# FINAL

## PRELIMINARY SOLAR FEASIBILITY STUDY

Providence Water Supply Board

June 2016

CDM Smith

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# Executive Summary

## 1.1 Purpose and Scope

Providence Water Supply Board (Providence Water) retained the services of CDM Smith to prepare a study that assesses the feasibility of solar photovoltaic (PV) installations at various locations under their jurisdiction. This study will provide Providence Water with a basis to determine the economic viability for solar installation at each site.

It should be noted that the magnitude of energy production is not only dependent on the type of equipment used, but also on the weather. Due to the rising cost of power and the desire to minimize dependence on foreign oil supplies, alternative energy production is taking a higher priority across the nation. Feasible alternatives for energy production are site specific and must be evaluated on a case-by-case basis; since not every site is the same, all variables must be identified and assessed in the study.

There is potential for further energy cost savings through energy efficiency measures that can be developed and identified through energy audits. This approach, in conjunction with to renewable energy, can potentially help lower operations and maintenance costs for Providence Water.

## 1.2 System Overview

CDM Smith completed a high-level solar feasibility study for five locations within and outside of Providence, Rhode Island. The study analyzed each site for different sized systems—maximum solar installation and a reduced solar installation—as detailed in Section 3 of this study. The locations analyzed are below:

- 61 North Road, Scituate
- 125 Dupont Road, Providence
- 430 Scituate Avenue, Cranston
- 730 Plainfield Pike, Smithfield
- Joslin Farm, Scituate

These sites are currently under the jurisdiction of Providence Water. An economic analysis was performed for each proposed solar system. These economic analyses allowed for the comparison of two scenarios: a system owned by Providence Water, and a third party owned and operated system through a Power Purchase Agreement (PPA).

## 1.3 Historical Energy Usage

Providence Water provided historical energy usage in the form of utility bills from February 2014 to January 2016 for 61 North Road, 430 Scituate Avenue, and the Aqueduct Pump Station (at 430 Scituate Avenue). The data is representative of demand (kW), energy consumption (kWh), utility monthly charges ($, supply and delivery) for the baseline and future conditions of each site. A blended rate is used to estimate energy savings and potential energy production income. The blended rate is calculated by taking the total monthly charge (supply and delivery) divided by the energy consumption for that month. An average is taken for a time frame of no less than one year. The calculated blended rate used for this study is $0.13/kWh. Appendix A provides the utility usage data and blended rate calculations.

## 1.4 Recommendations

If the solar installations were owned and operated by Providence Water, the simple payback time for the installations would be between 9.47 and 10.72 years with total cost varying between $2.1m and $8.8m depending on the site and option.

If the solar installations were installed as part of a Power Purchase Agreement (PPA) there would be no upfront cost. Providence Water would not initially own the system, and would pay an electric rate to the developer as agreed upon through the PPA.

**Table 1-1 Summary of Providence Water Owned Proposed Solar Systems**

| Rank | Site Location | | Array Size (kW) | Construction Cost ($) | Initial Annual Energy Production (kWhr) | Initial Annual Electric Savings[1] ($/Yr) | Simple Payback (Yr) |
|---|---|---|---|---|---|---|---|
| 1 | 125 Dupont Drive | Option C | 696 | $ 2,039,678 | 923,137 | $ 120,007.81 | 9.47 |
| 2 | 125 Dupont Drive | Option B | 996 | $ 2,919,288 | 1,322,941 | $ 171,982.33 | 9.97 |
| 3 | 125 Dupont Drive | Option A | 1,144 | $ 3,352,720 | 1,520,852 | $ 197,710.76 | 10.11 |
| 4 | 430 Scituate Ave | Option B | 1,327 | $ 3,888,135 | 1,774,063 | $ 230,628.19 | 10.24 |
| 5 | 61 North Road | Option B | 1,492 | $ 4,372,559 | 1,994,651 | $ 259,304.63 | 10.33 |
| 6 | 730 Plainfield Pike | Option B | 1,496 | $ 4,385,307 | 1,999,999 | $ 259,999.87 | 10.34 |
| 7 | Joslin Farms | Option B | 1,496 | $ 4,385,307 | 1,999,999 | $ 259,999.87 | 10.34 |
| 8 | 430 Scituate Ave | Option A | 2,588 | $ 7,585,051 | 3,459,891 | $ 449,785.83 | 10.66 |
| 9 | 730 Plainfield Pike | Option A | 2,701 | $ 7,916,498 | 3,610,960 | $ 469,424.80 | 10.68 |
| 10 | 61 North Road | Option A | 2,997 | $ 8,783,361 | 4,006,682 | $ 520,868.66 | 10.72 |
| 11 | Joslin Farms | Option A | 2,997 | $ 8,783,361 | 4,006,682 | $ 520,868.66 | 10.72 |

**Table 1-2 Bay State Solar Owned and Operated Installations (PPA)**

| Location | PPA Energy Rate[2] ($/kWhr) | Array Size (kW) | Initial Energy Production (kWhr) | Contract Duration until System is Handed over to PW | Buyout Price after 10 yrs[1] ($) | Electrical Savings per year |
|---|---|---|---|---|---|---|
| Dupont Drive | 0.12 | 1,000 | 1,100,000 | 20 | - | $11,000.00 |
| Scituate Ave | 0.12 | 2,500 | 2,750,000 | 20 | - | $27,500.00 |
| North Rd3 | 0.12 | 3,000 | 3,300,000 | 20 | - | $33,000.00 |
| Plainfield Pike3 | 0.12 | 2,700 | 2,970,000 | 20 | - | $29,700.00 |
| Joslin Farms3 | 0.12 | 3,000 | 3,300,000 | 20 | - | $33,000.00 |

1. Estimate does not show a buyout price, but discussions with developer point to fair market value
2. Discussions with developer states actual estimates can be lower once a detailed evaluation of the sites is performed
3. No data provided by BSS, but we estimate their rate will be within 10% of shown values

**Table 1-3 Financial Analysis under C-PACE Program**

| Location | New Energy Rate[1] ($/kWhr) | Array Size (kW) | Initial Energy Production (kWhr) | Base Cost ($) | Incentives[2] ($) | Total Cost ($) | Electrical Savings per year |
|---|---|---|---|---|---|---|---|
| Dupont Drive | 0.08 | 1,000 | 1,100,000 | $1,940,000 | $919,200 | $1,020,800 | $55,000 |
| Scituate Ave | 0.0832 | 2,500 | 2,750,000 | $4,700,000 | $1,796,000 | $2,904,000 | $128,700 |

1. New Rate of electricity on the C-Pace Program
2. Includes ITC tax credit (purchased by a third party entity), REC payments (5 years only) and RI Renewable Growth Fund

**Table 1-4 Financial Analysis Under Renewable Energy Growth Program**

| Location | Base Cost ($) | Incentives[1] ($) | Total Cost ($) | O&M Cost ($) | Annual Production (kWh) | National Grid Offset[2] ($) | Simple Payback[3] (years) | AROI (%) | IRR (%) | NPV (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Dupont - B | $2,919,289 | $- | $2,919,289 | $19,923.00 | 1,322,941 | $105,173.81 | 10.40 | 3.81 | 7.9 | $1,598,040 |
| Dupont - C | $2,039,677 | $- | $2,039,677 | $10,779.30 | 923,137 | $73,389.39 | 10.24 | 3.95 | 8.12 | $1,173,114 |

1. Only Incentive allowed under REG program is ITC (Corporate Tax Credit)
2. Under the REG Program, all RECs and environmental benefits are surrendered to National Grid.
3. Under the REG Program, PW would be locked in to a fixed tariff for 20 years.

# Section 2
# Introduction

This section describes the design process and assumptions utilized, as well as limitations for the solar installations.

## 2.1 General

Photovoltaic (PV) cells convert energy from sunlight directly into electrical energy through the use of silicon semiconductors, diodes and collection grids. Several PV cells are then linked together in a single frame or module to become a solar panel. PV cells are able to convert the energy from the sun into electricity. The angle of inclination of the PV panel, the amount of sunlight available, the orientation of the panels, the amount of physical space available, and the efficiency of the individual panels are all factors that affect the amount of electricity that is generated.

Solar panels generate DC power. PV modules are connected together either in series or parallel (called strings) to achieve a higher voltage and current, respectively. These strings of PV modules are then combined through a combiner box and a single feeder is fed to the inverter. The inverter converts the DC electricity into alternating current (AC) electricity.

Once the electricity is converted into AC, the energy is ready to be introduced into the utility grid. Depending on the size of the solar system and the demand of the facility, the AC energy from the solar system can be connected directly to the facility's utility feed.

## 2.2 Design Criteria Used

The proposed PV power systems are comprised of the PV arrays, inverter(s), combiner boxes, disconnect switches, and all of the necessary wiring and interconnection equipment. One system will be mounted on the roof, while the other systems will be ground mounted. Roof mounted systems are typically installed with self-ballasting racking systems to avoid roof penetrations. Ground mounted systems are either pole driven or ballast mounted.

For systems being installed on flat surfaces, in which the ground is relatively parallel to the horizon, the PV system sizing and kWh production is calculated assuming the installation of a crystalline module facing south and tilted approximately 20 degrees to maximize the energy harvesting at this given location, and at this tilt, there will be better rain water shedding and snow melting. To maximize the solar harvesting, the panels should be installed such that the face of the panel is normal to the angle of the incoming sun ray. The angle of the sun, with respect to the ground, will be different on other locations that are on different latitude coordinates on the earth. Note that kWh production as well as system size may differ based on the final panel tilt selected during the RFP or design phase.

Blended electric rates were used based on utility data provided by Providence Water and were applied for the systems' performance financials.

### 2.2.1 Solar Panels

Solar panels are typically compared by calculating their power density. The power density of a solar panel is the power produced over the area of the panel at standard testing conditions (STC). Standard testing conditions are 1,000W/m2 of incident solar radiation at 25 degrees Celsius.

The study evaluated the leading solar PV panels from six reputable manufacturers most commonly used in the industry - Suniva, Yingli, Sunpower, Suntech, First Solar and Solar World. All the panels chosen for evaluation were UL listed at 1000VDC and commercial grade. Appendix H details the comparisons.

The solar panel chosen as the representative standard for this feasibility study was the Sunpower 435W panel. A cut sheet is provided in Appendix F.

### 2.2.2 Inverters

Inverters are a critical portion of the system; this equipment governs the output capacity in its most "useful form". The electric utility is interested in this output capacity and how it may affect their distribution system. There are three types of inverters: string type, centralized, and utility-scale inverters.

- String types inverters are small scale and typically able to convert power under 50KWDC. Multiple string inverters can be tied together and be fed back to the grid.
- Centralized inverters, are typically used for medium scale systems (50KWDC to 500KWDC).
- Utility Scale inverters are typically used for large scale systems (500KWDC to around 2MWDC). These inverters are more complex and come with prepackaged features to minimize the impact on the grid.

Datasheets of the inverters typically used for system sizes discussed within this report are included in Appendix D and E.

### 2.2.3 Climate

Per Article 690.7(A) of the National Electrical Code (NEC), solar system arrays must be designed around the average low temperature of the installation site. According to the Solar America Board for Codes and Standards website (http://www.solarabcs.org/about/publications/reports/expedited-permit/map/), the average low for Providence is -17 degrees Celsius.

## 2.3 Assumptions and Limitations

### 2.3.1 Interconnection Limitations

As part of this effort, CDM Smith submitted Pre-Application forms to National Grid for all five locations to determine their viability. See Appendix M for National Grid responses to the submitted Pre-Application Forms. National Grid will consider a maximum capacity of 3MW of distributed generation per feeder without modifications to the substation or feeder; any required modifications would be at the expense of Providence Water.

The added costs could approach or exceed $500,000/mile for line extensions, resizing of feeders, or impact studies required by National Grid to determine interconnection feasibility.

After reviewing the Pre-Application Report for all the sites, it has been determined that any system size installed at the Plainfield Pike site would not be feasible due to the likely extra costs to upgrade National Grid's infrastructure. There is currently over 5MW pending to be installed at the substation closest to Plainfield Pike.

As a result of the limitations discovered during the pre-application process, this preliminary study focused on a PV system size of 3MW or less. The system shown on Plainfield Pike is included for reference and possible future consideration if National Grid increases the scale of their infrastructure for that substation.

### 2.3.2 Assumptions

CDM Smith has assumed that one third of the total roof area is suitable for solar equipment installation. This assumption is a conservative approach to account for access to panels, and to provide sufficient clearance for existing roof equipment and access. According to an engineering report conducted by another firm, it was determined that some structural improvements are required for the roofs of all buildings at the Dupont Drive location to withstand the extra load from a PV system installation. This solar feasibility assessment does not include any extra cost required for these structural improvements and assumes all structural enhancements will be completed prior to the solar installation.

The remaining four sites have been assumed to be "greenfield sites" that require minimal ground clearing and/or grading. These locations were deemed suitable for ground penetrating mounting racks.

# Section 3
# Facility Descriptions

Five locations were evaluated for feasibility of solar installation. These locations are 125 Dupont Drive (Providence), 61 North Road (Scituate), 430 Scituate Ave (Cranston), 730 Plainfield Pike (Smithfield) and Joslin Farms (Scituate). The location at 125 Dupont Drive will require a rooftop mounted system. The remaining four sites will be ground mounted systems. Table 3-1 shows a summary of the proposed solar installations. Option A is a system with the largest power density of solar installed on the given site. Option B (for ground mounted systems) is half of the capacity of Option A. Option B (for roof mounted systems at Dupont Drive) is part of the 875 kW system requested by Providence Water. Option C (for roof mounted systems at Dupont Drive) is half of the capacity of Option A.

**Table 3.1 Summary of Proposed Solar Systems for Providence Water**

| Description | | Area Size (sq ft) | System Size ($kW_{DC}$) | Panel Count | Solar Area Size (sq ft) | Annual Energy Produced (kWh) | Estimated Install Cost ($) |
|---|---|---|---|---|---|---|---|
| 125 Dupont Drive Roof System 1 | Option A | 20,853 | 144 | 330 | 7,686 | 191,269 | $420,683 |
| | Option B | | 122 | 280 | 6,521 | 162,047 | $356,944 |
| | Option C | | - | - | - | - | N/A |
| 125 Dupont Drive Roof System 2 | Option A | 42,969 | 370 | 850 | 19,797 | 491,454 | $1,083,579 |
| | Option B | | 322 | 740 | 17,235 | 427,698 | $943,351 |
| | Option C | | 278 | 640 | 14,906 | 369,255 | $815,871 |
| 125 Dupont Drive Roof System 3 | Option A | 50,434 | 405 | 930 | 21,660 | 537,943 | $1,185,563 |
| | Option B | | 339 | 780 | 18,166 | 450,278 | $994,343 |
| | Option C | | 252 | 580 | 13,508 | 334,720 | $739,383 |
| 125 Dupont Drive Roof System 4 | Option A | 25,915 | 226 | 520 | 12,111 | 300,186 | $662,895 |
| | Option B | | 213 | 490 | 11,412 | 282,918 | $624,651 |
| | Option C | | 165 | 380 | 8,850 | 219,162 | $484,423 |
| 125 Dupont Drive Full System | Option A | 140,171 | 1,145 | 2,630 | 61,253 | 1,520,852 | $3,352,720 |
| | Option B | | 996 | 2,290 | 53,334 | 1,322,941 | $2,919,289 |
| | Option C | | 695 | 1,600 | 37,264 | 923,137 | $2,039,677 |
| 61 North Road Ground System 1 | Option A | 340,916 | 2,997 | 6,890 | 160,468 | 4,006,682 | $8,783,361 |
| | Option B | | 1,492 | 3,430 | 79,885 | 1,994,651 | $4,372,559 |
| 430 Scituate Ave Ground System 1 | Option A | 216,230 | 2,588 | 5,950 | 138,576 | 3,459,891 | $7,585,051 |
| | Option B | | 1,327 | 3,050 | 71,035 | 1,774,063 | $3,888,135 |
| 730 Plainfield Pike Ground System 1 | Option A | 319,680 | 2,701 | 6,210 | 144,631 | 3,610,960 | $7,916,498 |
| | Option B | | 1,496 | 3,440 | 80,118 | 2,000,000 | $4,385,307 |
| Joslin Farms Ground System 1 | Option A | 375,413 | 2,997 | 6,890 | 160,468 | 4,006,682 | $8,783,361 |
| | Option B | | 1,496 | 3,440 | 80,118 | 2,000,000 | $4,385,307 |

# 3.1. 125 Dupont Drive

125 Dupont Drive will require a rooftop solar system.

The most common roof mounted system is a fixed-tilt system typically mounted to a metal rack that can be fixed at a specific angle. For a fixed-tilt system, the tilt is determined based on the following factors: geographical location, total targeted kWh production, seasonal electricity requirements and weather conditions such as wind. This assessment has assumed a 20-degree angle of installation.

The type of PV panels and equipment used to mount the system should be determined based on the wind conditions and structural integrity of the roof determined during the design phase of a possible project. In general, penetration/tie-down systems, non-penetrating ballasted type systems, or a combination of the two should be considered.

## 3.1.1 Option A

Option A is designed for maximum solar harvesting, via the maximum amount of solar that can fit in the given space. Based on the estimated available roof area, it was calculated that the installation of four systems would total 1,145 KWDC. Table 3.2 below summarizes the installation of each roof top system.

A preliminary site plan with roof conditions as shown on Google Earth is included in Appendix I.

**Figure 3.1 125 Dupont Drive Courtesy of Google Earth**

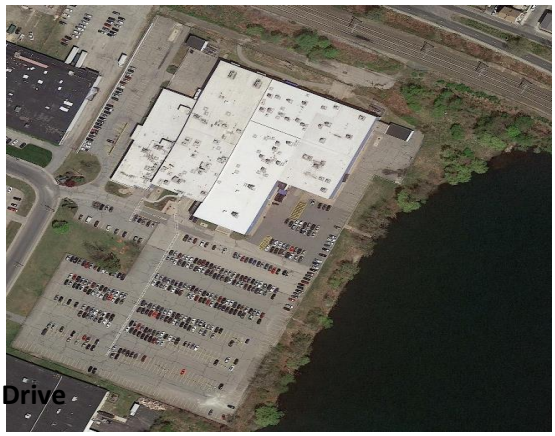

**Table 3.2 Proposed Solar Option A at 125 Dupont Drive**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Rooftop 1 | Flat | 144 | $420,683 | 330 |
| Rooftop 2 | Flat | 370 | $1,083,579 | 850 |
| Rooftop 3 | Flat | 405 | $1,185,563 | 930 |
| Rooftop 4 | Flat | 226 | $662,895 | 520 |
| **Totals** | Flat | 1,145 | $3,352,720 | 2,630 |

This plan reflects a capacity of 1,145 KWDC.

### 3.1.2 Option B

**Table 3.3 Proposed Solar Option B at 125 Dupont Drive**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Rooftop 1 | Flat | 122 | $356,944 | 280 |
| Rooftop 2 | Flat | 322 | $943,351 | 740 |
| Rooftop 3 | Flat | 339 | $994,343 | 780 |
| Rooftop 4 | Flat | 213 | $624,651 | 490 |
| **Totals** | Flat | 996 | $2,919,289 | 2,290 |

A preliminary site plan is included for this option in Appendix I, which includes roof conditions, and also shows the requested system size, as shown on Google Earth Figure 3-1.

### 3.1.3 Option C

A preliminary site plan is included for this option in Appendix I, which includes roof conditions, and also shows the requested system size, as shown on Google Earth Figure 3-1.

**Table 3.4 Proposed Solar Option C at 125 Dupont Drive**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Rooftop 1 | Flat | - | - | - |
| Rooftop 2 | Flat | 278 | $815,871 | 640 |
| Rooftop 3 | Flat | 252 | $739,383 | 580 |
| Rooftop 4 | Flat | 165 | $484,423 | 380 |
| **Totals** | Flat | 695 | $2,039,677 | 1,600 |

## 3.2. 61 North Road

61 North Road will be a ground mounted solar system across from the WTP.

**Figure 3.2 61 North Road-Courtesy of Google Earth**

### 3.2.1 Option A

Option A is designed for maximum solar harvesting, up to 3000KWDC. Based on the estimated total available ground area, calculations determined that the installation of four systems would total 3000 KWDC.

**Table 3.5 Proposed Solar Option A at 61 North Road**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 2,997 | $8,030,650 | 6,890 |

A preliminary site plan is included for this option in Appendix I, with site conditions as shown on Google Earth, and shows that maximizing the area with solar panels can yield a capacity of over 3,000 KWDC.

### 3.2.2 Option B

A preliminary site plan is included for this option in Appendix I, with site conditions as shown on Google Earth.

**Table 3.6 Proposed Solar Option B at 61 North Road**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 1,492 | 4,372,559 | 3,430 |

## 3.3. 430 Scituate Avenue

430 Scituate Avenue will be a ground mounted solar system. The current site conditions include a building and a parking lot. It is assumed that the building will be demolished and the site will become a greenfield. For that reason, no costs for clearing or grading were included in the cost analysis.

**Figure 3.3 430 Scituate Avenue Courtesy of Google Earth**

### 3.3.1 Option A

Option A is designed for maximum solar harvesting, up to 3,000 KWDC. Based on the estimated total available ground area, calculations determine that the installation of systems would total 2,600 KWDC.

**Table 3.7 Proposed Solar Option A at 430 Scituate Avenue**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 2,588 | $7,585,051 | 5,950 |

A preliminary site plan is included for this option in Appendix I, with site conditions as shown on Google Earth displaying that maximizing the area with solar panels can yield an approximate capacity of 2,600 KWDC.

### 3.3.2 Option B

**Table 3.8 Proposed Solar Option B at 430 Scituate Avenue**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 1,327 | $3,888,135 | 1,327 |

A preliminary site plan is included for this option in Appendix I, with the current site conditions as shown on Google Earth displaying the new proposed system.

## 3.4 730 Plainfield Pike

730 Plainfield Pike will be a ground mounted solar system. This site appears to be a relatively flat and clear greenfield and no cost for clearing or grading was included in the cost analysis. As noted in Section 2 there are electrical interconnection limitations in this area currently.

**Figure 3.4 730 Plainfield Pike Courtesy of Google Earth**

### 3.4.1 Option A

Option A is designed for maximum solar harvesting, up to 3000 KWDC. Based on the estimated total ground area available, calculations determine that the installation of a system with a total rating of approximately 2,700 KWDC.

A preliminary site plan is included for this option in Appendix I with current site conditions as shown on Google Earth displaying that maximizing the area with solar panels can yield an approximate capacity of 2,700 KWDC.

**Table 3-9 Proposed Solar Option A at 730 Plainfield Pike**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 2,700 | 7,916,498 | 6,210 |

### 3.4.2 Option B

Option B is a system scaled down to approximately 1,500 KWDC.

**Table 3.10 Proposed Solar Option B at 730 Plainfield Pike**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 1,500 | 4,385,307 | 3,440 |

A preliminary site plan is included for this option in Appendix I, with the current site conditions as shown on Google Earth displaying the new proposed system.

## 3.5. Joslin Farm

Joslin Farms will be a ground mounted solar system. This location has immense solar potential as a utility scale installation. A utility scale solar system can be installed in the middle of the land where the clearing requirements and site prepping will be minimized. This location is shown in Appendix I.

### 3.5.1 Option A

Option A is designed for maximum solar harvesting, up to 3MWDC, due to National Grid's interconnection cap.

A preliminary site plan is included for this option in Appendix I, with current site conditions as shown on Google Earth displaying that maximizing the area with solar panels can yield an approximate capacity of 3,000 KWDC.

**Figure 3.5 Joslin Farm Courtesy of Google Earth**

**Table 3.11 Proposed Solar Option A at Joslin Farm**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 2,997 | 8,783,361 | 6,890 |

### 3.5.2 Option B

Option B is a system scaled down to approximately 1,500 KWDC.

**Table 3.12 Proposed Solar Option B at Joslin Farm**

| Location | Area Type | Proposed PV Array Size (KWDC) | Estimated Cost of System ($) | Approximate Panel Count |
|---|---|---|---|---|
| Ground Mount | Flat | 1,500 | 4,385,307 | 3,440 |

A preliminary site plan is included for this option in Appendix I, with the current site conditions as shown on Google Earth displaying the new proposed system.

# Section 4
# Typical Power Purchase Agreements

CDM Smith has obtained a quote for a Power Purchase Agreement (PPA) based on the following terms:

- 10-year contract with the option to buy out the system at the end of the agreement. This PPA would include the $/kWh for the duration of the agreement and the buyout price of the system after the end of the agreement.
- Provide a contract duration ending when the value of the system becomes $0, at which the system will be handed to Providence Water at no cost. This PPA would include a $/kWh for the duration of the agreement and the length of the agreement.

Table 4-1 shows a typical PPA summary for all the sites under Providence Water's jurisdiction. Note that electrical savings are not realized since the current rate is equal to the proposed rate from Greenside.

**Table 4-1 Greenside Energy Owned and Operated Installations (PPA)**

| Location | PPA Energy Rate[4] ($/kWhr) | Array Size (kW) | Initial Energy Production (kWhr) | Contract Duration until System is Handed over to PW | Buyout Price after 10 yrs ($) | Electrical Savings per year |
|---|---|---|---|---|---|---|
| Dupont Drive[1] | 0.13 | 1,168 | 1,555,799 | 20 | $1,426,154 | $0 |
| Scituate Ave[2] | 0.13 | 1,137 | 1,514,108 | 20 | $1,387,820 | $0 |
| North Rd[3] | 0.13 | 1,671 | 2,225,880 | 20 | $2,040,522 | $0 |
| Plainfield Pike[5] | 0.13 | - | - | - | - | $- |
| Joslin Farms[5] | 0.13 | - | - | - | - | $- |

1. Referenced as Site 1 on Greenside Energy's estimate
2. Referenced as Site 2 on Greenside Energy's estimate
3. Referenced as Site 3 on Greenside Energy's estimate
4. Discussions with developer indicated that actual estimates can be lower once a detailed evaluation of the sites is performed
5. No information gathered from developer, but during initial discussion they stated the PPA rate would be the same as the North Rd site

See Appendix K for detailed estimate provided by Greenside Energy and the Bay State Solar estimates. Further discussion of the two PPA proposals is included in Section 5.

# Section 5
# Calculations and Recommendations

## 5.1 Calculations

The following is a summary of how Annual Return on Investment (AROI), Internal Rate of Return (IRR), and Net Present Value (NPV) will be evaluated in the cost analysis for all systems recommended in this report.

Included in the simplified payback analysis summary table are the "Annual Return on Investment" (AROI) values. This value is a performance measure used to evaluate the efficiency of an investment and is calculated using the following equation:

$$AROI = \frac{AECS + OCS}{NET\ Cost} - \frac{1}{Lifetime}$$

Where OCS = Operating Cost Savings, and AECS = Annual Energy Cost Savings.

Also included in the table are net present values for each option. The NPV calculates the present value of an investment's future cash flows based on the time value of money, which is accounted for by a discount rate (DR) (assume bond rate of 3%). NPV is calculated using the following equation:

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+DR)^n}$$

Where $C_n$=Annual cash flow, and N = number of years.

The Internal Rate of Return (IRR) expresses an annual rate that results in a break-even point for the investment. If Providence Water is currently experiencing a lower return on their capital than the IRR, the project is financially advantageous. This measure also allows Providence Water to compare systems against each other to determine the most appealing choices.

$$IRR \rightarrow 0 = \sum_{n=0}^{N} \frac{C_n}{(1+IRR)^n}$$

Where $C_n$ = Annual cash flow, and N = number of years.

The lifetime energy savings represents the cumulative energy savings over the assumed life of the System. As noted in previous sections of this report, CDM Smith bases a recommendation on a measure's calculated simple payback under this preliminary evaluation. The metrics defined above (IRR, NPV, AROI) are included as part of the scope of this study, and for Providence Water's consideration as additional financial metrics to consider when deciding whether or not to pursue a specific measure that has been evaluated in this report.

Initial capital costs for measures are based upon data gathered from OpenPV and developers' estimates. A Simple Payback is determined by dividing a measure's NET Cost by the sum of its Operating Cost Savings and Annual Energy Cost Savings (including the inflation rate).

## 5.2 Providence Water Owned

The goal of this section is to present and compare all the proposed systems in the case where Providence Water owns and operates them.

The installation costs presented herein are estimates based on historical data compiled from similar installations and engineering opinions, provided by OpenPV. Additional engineering is required to further develop each measure identified in this report. Final scope of work and budget cost estimates need to be confirmed prior to the coordination of project financing or the issuance of a Request for Proposal.

Table 5-1 summarizes a simple payback analysis assuming the implementation of the systems at all identified locations. Incentives are taken from the Database of State Incentives for Renewables & Efficiency (DSIRE) website.

It should be noted that since Providence Water is a department of the City of Providence, they are unable to benefit from federal tax incentives. The only incentive Providence Water is able to obtain is the Renewable Energy Grant. See Section 6 for more details on the Renewable Energy Grant.

**Table 5-1 Simple Payback Analysis of Providence Water Owned Installations**

| Location | Total Solar Area (sqft) | Base Cost ($) | Incentives[3] ($) | Total Cost ($) | O&M Cost[2] ($) | Annual Production (kWh) | REC Revenue[1,4] ($) | Simple Payback (years) | AROI (%) | IRR (%) | NPV ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dupont – C | 37,264 | $2,039,677 | $350,000 | $1,689,677 | $13,920.00 | 923,137 | $50,772.54 | 9.47 | 3.69 | 10.78 | $2,117,613 |
| Dupont – B | 53,334 | $2,919,289 | $350,000 | $2,569,289 | $19,923.00 | 1,322,941 | $72,761.76 | 9.97 | 3.7 | 10.1 | $2,887,533 |
| Dupont – A | 61,253 | $3,352,720 | $350,000 | $3,002,720 | $22,881.00 | 1,520,852 | $83,646.86 | 10.11 | 3.71 | 9.91 | $3,270,984 |
| Scituate Ave – B | 71,035 | $3,888,135 | $350,000 | $3,538,135 | $27,861.75 | 1,774,063 | $97,573.47 | 10.24 | 3.72 | 9.75 | $3,751,669 |
| North Rd – B | 79,885 | $4,372,559 | $350,000 | $4,022,559 | $31,333.05 | 1,994,651 | $109,705.81 | 10.33 | 3.72 | 9.63 | $4,173,494 |
| Plainfield – B | 80,118 | $4,385,307 | $350,000 | $4,035,307 | $31,424.40 | 2,000,000 | $109,999.95 | 10.34 | 3.72 | 9.62 | $4,182,543 |
| Joslin Farm – B | 80,118 | $4,385,307 | $350,000 | $4,035,307 | $31,424.40 | 2,000,000 | $109,999.95 | 10.34 | 3.72 | 9.62 | $4,182,543 |
| Scituate Ave – A | 138,576 | $7,585,051 | $350,000 | $7,235,051 | $54,353.25 | 3,459,891 | $190,294.01 | 10.66 | 3.72 | 9.23 | $6,981,614 |
| Plainfield – A | 144,631 | $7,916,498 | $350,000 | $7,566,498 | $56,728.35 | 3,610,960 | $198,602.80 | 10.68 | 3.72 | 9.21 | $7,270,862 |
| North Rd – A | 160,468 | $8,782,922 | $350,000 | $8,432,922 | $62,937.00 | 4,006,682 | $220,367.51 | 10.72 | 3.72 | 9.16 | $8,030,650 |
| Joslin Farm – A | 160,468 | $8,783,631 | $350,000 | $8,433,631 | $62,940.15 | 4,006,682 | $220,367.51 | 10.72 | 3.72 | 9.16 | $8,030,135 |

1. REC are assumed to have a market value of $55 per certificate
2. O&M assumed to be $20/W installed for systems under 1MW and $21/W installed for systems over 1MW
3. Only include RE Growth fund, maximum cutoff of $350,000 per project
4. Value shown is for initial annual production

## 5.3 Third Party Owned and Operated

This section evaluates the power purchase agreements submitted by developers.

Please note that these are preliminary estimates and should not be used as quotes from developers. CDM Smith worked with each developer to provide sufficient information for them to provide as high quality of an estimate as possible.

The following table summarizes the PPA estimates submitted to CDM Smith.

**Table 5.2 Greenside Energy Owned and Operated Installations (PPA)**

| Location | PPA Energy Rate[4] ($/kWhr) | Array Size (kW) | Initial Energy Production (kWhr) | Contract Duration until System is Handed over to PW | Buyout Price after 10 yrs ($) | Electrical Savings per year |
|---|---|---|---|---|---|---|
| Dupont Drive[1] | 0.13 | 1,168 | 1,555,799 | 20 | $1,426,154 | $0 |
| Scituate Ave[2] | 0.13 | 1,137 | 1,514,108 | 20 | $1,387,820 | $0 |
| North Rd[3] | 0.13 | 1,671 | 2,225,880 | 20 | $2,040,522 | $0 |
| Plainfield Pike[5] | 0.13 | - | - | - | - | $- |
| Joslin Farms[5] | 0.13 | - | - | - | - | $- |

1. Referenced as Site 1 on Greenside Energy's estimate
2. Referenced as Site 2 on Greenside Energy's estimate
3. Referenced as Site 3 on Greenside Energy's estimate
4. Discussions with developer indicated that actual estimates can be lower once a detailed evaluation of the sites is performed
5. No information gathered from developer, but during initial discussion they stated the PPA rate would be the same as the North Rd site

**Table 5.3 Bay State Solar Owned and Operated Installations (PPA)**

| Location | PPA Energy Rate ($/kWhr) | Array Size (kW) | Initial Energy Production (kWhr) | Contract Duration until System is Handed over to PW | Buyout Price after 10 yrs[1] ($) | Electrical Savings per year |
|---|---|---|---|---|---|---|
| Dupont Drive | 0.12 | 1,000 | 1,100,000 | 20 | - | $11,000.00 |
| Scituate Ave | 0.12 | 2,500 | 2,750,000 | 20 | - | $27,500.00 |
| North Rd[2] | 0.12 | 3,000 | 3,300,000 | 20 | - | $33,000.00 |
| Plainfield Pike[2] | 0.12 | 2,700 | 2,970,000 | 20 | - | $29,700.00 |
| Joslin Farms[2] | 0.12 | 3,000 | 3,300,000 | 20 | - | $33,000.00 |

1. Estimate does not show a buyout price, but discussions with developer point to fair market value
2. No data provided by BSS, but we estimate their rate will be within 10% of shown values

See Appendix K for further details on the estimates provided by Greenside Energy and Bay State Solar.

## 5.4 C-PACE Program

During our discussions with several solar developers in Rhode Island, Bay State Solar mentioned there is another ownership and funding option that may be feasible; similar to a PPA, the only difference would be that the customer (Providence Water) would own the system outright. This program is known as the C-PACE program.

C-PACE is a voluntary tax assessment-based private financing program used to fund facility upgrades or additions such as solar PV systems.

Table 5-4 summarizes the financial analysis on the Dupont Drive and Scituate systems under C-PACE.

**Table 5.4 Financial Analysis under C-PACE Program**

| Location | New Energy Rate[1] ($/kWhr) | Array Size (kW) | Initial Energy Production (kWhr) | Base Cost ($) | Incentives[2] ($) | Total Cost ($) | Electrical Savings per year |
|---|---|---|---|---|---|---|---|
| Dupont Drive | 0.08 | 1,000 | 1,100,000 | $1,940,000 | $919,200 | $1,020,800 | $55,000 |
| Scituate Ave | 0.0832 | 2,500 | 2,750,000 | $4,700,000 | $1,796,000 | $2,904,000 | $128,700 |

1. New Rate of electricity via the C-Pace Program

2. Includes ITC tax credit (purchased by a third party entity), REC payments (5 years only) and RI Renewable Growth Fund

See Appendix K for further details for on the C-PACE estimate provided by Bay State Solar.

## 5.5 National Grid's Renewable Energy Growth Program

A comparison between National Grid's Renewable Energy Growth Program and standard Net Metering provisions was performed. Besides having a PPA, National Grid provides a program that will compensate a solar provider in return for all the environmental benefits that comes with a solar system, including Renewable Energy Credits.

Table 5-5 and Table 5-6 summarizes the financial analysis on Dupont Drive under standard Net Metering feed-in tariff compared to National Grid's Renewable Energy Growth Program.

**Table 5.5 Financial Analysis under Standard Net Metering**

| Location | Base Cost ($) | Incentives ($) | Total Cost ($) | O&M Cost ($) | Annual Production (kWh) | Annual REC ($) | Simple Payback[1] (years) | AROI (%) | IRR (%) | NPV (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Dupont - B | $2,919,289 | $350,000 | $2,569,289 | $19,923.00 | 1,322,941 | $72,761.76 | 9.97 | 2.7 | 8.85 | $1,796,169 |
| Dupont - C | $2,039,677 | $350,000 | $1,689,677 | $10,779.30 | 923,137 | $50,772.54 | 9.47 | 2.69 | 9.61 | $1,356,155 |

1. Calculations reflect 20-year period

**Table 5.6 Financial Analysis under Renewable Energy Growth Program**

| Location | Base Cost ($) | Incentives[1] ($) | Total Cost ($) | O&M Cost ($) | Annual Production (kWh) | National Grid Offset[2] ($) | Simple Payback[3] (years) | AROI (%) | IRR (%) | NPV (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Dupont - B | $2,919,289 | $- | $2,919,289 | $19,923.00 | 1,322,941 | $105,173.81 | 10.40 | 3.81 | 7.9 | $1,598,040 |
| Dupont - C | $2,039,677 | $- | $2,039,677 | $10,779.30 | 923,137 | $73,389.39 | 10.24 | 3.95 | 8.12 | $1,173,114 |

1. Only Incentive allowed under REG program is ITC (Corporate Tax Credit)

2. Under the REG Program, all RECs and environmental benefits are surrendered to National Grid

3. Under the REG Program, PW would be locked into a fixed tariff for 20 years

See Appendix B for a more detailed explanation of these financial calculations.

# Section 6

# Grants, Incentives, and Funding Sources

## 6.1 Renewable Energy

### 6.1.1. Rhode Island Renewable Energy Fund (RIREF)

As part of Rhode Island's commitment to clean renewable energy, Rhode Island's Public Utilities Restructuring Act of 1996 created the nation's first public benefits fund for renewable energy called the Rhode Island Renewable Energy Fund (RIREF).

The RIREF provides grants and loan opportunities for eligible renewable energy technologies for preliminary feasibility studies, as well as direct residential, commercial and municipal installations.

This program is administered by the Rhode Island Commerce Corporation with the office of Energy Resources. The fund is also supported by a surcharge on electric customer's bills.

Eligible Renewable Technologies include:

- Solar Photovoltaics
- Solar Water Heat
- Solar Thermal
- Solar Thermal Process Heat
- Solar Space Heat
- Solar - Passive
- Wind
- Biomass
- Hydroelectric
- Landfill Gas
- Tidal
- Wave
- Ocean Thermal
- Anaerobic Digestion
- Fuel Cells using renewable fuels
- Geothermal Electric

Applicable Sectors include:

- Commercial
- Industrial
- Investor-Owned Utility
- Municipal utilities
- Residential
- Cooperative Utilities
- Institutional

For more information on RIREF, please see http://commerceri.com/finance-business/renewable-energy-fund/. This program affects Providence Water indirectly, as most of the funding for renewable energy stem from this fund.

### 6.1.2. Renewable Energy Products Sales and Use Tax Exemption

Certain Renewable Energy Systems and equipment sold in Rhode Island are exempt from the state's sales and use tax. Incentive amount is a 100% tax exemption.

Eligible renewable technologies include:

- Solar Water Heaters
- Solar Space Heat
- Solar Thermal Electric
- Solar Photovoltaics
- Wind
- Geothermal Heat Pumps
- Solar Pool Heating

For more information on this Tax exemption, please see http://www.energy.ri.gov/renewable/tax/.

This tax exempt may apply to Providence Water indirectly, if the systems purchased are within Rhode Island.

### 6.1.3. Commercial-Scale Renewable Energy Grants

The Commercial-Scale Renewable Energy Grants progra was created by the Rhode Island Commerce Corporation to fund commercial scale renewable energy projects to generate electricity for onsite consumption. Grants are available for electricity-generating renewable-energy systems greater than 10kW. Project owners must have conducted an energy audit prior to application submittal.

Eligible Renewable Technologies include:

- Solar Photovoltaics
- Solar Thermal Electric
- Geothermal Electric
- Biomass
- Combined Heat & Power
- Fuel Cells using Non-Renewable Fuels
- Landfill Gas
- Wind (small)
- Hydroelectric (small)

Applicable Sectors include:

- Commercial
- Local Government
- Nonprofit
- Installers/Contractors
- Multifamily Residential
- Institutional

Incentive Amounts include:

- $1.15/W for the first 50kW installed
- $1.00/W for the second 50kW installed
- $0.85/W for the third 50kW installed
- $0.70/W for the fourth 50kW installed
- $0.55/W for the fifth 50kW installed
- $0.40/W for all installed capacity over the first 250kW
- Maximum Incentive amount cannot exceed $350,000

For more information on REF, please see http://commerceri.com/finance-business/renewable-energy-fund/.

This Grant applies to almost everyone that wants to install solar in Rhode Island. This Grant is included in CDM Smith's financial analysis.

### 6.1.4. Local Option – Property Tax Exemption for Renewable Energy Systems

Rhode Island allows cities and towns to exempt, by ordinance, renewable energy systems from property taxation.

Eligible Renewable Technologies include:

- Solar Photovoltaics
- Solar Water Heat
- Solar Space Heat
- Wind
- Biomass
- Geothermal Heat Pumps
- Wind (Small)
- Hydroelectric (Small)

For more information on Property Tax Exemption, please see http://programs.dsireusa.org/system/program/detail/2801.

Since Providence water does not pay property tax in Providence, they are already exceeding this benefit. However, depending on the disposition of taxes for properties Providence Water owns outside the City of Providence, further investigation will be required as to whether the other towns provide ordinances that exempt property tax for renewable energy systems.

### 6.1.5. Renewable Energy Growth Program

The Renewable Energy Growth Program is a program developed by National Grid to facilitate the development and compensation of distributed generation projects in Rhode Island, following the Rhode Island General Laws Chapter 26.6 of Title 39.

Projects enrolled in the RE Growth Programs must supply National Grid with energy, capacity, Renewable Energy Certificates (RECs) and other environmental attributes and market products.

The table below shows the prices of approved renewable projects.

**Table 6-1 Approved Renewable Energy Classes, Enrollment Targets, Standard PBIs and Ceiling Prices Applicable to Current Enrollment Period**

| Renewable Energy Class (Nameplate kW) | Renewable Energy Class (Nameplate kW) | Enrollment Target (Nameplate kW) | Standard PBI applicable to Medium Solar only (cents/kWh) | Ceiling Price w/PTC (cents/kWh) | Ceiling Price w/o ITC/PTC (cents/kWh) | Term of Service (years) |
|---|---|---|---|---|---|---|
| Medium-Scale Solar (26-250 kW DC) | 3,472 | 24.40 | 24.40 | N/A | N/A | 20 |
| Commercial-Scale Solar (251-999 kW DC) | 3,680 | N/A | 20.95 | N/A | N/A | 20 |
| Large -Scale Solar (1,000-5,000 kW DC) | 0 | N/A | 16.70 | N/A | N/A | 20 |
| Wind (1,500-5,000 kW)<br><br>1,500-2,999 kW<br>3,000-5,000 kW | 500 | <br><br>N/A<br>N/A | <br><br>18.40<br>18.20 | <br><br>19.85<br>19.45 | <br><br>22.75<br>22.35 | <br><br>20<br>20 |
| Anerobic Digestion (up to 1,000 kW)<br><br>150-1,000 kW | 1,500 | N/A | N/A | 20.20 | 20.60 | 20 |
| Small-Scale Hydropower (up to 1,000 kW)<br><br>10-250 kW<br>251-1,000 kW | | <br><br>N/A<br>N/A | <br><br>N/A<br>N/A | <br><br>19.80<br>18.55 | <br><br>21.35<br>20.10 | <br><br>20<br>20 |

**Note:** As indicated above, there is a 0 kW (nameplate) Enrollment Target for the Large-Scale Solar Renewable Energy Class and the 500 kW (nameplate) Enrollment Target for the Wind Renewable Energy Class is less than the minimum project size (1,500 kW). However, applications for projects in either of these Renewable Energy Classes may be submitted in the October Open Enrollment and be selected if other Renewable Energy classes are under-represented.

This program is applicable for all of Providence Water's proposed sites, but only for the systems lower than 1MW in scale. The table above shows that there are currently no enrollment targets for large-scale solar, thus CDM Smith did not evaluate this option.

### 6.1.6. Energy Revolving Loan Fund

The Energy Revolving Loan Fund (ELF) provides low interest loans for Rhode Island Business for energy saving investments. This program is funded from the American recovery and Reinvestment Act. This loan fund is administered by the Rhode Island Economic Development Cooperation (RIEDC).

Eligible Renewable Technologies include:

- Solar Photovoltaics
- Solar Thermal Electric
- Solar Thermal Process Heat
- Biomass
- Geothermal Heat Pumps
- Combined Heat & Power
- Wind (Small)

Loan terms are of typical 5-10 years with interest rates between 1%-3%.

For more information on ELF, please see http://www.irs.gov/pub/irs-pdf/f8835.pdf.

This incentive can be an option for Providence Water if they decided to finance any of the systems.

### 6.1.7. Business Energy Investment Tax Credit

The Business Energy Tax Credit (ITC) is a corporate tax credit in the amount of 30% for solar, fuel cells, and small wind.

For more information on the ITC, please see http://energy.gov/savings/business-energy-investment-tax-credit-itc.

This corporate tax credit would only be viable if Providence Water went under a Power Purchase Agreement. This Tax write off was included in the 3rd party financial analysis.

### 6.1.8. Qualified Energy Conservation Bonds (IRS)

A Qualified Energy Conservation Bond (QECB) is a bond that enables qualified state, tribal, and local government issuers to borrow money at attractive rates to fund energy conservation projects. These funds are not to be mistaken for grants.

For more information on these bonds, please see http://energy.gov/eere/slsc/qualified-energy-conservation-bonds.

This can be another source of loan to fund the projects.

### 6.1.9. Modified Accelerated Cost-Recovery System (MACRS)

Under the Consolidated Appropriations Act, equipment placed in service before January 1, 2018 can qualify for 50% bonus depreciation. Equipment placed in service during 2018 can qualify for 40% bonus depreciation. Equipment placed in service during 2019 can qualify for 30% bonus depreciation.

Solar Photovoltaics are among the equipment allowed to qualify for the bonus depreciation mentioned above.

For more information on MACRS, please see http://programs.dsireusa.org/system/program/detail/676.

## 6.1.10. Power Purchase Agreements (SPCs)

A Power Purchase Agreement (PPA) also delivers a project with no initial capital contribution by the original owner. In this model, a Special Purpose Company (SPC) created by a developer, would own the energy production facilities. Within the framework of a PPA, a SPC will typically lease property from the owners for construction and operation of the new facilities. The funding and construction of the new facilities would be performed by the SPC who would then own and operate the facilities for the duration of the contract (typically 20 to 30 years). Throughout that period of time, the original owner would purchase power from the SPC at a pre-negotiated rate which would take into account the initial capital cost, operation and maintenance of the constructed facility, ancillary benefits of the project and investor returns on investment. For renewable energy, financial incentives may enable this financing approach to compete favorably with utility power tariffs. Incentives include state and local tax credits, renewable energy credits, and Federal energy production tax credits or energy investment tax credits.

Power Purchase agreement options are included in this feasibility study.

## 6.1.11. Loan Guarantee Program (US DoE)

Under Section 1703 of Title XVII of the Energy Policy Act (EPAct) of 2005, the Department of Energy is authorized to issue loan guarantees for projects with high technology risks that "avoid, reduce or sequester air pollutants or anthropogenic emissions for greenhouse gases…". The loan guarantees are intended to encourage early commercial use of new and significantly improved technologies in energy projects.

It is unclear what the maximum loan limit may be or what is the typical interest rate. Loan terms include full repayment required over a period not to exceed the lesser of 30 years or 90% of the project useful life of the physical asset to be financed.

For more information on the Loan Guarantee Program, please see http://energy.gov/lpo/loan-programs-office.

## 6.1.12. Virtual Net Metering

Net metering is available to customers that have distributed generation such as Solar and Wind power. Net metering in Rhode Island allows distributed generation customers like Providence Water to financially balance the total amount of energy imported with the amount of energy exported over the course of a billing period. The charge would only amount to the net difference between these two amounts. If the energy consumption exceeds the energy generated, the customer would be charged the net difference of the total amount. If the energy generated exceeds the energy consumption, the custumer would receive a credit of the net difference of the total amount. Under National Grid guidelines, the net credit will never exceed 125% of the energy demand at the location.

Virtual Net Metering is the ability to allocate these credits to other National Grid electric billing accounts using a specified form (**Schedule B**). In order for a customer to allocate credits to other sites, the site needs to be qualified as "Eligible Net Metering Systems Site".

The net metering system must:

- Include an eligible generating facility (such as Solar or Wind)
- Be located in the same geographical location such that:
    - The net metering system is owned or operated on behalf of a municipality or multi-municipal collaborative through a municipal net metering financing arrangement.
- Be used to allocate Net Metering Credits (NMC) only to accounts of the same customer of record. (Generally, names on accounts may not be changes for the purpose of allocating credits)
    - This does not apply if the net metering system is part of a multi-municipal collaborative.

It should be noted that the customers with net metering services should not expect to receive a check or payment as compensation for accrued NMC.

### 6.1.13. C-PACE Program

The Commercial Property Assessed Clean Energy (C-PACE) program is an initiative of the Rhode Island Infrastructure Bank (RIIB) and was authorized by legislation, signed into law on June 30, 2015. The PACE statute can be found in the Rhode Island General Laws at chapter 39-26.5. C-PACE is administered by SRS, an industry leader in market-making solutions for the commercial and industrial real estate information services market.

C-PACE facilitates financing for clean energy improvements to commercial, industrial, agricultural, non-profit and some multifamily properties. To encourage long term financing the program utilizes the municipal property assessment mechanism to provide security for repayment of the financing.

# Section 7
# Conclusions

## 7.1 Conclusions

As shown in this report, the array at 125 Dupont Drive represents the lowest simple payback for a City-owned system. Further, the site at 61 North Road appears to have an accessible utility interconnection point and minimal site preparation requirements. If Providence Water would like to proceed with self-funding the installation of Solar PV at one or more location, solar PV developers should be engaged to provide detailed design and installation services.

An unexpected financing option was discovered during initial contact with Rhode Island solar developers. Bay State Solar identified another option for solar PV financing in addition to the traditional forms, upfront capital investment or Power Purchase Agreements. C-PACE is a new financing program modeled to help aid the development of clean energy in the commercial sector. The C-PACE program helps property owners overcome short-term payback focus and look at other system constraints. This program was recently opened up to municipalities, thus extending this development aid to sectors where financing options may be limited.

As shown in Section 5, the lowest energy rate available is under the C-PACE program with a utility rate of $0.08 per kilowatt-hour, compared to $0.12 and $0.13 for Greenside Energy and Bay State Solar PPA estimates, respectively. National Grid offers an incentive program under the Renewable Energy Growth program, which reflects lower cost savings than the C-PACE program.

Based on potential cost savings, CDM Smith recommends that Providence Water engage Bay State Solar to have their team assess the 125 Dupont Drive and 61 North Road sites in more detail. This will provide Providence Water with more detailed and precise solar installation estimates for both sites. Pairing the C-PACE program and virtual net metering, could potentially increase energy cost savings associated with the solar PV system, by allocating converted energy credits from 61 North Road, and offsetting energy consumption at other Providence Water facilities.

# Appendix A
# Utility Bill Information

Blended Rates

| Blended Rates per Location | | | |
|---|---|---|---|
| **Site** | **Blended Rate** | | **Peak Demand** |
| Dupont Dr. | $ | 0.14 | 405 |
| 61 North Rd | $ | 0.13 | 520 |
| 430 Scituate Ave | $ | 0.14 | 59.1 |
| Aqueduct Pump Station | $ | 0.15 | 444 |

Notes: Includes $0.082 Direct Energy Power Contract Charge

Dupont Dr.

| Read Date & Days | Read | Energy kwhr | Delivery | Supply | Other Charges | Late Payment | Total Monthly Charge | Peak Demand |
|---|---|---|---|---|---|---|---|---|
| Feb-Mar, 2016 | Actual | 154000 | $ 7,021.58 | $ 15,028.91 | $ 918.41 | $ - | 22968.9 | 405 |
| Mar-Apr, 2016 | Actual | 126,000 | $ 6,577.75 | $ 8,595.96 | $ 631.89 | $ - | 15805.6 | 405 |

61 North Rd

| Read Date & Days | Read | Energy kwhr | Delivery | Supply | Late Payment | Total Monthly Charge | Peak Demand |
|---|---|---|---|---|---|---|---|
| 1/11/2016 & 33 Days | Actual | 196,000 | $8,890.74 | $0.00* | $0.00 | $9,260.83 | 440 |
| 12/9/2015 & 33 Days | Actual | 187,000 | $8,368.59 | $0.00* | $0.00 | $8,716.93 | 420 |
| 11/6/2015 & 29 Days | Actual | 141,000 | $6,873.87 | $0.00* | $0.00 | $7,159.93 | 370 |
| 10/8/2015 & 28 Days | Actual | 135,000 | $6,727.16 | $0.00* | $0.00 | $7,007.10 | 370 |
| 9/10/2015 & 30 Days | Actual | 151,000 | $8,145.85 | $0.00* | $0.00 | $8,484.91 | 500 |
| 8/11/2015 & 32 Days | Actual | 155,000 | $7,315.71 | $0.00* | $0.00 | $7,620.18 | 380 |
| 7/10/2015 & 30 Days | Actual | 141,000 | $6,833.80 | $0.00* | $0.00 | $7,118.19 | 400 |
| 6/10/2015 & 30 Days | Actual | 122,000 | $6,108.37 | $0.00* | $0.00 | $6,362.53 | 380 |
| 5/11/2015 & 28 Days | Actual | 124,000 | $6,423.13 | $0.00* | $0.00 | $6,690.41 | 420 |
| 4/13/2015 & 32 Days | Actual | 171,000 | $7,793.02 | $0.00* | $0.00 | $8,117.38 | 450 |
| 3/12/2015 & 29 Days | Actual | 181,000 | $7,834.51 | $0.00* | $0.00 | $8,160.59 | 440 |
| 2/11/2015 & 30 Days | Actual | 179,000 | $7,786.14 | $0.00* | $0.00 | $8,110.21 | 440 |
| 1/12/2015 & 33 Days | Actual | 194,000 | $8,174.59 | $0.00* | $0.00 | $8,514.84 | 430 |
| 12/10/2014 & 33 Days | Actual | 177,000 | $7,599.24 | $0.00* | $0.00 | $7,915.52 | 390 |
| 11/7/2014 & 29 Days | Actual | 148,000 | $6,891.83 | $0.00* | $0.00 | $7,178.64 | 390 |
| 10/9/2014 & 29 Days | Actual | 149,000 | $6,923.35 | $0.00* | $0.00 | $7,211.47 | 380 |
| 9/10/2014 & 29 Days | Actual | 132,000 | $6,749.89 | $0.00* | $0.00 | $7,030.78 | 420 |
| 8/12/2014 & 34 Days | Actual | 169,000 | $7,910.56 | $0.00* | $0.00 | $8,239.81 | 470 |
| 7/9/2014 & 28 Days | Estimated | 116,000 | $6,063.94 | $0.00* | $0.00 | $6,316.25 | 380 |
| 6/11/2014 & 30 Days | Actual | 125,000 | $6,490.79 | $0.00* | $0.00 | $6,760.89 | 430 |
| 5/12/2014 & 33 Days | Actual | 146,000 | $6,750.53 | $0.00* | $0.00 | $7,031.45 | 400 |
| 4/9/2014 & 28 Days | Actual | 137,000 | $6,582.70 | $0.00* | $0.00 | $6,856.63 | 370 |
| 3/12/2014 & 30 Days | Actual | 151,000 | $7,308.32 | $0.00* | $0.00 | $7,612.48 | 460 |
| 2/10/2014 & 31 Days | Actual | 170,000 | $8,461.35 | $0.00* | $0.00 | $8,813.55 | 520 |

| ReadDate & Days | Read Type | Total kWh | Delivery Charges | Supply Charges | Late Payment Charges | Total Charges | Metered Peak kW |
|---|---|---|---|---|---|---|---|
| 1/22/2016 & 32 Days | Actual | 15,022 | $865.81 | $0.00* | $0.00 | $901.53 | 38.8 |
| 12/21/2015 & 32 Days | Actual | 13,002 | $798.91 | $0.00* | $0.00 | $831.84 | 34.9 |
| 11/19/2015 & 29 Days | Actual | 11,379 | $753.25 | $0.00* | $0.00 | $784.28 | 34.5 |
| 10/21/2015 & 29 Days | Actual | 12,612 | $825.85 | $0.00* | $0.00 | $859.91 | 49.8 |
| 9/22/2015 & 29 Days | Actual | 16,946 | $1,009.92 | $0.00* | $0.00 | $1,051.65 | 58.7 |
| 8/24/2015 & 32 Days | Actual | 16,776 | $1,008.80 | $0.00* | $0.00 | $1,050.48 | 59.1 |
| 7/23/2015 & 30 Days | Actual | 16,174 | $967.49 | $0.00* | $0.00 | $1,007.45 | 57.2 |
| 6/23/2015 & 28 Days | Actual | 14,870 | $835.79 | $0.00* | $0.00 | $870.26 | 49.2 |
| 5/26/2015 & 33 Days | Actual | 13,030 | $846.55 | $0.00* | $0.00 | $881.47 | 55.7 |
| 4/23/2015 & 30 Days | Actual | 13,170 | $751.27 | $0.00* | $0.00 | $782.22 | 35.7 |
| 3/24/2015 & 28 Days | Actual | 13,646 | $761.39 | $0.00* | $0.00 | $792.76 | 36.1 |
| 2/24/2015 & 32 Days | Actual | 12,749 | $739.91 | $0.00* | $0.00 | $770.39 | 37.2 |
| 1/23/2015 & 32 Days | Actual | 13,381 | $755.83 | $0.00* | $0.00 | $786.97 | 36.2 |
| 12/22/2014 & 32 Days | Actual | 12,396 | $734.04 | $0.00* | $0.00 | $764.27 | 31.6 |
| 11/20/2014 & 29 Days | Actual | 11,356 | $708.91 | $0.00* | $0.00 | $738.09 | 41 |
| 10/22/2014 & 30 Days | Actual | 13,299 | $812.65 | $0.00* | $0.00 | $846.16 | 50.9 |
| 9/22/2014 & 32 Days | Actual | 14,376 | $879.58 | $0.00* | $0.00 | $915.88 | 55.9 |
| 8/21/2014 & 28 Days | Actual | 14,179 | $866.06 | $0.00* | $0.00 | $901.79 | 54.8 |
| 7/24/2014 & 31 Days | Actual | 15,902 | $933.93 | $0.00* | $0.00 | $972.49 | 58.4 |
| 6/23/2014 & 31 Days | Actual | 13,097 | $824.13 | $0.00* | $0.00 | $858.11 | 54 |
| 5/23/2014 & 30 Days | Actual | 12,192 | $754.36 | $0.00* | $0.00 | $785.44 | 39.1 |
| 4/23/2014 & 30 Days | Actual | 13,270 | $777.89 | $0.00* | $0.00 | $809.95 | 33.1 |
| 3/24/2014 & 31 Days | Actual | 12,747 | $759.32 | $0.00* | $0.00 | $790.60 | 35.4 |
| 2/21/2014 & 29 Days | Actual | 12,576 | $755.29 | $0.00* | $0.00 | $786.41 | 36.4 |

Aqueduct Pump Station

| ReadDate & Days | Read Type | Total kWh | Delivery Charges | Supply Charges | Late Payment Charges | Total Charges | Metered Peak kW |
|---|---|---|---|---|---|---|---|
| 1/14/2016 & 31 Days | Actual | 58,400 | $5,077.52 | $0.00* | $0.00 | $5,288.73 | 438 |
| 12/14/2015 & 32 Days | Actual | 61,800 | $5,055.47 | $0.00* | $0.00 | $5,265.76 | 432 |
| 11/12/2015 & 29 Days | Actual | 59,200 | $4,935.31 | $0.00* | $0.00 | $5,140.59 | 422 |
| 10/14/2015 & 29 Days | Actual | 99,800 | $5,940.43 | $0.00* | $0.00 | $6,187.59 | 418 |
| 9/15/2015 & 32 Days | Actual | 162,600 | $7,645.94 | $0.00* | $0.00 | $7,964.17 | 422 |
| 8/14/2015 & 30 Days | Actual | 138,800 | $6,998.87 | $0.00* | $0.00 | $7,290.14 | 422 |
| 7/15/2015 & 29 Days | Actual | 119,400 | $6,329.67 | $0.00* | $0.00 | $6,593.05 | 424 |
| 6/16/2015 & 33 Days | Actual | 156,400 | $7,035.13 | $0.00* | $0.00 | $7,327.91 | 422 |
| 5/14/2015 & 28 Days | Actual | 72,800 | $5,085.24 | $0.00* | $0.00 | $5,296.77 | 428 |
| 4/16/2015 & 30 Days | Actual | 59,200 | $4,773.96 | $0.00* | $0.00 | $4,972.52 | 434 |
| 3/17/2015 & 34 Days | Actual | 68,000 | $4,985.28 | $0.00* | $0.00 | $5,192.65 | 440 |
| 2/11/2015 & 27 Days | Estimated | 53,200 | $4,649.53 | $0.00* | $0.00 | $4,842.91 | 442 |
| 1/15/2015 & 31 Days | Actual | 63,600 | $4,884.70 | $0.00* | $0.00 | $5,087.88 | 438 |
| 12/15/2014 & 32 Days | Actual | 63,000 | $4,876.36 | $0.00* | $0.00 | $5,079.19 | 438 |
| 11/13/2014 & 29 Days | Actual | 58,600 | $4,651.81 | $0.00* | $0.00 | $4,845.28 | 422 |
| 10/15/2014 & 30 Days | Actual | 90,400 | $5,503.03 | $0.00* | $0.00 | $5,731.97 | 434 |
| 9/15/2014 & 31 Days | Actual | 138,600 | $6,632.70 | $0.00* | $0.00 | $6,908.71 | 420 |
| 8/15/2014 & 30 Days | Actual | 138,600 | $6,658.51 | $0.00* | $0.00 | $6,935.59 | 424 |
| 7/16/2014 & 30 Days | Actual | 151,200 | $6,945.56 | $0.00* | $0.00 | $7,234.60 | 424 |
| 6/16/2014 & 32 Days | Actual | 106,600 | $5,779.21 | $0.00* | $0.00 | $6,019.66 | 422 |
| 5/15/2014 & 30 Days | Actual | 64,600 | $4,797.03 | $0.00* | $0.00 | $4,996.55 | 426 |
| 4/15/2014 & 29 Days | Actual | 55,000 | $4,579.04 | $0.00* | $0.00 | $4,769.48 | 430 |
| 3/17/2014 & 32 Days | Actual | 62,000 | $4,815.91 | $0.00* | $0.00 | $5,016.22 | 440 |
| 2/13/2014 & 30 Days | Actual | 59,000 | $4,740.34 | $0.00* | $0.00 | $4,937.50 | 444 |

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**ELECTRIC BILL**

SERVICE FOR
PROVIDENCE WATER SUPPLY
WATER SUPPLY BOARD
125 DUPONT DR
PROVIDENCE RI 02907

BILLING PERIOD
Feb 12, 2016 to Mar 14, 2016



| ACCOUNT NUMBER | PLEASE PAY BY | AMOUNT DUE |
|---|---|---|
| 27144-85017 | Apr 15, 2016 | $ 53,172.04 |

www.nationalgridus.com
CUSTOMER SERVICE
1-800-322-3223
CREDIT DEPARTMENT
1-888-211-1313
GAS EMERGENCIES
1-800-640-1595
POWER OUTAGE OR DOWNED LINE
1-800-465-1212
CONTACT US
ngrid.com/ri-contactus
CORRESPONDENCE ADDRESS
PO Box 960
Northborough, MA 01532-0960
PAYMENT ADDRESS
PO Box 11739
Newark, NJ 07101-4739

DATE BILL ISSUED
Mar 22, 2016

**Enrollment Information**

To enroll with a supplier or change to another supplier, you will need the following information about your account:
Loadzone Rhodelsland
Acct No: 27144-85017 Cycle: 11, PROV

**Electric Usage History**

| Month | kWh |
|---|---|
| Jan 16 | 30000 |
| Feb 16 | 144000 |
| Mar 16 | 154000 |

**Billed Demand Last 12 months**

| | |
|---|---|
| Minimum | 405 |
| Maximum | 540 |
| Average | 450 |

## ACCOUNT BALANCE

| | |
|---|---|
| Previous Balance | 30,203.14 |
| Payment Received *No payments have been received during this billing period* | - 0.00 |
| Balance Forward | 30,203.14 |
| Current Charges | + 22,968.90 |
| Amount Due ▶ | $ 53,172.04 |

*To avoid late payment charges of 1.25%, $ 53,172.04 must be received by Apr 15 2016.*

## SUMMARY OF CURRENT CHARGES

| | DELIVERY SERVICES | SUPPLY SERVICES | OTHER CHARGES/ ADJUSTMENTS | TOTAL |
|---|---|---|---|---|
| Electric Service | 7,021.58 | 15,028.91 | | 22,050.49 |
| Other Charges/Adjustments | | | 918.41 | 918.41 |
| Total Current Charges | $ 7,021.58 | $ 15,028.91 | $ 918.41 | $ 22,968.90 |

The Energy Charge now includes the Renewable Energy Standard Charge which was previously identified separately on the bill. This charge is collected for the purpose of acquiring a portion of Rhode Island's energy supply from renewable energy resources, as required by Rhode Island General Laws section 39-26-1.

What is the Energy Efficiency Charge on my bill? This charge funds Energy Efficiency programs that can help consumers lower their energy usage and bills, improve comfort in their homes or businesses, and lower pollutants and carbon emissions in our communities. To learn how to take advantage of these programs and your eligibility, please call 1-866-903-2811 or visit www.ngrid.com/ri-ee.

★ WILL WE BE ABLE TO REACH YOU DURING A POWER OUTAGE?: During a power outage, phones with a direct link to a local phone line are able to operate. Phones that are not directly linked (for example, wireless phones with answering machines) need electricity to make/receive calls. If you would like to register another phone number, such as a cell phone, as your account's primary phone number, please go to www.nationalgrid.com/myaccount to update your information so that we may be able to reach you with important information during power outages.

KEEP THIS PORTION FOR YOUR RECORDS.

RETURN THIS PORTION WITH YOUR PAYMENT.

nationalgrid

| ACCOUNT NUMBER | PLEASE PAY BY | AMOUNT DUE |
|---|---|---|
| 27144-85017 | Apr 15, 2016 | $ 53,172.04 |

PO Box 960
Northborough MA 01532

ENTER AMOUNT ENCLOSED
$

*Write account number on check and make payable to National Grid*

PROVIDENCE WATER SUPPLY
WATER SUPPLY BOARD
PHIL MATHESON
552 ACADEMY AVE
PROVIDENCE RI 02908-2908

019957

NATIONAL GRID
PO BOX 11739
NEWARK NJ 07101-4739

002296890 271448501740053172041 06

nationalgrid

SERVICE FOR
PROVIDENCE WATER SUPPLY
WATER SUPPLY BOARD
125 DUPONT DR
PROVIDENCE RI 02907

BILLING PERIOD
Feb 12, 2016 to Mar 14, 2016

| ACCOUNT NUMBER | PLEASE PAY BY | AMOUNT DUE |
|---|---|---|
| 27144-85017 | Apr 15, 2016 | $ 53,172.04 |

**Enrollment Information**

To enroll with a supplier or change to another supplier, you will need the following information about your account:
Loadzone Rhodelsland
Acct No: 27144-85017 Cycle: 11, PROV

**Choosing an Energy Supplier** You can choose who supplies your energy. No matter which energy supplier you choose, National Grid will continue to deliver energy to you safely, efficiently and reliably. We will also continue to provide your customer service, including emergency response and storm restoration. National Grid is dedicated to creating an open energy market that lets you choose from a variety of competitive energy suppliers, who may offer different pricing options. For information on authorized energy suppliers and how to choose, please visit us online at www.nationalgridus.com/energychoice

## Right To Dispute Your Bill And To An Impartial Hearing

If you believe your bill is inaccurate or for any reason payment may be withheld, you should first contact our Customer Service Department at 1-800-322-3223. If a mutually satisfactory settlement of this matter cannot be made, you have the right to submit this matter to: Reviewing Officer, Division of Public Utilities and Carriers, 89 Jefferson Blvd., Warwick, Rhode Island 02888 Telephone: 401-780-9700. National Grid will not disconnect your service pending proceedings before a reviewing officer appointed by the Public Utilities Administrator.

**LIHEAP Charge**
This charge is required under Rhode Island law and will be used to provide funding for a Low-Income Home Energy Assistance Program ("LIHEAP") Enhancement Plan, designed to assist low-income electric and natural gas households with their home energy and heating needs. By law, this charge may not be more than $10 per year for each electric or natural gas service account.

## Explanation of Billing Terms Available

If you would like an explanation of any of the terms used on your bill, you may find them on our web site at www.nationalgrid.com or you may call us at 1-800-322-3223.

## DETAIL OF CURRENT CHARGES

### *Delivery Services*

| Type of Service | Current Reading | - | Previous Reading | = | Difference | x | Meter Multiplier | = | Total Usage |
|---|---|---|---|---|---|---|---|---|---|
| Energy | 164 *Actual* | | 87 *Estimate* | | 77 | | 2000 | | 154000 kWh |
| Peak | 73 *Actual* | | 39 *Estimate* | | 34 | | 2000 | | 68000 kWh |
| Off Peak | 91 *Actual* | | 48 *Estimate* | | 43 | | 2000 | | 86000 kWh |
| | | | | | | | Total Energy | | 154000 kWh |

| Demand-kW | Demand-kVA |
|---|---|
| 340.0 kW | 400.0 kVA |

Billed Demand 405.0 kW

METER NUMBER 04848561 NEXT SCHEDULED READ DATE ON OR ABOUT Apr 15
SERVICE PERIOD Feb 12 - Mar 14 NUMBER OF DAYS IN PERIOD 31
RATE Large Demand G-32 VOLTAGE DELIVERY LEVEL 22 - 50 kv

| | | | |
|---|---|---|---|
| Customer Charge | | | 825.00 |
| LIHEAP Enhancement Charge | | | 0.73 |
| Distribution Energy Chg | 0.00759 x | 154000 kWh | 1,168.86 |
| Renewable Egy Dist Chg | 0.00233 x | 154000 kWh | 358.82 |
| Distribution Demand Chg | 4.1 x | 205 kW/kVA | 840.50 |
| Transmission Dem Chg | 3.4 x | 405 kW/kVA | 1,377.00 |
| Transmission Adj | 0.0093 x | 154000 kWh | 1,432.20 |
| Transition Charge | -0.00201 x | 154000 kWh | -309.54 |
| Energy Efficiency Prgrms | 0.01107 x | 154000 kWh | 1,704.78 |
| RE Growth Program | | | 17.78 |
| High Voltage Discount | -0.42 x | 405 kW | -170.10 |
| High Voltage Metering | -1.0 % x | $ 22445.04 | -224.45 |
| | | **Total Delivery Services** | **$ 7,021.58** |

## Right To Electric Service:

**During Serious Illness:** If you or anyone presently and normally living in your home is seriously ill, we will not discontinue your electric service during such illness providing you: have a registered physician certify in writing to us that such illness exists, the nature and duration of the illness and you make satisfactory arrangements to pay your bill. This certification must be received within seven (7) days from the date that your physician initially contacts our Credit Department at 1-888-211-1313.
**You have a child under twenty four months and a financial hardship:** If you or anyone presently and normally living in your home has a child under twenty four months old we will not terminate your electric service, provided you also have a financial hardship. Please call our Credit Department at 1-888-211-1313 immediately if this applies to you.

## Termination of Service to Elderly or Handicapped Persons

If all residents in your household are 62 years of age or older or if any resident in your household is handicapped, the Company will not terminate your service for failure to pay the past due bill without written approval from the Division of Public Utilities. If you cannot pay your bill all at once, you may be able to work out a payment plan with the Company. The Elderly or Handicapped Forms that must be filled out are available at the Company. The Form also enables you to participate in "Third Party Notification". If you have any questions or want further information, call the Credit Department at 1-888-211-1313.

### *Supply Services*

SUPPLIER National Grid

| | | |
|---|---|---|
| Energy Charge | 0.0975903 x 154000 kWh | 15,028.91 |
| | **Total Supply Services** | **$ 15,028.91** |

### *Other Charges/Adjustments*

| | | |
|---|---|---|
| Paperless Billing Credit | | -0.34 |
| Gross Earnings Tax | 0.04166667 x 22,050.15 | 918.75 |
| | **Total Other Charges/Adjustments** | **$ 918.41** |

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**ELECTRIC BILL**

SERVICE FOR
PROVIDENCE WATER SUPPLY
WATER SUPPLY BOARD
125 DUPONT DR
PROVIDENCE RI 02907

BILLING PERIOD
Mar 14, 2016 to Apr 14, 2016



| ACCOUNT NUMBER | PLEASE PAY BY | AMOUNT DUE |
|---|---|---|
| 27144-85017 | May 8, 2016 | $ 68,977.64 |

www.nationalgridus.com
CUSTOMER SERVICE
**1-800-322-3223**
CREDIT DEPARTMENT
**1-888-211-1313**
GAS EMERGENCIES
**1-800-640-1595**
POWER OUTAGE OR DOWNED LINE
**1-800-465-1212**
CONTACT US
ngrid.com/ri-contactus
CORRESPONDENCE ADDRESS
**PO Box 960**
**Northborough, MA 01532-0960**
PAYMENT ADDRESS
**PO Box 11739**
**Newark, NJ 07101-4739**

DATE BILL ISSUED
**Apr 14, 2016**

**Enrollment Information**

To enroll with a supplier or change to another supplier, you will need the following information about your account:
Loadzone Rhodelsland
**Acct No:** 27144-85017 **Cycle:** 11, PROV

**Electric Usage History**

| Month | kWh |
|---|---|
| Jan 16 | 30000 |
| Feb 16 | 144000 |
| Mar 16 | 154000 |
| Apr 16 | 126000 |

**Billed Demand Last 12 months**

| | |
|---|---|
| Minimum | 405 |
| Maximum | 540 |
| Average | 438.75 |

## ACCOUNT BALANCE

| | | |
|---|---|---|
| Previous Balance | | 53,172.04 |
| Payment Received | *No payments have been received during this billing period* | - 0.00 |
| **Balance Forward** | | **53,172.04** |
| Current Charges | | + 15,805.60 |
| | **Amount Due ▶** | **$ 68,977.64** |

*To avoid late payment charges of 1.25%, $ 68,977.64 must be received by May 8 2016.*

## SUMMARY OF CURRENT CHARGES

| | DELIVERY SERVICES | SUPPLY SERVICES | OTHER CHARGES/ ADJUSTMENTS | TOTAL |
|---|---|---|---|---|
| Electric Service | 6,577.75 | 8,595.96 | | 15,173.71 |
| Other Charges/Adjustments | | | 631.89 | 631.89 |
| **Total Current Charges** | **$ 6,577.75** | **$ 8,595.96** | **$ 631.89** | **$ 15,805.60** |

**What is the Energy Efficiency Charge on my bill?** This charge funds Energy Efficiency programs that can help consumers lower their energy usage and bills, improve comfort in their homes or businesses, and lower pollutants and carbon emissions in our communities. To learn how to take advantage of these programs and your eligibility, please call 1-866-903-2811 or visit www.ngrid.com/ri-ee.

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KEEP THIS PORTION FOR YOUR RECORDS.

RETURN THIS PORTION WITH YOUR PAYMENT.

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| ACCOUNT NUMBER | PLEASE PAY BY | AMOUNT DUE |
|---|---|---|
| **27144-85017** | **May 8, 2016** | **$ 68,977.64** |

PO Box 960
Northborough MA 01532

PROVIDENCE WATER SUPPLY
WATER SUPPLY BOARD
PHIL MATHESON
552 ACADEMY AVE
PROVIDENCE RI 02908

028934

**Please do not mail payment**
A separate Summary Bill has been submitted for payment.

001580560 27144850178006897764129

nationalgrid

SERVICE FOR
PROVIDENCE WATER SUPPLY
WATER SUPPLY BOARD
125 DUPONT DR
PROVIDENCE RI 02907

BILLING PERIOD
Mar 14, 2016 to Apr 14, 2016



| ACCOUNT NUMBER | PLEASE PAY BY | AMOUNT DUE |
|---|---|---|
| 27144-85017 | May 8, 2016 | $ 68,977.64 |

**Enrollment Information**

To enroll with a supplier or change to another supplier, you will need the following information about your account:
**Loadzone** Rhodelsland
**Acct No:** 27144-85017 **Cycle:** 11, PROV

## DETAIL OF CURRENT CHARGES

### *Delivery Services*

| Type of Service | Current Reading | - | Previous Reading | = | Difference | x | Meter Multiplier | = | Total Usage |
|---|---|---|---|---|---|---|---|---|---|
| Energy | 227 *Actual* | | 164 *Actual* | | 63 | | 2000 | | 126000 kWh |
| Peak | 100 *Actual* | | 73 *Actual* | | 27 | | 2000 | | 54000 kWh |
| Off Peak | 127 *Actual* | | 91 *Actual* | | 36 | | 2000 | | 72000 kWh |
| | | | | | | | | **Total Energy** | **126000 kWh** |

| Demand-kW | Demand-kVA | | |
|---|---|---|---|
| 340.0 kW | 400.0 kVA | | |
| | | **Billed Demand** | **405.0 kW** |

METER NUMBER 04848561 NEXT SCHEDULED READ DATE ON OR ABOUT May 13
SERVICE PERIOD Mar 14 - Apr 14 NUMBER OF DAYS IN PERIOD 31
RATE Large Demand G-32 VOLTAGE DELIVERY LEVEL 22 - 50 kv

| | | | | |
|---|---|---|---|---|
| Customer Charge | | | | 825.00 |
| LIHEAP Enhancement Charge | | | | 0.73 |
| Distribution Energy Chg | 0.00751322 | x | 126000 kWh | 946.67 |
| Renewable Egy Dist Chg | 0.00236612 | x | 126000 kWh | 298.13 |
| Distribution Demand Chg | 4.25354834 | x | 205 kW/kVA | 871.98 |
| Transmission Dem Chg | 3.65741901 | x | 405 kW/kVA | 1,481.25 |
| Transmission Adj | 0.00982835 | x | 126000 kWh | 1,238.37 |
| Transition Charge | -0.00136418 | x | 126000 kWh | -171.89 |
| Energy Efficiency Prgrms | 0.01107 | x | 126000 kWh | 1,394.82 |
| RE Growth Program | | | | 17.78 |
| High Voltage Discount | -0.42 | x | 405 kW | -170.10 |
| High Voltage Metering | -1.0 % | x | $ 15498.80 | -154.99 |
| | | | **Total Delivery Services** | **$ 6,577.75** |

### Right To Dispute Your Bill And To An Impartial Hearing

If you believe your bill is inaccurate or for any reason payment may be withheld, you should first contact our Customer Service Department at 1-800-322-3223. If a mutually satisfactory settlement of this matter cannot be made, you have the right to submit this matter to: Reviewing Officer, Division of Public Utilities and Carriers, 89 Jefferson Blvd., Warwick, Rhode Island 02888 Telephone: 401-780-9700. National Grid will not disconnect your service pending proceedings before a reviewing officer appointed by the Public Utilities Administrator.

### LIHEAP Charge

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### Explanation of Billing Terms Available

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**You have a child under twenty four months and a financial hardship:** If you or anyone presently and normally living in your home has a child under twenty four months old we will not terminate your electric service, provided you also have a financial hardship. Please call our Credit Department at 1-888-211-1313 immediately if this applies to you.

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### *Supply Services*

**SUPPLIER** National Grid

| | | |
|---|---|---|
| Energy Charge | 0.0682219 x 126000 kWh | 8,595.96 |
| | **Total Supply Services** | **$ 8,595.96** |

### *Other Charges/Adjustments*

| | | |
|---|---|---|
| Paperless Billing Credit | | -0.34 |
| Gross Earnings Tax | 0.04166667 x 15,173.37 | 632.23 |
| | **Total Other Charges/Adjustments** | **$ 631.89** |

# Appendix B

# Economic Analysis

| Option A | Solar PV for 430 Scituate Ave Ground System | Solar PV for 61 North Road | Solar PV for 125 Dupont Drive Rooftop Solar 1 | Solar PV for 125 Dupont Drive Rooftop Solar 2 | Solar PV for 125 Dupont Drive Rooftop Solar 3 | Solar PV for 125 Dupont Drive Rooftop Solar 4 | Solar PV for 125 Dupont Drive Complete System | Solar PV for 730 Plainfield Pike | Solar PV for Joslin Farms |
|---|---|---|---|---|---|---|---|---|---|
| Assumed Inflation Rate | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| Initial Capital Cost | $7,585,051.00 | $8,782,922.00 | $420,683.00 | $1,083,579.00 | $1,185,563.00 | $662,895.00 | $3,352,720.00 | $7,916,498.00 | $8,783,361.00 |
| Commercial Scale Renewable Energy Grant | $350,000.00 | $350,000.00 | $144,900.00 | $173,200.00 | $31,900.00 | $0.00 | $350,000.00 | $350,000.00 | $350,000.00 |
| Initial Capital Cost (Minus Incentives) | $7,235,051.00 | $8,432,922.00 | $275,783.00 | $910,379.00 | $1,153,663.00 | $662,895.00 | $3,002,720.00 | $7,566,498.00 | $8,433,361.00 |
| Initial Energy Savings | $449,785.83 | $520,868.66 | $24,864.97 | $63,889.02 | $69,932.59 | $39,024.18 | $197,710.76 | $469,424.80 | $520,868.66 |
| Renewable Energy Credits | $190,294.01 | $220,367.51 | $10,519.80 | $27,029.97 | $29,586.87 | $16,510.23 | $83,646.86 | $198,602.80 | $220,367.51 |
| O&M Costs | $54,353.25 | $62,937.00 | $2,871.00 | $7,395.00 | $8,091.00 | $4,524.00 | $22,881.00 | $56,728.35 | $62,940.15 |
| Total Initial Yearly Savings | $585,726.59 | $678,299.17 | $32,513.77 | $83,523.99 | $91,428.46 | $51,010.41 | $258,476.62 | $611,299.25 | $678,296.02 |
| Assumed Average Useful Life (Years) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Year | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow |
| 0 | -$7,235,051.00 | -$8,432,922.00 | -$275,783.00 | -$910,379.00 | -$1,153,663.00 | -$662,895.00 | -$3,002,720.00 | -$7,566,498.00 | -$8,433,361.00 |
| 1 | $585,726.59 | $678,299.17 | $32,513.77 | $83,523.99 | $91,428.46 | $51,010.41 | $258,476.62 | $611,299.25 | $678,296.02 |
| 2 | $603,298.38 | $698,648.15 | $33,489.18 | $86,029.71 | $94,171.31 | $52,540.72 | $266,230.92 | $629,638.23 | $698,644.90 |
| 3 | $621,397.33 | $719,607.59 | $34,493.85 | $88,610.60 | $96,996.45 | $54,116.94 | $274,217.85 | $648,527.37 | $719,604.25 |
| 4 | $640,039.25 | $741,195.82 | $35,528.67 | $91,268.92 | $99,906.34 | $55,740.45 | $282,444.38 | $667,983.20 | $741,192.38 |
| 5 | $659,240.43 | $763,431.69 | $36,594.53 | $94,006.99 | $102,903.53 | $57,412.67 | $290,917.71 | $688,022.69 | $763,428.15 |
| 6 | $679,017.64 | $786,334.64 | $37,692.36 | $96,827.20 | $105,990.64 | $59,135.05 | $299,645.24 | $708,663.37 | $786,330.99 |
| 7 | $699,388.17 | $809,924.68 | $38,823.14 | $99,732.01 | $109,170.36 | $60,909.10 | $308,634.60 | $729,923.27 | $809,920.92 |
| 8 | $720,369.82 | $834,222.42 | $39,987.83 | $102,723.97 | $112,445.47 | $62,736.37 | $317,893.64 | $751,820.97 | $834,218.55 |
| 9 | $741,980.91 | $859,249.09 | $41,187.46 | $105,805.69 | $115,818.83 | $64,618.46 | $327,430.45 | $774,375.60 | $859,245.10 |
| 10 | $764,240.34 | $885,026.57 | $42,423.09 | $108,979.86 | $119,293.40 | $66,557.02 | $337,253.36 | $797,606.87 | $885,022.46 |
| 11 | $787,167.55 | $911,577.36 | $43,695.78 | $112,249.26 | $122,872.20 | $68,553.73 | $347,370.96 | $821,535.07 | $911,573.13 |
| 12 | $810,782.58 | $938,924.69 | $45,006.65 | $115,616.74 | $126,558.36 | $70,610.34 | $357,792.09 | $846,181.13 | $938,920.33 |
| 13 | $835,106.06 | $967,092.43 | $46,356.85 | $119,085.24 | $130,355.12 | $72,728.65 | $368,525.85 | $871,566.56 | $967,087.94 |
| 14 | $860,159.24 | $996,105.20 | $47,747.56 | $122,657.80 | $134,265.77 | $74,910.51 | $379,581.63 | $897,713.56 | $996,100.57 |
| 15 | $885,964.01 | $1,025,988.35 | $49,179.99 | $126,337.53 | $138,293.74 | $77,157.82 | $390,969.08 | $924,644.96 | $1,025,983.59 |
| 16 | $912,542.93 | $1,056,768.01 | $50,655.39 | $130,127.65 | $142,442.55 | $79,472.56 | $402,698.15 | $952,384.31 | $1,056,763.10 |
| 17 | $939,919.22 | $1,088,471.05 | $52,175.05 | $134,031.48 | $146,715.83 | $81,856.73 | $414,779.10 | $980,955.84 | $1,088,465.99 |
| 18 | $968,116.80 | $1,121,125.18 | $53,740.30 | $138,052.43 | $151,117.31 | $84,312.44 | $427,222.47 | $1,010,384.52 | $1,121,119.97 |
| 19 | $997,160.30 | $1,154,758.93 | $55,352.51 | $142,194.00 | $155,650.82 | $86,841.81 | $440,039.14 | $1,040,696.05 | $1,154,753.57 |
| 20 | $1,027,075.11 | $1,189,401.70 | $57,013.08 | $146,459.82 | $160,320.35 | $89,447.06 | $453,240.32 | $1,071,916.94 | $1,189,396.18 |
| 21 | $1,057,887.37 | $1,225,083.75 | $58,723.48 | $150,853.62 | $165,129.96 | $92,130.47 | $466,837.53 | $1,104,074.44 | $1,225,078.06 |
| 22 | $1,089,623.99 | $1,261,836.26 | $60,485.18 | $155,379.23 | $170,083.86 | $94,894.39 | $480,842.65 | $1,137,196.68 | $1,261,830.40 |
| 23 | $1,122,312.71 | $1,299,691.35 | $62,299.74 | $160,040.60 | $175,186.37 | $97,741.22 | $495,267.93 | $1,171,312.58 | $1,299,685.32 |
| 24 | $1,155,982.09 | $1,338,682.09 | $64,168.73 | $164,841.82 | $180,441.97 | $100,673.46 | $510,125.97 | $1,206,451.95 | $1,338,675.88 |
| 25 | $1,190,661.55 | $1,378,842.56 | $66,093.79 | $169,787.07 | $185,855.22 | $103,693.66 | $525,429.75 | $1,242,645.51 | $1,378,836.15 |
| **AROI** | 3.72% | 3.72% | 3.73% | 3.71% | 3.71% | 3.70% | 3.71% | 3.72% | 3.72% |
| **IRR** | 9.23% | 9.16% | 13.82% | 10.64% | 9.00% | 8.69% | 9.91% | 9.21% | 9.16% |
| **NPV** | $6,981,613.68 | $8,030,650.09 | $513,386.05 | $1,116,902.31 | $1,065,474.26 | $575,221.75 | $3,270,984.37 | $7,270,862.44 | $8,030,134.63 |
| **Simple Payback** | 10.66 | 10.72 | 7.67 | 9.57 | 10.86 | 11.14 | 10.11 | 10.68 | 10.72 |

Notes:
1. Initial Capital Cost does not include any costs related to demolition
2. Initial Capital Cost used a blended rate from material, labor and installation of similar solar installation in Rhode Island
3. This economic analysis does not take into account the degradation the system may experience
4. Energy Cost used to calculate energy savings = $0.1382
5. Assumed $55 per REC.
6. Assumed Energy Production equals Energy Demand

| Option B | Solar PV for 430 Scituate Ave Ground System 2 | Solar PV for 61 North Road | Solar PV for 125 Dupont Drive Rooftop Solar 1 | Solar PV for 125 Dupont Drive Rooftop Solar 2 | Solar PV for 125 Dupont Drive Rooftop Solar 3 | Solar PV for 125 Dupont Drive Rooftop Solar 4 | Solar PV for 125 Dupont Drive Complete System | Solar PV for 730 Plainfield Pike | Solar PV for Joslin Farms |
|---|---|---|---|---|---|---|---|---|---|
| Assumed Inflation Rate | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| Initial Capital Cost | $3,888,135.00 | $4,372,559.00 | $356,944.00 | $943,351.00 | $994,343.00 | $624,651.00 | $2,919,289.00 | $4,385,307.00 | $4,385,307.00 |
| Commercial Scale Renewable Energy Grant | $350,000.00 | $350,000.00 | $126,200.00 | $163,900.00 | $59,900.00 | $0.00 | $350,000.00 | $350,000.00 | $350,000.00 |
| Initial Capital Cost (Minus Incentives) | $3,538,135.00 | $4,022,559.00 | $230,744.00 | $779,451.00 | $934,443.00 | $624,651.00 | $2,569,289.00 | $4,035,307.00 | $4,035,307.00 |
| Initial Energy Savings | $230,628.19 | $259,304.63 | $21,066.11 | $55,600.74 | $58,536.14 | $36,779.34 | $171,982.33 | $259,999.87 | $259,999.87 |
| Renewable Energy Credits | $97,573.47 | $109,705.81 | $8,912.59 | $23,523.39 | $24,765.29 | $15,560.49 | $72,761.76 | $109,999.95 | $109,999.95 |
| O&M Costs | $27,861.75 | $31,333.05 | $2,436.00 | $6,438.00 | $6,786.00 | $4,263.00 | $19,923.00 | $31,424.40 | $31,424.40 |
| Total Initial Yearly Savings | $300,339.91 | $337,677.39 | $27,542.70 | $72,686.13 | $76,515.43 | $48,076.83 | $224,821.09 | $338,575.42 | $338,575.42 |
| Assumed Average Useful Life (Years) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| | | | | | | | | | |
| Year | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow |
| 0 | -$3,538,135.00 | -$4,022,559.00 | -$230,744.00 | -$779,451.00 | -$934,443.00 | -$624,651.00 | -$2,569,289.00 | -$4,035,307.00 | -$4,035,307.00 |
| 1 | $300,339.91 | $337,677.39 | $27,542.70 | $72,686.13 | $76,515.43 | $48,076.83 | $224,821.09 | $338,575.42 | $338,575.42 |
| 2 | $309,350.10 | $347,807.71 | $28,368.98 | $74,866.71 | $78,810.89 | $49,519.13 | $231,565.72 | $348,732.68 | $348,732.68 |
| 3 | $318,630.61 | $358,241.94 | $29,220.05 | $77,112.72 | $81,175.22 | $51,004.71 | $238,512.69 | $359,194.66 | $359,194.66 |
| 4 | $328,189.52 | $368,989.20 | $30,096.65 | $79,426.10 | $83,610.48 | $52,534.85 | $245,668.07 | $369,970.50 | $369,970.50 |
| 5 | $338,035.21 | $380,058.87 | $30,999.55 | $81,808.88 | $86,118.79 | $54,110.90 | $253,038.11 | $381,069.61 | $381,069.61 |
| 6 | $348,176.27 | $391,460.64 | $31,929.53 | $84,263.15 | $88,702.35 | $55,734.22 | $260,629.26 | $392,501.70 | $392,501.70 |
| 7 | $358,621.55 | $403,204.46 | $32,887.42 | $86,791.04 | $91,363.42 | $57,406.25 | $268,448.13 | $404,276.75 | $404,276.75 |
| 8 | $369,380.20 | $415,300.59 | $33,874.04 | $89,394.77 | $94,104.33 | $59,128.44 | $276,501.58 | $416,405.05 | $416,405.05 |
| 9 | $380,461.61 | $427,759.61 | $34,890.26 | $92,076.61 | $96,927.46 | $60,902.29 | $284,796.62 | $428,897.21 | $428,897.21 |
| 10 | $391,875.45 | $440,592.40 | $35,936.97 | $94,838.91 | $99,835.28 | $62,729.36 | $293,340.52 | $441,764.12 | $441,764.12 |
| 11 | $403,631.72 | $453,810.17 | $37,015.08 | $97,684.08 | $102,830.34 | $64,611.24 | $302,140.74 | $455,017.05 | $455,017.05 |
| 12 | $415,740.67 | $467,424.47 | $38,125.53 | $100,614.60 | $105,915.25 | $66,549.58 | $311,204.96 | $468,667.56 | $468,667.56 |
| 13 | $428,212.89 | $481,447.21 | $39,269.30 | $103,633.04 | $109,092.71 | $68,546.06 | $320,541.11 | $482,727.58 | $482,727.58 |
| 14 | $441,059.28 | $495,890.62 | $40,447.38 | $106,742.03 | $112,365.49 | $70,602.45 | $330,157.34 | $497,209.41 | $497,209.41 |
| 15 | $454,291.05 | $510,767.34 | $41,660.80 | $109,944.29 | $115,736.45 | $72,720.52 | $340,062.06 | $512,125.69 | $512,125.69 |
| 16 | $467,919.79 | $526,090.36 | $42,910.62 | $113,242.62 | $119,208.55 | $74,902.13 | $350,263.92 | $527,489.46 | $527,489.46 |
| 17 | $481,957.38 | $541,873.07 | $44,197.94 | $116,639.90 | $122,784.80 | $77,149.20 | $360,771.84 | $543,314.15 | $543,314.15 |
| 18 | $496,416.10 | $558,129.27 | $45,523.88 | $120,139.10 | $126,468.35 | $79,463.67 | $371,595.00 | $559,613.57 | $559,613.57 |
| 19 | $511,308.58 | $574,873.14 | $46,889.59 | $123,743.27 | $130,262.40 | $81,847.58 | $382,742.85 | $576,401.98 | $576,401.98 |
| 20 | $526,647.84 | $592,119.34 | $48,296.28 | $127,455.57 | $134,170.27 | $84,303.01 | $394,225.13 | $593,694.04 | $593,694.04 |
| 21 | $542,447.28 | $609,882.92 | $49,745.17 | $131,279.24 | $138,195.38 | $86,832.10 | $406,051.89 | $611,504.86 | $611,504.86 |
| 22 | $558,720.69 | $628,179.41 | $51,237.53 | $135,217.61 | $142,341.24 | $89,437.07 | $418,233.44 | $629,850.01 | $629,850.01 |
| 23 | $575,482.32 | $647,024.79 | $52,774.65 | $139,274.14 | $146,611.48 | $92,120.18 | $430,780.45 | $648,745.51 | $648,745.51 |
| 24 | $592,746.79 | $666,435.53 | $54,357.89 | $143,452.37 | $151,009.82 | $94,883.78 | $443,703.86 | $668,207.87 | $668,207.87 |
| 25 | $610,529.19 | $686,428.60 | $55,988.63 | $147,755.94 | $155,540.12 | $97,730.30 | $457,014.98 | $688,254.11 | $688,254.11 |
| **AROI** | 3.72% | 3.72% | 3.72% | 3.71% | 3.70% | 3.70% | 3.70% | 3.72% | 3.72% |
| **IRR** | 9.75% | 9.63% | 13.99% | 10.83% | 9.36% | 8.69% | 10.10% | 9.62% | 9.62% |
| **NPV** | $3,751,668.52 | $4,173,494.03 | $437,768.01 | $984,775.46 | $922,727.63 | $542,262.35 | $2,887,533.45 | $4,182,542.88 | $4,182,542.88 |
| **Simple Payback** | 10.24 | 10.33 | 7.58 | 9.43 | 10.56 | 11.13 | 9.97 | 10.34 | 10.34 |

Notes:

1. Initial Capital Cost does not include any costs related to demolition
2. Initial Capital Cost used a blended rate from material, labor and installation of similar solar installation in Rhode Island
3. This economic analysis does not take into account the degradation the system may experience
4. Energy Cost used to calculate energy savings = $0.1382
5. Assumed $55 per REC.
6. Assumed Energy Production equals Energy Demand.

| Option C | Solar PV for 125 Dupont Drive Rooftop Solar 1 | Solar PV for 125 Dupont Drive Rooftop Solar 2 | Solar PV for 125 Dupont Drive Rooftop Solar 3 | Solar PV for 125 Dupont Drive Rooftop Solar 4 | Solar PV for 125 Dupont Drive Complete System |
|---|---|---|---|---|---|
| Assumed Inflation Rate | 3% | 3% | 3% | 3% | 3% |
| Initial Capital Cost | $0.00 | $815,871.00 | $739,383.00 | $484,423.00 | $2,039,677.00 |
| Commercial Scale Renewable Energy Grant | $0.00 | $223,700.00 | $100,800.00 | $25,500.00 | $350,000.00 |
| Initial Capital Cost (Minus Incentives) | $0.00 | $592,171.00 | $638,583.00 | $458,923.00 | $1,689,677.00 |
| Initial Energy Savings | $0.00 | $48,003.15 | $43,513.60 | $28,491.06 | $120,007.81 |
| Renewable Energy Credits | $0.00 | $20,309.03 | $18,409.60 | $12,053.91 | $50,772.54 |
| O&M Costs | $0.00 | $5,568.00 | $5,046.00 | $3,306.00 | $13,920.00 |
| Total Initial Yearly Savings | $0.00 | $62,744.18 | $56,877.20 | $37,238.97 | $156,860.35 |
| Assumed Average Useful Life (Years) | 0 | 25 | 25 | 25 | 25 |
| | | | | | |
| Year | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow |
| 0 | $0.00 | -$592,171.00 | -$638,583.00 | -$458,923.00 | -$1,689,677.00 |
| 1 | | $62,744.18 | $56,877.20 | $37,238.97 | $156,860.35 |
| 2 | | $64,626.50 | $58,583.52 | $38,356.14 | $161,566.16 |
| 3 | | $66,565.30 | $60,341.02 | $39,506.82 | $166,413.14 |
| 4 | | $68,562.25 | $62,151.25 | $40,692.03 | $171,405.53 |
| 5 | | $70,619.12 | $64,015.79 | $41,912.79 | $176,547.70 |
| 6 | | $72,737.70 | $65,936.26 | $43,170.17 | $181,844.13 |
| 7 | | $74,919.83 | $67,914.35 | $44,465.28 | $187,299.46 |
| 8 | | $77,167.42 | $69,951.78 | $45,799.24 | $192,918.44 |
| 9 | | $79,482.44 | $72,050.34 | $47,173.21 | $198,705.99 |
| 10 | | $81,866.92 | $74,211.85 | $48,588.41 | $204,667.17 |
| 11 | | $84,322.92 | $76,438.20 | $50,046.06 | $210,807.19 |
| 12 | | $86,852.61 | $78,731.35 | $51,547.44 | $217,131.40 |
| 13 | | $89,458.19 | $81,093.29 | $53,093.87 | $223,645.34 |
| 14 | | $92,141.94 | $83,526.09 | $54,686.68 | $230,354.70 |
| 15 | | $94,906.19 | $86,031.87 | $56,327.28 | $237,265.35 |
| 16 | | $97,753.38 | $88,612.82 | $58,017.10 | $244,383.31 |
| 17 | | $100,685.98 | $91,271.21 | $59,757.61 | $251,714.81 |
| 18 | | $103,706.56 | $94,009.35 | $61,550.34 | $259,266.25 |
| 19 | | $106,817.76 | $96,829.63 | $63,396.85 | $267,044.24 |
| 20 | | $110,022.29 | $99,734.51 | $65,298.76 | $275,055.56 |
| 21 | | $113,322.96 | $102,726.55 | $67,257.72 | $283,307.23 |
| 22 | | $116,722.65 | $105,808.35 | $69,275.45 | $291,806.45 |
| 23 | | $120,224.33 | $108,982.60 | $71,353.72 | $300,560.64 |
| 24 | | $123,831.06 | $112,252.07 | $73,494.33 | $309,577.46 |
| 25 | | $127,545.99 | $115,619.64 | $75,699.16 | $318,864.78 |
| **AROI** | #DIV/0! | 3.69% | 3.69% | 3.69% | 3.69% |
| **IRR** | #NUM! | 12.40% | 10.30% | 9.26% | 10.78% |
| **NPV** | $0.00 | $930,745.87 | $741,931.56 | $444,935.50 | $2,117,612.93 |
| **Simple Payback** | #DIV/0! | 8.43 | 9.82 | 11.66 | 9.47 |

| REG<br>Option B | Solar PV for 125 Dupont Drive Rooftop Solar 1 | Solar PV for 125 Dupont Drive Rooftop Solar 2 | Solar PV for 125 Dupont Drive Rooftop Solar 3 | Solar PV for 125 Dupont Drive Rooftop Solar 4 | Solar PV for 125 Dupont Drive Complete System |
|---|---|---|---|---|---|
| Assumed Inflation Rate | 3% | 3% | 3% | 3% | 3% |
| Initial Capital Cost | $356,944.00 | $943,351.00 | $994,343.00 | $624,651.00 | $2,919,289.00 |
| Commercial Scale Renewable Energy Grant | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Initial Capital Cost (Minus Incentives) | $356,944.00 | $943,351.00 | $994,343.00 | $624,651.00 | $2,919,289.00 |
| Initial Energy Savings | $21,066.11 | $55,600.74 | $58,536.14 | $36,779.34 | $171,982.33 |
| Nat Grid Offset | $12,882.74 | $34,001.99 | $35,797.10 | $22,491.98 | $105,173.81 |
| O&M Costs | $2,436.00 | $6,438.00 | $6,786.00 | $4,263.00 | $19,923.00 |
| Total Initial Yearly Savings | $31,512.85 | $83,164.73 | $87,547.24 | $55,008.32 | $257,233.14 |
| Assumed Average Useful Life (Years) | 20 | 20 | 20 | 20 | 20 |
| Year | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow |
| 0 | -$356,944.00 | -$943,351.00 | -$994,343.00 | -$624,651.00 | -$2,919,289.00 |
| 1 | $31,512.85 | $83,164.73 | $87,547.24 | $55,008.32 | $257,233.14 |
| 2 | $32,071.75 | $84,639.61 | $89,099.75 | $55,983.81 | $261,794.92 |
| 3 | $32,647.42 | $86,158.74 | $90,698.82 | $56,988.57 | $266,493.55 |
| 4 | $33,240.36 | $87,723.44 | $92,345.88 | $58,023.46 | $271,333.14 |
| 5 | $33,851.09 | $89,335.09 | $94,042.34 | $59,089.41 | $276,317.93 |
| 6 | $34,480.14 | $90,995.08 | $95,789.70 | $60,187.33 | $281,452.25 |
| 7 | $35,128.06 | $92,704.87 | $97,589.47 | $61,318.19 | $286,740.60 |
| 8 | $35,795.42 | $94,465.96 | $99,443.25 | $62,482.98 | $292,187.61 |
| 9 | $36,482.80 | $96,279.88 | $101,352.63 | $63,682.71 | $297,798.02 |
| 10 | $37,190.80 | $98,148.22 | $103,319.30 | $64,918.43 | $303,576.75 |
| 11 | $37,920.05 | $100,072.60 | $105,344.96 | $66,191.22 | $309,528.83 |
| 12 | $38,671.17 | $102,054.72 | $107,431.40 | $67,502.20 | $315,659.48 |
| 13 | $39,444.82 | $104,096.30 | $109,580.43 | $68,852.51 | $321,974.05 |
| 14 | $40,241.68 | $106,199.13 | $111,793.93 | $70,243.32 | $328,478.06 |
| 15 | $41,062.45 | $108,365.05 | $114,073.83 | $71,675.86 | $335,177.19 |
| 16 | $41,907.84 | $110,595.94 | $116,422.13 | $73,151.38 | $342,077.29 |
| 17 | $42,778.59 | $112,893.76 | $118,840.88 | $74,671.16 | $349,184.40 |
| 18 | $43,675.47 | $115,260.51 | $121,332.20 | $76,236.54 | $356,504.71 |
| 19 | $44,599.25 | $117,698.26 | $123,898.25 | $77,848.87 | $364,044.64 |
| 20 | $45,550.75 | $120,209.15 | $126,541.28 | $79,509.58 | $371,810.77 |
| 21 | | | | | |
| 22 | | | | | |
| 23 | | | | | |
| 24 | | | | | |
| 25 | | | | | |
| **AROI** | 3.83% | 3.82% | 3.80% | 3.81% | 3.81% |
| **IRR** | 7.92% | 7.90% | 7.89% | 7.89% | 7.90% |
| **NPV** | $196,468.30 | $517,129.08 | $543,084.56 | $341,358.12 | $1,598,040.06 |
| **Simple Payback** | 10.38 | 10.40 | 10.41 | 10.41 | 10.40 |

Notes:

1. Initial Capital Cost does not include any costs related to demolition
2. Initial Capital Cost used a blended rate from material, labor and installation of similar solar installation in Rhode Island
3. This economic analysis does not take into account the degradation the system may experience
4. Energy Cost used to calculate energy savings = $0.1382

| REG Option C | Solar PV for 125 Dupont Drive Rooftop Solar 1 | Solar PV for 125 Dupont Drive Rooftop Solar 2 | Solar PV for 125 Dupont Drive Rooftop Solar 3 | Solar PV for 125 Dupont Drive Rooftop Solar 4 | Solar PV for 125 Dupont Drive Complete System |
|---|---|---|---|---|---|
| Assumed Inflation Rate | 3% | 3% | 3% | 3% | 3% |
| Initial Capital Cost | $0.00 | $815,871.00 | $739,383.00 | $484,423.00 | $2,039,677.00 |
| Commercial Scale Renewable Energy Grant | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Initial Capital Cost (Minus Incentives) | $0.00 | $815,871.00 | $739,383.00 | $484,423.00 | $2,039,677.00 |
| Initial Energy Savings | $0.00 | $48,003.15 | $43,513.60 | $28,491.06 | $120,007.81 |
| Nat Grid Offset | $0.00 | $29,355.77 | $26,610.24 | $17,423.38 | $73,389.39 |
| O&M Costs | $0.00 | $5,568.00 | $5,046.00 | $165.30 | $10,779.30 |
| Total Initial Yearly Savings | $0.00 | $71,790.92 | $65,077.84 | $45,749.14 | $182,617.90 |
| Assumed Average Useful Life (Years) | 0 | 20 | 20 | 20 | 20 |
| Year | Cash Flow | Cash Flow | Cash Flow | Cash Flow | Cash Flow |
| 0 | $0.00 | -$815,871.00 | -$739,383.00 | -$484,423.00 | -$2,039,677.00 |
| 1 | | $71,790.92 | $65,077.84 | $45,749.14 | $182,617.90 |
| 2 | | $73,063.98 | $66,231.87 | $46,598.91 | $185,894.76 |
| 3 | | $74,375.22 | $67,420.52 | $47,474.18 | $189,269.92 |
| 4 | | $75,725.81 | $68,644.83 | $48,375.70 | $192,746.33 |
| 5 | | $77,116.91 | $69,905.86 | $49,304.27 | $196,327.04 |
| 6 | | $78,549.74 | $71,204.73 | $50,260.70 | $200,015.17 |
| 7 | | $80,025.56 | $72,542.57 | $51,245.82 | $203,813.94 |
| 8 | | $81,545.65 | $73,920.54 | $52,260.49 | $207,726.68 |
| 9 | | $83,111.35 | $75,339.84 | $53,305.60 | $211,756.80 |
| 10 | | $84,724.02 | $76,801.73 | $54,382.07 | $215,907.82 |
| 11 | | $86,385.07 | $78,307.48 | $55,490.83 | $220,183.38 |
| 12 | | $88,095.94 | $79,858.39 | $56,632.86 | $224,587.19 |
| 13 | | $89,858.15 | $81,455.84 | $57,809.14 | $229,123.13 |
| 14 | | $91,673.22 | $83,101.21 | $59,020.71 | $233,795.14 |
| 15 | | $93,542.74 | $84,795.94 | $60,268.63 | $238,607.31 |
| 16 | | $95,468.35 | $86,541.51 | $61,553.99 | $243,563.85 |
| 17 | | $97,451.73 | $88,339.45 | $62,877.91 | $248,669.08 |
| 18 | | $99,494.61 | $90,191.32 | $64,241.54 | $253,927.48 |
| 19 | | $101,598.77 | $92,098.75 | $65,646.09 | $259,343.62 |
| 20 | | $103,766.06 | $94,063.41 | $67,092.77 | $264,922.24 |
| 21 | | | | | |
| 22 | | | | | |
| 23 | | | | | |
| 24 | | | | | |
| 25 | | | | | |
| **AROI** | #DIV/0! | 3.80% | 3.80% | 4.44% | 3.95% |
| **IRR** | #NUM! | 7.88% | 7.88% | 8.85% | 8.12% |
| **NPV** | $0.00 | $444,852.26 | $403,453.87 | $324,807.64 | $1,173,113.77 |
| **Simple Payback** | #DIV/0! | 10.41 | 10.41 | 9.73 | 10.24 |

Notes:

1. Initial Capital Cost does not include any costs related to demolition
2. Initial Capital Cost used a blended rate from material, labor and installation of similar solar installation in Rhode Island
3. This economic analysis does not take into account the degradation the system may experience
4. Energy Cost used to calculate energy savings = $0.1382
5. Assumed $55 per REC.
6. Assumed Energy Production equals Energy Demand.

# Appendix C
# Solar Calculations

| Site Location | Proposed Site | Area (m2) | Area (sq ft) | Site Layout Panel Count | Estimated Area for Solar (sq ft) | Calculated Capacity ($kW_{DC}$) | | Estimated Cost Based on Plan | Annual Energy Produced (kWhAC)2 |
|---|---|---|---|---|---|---|---|---|---|
| **125 Dupont Drive** | **Roof Top 1** | 1,937 | 20,853 | 330 | 7,685.52 | 144 | $ | 420,683 | 191,269 |
| **125 Dupont Drive** | **Roof Top 2** | 3,992 | 42,969 | 850 | 19,796.03 | 370 | $ | 1,083,579 | 491,454 |
| **125 Dupont Drive** | **Roof Top 3** | 4,685 | 50,434 | 930 | 21,659.18 | 405 | $ | 1,185,563 | 537,943 |
| **125 Dupont Drive** | **Roof Top 4** | 2,408 | 25,915 | 520 | 12,110.51 | 226 | $ | 662,895 | 300,186 |
| **125 Dupont Drive** | **Roof Top 1-4** | 13,022 | 140,171 | 2630 | 61,251.24 | 1,144 | $ | 3,352,720 | 1,520,852 |
| **430 Scituate Ave** | **Ground 1** | 21,543 | 231,890 | 5950 | 138,572.19 | 2,588 | $ | 7,585,051 | 3,459,891 |
| **61 North Road** | **Ground 1** | 31,672 | 340,916 | 6890 | 160,464.27 | 2,997 | $ | 8,782,922 | 4,006,682 |
| **730 Plainfield Pike** | **Ground 1** | 29,699 | 319,680 | 6210 | 144,627.45 | 2,701 | $ | 7,916,498 | 3,610,960 |
| **Joslin Farm** | **Ground 1** | 34,877 | 375,413 | 6890 | 160,464.27 | 2,997 | $ | 8,783,361 | 4,006,682 |
| | | | | | | | | | |
| **Totals** | | **143,836** | **1,548,241** | **31,200** | | **13,572** | | **39,773,272** | **18,125,919** |

| Site Location | Proposed Site | Area (m2) | Area (sq ft) | Site Layout Panel Count | Estimated Area for Solar (sq ft) | Calculated Capacity ($kW_{DC}$) | Estimated Cost Based on Plan | Annual Energy Produced (kWhAC)2 |
|---|---|---|---|---|---|---|---|---|
| **125 Dupont Drive** | **Roof Top 1** | 1,937 | 20,853 | 280 | 6,521.04 | 122 | $ 356,944 | 162,047 |
| **125 Dupont Drive** | **Roof Top 2** | 3,992 | 42,969 | 740 | 17,234.19 | 322 | $ 943,351 | 427,698 |
| **125 Dupont Drive** | **Roof Top 3** | 4,685 | 50,434 | 780 | 18,165.77 | 339 | $ 994,343 | 450,278 |
| **125 Dupont Drive** | **Roof Top 4** | 2,408 | 25,915 | 490 | 11,411.83 | 213 | $ 624,651 | 282,918 |
| **125 Dupont Drive** | **Rooftop 1-4** | 13,022 | 140,171 | 2290 | 53,332.83 | 996 | $ 2,919,288 | 1,322,941 |
| **430 Scituate Ave** | **Ground 1** | 21,543 | 231,890 | 3050 | 71,032.81 | 1,327 | $ 3,888,135 | 1,774,063 |
| **61 North Road** | **Ground 1** | 31,672 | 340,916 | 3430 | 79,882.79 | 1,492 | $ 4,372,559 | 1,994,651 |
| **730 Plainfield Pike** | **Ground 1** | 29,699 | 319,680 | 3440 | 80,115.69 | 1,496 | $ 4,385,307 | 1,999,999 |
| **Joslin Farm** | **Ground 1** | 34,877 | 375,413 | 3440 | 80,115.69 | 1,496 | $ 4,385,307 | 1,999,999 |
| **Totals** | | **143,836** | **1,548,241** | **17,940** | | **7,804** | **22,869,885** | **10,414,594** |

| Site Location | Proposed Site | Area (m2) | Area (sq ft) | Site Layout Panel Count | Estimated Area for Solar (sq ft) | Calculated Capacity ($kW_{DC}$) | | Estimated Cost Based on Plan | Annual Energy Produced (kWhAC)2 |
|---|---|---|---|---|---|---|---|---|---|
| **125 Dupont Drive** | **Roof Top 1** | 1,937 | 20,853 | 0 | - | - | $ | - | - |
| **125 Dupont Drive** | **Roof Top 2** | 3,992 | 42,969 | 640 | 14,905.24 | 278 | $ | 815,871 | 369,255 |
| **125 Dupont Drive** | **Roof Top 3** | 4,685 | 50,434 | 580 | 13,507.88 | 252 | $ | 739,383 | 334,720 |
| **125 Dupont Drive** | **Roof Top 4** | 2,408 | 25,915 | 380 | 8,849.99 | 165 | $ | 484,423 | 219,162 |
| **125 Dupont Drive** | **Roof Top 1-4** | 13,022 | 140,171 | 1600 | 37,263.11 | 696 | $ | 2,039,678 | 923,137 |
| **Totals** | | **26,045** | **280,342** | **3,200** | | **1,392** | | **4,079,355** | **1,846,274** |

# Appendix D

# Datasheets of Typical Centralized Inverters


### Economic

- Highest power density
- Market leading efficiency
- Provides ancillary services with Q-on-Demand
- Reduce installation and transportation costs with up to four inverters in a standard shipping container on a flat-bed truck

### Robust

- Proven and intelligent precision air-cooling technology
- Durably built for outdoor installation in harsh environmental conditions
- Robust and redundant fiber optic communication network configurations

### Flexible

- Operation up to 1,000 V DC
- Highest DC:AC design ratio in the industry
- Nominal power operation from -25 °C to 50 °C

### Highly integrated

- Area for customer SCADA equipment
- Integrated zone monitoring
- LOTO DC and AC disconnects
- On-board 120V AC Power Outlet

# SUNNY CENTRAL 2200-US

## The new Sunny Central: maximum power density and integration

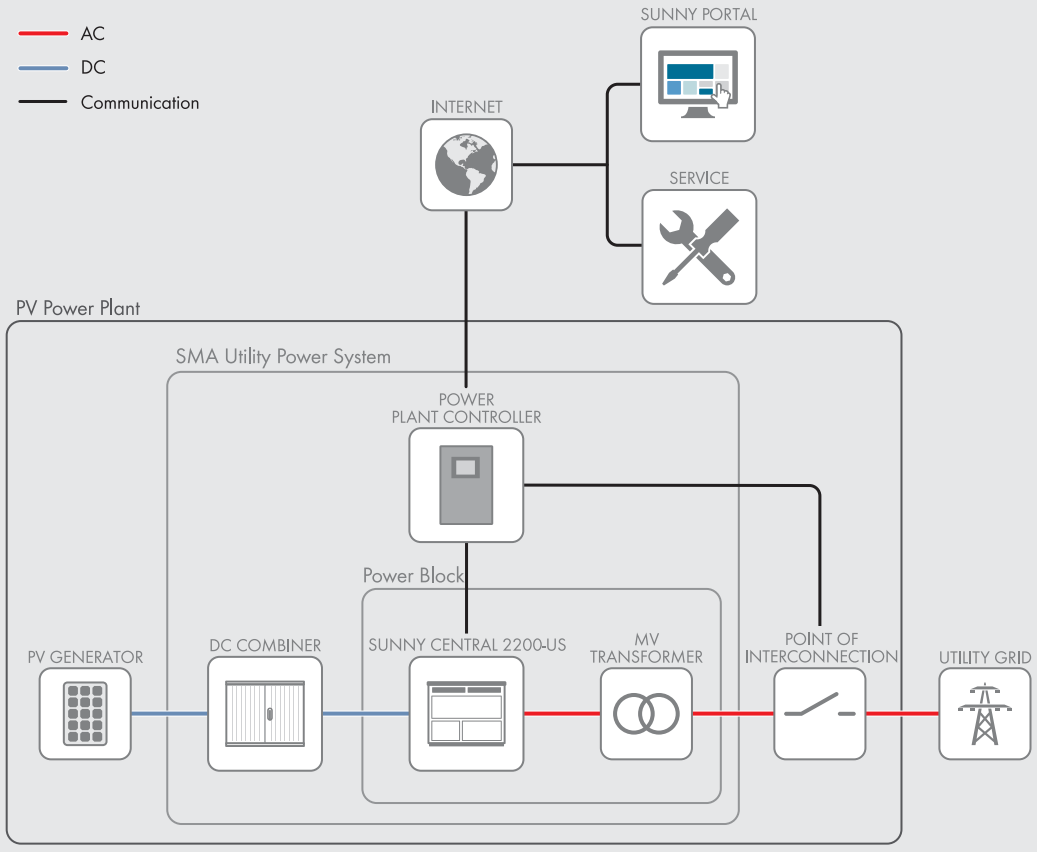
The Sunny Central 2200-US inverter (2,200 kVA for 1,000 V DC at 25 °C) minimizes the total installed cost while maximizing the energy production of the photovoltaic power plant. Integrated control power, convenience power, network switch and optional NEC 2014 compliant DC recombiner and disconnect dramatically increase the speed to energization. The new Sunny Central can connect to virtually any grid in the harshest conditions. It is suitable for global outdoor installation with its proven OptiCool™ precision air cooling technology ensuring smooth operation even under extreme environmental conditions.

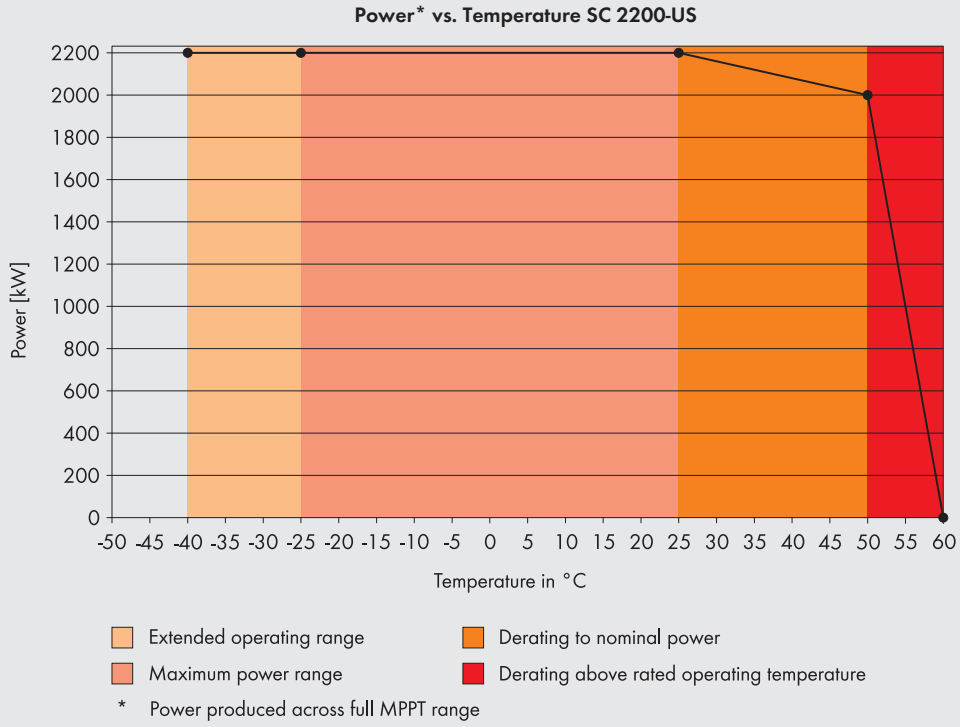
# SUNNY CENTRAL 2200-US

1) Preliminary values
2) At unity power factor
3) Ungrounded systems available with 24 inputs only
4) CEC efficiency includes all control power
5) Power derated above 50°C, 0 kVA above 60°C

| Technical Data | SC 2200-US |
|---|---|
| **Input (DC)** | |
| MPP voltage range $V_{DC}$ [2] | 570 V to 950 V |
| Max. open circuit and operating voltage $V_{DC, max}$ | 1,000 V |
| Max operating DC current $I_{DC, max}$ (@ 25°C / @ 50°C) | 4,110 A / 3,960 A |
| Number of DC inputs (24/28/32) [3] | ● / ○ / ○ |
| Max. number of DC cables per DC input (for each polarity) | 2 x 800 kcmil, 2 x 400 mm[4] |
| Integrated zone monitoring (shunt resistors) | ○ |
| Available DC fuse sizes (per input) | 200 A, 250 A, 315 A, 350 A, 400 A, 450 A |
| **Output (AC)** | |
| Nominal AC power (@ 25°C / @ 40°C / @ 50°C) | 2,200 kVA / 2,080 kVA / 2,000 kVA |
| Nominal AC power at cos ϕ =0.9 (@ 25°C / @ 40°C / @ 50°C) [5] | 1,980 kW / 1,872 kW / 1,800 kW |
| Max AC output current (@ 25°C / @ 40°C / @ 50°C) | 3,300 A / 3,120 A / 3,000 A |
| Nominal AC current $I_{AC, nom}$ | 3,300 A |
| Max. total harmonic distortion | < 3% at nominal power |
| Nominal AC voltage / nominal AC voltage range (line-to-line) | 385 V / 347 V to 424 V |
| AC power frequency | 50 Hz, 60 Hz |
| Power factor at rated power / displacement power factor adjustable | 1 / 0.8 leading to 0.8 lagging |
| **Efficiency** [1] | |
| Max. efficiency / European weighted efficiency / CEC weighted efficiency [4] | 98.6% / 98.3% / 98.0% |
| **Protection and Disconnection Devices** | |
| Input-side disconnection point | DC load-break switch |
| Output-side disconnection point | AC circuit breaker |
| DC overvoltage protection | Surge arrester, type II |
| Ground-fault monitoring / remote ground-fault monitoring | ○ / ○ |
| Insulation monitoring | ○ |
| Degree of protection (as per IEC 60529) | IP54 |
| Degree of protection (as per NEMA) | 3R |
| **General Data** | |
| Dimensions (W / H / D) | 2,780 mm / 2,318 mm / 1,588 mm (109.4 inch / 91.3 inch / 62.5 inch) |
| Weight | < 4,000 kg (8,819 lb) |
| Max. self-consumption (operation) / self-consumption (stand-by) | < 8,100 W / < 300 W |
| Internal control power supply | Integrated 8.4 kVA transformer |
| Operating temperature range [5] | -25°C to 60°C / -13°F to 140°F |
| Extended operating temperature range | ○ (-40°C to 60°C / -40°F to 140°F) |
| Temperature range (stand-by) | -40°C to 60°C / -40°F to 140°F |
| Temperature range (storage) | -40°C to 70°C / -40°F to 158°F |
| Max. permissible value for relative humidity (condensing) | 0% to 95% (non-condensing) and up to 100% (condensing) for max. 2 months per year |
| Maximum operating altitude above MSL 2000m (6562 ft) / 4000m (13123 ft) | ● / ○ (with power reduction) |
| Fresh air consumption | 3,826 cfm / 6,500 m³/h |
| **Features** | |
| DC connection | Terminal lug on each input with NEMA lug hole pattern |
| AC connection | With busbar system (three busbars, one per line conductor) |
| Communication | Ethernet, Ethernet/IP, Modbus TCP/IP |
| Enclosure / roof color | RAL 9016 / RAL 7004 |
| Display | HMI touchscreen (10.1") |
| Convenience power supply transformer | ○ (2.5 kVA) |
| Certificates and approvals | UL 1741, UL 1998, UL 840 Category IV, EMC FCC Part 15 Class A, IEEE 1547, BDEW and CE |
| | |
| | |
| | |
| | |
| ● Standard feature ○ Optional feature | |
| Type designation | SC-2200-US-10 |

## PLANT DIAGRAM



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Solar inverters

# ABB central inverters
# ULTRA-750/1100/1500
# 750kW to 1560kW

**ABB's utility-scale ULTRA inverters combine high efficiency with a wide input-voltage range and multiple maximum power point trackers (MPPT).**

**The inverters can be configured with up to four independent, high-speed MPPT.**
Each precise MPPT accommodates one of the widest input-voltage ranges in the market (470 to 900Vdc) to generate more energy and maximize the return on investment.

**The ULTRA inverter is a flexible and efficient platform.**
Modular design increases uptime and reduces service and maintenance costs. The low cost of ownership, higher energy production and ease of maintenance combine to make the ULTRA inverter the ideal choice for utility-scale solar projects.

**ULTRA inverters are rugged.**
The liquid-cooled, corrosion-resistant ULTRA inverters are certified by CSA to UL50E type 4X (meets NEMA 4X) and ideally suited for any environmental condition.

**ULTRA inverters are durable for long life.**
ABB ULTRA inverters utilize an advanced closed-loop liquid cooling system that limits both component temperatures and temperature cycling. ULTRA inverter film capacitors have longer life expectancy than traditional electrolytic capacitors. Generous component derating guidelines are followed. The combination of design and ABB commitment to service ensures the inverter will provide a long-term return on investment.

**Highlights:**
- The ULTRA inverter operates at high efficiency (98.4 percent peak, up to 98 percent CEC)
- The wide input voltage range maximizes energy production
- Liquid cooling increases reliability of critical components
- ULTRA inverters are compatible with all types of PV technologies
- The enclosure is certified to UL50E type 4X (NEMA 4X)
- The inverter output is 690 Vac, three-phase, DELTA configuration
- The ULTRA inverter operates with up to four MPPT connections
- ULTRA inverters are certified by CSA to UL 1741

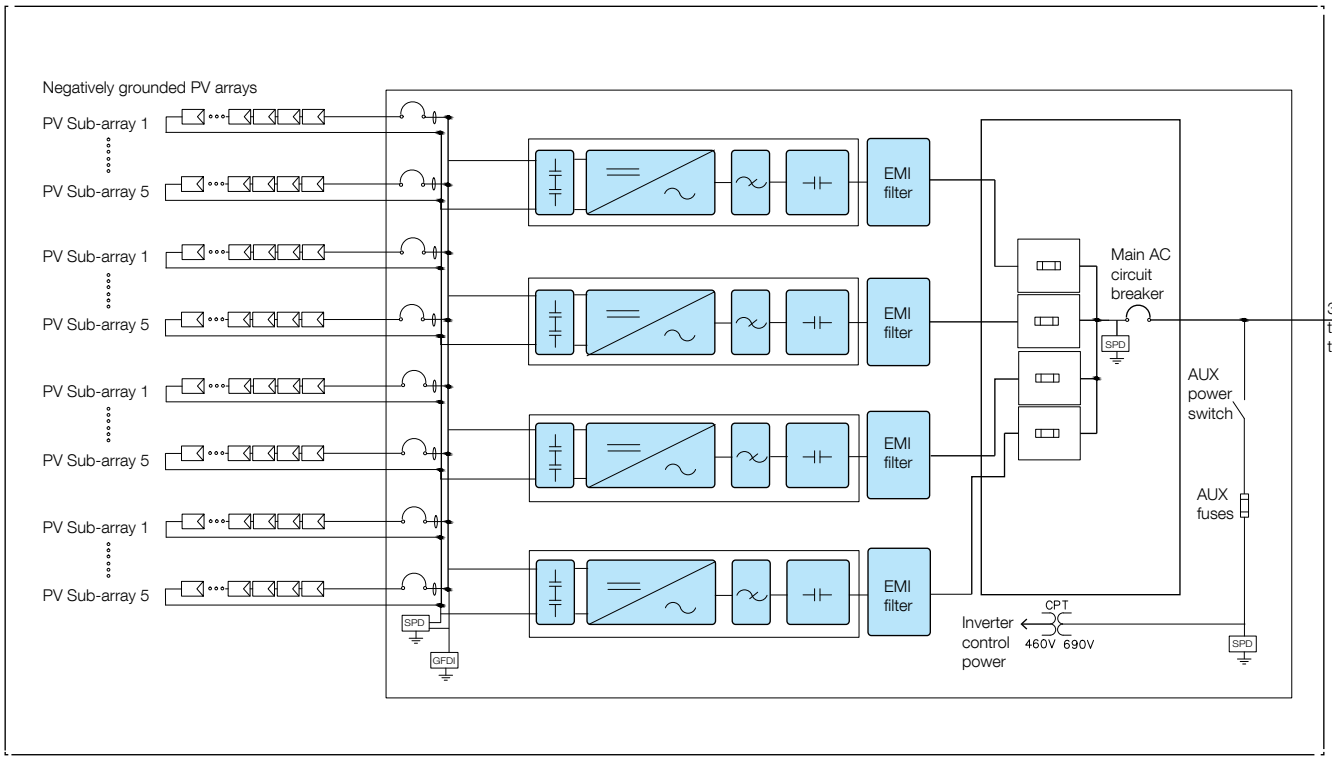
Power and productivity
for a better world™

## Technical data and types

| Type code | ULTRA-750-TL-OUTD-X-US-690 | | | | ULTRA-1100-TL-OUTD-X-US-690 | | | | ULTRA-1500-TL-OUTD-X-US-690 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X = | -1 | -2 | -3 | -4 | -1 | -2 | -3 | -4 | -1 | -2 | -3 | -4 |
| Rated output power (Pac) (active) | 780kW | 750kW | 780kW | 750kW | 1170kW | 1000kW | 1170kW | 1000kW | 1560kW | 1500kW | 1560kW | 1500kW |
| Rated output power (apparent) | 780kVA | | | | 1170 kVA | 1115 kVA | 1170 kVA | 1115 kVA | 1560kVA | | | |
| **Input side (DC)** | | | | | | | | | | | | |
| Absolute maximum voltage | 1000Vdc | | | | | | | | | | | |
| MPPT voltage range | 470-900Vdc | | | | | | | | | | | |
| MPPT range at full power (89°F/ 30°C) | 585-850Vdc | | | | 585-850 Vdc | 540-850 Vdc | 585-850 Vdc | 540-850 Vdc | 585-850Vdc | | | |
| MPPT range at full power (120°F/50°C) | 650-850Vdc | | | | | | | | | | | |
| Maximum current per 390kW inverter module | 700A | | | | | | | | | | | |
| Maximum combined current | 1400A | | | | 2100A | | | | 2800A | | | |
| Number of independent MPPT (fused input version only) | 2 | | | | 3 | | | | 4 | | | |
| Number of independent MPPT (master-slave) | 1 | | | | 1 | | | | 1 | | | |
| Maximum number of DC inputs | 10 | | | | 15 | | | | 20 | | | |
| DC connections (Cu or Al) | **Cu**; 1 x1000 MCM or 2 x 300 MCM, max. **Al**; 1 x 1000 MCM or 2 x 400 MCM, max. | | | | | | | | | | | |
| Array grounding | Negative or positive | | | | | | | | | | | |
| DC cable entry | Bottom | | | | | | | | | | | |
| **Inverter output side (AC)** | | | | | | | | | | | | |
| Rated voltage | 690Vac (3 Phase / 3 Wire) | | | | | | | | | | | |
| Operating range[1] | 607-759Vac (3 Phase / 3 Wire) | | | | | | | | | | | |
| Grid frequency (adjustment range) | 59.3-60.5Hz (57-63Hz) | | | | | | | | | | | |
| Maximum output current | 655A | | | | 983A | 932A | 983A | 932A | 1310A | | | |
| Power factor control range | 1.0 Nominal (adjust ±0.90 to ±0.99) | | | | | | | | | | | |
| Total harmonic distortion (@ rated output power) | <3% | | | | | | | | | | | |
| AC cable size (Cu or Al) bottom entry | Up to 6 cables per phase (maximum 1000 MCM), 90°C terminals, 3/8“ threaded stud | | | | | | | | | | | |
| AC busbar (option) | Side entry | | | | | | | | | | | |
| **Input protection devices** | | | | | | | | | | | | |
| Reverse polarity protection | Yes | | | | | | | | | | | |
| Overvoltage protection type | SPD (Class II) | | | | | | | | | | | |
| DC switch per 390kW inverter module (fused input option only) | 1000A / 1000V | | | | | | | | | | | |
| Fuse size on each input (fused input option only) | (125-400A) / 1000V | | | | | | | | | | | |
| DC breaker max size (breaker input option only) | 400A / 1000V | | | | | | | | | | | |
| PV array isolation control | According to NEC | | | | | | | | | | | |
| **Output protection devices** | | | | | | | | | | | | |
| Anti-islanding protection | IEEE 1547 | | | | | | | | | | | |
| Overvoltage protection | SPD (Class II) | | | | | | | | | | | |
| AC fuse per 390kW inverter module | Yes | | | | | | | | | | | |
| AC circuit breaker (adjustable) | 800 | | | | 1200 | | | | 1600 | | | |
| Nighttime disconnect | Automatic | | | | | | | | | | | |

1. The active / reactive power output varies as a function of output voltage

## Block diagram of ULTRA-1500-TL-OUTD with DC circuit breakers

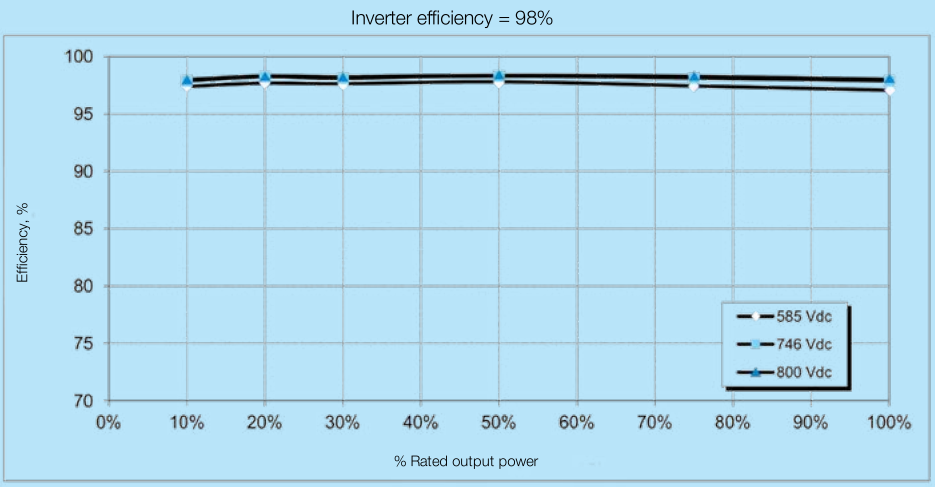



## Technical data and types

| Type code | ULTRA-750-TL-OUTD-X-US-690 | | | | ULTRA-1100-TL-OUTD-X-US-690 | | | | ULTRA-1500-TL-OUTD-X-US-690 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X= | -1 | -2 | -3 | -4 | -1 | -2 | -3 | -4 | -1 | -2 | -3 | -4 |
| **Efficiency** | | | | | | | | | | | | |
| CEC efficiency | 97.5% | 97.5% | 98.0% | 98.0% | 97.5% | 97.5% | 98.0% | 98.0% | 97.5% | 97.5% | 98.0% | 98.0% |
| Maximum efficiency | 98.4% | | | | | | | | | | | |
| **Operating performance** | | | | | | | | | | | | |
| Stand-by consumption/nighttime power loss | 302W | 302W | 347W | 347W | 329W | 329W | 382W | 382W | 374W | 374W | 430W | 430W |
| Auxiliary power supply connection type | 690Vac / 3 Phase | | | | | | | | | | | |
| Inverter internal power consumption | <0.50% | | | | <0.40% | | | | <0.50% | | | |
| **Environmental** | | | | | | | | | | | | |
| Ambient air operating temperature range | -4°F to 140°F (-20°C to 60°C) with derating above 122°F (50°C) | | | | | | | | | | | |
| Noise emission level at 1m (EN62109) | <78dBA | | | | | | | | | | | |
| Maximum operating altitude without derating | 6560ft (2000m) | | | | | | | | | | | |
| Relative humidity | 0-100%, condensing | | | | | | | | | | | |
| **Communication** | | | | | | | | | | | | |
| Communication protocol | RS-485, Modbus RTU, Modbus TCP (optional), Ethernet IP (optional) | | | | | | | | | | | |
| User interface | 5.7" touchscreen LCD | | | | | | | | | | | |
| Monitoring system | AURORA Universal, PVI-AEC-EVO | | | | | | | | | | | |
| **Mechanical specifications** | | | | | | | | | | | | |
| Environmental protection rating | UL50E Type 4X (NEMA 4X) | | | | | | | | | | | |
| Seismic | IBC 2012 ( ASCE 7-10), Sds = 2.0g, Risk Category I and II | | | | | | | | | | | |
| Cooling | Liquid cooled with on-board heat exchanger | | | | | | | | | | | |
| Dimension H x W x D | 115in x 118in x 58in (2912mm x 3003mm x 1470mm) | | | | 115in x 146in x 58in (2912mm x 3703mm x 1470mm) | | | | 115in x 173in x 58in (2912mm x 4403mm x 1470mm) | | | |
| Approximate unit weight | 9000lb (4100kg) | | | | 10500lb (4800kg) | | | | 12000lb (5500kg) | | | |
| Swappable 390kW power conversion module weight | >121lb (55kg) | | | | | | | | | | | |
| **Safety** | | | | | | | | | | | | |
| Marking | $_{C}$CSA$_{US}$ | | | | | | | | | | | |
| Safety and EMC standards | UL1741 | | | | | | | | | | | |
| Utility interconnect standards | IEEE 1547, IEEE1547.1, NERC PRC-024-1, WECC, BDEW | | | | | | | | | | | |
| **Warranty** | | | | | | | | | | | | |
| Standard warranty | 5 years | | | | | | | | | | | |
| Extended warranty | 5 years | | | | | | | | | | | |

1. The active / reactive power output varies as a function of output voltage

# Maximize yields with high efficiency and advanced grid support




### Maximum energy and return on investment

ABB ULTRA inverters have industry-leading peak and weighted efficiencies. Optimized and accurate system control, an industry-leading MPPT algorithm, and a high-efficiency power converter design ensure that maximum energy is delivered to the power distribution network from the PV modules. For plant owners this translates into a high rate of return.

### Proven components

The inverters comprise proven and reliable components, with a long track record of performance in demanding applications and harsh environments. Equipped with extensive electrical and mechanical protection, the inverters operate reliably for the life of the plant.

### Multi-stage modular design

ULTRA inverters have a two-stage modular architecture for maximum design flexibility. The two-stage topology results in a wide MPPT window and a high (690Vac) output voltage. The modular design (390kW blocks) enables the integrator to choose an inverter with a master-slave or multimaster configuration. This enables integrators to optimize production for each site and reduces installation and service times.

### Effective connectivity to the power distribution network

ABB's transformerless ULTRA inverters enable system integrators to design a PV power plant using the optimum combination of different inverter power ratings. Inverters are connected to the medium voltage (MV) power distribution network either centrally or in a distributed architecture, depending on the plant design and size.

### Advanced grid support features

ABB ULTRA inverters include all the latest grid support and monitoring features including active/reactive power curtailment, low/high voltage ride through, power factor and reactive power control.
All these features can be accessed through a supervisory control and data acquisition (SCADA) system. Voltage and frequency droop functions can be enabled for specific applications.

## High total performance

- High efficiency (CEC listed)
- Wide MPPT operating range
- Efficient maximum power point tracking
- Liquid-cooled design for a 20-year life

## Modular architecture

- Higher up time
- Compact and easy to service
- All front-accessible components
- Integrated and flexible DC input cabinet with DC fuses or breakers
- Integrated station design available

## Full grid support functionality

- Power factor operation, Q priority mode
- Voltage regulation, active power curtailment
- Droop control functions, VRT, FRT
- Rule 21 ready and HECO compliant

## Extensive protection

- AC output circuit breaker with remote operation
- DC fuses or circuit breakers for redundant protection
- DC and AC surge protection standard

## Grid code compatibility

- IEEE1547 and NERC PRC-024-1 (CSA-approved)
- Country-specific grid code compliance
- Adjustable to various local utility requirements
- Meets international utility requirements

## Proven technology

- Based on ABB‘s market-leading ULTRA technology designed for utility-scale PV
- NEMA 4X design with closed-loop liquid cooling
- Zone 4 seismic design

## Life cycle service and support

- ABB‘s extensive global service network
- Extended warranties
- Service contracts
- Technical support throughout the product life

## Communication

- Modbus RTU, Modbus TCP, Ethernet IP communication interfaces available
- Optional remote monitoring and SCADA reporting

## Model configurations

| Product line | Model | No isolation transformer | For outdoor use | Power option | North American model* | 690Vac 3-Phase delta | Standard options |
|---|---|---|---|---|---|---|---|
| ULTRA | -750 | -TL | OUTD | -1 | -US | -690 | -ABCDE-FGHJKL |
| | -1100 | | | -2 | | | |
| | -1500 | | | -3 | | | |
| | | | | -4 | | | |

| Model | Description |
|---|---|
| -750 | 750 or 780kW active power |
| -1100 | 1100 or 1170kW active power |
| -1500 | 1500 or 1560kW active power |

| Power option | Description |
|---|---|
| -1 | active power = apparent power |
| -2 | reduced active power compared to apparent power |
| -3 | increased efficiency, active power = apparent power |
| -4 | increased efficiency, reduced active power compared to apparent power |

| Standard options | Description | Available options | | |
|---|---|---|---|---|
| A | MPPT | S = Single Master/Slave | M = Multiple MPPT** | |
| B | Grounding | S = Solid | R = Resistive | |
| C | Array configuration | N = Negative gnd | P = Positive gnd | |
| D | DC input protection type | 2 = 200 A fuse box | 4 = 400 A fuse box | D = DC circuit breakers |
| E | Communication | R = Modbus RTU | T = Modbus TCP | I = Ethernet IP |
| F | Zone level monitoring | 1=Yes | 0 = No | |
| G | Programmable MPPT sweep | 1=Yes | 0 = No | |
| H | IR window | 1=Yes | 0 = No | |
| J | Leakage current monitor | 1=Yes | 0 = No | |
| K | Array ground insulation monitor | 1=Yes | 0 = No | |
| L | Cable glands | 1=Yes | 0 = No | |

*CE-marked, 50Hz inverter also available
**Resistive grounding only. DC fuse models only

### Support and service

ABB supports its customers with a dedicated, global service organization in more than 60 countries, with strong regional and national technical partner networks providing a complete range of life cycle services.

For more information please contact your local ABB representative or visit:

**www.abb.com/solarinverters**

**www.abb.com**



9AKK106103A5770 REV E EN 09.12.2015 #16634

Power and productivity for a better world™

# Appendix E

# Datasheets of Typical Rooftop Inverters

YASKAWA SOLECTRIA SOLAR

# PVI 14TL
# PVI 20TL
# PVI 23TL
# PVI 28TL
# PVI 36TL

3-PH TRANSFORMERLESS STRING INVERTERS

## FEATURES

- 600 or 1000 VDC
- Best in class efficiency
- Touch-safe fuses
- Dual & wide MPP tracking zones
- Modbus communications
- Integrated DC fused string combiner
- DC arc-fault protection
- PVI 36TL - HECO and Rule 21 compliant

## OPTIONS

- Web-based monitoring
- Shade cover
- DC/AC disconnect covers
- Roof mount array brackets
- DC combiners bypass

SOLECTRIA.COM

## 3-PH TRANSFORMERLESS STRING INVERTERS

Yaskawa - Solectria Solar's PVI 14TL, PVI 20TL, PVI 23TL, PVI 28TL, and PVI 36TL are compact, transformerless three-phase inverters with a dual MPP tracker. These inverters come standard with AC and DC disconnects, user-interactive LCD, and an 8-position string combiner. Its small, lightweight design makes for quick and easy installation and maintenance. These inverters include an enhanced DSP control, comprehensive protection functions, and advanced thermal design enabling highest reliability and uptime. They also come with a standard 10 year warranty with options for 15 and 20 years. Options include web-based monitoring, shade cover, DC/AC disconnect covers, DC combiners bypass, and roof mount array bracket.

| SPECIFICATIONS | PVI 14TL | PVI 20TL | PVI 23TL | PVI 28TL | PVI 36TL |
|---|---|---|---|---|---|
| **DC Input** | | | | | |
| Absolute Maximum Open Circuit Voltage | 600 VDC | | 1000 VDC | | |
| Operating Voltage Range | 180-580 VDC | 260-580 VDC | 300-900 VDC | | 200-950 VDC |
| Max Power Input Voltage Range (MPPT) | 300-540 VDC | 300-550 VDC | 480-800 VDC | 500-800 VDC | 540-800 VDC |
| MPP Trackers | 2 with 4-fused inputs per tracker | | | | |
| Maximum Operating Input Current | 25 A per MPPT (50 A) | 35 A per MPPT (70 A) | 25 A per MPPT (50 A) | 29 A per MPPT (58 A) | 35 A per MPPT (70 A) |
| Maximum Available PV Current (Isc x 1.25) | 45 A per MPPT (90 A) | 45.5 A per MPPT (91 A) | 41 A per MPPT (82 A) | 48 A per MPPT (96 A) | 53.5 A per MPPT (107 A) |
| Maximum PV Power (per MPPT) | 9.5 kW | 13.5 kW | 15.5 kW | 19 kW | 27 kW |
| Strike Voltage | 300 V | | 330 V | | |
| **AC Output** | | | | | |
| Nominal Output Voltage | 208 VAC, 3-Ph | 480 VAC, 3-Ph | | | |
| AC Voltage Range (Standard) | -12%/+10% | | | | |
| Continuous Output Power | 14 kW | 20 kW | 23 kW | 28 kW | 36 kW |
| Maximum Output Current | 39 A | 25.5 A | 27.7 A | 33.7 A | 43.5 A |
| Maximum Backfeed Current | 0 A | | | | |
| Nominal Output Frequency | 60 Hz | | | | |
| Output Frequency Range | 59.3-60.5 Hz (adjustable 55-65 Hz) | | | | 57-63 Hz |
| Power Factor | Unity, >0.99 (±0.8 adjustable) | Unity, >0.99 (±0.9 adjustable) | Unity, >0.99 (±0.8 adjustable) | | |
| Fault Current Contribution (1 Cycle RMS) | 70.4 A | 43.3 A | 69.6 A | | 73.2 A |
| Total Harmonic Distortion (THD) @ Rated Load | < 3% | | | | |
| Grid Connection Type | 3ø+/N/GND (4-wire) | | | | |
| **Efficiency** | | | | | |
| Peak Efficiency | 96.9% | 97.4% | 98.6% | 98.4% | |
| CEC Efficiency | 96.0% | 97.0% | 98.0% | | |
| Tare Loss | 4 W | 2 W | | | |
| **Integrated String Combiner** | | | | | |
| 8 Fused Positions (4 positions per MPPT) | 15 A (fuse by-pass available) | | | | 15 or 30 A (30 A only for combined inputs) |
| **Temperature** | | | | | |
| Ambient Temperature Range | -13°F to +140°F (-25°C to +60°C) Derating occurs over +50°C | | -13°F to +140°F (-25°C to +60°C) Derating occurs over +45°C | | |
| Storage Temperature Range | -22°F to +158°F (-30°C to +70°C) | | | | -40°F to +158°F (-40°C to +70°C) |
| Relative Humidity (non-condensing) | 0-95% | | | | |
| Operating Altitude | 13,123 ft/4,000 m (derating from 6,562 ft/2,000 m) | | | | 13,123 ft/4,000 m (derating from 9,800 ft/3,000 m) |
| **Data Monitoring** | | | | | |
| Optional SolrenView Web-based Monitoring | Integrated | | | | |
| Optional Revenue Grade Monitoring | External | | | | |
| External Communication Interface | RS-485 Modbus RTU | | | | |
| **Testing & Certifications** | | | | | |
| Safety Listings & Certifications | UL 1741/IEEE 1547, CSA C22.2#107.1, FCC part 15 B | | | | |
| Testing Agency | ETL | | CSA | | |
| **Warranty** | | | | | |
| Standard | 10 year | | | | |
| Optional | 15, 20 year; extended service agreement | | | | |
| **Enclosure** | | | | | |
| dBA (Decibel) Rating | < 50 dBA @ 3 m | | | | |
| AC/DC Disconnect | Standard, fully-integrated | | | | |
| Dimensions (H x W x D) | 41.6 in. x 21.4 in. x 8.5 in. (1057 mm x 544 mm x 216 mm) | | 39.4 in. x 23.6 in. x 9.1 in. (1001 mm x 600 mm x 232 mm) | | |
| Weight | 141 lbs (64 kg) | 132 lbs (60 kg) | 104 lbs (47.2 kg) | | 121 lbs (55kg) |
| Enclosure Rating | Type 4 | | | | Type 4X |
| Enclosure Finish | Polyester powder coated aluminum | | | | |


**Efficient**
- Maximum efficiency of 98.8%
- Superior power density: 60 kVA at only 165 pounds

**Reliable**
- Distributed architecture for maximum system availability
- Central control with SMA Inverter Manager

**Cost-Effective**
- DC input of up to 1,000 V
- Up to 2.5 MW per inverter manager

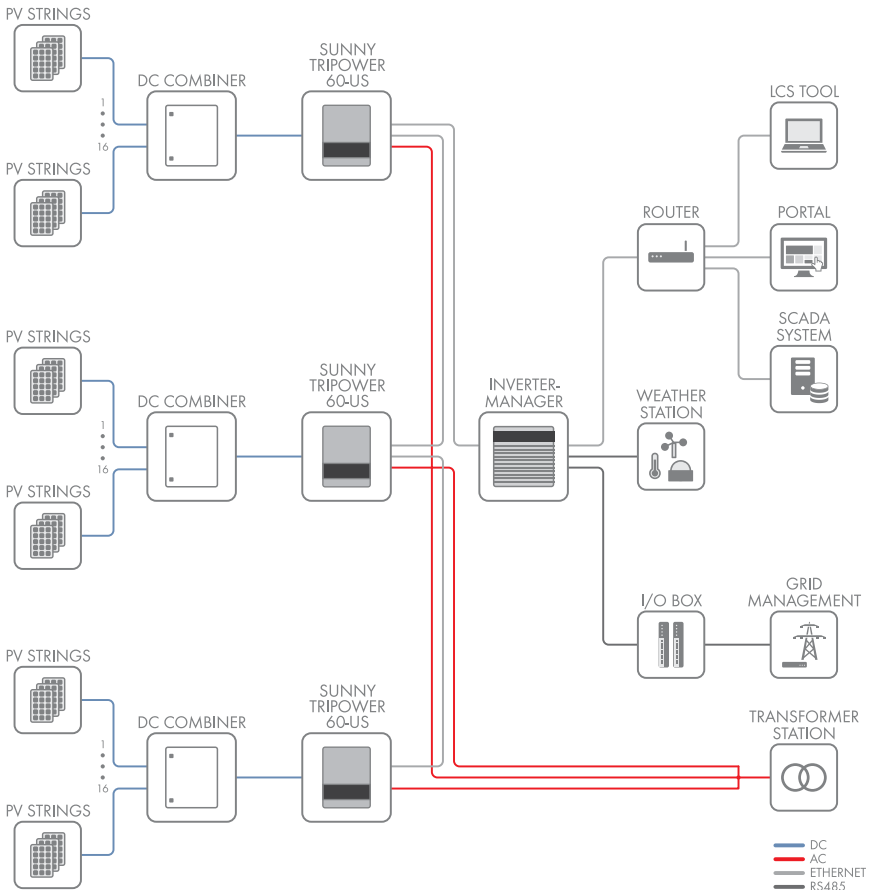
**Innovative**
- Suitable for commercial and utility applications
- Complete grid management feature set

# SUNNY TRIPOWER 60-US

## The efficient solution for medium to large-scale PV Plants

The new Sunny Tripower 60-US is part of an innovative, global system solution for commercial and utility PV plants. This solution combines the advantages of a decentralized system layout with the benefits of centralized inverter designs which results in the best of both worlds. High efficiency, easy installation, simple commissioning and low maintenance requirements contribute decisively to reducing the operating costs for the entire plant.

## THE SMART SUNNY TRIPOWER 60-US SYSTEM PHILOSOPHY



# UNMATCHED POWER DENSITY

## With Maximum Efficiency

The new SMA system solution consists of three components: highly efficient Sunny Tripower 60-US inverters, the SMA Inverter Manager and the LCS commissioning tool. It is precisely this systemized approach that makes the Sunny Tripower 60-US so unique and ensures a high level of performance.

**System Cost Reduction**
With a compact design of 60 kVA weighing only 165 pounds, the Sunny Tripower 60-US requires little space, reduces on-site preparation work, simplifies installation and lowers maintenance costs.

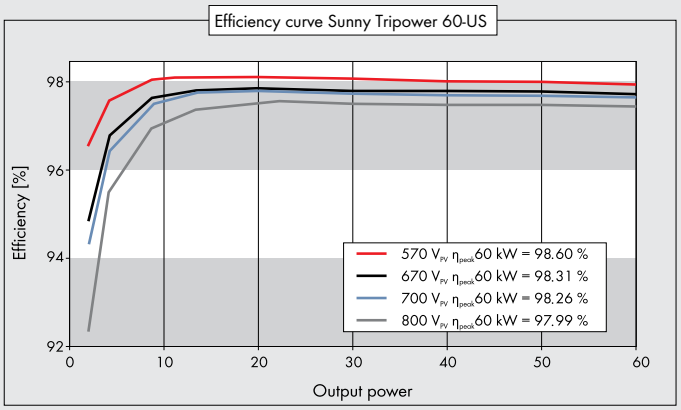
**Innovative system management**
The SMA Inverter Manager is the central communications component and sole interface for the entire system control. It handles all the important inverter and system management functions for up to 2.5 MW with a single inverter manager.

The Sunny Tripower 60-US benefits from a self-configuring inverter network with automatic IP configuration and device discovery, which eliminates manual setup. The SMA Inverter Manager also creates a seamless inverter control loop which enables complete grid management capabilities.

**Simple commissioning**
The specially developed LCS tool (Local Commissioning and Service Tool) makes commissioning easy, saves time and reduces costs. The inverter is configured by simply selecting the system-specific configuration files and then transmitting them to all inverters. In addition, individual inverter data is aggregated into a single plant profile for comprehensive plant performance analysis.

| Technical data | Sunny Tripower 60-US |
|---|---|
| **Input (DC)** | |
| Max. input voltage | 1,000 V |
| MPP voltage range | 570 V to 800 V @400 VAC, 685 V to 800 V @480 VAC |
| Min. input voltage | 565 V @400 VAC, 680 V @480 VAC |
| Max. input current / short-circuit current | 110 A / 150 A |
| Number of independent MPP inputs / strings per MPP input | 1/1 (split up by external PV array junction box) |
| **Output (AC)** | |
| Rated power at nominal voltage | 60,000 W |
| Max. apparent AC power | 60,000 VA |
| Output Phases / line connections | 3 / PE |
| Nominal AC voltage | 400 V, 480 V |
| Nominal AC voltage range | 352 V to 440 V @400 VAC, 423 V to 528 V @480 VAC |
| AC power frequency | 50 Hz, 60 Hz |
| Rated power frequency / rated grid voltage | 50 Hz, 60 Hz / 400 V, 480 V |
| Max. output current | 3 x 87 A @ 400 V, 3 x 72 A @ 480 V |
| Power factor at rated power/displacement power factor adjustable | 1/0.8 lagging ... 0.8 leading |
| Feed-in phases / connection phases | 3 / 3 |
| **Efficiency** | |
| Max. efficiency / CEC @ 400 VAC / CEC @ 480 VAC | 98.8% / 98.0% / 98.5% |
| **Protective devices** | |
| DC-side disconnection point / DC surge arrester (type II) can be integrated | ● / ● |
| Ground fault monitoring / grid monitoring | ● / ● |
| DC reverse polarity protection / AC short-circuit current capability / galvanically isolated | ● / ● / – |
| All-pole sensitive residual-current monitoring unit | ● |
| Protection class (acc. to IEC 62103)/overvoltage category (acc. to IEC 60664-1) | I / AC: III, DC: II |
| **General data** | |
| Dimensions (W / H / D) / weight | 570 / 740 / 300 mm (22.4 / 29.1 / 11.8 inch) / 75 kg (165.3 lbs) |
| Operating temperature range | -25 °C ... +60 °C (-13 °F to +140°F) |
| Noise emission, typical / Self-consumption (at night) | 55 dB(A) / 3W |
| Topology / cooling concept, degree of protect. (IEC 60529/ UL50E ), climatic cat. (IEC 60721-3-4) | Transformerless / active, IP65 / NEMA 3R, 4K4H |
| Maximum permissible value for relative humidity (non-condensing) | 95% |
| **Features** | |
| DC connection / AC connection | Screw terminal / screw terminal |
| Display / Interface | Graphic / Using external inverter manager: Modbus TCP |

● Standard features ○ Optional features – Not available




**Type Designation**

Sunny Tripower 60-US:
STP 60-US-10 with DC Switch

SMA Inverter Manager:
IM-10: SMA Inverter Manager for max. 42 inverters

I/O Module:
IM-DIO-10: SMA Digital I/O Box with 6 digital inputs

**Certificates and Approvals**

Sunny Tripower 60-US: IEC 62109-1/IEC 62109-2 (Class I, grounded–communication Class II, PELV), UL1741–w. Non-Isolated EPS Interactive PV Inverters, IEEE 1547, FCC Part 15, Subpart B Class A

SMA Inverter Manager: UL 508, UL 60950-1, CSA C22.2 No. 60950-1-07, EN 60950-1, EN 55022 Class A, EN 61000-3-2 Class D, EN 61000-3-3, EN55024, FCC Part 15, Subpart B Class A

| Technical data | SMA Inverter Manager |
|---|---|
| **Voltage supply** | |
| Input voltage | 9 - 36 Vdc |
| Power consumption | < 20 W |
| **General data** | |
| Dimensions (W / H / D) / weight | 160 / 125 / 49 mm (6.3 / 4.9 / 1.9 inch) / 940 g (2 lbs) |
| Degree of protection / assembly | IP21 / DIN top-hat rails or wall mounting |
| Operating temperature range / relative humidity | -40 to +85 °C / 5 - 95 % (non-condensing) |
| Cooling concept | Convection |
| **Interfaces** | |
| User interface / Sensor interface | LCS tool for PC / RS-485 for Sunspec Alliance compatible weather stations |
| Active and reactive power setpoints | Constant values, curves, remotely controlled |
| Interface to inverter network / Interface to external network | 1 Ethernet port (RJ45) / 1 Ethernet port (RJ45) Modbus TCP, SunSpec Alliance |
| Interface to remote control | 6 x DI, Modbus TCP via external I/O module |
| Data at nominal conditions | |



STP60-US-DUS151619

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**SMA America, LLC**

# Appendix F

# Datasheet of Solar Panel Used as the Design Basis

# SunPower® E-Series Commercial Solar Panels | E20-435-COM

## More than 20% Efficiency

Captures more sunlight and generates more power than Conventional Panels.

## High Performance

Delivers excellent performance in real world conditions, such as high temperatures, clouds and low light.[1,2,4]

## Utility grade

Optimized to maximize returns, the E-Series panel is a bankable solution for large-scale power plants.

**Maxeon® Solar Cells: Fundamentally better.**
Engineered for performance, designed for reliability.

## Engineered for Peace of Mind

Designed to deliver consistent, trouble-free energy over a very long lifetime. [3,4]

## Designed for Reliability

The SunPower Maxeon Solar Cell is the only cell built on a solid copper foundation. Virtually impervious to the corrosion and cracking that degrade Conventional Panels. [3]

#1 Rank in Fraunhofer durability test.[9]
100% power maintained in Atlas 25+ comprehensive Durability test.[10]

## High Performance & Excellent Reliability

SPR-E20-435-COM

E20 SERIES

## High Efficiency[5]

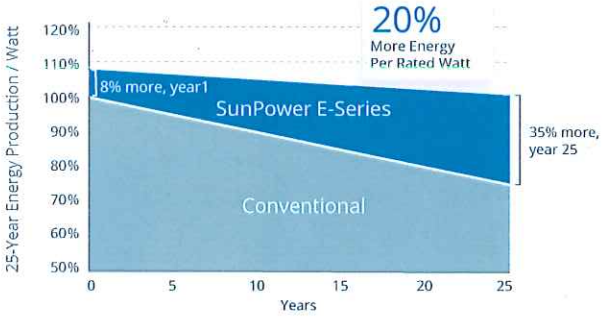
### Generate more energy per square foot

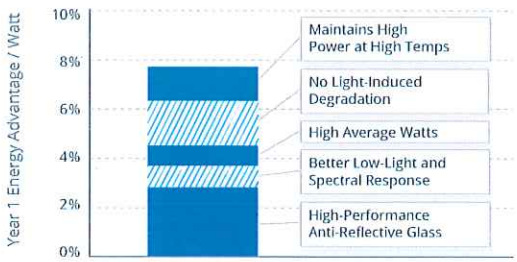
E-Series commercial panels convert more sunlight to electricity producing 31% more power per panel,[1] and 60% more energy per square foot over 25 years.[1,2,3]

## High Energy Production[6]

### Produce more energy per rated watt

More energy to power your operations. High year one performance delivers 7-9% more energy per rated watt.[2] This advantage increases over time, producing 20% more energy over the first 25 years to meet your needs.[3]



# SunPower® E-Series Commercial Solar Panels | E20-435-COM

## Sunpower Offers The Best Combined Power And Product Warranty

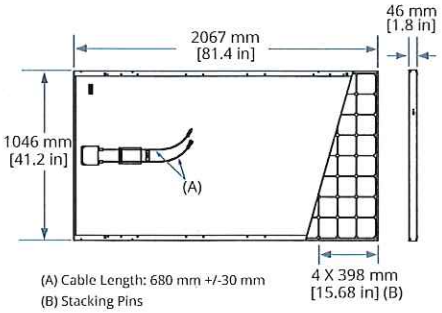

More guaranteed power: 95% for first 5 years, -0.4%/yr. to year 25. [7]


Combined Power and Product defect 25 year coverage that includes panel replacement costs. [8]

| Electrical Data | | |
|---|---|---|
| | SPR-E20-435-COM | SPR-E19-410-COM |
| Nominal Power (Pnom)[11] | 435 W | 410 W |
| Power Tolerance | +/– 5% | +/– 5% |
| Avg. Panel Efficiency[12] | 20.3% | 19.1% |
| Rated Voltage (Vmpp) | 72.9 V | 72.9 V |
| Rated Current (Impp) | 5.97 A | 5.62 A |
| Open-Circuit Voltage (Voc) | 85.6 V | 85.3 V |
| Short-Circuit Current (Isc) | 6.43 A | 6.01 A |
| Max. System Voltage | 1000 V UL & 1000 V IEC | |
| Maximum Series Fuse | 15 A | |
| Power Temp Coef. | –0.38% / °C | |
| Voltage Temp Coef. | –235.5 mV / °C | |
| Current Temp Coef. | 3.5 mA / °C | |

| Tests And Certifications | |
|---|---|
| Standard tests[13] | UL1703 (Type 2 Fire Rating), IEC 61215, IEC 61730 |
| Quality Certs | ISO 9001:2008, ISO 14001:2004 |
| EHS Compliance | RoHS, OHSAS 18001:2007, lead free, REACH SVHC-155, PV Cycle |
| Sustainability | Cradle to Cradle (eligible for LEED points)[14] |
| Ammonia test | IEC 62716 |
| Desert test | 10.1109/PVSC.2013.6744437 |
| Salt Spray test | IEC 61701 (maximum severity) |
| PID test | Potential-Induced Degradation free: 1000V[9] |
| Available listings | UL, CEC, CSA, TUV, FSEC |

| Operating Condition And Mechanical Data | |
|---|---|
| Temperature | – 40°F to +185°F (– 40°C to +85°C) |
| Impact resistance | 1 inch (25mm) diameter hail at 52 mph (23 m/s) |
| Appearance | Class B |
| Solar Cells | 128 Monocrystalline Maxeon Gen II |
| Tempered Glass | High transmission tempered Anti-Reflective |
| Junction Box | IP-65, 680mm cables / MC4 Compatible |
| Weight | 56 lbs (25.4 kg) |
| Max load | Wind: 2400 Pa, 50 psf front & back<br>Snow: 2400 Pa, 50 psf front |
| Frame | Class 2 silver anodized; stacking pins |




(A) Cable Length: 680 mm +/-30 mm
(B) Stacking Pins

Please read the safety and installation guide.

REFERENCES:
1 All comparisons are SPR-E20-327 vs. a representative conventional panel: 250W, approx. 1.6 m², 15.3% efficiency.
2 Typically 7-9% more energy per watt, BEW/DNV Engineering "SunPower Yield Report," Jan 2013.
3 SunPower 0.25%/yr degradation vs. 1.0%/yr conv. panel. Campeau, Z. et al. "SunPower Module Degradation Rate," SunPower white paper, Feb 2013; Jordan, Dirk "SunPower Test Report," NREL, Q1-2015.
4 "SunPower Module 40-Year Useful Life" SunPower white paper, May 2015. Useful life is 99 out of 100 panels operating at more than 70% of rated power.
5 Second highest, after SunPower X-Series, of over 3,200 silicon solar panels, Photon Module Survey, Feb 2014.
6 8% more energy than the average of the top 10 panel companies tested in 2012 (151 panels, 102 companies), Photon International, Feb 2013.
7 Compared with the top 15 manufacturers. SunPower Warranty Review, May 2015.
8 Some restrictions and exclusions may apply. See warranty for details.
9 5 of top 8 panel manufacturers tested in 2013 report, 3 additional panels in 2014. Ferrara, C., et al. "Fraunhofer PV Durability Initiative for Solar Modules: Part 2". Photovoltaics International, 2014.
10 Compared with the non-stress-tested control panel. Atlas 25+ Durability test report, Feb 2013.
11 Standard Test Conditions (1000 W/m² irradiance, AM 1.5, 25° C). NREL calibration Standard: SOMS current, LACCS FF and Voltage.
12 Based on average of measured power values during production.
13 Type 2 fire rating per UL1703:2013, Class C fire rating per UL1703:2002.
14 See sales person for details.

See http://www.sunpower.com/facts for more reference information.
For more details, see extended datasheet: www.sunpower.com/datasheets.

Document # 505699 Rev F /LTR_US



SUNPOWER®

# Appendix G

# Lifetime Energy Production

Lifetime Energy Output

| Option A | | | Dupont Drive | | | North Rd | Scituate Ave | Plainfield Pike | Joslin Farm | Degredation Yearly Rate |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rooftop 1 | Rooftop 2 | Rooftop 3 | Rooftop 4 | Full System | | | | | 0.10% |
| Initial Energy Ouput | 191,269.00 | 491,454.00 | 537,943.00 | 300,186.00 | 1,520,852.00 | 4,006,682.00 | 3,459,891.00 | 3,610,960.00 | 4,006,682.00 | |
| 1 | 191,269.00 | 491,454.00 | 537,943.00 | 300,186.00 | 1,520,852.00 | 4,006,682.00 | 3,459,891.00 | 3,610,960.00 | 4,006,682.00 | |
| 2 | 191,077.73 | 490,962.55 | 537,405.06 | 299,885.81 | 1,519,331.15 | 4,002,675.32 | 3,456,431.11 | 3,607,349.04 | 4,002,675.32 | |
| 3 | 190,886.65 | 490,471.58 | 536,867.65 | 299,585.93 | 1,517,811.82 | 3,998,672.64 | 3,452,974.68 | 3,603,741.69 | 3,998,672.64 | |
| 4 | 190,695.77 | 489,981.11 | 536,330.78 | 299,286.34 | 1,516,294.01 | 3,994,673.97 | 3,449,521.70 | 3,600,137.95 | 3,994,673.97 | |
| 5 | 190,505.07 | 489,491.13 | 535,794.45 | 298,987.06 | 1,514,777.71 | 3,990,679.30 | 3,446,072.18 | 3,596,537.81 | 3,990,679.30 | |
| 6 | 190,314.57 | 489,001.64 | 535,258.66 | 298,688.07 | 1,513,262.93 | 3,986,688.62 | 3,442,626.11 | 3,592,941.27 | 3,986,688.62 | |
| 7 | 190,124.25 | 488,512.64 | 534,723.40 | 298,389.38 | 1,511,749.67 | 3,982,701.93 | 3,439,183.48 | 3,589,348.33 | 3,982,701.93 | |
| 8 | 189,934.13 | 488,024.13 | 534,188.68 | 298,090.99 | 1,510,237.92 | 3,978,719.23 | 3,435,744.30 | 3,585,758.98 | 3,978,719.23 | |
| 9 | 189,744.19 | 487,536.10 | 533,654.49 | 297,792.90 | 1,508,727.68 | 3,974,740.51 | 3,432,308.56 | 3,582,173.22 | 3,974,740.51 | |
| 10 | 189,554.45 | 487,048.57 | 533,120.83 | 297,495.11 | 1,507,218.96 | 3,970,765.77 | 3,428,876.25 | 3,578,591.05 | 3,970,765.77 | |
| 11 | 189,364.89 | 486,561.52 | 532,587.71 | 297,197.61 | 1,505,711.74 | 3,966,795.00 | 3,425,447.37 | 3,575,012.46 | 3,966,795.00 | |
| 12 | 189,175.53 | 486,074.96 | 532,055.13 | 296,900.41 | 1,504,206.02 | 3,962,828.21 | 3,422,021.92 | 3,571,437.45 | 3,962,828.21 | |
| 13 | 188,986.35 | 485,588.88 | 531,523.07 | 296,603.51 | 1,502,701.82 | 3,958,865.38 | 3,418,599.90 | 3,567,866.01 | 3,958,865.38 | |
| 14 | 188,797.37 | 485,103.29 | 530,991.55 | 296,306.91 | 1,501,199.12 | 3,954,906.51 | 3,415,181.30 | 3,564,298.14 | 3,954,906.51 | |
| 15 | 188,608.57 | 484,618.19 | 530,460.56 | 296,010.60 | 1,499,697.92 | 3,950,951.61 | 3,411,766.12 | 3,560,733.85 | 3,950,951.61 | |
| 16 | 188,419.96 | 484,133.57 | 529,930.09 | 295,714.59 | 1,498,198.22 | 3,947,000.65 | 3,408,354.35 | 3,557,173.11 | 3,947,000.65 | |
| 17 | 188,231.54 | 483,649.44 | 529,400.16 | 295,418.88 | 1,496,700.02 | 3,943,053.65 | 3,404,946.00 | 3,553,615.94 | 3,943,053.65 | |
| 18 | 188,043.31 | 483,165.79 | 528,870.76 | 295,123.46 | 1,495,203.32 | 3,939,110.60 | 3,401,541.05 | 3,550,062.32 | 3,939,110.60 | |
| 19 | 187,855.27 | 482,682.62 | 528,341.89 | 294,828.34 | 1,493,708.12 | 3,935,171.49 | 3,398,139.51 | 3,546,512.26 | 3,935,171.49 | |
| 20 | 187,667.41 | 482,199.94 | 527,813.55 | 294,533.51 | 1,492,214.41 | 3,931,236.32 | 3,394,741.37 | 3,542,965.75 | 3,931,236.32 | |
| 21 | 187,479.74 | 481,717.74 | 527,285.74 | 294,238.97 | 1,490,722.20 | 3,927,305.08 | 3,391,346.63 | 3,539,422.78 | 3,927,305.08 | |
| 22 | 187,292.26 | 481,236.02 | 526,758.45 | 293,944.74 | 1,489,231.47 | 3,923,377.78 | 3,387,955.29 | 3,535,883.36 | 3,923,377.78 | |
| 23 | 187,104.97 | 480,754.78 | 526,231.69 | 293,650.79 | 1,487,742.24 | 3,919,454.40 | 3,384,567.33 | 3,532,347.48 | 3,919,454.40 | |
| 24 | 186,917.87 | 480,274.03 | 525,705.46 | 293,357.14 | 1,486,254.50 | 3,915,534.94 | 3,381,182.76 | 3,528,815.13 | 3,915,534.94 | |
| 25 | 186,730.95 | 479,793.76 | 525,179.76 | 293,063.78 | 1,484,768.25 | 3,911,619.41 | 3,377,801.58 | 3,525,286.31 | 3,911,619.41 | |
| Total | 4,724,781.81 | 12,140,037.95 | 13,288,422.59 | 7,415,280.85 | 37,568,523.20 | 98,974,210.30 | 85,467,221.86 | 89,198,971.72 | 98,974,210.30 | |

Lifetime Energy Output

| Option B | | | Dupont Drive | | | North Rd | Scituate Ave | Plainfield Pike | Joslin Farm | Degredation Yearly Rate |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rooftop 1 | Rooftop 2 | Rooftop 3 | Rooftop 4 | Full System | | | | | 0.10% |
| Initial Energy Ouput | 162,047.00 | 427,698.00 | 450,278.00 | 282,918.00 | 1,322,941.00 | 1,994,651.00 | 1,774,063.00 | 1,999,999.00 | 1,999,999.00 | |
| 1 | 162,047.00 | 427,698.00 | 450,278.00 | 282,918.00 | 1,322,941.00 | 1,994,651.00 | 1,774,063.00 | 1,999,999.00 | 1,999,999.00 | |
| 2 | 161,884.95 | 427,270.30 | 449,827.72 | 282,635.08 | 1,321,618.06 | 1,992,656.35 | 1,772,288.94 | 1,997,999.00 | 1,997,999.00 | |
| 3 | 161,723.07 | 426,843.03 | 449,377.89 | 282,352.45 | 1,320,296.44 | 1,990,663.69 | 1,770,516.65 | 1,996,001.00 | 1,996,001.00 | |
| 4 | 161,561.34 | 426,416.19 | 448,928.52 | 282,070.09 | 1,318,976.14 | 1,988,673.03 | 1,768,746.13 | 1,994,005.00 | 1,994,005.00 | |
| 5 | 161,399.78 | 425,989.77 | 448,479.59 | 281,788.02 | 1,317,657.17 | 1,986,684.36 | 1,766,977.39 | 1,992,011.00 | 1,992,011.00 | |
| 6 | 161,238.38 | 425,563.78 | 448,031.11 | 281,506.24 | 1,316,339.51 | 1,984,697.67 | 1,765,210.41 | 1,990,018.99 | 1,990,018.99 | |
| 7 | 161,077.15 | 425,138.22 | 447,583.08 | 281,224.73 | 1,315,023.17 | 1,982,712.97 | 1,763,445.20 | 1,988,028.97 | 1,988,028.97 | |
| 8 | 160,916.07 | 424,713.08 | 447,135.49 | 280,943.51 | 1,313,708.15 | 1,980,730.26 | 1,761,681.75 | 1,986,040.94 | 1,986,040.94 | |
| 9 | 160,755.15 | 424,288.37 | 446,688.36 | 280,662.56 | 1,312,394.44 | 1,978,749.53 | 1,759,920.07 | 1,984,054.90 | 1,984,054.90 | |
| 10 | 160,594.40 | 423,864.08 | 446,241.67 | 280,381.90 | 1,311,082.05 | 1,976,770.78 | 1,758,160.15 | 1,982,070.84 | 1,982,070.84 | |
| 11 | 160,433.80 | 423,440.22 | 445,795.43 | 280,101.52 | 1,309,770.96 | 1,974,794.01 | 1,756,401.99 | 1,980,088.77 | 1,980,088.77 | |
| 12 | 160,273.37 | 423,016.77 | 445,349.63 | 279,821.42 | 1,308,461.19 | 1,972,819.22 | 1,754,645.59 | 1,978,108.68 | 1,978,108.68 | |
| 13 | 160,113.10 | 422,593.76 | 444,904.28 | 279,541.59 | 1,307,152.73 | 1,970,846.40 | 1,752,890.94 | 1,976,130.57 | 1,976,130.57 | |
| 14 | 159,952.98 | 422,171.16 | 444,459.38 | 279,262.05 | 1,305,845.58 | 1,968,875.55 | 1,751,138.05 | 1,974,154.44 | 1,974,154.44 | |
| 15 | 159,793.03 | 421,748.99 | 444,014.92 | 278,982.79 | 1,304,539.73 | 1,966,906.68 | 1,749,386.91 | 1,972,180.29 | 1,972,180.29 | |
| 16 | 159,633.24 | 421,327.24 | 443,570.90 | 278,703.81 | 1,303,235.19 | 1,964,939.77 | 1,747,637.53 | 1,970,208.11 | 1,970,208.11 | |
| 17 | 159,473.60 | 420,905.92 | 443,127.33 | 278,425.10 | 1,301,931.96 | 1,962,974.83 | 1,745,889.89 | 1,968,237.90 | 1,968,237.90 | |
| 18 | 159,314.13 | 420,485.01 | 442,684.21 | 278,146.68 | 1,300,630.03 | 1,961,011.85 | 1,744,144.00 | 1,966,269.66 | 1,966,269.66 | |
| 19 | 159,154.82 | 420,064.53 | 442,241.52 | 277,868.53 | 1,299,329.40 | 1,959,050.84 | 1,742,399.86 | 1,964,303.39 | 1,964,303.39 | |
| 20 | 158,995.66 | 419,644.46 | 441,799.28 | 277,590.66 | 1,298,030.07 | 1,957,091.79 | 1,740,657.46 | 1,962,339.09 | 1,962,339.09 | |
| 21 | 158,836.66 | 419,224.82 | 441,357.48 | 277,313.07 | 1,296,732.04 | 1,955,134.70 | 1,738,916.80 | 1,960,376.75 | 1,960,376.75 | |
| 22 | 158,677.83 | 418,805.59 | 440,916.12 | 277,035.76 | 1,295,435.30 | 1,953,179.56 | 1,737,177.88 | 1,958,416.37 | 1,958,416.37 | |
| 23 | 158,519.15 | 418,386.79 | 440,475.21 | 276,758.72 | 1,294,139.87 | 1,951,226.39 | 1,735,440.70 | 1,956,457.96 | 1,956,457.96 | |
| 24 | 158,360.63 | 417,968.40 | 440,034.73 | 276,481.97 | 1,292,845.73 | 1,949,275.16 | 1,733,705.26 | 1,954,501.50 | 1,954,501.50 | |
| 25 | 158,202.27 | 417,550.43 | 439,594.70 | 276,205.48 | 1,291,552.88 | 1,947,325.88 | 1,731,971.56 | 1,952,547.00 | 1,952,547.00 | |
| Total | 4,002,931.57 | 10,565,118.92 | 11,122,896.57 | 6,988,721.75 | 32,679,668.80 | 49,272,442.27 | 43,823,414.10 | 49,404,550.10 | 49,404,550.10 | |

Lifetime Energy Output

| Option C | | | Dupont Drive | | | | | | | Degredation Yearly Rate |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rooftop 1 | Rooftop 2 | Rooftop 3 | Rooftop 4 | Full System | | | | | 0.10% |
| Initial Energy Ouput | - | 369,255.00 | 334,720.00 | 219,162.00 | 923,137.00 | - | - | - | - | |
| 1 | - | 369,255.00 | 334,720.00 | 219,162.00 | 923,137.00 | - | - | - | - | |
| 2 | - | 368,885.75 | 334,385.28 | 218,942.84 | 922,213.86 | - | - | - | - | |
| 3 | - | 368,516.86 | 334,050.89 | 218,723.90 | 921,291.65 | - | - | - | - | |
| 4 | - | 368,148.34 | 333,716.84 | 218,505.17 | 920,370.36 | - | - | - | - | |
| 5 | - | 367,780.19 | 333,383.13 | 218,286.67 | 919,449.99 | - | - | - | - | |
| 6 | - | 367,412.41 | 333,049.74 | 218,068.38 | 918,530.54 | - | - | - | - | |
| 7 | - | 367,045.00 | 332,716.69 | 217,850.31 | 917,612.01 | - | - | - | - | |
| 8 | - | 366,677.96 | 332,383.98 | 217,632.46 | 916,694.39 | - | - | - | - | |
| 9 | - | 366,311.28 | 332,051.59 | 217,414.83 | 915,777.70 | - | - | - | - | |
| 10 | - | 365,944.97 | 331,719.54 | 217,197.41 | 914,861.92 | - | - | - | - | |
| 11 | - | 365,579.02 | 331,387.82 | 216,980.22 | 913,947.06 | - | - | - | - | |
| 12 | - | 365,213.44 | 331,056.43 | 216,763.24 | 913,033.11 | - | - | - | - | |
| 13 | - | 364,848.23 | 330,725.38 | 216,546.47 | 912,120.08 | - | - | - | - | |
| 14 | - | 364,483.38 | 330,394.65 | 216,329.93 | 911,207.96 | - | - | - | - | |
| 15 | - | 364,118.90 | 330,064.26 | 216,113.60 | 910,296.75 | - | - | - | - | |
| 16 | - | 363,754.78 | 329,734.19 | 215,897.48 | 909,386.46 | - | - | - | - | |
| 17 | - | 363,391.02 | 329,404.46 | 215,681.59 | 908,477.07 | - | - | - | - | |
| 18 | - | 363,027.63 | 329,075.06 | 215,465.90 | 907,568.59 | - | - | - | - | |
| 19 | - | 362,664.61 | 328,745.98 | 215,250.44 | 906,661.02 | - | - | - | - | |
| 20 | - | 362,301.94 | 328,417.23 | 215,035.19 | 905,754.36 | - | - | - | - | |
| 21 | - | 361,939.64 | 328,088.82 | 214,820.15 | 904,848.61 | - | - | - | - | |
| 22 | - | 361,577.70 | 327,760.73 | 214,605.33 | 903,943.76 | - | - | - | - | |
| 23 | - | 361,216.12 | 327,432.97 | 214,390.73 | 903,039.82 | - | - | - | - | |
| 24 | - | 360,854.91 | 327,105.53 | 214,176.34 | 902,136.78 | - | - | - | - | |
| 25 | - | 360,494.05 | 326,778.43 | 213,962.16 | 901,234.64 | - | - | - | - | |
| Total | - | 9,121,443.13 | 8,268,349.64 | 5,413,802.71 | 22,803,595.49 | - | - | - | - | |

# Appendix H

# Panel Specifications and String Size Builder

Panel Specs

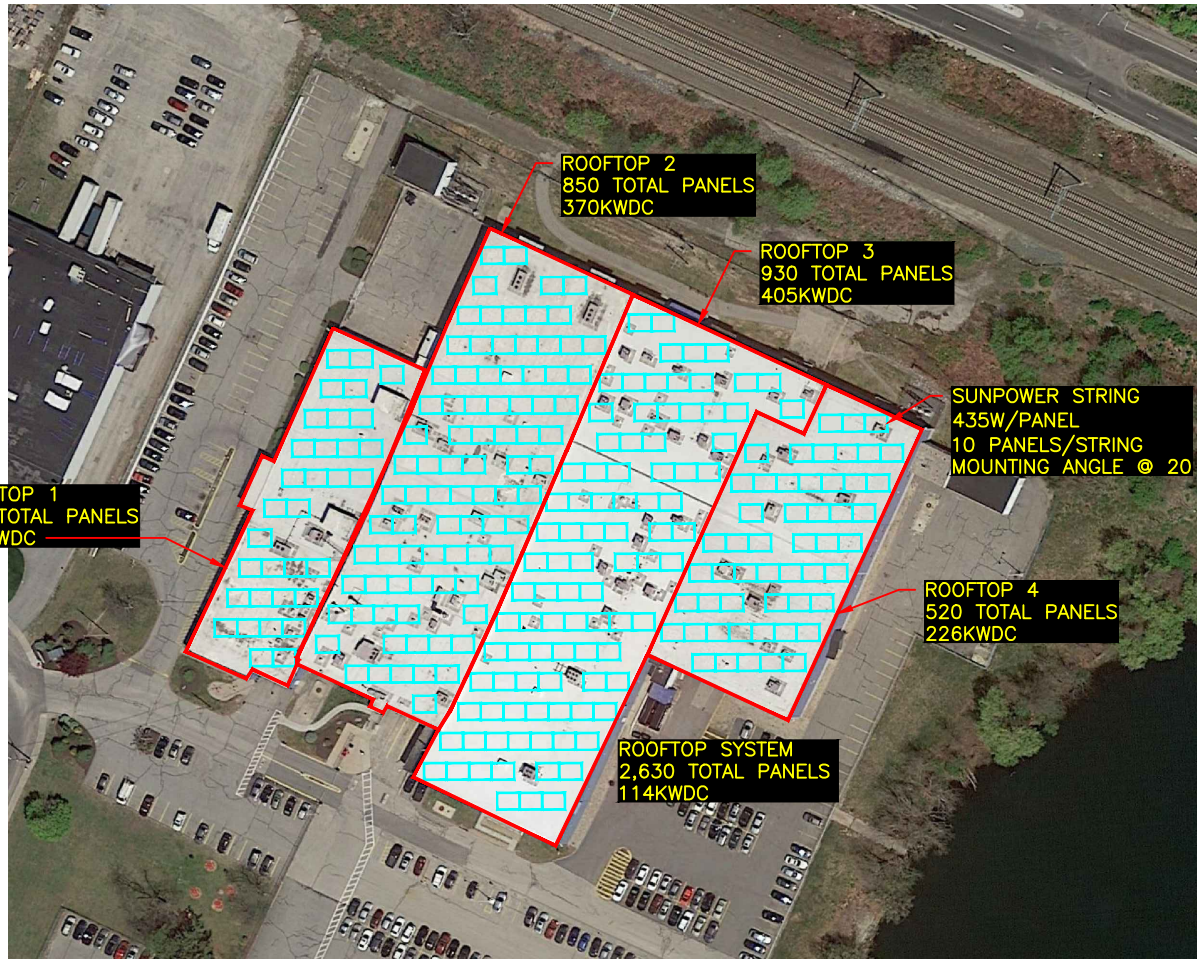
| | | | | | | | | | | | | | | | | Cold Day | | | Hot Day | | | | | | Temperature Coeff | | | | 1000VDC string sets at STC | | | | | | 600VDC String Set at STC | | | | | | 1000VDC @ Coldest Day | | | | 600VDC @ Coldest Day | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manufacturer | Model | Cell # | Length (in) | Width (in) | Square Area ($in^2$) | Length (ft) | Width (ft) | Square Area ($ft^2$) | Weight (lbs) | Power | $V_{OC}$ | $I_{SC}$ | $P_{MPP}$ | VMPP | IMPP | $V_{OC}$ | $I_{SC}$ | $P_{MPP}$ | $V_{OC}$ | $I_{SC}$ | $P_{MPP}$ | Max String V | Listing | Voltage %/C | Current %/C | Power %/C | Power Density $W/ft^2$ | String Size | Max $V_{OC}$ Per String | Max $I_{SC}$ Per String | Max $V_{MPP}$ Per String | Max $I_{MPP}$ Per String | Max $P_{MPP}$ Per String | String Size | Max $V_{OC}$ Per String | Max $I_{SC}$ Per String | Max $V_{MPP}$ Per String | Max $I_{MPP}$ Per String | Max $P_{MPP}$ Per String | String Size | Max $V_{OC}$ Per String | Max $I_{SC}$ Per String | Max $P_{MPP}$ Per String | String Size | Max $V_{OC}$ Per String | Max $I_{SC}$ Per String | Max $P_{MPP}$ Per String |
| Suniva | Optimus | 72 | 77.6 | 39 | 3026.40 | 6.47 | 3.25 | 21.02 | 50.7 | 340 | 46 | 9.78 | 340 | 37.8 | 8.99 | 52.4722 | 9.586943 | 399.976 | 43.6885 | 9.848949 | 318.58 | 1000 | UL/IEC | -0.34% | 0.05% | -0.42% | 16.17764 | 20 | 920 | 9.78 | 756 | 8.99 | 6796 | 12 | 552 | 9.78 | 453.6 | 8.99 | 4078 | 18 | 944.50 | 9.59 | 7200 | 10 | 524.72 | 9.59 | 4000 |
| Yingli | 1500 Series | 72 | 77.56 | 39.37 | 3053.54 | 6.46 | 3.28 | 21.21 | 56.2 | 320 | 46 | 9.12 | 320 | 36.9 | 8.68 | 52.1824 | 8.92848 | 376.448 | 43.792 | 9.1884 | 299.84 | 1500 | UL 1703 IEC 61730 both Pending | -0.32% | 0.05% | -0.42% | 15.0907 | 20 | 920 | 9.12 | 738 | 8.68 | 6406 | 12 | 552 | 9.12 | 442.8 | 8.68 | 3844 | 18 | 939.28 | 8.93 | 6776 | 10 | 521.82 | 8.93 | 3764 |
| Sun Power | X Series | 96 | 81.4 | 41.2 | 3353.68 | 6.78 | 3.43 | 23.29 | 56 | 435 | 85.6 | 6.43 | 435 | 72.9 | 5.97 | 95.491 | 6.283 | 504.426 | 82.0675 | 6.4825 | 410.205 | 600 1000 | UL IEC | -0.2355 v/C | 0.0035 a/C | -0.38% | 18.67799 | 10 | 856 | 6.43 | 729 | 5.97 | 4352 | 7 | 599.2 | 6.43 | 510.3 | 5.97 | 3046 | 10 | 954.91 | 6.28 | 5044 | 6 | 572.95 | 6.28 | 3027 |
| Suntech | | 72 | 77 | 39.1 | 3010.70 | 6.42 | 3.26 | 20.91 | 56.9 | 325 | 45.8 | 9.28 | 325 | 37.1 | 8.77 | 52.34024 | 9.046144 | 380.965 | 43.4642 | 9.36352 | 305.0125 | 1000 | IEC | -0.34% | 0.06% | -0.41% | 15.54456 | 20 | 916 | 9.28 | 742 | 8.77 | 6507 | 12 | 549.6 | 9.28 | 445.2 | 8.77 | 3904 | 18 | 942.12 | 9.05 | 6857 | 10 | 523.40 | 9.05 | 3810 |
| First Solar | Series 4 | | 42.3 | 23.62 | 999.13 | 3.53 | 1.97 | 6.94 | 26.5 | 105 | 88.2 | 1.58 | 105 | 70.4 | 1.49 | 98.57232 | 1.553456 | 117.789 | 84.4956 | 1.58948 | 100.4325 | 1000 | UL | -0.28% | 0.04% | -0.29% | 15.13323 | 10 | 882 | 1.58 | 704 | 1.49 | 1049 | 6 | 529.2 | 1.58 | 422.4 | 1.49 | 629 | 10 | 985.72 | 1.55 | 1178 | 6 | 591.43 | 1.55 | 707 |
| First Solar | Series 4 V2 | | 42.3 | 23.62 | 999.13 | 3.53 | 1.97 | 6.94 | 26.5 | 117.5 | 88.2 | 1.79 | 117.5 | 71.2 | 1.65 | 98.94276 | 1.759928 | 134.279 | 84.3633 | 1.80074 | 111.5075 | 1000 | UL | -0.29% | 0.04% | -0.34% | 16.9348 | 10 | 882 | 1.79 | 712 | 1.65 | 1175 | 6 | 529.2 | 1.79 | 427.2 | 1.65 | 705 | 10 | 989.43 | 1.76 | 1343 | 6 | 593.66 | 1.76 | 806 |
| Solar World | | 65.95 | 39.4 | 2598.43 | 5.50 | 3.28 | 18.04 | 39.7 | 285 | 39.7 | 9.84 | 285 | 31.3 | 9.2 | 44.7022 | 9.674688 | 334.077 | 37.9135 | 9.89904 | 267.4725 | | | -0.30% | 0.04% | -0.41% | 15.79415 | 24 | 952.8 | 9.84 | 751.2 | 9.2 | 6911 | 15 | 595.5 | 9.84 | 469.5 | 9.2 | 4319 | 22 | 983.45 | 9.67 | 7350 | 13 | 581.13 | 9.67 | 4343 |
| Solar World | | 65.95 | 39.4 | 2598.43 | 5.50 | 3.28 | 18.04 | 39.7 | 300 | 40.1 | 10.23 | 300 | 31.6 | 9.57 | 45.1526 | 10.05814 | 351.66 | 38.2955 | 10.29138 | 281.55 | | | -0.30% | 0.04% | -0.41% | 16.62542 | 23 | 922.3 | 10.23 | 726.8 | 9.57 | 6955 | 14 | 561.4 | 10.23 | 442.4 | 9.57 | 4234 | 22 | 993.36 | 10.06 | 7737 | 13 | 586.98 | 10.06 | 4572 |

SiteTemp (avg)
28.2
-6.1
Site Temp (HI)
40
Site Temp (LO)
-17

http://www.solarabcs.org/about/publications/reports/expedited-permit/map/

# Appendix I

# Site Plans




1" = 100'

50 0 100

N

LEGEND

ROOF LINE

1000VDC STRING (10 PANELS)

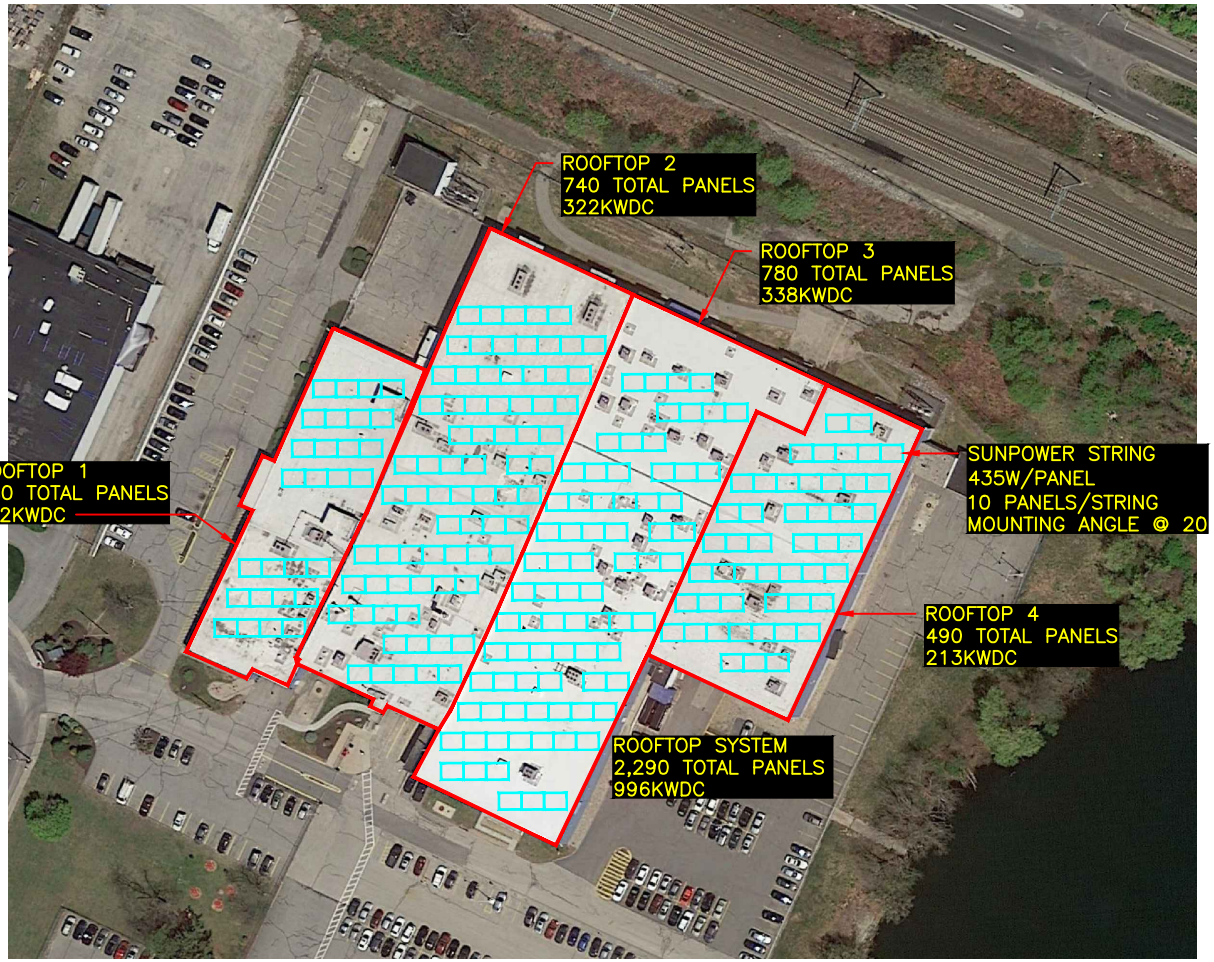
NOTES:

1. THIS ROOF DEPICTED ON THIS AERIAL VIEW IS ASSUMED TO BE THE MOST UP TO DATE. FURTHER ANALYSIS OF THE CURRENT CONDITIONS WILL BE NEEDED TO ENSURE THERE IS NO CONFLICT WITH THE EXISTING ROOF EQUIPMENT.

CDM Smith

125 DUPONT DRIVE - A

APRIL 2016




1" = 100'

50 0 100

N

LEGEND

ROOF LINE

1000VDC STRING (10 PANELS)

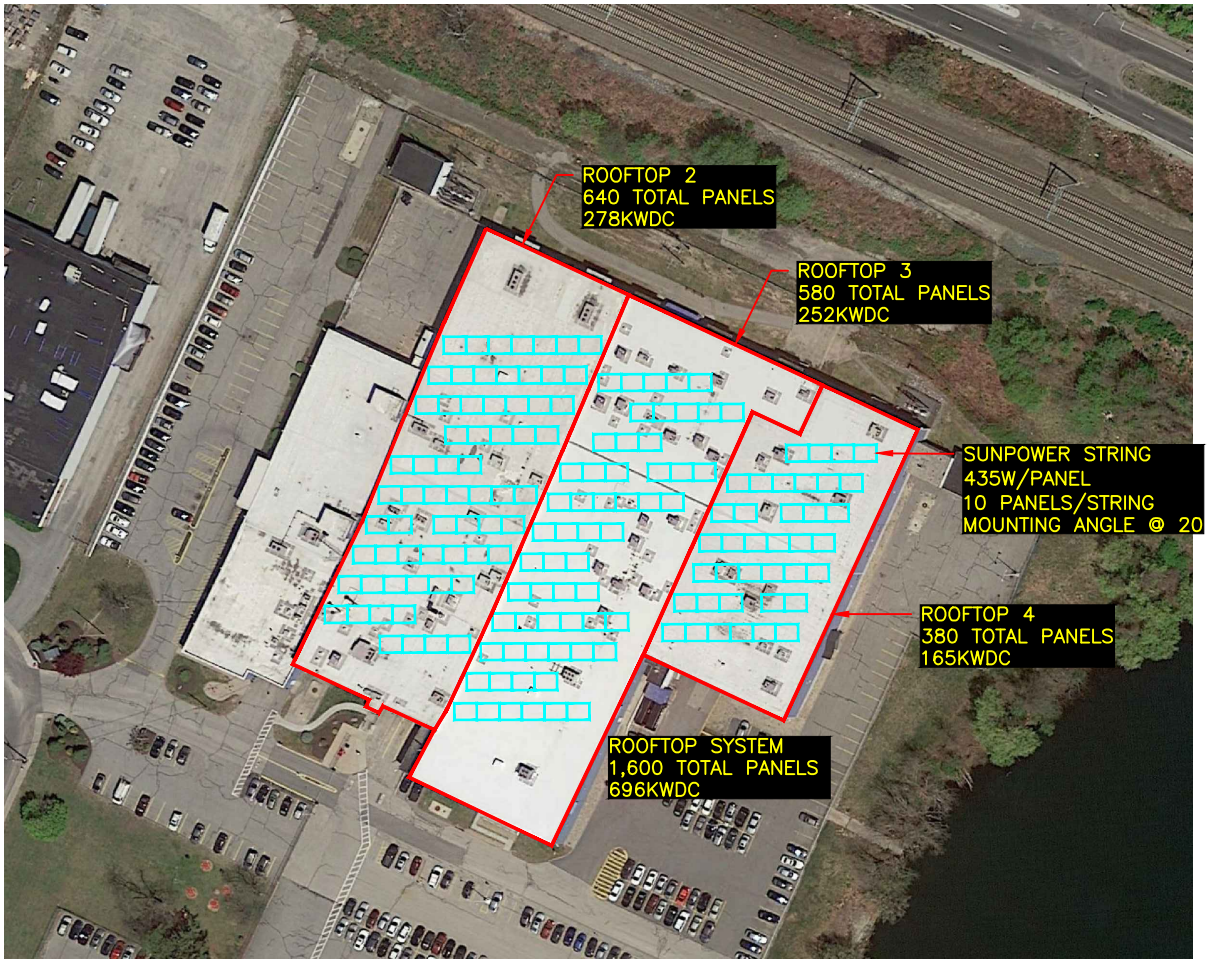
NOTES:

1. THIS ROOF DEPICTED ON THIS AERIAL VIEW IS ASSUMED TO BE THE MOST UP TO DATE. FURTHER ANALYSIS OF THE CURRENT CONDITIONS WILL BE NEEDED TO ENSURE THERE IS NO CONFLICT WITH THE EXISTING ROOF EQUIPMENT.

CDM Smith

125 DUPONT DRIVE - B

APRIL 2016




1" = 100'

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N

LEGEND

ROOF LINE

1000VDC STRING (10 PANELS)

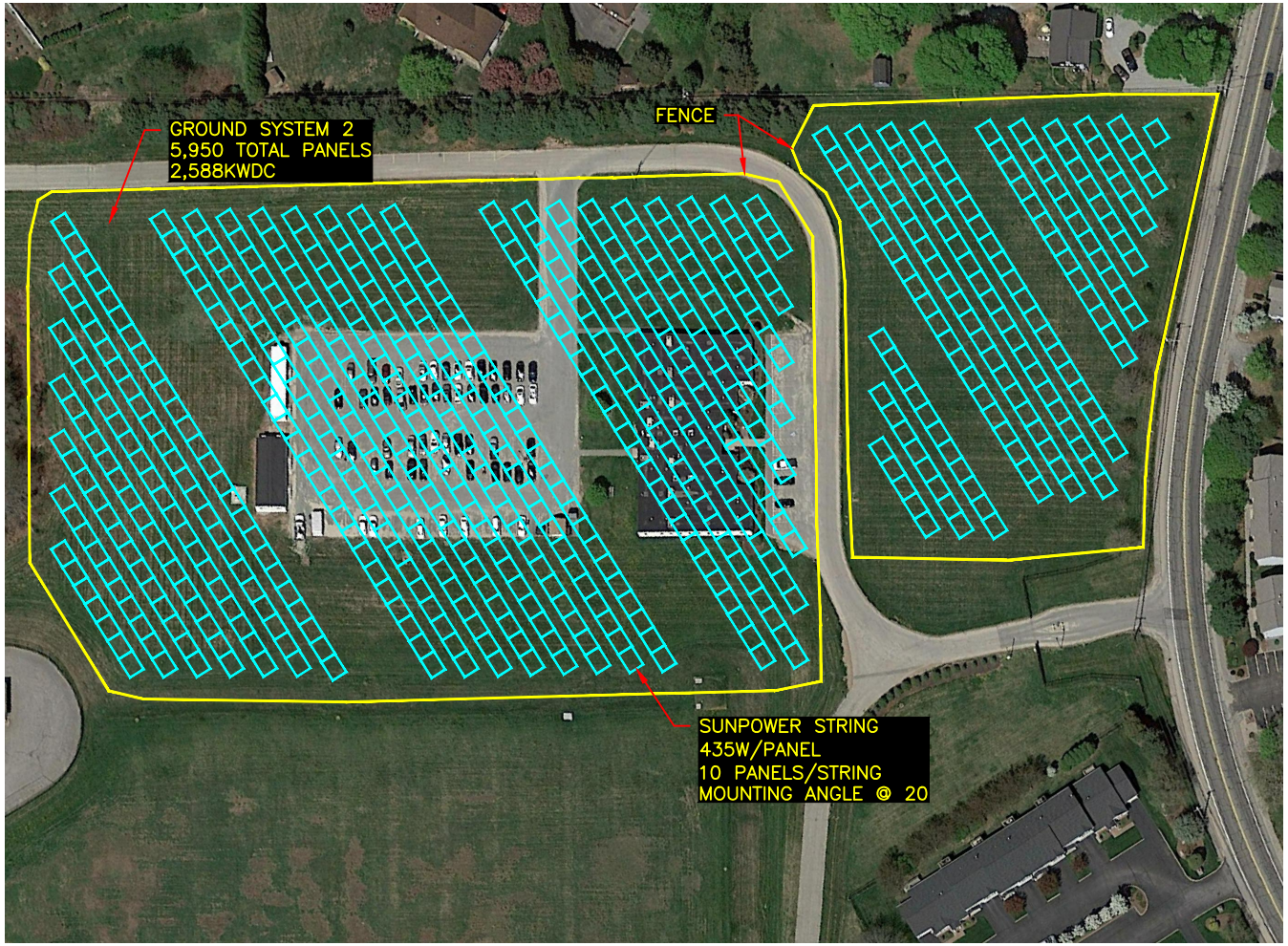
NOTES:

1. THIS ROOF DEPICTED ON THIS AERIAL VIEW IS ASSUMED TO BE THE MOST UP TO DATE. FURTHER ANALYSIS OF THE CURRENT CONDITIONS WILL BE NEEDED TO ENSURE THERE IS NO CONFLICT WITH THE EXISTING ROOF EQUIPMENT.

CDM Smith

125 DUPONT DRIVE - C

APRIL 2016




1" = 100'

50 0 100

N

LEGEND

FENCE

1000VDC STRING
(10 PANELS)

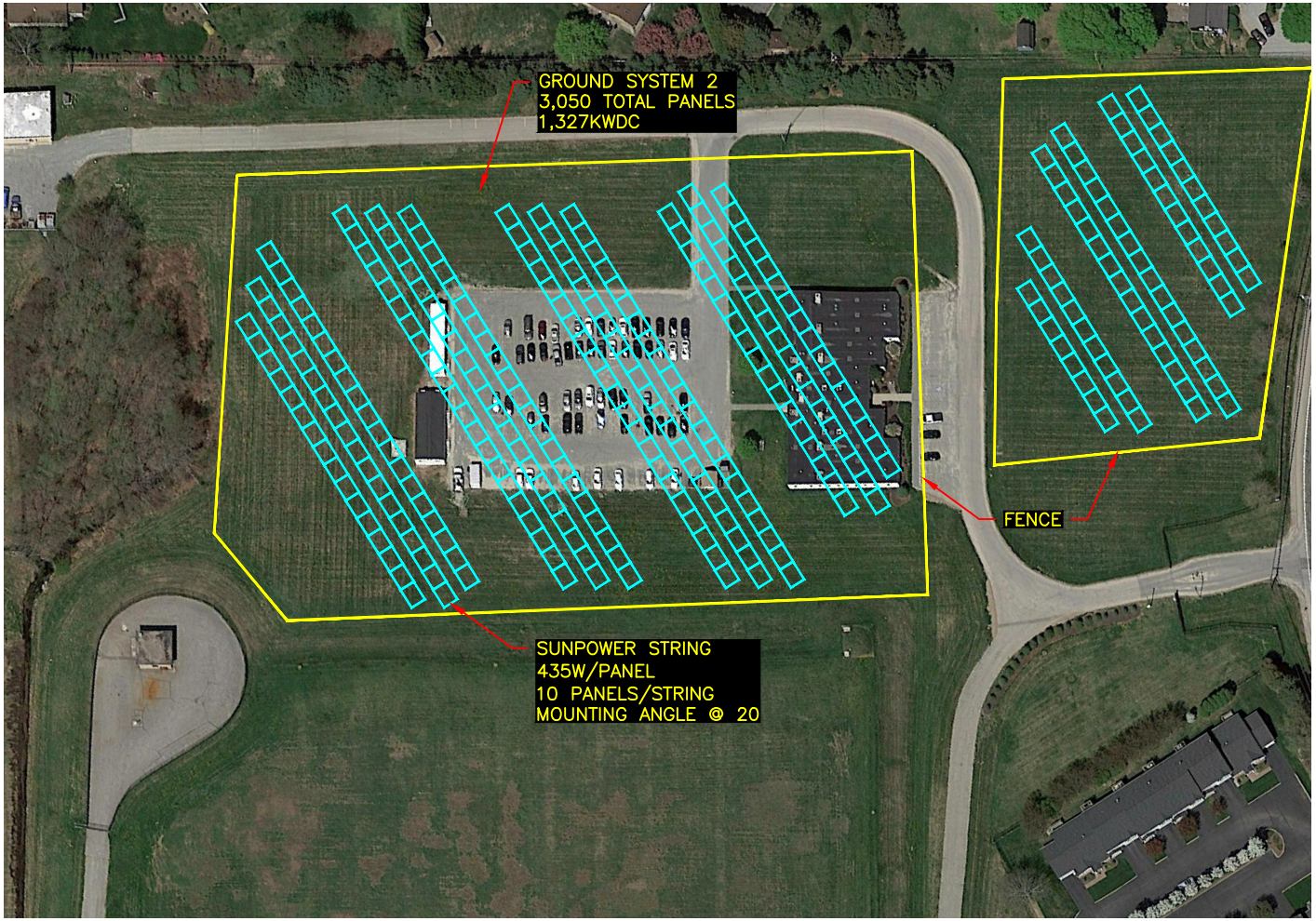
NOTES:

1. THIS PROPOSED GROUND SYSTEM ASSUMES THE AREA WILL BE A GREENFIELD, COMPLETELY CLEARED. THE STUDY DOES NOT INCLUDE ANY DEMOLISHING OF ANY STRUCTURES, ROADWAYS AND CLEARING OF TREES/VEGETATION.

CDM Smith

430 SCITUATE AVENUE - A

APRIL 2016




1" = 100'

50 0 100

N

LEGEND

FENCE

1000VDC STRING (10 PANELS)

NOTES:

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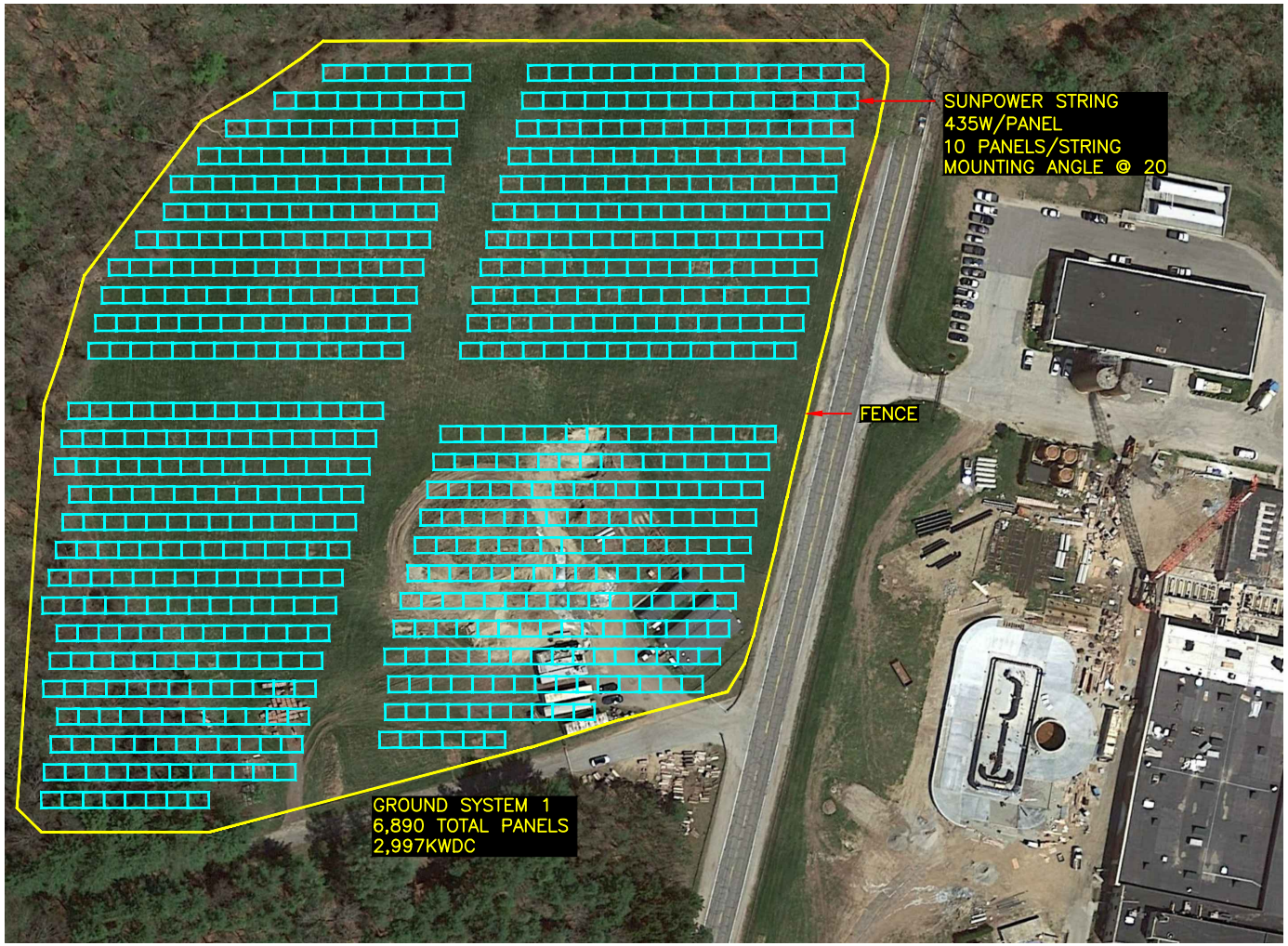
CDM Smith

430 SCITUATE AVENUE - B

APRIL 2016




N

LEGEND

- FENCE
- 1000VDC STRING (10 PANELS)

NOTES:

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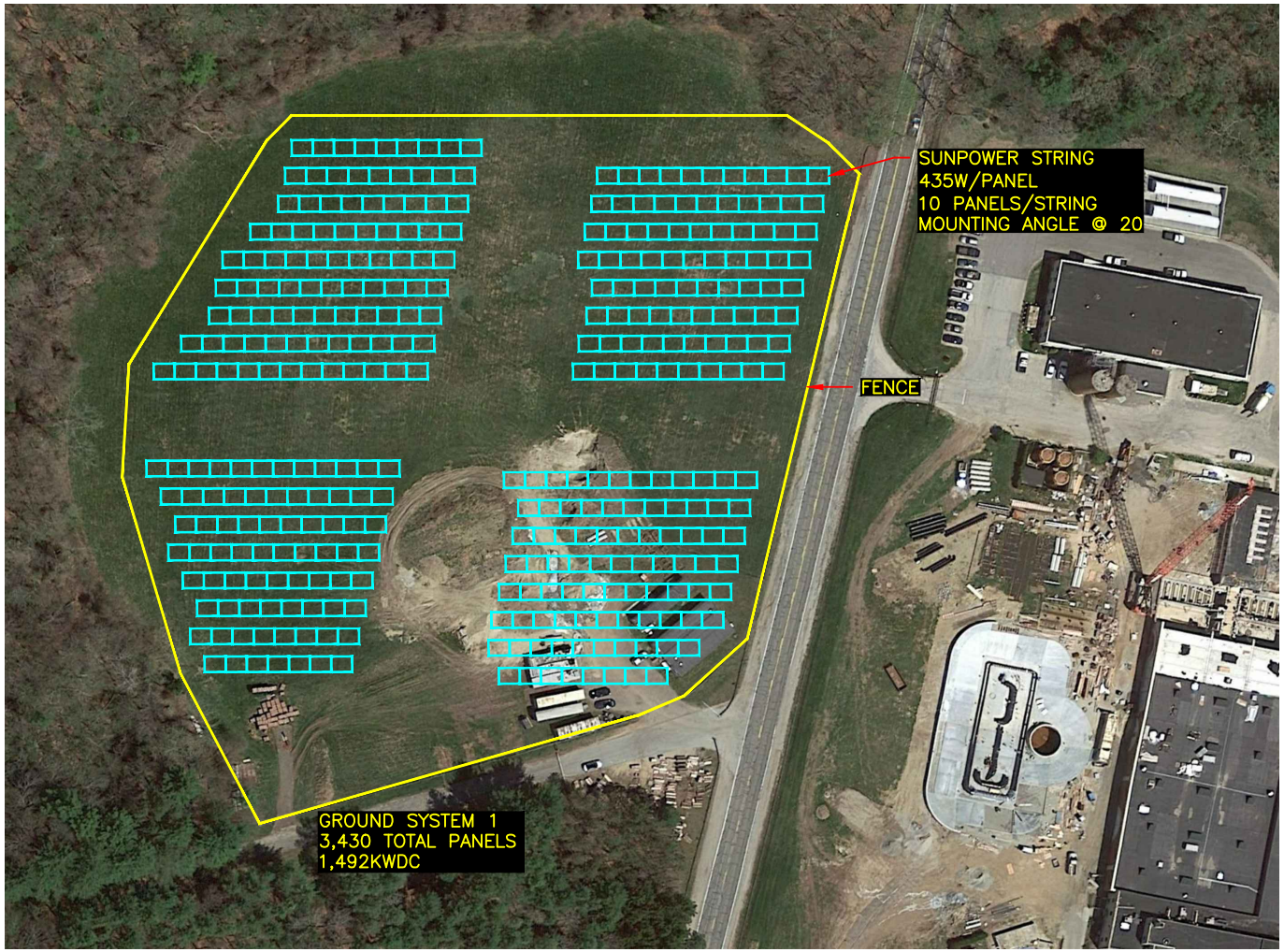
1" = 100'

50 0 100

CDM Smith

61 NORTH ROAD - A

APRIL 2016




N

LEGEND

- FENCE
- 1000VDC STRING (10 PANELS)

NOTES:

1. THIS PROPOSED GROUND SYSTEM ASSUMES THE AREA WILL BE A GREENFIELD, COMPLETELY CLEARED. THE STUDY DOES NOT INCLUDE ANY DEMOLISHING OF ANY STRUCTURES, ROADWAYS AND CLEARING OF TREES/VEGETATION.

1" = 100'

50 0 100

CDM Smith

61 NORTH ROAD - B

APRIL 2016


1" = 250'

125 0 250

N

LEGEND

- PROPERTY LINE
- FENCE
- 1000VDC STRING (10 PANELS)

NOTES:

1. THIS PROPOSED GROUND SYSTEM ASSUMES THE AREA WILL BE A GREENFIELD, COMPLETELY CLEARED. THE STUDY DOES NOT INCLUDE ANY DEMOLISHING OF ANY STRUCTURES, ROADWAYS AND CLEARING OF TREES/VEGETATION.

CDM Smith

730 PLAINFIELD PIKE - A
SCITUATE, RI
APRIL 2016


1" = 250'

125 0 250

N

LEGEND

PROPERTY LINE

FENCE

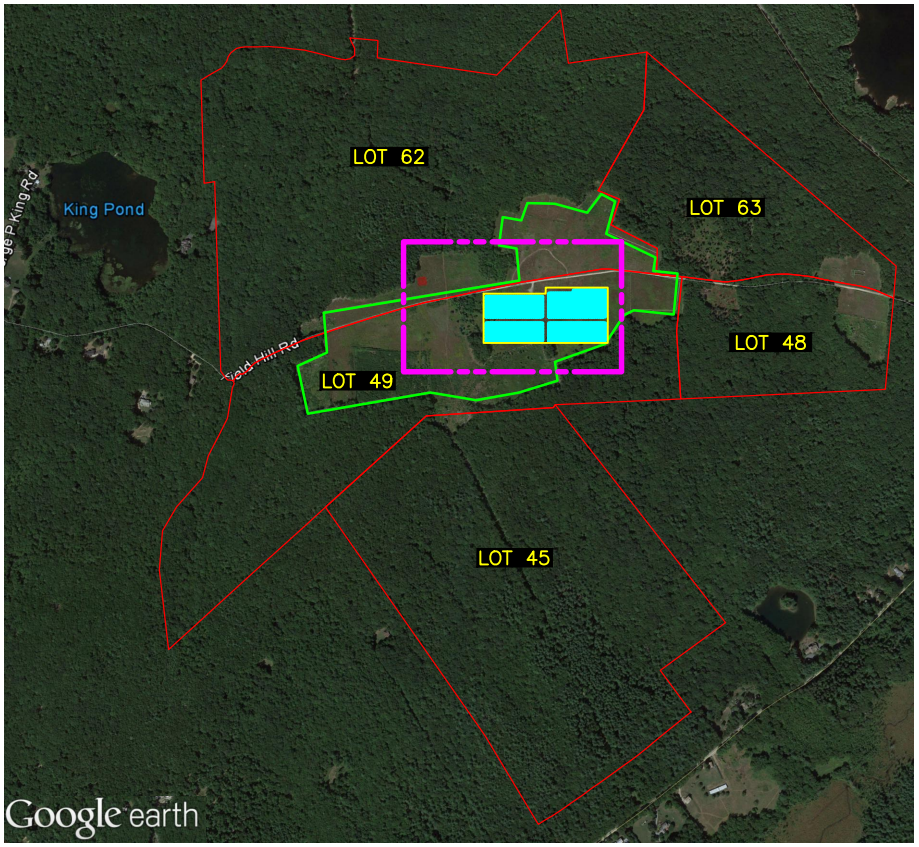
1000VDC STRING (10 PANELS)

NOTES:

1. THIS PROPOSED GROUND SYSTEM ASSUMES THE AREA WILL BE A GREENFIELD, COMPLETELY CLEARED. THE STUDY DOES NOT INCLUDE ANY DEMOLISHING OF ANY STRUCTURES, ROADWAYS AND CLEARING OF TREES/VEGETATION.

CDM Smith

730 PLAINFIELD PIKE - B
SCITUATE, RI
APRIL 2016



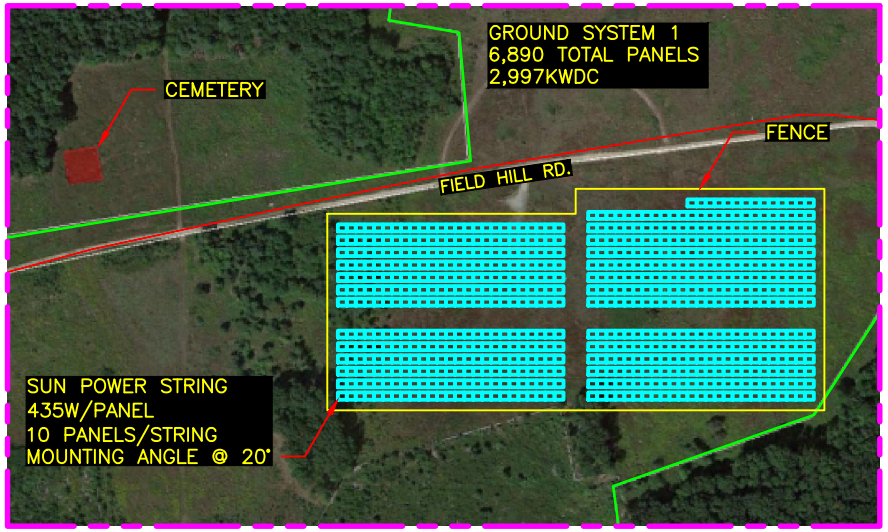

1" = 1000'
500 0 1000

N

NOTES:

1. THIS PROPOSED GROUND SYSTEM ASSUMES THE AREA WILL BE A GREENFIELD, COMPLETELY CLEARED. THE STUDY DOES NOT INCLUDE ANY DEMOLISHING OF ANY STRUCTURES, ROADWAYS AND CLEARING OF TREES/VEGETATION.

LEGEND
- PROPERTY LINE
- TREE LINE
- MATCH LINE
- FENCE
- 1000VDC STRING (10 PANELS)

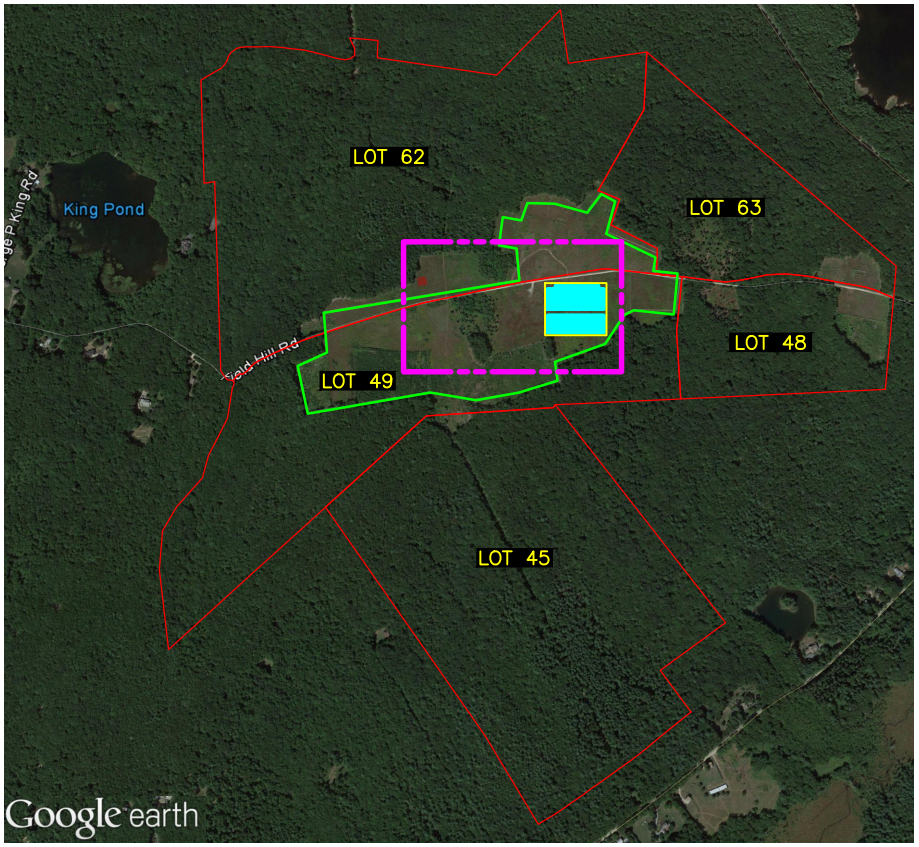



N

1" = 250'
125 0 250

CDM Smith

JOSLIN FARM - A
SCITUATE, RI
APRIL 2016



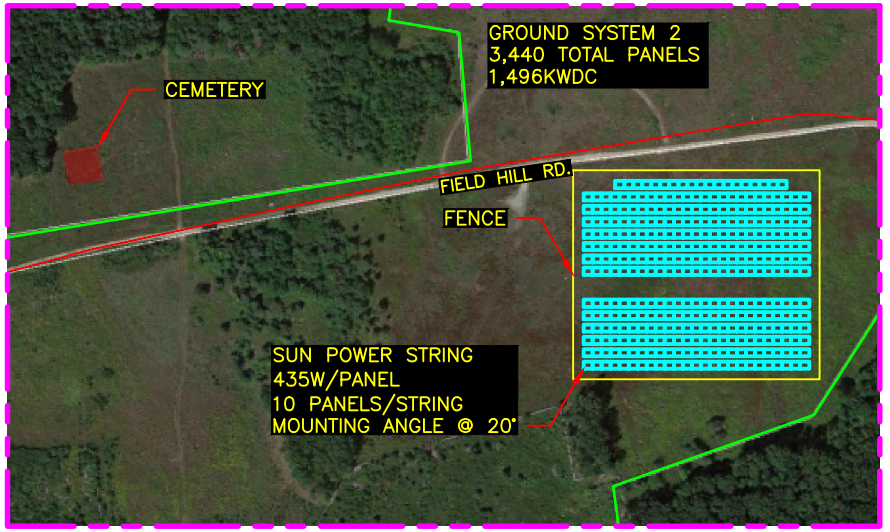

1" = 1000'
500 0 1000

N

NOTES:

1. THIS PROPOSED GROUND SYSTEM ASSUMES THE AREA WILL BE A GREENFIELD, COMPLETELY CLEARED. THE STUDY DOES NOT INCLUDE ANY DEMOLISHING OF ANY STRUCTURES, ROADWAYS AND CLEARING OF TREES/VEGETATION.

LEGEND
- PROPERTY LINE
- TREE LINE
- MATCH LINE
- FENCE
- 1000VDC STRING (10 PANELS)




N

1" = 250'
125 0 250

CDM Smith

JOSLIN FARM - B
SCITUATE, RI
APRIL 2016

# Appendix J

# National Grid Re-Growth Program Literature

## The Narragansett Electric Company d/b/a National Grid

# Rhode Island Renewable Energy Growth Program Solicitation and Enrollment Process Rules for Solar (Greater than 25kW), Wind, Hydro and Anaerobic Digester Projects

***Effective Date: April 1, 2015***

## Table of Contents

**I. Introduction and Overview**

## 1.1 Purpose of the Solicitation and Enrollment

National Grid developed the Renewable Energy Growth Program (RE Growth Program) pursuant to Chapter 26.6 of Title 39 of the Rhode Island General Laws to facilitate the development and compensation of distributed generation projects in Rhode Island. These Solicitation and Enrollment Process Rules for Non-Residential Projects (Rules) provide the means by which an applicant (Applicant) can qualify and enroll a project (Project) in the RE Growth Program. The Rules are only part of the RE Growth Program documents and should be read along with the Non-Residential RE Growth Program Tariff (Tariff). As described below, a Project enrolled in the RE Growth Program must supply National Grid with energy, capacity, Renewable Energy Certificates (RECs), and other environmental attributes and market products. Any term not defined in the Rules is defined in the Tariff.

These Rules will apply to all Projects that are not Small-Scale Solar Projects, subject to the eligibility provisions below. A Small-Scale Solar Project is a solar project having a nameplate capacity of up to and including twenty-five kilowatts (25 kW), and is subject to the rules for Small-Scale Solar Projects.

These Rules, along with the Tariff, will govern the eligibility and procedures for Projects in the RE Growth Program. National Grid will not execute contracts with Applicants.

## 1.2 Enrollment Framework

National Grid is operating the RE Growth Program, as guided by the Distributed Generation Board (Board) in consultation with the Rhode Island Office of Energy Resources (OER). The Program is subject to the approval of the Rhode Island Public Utilities Commission (Commission). National Grid may also consult with the Rhode Island Division of Public Utilities and Carriers (Division).

For each program year, there will be a target amount of megawatts to be enrolled for the year (annual MW target), and a target amount of megawatts for each enrollment event (enrollment MW target), both of which will be based on nameplate capacity. The nameplate capacity of a Project is its maximum rated output or gross output of a generator; for solar technology, it is the total rated power output of all the panels measured in direct current (DC). The enrollment MW target will be a specific portion of the annual MW target.

For each program year, the Board will recommend the enrollment MW target and a target amount of megawatts for each class of renewable resource (class MW target), which will be a specific portion of the enrollment MW target. Both of these recommendations from the Board are subject to Commission approval. If there is an over-subscription in one class and an under-subscription in an enrollment MW target, then National Grid, the OER, and the Board may

mutually agree to allocate megawatts from one class to another without Commission approval as long as the re-allocated targets would not exceed the annual MW Target.

Annual MW targets are as follows, with at least three megawatts (3 MW) of capacity to be carved out exclusively for small-scale solar projects in each of the first four (4) program years. The Board may recommend and/or the Commission may adopt a new annual MW target. Nameplate capacity associated with projects from the DG Standard Contracts Program that do not achieve commercial operation will also be added to the last program year.

| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| Annual Target | 25 MW | 40 MW | 40 MW | 40 MW | 160 MW + Actual remaining DG Standard Contract Capacity[1] - (Actual 2015 + Actual 2016 + Actual 2017 + Actual 2018) |

A "program year" means a year beginning April 1 and ending March 31, except that the first program year may begin after April 1, 2015, subject to Commission approval. Except for the first program year (2015), National Grid is required, in consultation with the Board and the OER, to conduct at least three (3) tariff enrollments for each distributed generation class each program year. For the first program year, the Board may recommend that either two (2) or three (3) enrollments be conducted. The classes and targets for each program year are listed in Schedule 2 of this application, which will be updated periodically.

For each program year, the Board will recommend the Ceiling Prices and Standard Performance-Based Incentives (PBI), as applicable, for each renewable energy class, subject to Commission approval. For Competitive Bid projects, the Ceiling Price is the bidding price cap, further described in Section 2.1.5. Small-scale solar and medium-scale solar projects will receive a Standard PBI under the tariff, further described in Section 2.1.4. See Schedule 2 for the approved Ceiling Prices and Standard PBIs for the current program year.

### 1.2.1 Applications

Each enrollment will be open for a two (2) week period. During the enrollment period, National Grid will accept standard short-form applications. The standard application shall require the Applicant to provide the following information about the project: (1) the project ownership; (2) the location of the proposed project; (3) the nameplate capacity; and (4) the renewable energy class. The application allows Applicants to provide additional information relative to the

[1] Pursuant to Chapter 26.6 of Title 39 of the Rhode Island General Laws (R.I.G.L § 39-26.6-12(e)), any shortfall in the 2014 Distributed Generation Standard Contracts Program shall be added to the 160 MW target for the fifth program year.

permitting, financial feasibility, ability to build, and timing for achieving commercial operation of the proposed projects. The Applicant must certify in the application that the project will not violate the prohibition on project segmentation, as set forth in the Tariff.

Applicants will be selected for the RE Growth Program in accordance with the rules below.

### 1.2.2 Eligibility Requirements

#### 1.2.2.1 Introduction

To be eligible, a Project must meet certain requirements, and National Grid will review all applications to determine whether they meet these requirements. Projects that do not meet eligibility requirements will be disqualified from the RE Growth Program.

#### 1.2.2.2 Eligible Applicant

An Applicant must be in good standing with regard to obligations to National Grid. Such obligations include but are not limited to obligations under an interconnection service agreement, and being current with amounts due on the electric service account(s) or fulfilling the requirements of an approved payment plan.

#### 1.2.2.3 Eligible Facilities

To be eligible for an enrollment, a Project must: (1) be an eligible renewable energy resource under the RE Growth Program, as determined by the Board and approved by the Commission; (2) have a nameplate capacity equal to or less than five megawatts (5 MW); (3) interconnect with the distribution system of The Narragansett Electric Company; and (4) be located in the The Narragansett Electric Company ISO-NE load zone.

Nameplate capacity is the maximum rated output or gross output of a generator; for solar technology it is the total rated power output of all panels measured in direct current (DC).

To apply, a distributed generation project must not be: (1) already operating; (2) under construction, except for preparatory site work that is less than twenty-five percent (25%) of the estimated total project cost; or (3) fully financed for construction, except to the extent that financing agreements are conditioned upon the selection of the project in this program. A pre-existing hydroelectric generating facility that is already operating may be eligible for the RE Growth Program if it can demonstrate with reasonable evidence its need for a material investment to restore or maintain reliable and efficient operation and meet all regulatory, environmental or operational requirements, in addition to meeting the other criteria of the RE Growth Program.

#### 1.2.2.3.1 Renewable Energy Classes

For each program year, the Board shall determine the renewable energy classes, which are defined by specific technology, nameplate size, and other requirements as may be applicable as determined by the Board, subject to Commission approval. The Board may make recommendations to the Commission to add, eliminate, or adjust renewable energy classes for each program year. See Schedule 2 for the approved renewable energy classes for the applicable program year. To be eligible for an enrollment, a distributed generation project must qualify within one of the approved renewable energy classes for the applicable program year as indicated in Schedule 2.

#### 1.2.2.3.2 Prohibition on Project Segmentation

Project segmentation occurs when one distributed generation project is split into multiple projects on a single parcel or on contiguous parcels in order to qualify under smaller size project classifications.

Under the RE Growth Program, project segmentation is not allowed. However, a Project developer may designate an additional distributed generation unit or portion of a unit on the same parcel or on a contiguous parcel for net metering or for other means of participating in electricity markets, as long as any such unit or portion of such unit: (1) is not receiving Performance-Based Incentives through the RE Growth Program; (2) is segregated electrically; and (3) is separately metered.

A Project is not considered segmented if: (1) at least twenty-four (24) months elapse between the operating start-date of the Project and the start of construction of new distributed generation unit(s) of the same resource technology on the same parcel or a contiguous parcel; or (2) the distributed generation projects use different renewable resource technologies (e.g., a wind turbine and a solar array could both be eligible within the 24 month window). In addition, DG projects installed on contiguous parcels will not be considered segmented if they serve different customers and both customers opt to receive bill credits under Option 2 as described in Section 8.c. of the Tariff.

#### 1.2.2.3.3 Small Distributed Generation Projects

A small distributed generation project means a Project with a nameplate capacity within the following statutory limits:

| **Small Wind** | **Small-Scale Solar** | **Medium-Scale Solar** | **Other Technology** |
|---|---|---|---|
| 50 kW - 1,500 kW | Up to and including 25 kW | Greater than 25 kW, up to and including 250 kW | TBD by the Board, up to 1 MW. |

See Schedule 2 for approved renewable energy classes that are eligible for the current enrollment. Note that there is a separate solicitation and enrollment process rules for Small-Scale Solar projects.

#### 1.2.2.3.4 Large Distributed Generation Projects

A large distributed generation project means a Project with a nameplate capacity within the following statutory limits:

| Commercial-Scale Solar | Large-Scale Solar | Large Wind | Other Technology |
|---|---|---|---|
| Greater than 250 kW, but less than 1 MW | 1 MW, up to and including 5 MW | Greater than 1.5 MW, up to and including 5 MW | Greater than small DG, up to and including 5 MW |

See Schedule 2 for approved renewable energy classes that are eligible for the current enrollment.

## II. Application Evaluation and Selection Criteria and Process

## 2.1 Overview of Application Evaluation and Selection Process

Applications will be subject to a consistent, defined review and selection process. Except for small-scale and medium-scale solar, Projects in an enrollment period will be evaluated against other Projects in the same renewable energy class. The first stage of review determines whether a Project satisfies specified eligibility and minimum threshold requirements. National Grid will conduct any additional evaluation as required, consistent with the requirements set forth above, and select eligible Applicants to move onto the next stage in the selection process. Subsequent to this selection, National Grid will evaluate Projects based on certain threshold criteria, described below in sections 2.1.1-2.1.3, and then award selected projects Certificates of Eligibility as described in sections 2.1.4 and 2.1.5.

### 2.1.1 Interconnection Progress Prior to Enrollment

A Project must have made sufficient progress in the interconnection process prior to enrollment to ensure that interconnection costs have been estimated and the Project is likely to meet the statutory deadlines above. Project owners must have already submitted an application for interconnection and, if necessary, must have received a completed Impact Study for Renewable DG (ISRDG) from the Company. A copy of the interconnection application and a completed ISRDG, or valid Interconnection Service Agreement (signed by Applicant and National Grid), must be enclosed along with an application for enrollment under this program. All interconnection costs must be paid by the Applicant of the distributed generation (DG) project. However, a distributed generation facility owner may appeal to the Commission to reduce any required system upgrade costs to the extent such upgrades can be shown to benefit other customers of the electric distribution company and the balance of such costs shall be included in rates by the electric distribution company for recovery in the year incurred or the year following incurrence.

For information regarding ISRDG and the standards for the interconnection of generators in Rhode Island, please see:

https://www.nationalgridus.com/narragansett/business/energyeff/4_standard_interconnection.asp

### 2.1.2 Site Control

The Applicant must show actual control of the site where the Project is to be located, or show that it has exercised its right to acquire control of the site. To meet this requirement, the Applicant must represent that it owns or leases (or has an executed, exclusive, unconditional option to own or lease) the site on which the proposed project will be located, and that it has any additional rights required to develop and operate the project at the site.

### 2.1.3 Application Completeness and Timeliness

Applicants must endeavor to complete the entire application and provide all reasonably available information in each section of the application. Applicants will not be allowed to modify their applications after they are submitted to the Company.

Applications must be timely submitted in accordance with the enrollment dates set forth in Schedule 1. Applications received after the deadline will not be accepted.

Following the submission of applications, National Grid may request additional information from Applicants at any time during the process. Applicants that do not respond to requests for information may be disqualified from an enrollment.

### 2.1.4 Standard Performance-Based Incentive (PBI) Payments for Small-Scale and Medium-Scale Solar Projects

Small-scale and medium-scale solar projects enrolled in the RE Growth Program will receive a Standard PBI for the period of years shown in the applicable Tariff supplement. See Schedule 2 for the approved Standard PBIs for the current program year. The Standard Performance-Based Incentive is recommended by the Board and approved by the Commission. The Standard Performance-Based Incentive is a price per kilowatt-hour to be paid for the entire output of the facility for as long as the facility is enrolled in the Program. These projects shall be selected on a "first come, first served" basis. Small-scale solar projects must apply to the RE Growth Program pursuant to the Small-Scale Solar Solicitation and Enrollment Rules.

If, after the first program year, the applications for the medium-scale solar projects are significantly over-subscribed, then the Board and National Grid, in consultation with the OER, may propose to the Commission a bidding process for medium-scale solar projects or a subset of the medium-scale solar projects as described in section 2.1.5 below.

### 2.1.5 Competitive Bidding for Distributed Generation Projects

Large-scale and commercial-scale solar projects and distributed generation projects for other eligible technologies are subject to a bidding process to determine which Projects are selected for the RE Growth Program. Each Project is required to bid a price per kilowatt-hour for its entire output (net of any station service) for the approved tariff term length, which shall not exceed the applicable ceiling price. Following eligibility and threshold evaluations, the price evaluation of the bids for that applicable Tariff supplement will be applied on a consistent basis such that the same approved term lengths for competing bids are used to determine the winning bids. Selection will be made by ranking the eligible projects from lowest bid price received to highest, but not to exceed the applicable ceiling price. See Schedule 2 for the approved Ceiling Prices for the current program year. Projects will be selected beginning with the lowest bid price and continuing to select projects up to the enrollment MW target for the applicable class. If selected, the price each Project bids into the solicitation will be its PBI paid under the applicable Tariff supplement.

If the Projects that bid the same price exceed the capacity specified for a renewable energy class target, National Grid will consult with the Board and the OER in selecting first those projects that appear to be the furthest along in development and that are most likely to be deployed. Those Projects that are likely to achieve commercial operations at the earliest time shall be selected first. The Company may also consult with the Board, the OER, and/or the Division during this further assessment.

## 2.2 Issuance of Certificates of Eligibility

For small-scale and medium-scale solar projects, National Grid shall provide Certificates of Eligibility to the selected projects without obtaining Commission confirmation or approval, but subject to the review and consent of the OER. National Grid will file with the Commission a list of all small-scale and medium-scale solar Projects that are awarded Certificates of Eligibility. National Grid will award Certificates of Eligibility to eligible small-scale solar projects in accordance with the Solicitation and Enrollment Process Rules for Small-Scale Solar Projects. National Grid will award Certificates of Eligibility to eligible medium-scale solar projects on a "first come, first served" basis until the enrollment MW target for that renewable energy class is fully subscribed.

For commercial-scale and large-scale solar, and all other distributed generation projects, National Grid shall file with the Commission a list of the distributed generation projects selected together with the corresponding pricing information. The Commission shall issue an order listing those projects to which Certificates of Eligibility are awarded within sixty (60) days of receipt of the list.

The Certificate of Eligibility will contain applicable DG Facility information, including renewable technology and class, facility size and energy output, term length, price, certificate issuance and certificate effective dates.

## 2.3 Requirements to Initiate Payment for Output

If awarded a Certificate of Eligibility, a Project is required to meet specific requirements to maintain its status in the RE Growth Program prior to and during construction, and to initiate the start of the payments for its output. These requirements are set forth below.

### 2.3.1 Performance Guarantee Deposit

Except for small-scale solar and medium-scale solar projects, Applicants are required to pay a performance guarantee deposit to National Grid, which must be made by wire transfer. The performance guarantee deposit is determined, in part, on the quantity of renewable energy certificate estimated to be generated per year under the Program. The deposit is fifteen dollars ($15.00) for each REC estimated to be generated per year by a Small Distributed Generation project and twenty-five dollars ($25.00) for each REC estimated to be generated per year by a Large Distributed Generation project. A performance guarantee deposit is at least five hundred dollars ($500) and not more than seventy-five thousand dollars ($75,000).

The deposit must be received and confirmed by National Grid within five (5) business days after a project is offered a Certificate of Eligibility. There are no exceptions to this requirement. Applicants should be prepared to make a deposit when submitting applications into any enrollment. If payment of the required performance guarantee deposit is not received by the date required, the Company will withdraw the offer and proceed with the next competitive bid in that enrollment.

The Company will refund the performance guarantee deposit over the course of the first year of the project's operation, paid quarterly.

### 2.3.2 Project Schedule and Output Certification

A project must certify that it is capable of producing at least ninety percent (90%) of the output that was proposed in its enrollment application before its deadline. All projects will have a twenty-four (24) month deadline to meet this requirement, but anaerobic digestion projects will have thirty six (36) months, and small-scale hydro will have forty-eight (48) months). A project's proposed construction schedule must allow it to meet the applicable deadline after it has received a Certificate of Eligibility.

If a project does not certify that it is capable of generating the output proposed in its enrollment application on or before the applicable deadline, the project's Certificate of Eligibility will be voided and its performance guarantee deposit will be forfeited. Forfeited performance guarantee deposits shall be credited to all distribution customers through rates and not retained by National Grid. National Grid will not refund the Performance Guarantee

Deposit to any project that does not provide an Output Certification within the applicable deadlines, including any extensions available to the Applicant as described in Section 3.f. and 3.g. of the Tariff (note: deadline may be extended by 6 months with no additional PGD and an additional 6 months beyond that by posting one-half original PGD for the second extension).

A DG Facility must provide an independent third-party (licensed PE) engineer's "Output Certification" stating:

1. that the DG Facility or project has been completed in all material respects;
    a. including completion of construction of facility and all interconnection facilities necessary for operation;
    b. applicable meters have been installed and tested (commissioned).
2. that the DG Facility or project is capable of producing at least 90% of the maximum hourly output proposed in the project application and specified on the *Certificate of Eligibility*;
3. the actual nameplate capacity of the DG Facility or project as built and specified on the *Certificate of Eligibility;* and
4. the maximum hourly output in kWh/hour in Alternating Current (AC) of the facility as built and specified on the *Certificate of Eligibility*.

Once a DG Project has provided the Output Certification to National Grid, the Project then has 90 days to meet all other requirements pursuant to Section 8.a. of the Tariff in order to receive payment.

Small-scale and medium-scale solar projects are not required to provide the Output Certification or pay a performance guarantee deposit. However, after receiving a Certificate of Eligibility, a small-scale or medium-scale solar project has twenty-four (24) months to meet all other requirements pursuant to the Tariff in order to receive compensation under the RE Growth Program. If a Project does not meet this deadline, the Certificate of Eligibility will be voided.

### 2.3.3 Qualification as a Eligible Renewable Energy Resource under the RES

An Applicant to the RE Growth Program must obtain qualification for a Project as a renewable energy resource pursuant to the Rhode Island Renewable Energy Standard (RES). Applicants must complete a Renewable Energy Resources Eligibility Form and obtain Commission approval in order to be qualified under the RES. The form can be found at:

http://www.ripuc.org/utilityinfo/res.html

In addition, the Company may require Applicants to register and qualify RECs in other jurisdictions in order to monetize the value of these market products to offset the cost of the RE Growth Program.

## 2.4 Ownership of Products

The Company shall have the rights and receive title to:

(1) Renewable Energy Certificates (RECs) generated by the Project during the applicable term of the Tariff supplement;

(2) All energy produced by the Project; and

(3) Rights to any other environmental attributes or electricity market products or services that are created or produced by the Project; provided, however, that it shall be the Company's choice to acquire the capacity of the DG Project.

### 2.4.1 Delivery of Energy into ISO-NE Market

Energy must be delivered to National Grid in the ISO–NE Rhode Island load zone at the delivery node associated with the Project.

### 2.4.2 Delivery of RECs and Registration in NEPOOL GIS

Applicants must cooperate with and provide information to the Company to enable RECs to be created by the Project at the NEPOOL Generation Information System, and for such RECs to be transferred or assigned to the Company's appropriate NEPOOL GIS account, as governed by the Tariff.

### 2.4.3 Participation in ISO-NE Forward Capacity Market (FCM)

Upon National Grid's election to acquire the capacity from a Project, National Grid will assume the rights to the capacity, pursuant to the Tariff. National Grid reserves the right to be the "Project Sponsor" for the Project, after consultation with the Division and the Board. If and when National Grid participates as Project Sponsor on behalf of any Project, the Applicant must support National Grid, as required, to qualify the Project as an Existing Capacity Resource in the FCM. Applicants are required to take commercially reasonable actions to maximize performance against any FCM Capacity Supply Obligations.

**III. Contact Information and Other Provisions**

## 3.1 Official Contact

All questions and communications regarding these Rules should be directed via electronic mail to National Grid Environmental Transactions at the following address:

RenewableContracts@nationalgrid.com

## 3.2 Submittal of Enrollment Applications

The Solicitation and Enrollment Process Rules are posted on the National Grid Rhode Island Renewable Energy Growth Program website:

ngrid.com/REGrowth

Completed applications should be submitted electronically via the website, on the due date set forth in Schedule 1. Applications received after the deadline cannot be accepted for that particular open enrollment but can be submitted in a future open enrollment solicitation.

## 3.3 Confidentiality

Each application shall contain the full name and business address of the Applicant, and a contact person, and shall be signed by an authorized person.

The Board, the OER, and National Grid shall enter into an agreement regarding the sharing of the information and data related to the RE Growth Program, including such information as application information, details regarding project ownership, and pricing. At the request of the Board, the OER, National Grid, or the Division, the Commission shall have the authority to protect from public disclosure individual information for any projects that have not been awarded a Certificate of Eligibility. Information regarding project size, location, owner, and price will be made public for projects awarded a Certificate of Eligibility.

## 3.4 Modification or Cancellation of an Enrollment

Pursuant to Chapter 26.6 of Title 39 of the Rhode Island General Laws, any dispute involving the performance-based incentive payments, terms, conditions, rights, enforcement, and implementation of the Tariffs and these Rules, is subject to the exclusive jurisdiction of the Commission. National Grid may, at any time up to the issuance of Certificates of Eligibility (Section 2.2 above) and without any liability on the part of National Grid, postpone, withdraw and/or cancel this enrollment; alter, extend or cancel any due date; and/or, alter, amend, withdraw and/or cancel any requirement, term or condition of this enrollment.

**Schedule 1**

**Anticipated Timeline**

| Event | Anticipated Dates |
|---|---|
| Enrollment begins | October 19, 2015 – 9am EPT |
| Due Date for Submission of Applications | October 30, 2015 – 5pm EPT |
| Select Projects for Certificates of Eligibility | December 9, 2015 |

Note: Schedule 1 will be updated as required for each enrollment period.

**Schedule 2**

**Approved Renewable Energy Classes, Enrollment Targets, Standard PBIs and Ceiling Prices Applicable to Current Enrollment Period**

| Renewable Energy Class (Nameplate kW) | Enrollment Target (Nameplate kW) | Standard PBI *applicable to Medium Solar only* (cents/kWh) | Ceiling Price w/ITC (cents/kWh) | Ceiling Price w/ PTC (cents/kWh) | Ceiling Price w/o ITC/PTC (cents/kWh) | Term of Service (years) |
|---|---|---|---|---|---|---|
| Medium-Scale Solar (26-250 kW DC) | 3,472 | 24.40 | 24.40 | N/A | N/A | 20 |
| Commercial-Scale Solar (251-999 kW DC) | 3,680 | N/A | 20.95 | N/A | N/A | 20 |
| Large-Scale Solar (1,000-5,000 kW DC) | 0 | N/A | 16.70 | N/A | N/A | 20 |
| Wind (1,500-5,000 kW) | 500 | | | | | |
| 1,500-2,999 kW | | N/A | 18.40 | 19.85 | 22.75 | 20 |
| 3,000-5,000 kW | | N/A | 18.20 | 19.45 | 22.35 | 20 |
| Anaerobic Digestion (up to 1,000 kW) | 1,500 | | | | | |
| 150-1,000 kW | | N/A | N/A | 20.20 | 20.60 | 20 |
| Small-Scale Hydropower (up to 1,000 kW) | | | | | | |
| 10-250 kW | | N/A | N/A | 19.80 | 21.35 | 20 |
| 251-1,000 kW | | N/A | N/A | 18.55 | 20.10 | 20 |

***As indicated above, there is a 0 kW (nameplate) Enrollment Target for the Large-Scale Solar Renewable Energy Class and the 500 kW (nameplate) Enrollment Target for the Wind Renewable Energy Class is less than the minimum project size (1,500 kW). However, applications for projects in either of these Renewable Energy Classes may be submitted in the October Open Enrollment and be selected if other Renewable Energy Classes are under-represented.***

Note: Schedule 2 will be updated as required for each enrollment period.

# Appendix K

# Solar Developers Power Purchase Agreement Estimates

# Preliminary Solar Proposal for CDM Smith

Presented By:

Kenny Alves
401-626-6378
Alves.kenny@gmail.com

# Site Summaries

| Site 1 | | Sq Ft | PV size in Watts / Dc | PV Size in KW | Annual Production in kWh | Cost Per Watt | Cost In Dollars |
|---|---|---|---|---|---|---|---|
| | Roof 1 | 20,853 | 173775 | 173.8 | 231,485 | $2.35 | $408,371.25 |
| | Roof 2 | 42,969 | 358075 | 358.1 | 476,955 | $2.35 | $841,476.25 |
| | Roof 3 | 50,434 | 420283 | 420.3 | 559,800 | $2.35 | $987,665.83 |
| | Roof 4 | 25,915 | 215958 | 216.0 | 287,691 | $2.35 | $507,502.08 |
| Total | | | 1168092 | 1168.1 | 1,555,931 | $2.35 | $2,745,015.41 |
| | | | | | | | |
| Site 2 | | | | | | | |
| | Ground 1 | 15,660 | 76765 | 76.8 | 102,290 | $2.15 | $165,044.12 |
| | Ground 2 | 216,230 | 1059951 | 1060.0 | 1,411,819 | $2.15 | $2,278,894.61 |
| Total | | | 1136716 | 1136.7 | 1,514,109 | $2.15 | $2,443,938.73 |
| | | | | | | | |
| Site 3 | | | | | | | |
| | Ground | 340,916 | 1671157 | 1671.2 | 2,225,879 | $2.15 | $3,592,987.25 |
| | | | | | | | |
| Global | Ground Sq Ft | Roof Sq Ft | PV Size in Watts | PV Size in KW | | Cost Per Watt | Cost In Dollars |
| | 572,806 | 140,171 | 3975964 | 3976.0 | 5,295,919 | $2.21 | $8,781,941.39 |

- Assuming All Roof Space is free and clear of any shading obstructions
- Utility Expenses & Upgrades are not included in estimate.

# System Overview Global

- Greenside Energy has determined that the roof space and land located at the 3 sites could accommodate approximately 3.9 Mega-watts. This system could produce approximately 5.3 Million kWh per year.

| System Size | 3976 KW |
|---|---|
| **Annual Production (kWh)** | 5,295,607 |
| **Upfront Cost** | $8,786,960 |
| **Price Per Watt** | $2.21 |
| **Federal Tax Credit** | $2,636,088 |
| **REF Grant after Taxes (45%)** | $577,500 |
| **Total Cost After Incentives** | $5,573,372 |
| **Estimated Payback in Years** | 6.68 |
| **Internal Rate of Return (IRR)** | 11% |
| **Return on Investment (ROI)** | 15.0% |
| **Inverter Type** | Solar Edge |
| **Racking Solution** | Ecolibrium |
| **Number of Panels** | 12,623 |
| **Panel Manufacturer and Rating** | Solar World 315 (72cell) |

# Financial Analysis Global

| Year | Purchase Price | Depreciation | Fed Tax Credit | REF Grant | Energy Income | REC Income | O & M | Real Estate Taxes | Insurance | Annual Cash Flow | Cumulative Cash Flow | Annual Percentage Rate (APR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ($8,786,960) | $0 | $0 | $0 | $0 | | | | | ($8,786,960) | ($8,786,960) | |
| 1 | $0 | $672,202 | $2,636,088 | $577,500 | $378,636 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $4,080,735 | ($4,706,225) | 46% |
| 2 | $0 | $1,075,524 | $0 | $0 | $388,045 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $1,407,110 | ($3,299,115) | 16% |
| 3 | $0 | $645,314 | $0 | $0 | $397,688 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $986,543 | ($2,312,572) | 11% |
| 4 | $0 | $387,189 | $0 | $0 | $407,570 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $738,300 | ($1,574,272) | 8% |
| 5 | $0 | $387,189 | $0 | $0 | $417,699 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $748,428 | ($825,844) | 9% |
| 6 | $0 | $193,594 | $0 | $0 | $428,078 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $565,214 | ($260,631) | 6% |
| 7 | $0 | $0 | $0 | $0 | $438,716 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $382,257 | $121,626 | 4% |
| 8 | $0 | $0 | $0 | $0 | $449,618 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $393,159 | $514,785 | 4% |
| 9 | $0 | $0 | $0 | $0 | $460,791 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $404,332 | $919,117 | 5% |
| 10 | $0 | $0 | $0 | $0 | $472,242 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $415,783 | $1,334,900 | 5% |
| 11 | $0 | $0 | $0 | $0 | $483,977 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $427,518 | $1,762,418 | 5% |
| 12 | $0 | $0 | $0 | $0 | $496,004 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $439,545 | $2,201,963 | 5% |
| 13 | $0 | $0 | $0 | $0 | $508,330 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $451,870 | $2,653,833 | 5% |
| 14 | $0 | $0 | $0 | $0 | $520,962 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $464,502 | $3,118,336 | 5% |
| 15 | $0 | $0 | $0 | $0 | $533,908 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $477,448 | $3,595,784 | 5% |
| 16 | $0 | $0 | $0 | $0 | $547,175 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $490,716 | $4,086,500 | 6% |
| 17 | $0 | $0 | $0 | $0 | $560,772 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $504,313 | $4,590,813 | 6% |
| 18 | $0 | $0 | $0 | $0 | $574,708 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $518,248 | $5,109,062 | 6% |
| 19 | $0 | $0 | $0 | $0 | $588,989 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $532,530 | $5,641,592 | 6% |
| 20 | $0 | $0 | $0 | $0 | $603,626 | $83,098 | ($12,326) | ($127,232) | ($127,232) | $547,166 | $6,188,758 | 6% |

- Assuming a 45% Tax Rate.
- PPA Price @ .13 per kWh.
- Energy Income, REF Grant, and REC Income are all shown after tax.

# System Overview Site 1

- Greenside Energy has determined that the roof space located at site 1 could accommodate approximately 1.1 Mega-Watt Solar Array. This system could produce approximately 1.5 Million kWh per year.

| System Size | 1168.1 KW |
|---|---|
| **Annual Production (kWh)** | 1,555,799 |
| **Upfront Cost** | $2,745,035 |
| **Price Per Watt** | $2.35 |
| **Federal Tax Credit** | $823,511 |
| **REF Grant after Taxes (45%)** | $192,500 |
| **Total Cost After Incentives** | $1,729,025 |
| **Estimated Payback in Years** | 6.94 |
| **Internal Rate of Return (IRR)** | 10% |
| **Return on Investment (ROI)** | 14.4% |
| **Inverter Type** | Solar Edge |
| **Racking Solution** | Ecolibrium |
| **Number of Panels** | 3,708 |
| **Panel Manufacturer and Rating** | Solar World 315 (72 Cell) |

# Financial Analysis Site 1

| Year | Purchase Price | Depreciation | Fed Tax Credit | REF Grant | Energy Income | REC Income | O & M | Real Estate Taxes | Insurance | Annual Cash Flow | Cumulative Cash Flow | Annual Percentage Rate (APR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ($2,745,035) | $0 | $0 | $0 | $0 | | | | | ($2,745,035) | ($2,745,035) | |
| 1 | $0 | $209,995 | $823,511 | $192,500 | $111,249 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $1,283,289 | ($1,461,746) | 47% |
| 2 | $0 | $335,992 | $0 | $0 | $114,014 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $433,419 | ($1,028,328) | 16% |
| 3 | $0 | $201,595 | $0 | $0 | $116,847 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $301,855 | ($726,472) | 11% |
| 4 | $0 | $120,957 | $0 | $0 | $119,750 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $224,121 | ($502,352) | 8% |
| 5 | $0 | $120,957 | $0 | $0 | $122,726 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $227,096 | ($275,255) | 8% |
| 6 | $0 | $60,479 | $0 | $0 | $125,776 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $169,668 | ($105,588) | 6% |
| 7 | $0 | $0 | $0 | $0 | $128,902 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $112,315 | $6,727 | 4% |
| 8 | $0 | $0 | $0 | $0 | $132,105 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $115,518 | $122,245 | 4% |
| 9 | $0 | $0 | $0 | $0 | $135,388 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $118,801 | $241,045 | 4% |
| 10 | $0 | $0 | $0 | $0 | $138,752 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $122,165 | $363,210 | 4% |
| 11 | $0 | $0 | $0 | $0 | $142,200 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $125,613 | $488,823 | 5% |
| 12 | $0 | $0 | $0 | $0 | $145,734 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $129,147 | $617,970 | 5% |
| 13 | $0 | $0 | $0 | $0 | $149,355 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $132,768 | $750,738 | 5% |
| 14 | $0 | $0 | $0 | $0 | $153,067 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $136,480 | $887,217 | 5% |
| 15 | $0 | $0 | $0 | $0 | $156,870 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $140,283 | $1,027,501 | 5% |
| 16 | $0 | $0 | $0 | $0 | $160,768 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $144,181 | $1,171,682 | 5% |
| 17 | $0 | $0 | $0 | $0 | $164,764 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $148,177 | $1,319,859 | 5% |
| 18 | $0 | $0 | $0 | $0 | $168,858 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $152,271 | $1,472,130 | 6% |
| 19 | $0 | $0 | $0 | $0 | $173,054 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $156,467 | $1,628,597 | 6% |
| 20 | $0 | $0 | $0 | $0 | $177,354 | $24,413 | ($3,621) | ($37,379) | ($37,379) | $160,767 | $1,789,364 | 6% |

- Assuming a 45% Tax Rate.
- PPA Price @ .13 per kWh.
- Energy Income, REF Grant, and REC Income are all shown after tax.

# System Overview Site 2

- Greenside Energy has determined that the roof space located at site 1 could accommodate approximately 1.1 Mega-Watt Solar Array. This system could produce approximately 1.5 Million kWh per year.

| System Size | 1136.7 KW |
|---|---|
| **Annual Production (kWh)** | 1,514,108 |
| **Upfront Cost** | $2,443,905 |
| **Price Per Watt** | $2.15 |
| **Federal Tax Credit** | $733,172 |
| **REF Grant after Taxes (45%)** | $192,500 |
| **Total Cost After Incentives** | $1,518,234 |
| **Estimated Payback in Years** | 6.23 |
| **Internal Rate of Return (IRR)** | 11% |
| **Return on Investment (ROI)** | 16.0% |
| **Inverter Type** | Solar Edge |
| **Racking Solution** | Ecolibrium |
| **Number of Panels** | 3,609 |
| **Panel Manufacturer and Rating** | SW 315 |

# Financial Analysis Site 2

| Year | Purchase Price | Depreciation | Fed Tax Credit | REF Grant | Energy Income | REC Income | O & M | Real Estate Taxes | Insurance | Annual Cash Flow | Cumulative Cash Flow | Annual Percentage Rate (APR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ($2,443,905) | $0 | $0 | $0 | $0 | | | | | ($2,443,905) | ($2,443,905) | |
| 1 | $0 | $186,959 | $733,172 | $192,500 | $108,259 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $1,168,373 | ($1,275,532) | 48% |
| 2 | $0 | $299,134 | $0 | $0 | $110,949 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $393,942 | ($881,590) | 16% |
| 3 | $0 | $179,480 | $0 | $0 | $113,706 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $277,045 | ($604,545) | 11% |
| 4 | $0 | $107,688 | $0 | $0 | $116,532 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $208,079 | ($396,466) | 9% |
| 5 | $0 | $107,688 | $0 | $0 | $119,427 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $210,975 | ($185,491) | 9% |
| 6 | $0 | $53,844 | $0 | $0 | $122,395 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $160,098 | ($25,393) | 7% |
| 7 | $0 | $0 | $0 | $0 | $125,437 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $109,296 | $83,902 | 4% |
| 8 | $0 | $0 | $0 | $0 | $128,554 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $112,413 | $196,315 | 5% |
| 9 | $0 | $0 | $0 | $0 | $131,748 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $115,607 | $311,922 | 5% |
| 10 | $0 | $0 | $0 | $0 | $135,022 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $118,881 | $430,804 | 5% |
| 11 | $0 | $0 | $0 | $0 | $138,378 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $122,237 | $553,040 | 5% |
| 12 | $0 | $0 | $0 | $0 | $141,816 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $125,675 | $678,715 | 5% |
| 13 | $0 | $0 | $0 | $0 | $145,340 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $129,199 | $807,915 | 5% |
| 14 | $0 | $0 | $0 | $0 | $148,952 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $132,811 | $940,726 | 5% |
| 15 | $0 | $0 | $0 | $0 | $152,654 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $136,513 | $1,077,238 | 6% |
| 16 | $0 | $0 | $0 | $0 | $156,447 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $140,306 | $1,217,544 | 6% |
| 17 | $0 | $0 | $0 | $0 | $160,335 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $144,194 | $1,361,738 | 6% |
| 18 | $0 | $0 | $0 | $0 | $164,319 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $148,178 | $1,509,916 | 6% |
| 19 | $0 | $0 | $0 | $0 | $168,402 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $152,261 | $1,662,177 | 6% |
| 20 | $0 | $0 | $0 | $0 | $172,587 | $23,757 | ($3,524) | ($36,374) | ($36,374) | $156,446 | $1,818,623 | 6% |

- Assuming a 45% Tax Rate.
- PPA Price @ .13 per kWh.
- Energy Income, REF Grant, and REC Income are all shown after tax.

# System Overview Site 3

- Greenside Energy has determined that the roof space located at site 1 could accommodate approximately 1.6 Mega-Watt Solar Array. This system could produce approximately 2.2 Million kWh per year.

| System Size | 1671.2 KW |
|---|---|
| **Annual Production (kWh)** | 2,225,880 |
| **Upfront Cost** | $3,593,080 |
| **Price Per Watt** | $2.15 |
| **Federal Tax Credit** | $1,077,924 |
| **REF Grant after Taxes (45%)** | $192,500 |
| **Total Cost After Incentives** | $2,322,656 |
| **Estimated Payback in Years** | 6.80 |
| **Internal Rate of Return (IRR)** | 11% |
| **Return on Investment (ROI)** | 14.7% |
| **Inverter Type** | Solar Edge |
| **Racking Solution** | Ecolibrium |
| **Number of Panels** | 5,305 |
| **Panel Manufacturer and Rating** | SW 315 |

# Financial Analysis Site 3

| Year | Purchase Price | Depreciation | Fed Tax Credit | REF Grant | Energy Income | REC Income | O & M | Real Estate Taxes | Insurance | Annual Cash Flow | Cumulative Cash Flow | Annual Percentage Rate (APR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ($3,593,080) | $0 | $0 | $0 | $0 | | | | | ($3,593,080) | ($3,593,080) | |
| 1 | $0 | $274,871 | $1,077,924 | $192,500 | $159,150 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $1,627,236 | ($1,965,844) | 45% |
| 2 | $0 | $439,793 | $0 | $0 | $163,105 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $579,167 | ($1,386,677) | 16% |
| 3 | $0 | $263,876 | $0 | $0 | $167,158 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $407,303 | ($979,374) | 11% |
| 4 | $0 | $158,325 | $0 | $0 | $171,312 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $305,907 | ($673,467) | 9% |
| 5 | $0 | $158,325 | $0 | $0 | $175,569 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $310,164 | ($363,303) | 9% |
| 6 | $0 | $79,163 | $0 | $0 | $179,932 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $235,364 | ($127,939) | 7% |
| 7 | $0 | $0 | $0 | $0 | $184,404 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $160,673 | $32,734 | 4% |
| 8 | $0 | $0 | $0 | $0 | $188,986 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $165,255 | $197,989 | 5% |
| 9 | $0 | $0 | $0 | $0 | $193,682 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $169,951 | $367,940 | 5% |
| 10 | $0 | $0 | $0 | $0 | $198,495 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $174,764 | $542,704 | 5% |
| 11 | $0 | $0 | $0 | $0 | $203,428 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $179,697 | $722,401 | 5% |
| 12 | $0 | $0 | $0 | $0 | $208,483 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $184,752 | $907,154 | 5% |
| 13 | $0 | $0 | $0 | $0 | $213,664 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $189,933 | $1,097,087 | 5% |
| 14 | $0 | $0 | $0 | $0 | $218,974 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $195,243 | $1,292,329 | 5% |
| 15 | $0 | $0 | $0 | $0 | $224,415 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $200,684 | $1,493,013 | 6% |
| 16 | $0 | $0 | $0 | $0 | $229,992 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $206,261 | $1,699,274 | 6% |
| 17 | $0 | $0 | $0 | $0 | $235,707 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $211,976 | $1,911,250 | 6% |
| 18 | $0 | $0 | $0 | $0 | $241,564 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $217,833 | $2,129,083 | 6% |
| 19 | $0 | $0 | $0 | $0 | $247,567 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $223,836 | $2,352,920 | 6% |
| 20 | $0 | $0 | $0 | $0 | $253,719 | $34,928 | ($5,181) | ($53,478) | ($53,478) | $229,988 | $2,582,908 | 6% |

- Assuming a 45% Tax Rate.
- PPA Price @ .13 per kWh.
- Energy Income, REF Grant, and REC Income are all shown after tax.

# PPA for CDM Smith

- Greenside Energy would be able to offer a PPA at .13 per kWh

- If the client wishes to purchase the the solar array at the end of year 10 the purchase price would be $4,853,858 for all 3 sites.
- Site 1 : $1,426,154
- Site 2:  $1,387,820
- Site 3: $2,040,522

- If the client engages into a 20 year PPA at .13 per kWh the system would be handed over to client for $0 at the end of 20 year PPA.

- Greenside Energy is aware that no 2 PPAs are the same. If the client is planning on purchasing the solar array after year 10, Greenside could offer numerous scenarios to help meet the clients budget and needs.

# Experience

Cross Road Self Storage North Dartmouth, MA 02871

# Experience

- ***Construction:*** Greenside's Principles have been developing and managing commercial real estate in Rhode Island for over 30 years. We have a proven track record of success with strong references from Rhode Island residents and businesses.

*West Main Self Storage*
*825 West Main Rd Middletown RI*

# Experience

Former Governor Lincoln D. Chafee visited Quonset Business Park to celebrate the completion of New England's most powerful solar rooftop array.

- ***Financing:*** The Greenside Energy Team has extensive experience in the distributed renewable energy space. Greenside has made a strategic partnership with a reputable Asset Investment Management firm who financed and owns the 2.4 MW Quonset Naval Base Solar Array, and has deployed over $180 Million since 2010 in US-based municipal, commercial and military solar projects.

# About Greenside Energy

## OUR STRENGTHS

**Greenside is dedicated to using clean, renewable energy to reduce carbon emissions, create jobs, and aid economic development. As Developers we have:**

- **More than 30 years of combined experience in all aspects of development including finance, real estate, engineering and public policy.**
- **A proven track record of success with strong references from our customers and partners.**
- **A demonstrated and long-standing commitment to progressive environmental and energy policy and deep engagement in shaping those policies.**
- **A belief in using solar as not only a means of reducing electricity costs but also as a community and economic development tool.**

## OUR ROLE

**Greenside core competencies include site acquisition, project management, and collaboration. Our group of solar experts are ready and able to:**

- **Build and lead best-in-class project engineering and finance teams.**
- **Identify and secure solar project development sites.**
- **Identify and secure customers for solar energy generated at those sites.**
- **Negotiate Power Purchase Agreements.**
- **Obtain Interconnection Agreements and local site development approvals.**
- **Oversee project development until commissioning.**

## OUR RESULTS

**Greenside has achieved substantial results as a solar developer in Rhode Island & Massachusetts and thereby earned the trust and confidence of our customers.**

- **1+MW of projects completed or under construction.**
- **FAA Exemption Section 333 granted for aerial drone inspections relating to solar and utility inspections.**
- **Strategic partnerships with large distributors and contractors.**

# Legal Information

**This Pricing Estimate is valid until November 1st 2016. System design and calculations herein are tailored to the general physical characteristics of your business and electrical usage based on 3rd party information. Therefore, actual system cost and savings may vary upon a physical site verification of factors such as array location size (roof or ground) site system shading, electrical system limitations, and available financial incentives.**

**At time of physical site verification, any factors that may alter this estimate will be identified and reviewed with customer .**

**Tax savings described in this document are intended for discussion purposes only and should not be construed as professional advice.**

**All applicable state and federal tax credits are estimates. Please contact your tax professional for specific financial and tax advice.**



16

04/14/16

Oscar Del Olmo
CDM Smith
Boston, Ma

Dear Oscar,
Here is financial analysis we discussed at our meeting on 04/07/16. As you can see I am providing three options, two options where the customer owns the solar facility, and one with a third party ownership / PPA. These numbers were derived from specific data created for a 1-megawatt system at the 125 DuPont drive location.

Core Data:

- Cost of utility power .17 per kWh
- Production factor 1.1 (1,000,000 x 1.1 = 1,100,000 kwh pr. Yr.)
- Customer utility costs per year $ 187,000.00
- Solar offset per year $ 187,000.00
- System cost installed $ 1,9400,000.00 (1.94 per watt tier 1 equipment)

Ownership option #1
- 20-year assessment (CPACE)
- National Grid Feed in Tariff (.1510 per kwh 20 years)
- Third party tax equity provider.

| | |
|---|---|
| System cost | $1,940,000.00 |
| Tax equity cash investment | $349,200.00 |
| REC payments (.04 per kwh x 5 years) | $220,000.00 |
| Revised system cost | $1,370,800.00 |
| | |
| Monthly utility charge | $15,583.33 |
| CPACE monthly payment 1,332,388 @ 6% for 20 years | $9,820.84 |
| National Grid Feed in Tariff monthly payment | -$13,841.67 |
| New net payment | $11,562.50 |
| Monthly savings | $4,020.83 |
| New kWh price | $.1261 |

2 Shaylee Ln, Lakeville, MA 02347 774-260-2233 baystatesolar@gmail.com

Ownership option #2

- 20-year assessment (CPACE)
- National Grid Net Meter (.17 per kwh 20 years)
- Third party tax equity provider.

| | |
|---|---|
| System cost | $1,9400,000.00 |
| Tax equity cash investment | $349,200.00 |
| REC payments (.04 per kwh x 5 years) | $220,000.00 |
| RI Renewable Growth Fund | $350,000.00 |
| Revised system cost | $1,020,800.00 |
| | |
| Monthly utility charge | $15,583.33 |
| CPACE monthly payment 982,388 @ 6% for 20 years | $7,313.33 |
| National Net meter credit | -$15,583.33 |
| New net payment | $7,313.33 |
| Monthly savings | $8,270.00 |
| New kWh price | $.0797 |

PPA option #3

- 20-year .12 per kWh with 1.9% annual escalator

| | |
|---|---|
| System cost | $1,9400,000.00 |
| REC payments (.04 per kwh x 5 years)* | $220,000.00 |
| RI Renewable Growth Fund* | $350,000.00 |
| | |
| Monthly National Grid charge | $15,583.33 |
| Monthly PPA Charge | $11,000.00 |
| Monthly savings | $4,583.33 |
| New kWh price | $.1200 |

* Customer retains

2 Shaylee Ln, Lakeville, MA 02347 774-260-2233 baystatesolar@gmail.com

05/05/16

Oscar Del Olmo
CDM Smith
Boston, Ma

Dear Oscar,
Here is financial analysis we discussed at our meeting on 04/07/16. Based on our most recent conversation, I am providing a ownership option. These numbers were derived from specific data created for a 2.5-megawatt system at the 430 Scituate Ave location.

Core Data:

- Cost of utility power .17 per kWh
- Production factor 1.2 (2,500,000 x 1.2 = 3,000,000 kwh pr. Yr.)
- Customer utility costs per year $ 510,000.00
- Solar offset per year $ 510,000.00
- System cost installed $ 4,700,000.00 (1.88 per watt tier 1 equipment)
- Budget of $ 120,000.00 for site work
- Budget of $ 50,000.00 for fencing

Ownership option #1
- 20-year assessment (CPACE)
- National Grid Feed in Tariff (.1510 per kwh 20 years)
- Third party tax equity provider.

| | |
|---|---|
| System cost | $4,700,000.00 |
| Tax equity cash investment | $846,000.00 |
| REC payments (.04 per kwh x 5 years) | $600,000.00 |
| Revised system cost | $3,254,000.00 |
| | |
| Monthly utility charge | $42,500.00 |
| CPACE monthly payment $3,254,000.00@ 6% for 20 years | $23,312.67 |
| National Grid Feed in Tariff monthly payment | -$37,750.00 |
| New Monthly payment | $28,062.67 |
| Monthly Savings | $14,437.33 |
| New kWh price | $.1122 |

2 Shaylee Ln, Lakeville, MA 02347 774-260-2233 baystatesolar@gmail.com

Ownership option #2

- 20-year assessment (CPACE)
- National Grid Net Meter (.17 per kwh 20 years)
- Third party tax equity provider.

| | |
|---|---|
| System cost | $4,700,000.00 |
| Tax equity cash investment | $846,000.00 |
| REC payments (.04 per kwh x 5 years) | $600,000.00 |
| RI Renewable Growth Fund | $350,000.00 |
| Revised system cost | $2,904000.00 |
| | |
| Monthly utility charge | $42,500.00 |
| CPACE monthly payment $ 2,904000@ 6% for 20 years | $20,805.16 |
| National Net meter credit | -$42,500.00 |
| New net payment | $20,805.16 |
| Monthly Savings | $21,694.84 |
| New kWh price | $.0832 |

2 Shaylee Ln, Lakeville, MA 02347 774-260-2233 baystatesolar@gmail.com

# Appendix L

# Renewable Energy Credits Price Report

# NEPOOL Class I RECs: Shortage in the Midst of Plenty

March 10, 2015

Karbone

Karbone Research & Advisory

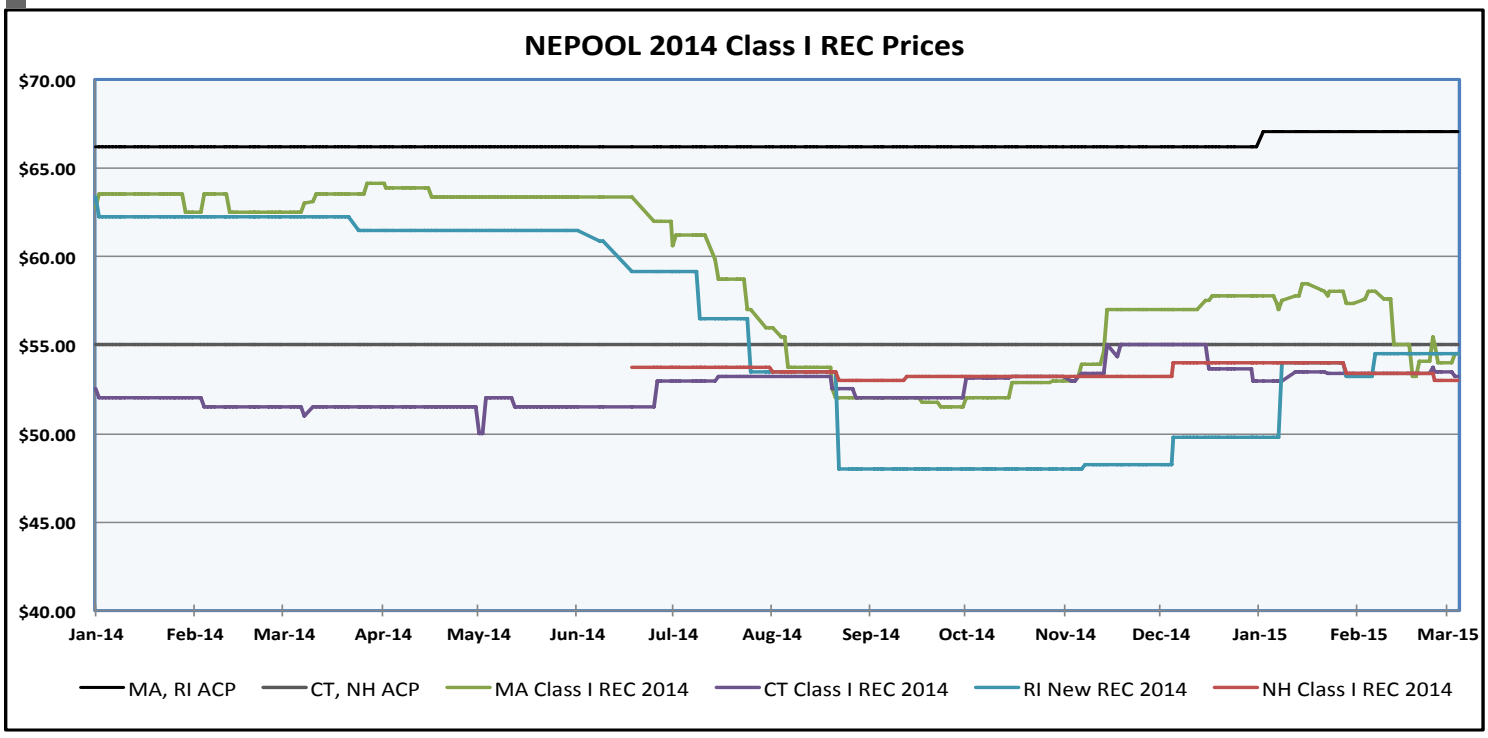
Jason Prince
Director of Research
(646) 845 0095

## REC Price Volatility

Price movements across NEPOOL Class I RECs since the back half of 2014 have brought into focus assumptions of persistent undersupply. Following a year of prices pegged just shy of their respective ACPs, Massachusetts Class I and Rhode Island New RECs each fell roughly 20% just over the course of Q3'14. MA pricing converged with CT levels but held north of $50/REC while RI dropped down into the high $40s. Pricing for both of these historically premium states rebounded through Q4'14 and Q1'15, but have settled at levels below their ACPs and just north of CT and NH RECs.

Given the interaction of state RPS programs within NEPOOL, focal events in particular markets have wider-reaching impacts. To provide context to the price volatility experienced over the last few quarters, Karbone examines a range of relevant policy and market developments in this research brief.

Overall, our fundamental view remains bullish for the short-term through Q2 2015, and cautiously bearish for the long term assuming that pipeline projects can overcome development hurdles and opposition.



## State Updates

### Massachusetts

Massachusetts boasts the highest ACP rate and the largest, most liquid market in NEPOOL. This makes it the most desirable retirement home for NEPOOL Class I RECs (most of which are cross-qualified and could sell into a range of NEPOOL state markets).

**Shortages to Surpluses**

For the 2013 compliance year, MA was so effective in attracting RECs that Class I REC supply exceeded demand by 7% and the state banked over 330 GWh of excess supply. This 2013 surplus stood in sharp contrast to the shortages that had pervaded from 2010-2012. For example, ACP payments fell 90% from 255 GWh in 2012 to only 31 GWh in 2013.

**REC Pricing**

Despite the 2013 surplus result, MA 2013 Class I REC pricing remained near ACP levels through Q2 2014 and the close of their trading period due to the assumption that shortages would persist. Around this time though, as entities closed their books and supply manifested itself as more adequate, MA 2014 Class I RECs suddenly fell, converging with CT Class I REC pricing levels before rallying back to a slight premium. For Karbone's forward price outlook, we turn to market supply and demand fundamentals.

**Bearish Fundamental: Solar Carve-Out**

Solar demand in MA is carved out of total Class I demand. Thus, as the following table shows, when solar demand increases, net demand for non-solar Class I RECs decreases.

| Year | Class I Demand (%) | Solar Demand (%) | Net Class I Demand (%) | Annual Net Class I Demand Change (MWh) |
|---|---|---|---|---|
| 2012 | 7% | 0.163% | 6.837% | |
| 2013 | 8% | 0.383% | 7.616% | 401,809 |
| 2014 | 9% | 1.032% | 7.967% | 166,853 |
| 2015 | 10% | 2.4730% | 7.5270% | (222,312) |

The year-on-year increase in net non-solar Class I demand drops from 401k RECs in 2013 to 166k RECs in 2014. Then, in 2015, net demand actually drops such that it will be 222k RECs less than it was in 2014. Comparing this anemic increase in demand with the supply increase of 550 MW of non-solar nameplate just qualified in MA in 2014, it suggests the potential for more adequate supply in 2014 and beyond.

**Bearish Fundamental: New York Wind**

Combined with reduced demand, the MA Class I market also has significant additional supply reserves in NY-sited wind facilities. As facilities roll-off their NY Main Tier contracts, they are incentivized to sell into NEPOOL to take advantage of higher power and REC prices. There is already over 1.3 GW of NY-sited wind qualified to earn MA Class I RECs, but NY wind only contributed 8% of the RECs used for 2013 MA compliance. If more of this nameplate figured out how to wheel its power into NEPOOL and sold its RECs into the MA market, the increased supply could put further downward pressure on prices.

**Bullish Fundamental: Cape Wind**

After more than a decade under development, Cape Wind had been expected to become the first offshore wind farm in the US. The 468 MW project was recently dealt a likely death-blow however when its contracts ($187/MWh + 3.5% escalator) with National Grid and NStar were terminated. Financing concerns and targeted opposition seem destined to ultimately prevent it from reaching completion and introducing millions of Class I RECs into MA and NEPOOL.

Cape Wind aside, the Department of Interior recently awarded leases for another 353k acres off the MA coast for offshore wind development. The long-term prospects for offshore wind supply are thus not dead but depend on the ability of future projects to overcome hurdles and reach completion.

### Massachusetts Class I REC Outlook

MA Class I REC prices have rallied back to levels premium to CT Class Is, but not to ACP levels indicative of acute shortages. Even though MA finished 2013 with a surplus, prompt spot pricing is likely to remain robust due to the opacity of the market and fungibility of Class I RECs. With buyers uncertain where supply will flow from, and with long-term contracts reducing OTC sell-side liquidity, Karbone projects that MA pricing will remain between $55 and $59 through Q2 2015. This is less to do with market fundamentals so much as the fact that aggregate NEPOOL supply will likely remain short and MA's ability to capture all the supply it needs will remain in question until compliance is due.

## Connecticut

Connecticut is the second largest market in NEPOOL but its low ACP makes it a last choice for REC sellers. Addressing the resultant persistent Class I REC shortages, Public Act 13-303 was passed in June 2013 intending to reduce reliance on ACP payments and encourage more renewable development.

### Long Term Procurements

To help CT meet its RPS targets, Public Act 13-303 authorized CT Electric Distribution Companies to enter into long-term contracts with eligible renewable generators. Solicitations have already procured almost 300 MW of Class I resources under Sections 6 and 8 of the Public Act, and further procurements are expected under Section 7 although the timing is uncertain. The contracting of large-scale hydro is also possible under Section 9, but is unlikely in the near-term given current CT expectations of adequate forward supply and a lack of available transmission capacity.

### Reduced REC Value

Section 5 of the Public Act required the establishment of a schedule for assigning a gradually reduced REC value to biomass and landfill methane gas facilities starting January 2015. Released in December, the 2014 Draft Integrated Resource Plan (IRP) however, suggested pushing the establishment of such a schedule to 2018, citing resource adequacy concerns and a reticence to jeopardize the continued operation of facilities in this context.

### Vermont SPEED RECs

Public Act 13-303 also made it clear that CT would not accept RECs for compliance that were being counted elsewhere. To implement this decision, CT has been investigating whether or not VT SPEED RECs should be allowed. There have been two dockets opened on this issue and although a ruling has been expected for several months now, a final decision should be forthcoming sometime this month. Almost 1 million NEPOOL Class I RECs hang in the balance and other NEPOOL states could well follow suite in disqualifying VT SPEED RECs for their respective markets too.

### Connecticut Class I REC Outlook

According to the 2014 Draft CT IRP, supply is expected to have been adequate for the CT Class I REC market in 2013 and 2014. This would represent a transition from the undersupply that had previously characterized the state market. Pricing for CT Class I RECs however have been stable and pegged just shy of the ACP since back in Q3 2013. Karbone expects these pricing levels to hold, even in the face of potential new supply, as the threat of RECs flowing to higher value states remains. As a result, Karbone is bullish on CT Class I REC pricing until enough development comes online across NEPOOL that MA and RI are sufficiently long.

## Vermont

Vermont has historically favored capacity, rather than generation targets for incentivizing renewables. That said, a recently proposed bill could alter this strategy and radically impact NEPOOL REC markets. Bill H.40 would replace the current SPEED program with a RESET program including a REC compliance component.

RESET (Renewable Energy Standard and Energy Transformation) would convert the state's current voluntary total renewables targets (55% by 2017 and 75% by 2032) to total renewables requirements and would have a carve-out for distributed generation.

Altogether, this would help harmonize VT renewable energy policy with other NEPOOL state RPS programs, and would address the issue of REC double-counting. H.40 is currently before the legislature but there is no deadline for a decision. If the bill passes, it would represent a significant new source of REC demand and should therefore have a bullish impact on prices.

## Rhode Island

Due to its small geographic size, Rhode Island depends almost entirely on renewable generators located out-of-state for its REC supply. Difficulties satisfying its demand caused the RI market to be short for 2011 and 2012, but the deficit seems to be tightening; 2012 was only short by 6.1% versus the 2011 shortage of 26.3%.

This trend of increasing supply could continue thanks to RI's successful long-term contracting initiatives. For example, there is a current proposal to provide 20-year tariffs for another 160 MW of capacity starting in 2015.

Lastly, RI could also start seeing additional supply from Deepwater Wind's 30 MW Block Island offshore wind farm. The project recently closed on over $290 million in financing and is expected to begin operating by the end of 2016.

## New Hampshire

Like CT, New Hampshire's relatively low ACP rate means that sellers first look elsewhere before selling to NH compliance buyers. As a result, NH has also been persistently short and Karbone doesn't expect that to change anytime soon.

**Useful Thermal RECs**

NH's pioneering 'useful thermal energy' Class I Carve-Out was finally adopted in December 2014. The compliance requirement will apply retroactively to all of 2014, and Karbone expects this market will be short. So far, only 3 facilities have been certified to earn useful thermal RECs (although generators can still apply to be certified and get credited back to the beginning of the year). Nonetheless, at this point in time, NEPOOL GIS has less than 6k RECs minted whereas demand for the carve-out in 2014 is projected at ~40k.

## Maine

Lenient refurbishment requirements have allowed for a substantial supply of old, dirty biomass to flood the Maine REC market. As a result, ME Class I RECs are currently trading around $3/REC. Given the state's abundance of forest and its importance to the state's economy, no policy changes (or upside prospects) are forecasted for the near-term.

More interesting than ME REC prices are the slew of efforts to develop transmission to bring more wind from Maine – and particularly northern Maine – to load in other parts of ISO-NE. There are currently over 3.3 GW of nameplate ME-sited wind currently proposed in the ISO-NE Interconnection Queue. Even if a small proportion of that gets tapped it could add significant volume to cross-eligible NEPOOL Class I REC supply.

## NEPOOL Supply, Demand & Pricing

### Short Term Outlook

Per the state-level data available, shortages across NEPOOL markets tightened in 2012 and 2013. Reporting lags in REC minting and compliance data make it as yet unclear how 2014 will fare, but Karbone expects the more adequate supply trend to have continued. Substantiating this view, the recent CT Draft 2014 IRP (see graph, opposite), projects that aggregate NEPOOL supply for 2014 will be sufficient, but that shortages could come back for 2015. As a result, Karbone envisions near-term Class I REC prices across NEPOOL to remain in the $53 - $59 / REC range through Q2 2015 and the close of 2014 compliance.

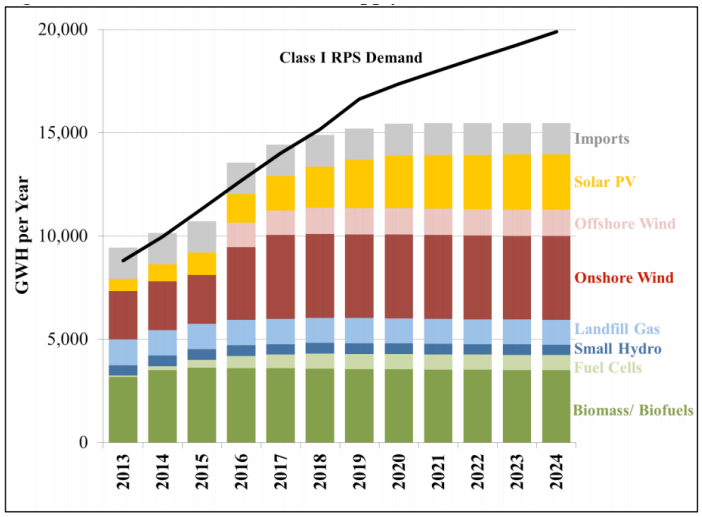
### Long Term Outlook

For renewable energy development, New England is at the same time one of the most attractive and difficult regions in the US. It affords leading power and REC prices, has capacity deficits expected as soon as 2017-18, and is straining to diversify from its reliance on natural gas. On the other hand, staunch "Not In My Backyard" (NIMBY) attitudes complicate project development, and congestion on the current transmission system limits siting opportunities.

Based on the compelling New England project economics and the 4.1GW of likely Class I nameplate capacity in the ISO-NE Interconnection Queue, Karbone suggests that with new build supply could be sufficient to meet NEPOOL REC demand in the long term. This scenario is supported by exogenous factors like a sluggish economy, anemic load growth, and increased energy efficiency – all of which would throttle REC demand increases going forward.

On the supply side, a recent draft RFP issued in collaboration by MA, CT and RI (expected to be finalized and released this spring) would provide term contracts to more Class I resources. More contracts of this type, in addition to potential PTC / ITC extensions would help pipeline projects get built and could eventually put downside pressure on prices. Such an adequate long term forward supply scenario will critically depend on new build though.

An analysis developed for the CT Draft 2014 IRP helps illustrate this point. Depicted below, it projects supply from existing and contracted resources, but excludes capacity in the Queue. In this CT scenario, aggregate NEPOOL Class I REC supply would mostly track demand to 2018 but fall persistently short thereafter.




This analysis underlines the fact that NEPOOL will need to capitalize on its abundant renewable resource potential to ensure that it doesn't fall short of increasing RPS demands going forward.

For more information on NEPOOL Class I RECs, contact **Jason Prince** at **(646) 845 0095**.

For NEPOOL Class I REC transactional opportunities, contact the **Brokerage Desk** at **(646) 616 0074**

# COMPANY OVERVIEW

Karbone is a full service firm specializing in Renewable Energy and Environmental Markets. Based in New York, with offices in London and Istanbul, the firm offers a unique combination of **Brokerage, Capital Advisory,** and **Research** services. The company's clients include large-scale energy companies, utilities, project developers, and financial firms.

Karbone's highly recognized Brokerage services include structuring long-term forward contracts for Bundled and Unbundled Power, RECs, SRECs, Carbon, and other commodities. The desk's voice Brokerage team also manages daily markets for short-term and spot trades. The firm's Capital Advisory group sources equity, debt, and tax equity for distributed generation and utility-scale projects including solar, wind, biomass, biogas, and energy efficiency technologies. The Capital Advisory team also originates projects for bespoke investor clients seeking to deploy capital. Finally, Karbone's Research team regularly publishes proprietary market pricing, regulatory analysis, and analytical research to help our clients make investment and trading decisions.

Karbone differentiates itself through a uniquely integrated service approach, which allows our team to add value along each segment of the project value chain. Our supply-demand analyses and price forecasts inform our clients' strategic decisions; our capital raising and investment advisory services enable our clients to get their projects off the ground; and our credit and commodity brokerage capabilities ensure that our clients maximize their revenue streams. We look forward to the opportunity to work with you and your company.

## BROKERAGE

- RECs, Carbon, Emissions
- Power, Ancillary Services
- Clean Fuels, Biofuels

## CAPITAL ADVISORY

- Project Origination
- Project Finance
- Asset Sales

## RESEARCH

- Market Analysis and Advisory
- Pricing Projections
- Deep-Dive Research Reports

### *Recent Awards*

***North American Renewable Energy Credit Broker***
***North American Carbon Broker***
***North American Advisory & Consultancy***
*- Environmental Finance Magazine*

***US Voluntary Carbon Offset Broker***
***US Renewable Energy Credit Broker***
***US Biofuels Broker***
*- Energy Risk Magazine*

***North American Brokerage***
*- Carbon Trading Magazine*

***Karbone CEO Izzet Bensusan among New York's Top Ten Energy Entreneurs***
*- Breaking Energy*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# Appendix M

# Pre-Application Reports

nationalgrid

| Pre-Application Report | Applicant: | Providence Water | | |
|---|---|---|---|---|
| | Pre-Application Request Date: | 3/17/2016 | Preparation Date: | 3/24/2016 |
| | Prepared by: | Joshua Dibia | Revision # (if any): | 0 |

## I. Executive Summary:

**A. Interconnection Application:** The Applicant (noted above), has submitted a request for a Pre-Application Report (Report) for the interconnection of a generation system (located at the proposed location(s) noted below) to the National Grid (Company) Electric Power System (EPS).

**B. Pre-Application Process:** The proposed location was reviewed (as per the Standards for Interconnecting Distributed Generation referenced below) to: (1) determine the characteristics of the existing Company EPS near the proposed location(s), (2) identify the aggregate amount of other proposed and existing generation capacity connected to the nearby Company EPS, and (3) identify other potential system constraints or critical items that may impact the proposed generation system(s).

**C. Further Inquiries:** All additional questions and comments related to this report should be directed to National Grid's Distributed Generation Services email account: Distributed.Generation@nationalgrid.com.

## II. Proposed Location Information:

The proposed location information provided in the table below is based on the information provided by the Applicant (i.e. Interconnecting Customer) in the **Exhibit B** - Pre-Application Report Form, which has been attached to this Report.

| **Table of Proposed Location Information** | | Proposed kW(AC): | 3,120 | Phase: | Three |
|---|---|---|---|---|---|
| Proposed Energy Source: | Solar | Existing Account (if applicable): | | N/A | |
| Street Address: | 61 North Road | | | | |
| City: | Scituate | State: | RI | Zip Code: | 02831 |
| GPS (North): | 41°45'21.4" | GPS (West): | 71°34'14.7" | | |

## III. The Company's Electric Power System (EPS):

**A.** As required by the Standards for Interconnecting Distributed Generation (referenced below), the Company must identify feeders within ¼ mile of the proposed interconnection site. Since many locations may not have any adequte feeders within ¼ mile, the Company may elect to provide information for the nearest adequate feeder(s) to the proposed location.

| **Table of Information for Nearest Feeder** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | 53-2229 | Radial or Network? | | Radial | |
| Substation: | Hope | Voltage at Substation: | | 22.9 KV | |
| Voltage (near location): | 4.16 KV | Phase (near location): | | Three | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | N/A | |
| DG on Feeder: | 44 KW | Pending DG: | 19 KW | Existing DG: | 25 KW |
| *Included in total above:* | | *Pending PV:* | 19 KW | *Existing PV:* | 25 KW |

| **Table of Information for Second Nearest Feeder (if available)** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | | Radial or Network? | | | |
| Substation: | | Voltage at Substation: | | | |
| Voltage (near location): | | Phase (near location): | | | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | | |
| DG on Feeder: | | Pending DG: | | Existing DG: | |
| *Included in total above:* | | *Pending PV:* | | *Existing PV:* | |

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**B. Other Known System Constraints:**

1. A conceptual grade cost estimate of the required system modifications will be determined during the System Impact Study (SIS). The cost for line extensions / re-conductoring of radial feeders can approach or exceed $500,000/mile depending on the level of complexity. State and Federal taxes apply to payments for system modifications, including feeder line extensions. The Point of Interconnection, circuit characteristics, and/or other projects may affect feasibility of installing the proposed generation capacity on this circuit at the proposed location. Also, the available distributed generation capacity is open to other project proponents unless and until a complete application is received.

2. Additional system constraints particular to the proposed location (if applicable):

Three phase is present at / or adjacent to the proposed location - Feeder #:53-2229.
There is no other three phase feeder present within a 1/4 mile from the proposed location.

3. This Pre-Application Report is a non-binding report of existing National Grid electrical facilities in the area of your proposed project. This report shall not be used to infer the ability to interconnect any project to any of the existing National Grid facilities. That determination can only be made following receipt of a completed Interconnection Application and National Grid completing the applicable review process as outlined in the Tariff.

## IV. References:

A. National Grid's Nantucket Distributed Generation Websites:
   1. Commercial: http://www.nationalgridus.com/nantucket/business/energyeff/distributed_generation.asp
   2. Residential: http://www.nationalgridus.com/nantucket/home/energyeff/distributed_generation.asp

B. National Grid's Nantucket Standards for Interconnecting Distributed Generation:
   https://www.nationalgridus.com/narragansett/home/energyeff/4_standard_interconnection.asp

C. Design Standards:
   1. ESB 756 (Appendix D) - Requirements for Parallel Generation:
   http://www.nationalgridus.com/non_html/shared_constr_esb756.pdf
   2. ESB 750 - Specifications for Electrical Installations:
   http://www.nationalgridus.com/non_html/shared_constr_esb750.pdf
   3. National Grid's Phone Line Installation Guide:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/Phone%20Line%20Installation.pdf

D. Other Guidance Documents:
   1. National Grid's Witness Test Procedure Guideline:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/NGrid%20Witness%20Test%20Guidelines%20Feb%202012.pdf

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| Pre-Application Report | | | | |
|---|---|---|---|---|
| | Applicant: | Providence Water | | |
| | Pre-Application Request Date: | 3/17/2016 | Preparation Date: | 3/24/2016 |
| | Prepared by: | Joshua Dibia | Revision # (if any): | 0 |

## I. Executive Summary:

**A. Interconnection Application:** The Applicant (noted above), has submitted a request for a Pre-Application Report (Report) for the interconnection of a generation system (located at the proposed location(s) noted below) to the National Grid (Company) Electric Power System (EPS).

**B. Pre-Application Process:** The proposed location was reviewed (as per the Standards for Interconnecting Distributed Generation referenced below) to: (1) determine the characteristics of the existing Company EPS near the proposed location(s), (2) identify the aggregate amount of other proposed and existing generation capacity connected to the nearby Company EPS, and (3) identify other potential system constraints or critical items that may impact the proposed generation system(s).

**C. Further Inquiries:** All additional questions and comments related to this report should be directed to National Grid's Distributed Generation Services email account: Distributed.Generation@nationalgrid.com.

## II. Proposed Location Information:

The proposed location information provided in the table below is based on the information provided by the Applicant (i.e. Interconnecting Customer) in the **Exhibit B** - Pre-Application Report Form, which has been attached to this Report.

| **Table of Proposed Location Information** | | Proposed kW(AC): | 1,020 | Phase: | Three |
|---|---|---|---|---|---|
| Proposed Energy Source: | Solar | Existing Account (if applicable): | | N/A | |
| Street Address: | 125 Dupont Drive | | | | |
| City: | Providence | State: | RI | Zip Code: | 02907 |
| GPS (North): | 41°47'58.6" | GPS (West): | 71°25'59.1" | | |

## III. The Company's Electric Power System (EPS):

**A.** As required by the Standards for Interconnecting Distributed Generation (referenced below), the Company must identify feeders within ¼ mile of the proposed interconnection site. Since many locations may not have any adequte feeders within ¼ mile, the Company may elect to provide information for the nearest adequate feeder(s) to the proposed location.

| **Table of Information for Nearest Feeder** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | 53-2228 ELM | Radial or Network? | | Radial | |
| Substation: | Elmwood | Voltage at Substation: | | 23 KV | |
| Voltage (near location): | 13.2 KV | Phase (near location): | | Three | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | N/A | |
| DG on Feeder: | 0 KW | Pending DG: | 0 KW | Existing DG: | 0 KW |
| *Included in total above:* | | *Pending PV:* | 0 KW | *Existing PV:* | 0 KW |

| **Table of Information for Second Nearest Feeder (if available)** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | 53-67J1 | Radial or Network? | | Radial | |
| Substation: | Huntington Park | Voltage at Substation: | | 4.16 KV | |
| Voltage (near location): | 4.16 KV | Phase (near location): | | Three | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | N/A | |
| DG on Feeder: | 0 KW | Pending DG: | 0 KW | Existing DG: | 0 KW |
| *Included in total above:* | | *Pending PV:* | 0 KW | *Existing PV:* | 0 KW |

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**B. Other Known System Constraints:**

1. A conceptual grade cost estimate of the required system modifications will be determined during the System Impact Study (SIS). The cost for line extensions / re-conductoring of radial feeders can approach or exceed $500,000/mile depending on the level of complexity. State and Federal taxes apply to payments for system modifications, including feeder line extensions. The Point of Interconnection, circuit characteristics, and/or other projects may affect feasibility of installing the proposed generation capacity on this circuit at the proposed location. Also, the available distributed generation capacity is open to other project proponents unless and until a complete application is received.

2. Additional system constraints particular to the proposed location (if applicable):

Three phase is present at / or adjacent to the proposed location - Feeder #:53-2228 ELM.
A second three phase feeder is present within a 1/4 mile from the proposed location - Feeder #: 53-67J1

3. This Pre-Application Report is a non-binding report of existing National Grid electrical facilities in the area of your proposed project. This report shall not be used to infer the ability to interconnect any project to any of the existing National Grid facilities. That determination can only be made following receipt of a completed Interconnection Application and National Grid completing the applicable review process as outlined in the Tariff.

## IV. References:

A. National Grid's Nantucket Distributed Generation Websites:
   1. Commercial: http://www.nationalgridus.com/nantucket/business/energyeff/distributed_generation.asp
   2. Residential: http://www.nationalgridus.com/nantucket/home/energyeff/distributed_generation.asp

B. National Grid's Nantucket Standards for Interconnecting Distributed Generation:
   https://www.nationalgridus.com/narragansett/home/energyeff/4_standard_interconnection.asp

C. Design Standards:
   1. ESB 756 (Appendix D) - Requirements for Parallel Generation:
   http://www.nationalgridus.com/non_html/shared_constr_esb756.pdf
   2. ESB 750 - Specifications for Electrical Installations:
   http://www.nationalgridus.com/non_html/shared_constr_esb750.pdf
   3. National Grid's Phone Line Installation Guide:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/Phone%20Line%20Installation.pdf

D. Other Guidance Documents:
   1. National Grid's Witness Test Procedure Guideline:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/NGrid%20Witness%20Test%20Guidelines%20Feb%202012.pdf

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| Pre-Application Report | Applicant: | Providence Water | | |
|---|---|---|---|---|
| | Pre-Application Request Date: | 3/17/2016 | Preparation Date: | 3/24/2016 |
| | Prepared by: | Joshua Dibia | Revision # (if any): | 0 |

## I. Executive Summary:

**A. Interconnection Application:** The Applicant (noted above), has submitted a request for a Pre-Application Report (Report) for the interconnection of a generation system (located at the proposed location(s) noted below) to the National Grid (Company) Electric Power System (EPS).

**B. Pre-Application Process:** The proposed location was reviewed (as per the Standards for Interconnecting Distributed Generation referenced below) to: (1) determine the characteristics of the existing Company EPS near the proposed location(s), (2) identify the aggregate amount of other proposed and existing generation capacity connected to the nearby Company EPS, and (3) identify other potential system constraints or critical items that may impact the proposed generation system(s).

**C. Further Inquiries:** All additional questions and comments related to this report should be directed to National Grid's Distributed Generation Services email account: Distributed.Generation@nationalgrid.com.

## II. Proposed Location Information:

The proposed location information provided in the table below is based on the information provided by the Applicant (i.e. Interconnecting Customer) in the **Exhibit B** - Pre-Application Report Form, which has been attached to this Report.

| **Table of Proposed Location Information** | | Proposed kW(AC): | 1,972 | Phase: | Three |
|---|---|---|---|---|---|
| Proposed Energy Source: | Solar | Existing Account (if applicable): | | N/A | |
| Street Address: | 430 Scituate Avenue (ground system 2) | | | | |
| City: | Cranston | State: | RI | Zip Code: | 02921 |
| GPS (North): | 41°46'40.8" | GPS (West): | 71°29'29.5" | | |

## III. The Company's Electric Power System (EPS):

**A.** As required by the Standards for Interconnecting Distributed Generation (referenced below), the Company must identify feeders within ¼ mile of the proposed interconnection site. Since many locations may not have any adequte feeders within ¼ mile, the Company may elect to provide information for the nearest adequate feeder(s) to the proposed location.

| **Table of Information for Nearest Feeder** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | 53-21F4 | Radial or Network? | | Radial | |
| Substation: | West Cranston | Voltage at Substation: | | 12.47 KV | |
| Voltage (near location): | 12.47 KV | Phase (near location): | | Three | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | N/A | |
| DG on Feeder: | 46 KW | Pending DG: | 27 KW | Existing DG: | 19 KW |
| *Included in total above:* | | *Pending PV:* | 27 KW | *Existing PV:* | 19 KW |

| **Table of Information for Second Nearest Feeder (if available)** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | | Radial or Network? | | | |
| Substation: | | Voltage at Substation: | | | |
| Voltage (near location): | | Phase (near location): | | | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | | |
| DG on Feeder: | | Pending DG: | | Existing DG: | |
| *Included in total above:* | | *Pending PV:* | | *Existing PV:* | |

**B. Other Known System Constraints:**

1. A conceptual grade cost estimate of the required system modifications will be determined during the System Impact Study (SIS). The cost for line extensions / re-conductoring of radial feeders can approach or exceed $500,000/mile depending on the level of complexity. State and Federal taxes apply to payments for system modifications, including feeder line extensions. The Point of Interconnection, circuit characteristics, and/or other projects may affect feasibility of installing the proposed generation capacity on this circuit at the proposed location. Also, the available distributed generation capacity is open to other project proponents unless and until a complete application is received.

2. Additional system constraints particular to the proposed location (if applicable):

Three phase is present at / or adjacent to the proposed location - Feeder #:53-21F4.
There is no other three phase feeder present within a 1/4 mile from the proposed location.

3. This Pre-Application Report is a non-binding report of existing National Grid electrical facilities in the area of your proposed project. This report shall not be used to infer the ability to interconnect any project to any of the existing National Grid facilities. That determination can only be made following receipt of a completed Interconnection Application and National Grid completing the applicable review process as outlined in the Tariff.

## IV. References:

A. National Grid's Nantucket Distributed Generation Websites:
   1. Commercial: http://www.nationalgridus.com/nantucket/business/energyeff/distributed_generation.asp
   2. Residential: http://www.nationalgridus.com/nantucket/home/energyeff/distributed_generation.asp

B. National Grid's Nantucket Standards for Interconnecting Distributed Generation:
   https://www.nationalgridus.com/narragansett/home/energyeff/4_standard_interconnection.asp

C. Design Standards:
   1. ESB 756 (Appendix D) - Requirements for Parallel Generation:
   http://www.nationalgridus.com/non_html/shared_constr_esb756.pdf
   2. ESB 750 - Specifications for Electrical Installations:
   http://www.nationalgridus.com/non_html/shared_constr_esb750.pdf
   3. National Grid's Phone Line Installation Guide:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/Phone%20Line%20Installation.pdf

D. Other Guidance Documents:
   1. National Grid's Witness Test Procedure Guideline:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/NGrid%20Witness%20Test%20Guidelines%20Feb%202012.pdf

nationalgrid

| Pre-Application Report | Applicant: | Providence Water | | |
|---|---|---|---|---|
| | Pre-Application Request Date: | 4/5/2016 | Preparation Date: | 4/26/2016 |
| | Prepared by: | John Rathbun | Revision # (if any): | 0 |

## I. Executive Summary:

**A. Interconnection Application:** The Applicant (noted above), has submitted a request for a Pre-Application Report (Report) for the interconnection of a generation system (located at the proposed location(s) noted below) to the National Grid (Company) Electric Power System (EPS).

**B. Pre-Application Process:** The proposed location was reviewed (as per the Standards for Interconnecting Distributed Generation referenced below) to: (1) determine the characteristics of the existing Company EPS near the proposed location(s), (2) identify the aggregate amount of other proposed and existing generation capacity connected to the nearby Company EPS, and (3) identify other potential system constraints or critical items that may impact the proposed generation system(s).

**C. Further Inquiries:** All additional questions and comments related to this report should be directed to National Grid's Distributed Generation Services email account: Distributed.Generation@nationalgrid.com.

## II. Proposed Location Information:

The proposed location information provided in the table below is based on the information provided by the Applicant (i.e. Interconnecting Customer) in the **Exhibit B** - Pre-Application Report Form, which has been attached to this Report.

| **Table of Proposed Location Information** | | Proposed kW(AC): | 3,000 | Phase: | 3 Phase |
|---|---|---|---|---|---|
| Proposed Energy Source: | Solar PV | Existing Account (if applicable): | | n/a | |
| Street Address: | 350 Field Hill Rd | | | | |
| City: | Scituate | State: | RI | Zip Code: | 02815 |
| GPS (North): | 41°46'12.99" | GPS (West): | 71°38'59.63" | | |

## III. The Company's Electric Power System (EPS):

**A.** As required by the Standards for Interconnecting Distributed Generation (referenced below), the Company must identify feeders within ¼ mile of the proposed interconnection site. Since many locations may not have any adequte feeders within ¼ mile, the Company may elect to provide information for the nearest adequate feeder(s) to the proposed location.

| **Table of Information for Nearest Feeder** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | 53-34F1 | Radial or Network? | | | Radial |
| Substation: | Chopmist | Voltage at Substation: | | | 12.47 kV |
| Voltage (near location): | 7.2 kV | Phase (near location): | | | single |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | | 7,000 ft |
| DG on Feeder: | 5385 kW | Pending DG: | 5313 kW | | 72 kW |
| *Included in total above:* | | *Pending PV:* | 5313 kW | *Existing PV:* | 72 kW |

| **Table of Information for Second Nearest Feeder (if available)** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | 53-15F2 | Radial or Network? | | | Radial |
| Substation: | Hope | Voltage at Substation: | | | 12.47 kV |
| Voltage (near location): | 7.2 kV | Phase (near location): | | | single |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | | 7,500 ft |
| DG on Feeder: | 60 kW | Pending DG: | 20 kW | Existing DG: | 40 kW |
| *Included in total above:* | | *Pending PV:* | 20 kW | *Existing PV:* | 40 kW |

**B. Other Known System Constraints:**

1. A conceptual grade cost estimate of the required system modifications will be determined during the System Impact

Study (SIS). The cost for line extensions / re-conductoring of radial feeders can approach or exceed $500,000/mile depending on the level of complexity. State and Federal taxes apply to payments for system modifications, including feeder line extensions. The Point of Interconnection, circuit characteristics, and/or other projects may affect feasibility of installing the proposed generation capacity on this circuit at the proposed location. Also, the available distributed generation capacity is open to other project proponents unless and until a complete application is received.

2. Additional system constraints particular to the proposed location (if applicable):

There is no three phase feeder present at or adjacent to the proposed location. The closest three phase feeder is on Plainfield Pike approximately 7,000 ft distance and the next closest three phase feeder is on Tunk hill Rd approximately 7,500 ft distance from proposed location.

3. This Pre-Application Report is a non-binding report of existing National Grid electrical facilities in the area of your proposed project. This report shall not be used to infer the ability to interconnect any project to any of the existing National Grid facilities. That determination can only be made following receipt of a completed Interconnection Application and National Grid completing the applicable review process as outlined in the Tariff.

## IV. References:

A. National Grid's Narraganset Distributed Generation Websites:
   1. Commercial: http://www.nationalgridus.com/narragansett/business/energyeff/distributed_generation.asp
   2. Residential:http://www.nationalgridus.com/narragansett/home/energyeff/distributed_generation.asp

B. National Grid's Rhode Island for Interconnecting Distributed Generation:
   http://www.nationalgridus.com/non_html/RI_DG_Net_Metering_Tariff.pdf

C. Design Standards:
   1. ESB 756 (Appendix D) - Requirements for Parallel Generation:
   http://www.nationalgridus.com/non_html/shared_constr_esb756.pdf
   2. ESB 750 - Specifications for Electrical Installations:
   http://www.nationalgridus.com/non_html/shared_constr_esb750.pdf
   3. National Grid's Phone Line Installation Guide:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/Phone%20Line%20Installation.pdf

D. Other Guidance Documents:
   1. National Grid's Witness Test Procedure Guideline:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/NGrid%20Witness%20Test%20Guidelines%20Feb%202012.pdf

nationalgrid

| Pre-Application Report | Applicant: | Providence Water | | |
|---|---|---|---|---|
| | Pre-Application Request Date: | 4/5/2016 | Preparation Date: | 4/26/2016 |
| | Prepared by: | John Rathbun | Revision # (if any): | 0 |

## I. Executive Summary:

**A. Interconnection Application:** The Applicant (noted above), has submitted a request for a Pre-Application Report (Report) for the interconnection of a generation system (located at the proposed location(s) noted below) to the National Grid (Company) Electric Power System (EPS).

**B. Pre-Application Process:** The proposed location was reviewed (as per the Standards for Interconnecting Distributed Generation referenced below) to: (1) determine the characteristics of the existing Company EPS near the proposed location(s), (2) identify the aggregate amount of other proposed and existing generation capacity connected to the nearby Company EPS, and (3) identify other potential system constraints or critical items that may impact the proposed generation system(s).

**C. Further Inquiries:** All additional questions and comments related to this report should be directed to National Grid's Distributed Generation Services email account: Distributed.Generation@nationalgrid.com.

## II. Proposed Location Information:

The proposed location information provided in the table below is based on the information provided by the Applicant (i.e. Interconnecting Customer) in the **Exhibit B** - Pre-Application Report Form, which has been attached to this Report.

| **Table of Proposed Location Information** | | Proposed kW(AC): | 2,700 | Phase: | 3 Phase |
|---|---|---|---|---|---|
| Proposed Energy Source: | Solar PV | Existing Account (if applicable): | | n/a | |
| Street Address: | 730 Plainfield Pike | | | | |
| City: | Scituate | State: | RI | Zip Code: | 02857 |
| GPS (North): | 41°47'23.13" | GPS (West): | 71°37'8.85" | | |

## III. The Company's Electric Power System (EPS):

**A.** As required by the Standards for Interconnecting Distributed Generation (referenced below), the Company must identify feeders within ¼ mile of the proposed interconnection site. Since many locations may not have any adequte feeders within ¼ mile, the Company may elect to provide information for the nearest adequate feeder(s) to the proposed location.

| **Table of Information for Nearest Feeder** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | 53-34F1 | Radial or Network? | | Radial | |
| Substation: | Chopmist | Voltage at Substation: | | 12.47 kV | |
| Voltage (near location): | 12.47 kV | Phase (near location): | | 3 Phase | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | n/a | |
| DG on Feeder: | 5385 kW | Pending DG: | 5313 kW | | 72 kW |
| *Included in total above:* | | *Pending PV:* | 5313 kW | *Existing PV:* | 72 kW |

| **Table of Information for Second Nearest Feeder (if available)** | | | | | |
|---|---|---|---|---|---|
| Feeder Number: | | Radial or Network? | | | |
| Substation: | | Voltage at Substation: | | | |
| Voltage (near location): | | Phase (near location): | | | |
| Distance to three-phase (if not within 1/4 mile of proposed location): | | | | | |
| DG on Feeder: | | Pending DG: | | Existing DG: | |
| *Included in total above:* | | *Pending PV:* | | *Existing PV:* | |

**B. Other Known System Constraints:**

1. A conceptual grade cost estimate of the required system modifications will be determined during the System Impact

Study (SIS). The cost for line extensions / re-conductoring of radial feeders can approach or exceed $500,000/mile depending on the level of complexity. State and Federal taxes apply to payments for system modifications, including feeder line extensions. The Point of Interconnection, circuit characteristics, and/or other projects may affect feasibility of installing the proposed generation capacity on this circuit at the proposed location. Also, the available distributed generation capacity is open to other project proponents unless and until a complete application is received.

2. Additional system constraints particular to the proposed location (if applicable):

There is a three phase feeder present at or adjacent to the proposed location.

3. This Pre-Application Report is a non-binding report of existing National Grid electrical facilities in the area of your proposed project. This report shall not be used to infer the ability to interconnect any project to any of the existing National Grid facilities. That determination can only be made following receipt of a completed Interconnection Application and National Grid completing the applicable review process as outlined in the Tariff.

## IV. References:

A. National Grid's Narraganset Distributed Generation Websites:
   1. Commercial: http://www.nationalgridus.com/narragansett/business/energyeff/distributed_generation.asp
   2. Residential:http://www.nationalgridus.com/narragansett/home/energyeff/distributed_generation.asp

B. National Grid's Rhode Island for Interconnecting Distributed Generation:
   http://www.nationalgridus.com/non_html/RI_DG_Net_Metering_Tariff.pdf

C. Design Standards:
   1. ESB 756 (Appendix D) - Requirements for Parallel Generation:
   http://www.nationalgridus.com/non_html/shared_constr_esb756.pdf
   2. ESB 750 - Specifications for Electrical Installations:
   http://www.nationalgridus.com/non_html/shared_constr_esb750.pdf
   3. National Grid's Phone Line Installation Guide:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/Phone%20Line%20Installation.pdf

D. Other Guidance Documents:
   1. National Grid's Witness Test Procedure Guideline:
   http://www.nationalgridus.com/non_html/Expedited%20Standard%20Interconnection/NGrid%20Witness%20Test%20Guidelines%20Feb%202012.pdf

# Appendix N

# PV Watts Outputs

# Dupont Roof 1 - A

## RESULTS

# 191,269 kWh per Year *

*System output may range from 176,503 to 196,165kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 10,500 | 136,495 |
| February | 3.67 | 12,630 | 164,189 |
| March | 4.58 | 17,080 | 222,040 |
| April | 5.35 | 18,935 | 246,149 |
| May | 5.78 | 20,593 | 267,709 |
| June | 6.15 | 20,748 | 269,725 |
| July | 6.39 | 21,931 | 285,103 |
| August | 5.95 | 20,509 | 266,620 |
| September | 4.55 | 15,439 | 200,711 |
| October | 4.00 | 14,452 | 187,882 |
| November | 2.74 | 9,822 | 127,681 |
| December | 2.28 | 8,630 | 112,187 |
| **Annual** | **4.51** | **191,269** | **$ 2,486,491** |

### Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

### PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 144 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

### Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

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 http://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

# 491,454 kWh per Year *

*System output may range from 453,514 to 504,035kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 26,978 | 350,717 |
| February | 3.67 | 32,452 | 421,875 |
| March | 4.58 | 43,886 | 570,520 |
| April | 5.35 | 48,651 | 632,465 |
| May | 5.78 | 52,913 | 687,864 |
| June | 6.15 | 53,311 | 693,045 |
| July | 6.39 | 56,351 | 732,557 |
| August | 5.95 | 52,697 | 685,066 |
| September | 4.55 | 39,671 | 515,717 |
| October | 4.00 | 37,135 | 482,752 |
| November | 2.74 | 25,236 | 328,070 |
| December | 2.28 | 22,174 | 288,258 |
| **Annual** | **4.51** | **491,455** | **$ 6,388,906** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 370 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

# Dupont Roof 3 - A

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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 http://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

# 537,943 kWh per Year *

*System output may range from 496,414 to 551,715kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 29,530 | 383,892 |
| February | 3.67 | 35,522 | 461,782 |
| March | 4.58 | 48,038 | 624,488 |
| April | 5.35 | 53,253 | 692,293 |
| May | 5.78 | 57,918 | 752,932 |
| June | 6.15 | 58,354 | 758,603 |
| July | 6.39 | 61,681 | 801,853 |
| August | 5.95 | 57,682 | 749,869 |
| September | 4.55 | 43,423 | 564,500 |
| October | 4.00 | 40,648 | 528,418 |
| November | 2.74 | 27,623 | 359,103 |
| December | 2.28 | 24,271 | 315,526 |
| **Annual** | **4.51** | **537,943** | **$ 6,993,259** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 405 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

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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

# 300,186 kWh per Year *

*System output may range from 277,011 to 307,870kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 16,479 | 214,222 |
| February | 3.67 | 19,822 | 257,686 |
| March | 4.58 | 26,806 | 348,480 |
| April | 5.35 | 29,717 | 386,317 |
| May | 5.78 | 32,320 | 420,155 |
| June | 6.15 | 32,563 | 423,319 |
| July | 6.39 | 34,420 | 447,454 |
| August | 5.95 | 32,188 | 418,446 |
| September | 4.55 | 24,231 | 315,005 |
| October | 4.00 | 22,682 | 294,870 |
| November | 2.74 | 15,415 | 200,389 |
| December | 2.28 | 13,544 | 176,071 |
| Annual | 4.51 | 300,187 | $ 3,902,414 |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 226 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

# Dupont Roof 1 - B

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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

**162,047 kWh per Year ***

*System output may range from 149,537 to 166,195kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 8,896 | 1,156 |
| February | 3.67 | 10,700 | 1,391 |
| March | 4.58 | 14,471 | 1,881 |
| April | 5.35 | 16,042 | 2,085 |
| May | 5.78 | 17,447 | 2,268 |
| June | 6.15 | 17,578 | 2,285 |
| July | 6.39 | 18,580 | 2,415 |
| August | 5.95 | 17,376 | 2,259 |
| September | 4.55 | 13,081 | 1,700 |
| October | 4.00 | 12,244 | 1,592 |
| November | 2.74 | 8,321 | 1,082 |
| December | 2.28 | 7,311 | 950 |
| **Annual** | **4.51** | **162,047** | **$ 21,064** |

### Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence ri | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

### PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 122 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

### Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 0.13 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

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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

# 427,698 kWh per Year *

*System output may range from 394,680 to 438,647kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 23,478 | 3,052 |
| February | 3.67 | 28,242 | 3,671 |
| March | 4.58 | 38,193 | 4,965 |
| April | 5.35 | 42,340 | 5,504 |
| May | 5.78 | 46,048 | 5,986 |
| June | 6.15 | 46,395 | 6,031 |
| July | 6.39 | 49,040 | 6,375 |
| August | 5.95 | 45,861 | 5,962 |
| September | 4.55 | 34,524 | 4,488 |
| October | 4.00 | 32,317 | 4,201 |
| November | 2.74 | 21,962 | 2,855 |
| December | 2.28 | 19,297 | 2,509 |
| **Annual** | **4.51** | **427,697** | **$ 55,599** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence ri | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 322 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 0.13 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

# Dupont Roof 3 - B

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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

# 450,278 kWh per Year *

*System output may range from 415,517 to 461,805kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 24,718 | 3,213 |
| February | 3.67 | 29,733 | 3,865 |
| March | 4.58 | 40,209 | 5,227 |
| April | 5.35 | 44,575 | 5,795 |
| May | 5.78 | 48,479 | 6,302 |
| June | 6.15 | 48,845 | 6,350 |
| July | 6.39 | 51,629 | 6,712 |
| August | 5.95 | 48,282 | 6,277 |
| September | 4.55 | 36,347 | 4,725 |
| October | 4.00 | 34,023 | 4,423 |
| November | 2.74 | 23,122 | 3,006 |
| December | 2.28 | 20,316 | 2,641 |
| **Annual** | **4.51** | **450,278** | **$ 58,536** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence ri | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 339 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 0.13 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

# Dupont Roof 4 - B

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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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

# 282,918 kWh per Year *

*System output may range from 261,077 to 290,161kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 15,531 | 2,019 |
| February | 3.67 | 18,682 | 2,429 |
| March | 4.58 | 25,264 | 3,284 |
| April | 5.35 | 28,007 | 3,641 |
| May | 5.78 | 30,461 | 3,960 |
| June | 6.15 | 30,690 | 3,990 |
| July | 6.39 | 32,440 | 4,217 |
| August | 5.95 | 30,337 | 3,944 |
| September | 4.55 | 22,837 | 2,969 |
| October | 4.00 | 21,378 | 2,779 |
| November | 2.74 | 14,528 | 1,889 |
| December | 2.28 | 12,765 | 1,659 |
| Annual | 4.51 | 282,920 | $ 36,780 |

### Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence ri | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

### PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 213 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

### Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 0.13 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

# Dupont Roof 2 - C

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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

# 369,255 kWh per Year *

*System output may range from 340,748 to 378,708kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 20,270 | 263,511 |
| February | 3.67 | 24,383 | 316,976 |
| March | 4.58 | 32,974 | 428,661 |
| April | 5.35 | 36,554 | 475,203 |
| May | 5.78 | 39,756 | 516,828 |
| June | 6.15 | 40,055 | 520,720 |
| July | 6.39 | 42,339 | 550,408 |
| August | 5.95 | 39,594 | 514,725 |
| September | 4.55 | 29,806 | 387,484 |
| October | 4.00 | 27,901 | 362,717 |
| November | 2.74 | 18,961 | 246,496 |
| December | 2.28 | 16,660 | 216,583 |
| Annual | 4.51 | 369,253 | $ 4,800,312 |

### Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

### PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 278 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

### Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

# Dupont Roof 3 - C

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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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

# 334,720 kWh per Year *

*System output may range from 308,880 to 343,289kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 18,374 | 238,866 |
| February | 3.67 | 22,102 | 287,331 |
| March | 4.58 | 29,890 | 388,570 |
| April | 5.35 | 33,135 | 430,760 |
| May | 5.78 | 36,038 | 468,492 |
| June | 6.15 | 36,309 | 472,020 |
| July | 6.39 | 38,379 | 498,931 |
| August | 5.95 | 35,891 | 466,585 |
| September | 4.55 | 27,019 | 351,245 |
| October | 4.00 | 25,292 | 328,793 |
| November | 2.74 | 17,188 | 223,442 |
| December | 2.28 | 15,102 | 196,327 |
| **Annual** | **4.51** | **334,719** | **$ 4,351,362** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 252 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

# Dupont Roof 4 - C

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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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

# 219,162 kWh per Year *

*System output may range from 202,243 to 224,773kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 12,031 | 156,401 |
| February | 3.67 | 14,472 | 188,133 |
| March | 4.58 | 19,571 | 254,421 |
| April | 5.35 | 21,696 | 282,045 |
| May | 5.78 | 23,596 | 306,750 |
| June | 6.15 | 23,774 | 309,061 |
| July | 6.39 | 25,129 | 326,681 |
| August | 5.95 | 23,500 | 305,502 |
| September | 4.55 | 17,691 | 229,982 |
| October | 4.00 | 16,560 | 215,281 |
| November | 2.74 | 11,254 | 146,302 |
| December | 2.28 | 9,888 | 128,548 |
| **Annual** | **4.51** | **219,162** | **$ 2,849,107** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 165 kW |
| Module Type | Premium |
| Array Type | Fixed (roof mount) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

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# RESULTS

# 4,221,922 kWh per Year *

*System output may range from 3,895,990 to 4,330,003kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 231,149 | 3,004,943 |
| February | 3.67 | 278,397 | 3,619,162 |
| March | 4.58 | 376,740 | 4,897,620 |
| April | 5.35 | 417,869 | 5,432,298 |
| May | 5.78 | 454,779 | 5,912,131 |
| June | 6.15 | 458,437 | 5,959,675 |
| July | 6.39 | 484,871 | 6,303,318 |
| August | 5.95 | 453,527 | 5,895,857 |
| September | 4.55 | 340,917 | 4,431,924 |
| October | 4.00 | 318,855 | 4,145,111 |
| November | 2.74 | 216,382 | 2,812,965 |
| December | 2.28 | 189,999 | 2,469,982 |
| **Annual** | **4.51** | **4,221,922** | **$ 54,884,986** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 3158 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

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# RESULTS

# 1,994,651 kWh per Year *

*System output may range from 1,840,664 to 2,045,714kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 109,207 | 1,419,688 |
| February | 3.67 | 131,529 | 1,709,878 |
| March | 4.58 | 177,991 | 2,313,884 |
| April | 5.35 | 197,423 | 2,566,494 |
| May | 5.78 | 214,861 | 2,793,191 |
| June | 6.15 | 216,589 | 2,815,654 |
| July | 6.39 | 229,078 | 2,978,010 |
| August | 5.95 | 214,270 | 2,785,504 |
| September | 4.55 | 161,067 | 2,093,866 |
| October | 4.00 | 150,643 | 1,958,361 |
| November | 2.74 | 102,230 | 1,328,987 |
| December | 2.28 | 89,765 | 1,166,946 |
| Annual | 4.51 | 1,994,653 | $ 25,930,463 |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 1492 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

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# RESULTS

# 3,459,891 kWh per Year *

*System output may range from 3,192,787 to 3,548,464kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 189,428 | 24,626 |
| February | 3.67 | 228,148 | 29,659 |
| March | 4.58 | 308,741 | 40,136 |
| April | 5.35 | 342,446 | 44,518 |
| May | 5.78 | 372,694 | 48,450 |
| June | 6.15 | 375,692 | 48,840 |
| July | 6.39 | 397,354 | 51,656 |
| August | 5.95 | 371,668 | 48,317 |
| September | 4.55 | 279,384 | 36,320 |
| October | 4.00 | 261,303 | 33,969 |
| November | 2.74 | 177,326 | 23,052 |
| December | 2.28 | 155,705 | 20,242 |
| **Annual** | **4.51** | **3,459,889** | **$ 449,785** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence ri | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 2588 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 0.13 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

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# RESULTS

# 1,774,063 kWh per Year *

*System output may range from 1,637,105 to 1,819,479kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 97,130 | 12,627 |
| February | 3.67 | 116,983 | 15,208 |
| March | 4.58 | 158,307 | 20,580 |
| April | 5.35 | 175,590 | 22,827 |
| May | 5.78 | 191,099 | 24,843 |
| June | 6.15 | 192,636 | 25,043 |
| July | 6.39 | 203,744 | 26,487 |
| August | 5.95 | 190,573 | 24,775 |
| September | 4.55 | 143,254 | 18,623 |
| October | 4.00 | 133,984 | 17,418 |
| November | 2.74 | 90,924 | 11,820 |
| December | 2.28 | 79,838 | 10,379 |
| **Annual** | **4.51** | **1,774,062** | **$ 230,630** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence ri | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 1327 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 0.13 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

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# RESULTS

# 3,610,960 kWh per Year *

*System output may range from 3,332,194 to 3,703,400kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 197,699 | 2,570,093 |
| February | 3.67 | 238,110 | 3,095,427 |
| March | 4.58 | 322,221 | 4,188,874 |
| April | 5.35 | 357,398 | 4,646,179 |
| May | 5.78 | 388,967 | 5,056,575 |
| June | 6.15 | 392,096 | 5,097,242 |
| July | 6.39 | 414,704 | 5,391,157 |
| August | 5.95 | 387,897 | 5,042,657 |
| September | 4.55 | 291,582 | 3,790,571 |
| October | 4.00 | 272,713 | 3,545,264 |
| November | 2.74 | 185,069 | 2,405,895 |
| December | 2.28 | 162,504 | 2,112,547 |
| **Annual** | **4.51** | **3,610,960** | **$ 46,942,481** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 2701 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

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# RESULTS

# 1,999,999 kWh per Year *

*System output may range from 1,845,599 to 2,051,198kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 109,500 | 1,423,495 |
| February | 3.67 | 131,882 | 1,714,461 |
| March | 4.58 | 178,468 | 2,320,088 |
| April | 5.35 | 197,952 | 2,573,375 |
| May | 5.78 | 215,437 | 2,800,680 |
| June | 6.15 | 217,169 | 2,823,202 |
| July | 6.39 | 229,692 | 2,985,993 |
| August | 5.95 | 214,844 | 2,792,972 |
| September | 4.55 | 161,498 | 2,099,480 |
| October | 4.00 | 151,047 | 1,963,611 |
| November | 2.74 | 102,504 | 1,332,551 |
| December | 2.28 | 90,006 | 1,170,074 |
| Annual | 4.51 | 1,999,999 | $ 25,999,982 |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 1496 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

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# RESULTS

## 4,006,682 kWh per Year *

*System output may range from 3,697,366 to 4,109,253kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 219,365 | 2,851,747 |
| February | 3.67 | 264,204 | 3,434,652 |
| March | 4.58 | 357,533 | 4,647,931 |
| April | 5.35 | 396,565 | 5,155,349 |
| May | 5.78 | 431,594 | 5,610,718 |
| June | 6.15 | 435,065 | 5,655,843 |
| July | 6.39 | 460,151 | 5,981,965 |
| August | 5.95 | 430,406 | 5,595,275 |
| September | 4.55 | 323,537 | 4,205,976 |
| October | 4.00 | 302,599 | 3,933,786 |
| November | 2.74 | 205,350 | 2,669,556 |
| December | 2.28 | 180,312 | 2,344,058 |
| **Annual** | **4.51** | **4,006,681** | **$ 52,086,856** |

### Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

### PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 2997 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

### Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

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# RESULTS

**1,999,999 kWh per Year ***

*System output may range from 1,845,599 to 2,051,198kWh per year near this location.*

| Month | Solar Radiation ( kWh / m$^2$ / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 2.73 | 109,500 | 1,423,495 |
| February | 3.67 | 131,882 | 1,714,461 |
| March | 4.58 | 178,468 | 2,320,088 |
| April | 5.35 | 197,952 | 2,573,375 |
| May | 5.78 | 215,437 | 2,800,680 |
| June | 6.15 | 217,169 | 2,823,202 |
| July | 6.39 | 229,692 | 2,985,993 |
| August | 5.95 | 214,844 | 2,792,972 |
| September | 4.55 | 161,498 | 2,099,480 |
| October | 4.00 | 151,047 | 1,963,611 |
| November | 2.74 | 102,504 | 1,332,551 |
| December | 2.28 | 90,006 | 1,170,074 |
| **Annual** | **4.51** | **1,999,999** | **$ 25,999,982** |

## Location and Station Identification

| | | |
|---|---|---|
| Requested Location | providence | |
| Weather Data Source | (TMY2) PROVIDENCE, RI | 7.5 mi |
| Latitude | 41.73° N | |
| Longitude | 71.43° W | |

## PV System Specifications *(Commercial)*

| | |
|---|---|
| DC System Size | 1496 kW |
| Module Type | Premium |
| Array Type | Fixed (open rack) |
| Array Tilt | 20° |
| Array Azimuth | 180° |
| System Losses | 14% |
| Inverter Efficiency | 96% |
| DC to AC Size Ratio | 1.1 |

## Initial Economic Comparison

| | |
|---|---|
| Average Cost of Electricity Purchased from Utility | 13.00 $/kWh |
| Initial Cost | 3.00 $/Wdc |
| Cost of Electricity Generated by System | 0.14 $/kWh |

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CDM Smith

cdmsmith.com