Town of Holden – MVP Action Grant
Water Station "Green" Emergency Power Study

Holden Department of Public Works

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Holden, MA 01520

January 2019

FUSS & O'NEILL

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1 Executive Summary

Fuss & O'Neill, Inc. (F&O) was contracted to complete a study for the following facilities: Brattle Street Vault Interconnection, Salisbury Street Interconnection, Mill Street Wellfield, Mason Road Wellfield, Spring Street Well, Spring Street Treatment Facility, Chapin Water Tank, and Jefferson Tank to investigate the possibilities of providing "green" emergency power. The study will investigate "green" power generation options such as; low-head hydro, solar photo-voltaic (PV), micro-wind for the tank facilities, battery storage technologies including the latest technologies such as the Tesla Power Wall system and fly-wheel storage systems, as well as combinations of the above. Each facility was assessed to determine its specific requirements and conditions on what options may be appropriate for that facility.

The scope of the study included the following:

- Review of existing facility information including record drawings, equipment information and utility bills.
- Site visit to each facility to determine existing conditions both site conditions as well as electrical systems and requirements.
- Once the existing information was acquired and reviewed each facility was assessed to determine an electrical load profile, existing infrastructure was assessed to determine if energy upgrades may reduce the electrical load consumption. The load profile was matched with available technologies for "green" emergency power.
- Each site was assessed for its environmental conditions, such as structure heights, availability of un-shaded property, boundaries of EPA Zone 1 area as well as flood plain elevations. As well as proximity to abutters. This information matched with and prohibited the use of some with available technologies for "green" emergency power.
- Once appropriate available technologies had been matched with the facility sites preliminary opinions of cost will be established for each potential solution.
- Below is a summary of our findings.

Station	Recommended Technology	TOTAL
Brattle Street Vault Interconnection	**Batteries Only**	**$61,200**
Salisbury Street Interconnection	**Portable Generator**	**$107,690**
Mill Street Wellfield	**Storm Switch for Portable Generator**	**$8,640**
Mason Road Wellfield	**Storm Switch for Portable Generator**	**$15,840**
Spring Street Wellfield	**Storm Switch for Portable Generator**	**$15,840**
Chapin Water Tank	**Solar PV & Batteries**	**$92,880**
Jefferson Tank	**Solar PV & Batteries**	**$92,880**
Portable 100kW Generator	**Portable Generator**	**$86,031**

2 Methodology

2.1.1 Existing Conditions

Information was gathered and reviewed for each facility including record drawings, equipment information and utility bills. A site visit to each facility to determine existing conditions both site conditions as well as electrical systems and requirements. Once the existing information was acquired and reviewed each facility will be assessed to determine an electrical load profile, existing infrastructure was assessed to determine if energy upgrades may reduce the electrical load consumption. The load profile was be matched with available technologies for "green" emergency power. Each site was assessed for its environmental conditions, such as structure heights, availability of un-shaded property, boundaries of EPA Zone 1 area as well as flood plain elevations. As well as proximity to abutters. This information matched with and prohibited the use of some with available technologies for "green" emergency power.

2.1.2 Electrical Assessment

The electrical assessment of the facilities essentially comes down to determining the size of the battery system. A battery system size is determined by the peak and continuous load (kW) and the number of hours that it is needed to operate (kWh). Since the utility was not able to provide peak and average electrical load data it was necessary to utilize estimated connected loads based on existing drawings and field investigation to determine the peak load. The utility was able to provide monthly data on kWh, total annual and average monthly values were calculated. A peak average per day was calculated by dividing the peak monthly value by number of days a "worst case scenario." From this continuous load was estimated by dividing the calculated average peak per day by 8 hours as a conservative estimate. Recording meters will need to be installed at each location to gather more accurate information for facilities that move forward into design.

Town of Holden Water Stations Electrical Assesments

Station	Address	Service				Estimated Peak kW	Average Peak kWh / Day	Estimated Continuous kW
		Amps	Volts	Phase	kVA			
Brattle Street Vault Interconnection	280 Brattle Street	100	120/240	1	3	1.5	21	3
Salisbury Street Interconnection	970 Salisbury St (Across from)	600	480/277	3	500	500	253	32
Mill Street Wellfield	80 Mill Street	100	480/277	3	83	80	669	84
Mason Road Wellfield	200 Mason Road	300	120/240	1	90	90	415	52
Spring Street Well / Treatment Facility	69 Spring Street	300	120/240	1	90	90	386	48
Chapin Water Tank	190 Sycamore Drive	15	120/240	1	3.6	3.6	21	3
Jefferson Tank	235 Muschopauge Road	100	120/240	1	2.4	2.4	18	2

3 Available Technologies

3.1.1 Introduction

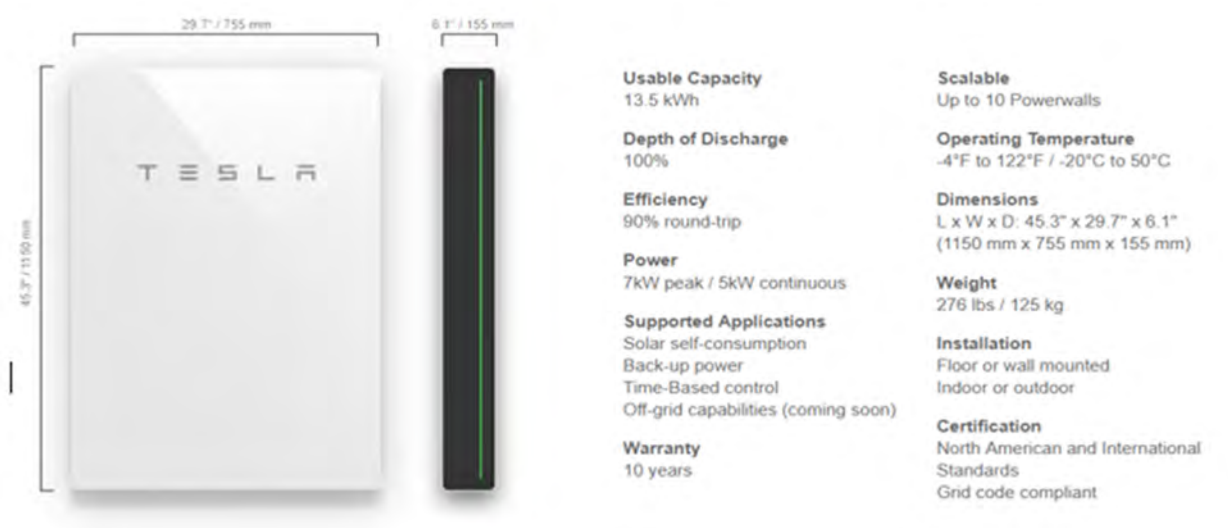
An emergency back-up power source by definition needs to be reliable during a power outage while the current standard in the industry is motor driven generators powered by fossil fuel new technologies have been developed to potentially provide "green" back-up power. While "green" or renewable power sources are extremely valuable to the environment and the energy supply in general their drawback is that they inherently only produce power derived from potentially un-reliable environmental factors such as wind, sunlight or water flow. Therefore storage must be considered and with the development of new battery technologies it now makes this feasible. Wherever possible a renewable power source is paired with a storage technology.

Batteries produce power at a direct current (DC) voltage so an inverter is required to convert the power to usable alternating current (AC). The renewable energy options considered also produce power at DC so they pair nicely with battery systems for storage and in most cases can share the inverter.

3.1.2 Battery

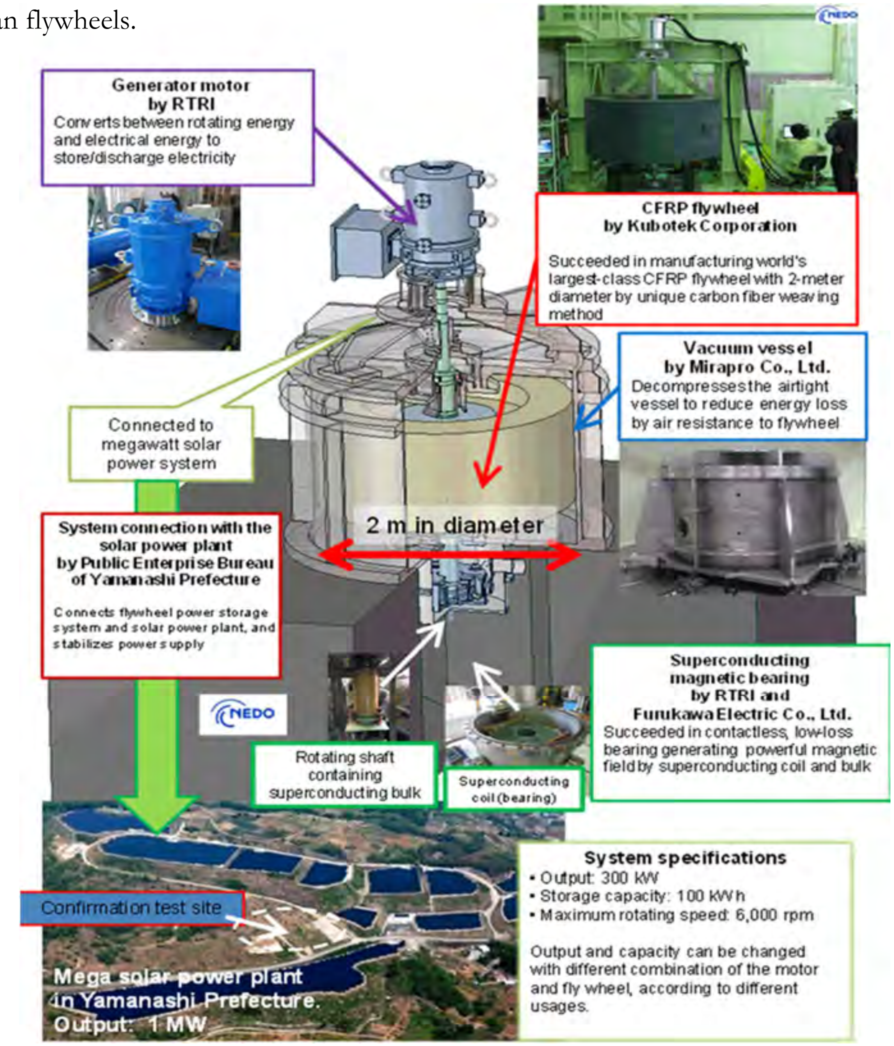
For reliable guaranteed backup energy storage, batteries are the safest bet and will maintain charge the longest. One of the newer battery storage units available – the Tesla Power wall and is a good benchmark for battery options available. The common unit provides 13.5 kWh of energy storage scalable up to ten to provide a maximum of 135kWh of storage at a 7kW peak and 5kW continuous power. There are several providers for battery options, most of which have similar solutions such as ABB and SolarEdge. Typical batteries use lithium Ion storage, but other technologies are available such as lead-acid and rare earth batteries.

The requirements or limitations on batteries essentially come down to capacity the more kWh's required the more batteries are required this drives up the cost of the installation as well as the space required.



3.1.3 Flywheel

This technology stores electricity in the form of kinetic energy by using grid power to speed up a large rotating wheel, and then slowing down the wheel to generate electricity to reduce peak load or during power outage. While there are 100 kWh flywheels, they are large, a challenge to design and install as well as more difficult to maintain given that they are a less used technology. Their real advantage flywheel technology is in peak shaving rather than for backup energy storage since they are capable of discharging and recharging multiple times without any chemical degradation that reduces their storage capacity. Since the primary forces of backup power is redundancy for guaranteed operation in a power outage, batteries are a better storage means than flywheels.



3.1.4 Solar Generation

Solar photovoltaic (PV) has gone from a unique renewable energy source to a major contributor in the energy market in a relatively short time. Just five years ago, the solar industry installed less than 5,000 MW of capacity annually. In 2018, the U.S. solar market will be double the size — with over 11,000 MW installed. There are now more than 1.9 million solar installations in the U.S. The DOE's National Renewable Energy Laboratory (NREL) released new research today that shows the average price of utility-scale solar is now under $1 per watt and below 6 cents per kilowatt-hour.

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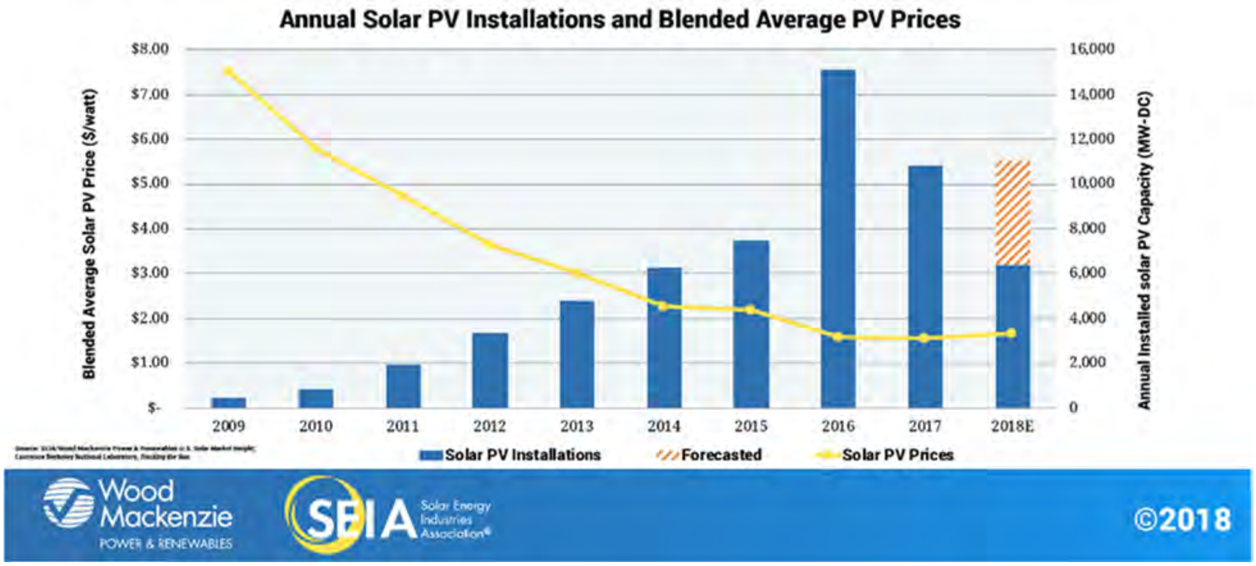
Solar PV essentially converts the power of the sun into more usable DC power. As such the amount of power generated by a solar energy system at a particular site depends on how much of the sun's energy reaches it, and the size of the system itself. For solar panels, it assumed, that each 1 kW of solar panels requires 100 square feet of surface area, and that 1 kW generates 1600 kWh annually based on standard Massachusetts solar conditions. Ideally you want a shade free southern exposure to maximize the solar installation here in the north east.

Based on their requirements or constraints Solar PV is a viable option for "green" emergency power at several sites.

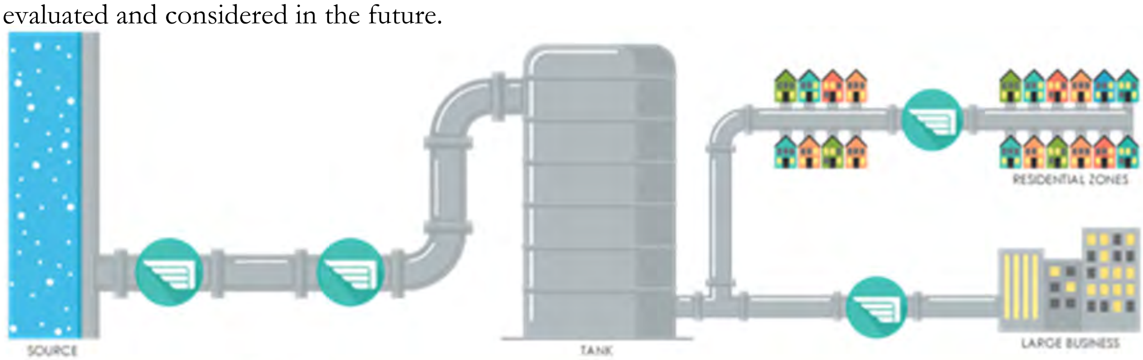


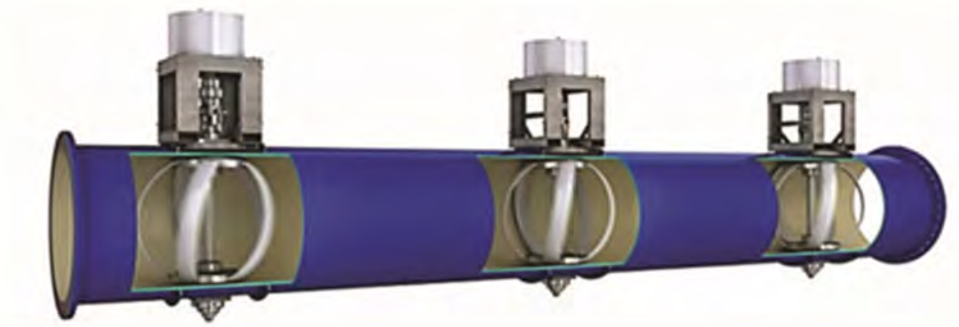
3.1.5 Conduit Hydro Generation

In conduit hydropower, existing tunnels, canals, pipelines, aqueducts and other manmade structures that carry water are fitted with electric generating equipment. Conduit projects often qualify as small hydro, and are able to extract power from water without the need for a large dam or reservoir. Conduit projects are efficient, cost-effective and environmentally friendly, as they are able to generate electricity from existing water flows, exploit synergies with infrastructure already in place and often requiring less of a capital investment. Recognizing the benefits of conduit projects, the Federal Energy Regulatory.

Commission provides a permitting exemption to certain qualifying facilities. Not all conduit systems are suitable for hydropower, however. Keeping in mind the first priority is the reliable supply of water to consumers, - not hydropower - it is important to remember that the first priority is not hydropower; it is the delivery of water. Adequate safeguards must be in place to ensure uninterrupted flow to consumers. One of the common risks with conduit systems is the conduit itself. Some pipelines were never designed to withstand the excess pressure that develops when the pipe is full and water flow is shut off. Add to this the risk of a pressure surge when the generator is tripped offline, and pipeline integrity becomes a major issue. Older, longer pipelines are most susceptible to damage from overpressure. A good time to evaluate a hydropower system is when an aging pipeline is replaced. A new pipeline can be designed with hydropower in mind, using modern design from end to end.

Conduit hydro requires head pressure and flow, the higher and more consistent the head pressure and flow are the more viable conduit hydro is. While conduit hydro certainly has it merits as a renewable power option the cost and conditions required do not make this a viable option for "green" emergency power at this time. However it is recommended that as the system itself is upgraded or replaced conduit hydro should be evaluated and considered in the future.





3.1.6 Wind Generation

A wind turbine, or alternatively referred to as a wind energy converter, is a device that converts the wind's kinetic energy into electrical energy. Wind turbines are manufactured in a wide range of vertical and horizontal axis. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels.

The amount of power produced and the reliability of that power is directly correlated to the wind speed and the consistence of that wind. The height of the turbine also affects how much electricity a turbine will generate. For example a typical home uses approximately 10,932 kilowatt-hours of electricity per year (about 911 kilowatt-hours per month). Depending on the average wind speed in the area, a wind turbine rated in the range of 5–15 kilowatts would be required to make a significant contribution to this demand. A 1.5-kilowatt wind turbine will meet the needs of a home requiring 300 kilowatt-hours per month in a location with a 14 mile-per-hour (6.26 meters-per-second) annual average wind speed. Most micro wind turbines require wind speed of approximately 8 mph to start up and approximately 13 mph of sustained wind to generate.

Wind power was considered at the start of the project as a potential source for a tall water storage tank or one that is elevated on a hill, but given height of the two tanks assessed and the surrounding tree lines limiting wind potential this was ruled out for the two tank locations. While it would be possible to asses wind further by opening up the possibilities of erecting towers these become cost prohibitive for this type of project and tend to be very difficult to permit near residential locations. Because of these constraints micro wind was determined to be infeasible.

4 Facilities

4.1.1 Brattle Street Interconnection

Existing Conditions
The Brattle Street Interconnection is located in the high service system and brings water in from the City of Worcester with a flow control valve. It has the ability to provide approximately 650 gallons per minute. This interconnection is imperative in keeping water supply and fire protection within the high service system. The Highland Street Booster station pumps water from the low service system to the high service. When the Highland Booster station system is off, the Brattle Street Interconnection works to fill the tanks in the high service system. In 2017 this station accounted for 23% of all water produced by Holden/purchased from Worcester. With this station out of power, the valve would not be able to open resulting in a loss of that supply which would in turn directly affect the entire high service system.

This is a below grade facility actually located in Brattle Street. There is an above grade control cabinet located just off the side of the road. Relatively dense tree canopy leaves the majority of this small lot shaded. The facility is relatively new around 2002 and is in good condition.

Primary electrical service is fed via underground at 120/240V – 1 Phase, 100 Amps. The utility meter is mounted to the side of the cabinet. There are two cabinet mounted receptacles for a temporary generator. One is oversized at 200 amps and the second is sized at 30 amps and was added at a later date. The electrical service terminates in 100 amp, 120/240 volt load center with a 100 amp main circuit breaker, located within the cabinet. The electrical load at this facility consists mainly of telemetry systems, lighting and cabinet heat and dehumidification. Estimated peak load is 3.0 kW, estimated continuous load is 2.0kW and average peak kWh / Day is 21.0 kWh.

Recommendations
Based on the existing site conditions solar PV is not an option. However based on the electrical loading of the facility battery back-up is an option. Based on the load profile five (5) Tesla Powerwalls would provide emergency back-up power for approximately 3 days of complete outage. This could be extended by re-charging the batteries utilizing a portable generator if needed. Our recommendation would be to install these units within in an enclosure similar to the existing enclosure.

Estimated Cost
The estimated cost for the engineering and construction of the above recommendation is **$61,200**.

4.1.2 Salisbury Street Interconnection

Existing Conditions
The Salisbury Street Interconnection is a pumped interconnection with the City of Worcester. It has the ability to provide over 2400 gallons per minute into the high service system. This interconnection typically runs secondary to the Brattle Street Interconnection during periods of high demand including the summer as well as during a fire. In 2017 this station accounted for 6% of all water produced by Holden/purchased from Worcester. With this station out of power, the pumps would not be able to run and F&O would lose the supply. This would directly affect the entire high service system.

This a below grade facility on a small lot located on Salisbury Street. There is an above grade pad mount transformer, below grade mechanical, electrical and surge tank vaults. The facility is relatively new around 2006 and is very good condition.

Primary electrical service is fed via underground from the utility pole on Salisbury Street The service 277/480V-3 Phase, 600 Amps and terminated at a motor control center located in the electrical vault. There is a 200-amp generator receptacle located at the pad transformer and a 200 amp manual transfer switch located in the electrical vault which could provide power in the event of an outage There are large pumps; (2) 100 HP and (1) 50 HP at this facility located in the mechanical vault. Estimated connected load is 500 kVA.

Recommendations
Based on the existing site conditions solar PV is not an option. Based on the electrical loading of the facility 480 volts battery back-up is also not an option. Our recommendation would be to invest in a portable diesel generator of approximately 150kW which could provide approximately 200 amps of power at 480/227 volt, three phase to be used in case of an outage, additionally the owner with the assistance of an engineer should develop an SOP for the emergency.

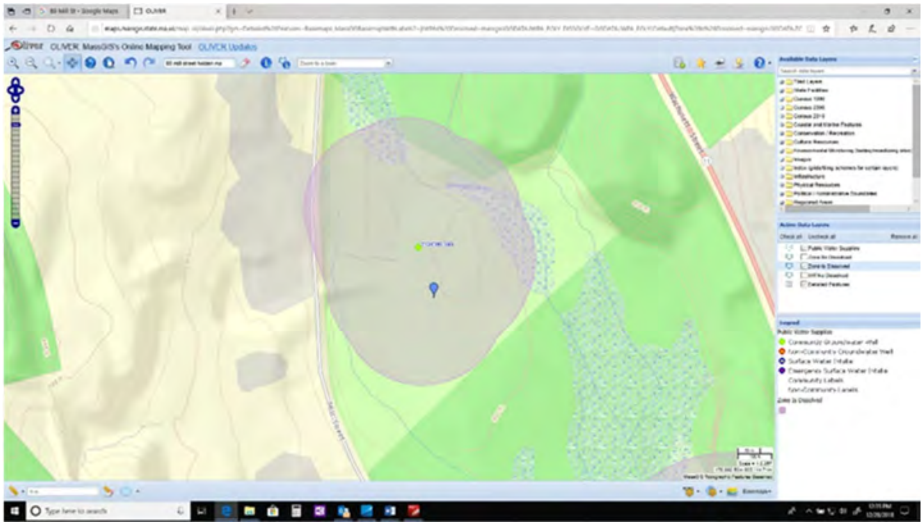
Estimated Cost
The estimated cost for the engineering and construction of the above recommendation is **$107,690**.

4.1.3 Mill Street Wellfield

Existing Conditions
The Mill Street Wellfield is located in the low service system and pumps water through a series of shallow tubular wells. The well produces around 275 gallons per minute at its peak, but typically produces around 220 gallons per minute. This well field accounts for approximately 43% of the water produced in the low service system and in 2017 accounted for 21% of the overall water produced by Holden/purchased from Worcester.

This is a well field facility actually located off of Mill Street via an access road. There is a Well Station building on site, the facility was built in approximately 1967. The well field itself consists of a fairly large area free from trees. The facility is in relatively good condition.

There is a MassDEP Zone 1 protective radius of 250' at this facility. MassDEP prohibits solar batteries and solar battery storage housings within Zone 1 and they also require a minimum 200 foot no disturbance area from the well within the Zone 1 for the installation of solar installations.



Primary electrical service is fed via overhead from the utility pole at 277/480V- 3 Phase 100 amps. The service terminates in the building at a 480V, 100 amp motor control center, there is (1) 40 HP well pump at this facility. Estimated connected load is 80 kVA.

Recommendations

Due to the MassDEP Zone 1 protective requirements of the 200 foot no disturbance area from the well "green" emergency back-up power is not an option at this site. A 100kW portable could be purchased that would provide power to any of the three (3) well field site; Mill Street, Mason Road and Spring Street. The generator would have multiple taps to support either 480/277V or 120/208V. Electrical distribution upgrades would be required to install a "Storm Switch" and connect this to the existing distribution system to allow for the connection of the generator.

Estimated Cost

Estimated cost for the engineering and procurement of the 100kW portable generator is **$86,031,** this could be used at multiple sites. The estimated cost for the engineering and construction to provide the "Storm Switch" is **$8,640.**

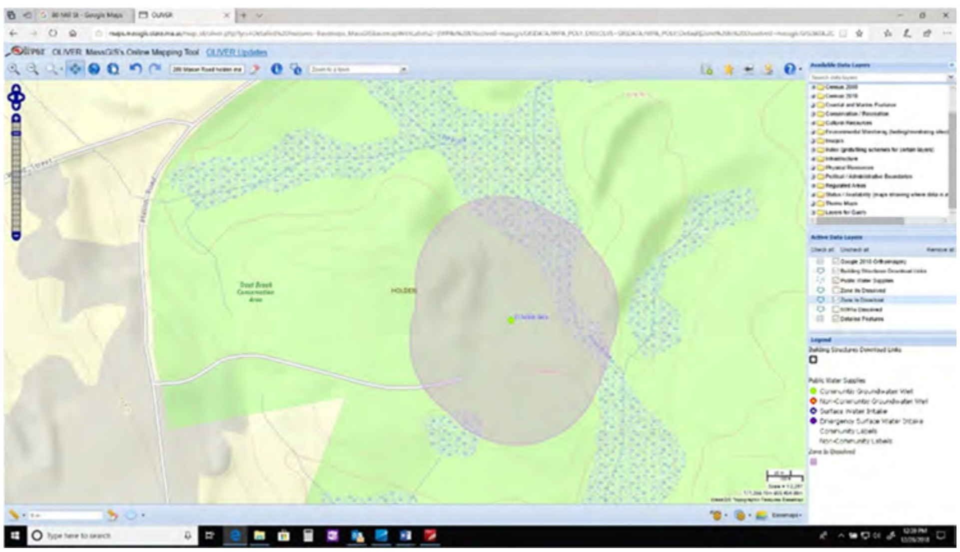
4.1.4 Mason Street Wellfield

Existing Conditions

The Mason Road Wellfield is located in the low service system and pumps water through a series of shallow tubular wells. The well produces around 50 gallons per minute. This well field accounts for approximately 9% of the water produced in the low service system and in 2017 accounted for 7% of the overall water produced by Holden/purchased from Worcester.

This is a well field facility actually located off of Mason Road via a long access road. There are two buildings on site the original Well Station, approximately 1975 and a newer Chemical Feed building which was added around 2002. Relatively dense tree canopy leaves the majority of this facility shaded with the exception of the roofs of the two buildings. The facility is in relatively good condition.

There is a MassDEP Zone 1 protective radius of 250' at this facility. MassDEP prohibits solar batteries and solar battery storage housings within Zone 1 and they also require a minimum 200 foot no disturbance area from the well within the Zone 1 for the installation of solar installations.



Primary electrical service is fed via an overhead pole line through the trees. There is a single service drop at 120/240V - 3 Phase, 300 Amps and terminated at a 400 amp, 120/240 volt distribution panel with a 300 amp main circuit breaker located in the Chemical Feed Building. The original Well Station Building is back fed from this distribution panel. Estimated connected load is 90 kVA.



Recommendations
Due to the MassDEP Zone 1 protective requirements of the 200 foot no disturbance area from the well "green" emergency back-up power is not an option at this site. A 100kW portable could be purchased that would provide power to any of the three (3) well field site; Mill Street, Mason Road and Spring Street. The generator would have multiple taps to support either 480/277V or 120/208V. Electrical distribution upgrades would be required to install a "Storm Switch" and connect this to the existing distribution system to allow for the connection of the generator.

Estimated Cost
Estimated cost for the engineering and procurement of the 100kW portable generator is **$86,031,** this could be used at multiple sites. The estimated cost for the engineering and construction to provide the "Storm Switch" is **$15,840.**

4.1.5 Jefferson Tank

Existing Conditions
The Jefferson Tank is located in the North end of the high service system. It works to provide storage and fire protection for residents on North Main Street. The tank is controlled by an altitude valve. Loss of power at this tank would result in loss of monitoring of the tank level and water operators would have to manually check the pressure gauges to interpolate the water level in the tank.

This is an above ground storage tank of approximately 92' in diameter and 20' high located off of Muschopauge Road down an access road in a residential neighborhood. There is approximately 35' clear to the tree canopy which is relatively high, there is a fairly good southern exposure with approximately 100' clear to the tree line on the south west side of the tank. The facility consists of the tank with a small electrical pedestal cabinet located on the south west side. The facility is relatively new around 2002 and is in good condition.

Primary electrical service is fed underground from Muschopauge Road. The service terminates at the pedestal cabinet with a cabinet mounted meter and interior mounted panelboard. The service is at 120/240V – 1 Phase, 100 amp. The load on this is very small consisting mainly of controls, lights, receptacle and heat for the cabinet. Estimated connected load is 2.4 kVA.

Recommendations
Based on the load profile five (5) Tesla Powerwalls would provide emergency back-up power for approximately 3 days of complete outage. Based on the existing site conditions solar PV is an option at this site, a 4kW DC array would potentially produce approximately 5,000 kWh exceeding the current annual kWh. By providing solar PV at this site combined with the battery system you could potentially extend the back-up capacity by several days depending upon conditions at the time the solar could recharge the batteries. Our recommendation would be to install a 4kW DC Solar array and the battery system. This would essentially make this facility net zero and construction cost would be recouped over time with reduced energy bills.

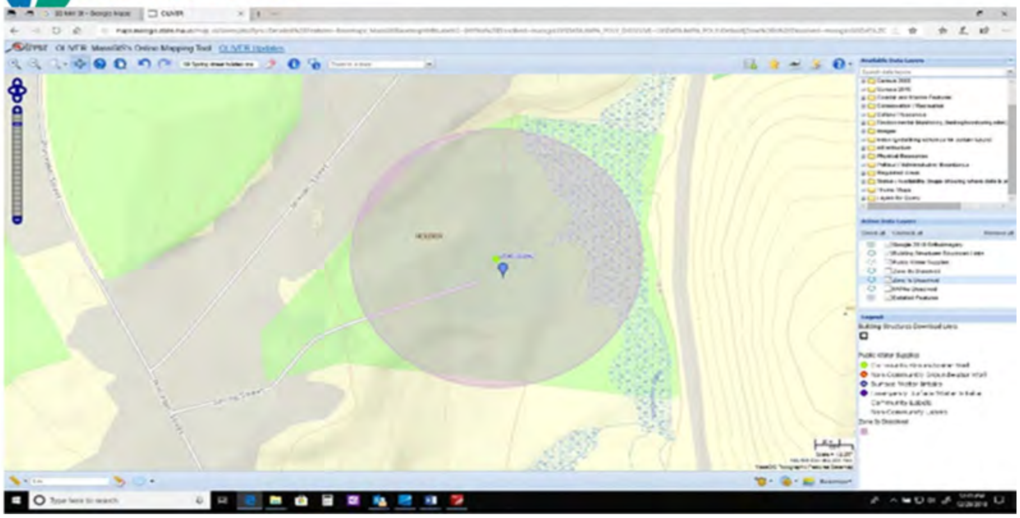
Estimated Cost
The estimated cost for the engineering and construction of the above recommendation is **$92,880**.

4.1.6 Spring Street

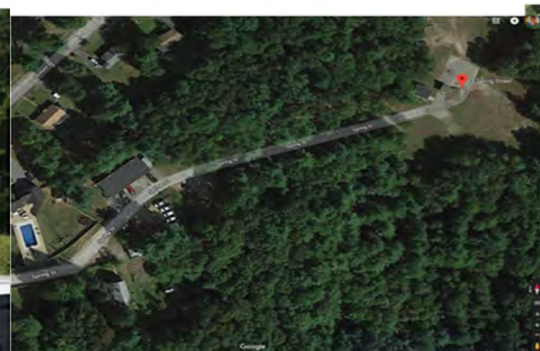
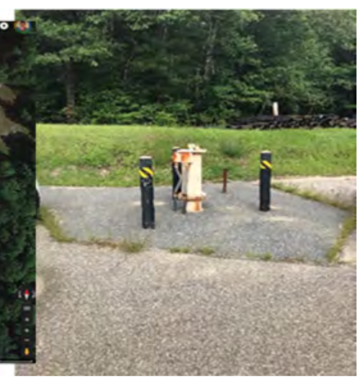
Existing Conditions
The Spring Street Well and Treatment Facility is located in the high service system. It consists of a single gravel packed well with a submersible pump and a treatment facility for corrosion control, fluoride and chlorine addition if necessary. The well typically produces 70 gallons per minute, and in 2017 accounted for 9% of water produced by Holden/purchased from Worcester.

This is a well field facility located at the end of Spring Street. There are two buildings on site the original Well Station, approximately 1975 and a newer Chemical Feed building which was added around 2002. There is a fairly large cleared area around the well. The facility is in relatively good condition.

There is a MassDEP Zone 1 protective radius of 400' at this facility. MassDEP prohibits solar batteries and solar battery storage housings within Zone 1 and they also require a minimum 200 foot no disturbance area from the well within the Zone 1 for the installation of solar installations.



Primary electrical service is fed via underground conduits from the utility pole at 120/240V – 1 Phase, 400 Amps and terminated at a 400 amp, 120/240 volt distribution panel with a 300 amp main circuit breaker located in the Chemical Feed Building. The original Well Station Building is back fed from this distribution panel. Estimated connected load is 90 kVA.

Recommendations

Due to the MassDEP Zone 1 protective requirements of the 200 foot no disturbance area from the well "green" emergency back-up power is not an option at this site. A 100kW portable could be purchased that would provide power to any of the three (3) well field site; Mill Street, Mason Road and Spring Street. The generator would have multiple taps to support either 480/277V or 120/208V. Electrical distribution upgrades would be required to install a "Storm Switch" and connect this to the existing distribution system to allow for the connection of the generator.

Estimated Cost

Estimated cost for the engineering and procurement of the 100kW portable generator is **$86,031,** this could be used at multiple sites. The estimated cost for the engineering and construction to provide the "Storm Switch" is **$15,840.**

4.1.7 Chapin Water Tank

Existing Conditions

The Chapin Water Tank in located in the high service system in the Fox Hill neighborhood and provides water service and fire flow to the area. The tank is filled off the Sycamore Large Booster Station and drains through a flow control valve, or pressure reducing valve in times of high demand. Should the tank lose power, the Sycamore Large Booster Station would be unable to see the tank level, and therefore would not fill the tank when needed. Loss of the tank will have direct effect on 162 properties and a residual effect on the high service system.

This is an above ground storage tank of approximately 104' in diameter and 36' high located off of Sycamore Drive down a long access road in a residential neighborhood. There is approximately 35' clear to the tree canopy which is relatively high, there is a fairly good south east exposure with approximately 100' clear to the tree line. The facility consists of the tank with a small electrical cabinet located on the south east side. The facility is relatively new around 1991 and is in good condition.

Primary electrical service is fed overhead from Sycamore Drive on a pole line along the access road. The service terminates at a utility pole with a pole mounted meter and disconnect switch. The service is at 120V – 1Phase, 15 amp feeds underground from the pole to the electrical enclose and the RTU. Estimated connected load is 0.18 kVA.


Recommendations

Based on the load profile five (5) Tesla Powerwalls would provide emergency back-up power for approximately 3 days of complete outage. Based on the existing site conditions solar PV is an option at this site, a 4kW DC array would potentially produce approximately 5,000 kWh exceeding the current annual kWh. By providing solar PV at this site combined with the battery system you could potentially extend the back-up capacity by several days depending upon conditions at the time the solar could recharge the batteries. Our recommendation would be to install a 4kW DC Solar array and the battery system. This would essentially make this facility net zero and construction cost would be recouped over time with reduced energy bills.

Estimated Cost

The estimated cost for the engineering and construction of the above recommendation is **$92,880**.

5 Conclusion

Upon completing this preliminary study, Fuss and O'Neill has identified several energy storage and renewable generation opportunities. Based of feedback and direction from the town of Holden as well as potential grant opportunities, the Fuss and O'Neill has made preliminary assessments for energy storage and renewable generation for each site. It also conducted assessments with several battery and energy storage suppliers and manufacturers including ABB, and Tesla. Based on their feedback, the smaller sites could be outfitted with battery backup at little to no design challenges. For the larger well fields, there is a greater challenge given the need for barge battery installation to provide adequate backup to their large energy loads. Additionally providing solar and or batteries at the larger well fields may be prohibited due to MassDEP requirements for drinking water wells.

Back-up power was targeted at a 3 day supply which is the average time of an extended outage in the area. The back-up power time cold be extended by providing solar PV. After many outages caused by storms or outside factors such as vehicle accidents the sun will come out within a couple days providing enough solar to re-charge the batteries there by extending the back-up time.

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Chapin Water Tank	**Solar PV & Batteries**	**$92,880**
Jefferson Tank	**Solar PV & Batteries**	**$92,880**
Portable 100kW Generator	**Portable Generator**	**$86,031**

There are ample opportunities to improve the reliability of the water distribution system and make it resilient to power outages. In addition, there are opportunities to make the town of Holden more sustainable by providing renewable power generation at many of this locations – an even make several of these stations net-zero. Based on the information provided in this report, the next steps are to work with the town and potential opportunities to determine what to pursue on each site. From there a more detailed solution will be developed for each site with layout, equipment selections, and estimated costs in order to proceed with the necessary construction work.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

5,257 kWh/Year*

System output may range from 5,032 to 5,445 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	3.27	332	43
February	4.17	373	49
March	5.07	499	65
April	5.63	508	66
May	5.83	537	70
June	5.99	521	68
July	6.52	565	74
August	6.00	526	69
September	5.37	470	61
October	3.88	367	48
November	3.15	300	39
December	2.55	259	34
Annual	**4.79**	**5,257**	**$ 686**

Location and Station Identification

Requested Location	190 Sycamore Drive, Holden, MA
Weather Data Source	Lat, Lon: 42.33, -71.86 0.4 mi
Latitude	42.33° N
Longitude	71.86° W

PV System Specifications *(Residential)*

DC System Size	4 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.130 $/kWh

Performance Metrics

Capacity Factor	15.0%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

5,232 kWh/Year*

System output may range from 5,008 to 5,420 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	3.32	339	42
February	4.15	372	46
March	5.06	498	62
April	5.49	495	62
May	5.82	536	67
June	5.95	518	65
July	6.39	561	70
August	6.00	526	66
September	5.39	468	58
October	3.87	366	46
November	3.10	296	37
December	2.54	259	32
Annual	**4.76**	**5,234**	**$ 653**

Location and Station Identification

Requested Location	235 Muschopauge Road, Holden, MA
Weather Data Source	Lat, Lon: 42.37, -71.86 1.3 mi
Latitude	42.37° N
Longitude	71.86° W

PV System Specifications *(Commercial)*

DC System Size	4 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.125 $/kWh

Performance Metrics

Capacity Factor	14.9%

BUDGETARY OPINION OF COST		SHEET:	1 OF 1
PROJECT:	Holden Water "Green" Emergency Power	DATE PREPARED:	
LOCATION:	Brattle Street Interconnection	ESTIMATOR:	MTA
DESCRIPTION:		CHECKED BY:	KMS
		PROJECT NO.:	20170390.A12

FUSS & O'NEILL
Disciplines to Deliver

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Tesla Batteries (5)	LS		-	-	$35,000
Enclosure for Batteries	EA	1	$6,500.00	$1,000.00	$7,500
TOTAL CONSTRUCTION COST					$42,500
20% Contingency					$8,500
Sub-Total					$51,000
ENGINEERING/LEGAL/ADMINISTRATIVE (20%)					$10,200
SUBTOTAL					**$61,200**

Notes:

BUDGETARY OPINION OF COST

PROJECT: Holden Water "Green" Emergency Power

LOCATION: Salisbury Street Interconnection

DESCRIPTION:

FUSS & O'NEILL *Disciplines to Deliver*

SHEET: 1 OF 1

DATE PREPARED:

ESTIMATOR: MTA

CHECKED BY: KMS

PROJECT NO.: 20170390.A12

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Portable Generator	EA	1	$84,000.00	$5,000.00	$89,000
TOTAL CONSTRUCTION COST					$89,000
10% Contingency					$8,900
Sub-Total					$97,900
ENGINEERING/LEGAL/ADMINISTRATIVE (10%)					$9,790
SUBTOTAL					**$107,690**

Notes:

BUDGETARY OPINION OF COST	FUSS & O'NEILL *Disciplines to Deliver*	**SHEET:** **1 OF 1**
PROJECT: Holden Water "Green" Emergency Power		DATE PREPARED:
LOCATION: Salisbury Street Interconnection		ESTIMATOR: MTA
DESCRIPTION: **100kW Portable Generator for Mill St, Mason and Spring Street Well Fields**		CHECKED BY: KMS
		PROJECT NO.: 20170390.A12

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Portable Generator	EA	1	$66,100.00	$5,000.00	$71,100
TOTAL CONSTRUCTION COST					$71,100
10% Contingency					$7,110
Sub-Total					$78,210
ENGINEERING/LEGAL/ADMINISTRATIVE (10%)					$7,821
SUBTOTAL					**$86,031**

Notes:

BUDGETARY OPINION OF COST		**SHEET:**	**1 OF 1**
PROJECT: Holden Water "Green" Emergency Power	FUSS & O'NEILL *Disciplines to Deliver*	DATE PREPARED:	
LOCATION: Mill Street Well Field		ESTIMATOR:	MTA
DESCRIPTION: **Mill Street Well Field Electrical Distribution**		CHECKED BY:	KMS
		PROJECT NO.:	20170390.A12

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Electrical distribution upgrades for Generator	LS	1.00	$3,000.00	$3,000.00	$6,000
TOTAL CONSTRUCTION COST					$6,000
20% Contingency					$1,200
Sub-Total					$7,200
ENGINEERING/LEGAL/ADMINISTRATIVE (20%)					$1,440
SUBTOTAL					**$8,640**

Notes:

BUDGETARY OPINION OF COST

PROJECT:	Holden Water "Green" Emergency Power	SHEET:	1 OF 1
LOCATION:	Mason Road Well Field	DATE PREPARED:	
DESCRIPTION:	**Mason Road Well Field Electrical Distribution**	ESTIMATOR:	MTA
		CHECKED BY:	KMS
		PROJECT NO.:	20170390.A12

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ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Electrical distribution upgrades for Generator	LS	1.00	$6,000.00	$5,000.00	$11,000
TOTAL CONSTRUCTION COST					$11,000
20% Contingency					$2,200
Sub-Total					$13,200
ENGINEERING/LEGAL/ADMINISTRATIVE (20%)					$2,640
SUBTOTAL					**$15,840**

Notes:

BUDGETARY OPINION OF COST		**SHEET:**	**1 OF 1**
PROJECT:	Holden Water "Green" Emergency Power	DATE PREPARED:	
LOCATION:	Spring Street Well Field	ESTIMATOR:	MTA
DESCRIPTION:	**Spring Street Well Field Electrical Distribution**	CHECKED BY:	KMS
		PROJECT NO.:	20170390.A12

FUSS & O'NEILL
Disciplines to Deliver

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ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Electrical distribution upgrades for Generator	LS	1.00	$6,000.00	$5,000.00	$11,000
TOTAL CONSTRUCTION COST					$11,000
20% Contingency					$2,200
Sub-Total					$13,200
ENGINEERING/LEGAL/ADMINISTRATIVE (20%)					$2,640
SUBTOTAL					**$15,840**

Notes:

BUDGETARY OPINION OF COST		FUSS & O'NEILL Disciplines to Deliver	SHEET:	1 OF 1
PROJECT:	Holden Water "Green" Emergency Power		DATE PREPARED:	
LOCATION:	Chapin Tank		ESTIMATOR:	MTA
DESCRIPTION:			CHECKED BY:	KMS
			PROJECT NO.:	20170390.A12

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Tesla Batteries (5)	LS		-	-	$35,000
Enclosure for Batteries	EA	1	$6,500.00	$1,000.00	$7,500
Solar up to 5kW	Watt	4,000	$2.50	$3.00	$22,000
TOTAL CONSTRUCTION COST					$64,500
20% Contingency					$12,900
Sub-Total					$77,400
ENGINEERING/LEGAL/ADMINISTRATIVE (20%)					$15,480
SUBTOTAL					**$92,880**

Notes:

BUDGETARY OPINION OF COST		FUSS & O'NEILL *Disciplines to Deliver*	SHEET:	1 OF 1
PROJECT:	Holden Water "Green" Emergency Power		DATE PREPARED:	
LOCATION:	Jefferson Tank		ESTIMATOR:	MTA
DESCRIPTION:			CHECKED BY:	KMS
			PROJECT NO.:	20170390.A12

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Tesla Batteries (5)	LS		-	-	$35,000
Enclosure for Batteries	EA	1	$6,500.00	$1,000.00	$7,500
Solar up to 5kW	Watt	4,000	$2.50	$3.00	$22,000
TOTAL CONSTRUCTION COST					$64,500
20% Contingency					$12,900
Sub-Total					$77,400
ENGINEERING/LEGAL/ADMINISTRATIVE (20%)					$15,480
SUBTOTAL					**$92,880**

Notes:

Model: 120REOZT4

KOHLER. Power Systems

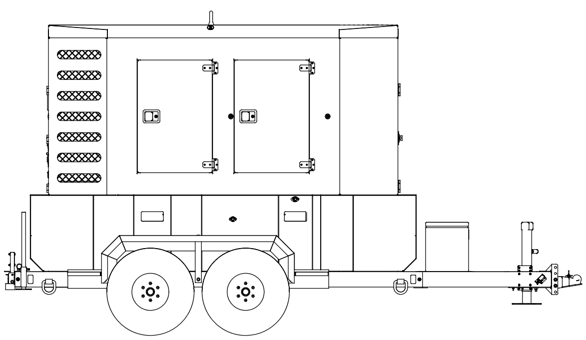
208–600 V **Diesel**

ISO 9001 KOHLER POWER SYSTEMS NATIONALLY REGISTERED

Tier 4 Final EPA-Certified for Nonroad Applications

Ratings Range

		60 Hz
Standby:	**kW**	95–105
	kVA	95–131
Prime:	**kW**	90–96
	kVA	90–120
Continuous:	**kW**	79–89
	kVA	79–111



Standard Skid Model with Available Options

- Convenience Package option (see page 4 for all available options):
  - Battery chargers
  - Camlock style load connectors, color coded
  - Cold weather package (includes block heater and battery heater pad and wrap)
  - Duplex receptacles, two 120 V, 15 amp
  - Twistlock receptacles, three 240 V, 50 amp
  - Two-way fuel valve (for connection of a user-supplied external fuel tank)
  - Voltage selector switch, 3-position lockable

Mobile Generator Set

- Kohler Co. provides one-source responsibility for the generating system and accessories.
- The generator set and its components are prototype-tested, factory-built, and production-tested.
- A three-year, 3000-hour limited warranty covers all generator set systems and components. The trailer has a one-year limited warranty.
- Generator set features:
  - Unit-mounted radiator with 45°C (113°F) ambient air capability at the prime rating.
  - The unique Fast-Response™ X excitation system delivers excellent voltage response and short-circuit capability using a rare-earth, permanent magnet (PM)-excited alternator.
  - The brushless, rotating-field alternator has broadrange reconnectability when ordered without a selector switch.
- Engine features:
  - Heavy-duty air cleaner with air restrictor indicator.
  - The generator set engine is certified by the Environmental Protection Agency (EPA) to conform to Tier 4 Final nonroad emissions regulations.
  - Lockable battery disconnect switch.
- Enclosure/tank features:
  - Durable steel, sound-attenuating housing with quiet operation of 71 dB(A) log average @ 7 m (23 ft.) with full load at the prime rating.
  - Stainless steel hinges and lockable latches on doors.
  - 125% environmental containment basin for oil and coolant.
  - 110% secondary containment tank for fuel.
  - Single-point lifting eye and four-point tie down system.
  - Subbase fuel tank for 24-hour run time with full load at prime rating (minimum).
  - Fuel fill and Diesel Exhaust Fluid (DEF) fill with lockable caps.
- Customer connection panel features:
  - Decision-Maker® 3500 controller with potted circuitry for protection from vibration and debris.
  - Externally mounted, recessed emergency stop switch.
  - Adjustable trip main line circuit breaker.
  - Remote start/stop capabilities.
  - Load lug connections (see page 3 for details).
  - Shore power connection points to front of junction box for block heater, battery chargers, and battery heater.

Generator Set Ratings

				150°C Rise Standby Rating		125°C Rise Prime Rating		125°C Rise Continuous Rating		
Alternator	**Voltage**	**Ph**	**Hz**	**kW/kVA**	**Amps**	**kW/kVA**	**Amps**	**kW/kVA**	**Amps**	**Ordering Options***
	120/208	3	60	105/131	364	96/120	333	89/111	308	A
	120/240	3	60	100/125	300	93/116	279	84/105	252	B
4R12X	120/240	1	60	95/95	395	90/90	375	79/79	329	A
	277/480	3	60	105/131	157	96/120	144	89/111	133	A
	347/600	3	60	105/131	126	96/120	115	89/111	107	C

* Ordering Options: A–Reconnectable or selector switch, B–Reconnectable, C–Stand alone

RATINGS: All three-phase units are rated at 0.8 power factor. All single-phase units are rated at 1.0 power factor. *Standby Ratings:* The standby rating is applicable to varying loads for the duration of a power outage. There is no overload capability for this rating. *Prime Power Ratings:* At varying load, the number of generator set operating hours is unlimited. A 10% overload capacity is available for one hour in twelve. *Continuous Ratings:* At constant or nonvarying load, the number of generator set operating hours is unlimited. There is no overload capability for this rating. Ratings are in accordance with ISO-8528-1 and ISO-3046-1. For limited running time ratings, consult the factory. Obtain technical information bulletin (TIB-101) for ratings guidelines, complete ratings definitions, and site condition derates. The generator set manufacturer reserves the right to change the design or specifications without notice and without any obligation or liability whatsoever.

Alternator Specifications

Specifications	Alternator
Manufacturer	Kohler
Type	4-Pole, Rotating-Field
Exciter type	Brushless, Rare-Earth Permanent Magnet
Leads: quantity, type	12, Reconnectable 6, 600 Volt
Voltage regulator	Solid State, Volts/Hz
Insulation:	NEMA MG1
Material	Class H
Temperature rise	150°C, Standby
Bearing: quantity, type	1, Sealed
Coupling	Flexible Disc
Amortisseur windings	Full
Voltage regulation, no-load to full-load	±0.5%
One-step load acceptance	100% of Rating
Unbalanced load capability	100% of Rated Standby Current
Peak motor starting kVA @ 0.3 PF:	(35% dip for voltages below)
480 V 4R12X (12 lead)	448

- NEMA MG1, IEEE, and ANSI standards compliance for temperature rise and motor starting.
- Sustained short-circuit current of up to 300% of the rated current for up to 10 seconds.
- Sustained short-circuit current enabling downstream circuit breakers to trip without collapsing the alternator field.
- Self-ventilated and dripproof construction.
- Windings are vacuum-impregnated with epoxy varnish for dependability and long life.
- Superior voltage waveform from a two-thirds pitch stator and skewed rotor.
- The unique Fast-Response® X excitation system delivers excellent voltage response and short-circuit capability using a rare-earth, permanent magnet (PM)-excited alternator.

Application Data

Engine

Engine Specifications	
Manufacturer	John Deere
Engine: model, type	4045HFG09 4-Cycle Turbocharged, Charge Air-Cooled
Cylinder arrangement	4 Inline
Displacement, L (cu. in.)	4.5 (275)
Bore and stroke, mm (in.)	106 x 127 (4.2 x 5.0)
Compression ratio	17.2:1
Piston speed, m/min. (ft./min.)	457.2 (1500)
Rated rpm	1800
Max. power at rated rpm, kW (HP)	124 (166)
Valve (exhaust) material	Silicon-Chrome stem with Inconel head (NiCr)
Valve (intake) material	CrMo Alloy
Governor type	Electronic
Frequency regulation, no-load to full-load	Isochronous
Frequency regulation, steady state	±0.5%
Air cleaner type, all models	Dry

Exhaust

Exhaust System	
Exhaust manifold type	Dry
Exhaust flow at rated kW, m^3/min. (cfm)	17.0 (600)
Exhaust temperature at rated kW, dry exhaust, °C (°F)	496 (925)
Maximum allowable back pressure, kPa (in. Hg)	22.7 (6.7)

Engine Electrical

Engine Electrical System	
Battery charging alternator:	
Ground (negative/positive)	Negative
Volts (DC)	14
Ampere rating	90
Starter motor rated voltage (DC)	12
Battery, recommended cold cranking amps (CCA):	
Qty., rating for 0°C (32°F)	One, 450
Battery voltage (DC)	12

Fuel

Fuel System	
Fuel supply line, min. ID, mm (in.)	8 (0.31)
Fuel return line, min. ID, mm (in.)	5 (0.19)
Max. lift, fuel pump: type, m (ft.)	Electronic, 3.5 (11.5)
Max. fuel flow, Lph (gph)	58.3 (15.4)
Max. return line restriction, kPa (in. Hg)	20 (5.9)
Fuel prime pump	Automatic
Fuel filter	
Primary	2 Microns
Recommended fuel	ASTM D975 or EN 590 Ultra Low Sulfur Diesel (ULSD) with sulfur content <15 mg/kg (15 ppm)

Lubrication

Lubricating System	
Type	Full Pressure
Oil pan capacity, L (qt.)	20.5 (21.7)
Oil pan capacity with filter, L (qt.)	21.0 (22.2)
Oil filter: quantity, type	One, Cartridge
Oil type	API CJ-4 or ACEA E6–E9

Cooling

Radiator System	
Radiator system capacity, including engine, L (gal.)	26.1 (6.9)

Operation Requirements

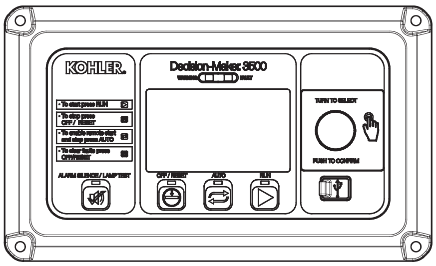
Air Requirements	
Radiator-cooled cooling air, m^3/min. (scfm) †	283 (10000)
Combustion air, m^3/min. (cfm)	7.6 (268)
Heat rejected to ambient air:	
Engine, kW (Btu/min.)	14.5 (825)
Alternator, kW (Btu/min.)	11.6 (660)

† Air density = 1.20 kg/m^3 (0.075 lbm/ft^3)

Fuel Consumption		
Diesel, Lph (gph) at % load	Standby Ratings	Prime Ratings
100%	30.8 (8.1)	28.0 (7.4)
75%	22.9 (6.0)	21.2 (5.6)
50%	16.3 (4.3)	15.4 (4.1)
25%	10.4 (2.7)	9.8 (2.6)
0%	3.2 (0.8)	3.2 (0.8)

Note: For continuous rating fuel consumption, use the prime ratings data.

Controller



Decision-Maker[®] 3500 Paralleling Controller

Provides advanced control, system monitoring, and system diagnostics for optimum performance and compatibility.

- Paralleling capability with bus sensing, first-on logic, synchronizer, and (isochronous, droop, and external controlled) load sharing
- Digital display with adjustable contrast and menu control provide easy local data access
- Measurements are selectable in metric or English units
- Remote communication thru a PC via network or serial configuration
- Controller supports Modbus® protocol
- Integrated hybrid voltage regulator with ±0.5% regulation
- Potted circuitry for protection from vibration and debris
- Built-in alternator thermal overload protection
- NFPA 110 Level 1 capability

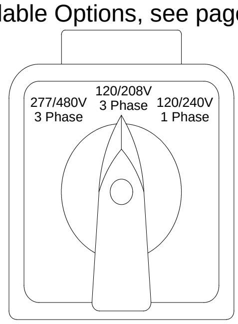
Fuel and DEF Tanks

- Subbase fuel tank for 24-hour run time with full load at prime rating (minimum).
- Fuel tank includes the fuel level gauge, fuel fill with lockable cap, and an atmospheric vent.
- The secondary containment tank's construction protects against fuel leaks or ruptures. The inner (primary) tank is sealed inside the outer (secondary) tank. The outer tank contains the fuel if the inner tank leaks or ruptures.

Tank Specifications	
Diesel tank capacity	727 L (192 gal.)
DEF tank capacity	21.7 L (5.7 gal.)
Recommended DEF	AUS 32 according to ISO 22241-1

Available Voltage Selector Switch

(Available Options, see page 4)

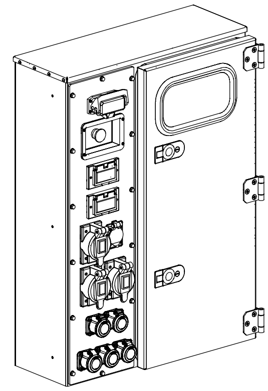


3-Position

- Voltage selector switch, 3-position lockable, wired for:
  - 120/240 volt, 1 phase
  - 120/208 volt, 3 phase
  - 277/480 volt, 3 phase

Modbus® is a registered trademark of Schneider Electric.

Customer Connection Panel



- Viewable generator set controller with security cover
- Emergency stop switch
- Shore power connector, 120 V, 15 amp (for battery charger(s) and battery heater)
- Shore power connector, 120 V, 15 amp (for block heater)
- Remote start connection
- Mobile paralleling box connection
- Main line circuit breaker
  - Reconnectable and selector switch models: Rating 400 amps, field adjustable based on voltage selected
  - 600 volt models: Rating 150 amps, field adjustable
- Available Options, see page 4
  - Two 15-amp 120 V, 1 phase, GFCI duplex receptacles (includes circuit breakers)
  - Three 50-amp 240 V twistlock receptacles (includes circuit breakers)
  - Color-coded camlock connectors

Load Lug Connections, Qty., Min./Max., Rating
1 load lug per phase #6–350MCM, 400 amp

Available Trailer

(Available Options, see page 4)

- Dual-axle trailer with electric brake system on both axles with battery back-up breakaway system.
- DOT and TC (Transport Canada) compliant per current specifications published by both agencies, at the time of trailer manufacture.
- 2 5/16 in. ball hitch coupler with adaptability for an optional Lunette eye.
- Lockable utility tool box with bottle jack, lug wrench, and fire extinguisher. Common key to enclosure.
- Running lights with 7-wire harness and connector.
- Front tongue jack.
- Rear stabilizer trailer jacks.
- Weight bearing fenders up to 227 kg (500 lbs.)

Trailer Specifications	
Axle Rating	Dual, 2268 kg (5000 lb.) per axle
Tires	ST225/75R15 LRD with 1152 kg (2540 lb.) load rating
Wheels	Steel, 15 x 6, 6-bolt

Available Field Draggable Skid

(Available Options, see page 4)

- Heavy gauge steel skid with integrated drains and pull bars.

KOHLER CO., Kohler, Wisconsin 53044 USA
Phone 920-457-4441, Fax 920-459-1646
For the nearest sales and service outlet in the
US and Canada, phone 1-800-544-2444
KOHLERPower.com

Kohler Power Systems
Asia Pacific Headquarters
7 Jurong Pier Road
Singapore 619159
Phone (65) 6264-6422, Fax (65) 6264-6455

Standard Features

- Alternator Protection
- Battery, Battery Rack, and Battery Cables
- Engine Oil and Coolant Added
- Integral Vibration Isolation
- Local Emergency Stop Switch
- Oil and Coolant Drain Extension
- Operation Literature

Tier 4 Final Technologies Applied

- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- High Pressure Common Rail (HPCR)
- Selective Catalytic Reduction (SCR)

Available Options

Approvals and Listings

❑ CSA Certified

Controller

❑ 15-Relay Dry Contact

Customer Connection Panel

❑ Camlock Style Load Connectors, Color Coded
❑ Convenience Receptacles (3-240 volt, 2-120 volt) (includes individual circuit breakers)

Electrical System

❑ Battery Charger, Equalize/Float Type
❑ Cold Weather Package (includes block heater and battery heater pad and wrap)
❑ Convenience Package (see page 1 for details)
❑ Voltage Selector Switch, Lockable

Fuel System

❑ Two-Way Fuel Valve (for connection of a user-supplied external fuel tank)

Paralleling System

❑ Mobile Paralleling Box

Skid

❑ Field Draggable Skid

Trailer and Options

❑ Trailer
❑ Lunette Eye (for pintle hitch tow vehicles)
❑ Spare Tire
❑ Wheel Chock Blocks

Literature

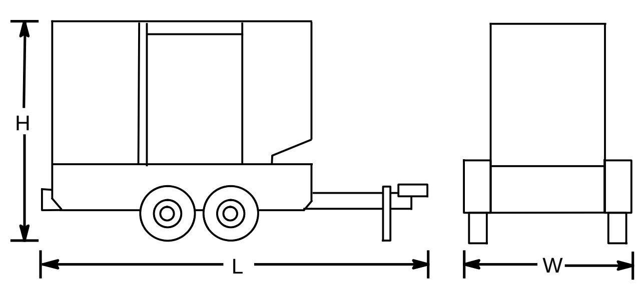
❑ General Maintenance
❑ NFPA 110
❑ Overhaul
❑ Production

Other Options

❑ ____________________
❑ ____________________
❑ ____________________
❑ ____________________
❑ ____________________
❑ ____________________
❑ ____________________
❑ ____________________

Dimensions and Weights

Overall Size, L x W x H, mm (in.): Standard Skid	4772 x 2018 x 2682 (187.9 x 79.4 x 105.6)
Weight with engine fluids and no fuel in tank kg (lb.):	3241 (7145)
Overall Size, L x W x H, mm (in.): Field Draggable Skid	4772 x 2018 x 2682 (187.9 x 79.4 x 105.6)
Weight with engine fluids and no fuel in tank kg (lb.):	3320 (7320)



Note: This drawing is provided for reference only and should not be used for planning. Contact your local distributor for more detailed information.

DISTRIBUTED BY:

BUDGETARY OPINION OF COST		**SHEET:**	**1 OF 1**
PROJECT:	Holden Water "Green" Emergency Power	DATE PREPARED:	
LOCATION:	Well Fields	ESTIMATOR:	MTA
DESCRIPTION:		CHECKED BY:	KMS
		PROJECT NO.:	20170390.A12

FUSS & O'NEILL
Disciplines to Deliver

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM DESCRIPTION	UNITS	NO. UNITS	COST PER UNIT		TOTAL COST
			MATERIAL	LABOR	
Solar up to 100kW	Watt	100,000	$2.00	$2.50	$450,000
Batteries for Larger Solar	Watt	100,000	$2.00	$1.00	$300,000
TOTAL CONSTRUCTION COST					$750,000
20% Contingency					$150,000
Sub-Total					$900,000
ENGINEERING/LEGAL/ADMINISTRATIVE (20%)					$180,000
SUBTOTAL					**$1,080,000**

Notes: