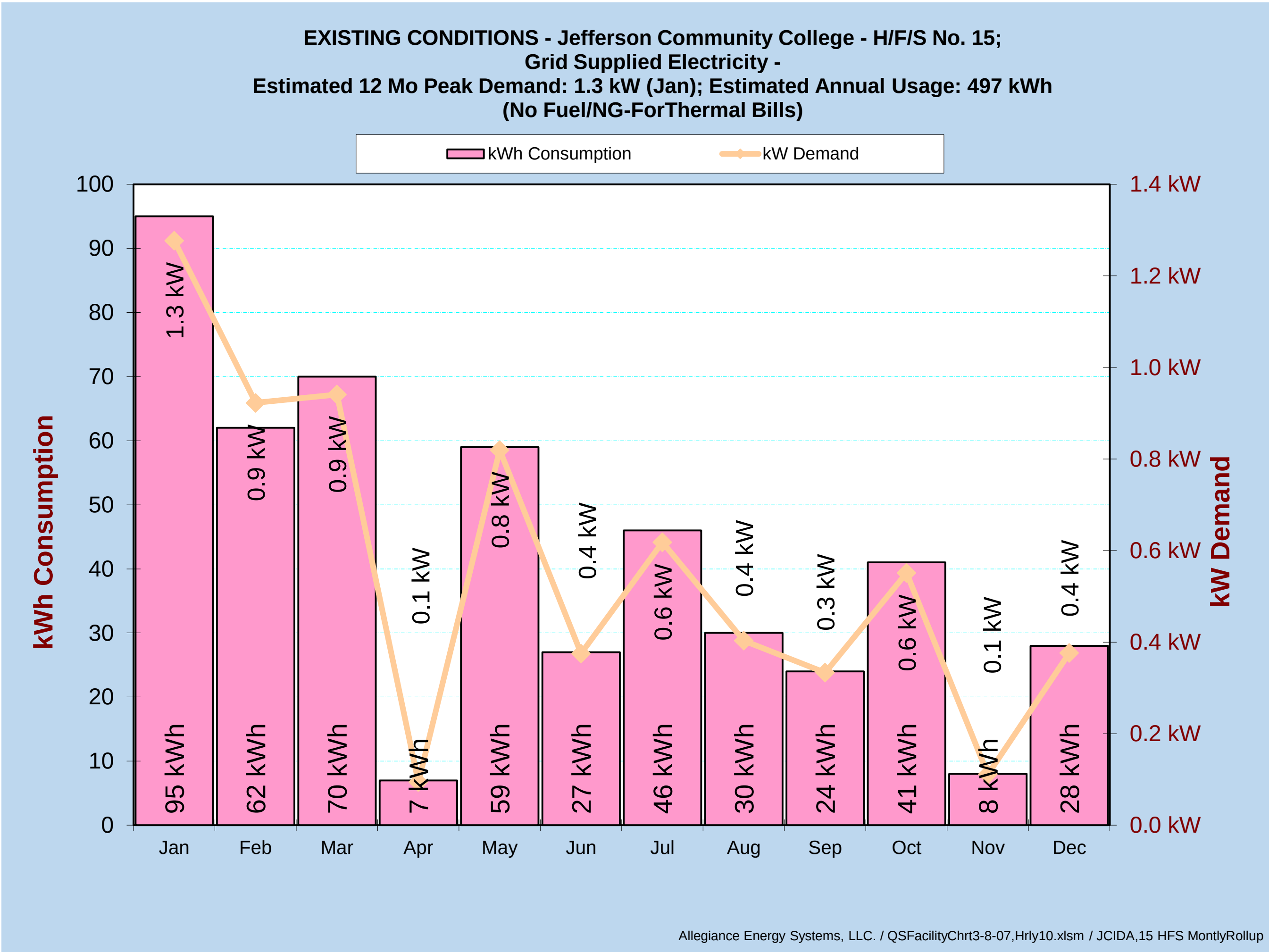
➢ CHP Perspective 3.



EXISTING CONDITIONS – H/F/S 15– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

No Thermal Usage

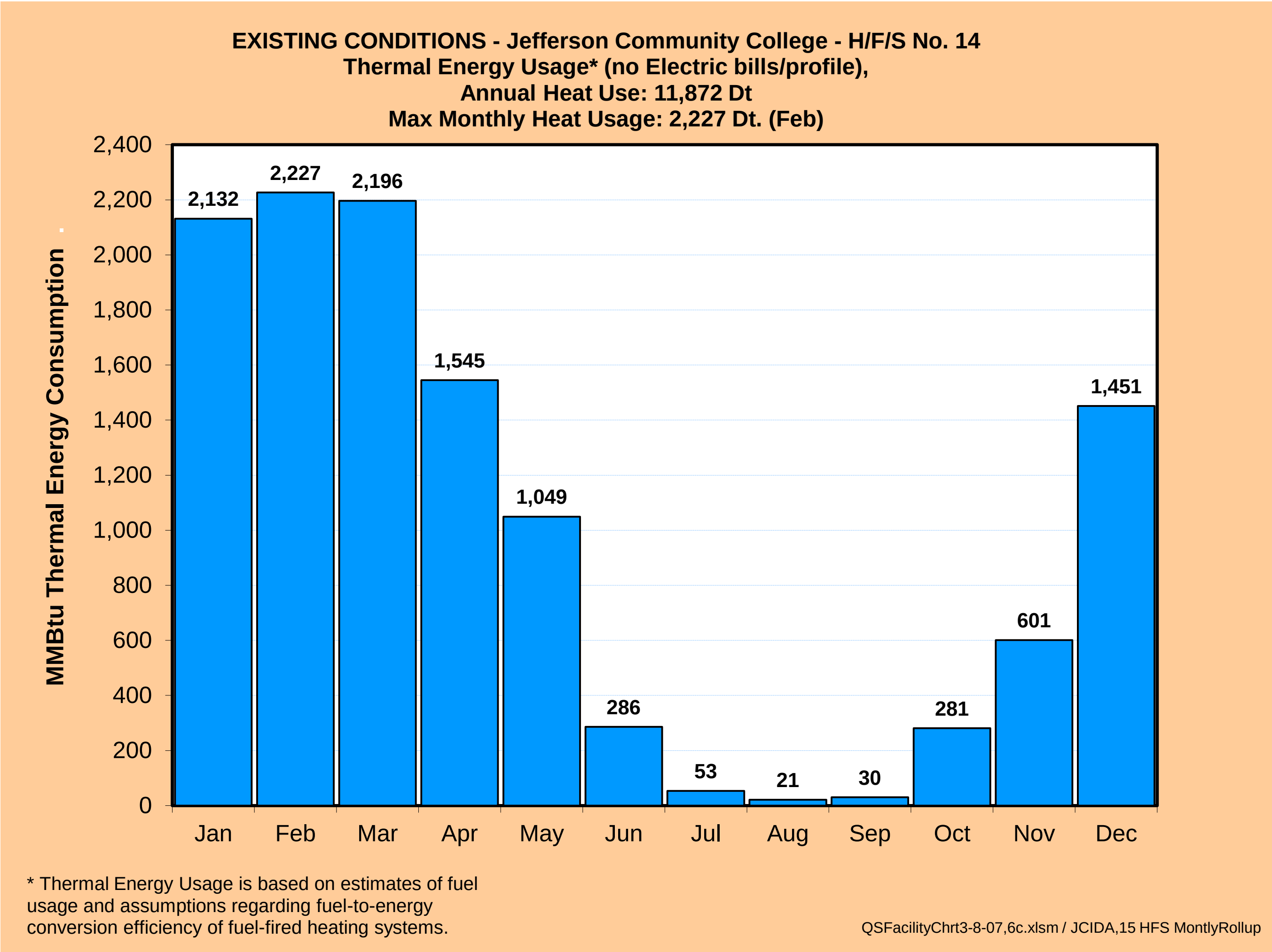
Electricity Demand & Usage Chart



EXISTING CONDITIONS – H/F/S 14– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

No Electricity Usage

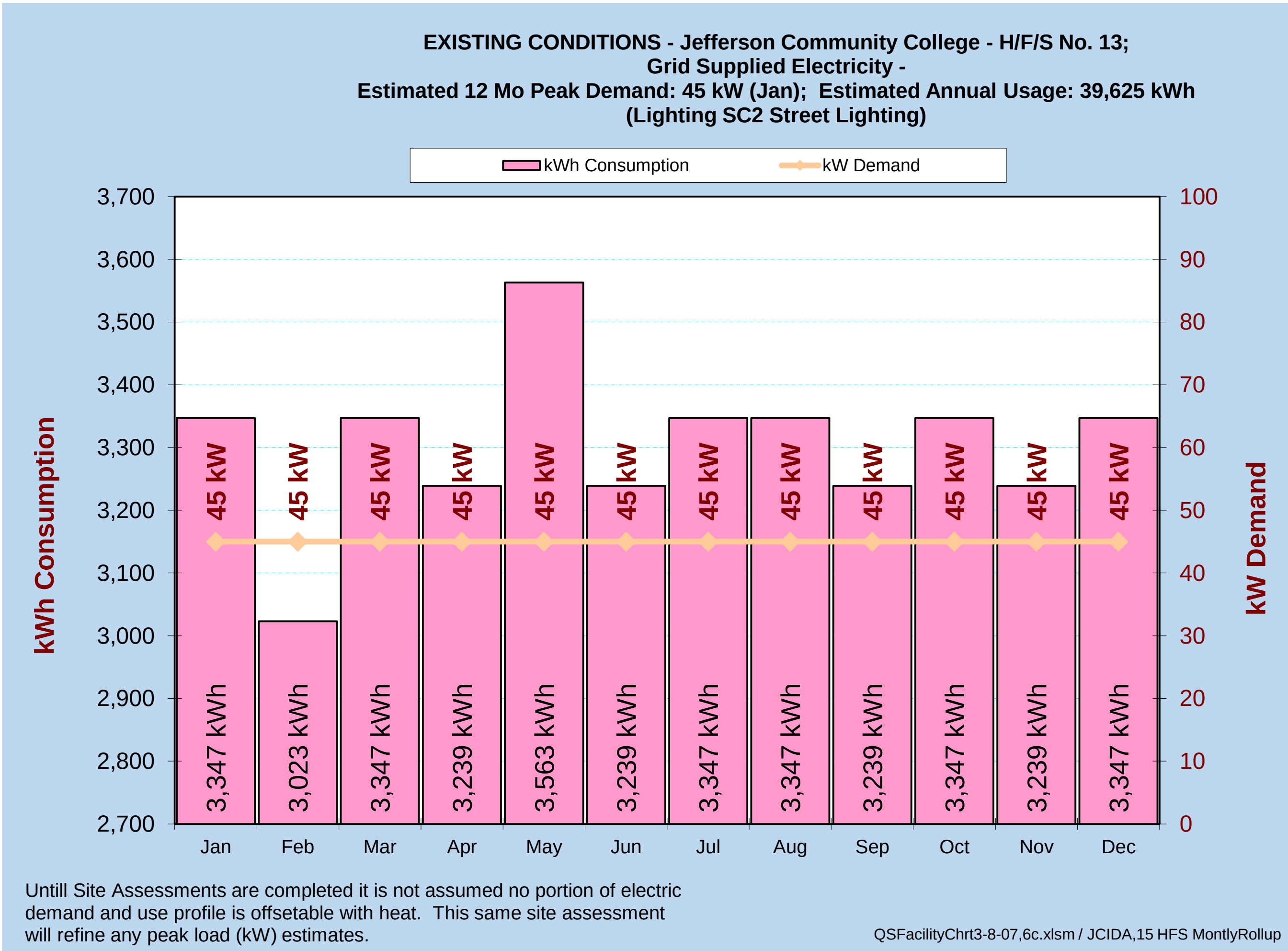
Thermal Usage Chart



EXISTING CONDITIONS – H/F/S 13– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

No Thermal Usage

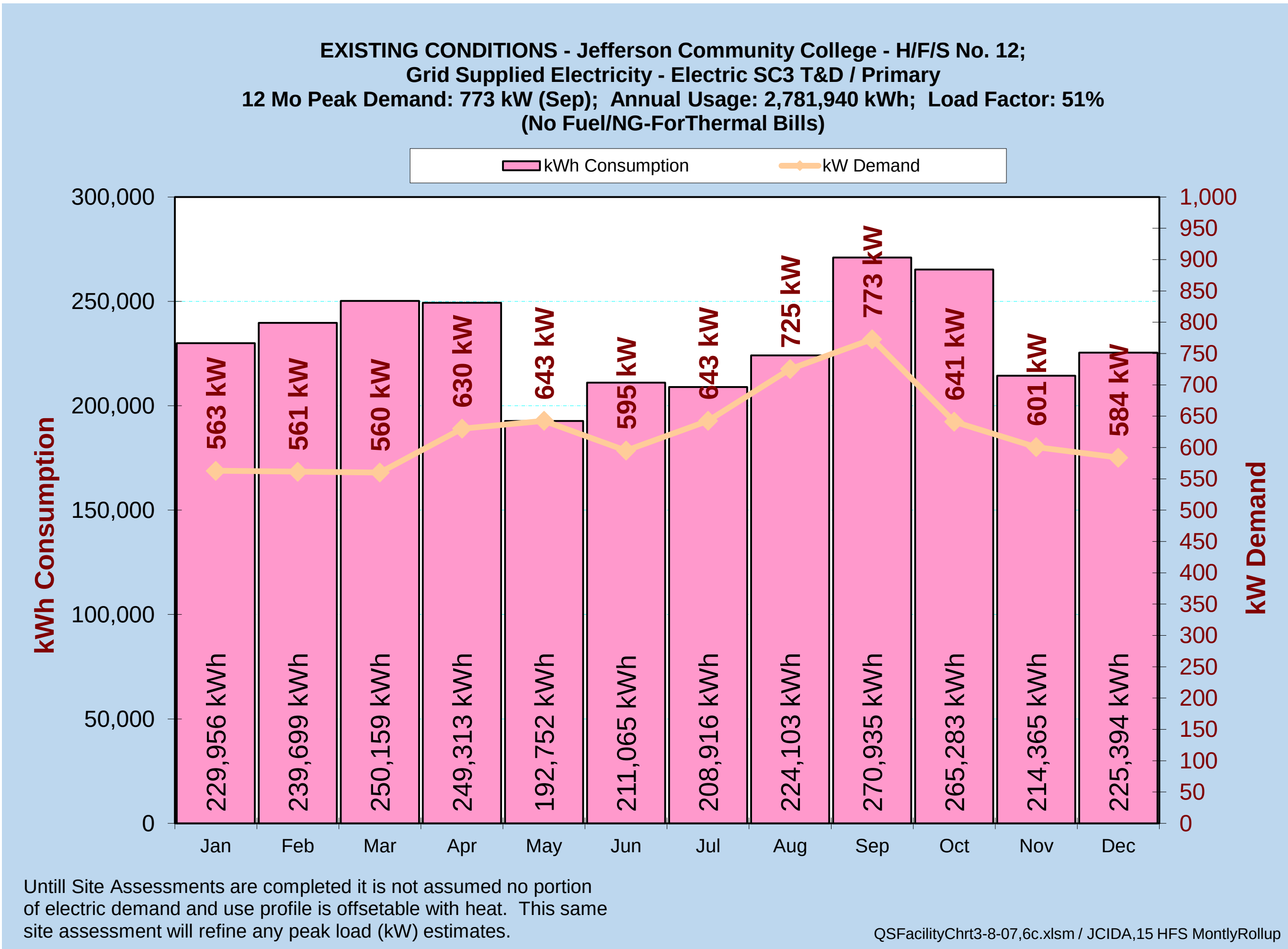
Electricity Demand & Usage Chart



EXISTING CONDITIONS – H/F/S 12– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

No Thermal Usage

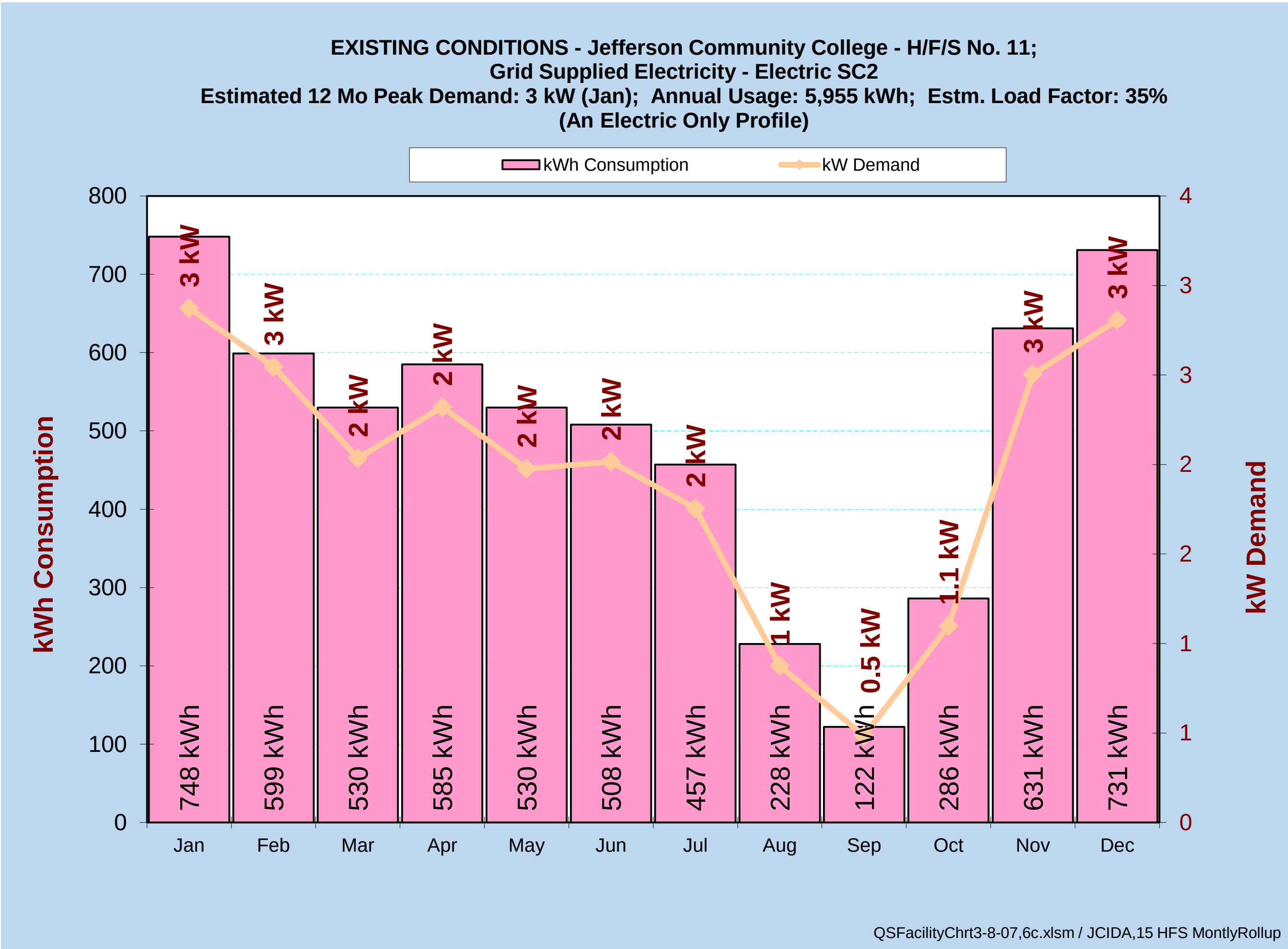
Electricity Demand & Usage Chart



EXISTING CONDITIONS – H/F/S 11– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

No Thermal Usage

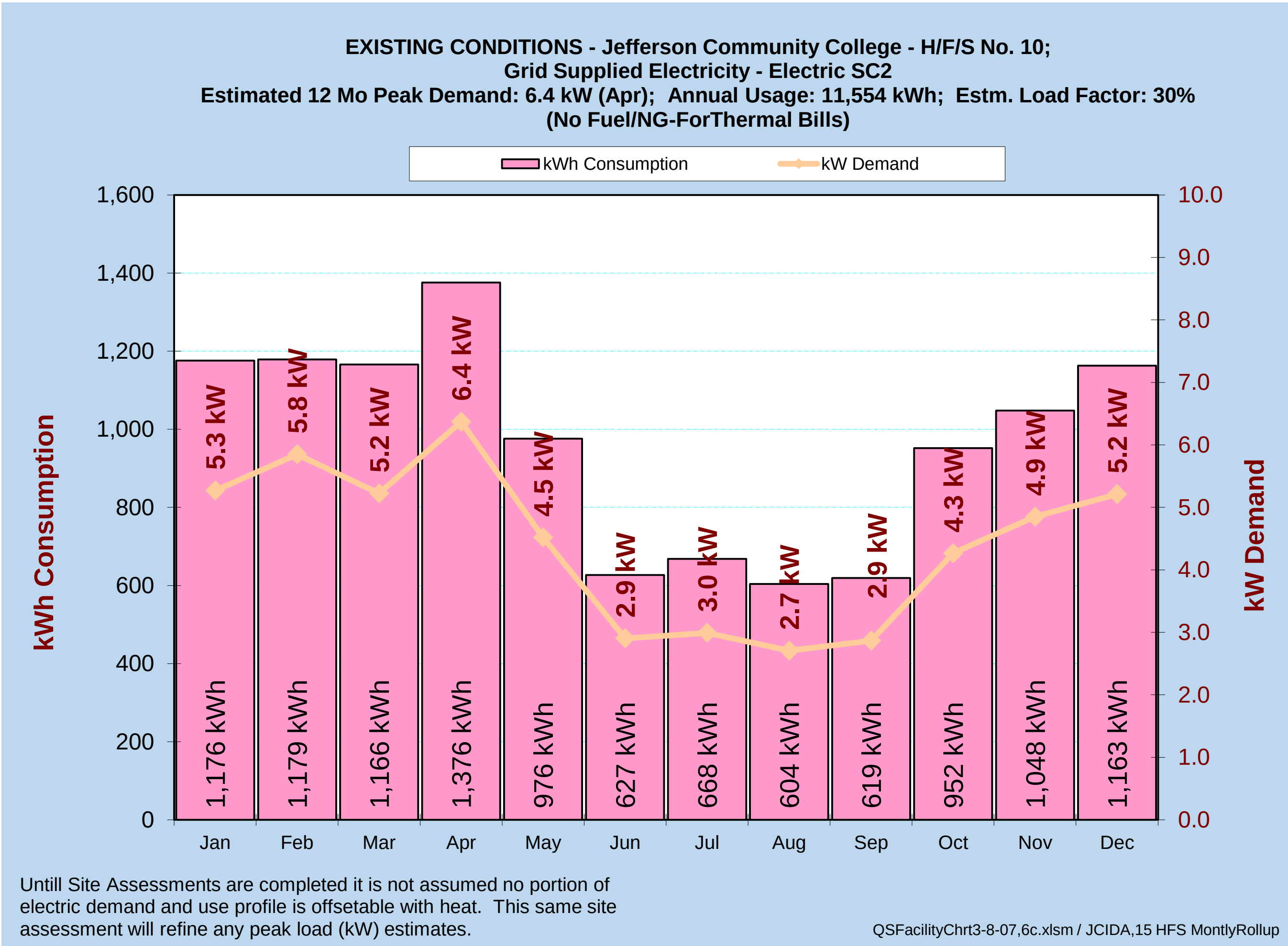
Electricity Demand & Usage Chart



EXISTING CONDITIONS – H/F/S 10– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

No Thermal Usage

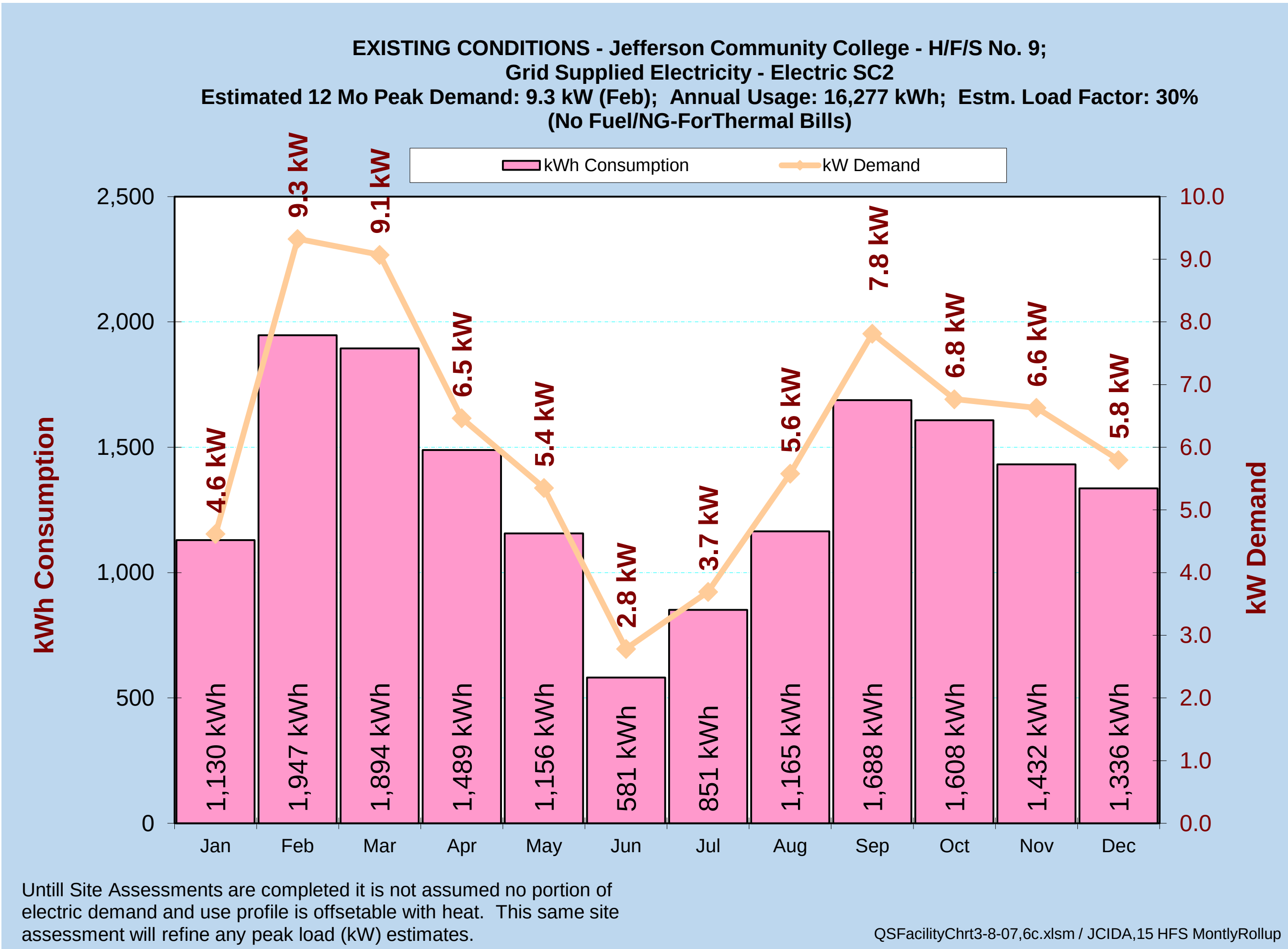
Electricity Demand & Usage Chart



EXISTING CONDITIONS – H/F/S 9– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

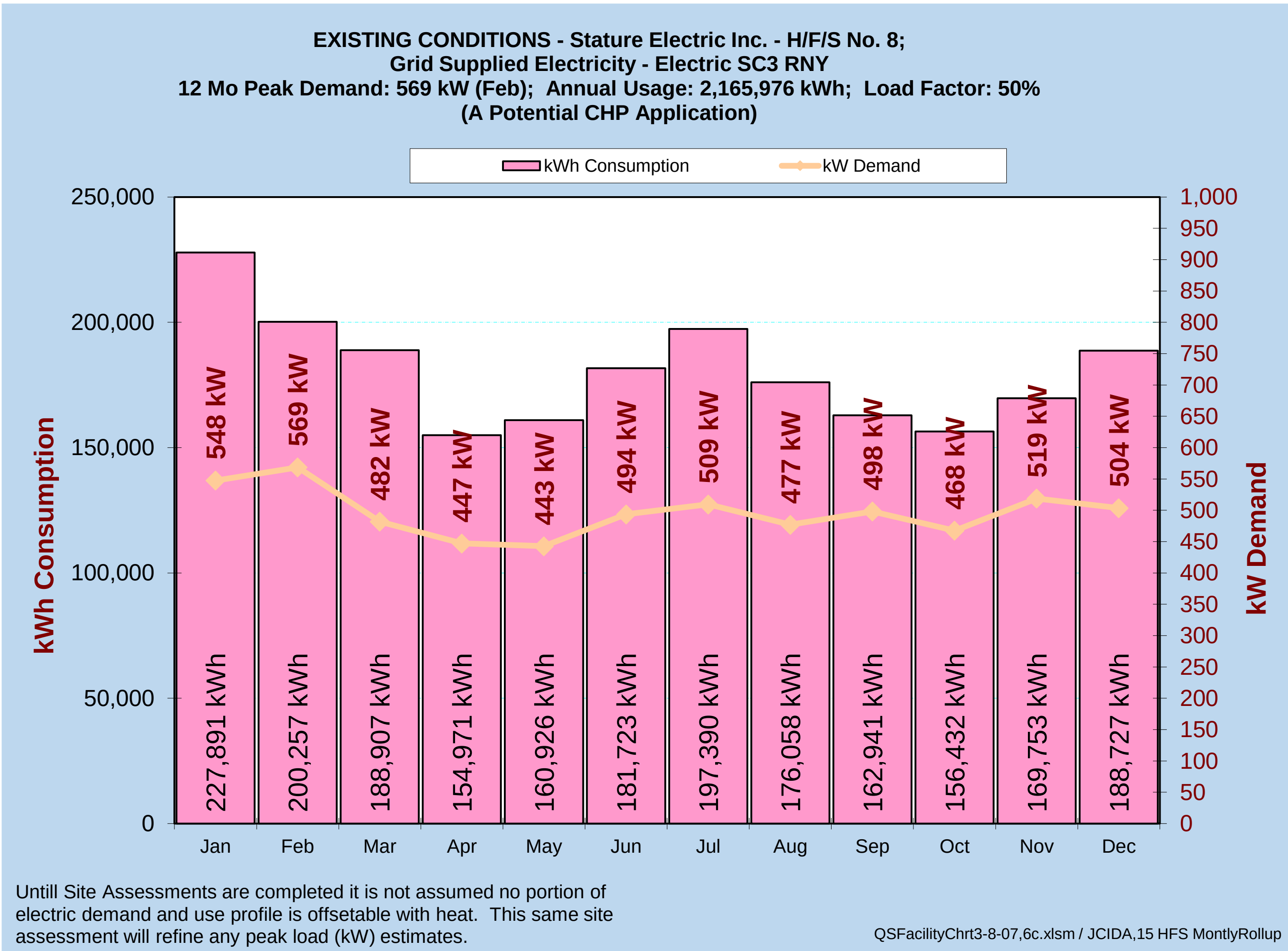
No Thermal Usage

Electricity Demand & Usage Chart

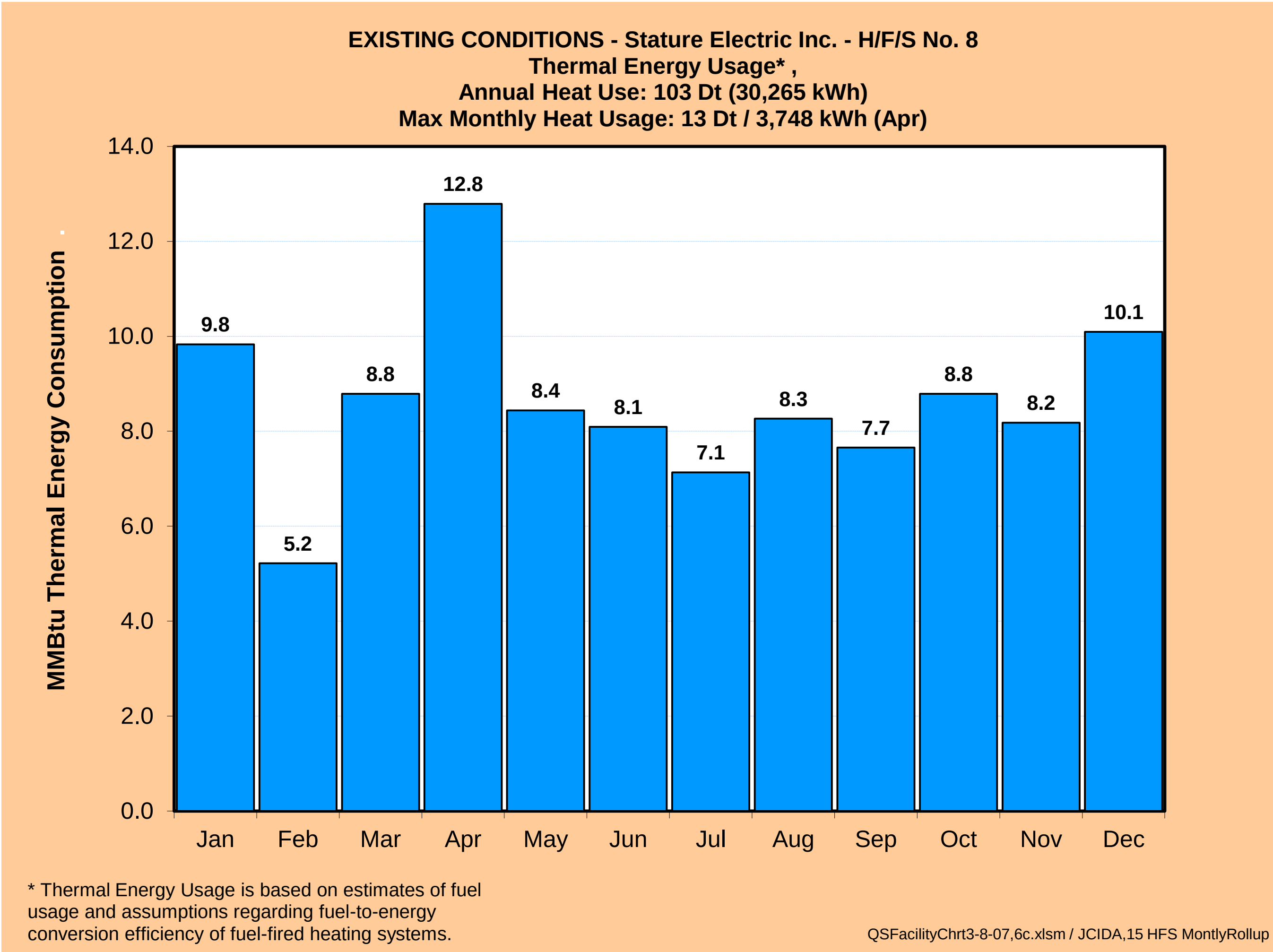


EXISTING CONDITIONS – H/F/S 8– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Electricity Demand & Usage Chart



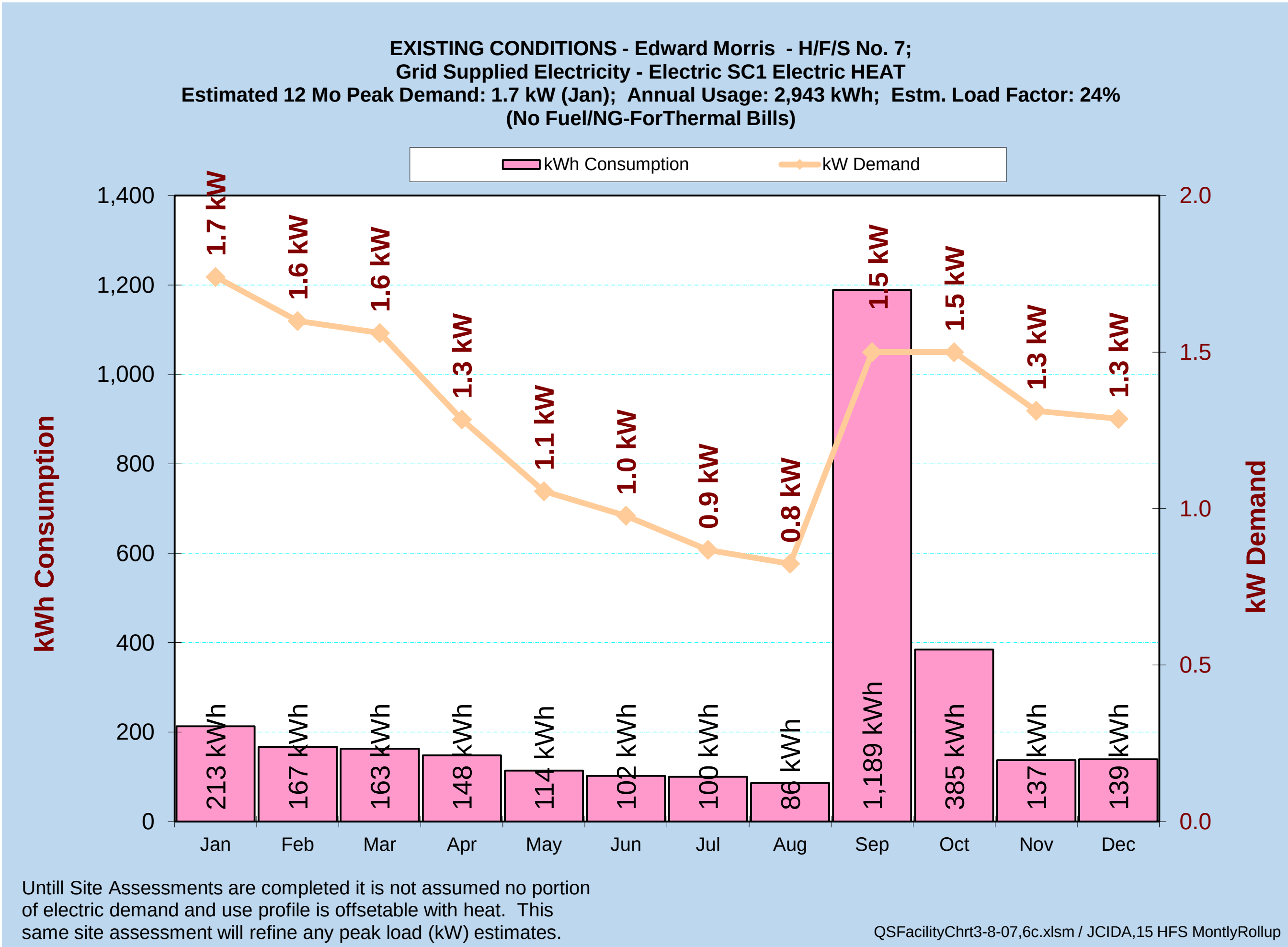
Thermal Usage Chart



EXISTING CONDITIONS – H/F/S 7– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

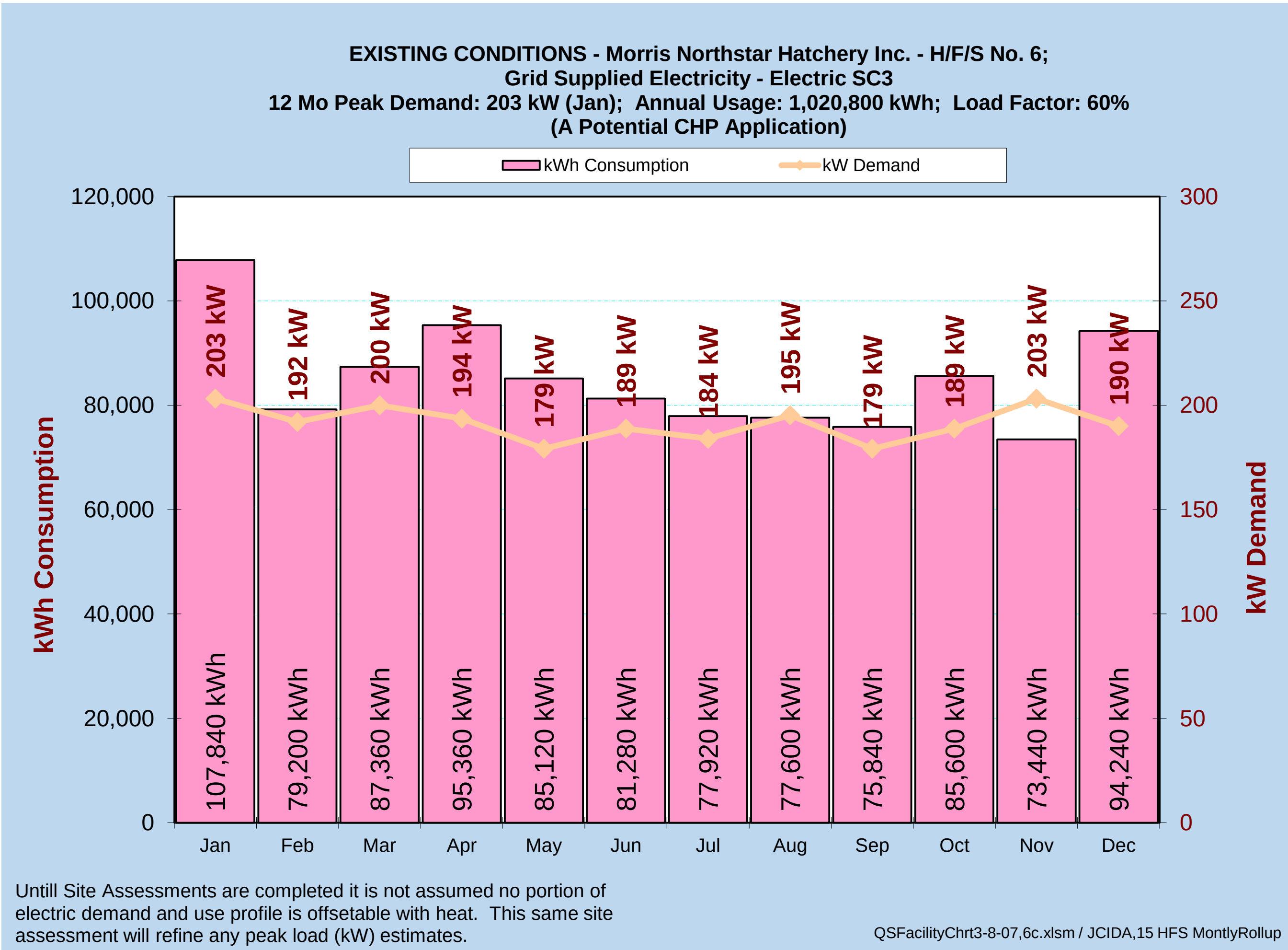
No Thermal Usage Chart

Electricity Demand & Usage Chart

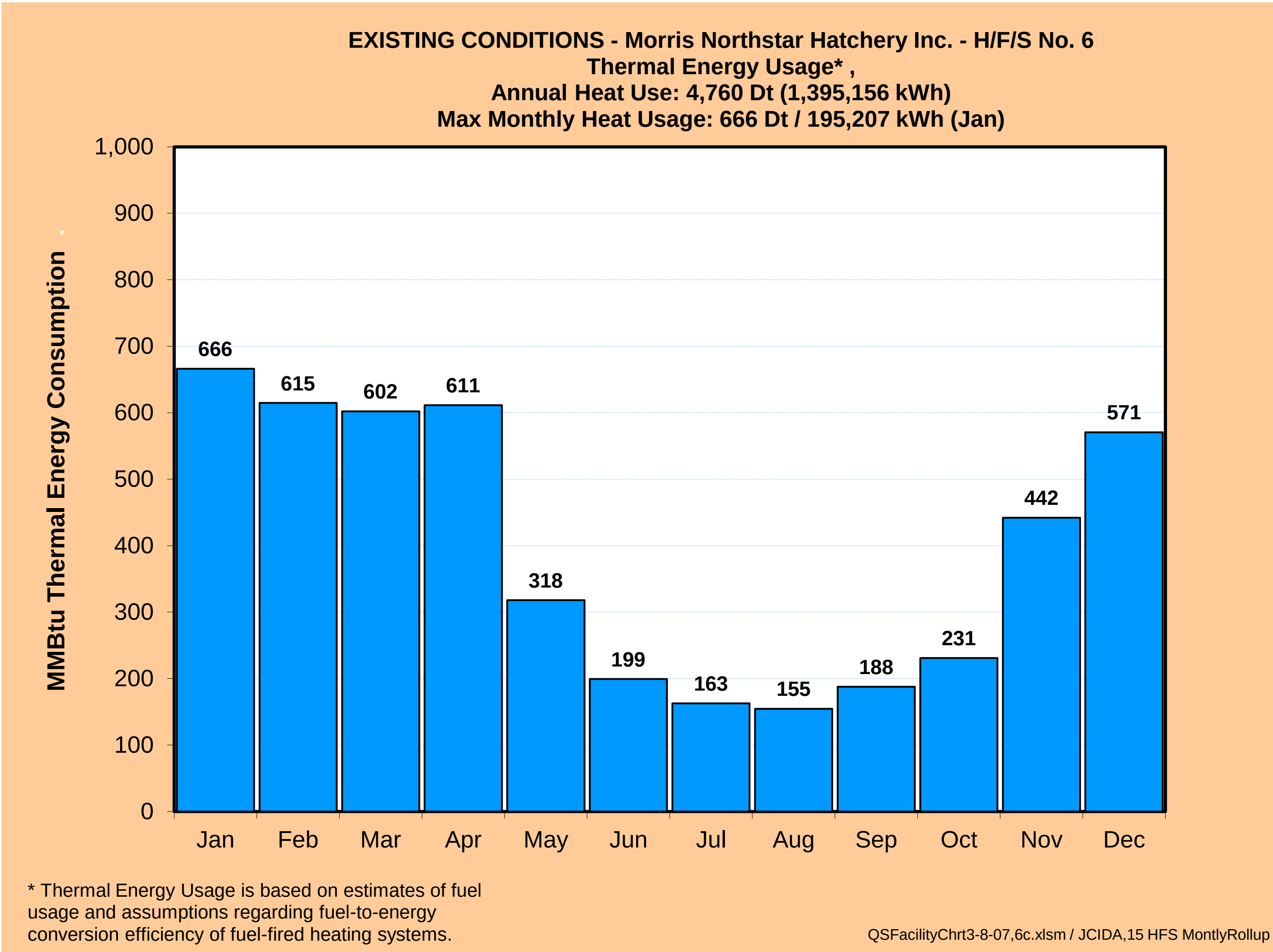


EXISTING CONDITIONS – H/F/S 6– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Electricity Demand & Usage Chart

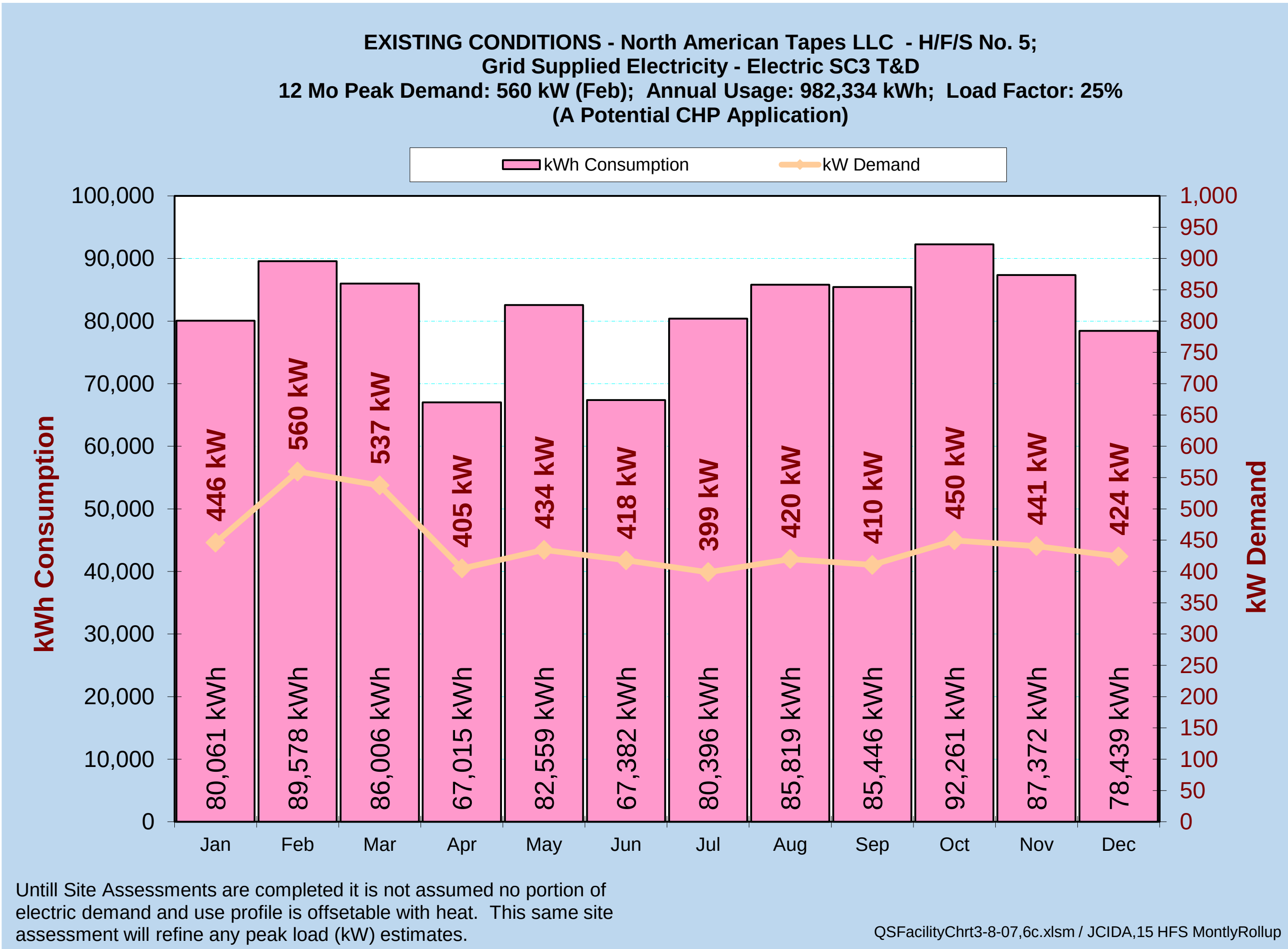


Thermal Usage Chart

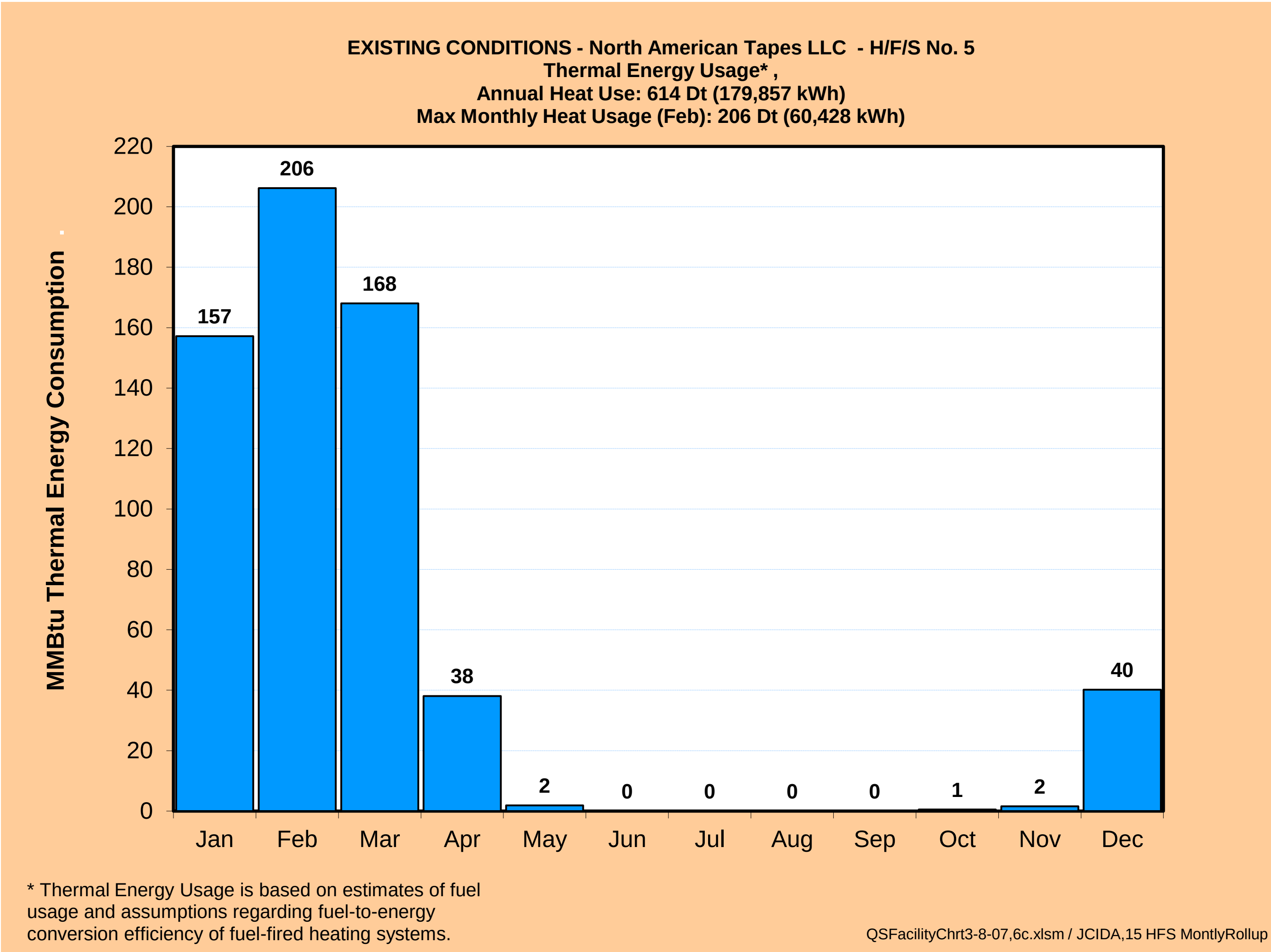


EXISTING CONDITIONS – H/F/S 5– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Electricity Demand & Usage Chart

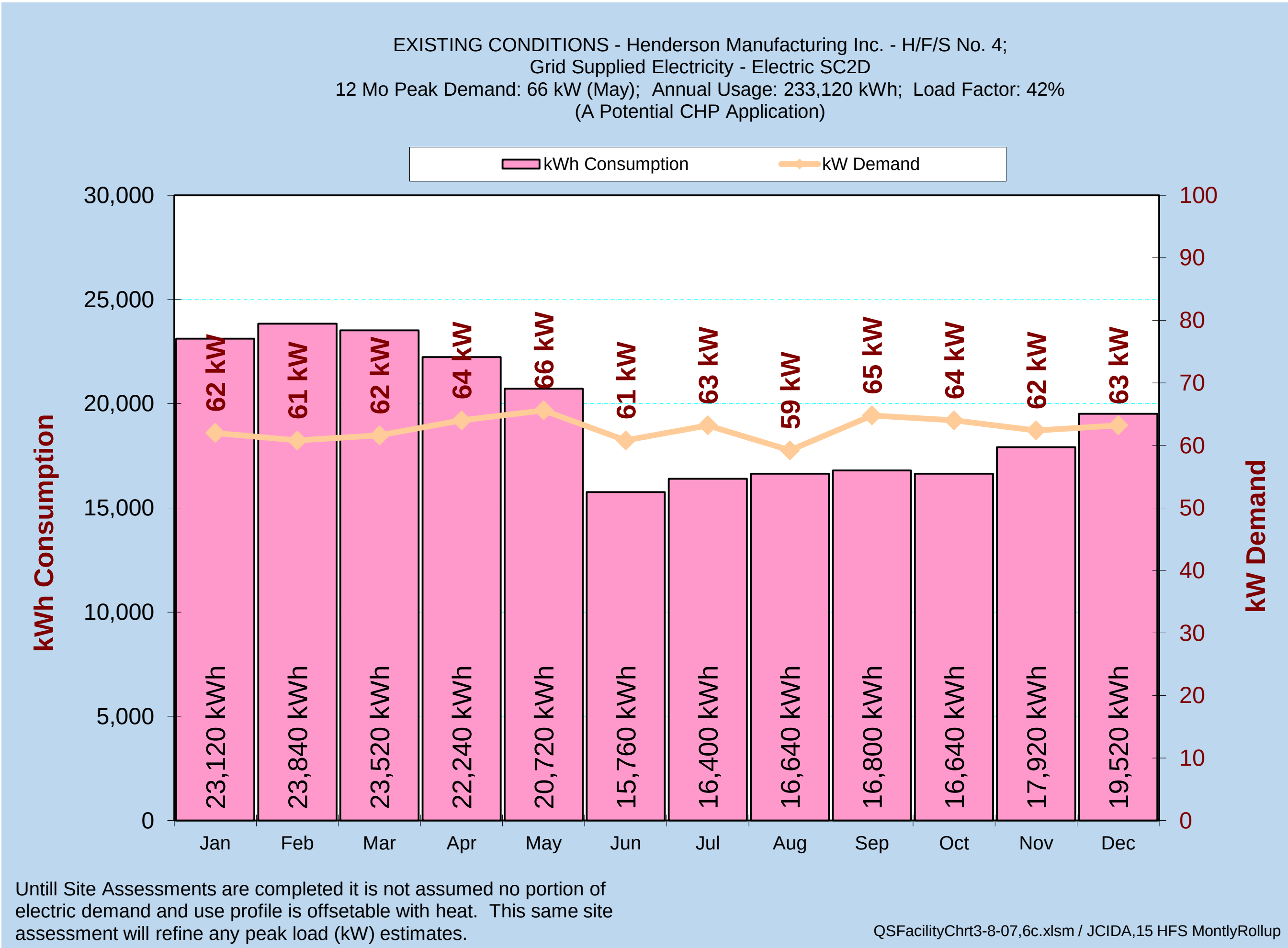


Thermal Usage Chart

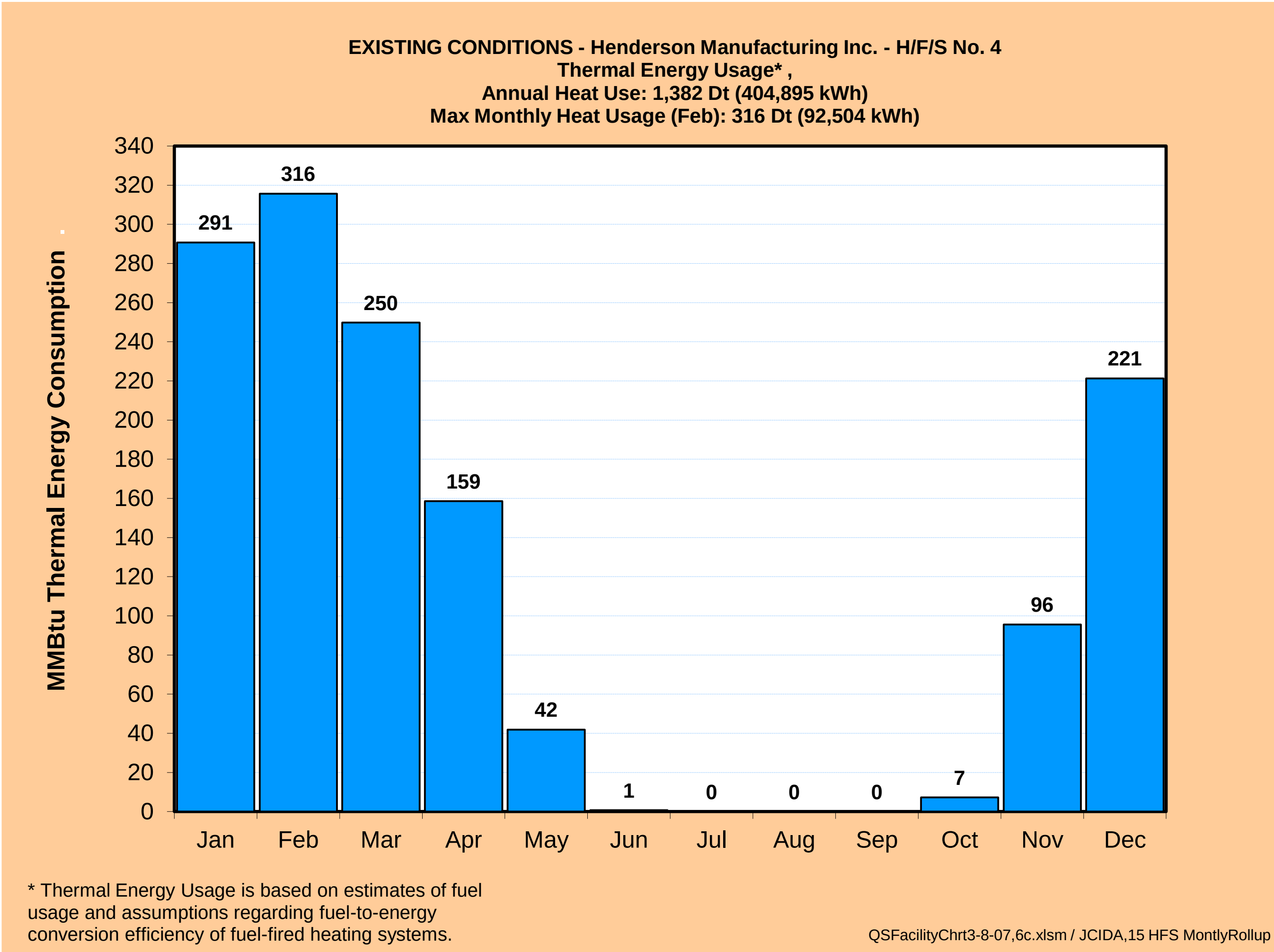


EXISTING CONDITIONS – H/F/S 4– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Electricity Demand & Usage Chart

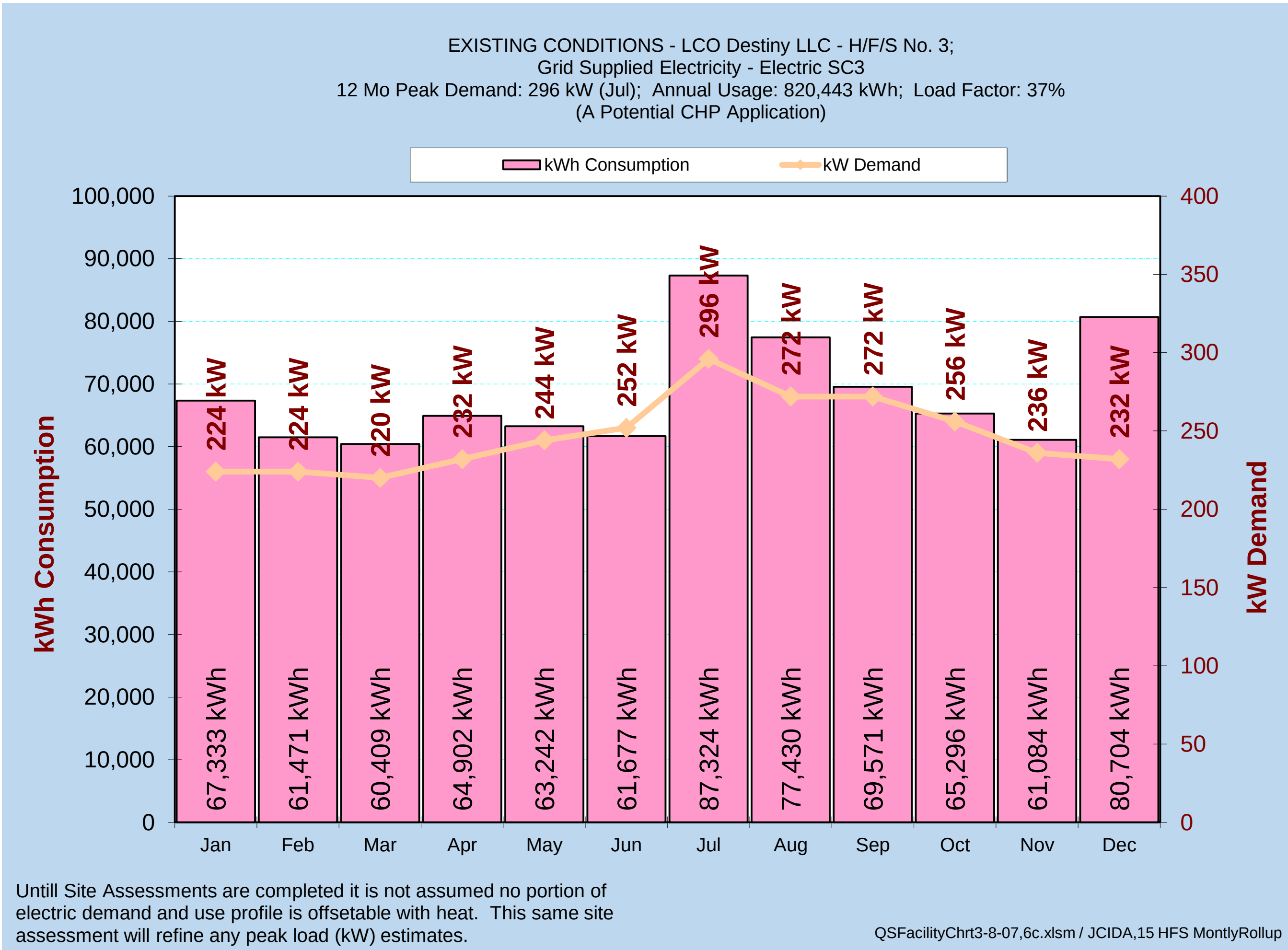


Thermal Usage Chart

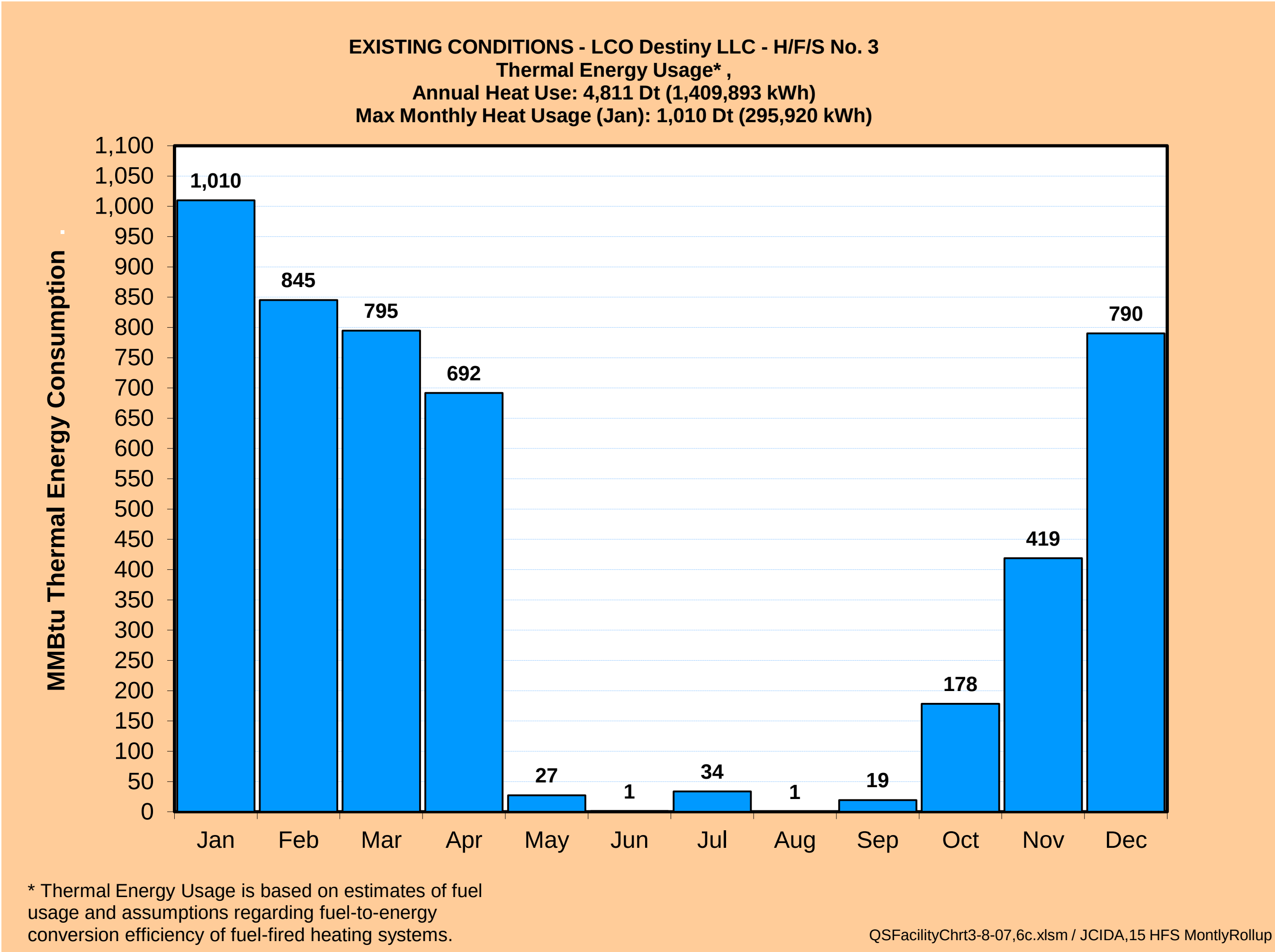


EXISTING CONDITIONS – H/F/S 3– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Electricity Demand & Usage Chart

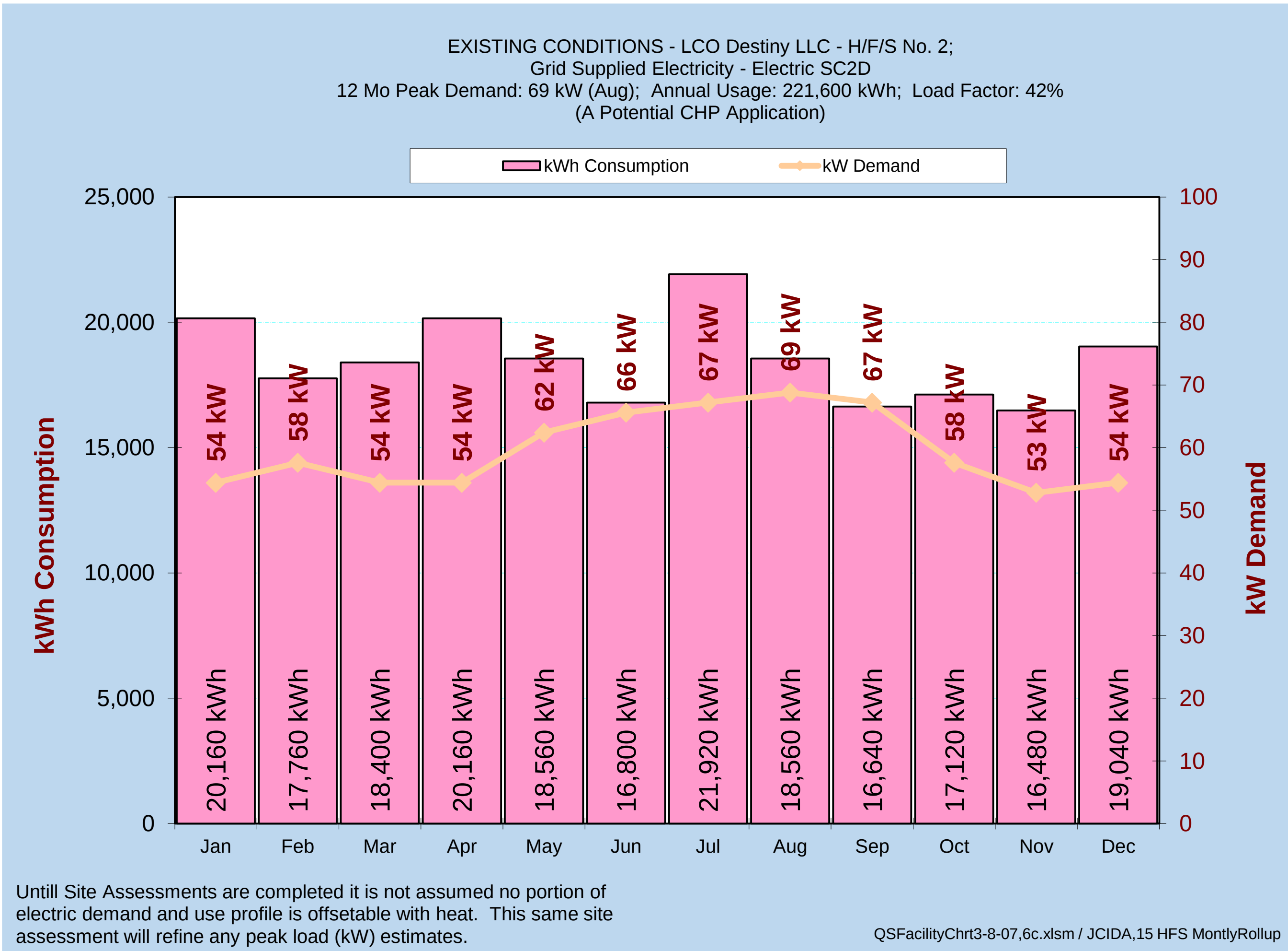


Thermal Usage Chart

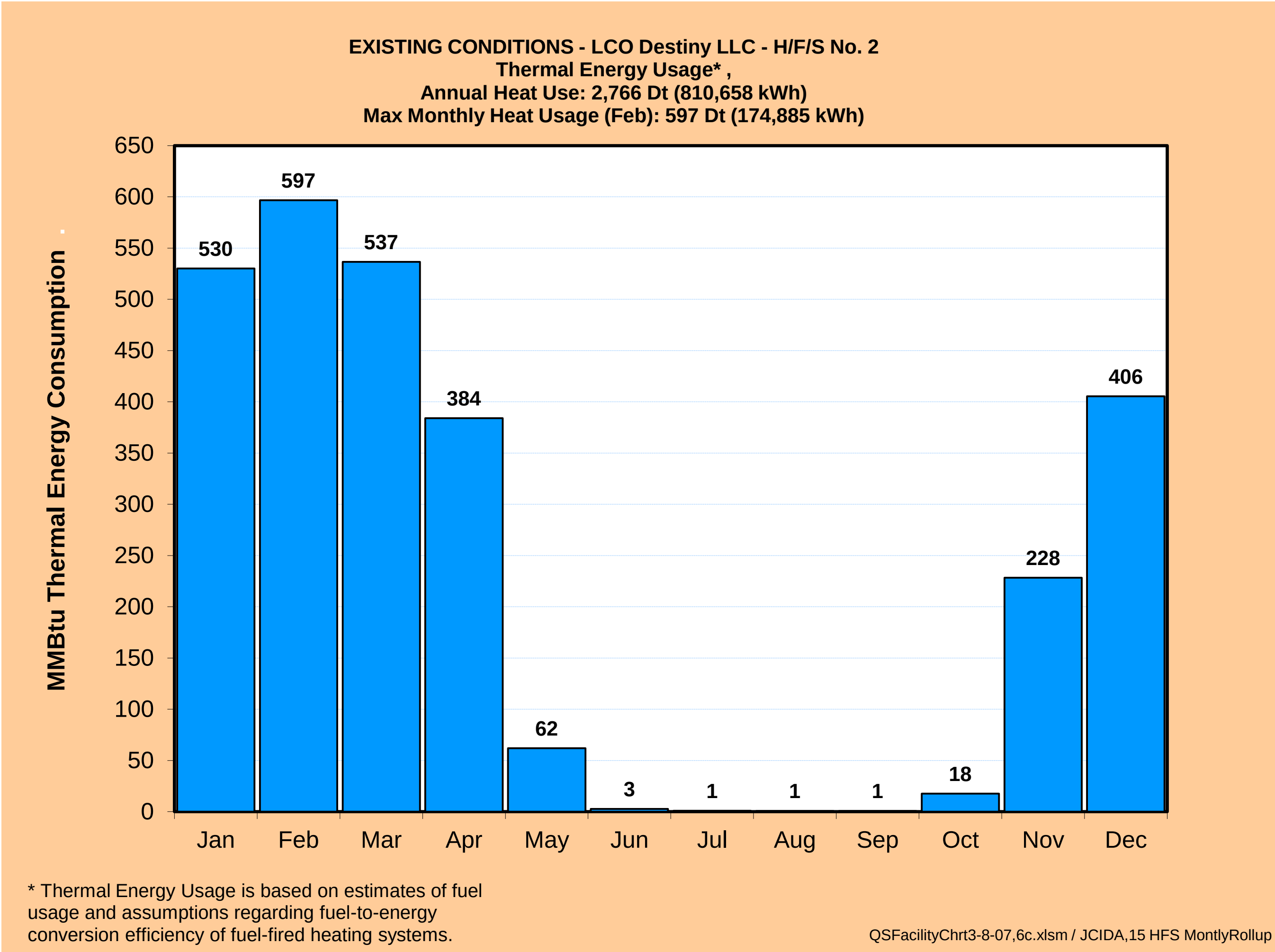


EXISTING CONDITIONS – H/F/S 2– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

Electricity Demand & Usage Chart



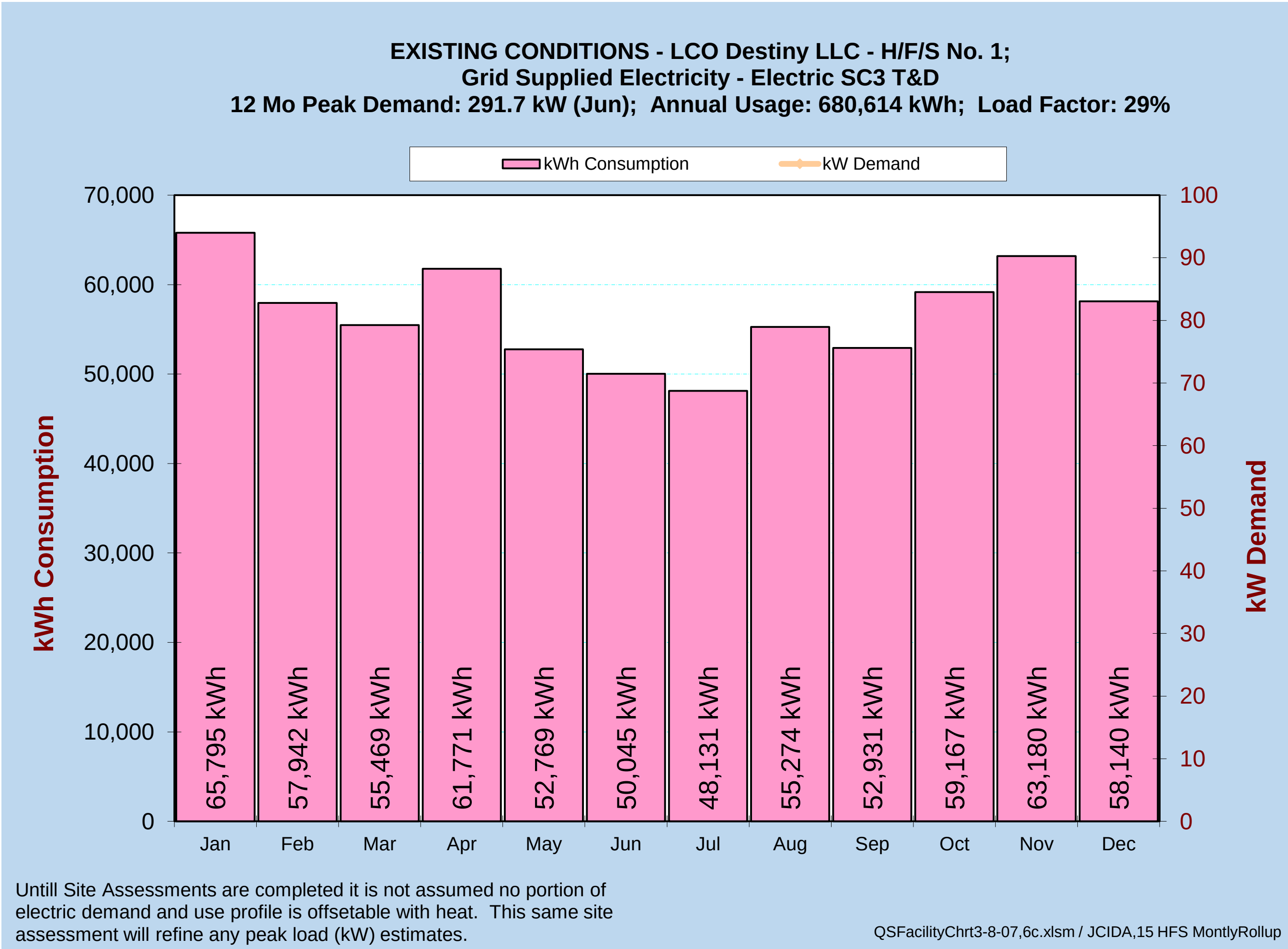
Thermal Usage Chart



EXISTING CONDITIONS – H/F/S 1– MONTHLY ELECTRICITY & THERMAL DEMAND AND USAGE

No Thermal Usage

Electricity Demand & Usage Chart



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