REFLO INC
Solar Photovoltaic (PV) Feasibility Study

for the

North Division High School

Milwaukee WI

November 3, 2020

Niels Wolter, Madison Solar Consulting

Disclaimers:

The information presented here provides a feasibility study level overview of PV project siting, sizing, generation, site electricity use offset, pricing and project economics. It should not be used as the only source of information.

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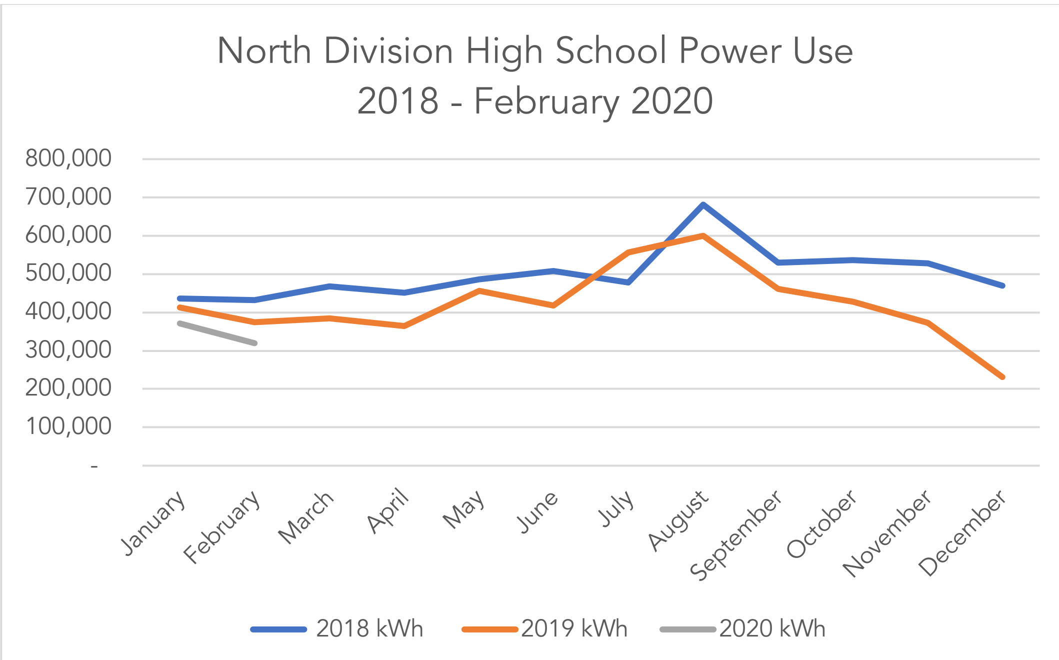
Abbreviations

AC	Alternating Current
AIA	American Institute of Architects
CGS	Customer Generating System rates, WE's electric rates for connecting customer-owned generating systems and delivering power to the WE grid
CGS-NM	Customer Generating System – Net Metering rate
CGS-NP	Customer Generating System – Non-Purchase rate
CO2	Carbon dioxide
CP1	Electric rate used by the School to purchase power from WE
DC	Direct Current
EIGP	Energy Innovation Grant Program
kW	Kilowatts (1000 watts)
kWh	Kilowatt hour
MSC	Madison Solar Consulting
NA	Not Applicable
NPV	Net present value
NREL	National Renewable Energy Laboratory
OEI	Office of Energy Innovation, part of the Public Service Commission of Wisconsin
PERC	Passive Emitter Rear Cell (new PV cell type that is very efficient)
PV	Photovoltaic
RFP	Request for proposal
TPO	Thermoplastic Olefin or Polyolefin – type of membrane roofing
UL	United Laboratories
WE	We Energies, the School's electricity provider

Executive Summary

The North Division High School (School) uses 5 to 6 million kWh of electricity per year. The highest use is in the summer months (July and August). Year-round electricity use is fairly flat (average of 450,000 kWh/month).



PV System Siting and Sizing

Two roof areas are considered for siting the PV system:

- Flat Roof: east side of the building on the three-story roof
- Sloped Roof: south side of the building on the south-facing sloped roof

PV systems of 10-, 100-, 200- and 300-kW AC are modeled.

PV System Racking Options

Three different PV system racking options are considered

- Flat Roof: Ballasted Racking
  - Simple commonly used racking system with no roof penetrations
- Sloped Roof:
  - Ballasted Racking with integration into the building's structure
  - Standard Sloped-Roof Racking with integration into the building's structure

- Design of the sloped roof racking is likely to require a structural engineer familiar with PV systems
    - The school district could do this analysis in advance of bidding out the project or the selected installation contractors could do this assessment (as part of their installation contract)
- The racking system's structural integration into the building could include either
    - Use roof penetrations
    - Be structurally integrated into the building wall north of the PV array

<u>School's Aged Roof</u>

The School has an older roof. Solar arrays have a predicted lifespan of more than 25 years. It's important that the roof has a commensurate or greater life expectancy.

If the PV system is installed on the existing roof, it is likely that the roof will need to be replaced in the next 25 to 40 years. To replace a roof under an existing PV system is estimated to cost 1/3rd of a new PV system ($500 to $700/ kW DC).

<u>PV System's Modeled Annual Generation, Performance Ratio and Share of School Use</u>

System Type and Size	Annual Generation (kWh)	Performance Ratio kWh/kW DC	Share of School's Electricity Use
Sloped Roof Plane of the Roof 10 kW AC	13,991	1,166	0.26%
Sloped Roof Ballasted 10 kW AC	14,700	1,225	0.27%
Sloped Roof Plane of the Roof 100 kW AC	138,954	1,113	2.5%
Flat Roof Ballasted 100 kW AC	156,278	1252	2.8%
Flat Roof Ballasted 200 kW AC	310,679	1,243	5.7%
Flat Roof Ballasted 300 kW AC	472,027	1,261	8.6%

Electricity Purchase Rate and Solar Customer Generating Systems (CGS) Rates

- The School is on the WE CP1 electric rate
- Currently, it is most cost effective to use the CGS Non-Purchase (NP) rate for the PV systems
    - Given the small size of the PV systems, it is unlikely that they will ever put power onto the grid. So, selling power to We Energies (WE) under the CGS Net Meter (NM) rate is not needed
    - The CGS-NM has a high Facilities Charge, does not value the demand savings resulting from the PV system, and has solar metering costs
    - In all cases, the economics of using the CGS-NP rate is better than using the CGS-NM rate.

WE's CGS rates will be changing, to better understand which rate most benefits the School's PV system economics, it would be very useful to collect the School's 15-minute electricity usage data.

Analysis Assumptions

The project's energy and financial analysis require many assumptions. All assumptions are detailed in this report, and include:

- The output of the PV systems
- Array soiling and snow cover estimates
- The cost of electricity and the value of power delivered to the WE grid and demand savings
- The rate at which the future electric price changes over the PV systems' 25-year life
- The installed cost of the PV systems
- Incentive level funding levels in 2022 – the project's installation date
- Operation and maintenance costs, replacements, and insurance costs

This analysis attempts to use realistic assumptions

- All assumptions are clearly presented
- Please review and consider them carefully

Results of Cash Flow Analysis

PV System Size and Racking Type	10 KW AC in plane of roof	10 KW AC ballasted	100 kW AC in plane of roof	100 kW AC ballasted	200 kW AC ballasted	300 kW AC ballasted
System size (kW DC)	12	12	125	125	250	375
System cost	$25,200	$25,800	$231,250	$218,750	$400,000	$562,500
System cost after incentives	$15,770	$16,250	$149,000	$139,000	$269,000	$384,000
Year-one generation (kWh)	13,992	14,700	139,125	156,500	310,750	472,875
Year-one CO2 Equivalent reduction (tons)	9	10	94	105	209	318
Simple payback period (years)	11.2	10.0	10.9	8.9	9.0	9.4
Years to cost recovery (years)	13	11	12	10	10	10
Year 25 IRR	7.8%	9.5%	8.3%	11.5%	11.2%	10.6%
Year 25 NPV	$3,470	$6,425	$40,299	$83,976	$155,328	$194,779

The economics of the PV systems are similar. The small changes in economics are largely driven by small changes in the analysis' assumptions.

Sensitivity Analysis for the 300 kW AC PV System

Scenarios	25 Year IRR	25 Year NPV	Comments
Base Case Scenario	10.6%	$194,779	Same as shown above
No OEI grant funding	7.2%	$82,279	Total incentives $66,000
No Solar on Schools PV module donation	9.4%	$161,779	Total incentives $145,500

No OEI funding and no Solar on Schools donation	6.5%	$49,279	Total incentives $33,000
PV system cost decreases by 10%	13.2%	$257,724	To $1,350/kW DC
PV system cost increase by 10%	8.6%	$131,835	To $1,650/kW DC
Electric rates increase by 3%/year	12.4%	$300,545	Base Case assumption 1.5%/year
20-year financing 2.5% interest rate, for $384,000	Cashflow positive from year one	$270,631	Because the project is cash flow positive from year one, unable to determine the IRR

<u>Other General Comments</u>

- Solar PV systems have an expected lifespan of more than 25 years, so it's important that the roof have a commensurate or greater life expectancy
- The roof must be able to support the weight of the PV array and related loads
- Madison Solar Consulting (MSC) did not visit the roof, so the roof's characteristics were estimated based on a virtual site assessment done with Milwaukee School District Staff, Justin Hegarty and Elizabeth Hitman, aerial photographs, and Madison Solar Consulting's experience.

Next Steps

1. Review the findings of this report. Ask questions.
    - Additional analysis can be completed
2. Determine the next steps. This includes determining:
    - If the remaining life of the School's roof is sufficient
    - The siting of the PV array
        - Multiple sites can be selected, for example on the south-facing roof and the flat roof
    - The size of PV system
    - The type of PV racking
3. Have a PE review of the building's structure to ensure that it can support the weight and added wind and snow loading of the selected PV system. Also, consider having a PE review racking integration options for the south-facing roof area.
    - Based on the PE's input, modify plans as needed
    - A PE stamped review showing that the School's structure is able to support the selected rooftop PV array may be needed for permitting
4. Finalize the details of the PV system to be bid out
5. Develop the request for proposal (RFP) and run the RFP process
6. Apply for Grant funding
   Incentive funding typically requires that the system has been bid out
7. Re-run financial analysis with updated costs, incentive levels, and other updated information
8. Selected the installation contractor and after contract negotiations, sign the installation contract
9. Install the PV system

Quick Introduction to PV Systems

Solar Photovoltaic (PV) Systems - Basic Information

- No moving parts and low maintenance needs
- Modules have a 25-year warranty (to produce >80% of their rated capacity)
- Inverters typically have a 10 to 20-year warranty
- Racking systems typically have a 10 to 25-year warranty
- With regular maintenance and as needed component replacement a solar PV system should have a 30- to 40-year life
- The National Electric Code (NEC) includes solar PV systems
- All key components are United Laboratories (UL) certified
- Many highly qualified licensed electricians with PV certification are available to design, specify, and install solar PV systems to code
- Solar modules are made of the high-strength glass and are rated for hail
- Property insurance policies cover PV systems
- Solar system prices, after significant declines over the last 25 years, are generally stable over the last 3 to 4 years.
- Battery storage systems and/or additional PV systems can be installed at a later time

Technical and Economic Modeling

Prediction is very difficult, especially if it's about the future.

- Niels Bohr

And even more difficult - if the prediction looks forward 25 years.

This analysis attempts to use realistic assumptions. All assumptions are clearly presented. The assumptions are more important than the results. Thus, please review and consider them carefully.

Assumptions such as the system's price, year one insurance costs, year one generation, and utility interconnection costs can be more precisely determined after bidding and designing the PV system.

Perhaps the largest unknown is the future value of the solar energy produced and demand savings. Every year or two, We Energies (WE) can change both their customer purchase rates and customer generating system (CGS) rates.

North Division High School PV Array Siting: Roof

The PV system is to be sited on the School's roof. The roof has plenty of room for the size of PV systems considered.

There is limited room for a ground-mounted PV array. PV parking structures were considered but they are costly, have issues with snow sliding off, and are complex to snowplow around.

The images of the School's roof, below, shows the large empty roof. The roof has relatively few mechanicals, which makes it easier to site a PV system.

Two main roof areas are considered for siting the PV system:

- East-side of the building, on the three-story roof, which is close to the building's electrical connection to WE (and assumed to be closer to the main electrical room). It is assumed the PV will be interconnection to the School's main electrical panel.
- South-side of the building on the south-facing sloped roof. This siting allows the PV system to be visible from the street and sidewalk. But the racking systems will require roof-penetrations and or physical connection to the school's wall.

The image below of the south-facing roof area shows the trees that throw shade on to the roof area. Source: Justin Hegarty

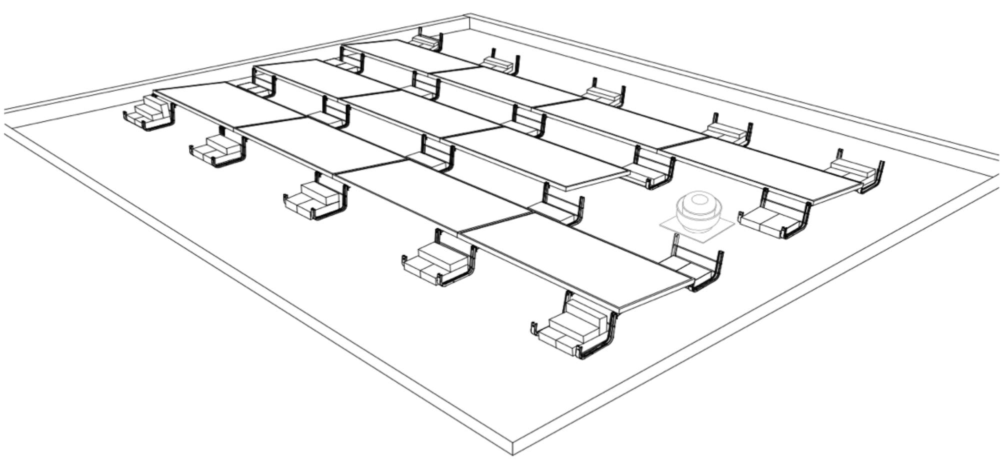
Google Maps Image, below, shows the School's entire roof area. Note the trees shading the roof. The trees are estimated to have heights of 30 to 65 feet. Their heights will change over the 30- to 40-year life of the PV system. Tree shading will change as trees grow, die, and are removed and replaced

PV System Racking Options

Flat Roof: Ballasted PV Racking System

Ballasted PV racking systems sit directly on the flat membrane roof with no roof penetrations. In Wisconsin, a very commonly used ballasted rack is the Unirac RM10. The images, below, are from the RM10 installation manual[1].

Images below, Unirac RM10 drawings showing the U-shaped racks, cement ballast blocks and empty PV modules. The number of ballast blocks are specified depending on the results of the structural analysis (e.g., expected wind loading).



[1] To view the installation manual visit: https://unirac.com/wp-content/uploads/pdf/RM10_Installation-Guide_20190628-1.pdf Sourced 10/06/20

Photo, below, of the Unirac RM10 Ballasted PV Mounting System. Photo from the Darlington Elementary and Middle School, Darlington WI. (Source: Niels Wolter, Madison Solar Consulting)

Photo, below, of the Unirac RM10 Ballasted PV Racking System with the concrete ballast, aluminum racking system, Unirac roof pad (the black plastic extrusion between the rack and the slip sheet), and the black slip-sheet. Also note the single-use bolt (with a blue threaded end) attaching the rack to the PV module. Photo from the Darlington Elementary and Middle School, Darlington WI. (Source: Niels Wolter, Madison Solar Consulting)

Sloped Roof PV System Racking Options

The south roof area has a slope of about 15°. Given its visibility from the street, it is a great site for locating a solar PV system. The more visible the PV system, the more the students, staff, and community will become interested in PV.

Given the complexity of racking on the sloped roof, and shading from nearby trees, only the smaller PV arrays, 10 kW AC and 100 kW AC, are recommended.

There are three potential racking options for the south-facing low-sloped roof area:

- Standard sloped roof racking in the plane of the roof with roof penetrations
- Standard ballasted flat roof racking system with roof penetrations
- (perhaps) A hanging racking system, structurally integrated into the building's wall (north of the PV array)

<u>Sloped-roof or Ballasted Racking Systems with Roof Penetrations</u>
Fewer roof penetrations should be required to tie the sloped-roof racking system into the low sloped roof (when compared to a PV array on a steeper sloping roof).

The roof penetrations should ensure that:

- The mechanical/structural attachments are to the structural deck or beams
- The PV array is 6" to 8" off the roof surface (to permit maintenance under the array)
- Penetrations are coordinated with the TPO roofing contractor and solar contractor
- The TPO attachment cover is bonded/welded to the TPO roofing
- The flashing follows the roof manufacturers' instructions

Low slope, plane of the roof PV array, photo below, with mechanical attachment/roof penetration. Source AIA/GAF[2]

- Ballasted flat-roof racking with roof penetrations
    - Ballasted racking systems can be sited on roofs with a slope of 10° or less without any roof penetrations.
        - The structural forces on a 15° roof on the ballasted array should not be significant.
    - The ballasted array could tie into the building using roof penetrations/mechanical attachment to the roof structure.

- With building wall structural connection: It may be possible to "hang" or "tie" the PV array (image below) into structural components of the building/parapet wall north of the PV array. This is uncommon but may be worth considering.

[2] Link: https://www.aia.org/articles/6198582-solar-ready-design-for-low-slope-roofs--Sourced 10/06/20

Image below of the Z-Rack "hanging" rack system[3].

To design the roof-penetrating post mounted racks, or roof-penetrating ballasted racks, or the hanging racking systems, or some combination, a review by a qualified structural engineer is needed.

1. In the plane of the roof racking using mounting posts: a structural engineer will need to provide a stamp for the roof, showing that it is capable of bearing the weight of the PV array. Usually, the installation firm works with the racking system provider to determine the siting and spacing of the PV racking system mounting posts.
2. Ballasted with roof-penetrating mechanical attachment: a structural engineer will need to provide a stamp for the roof, showing that it is capable of bearing the weight of the PV array. Usually, the installation firm works with the racking system provider to determine the siting and spacing of the PV racking system's penetrations.
3. Hanging PV array: a structural engineer will probably need to design and stamp the wall integration

[3] Link: https://mysolarpod.com/z-rack-sloped-roofs/ Sourced:10/06/20

Example: Installing and Weather Proofing a Roof Penetrating Mechanically Attached Mounting Post

One method of attaching a penetrating solar mounting point on a TPO roof is to:

1. Install the mounting post at the desired location
    - With physical attachment to a structural member of the roof
    - The mounting post is designed specifically for the low-sloped membrane roof mounting of PV systems
        - One example is the QBase Low slope Mount made by Quick Mount PV[4]

Image below of the QBase Low Slope Mounts of different heights. Note that up to four stainless steel mounting screws can be used. (Source Solarflexion[5])

2. A TPO flashing/cover is installed over each mounting post
    - A how-to video can be found [here](#)[6]
    - The TPO cone-shaped flashing is manufactured to fit over and around the mounting post. See the image below.
    - The top of the post and cone is sealed with the appropriate sealant

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[4] Link: https://www.quickmountpv.com/products/low-slope-mount.html?cur=3 Sourced: 10/12/20

[5] Link https://www.solarflexion.com/product-p/qmlsh-9.htm?gclid=CjwKCAjw_Y_8BRBiEiwA5MCBJvbX2xYlK36HSSVQfBROKd9gKJFkMzjYy4uDSxrhHPU0-QNuNE0HqRoCOgEQAvD_BwE Sourced: 10/12/20

[6] Can also search YouTube "Acme Cone Quick Mount PV TPO Installation" Sourced: 10/12/20

- The base of the TPO cone is sealing using heat welding to the roofing TPO membrane
    - It is recommended that a roofing contractor installs the TPO cones.

Image below, TPO roofing cone that seals around the mounting post. Note the mounting post under the cone and the heat gun used for welding the TPO cone to the TPO roofing on the left side of the image. The same type of heat welding, of TPO materials, is used to weld long sheets of roofing together. (Source: Acme Cones[7])

[7] https://www.youtube.com/watch?v=l-6Dfuq3UoY Source: 10/12/20

Recommendations: PV on Flat and Low-Sloped Building Roofs

If the District decides to replace roofing before installing PV systems.

PV System Flat Roofing Recommendations[8]

- The best roof for a flat application fully adhered thermoplastic olefin or polyolefin (TPO) membrane roof[9].
- Consider using a white roof to reduce air conditioning costs while reducing PV array temperatures and increasing reflected light.
  - The beneficial impacts of a white roof on solar PV generation are not considered in this analysis.
- Use a roof membrane that provides enhanced protection against the effects of UV radiation and high service temperatures so that the roof life expectancy will match that of the PV array.
- Consider Using
  - An increased roof membrane thickness to extend the roof's service life (e.g., 80-mil thickness rather than the standard 60-mil)
  - Wider rolls will minimize the number of seams buried below the solar arrays.
  - Adhered high-compressive-strength coverboard directly beneath the roof membrane to withstand increased foot traffic, enhance system durability, and extend the life expectancy of the roof.
- For flat roof areas to host a ballasted PV system
  - Use high-compressive-strength insulation beneath the TPO, a minimum of two layers, staggered and offset.
  - Consider including a protection or separation sheet adhered to the membrane or slip-sheet between the base of the ballasted array and the roof.

Recommendations: PV Array Layout and Installation

PV array design and installation should consider that:

- Rack heights should be set with enough clearance to service the roof membrane, especially at drains and penetrations
- Walk pads can be installed in high-traffic areas to prevent roof damage during service and tours of the PV array.

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[8] Source: AIA https://www.aia.org/articles/6198582-solar-ready-design-for-low-slope-roofs--sourced: 10/06/20

[9] Source NREL

- The PV system's installation contractor should meet with the roofing company onsite, to review the installation methods to ensure that it is acceptable and that the roof warranty is maintained.

Replacing Roofing Under an Existing Roof-top PV Array

Given the School's large roof area the PV array would have to be:

1. Partially or fully disassembled
2. Moved to an adjacent roof area while the roof is replaced
3. Moved back to the original roof area and re-assembled[10]

Most of the labor is manual labor but an electrician is needed, to break and make electrical connections, as is a trained racking installer. Some parts will need to be replaced. For example, the Unirac RM10 ballasted racking system has single-use clip bolts (which mount the PV modules to the racking) will have to be replaced, as will some electrical connections and fittings.

The estimated cost of disassembling, moving, and reassembling a PV system is estimated below.

Cost category	Share of Costs for Installing a New PV System (A)	Estimated Share (of A) Used When Moved and Reinstalled (B)	Estimated Cost of Moving and Reinstalling Compared to Installing a New System (A x B)
Labor	20%	100%	20%
Parts	58%	10%	6%
Overhead profit	22%	30%	7%
Total	100%	NA	33%

It would cost about 1/3 of the cost of the original PV system, to disassemble, move and re-assemble a roof-top PV system. Or at today's PV prices $500 to $700/kW DC.

[10] Given the School's large roof area, a cost-savings option would be to move the PV array to a recently reroofed area and reassemble it there.

Modeling Tools Used

Helioscope

Helioscope is a PV system siting, preliminary design, and PV production modeling tool. It was used for siting the PV arrays and developing high-quality production estimates for the different PV system siting options.

Madison Solar Consulting Solar PV Cash Flow Model

The outputs of the Helioscope analysis and additional assumptions (outlined below) are used in the MSC Solar PV Cash Flow Model to determine the cash flow and the economic metrics of each PV system option.

North Division High School Electricity Use 2018 and 2019

The School's power usage from January 2018 to June 2020 was provided by We Energies (WE). March 2020 to June 2020 electricity use data was not used, due to the building's expected reduced/unusual use due to COVID-19.

	2018 kWh	2019 kWh	2020 kWh	Average kWh
January	435,805	412,500	371,136	406,480
February	432,075	373,889	319,557	375,174
March	467,204	384,545		425,875
April	450,575	364,437		407,506
May	485,834	455,636		470,735
June	508,617	418,553		463,585
July	478,670	556,042		517,356
August	681,311	599,962		640,637
September	530,473	462,001		496,237
October	535,798	428,029		481,914
November	527,744	371,993		449,869
December	469,181	231,171		350,176
Total	6,003,287	5,058,758		5,485,542

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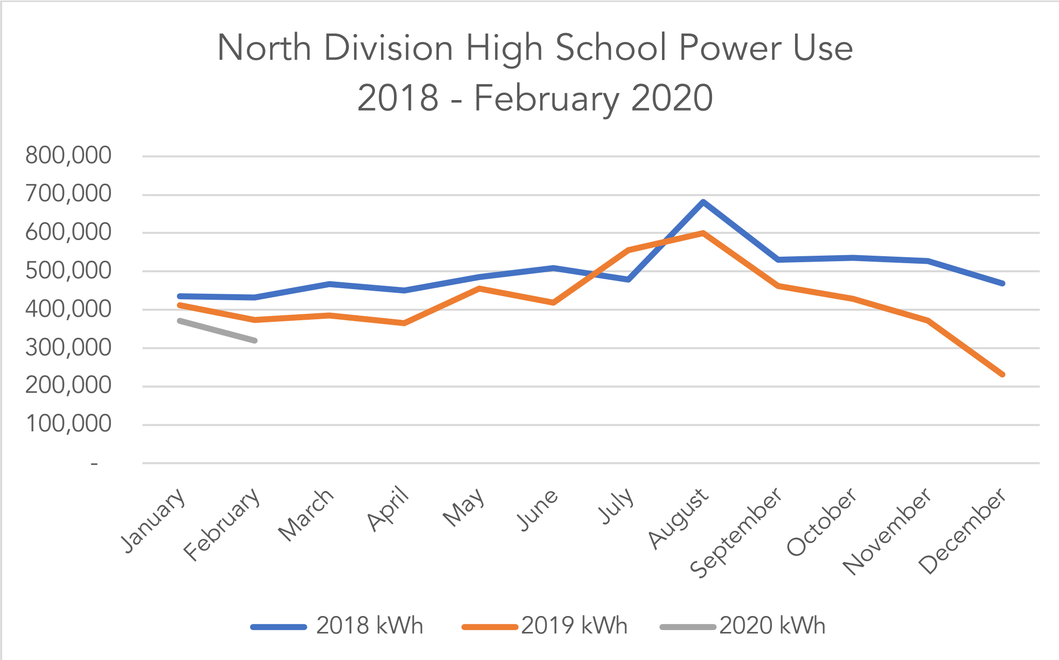

Assuming that a fix-mounted PV system generates 1250 kWh/year per kW DC of PV, 4.5 MW DC (or 3.6 MW AC) of PV would be needed to meet 100% of the School's annual power use.

Helioscope PV System Siting Analysis

Assumptions

Type of PV Array: Roof-sited and fixed-mounted
- All PV arrays face due south

Racking Type
- Flat roof areas: Ballasted flat-roof racking system
- South-facing sloped roof area:
  - Simple sloped roof PV array lying several inches off the roof
  - Ballasted roof racking system

Array Tilt Angle
- Flat roof areas: 10° tilt angle from the horizontal
- South-facing sloped roof area:
  - Simple sloped roof PV array: 15° tilt angle from the horizontal and in the plane of the roof
  - Ballasted roof racking system: 25° tilt angle from the horizontal

Height of the PV Array
- Flat roof areas: The roof surface is estimated to be 30 feet above ground level
- South-facing sloped roof area: The base of the PV array is estimated to be 27.5 feet above ground level

Row Spacing
- Flat roof areas: 1.45-ft row spacing, to allow room for racking and ballast
- Slope roof area: modules are installed next to each other with gaps of about ¼"

Array Layout Guidelines
- A clear pathway around roof edges, hatches, skylights, mechanicals, and service pathways
- A service pathway is a conduit-free route for contractors using dollies and wheeled trucks to move heavy mechanicals across the roof
- Pathways within the array when the array is more than 150 ft long or wide (to meet fire code)
- Distances of 4' to 10' between the edge of the array and the roof edge (to meet fire code, depends on the Fire code used by the local municipality)

PV System Components

Type of PV module: Hanwha, Q.Peak DUO L-G7.2 400, 400-watt DC
- This represents a commonly available module that is currently on the market. Many different manufacturers make similar modules. These modules are:

        - High efficiency monocrystalline silica
        - PERC[11] modules
        - Tier 1 manufacturer (per Bloomberg)
        - Made in China
        - 25-year production warranty
- PV module option: Bifacial Modules.
    - Bifacial modules generate power from both their front and back-sides
    - They have increased power generation when sited above a reflective surface (i.e., the school's light-colored roof).
    - Bifacial modules cost more
    - The Solar on School's program offers bifacial modules
    - The School's flat-roof PV array's 10° tilt angle and tight row spacing will not allow significant reflected light to strike the underside of the PV modules
    - The racking and wiring systems cost a little more as they must be designed and installed not to shade the back of the PV modules.
    - It is unlikely that using bifacial modules, on 10° tilted PV modules, would significantly improve the PV system's economics[12]
    - Bifacial modules are not considered in this analysis

Type of PV inverter:

- 10 KW AC PV system: SolarEdge SE5000A-US (5 kW)
- 100 KW AC PV system SolarEdge SE10000H-US (10 kW)
- 200- and 300-KW AC PV systems SolarEdge SE25K (25 kW)
- All PV systems: SolarEdge, P320 optimizer (320 watts AC)

These inverters are:

- Available in other sizes and models
- Meet the NEC's requirements for module level shut down
- Inverter: 12-year product warranty
    - Extended warranty available (for purchase)
- Optimizer: 25-year product warranty
- Service life of over 25-years
- Flextronics provides the manufacturing (products are likely to be made in China)

Type of Racking

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[11] Passivated Emitter and Rear Cell (PERC) is a newer PV cell technology that achieves higher energy conversion efficiency by adding a dielectric passivation layer on the rear of the cell.

[12] Steeper tilt angle PV racking systems are available that open the back of the PV module to reflected light. However, given Wisconsin's snow and wind loading these racking systems are unlikely to get PE stamps.

- Simple sloped roof racking: not selected (doesn't impact assessment)
- Ballasted racking: Unirac RM10

PV Array/Module Soiling and Snow Cover
Estimates of Madison Solar Consulting

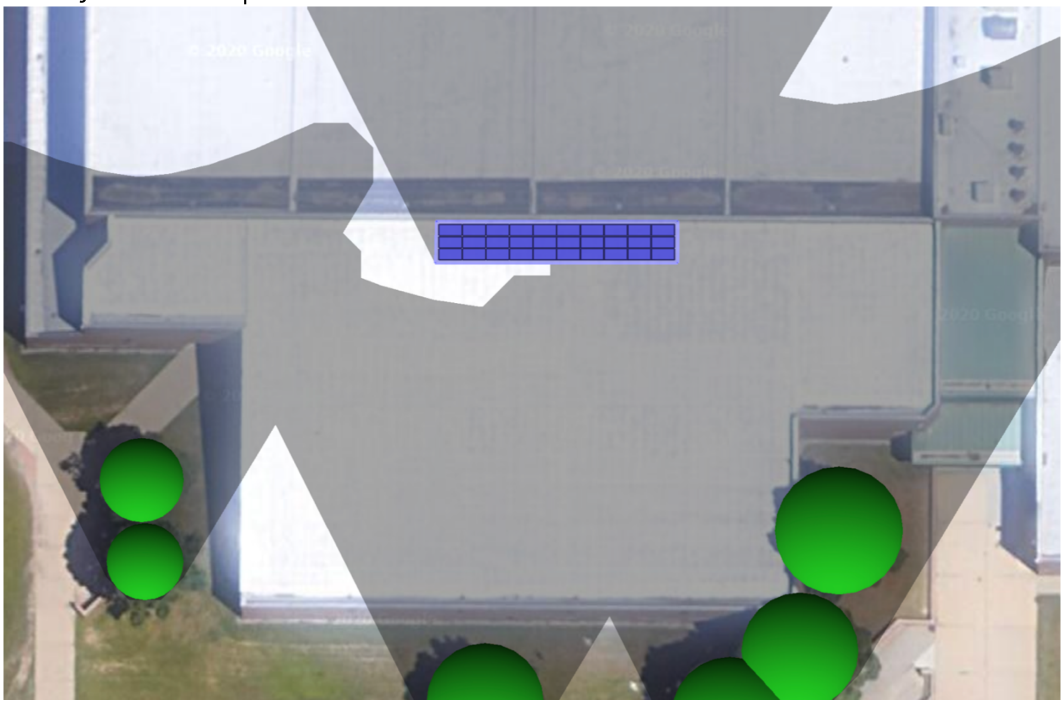
jan	40 %	may	3 %	sep	3 %
feb	40 %	jun	3 %	oct	3 %
mar	8 %	jul	3 %	nov	5 %
apr	3 %	aug	3 %	dec	30 %

Possible PV Array Locations

Helioscope Images Key and Notes

- Light blue areas are PV array areas
- Dark blue areas are the PV modules
- Darker orange areas are the trees and other areas where PV arrays cannot be located (aka "keep-outs")
- Light orange areas are the setbacks from the edge of the PV array areas to the edge of the PV modules.
- The green areas are trees
    - The trees are assumed to be 30' to 65' tall
- The PV array locations can be easily adjusted, images shown are examples
- The DC rating is the total rating of the PV modules
- The AC rating is the total rating of the PV inverters

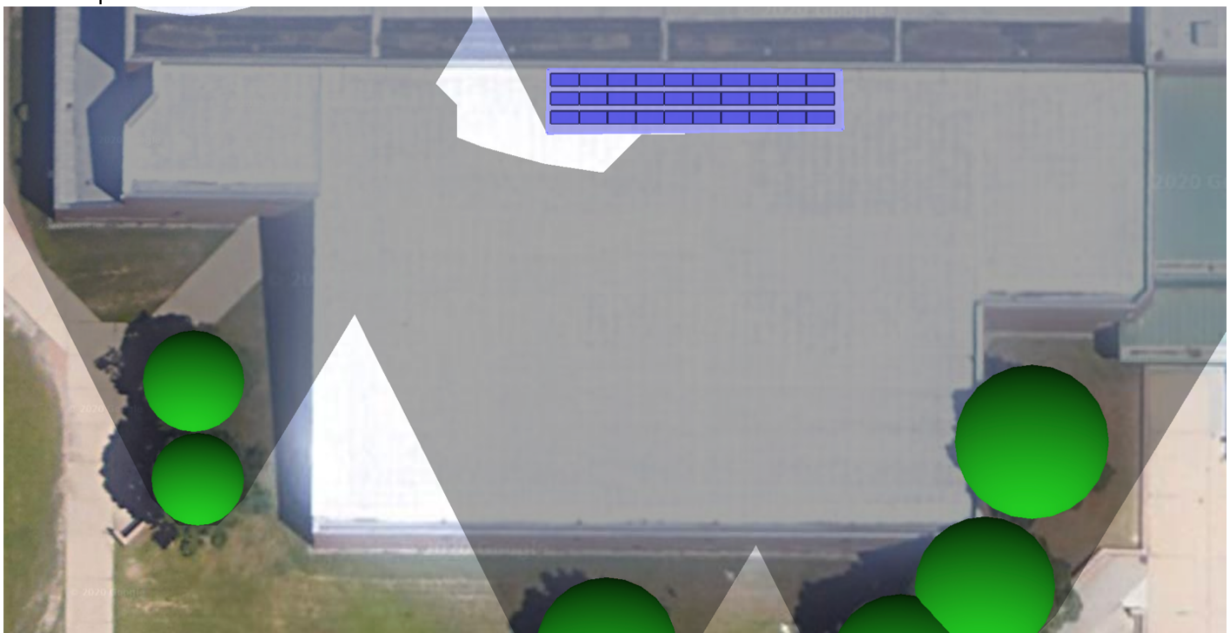
Helioscope Image of a 10 kW AC (12 kW DC) PV System on the sloped roof with simple in the plane of the roof racking. Sited for visibility. The system generates 13,991 kWh/year with a performance ratio of 1,166 kWh/kW DC.



10 kW AC PV system on the sloped roof, with a in the plane of the roof racking system, solar generation and site use.

Month	Solar (kWh)	Site Use (kWh)	Use after Solar (kWh)	Share Solar
January	391	406,480	406,090	0.10%
February	535	375,174	374,639	0.14%
March	1,137	425,875	424,738	0.27%
April	1,588	407,506	405,918	0.39%
May	1,709	470,735	469,026	0.36%
June	1,832	463,585	461,753	0.40%
July	1,866	517,356	515,490	0.36%
August	1,614	640,637	639,023	0.25%
September	1,360	496,237	494,877	0.27%
October	928	481,914	480,986	0.19%
November	648	449,869	449,220	0.14%
December	384	350,176	349,792	0.11%
Total	13,991	5,485,542	5,471,551	0.26%

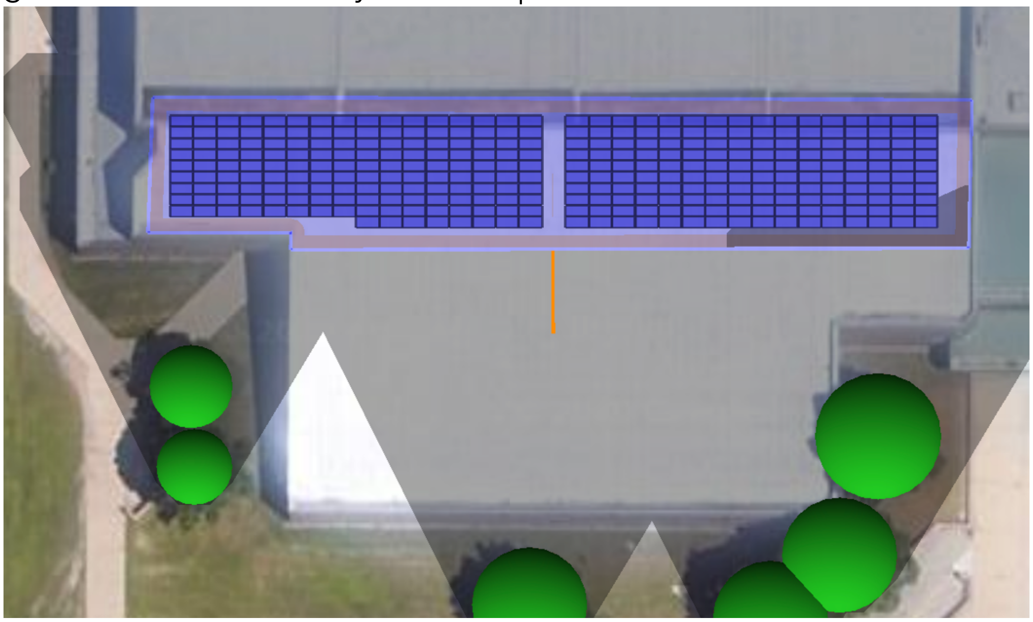
Helioscope Image of a 10 kW AC (12 kW DC) PV System on the sloped roof using ballasted racking. Sited for maximum visibility. The system generates 14,700 kWh/year with a performance ratio of 1,225 kWh/kW DC.



10 kW AC PV system on the sloped roof using ballasted racks solar generation and site use.

Month	Solar (kWh)	Site Use (kWh)	Use after Solar (kWh)	Share Solar
January	452	406,480	406,029	0.11%
February	601	375,174	374,572	0.16%
March	1,267	425,875	424,608	0.30%
April	1,651	407,506	405,855	0.41%
May	1,688	470,735	469,047	0.36%
June	1,790	463,585	461,795	0.39%
July	1,843	517,356	515,513	0.36%
August	1,657	640,637	638,980	0.26%
September	1,539	496,237	494,698	0.31%
October	1,028	481,914	480,886	0.21%
November	731	449,869	449,138	0.16%
December	454	350,176	349,722	0.13%
Total	14,700	5,485,542	5,470,842	0.27%

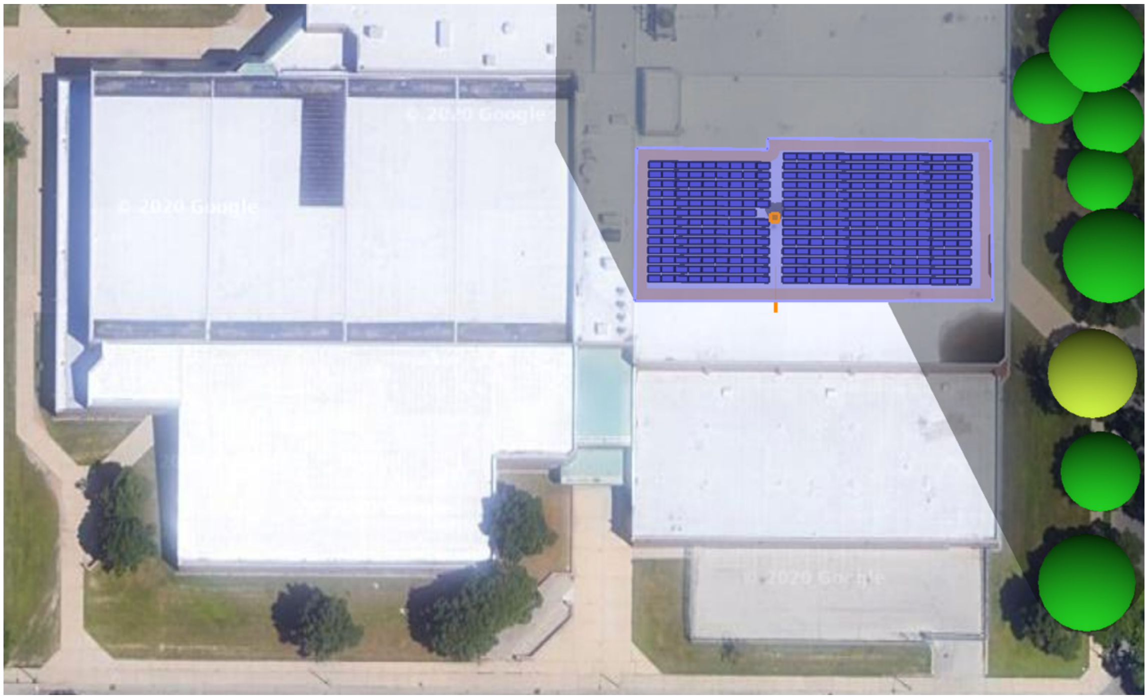
Helioscope Images of a 100 kW AC (125 kW DC) PV System on the sloped roof with a simple in the plane of the roof racking. Sited for maximum visibility. The system generates 138,954 kWh/year with a performance ratio of 1,113 kWh/kW DC.

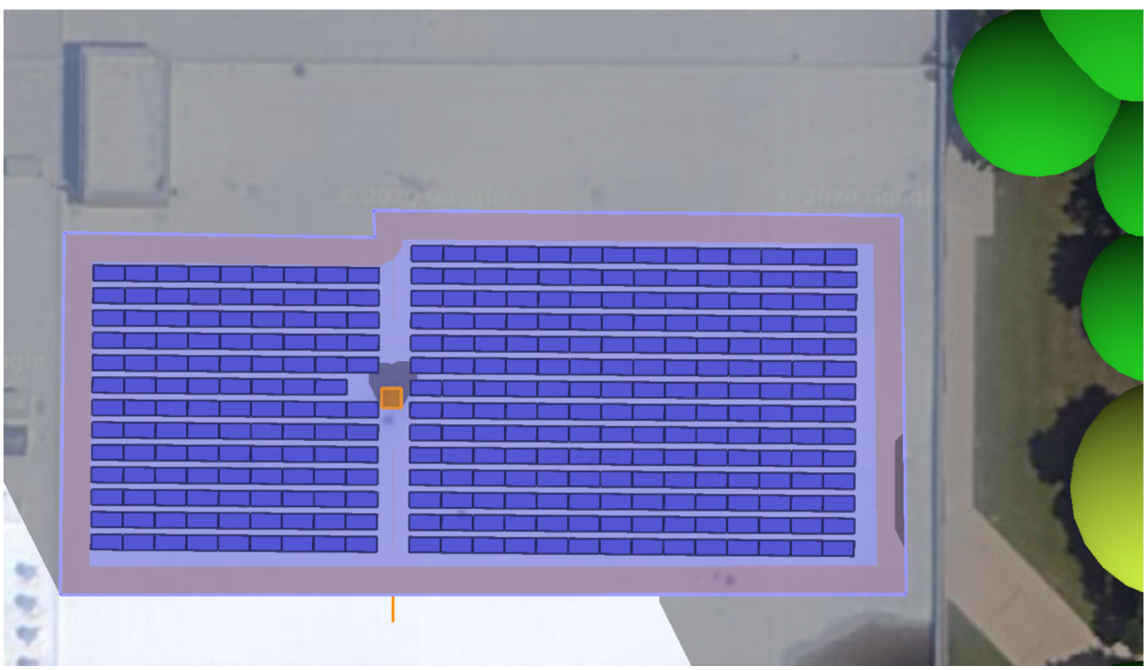


100 kW AC PV system on the sloped roof, with in the plane of the roof racking system, solar generation and site use.

Month	Solar (kWh)	Site Use (kWh)	Use after Solar (kWh)	Share Solar
January	3,626	406,480	402,854	0.9%
February	5,274	375,174	369,900	1.4%
March	11,398	425,875	414,476	2.7%
April	15,588	407,506	391,918	3.8%
May	17,277	470,735	453,459	3.7%
June	18,863	463,585	444,722	4.1%
July	18,898	517,356	498,459	3.7%
August	15,595	640,637	625,042	2.4%
September	13,472	496,237	482,765	2.7%
October	9,342	481,914	472,571	1.9%
November	6,132	449,869	443,737	1.4%
December	3,489	350,176	346,687	1.0%
Total	138,954	5,485,542	5,346,589	2.5%

Helioscope Images of a 100 kW AC (125 kW DC) PV System using ballasted racking. The system generates 156,278 kWh/year with a performance ratio of 1252 kWh/kW DC.

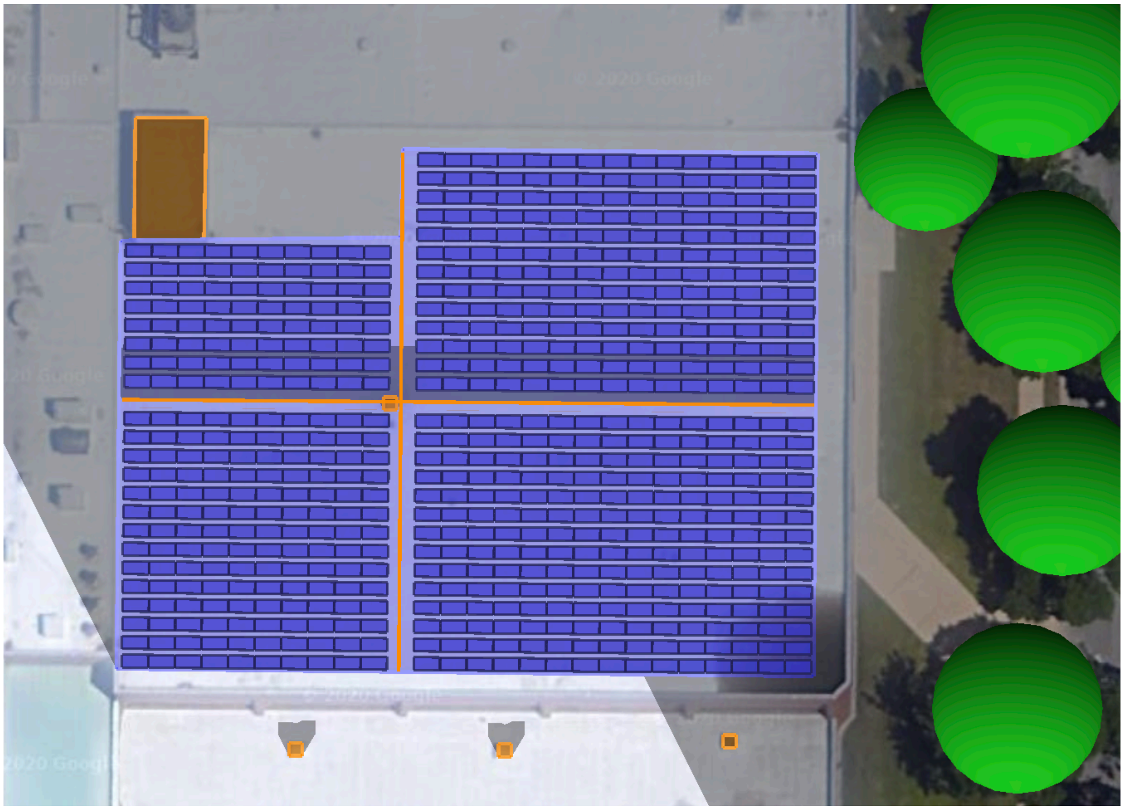


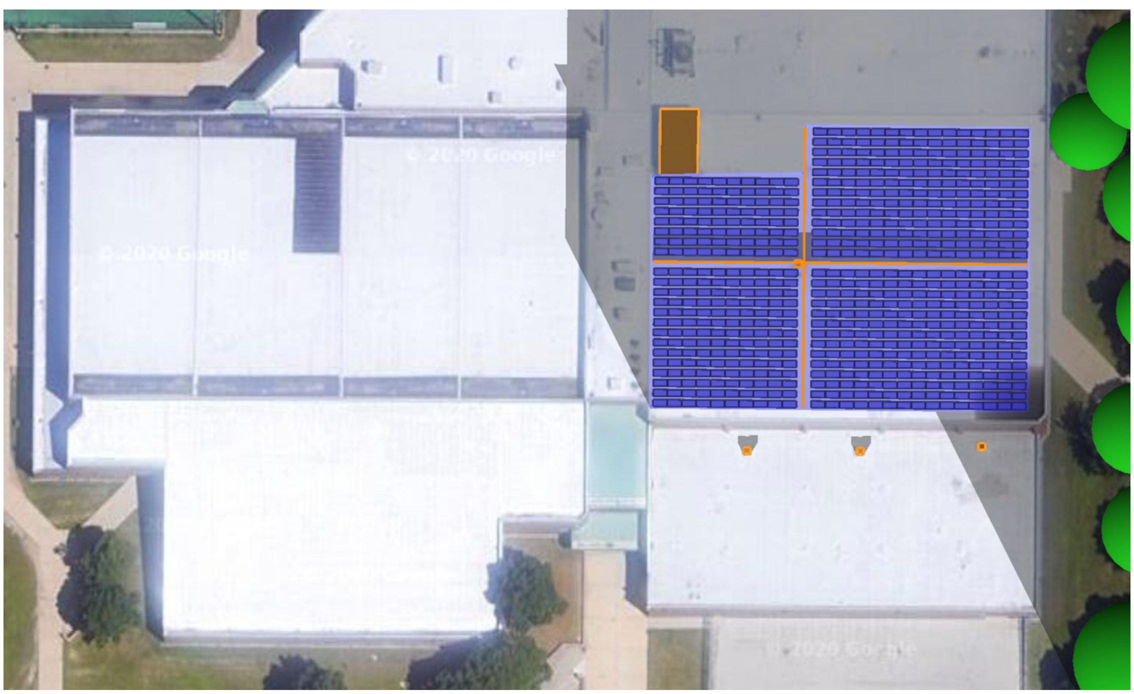


100 kW AC PV system on the flat roof, with ballasted racking system, solar generation and site use.

Month	Solar (kWh)	Site Use (kWh)	Use after Solar (kWh)	Share Solar
January	4,408	406,480	402,072	1.1%
February	6,172	375,174	369,001	1.6%
March	13,018	425,875	412,857	3.1%
April	17,622	407,506	389,884	4.3%
May	18,761	470,735	451,975	4.0%
June	20,048	463,585	443,537	4.3%
July	20,431	517,356	496,925	3.9%
August	17,790	640,637	622,846	2.8%
September	15,771	496,237	480,466	3.2%
October	10,613	481,914	471,301	2.2%
November	7,311	449,869	442,557	1.6%
December	4,333	350,176	345,843	1.2%
Total	156,278	5,485,542	5,329,264	2.8%

Helioscope Images of a 200 kW AC (250 kW DC) PV System using ballasted racking. The system generates 310,679 kWh/year with a performance ratio of 1,243 kWh/kW DC.





200 kW AC PV system on the flat roof, with ballasted racking system, solar generation and site use.

Month	Solar (kWh)	Site Use (kWh)	Use after Solar (kWh)	Share Solar
January	8,248	406,480	398,232	2.0%
February	11,740	375,174	363,434	3.1%
March	25,873	425,875	400,002	6.1%
April	35,495	407,506	372,011	8.7%
May	37,835	470,735	432,901	8.0%
June	40,606	463,585	422,979	8.8%
July	41,332	517,356	476,024	8.0%
August	35,842	640,637	604,795	5.6%
September	31,421	496,237	464,816	6.3%
October	20,458	481,914	461,456	4.2%
November	13,793	449,869	436,076	3.1%
December	8,037	350,176	342,139	2.3%
Total	310,679	5,485,542	5,174,863	5.7%

Helioscope Images of a 300 kW AC (375 kW DC) PV System using ballasted racking. The system generates 472,027 kWh/year with a performance ratio of 1,261 kWh/kW DC.

300 kW AC PV system on the flat roof, with ballasted racking system, solar generation and site use.

Month	Solar (kWh)	Site Use (kWh)	Use after Solar (kWh)	Share Solar
January	13,048	406,480	393,433	3.2%
February	18,292	375,174	356,882	4.9%
March	39,465	425,875	386,410	9.3%
April	53,442	407,506	354,064	13.1%
May	56,838	470,735	413,897	12.1%
June	61,012	463,585	402,573	13.2%
July	62,114	517,356	455,242	12.0%
August	53,988	640,637	586,649	8.4%
September	47,782	496,237	448,455	9.6%
October	31,551	481,914	450,362	6.5%
November	21,659	449,869	428,209	4.8%
December	12,837	350,176	337,340	3.7%
Total	472,027	5,485,542	5,013,516	8.6%

Solar PV System Generation Analysis

Assumptions and Data

<u>WE Electric Rates</u>

<u>Purchase Rate: CP1</u>
The School is on WE's large industrial customer CP1 electricity tariff for purchasing power. The CP1 rate sheet is provided in Annex 1. It is assumed that the School operates at a primary voltage of between 12,470 and 138,000.

The CP1 rate has two options for setting the on-peak period, from 8 am to 8 pm or from 10 am to 10 pm. (All holidays and weekends are off-peak.) This analysis assumes that the School is on the 8 am to the 8 pm option, which is more coincident with the School's use.

The CP1 rate has four cost components:

1. Facilities Charge: $19.7601/day (or $601.03/month)
2. kWh Usage Rate ($/kWh)

	Off Peak Hours	Peak Hours
Summer	0.04949	0.07687
Non-Summer[13]	0.04949	0.06672

3. Monthly On Peak Demand Charge ($/kW)

Summer	17.440
Non-Summer	12.547
Average Charge	14.178

4. Customer Annual Demand Charge: $2.23/kW

<u>Solar Power Sell Rate Options: CGS-NM or CGS-NP</u>
The WE net metering rate is called the Customer Generating Systems – Net Metering (CGS-NM) rate. A net metering rate allows the customer to sell any excess solar power to the grid at the site's retail rate (for the School the CP-1 rate). Solar power going to the grid only happens when the PV system produces more solar electricity than the School uses during any 15-minute period of the year. The CGS-NM is available to PV systems of 300 kW AC of less. The CGS-NM rate sheet is provided in Annex 2.

[13] Summer is from June 1 to September 30

Given the relatively small generation of the PV systems (offsetting from 0.25% to 9% of the School's power use) it is likely that the modeled PV systems will rarely, if ever, put power onto the WE grid[14].

The CGS NM rate has a significant monthly Facilities Charge ($95.61/month) and does not value the PV system's impact on reducing the School's electricity demand. For the 10 KW AC PVC system, this monthly charge is greater than the value of the solar kWh generated each month.

The CGS-NP rate is the Non-Purchase rate for customer generating systems. The CGS-NP rate is found in Annex 3. If any solar power is put onto the grid it is given to WE. But the rate has no Facilities Charge and the demand benefits of the PV go to the School[15].

The CGS NM rate has two components.

1. The Facilities Charge of $3.14334 per day or $95.61/month[16]
2. Generation Value
    - Value of solar kWh that are used by the site during any billing period (e.g., the monthly bill) are valued at: CP1 rate
    - Payment ($/kWh) for the net solar delivered to the WE grid during any billing period

	Off Peak Hours	Peak Hours
Summer	0.03725	0.05491
Non-Summer	0.03686	0.04427

- The CGS-NM rate does not value the customer's demand savings provided by the PV system[17].

This analysis assumes that the PV system never deliver solar power to the grid and that School's PV system uses the CGS-NP rate[18].

<u>Value of the Solar Generation</u>

The solar generation will offset the purchase of electricity on the CP1 rate. The CP1 rate is a time of use rate The cost of power changes depending on the time of day (on-

[14] If the School had 15-minute electricity use data, this could be more accurately determined

[15] Also, WE doesn't charge a metering fee to measure the PV system's output

[16] For residential customers this charge is $0.059/day (or $1.80/month)

[17] All other Wisconsin electric utility net metering rates reduce demand charges

[18] Financial analysis assuming the PV systems were on the CGS-NM rate showed that in all cases the economics were worse (far worse for the smaller PV systems).

peak vs off-peak), the day of the week (business day vs weekend and holiday), and the season (summer vs non-summer).

The PVWatts model, developed by the National Renewable Energy Laboratory (NREL), is used to estimate the hourly generation for a typical year of the three different array orientations (all due south facing with 10° 15° and 25° tilt angle) for a PV system sited in Milwaukee. A simple spreadsheet is used to value that generation based on the WE CP1 Rate for time of day, type of day, and season for one typical year.

- 10° tilt angle, value of the solar generation: $0.06419/kWh
- 15° tilt angle, value of the solar generation: $0.06415/kWh
- 20° tilt angle, value of the solar generation: $0.06407/kWh

Likely Future CGS Electric Rates

The Public Service Commission of Wisconsin (PSCW) currently has a docket open (Docket 5EI157) on customer parallel generation rates. The CGS rates determine how the solar generation from a customer sited-PV is valued by the utility. It is very likely that the CGS-NM rate will change in the near term (as soon as January 1, 2022). How the rates will change is not known.

Perhaps it is likely that :

- Solar power delivered to the WE grid will be valued at the grid's avoided cost[19] (e.g., between 2 and 5 cents/kWh)
- The value of the demand (kW) reduction provided by the PV system will go to the PV system's owner
- WE's net metering cap, currently 300 kW AC, could be changed (most likely reduced)

CGS-NP Rate Discussion

Under the current CGS-NP rate, all solar generation is valued at the School's CP1 retail electric rate.

Because WE's CGS rates are likely to change, having the site's 15-minute electricity use data[20] would be very useful. With this data, and modeled 15-minute solar generation data, solar power delivered to the WE grid during every 15-minute period of the year, as well as demand charge reductions, can be estimated.

[19] What the grid's cost would have been to generate that power

[20] Wisconsin's electric utilities measure customer power use in 15-minute intervals, for every 15-minute period of the year. This is how they determine monthly and annual peak demand charges and measure solar power delivered to the grid (for non-net metering customers).

Given the size of the School and its power use, it is unlikely that significant amounts of PV power, even from a 300 kW AC PV system, will flow to the WE grid. However, without the 15-minute School usage data it is not known how much PV power will go to the grid.

If WE is unable to provide 15-minute data, it is recommended that the School purchase and install an electricity metering system (see Annex 4).

<u>Assumptions</u>

- All PV systems are on the CGS-NP rate, per the rate sheet (Annex 3)
- Given that the PV system's generation is never more than the School's instantaneous use, all power generation is valued at the School's retail rate
- The value of the solar generation (kWh) is based on the time of solar generation over a typical meteorological year and the time-of-use details of the CP1 rate
- There are demand savings from the PV system

PV Cashflow Analysis

Additional Assumptions

Estimating the Value of Demand Savings

A PV system's kW output will directly offset peak demand charges only when solar generation coincides with the customer's monthly and annual peak demand periods. With 15-minute site use and solar generation data this can be accurately estimated. But without that data, it can only be estimated.

School's on peak load shapes tend to be similar to the solar resource, particularly if they are air-conditioned (as this school is). Schools operate during daylight hours when the sun tends to be out. Based on MSC's experience with other air-conditioned school PV systems in Wisconsin this analysis makes the following assumptions:

PV System Size	Share of the PV System's DC capacity that offsets Monthly peak demand charges	Share of the PV System's DC capacity that offsets Annual peak demand charges
10 kW AC (12 kW DC)	30%	20%
100 kW AC (125 kW DC)	20%	15%
200 kW AC (250 kW DC)	17.5%	12.5%
300 kW AC (375 kW DC)	15%	10%

PV System Cost

Based on recent bids and estimates by MSC

- 10 kW AC (12 kW DC):
  - Plane of the roof racking: $2,100/kW DC, or $25,200
  - Ballasted racking: $2,150/kW DC, or $25,800
- 100 kW AC (125 kW DC):
  - Plane of the roof racking: $1,850/kW DC, or $231,250
  - Ballasted Racking: $1,750/kW DC, or $218,750
- 200 kW AC (250 kW DC): $1,600/kW DC or $400,000
- 300 kW AC (375 kW DC): $1,500/kW DC or $562,500

Other PV System Costs:$0

Other costs may include:

- PE review of the building structure and racking options
- Consulting writing the bid document, etc.
- Grant writing costs
- WE's interconnection and distribution system studies: significant costs are unlikely
- Switchgear upgrades: significant costs are unlikely
- Other costs (e.g., extended inverter warranty)

<u>Incentives</u>

It is not known which incentives, or their incentive levels, will be available in 2022. Summarized below are three incentives that could support the School's PV system in 2020. It is assumed that incentive levels are based on the 2020 formulas.

- Focus on Energy Renewable Energy Program, Prescriptive Incentives
    - Incentive is first come first served with annual budget allocations.
        - Customers should be prepared to apply for funding early in the year
        - An installation bid is required for the application
    - 2020 Incentive formulas
        - 5 to 10 kW AC: $1,000 plus $150/kW AC above 5 kW AC
        - 100 to 300 kW AC: $13,000 plus $100/kW AC above 100 kW AC
    - Incentive level
        - 10 kW AC PV system: $1,750
        - 100 kW AC PV system: $13,000
        - 200 kW AC PV system: $23,000
        - 300 kW AC PV system: $33,000
- Office of Energy Innovation, Energy Innovation Grant Program (EIGP)
    - The grant is competitive and should be available on an annual basis through 2023
    - Applications for the 2021 funding round are expected to be due in early 2021
    - The School could ask for any incentive amount, but the greater the share of the project costs covered by the incentive the less likely the project will be funded.
    - EIGP grant is assumed to cover 20% of project's total cost
- Solar on Schools Program

  The program donates PV modules depending on the PV system's size

- The program is funded by a private foundation (the Couillard Solar Foundation[21])
- It is not known if it will be operating in 2022
- In 2020 the module donation formula is:
  - Less than 100 kW DC: half the PV modules
  - Greater than 100 kW DC: 50 KW DC of PV modules
    - The program values the 50 kW DC of PV modules at$20,000
      - The donation is valued at $400/kW DC
    - The donation value for each PV system:
      - 10 kW AC (12 kW DC) PV system: $2,400
      - 100 kW AC (125 kW DC) PV system and larger: $20,000
  - All other modules needed for the PV array can be purchased at cost from Speed Solar[22] this results in additional cost savings estimated at:
    - $40/kW DC or for:
      - 10 kW AC (12 kW DC) PV system: $240
      - 100 kW AC (125 kW DC) PV system: $3,000
      - 200 kW AC (250 kW DC) PV system: $8,000
      - 300 kW AC (375 kW DC) PV system: $13,000
  - Total value of the Solar on Schools donation value:
      - 10 kW AC (12 kW DC) PV system: $2,640
      - 100 kW AC (125 kW DC) PV system: $23,000
      - 200 kW AC (250 kW DC) PV system: $28,000
      - 300 kW AC (375 kW DC) PV system: $33,000

PV System Installed Cost, Grants and Cost After Incentives

System Size	PV System Installed Cost	Focus on Energy Grant	EIGP Grant	Solar on Schools Donation	PV System Cost After Incentives
10 kW AC plane of roof	$25,200	$1,750	$5,040	$2,640	$15,700
10 kW AC ballasted	$25,800	$1,750	$5,160	$2,640	$16,250
100 kW AC plane of roof	$231,250	$13,000	$46,250	23,000	149,000

[21] For more information visit: www.couillardsolarfoundation.org
[22] For more information visit: www.speedsolar.net

100 kW AC ballasted	$218,750	$13,000	$43,750	$23,000	$139,000
200 kW AC	$400,000	$23,000	$80,000	$28,000	$269,000
300 kW AC	$562,500	$33,000	$112,500	$33,000	$384,000

Other Modeling Assumptions

- PV system Installation date: Summer 2022
- PV system's modeled life: 25 years
    - With maintenance PV systems should last 30 to 40 years
- PV system output degradation: 0.5%/year
- General inflation: 2%/year
- Electricity cost inflation:
    - Usage (kWh) and Facilities Charges: 1.5%/year
- Real Discount Rate: 5%
    - Used only in Net Present Value (NPV) calculation
- Greenhouse gas intensity, pounds CO_2 equivalent emitted per kWh of conventional power generated: 1.345 pounds/kWh[23]
- Project Financing: None

Annual Costs

- Insurance: 0.35% of system cost
- Operation and maintenance: 0.25% of system cost
- Replacements: 0.1% of system cost

[23] Source: WEC Energy Group 2018 Corporate Responsibility Report. The analysis assumes that onsite PV generation will reduce WE's need to generate power at that emission rate shown.

Financial Analysis Terms

Financial Definitions

Simple Payback Period

- Defined as: The system cost less all incentives, including depreciation benefits, divided by year one bill savings
- Does not include maintenance, insurance, output degradation, increased value of power production, etc.

Years to Cost Recovery

- The year the system's cumulative cash flow goes positive
- Includes electric price changes, output degradation, maintenance and insurance costs, etc.

Internal Rate of Return (IRR)

- Definition 1: The actual return provided by the project's cash flows
- Definition 2: The interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment equal zero
- Can be used to compare other investment returns

Discounted Net Present Value (NPV)

- The difference between the discounted value of cash inflows and the discounted value of cash outflows
- Discounting uses the discount rate, the discount rate is
    - The percentage that each future year's cash inflows and outflow are reduced to reflect the time value of money

Financial Analysis Results

PV System and Racking Type	10 KW AC in plane of roof	10 KW AC ballasted	100 kW AC in plane of roof	100 kW AC ballasted	200 kW AC ballasted	300 kW AC ballasted
System size (kW DC)	12	12	125	125	250	375
System cost	$25,200	$25,800	$231,250	$218,750	$400,000	$562,500
System cost after incentives	$15,770	$16,250	$149,000	$139,000	$269,000	$384,000
Year-one generation (kWh)	13,992	14,700	139,125	156,500	310,750	472,875
Year-one CO2 Equivalent reduction (tons)	9	10	94	105	209	318
Simple payback period (years)	11.2	10.0	10.9	8.9	9.0	9.4
Years to cost recovery (years)	13	11	12	10	10	10
Year 25 IRR	7.8%	9.5%	8.3%	11.5%	11.2%	10.6%
Year 25 NPV	$3,470	$6,425	$40,299	$83,976	$155,328	$194,779

Discussion

- The economics from all the PV systems are similar
- For the PV systems of 100 kW AC and larger, the small changes in economics are largely driven by the PV system's installed cost assumptions and demand charge reduction assumptions.
  - Getting bids would help determine system costs
  - With the school's 15-minute electricity use data, demand savings can be more accurately estimated
- The 100 kW AC in the plane (of the sloped roof) PV system's economics are worse than the ballasted 100 kW AC system because of greater tree shading and higher installed cost

Example Year 1 to 20 Cash Flows for the 300 kW AC PV System

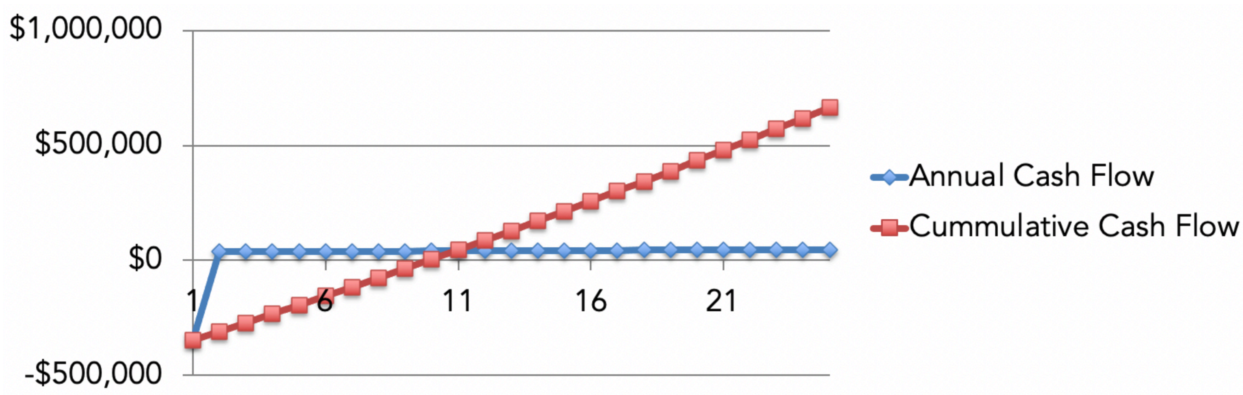
Year	1	2	3	4	5	6	7
System Cost	$(562,500)						
Incentives	$178,500						
kWh Savings	$30,354	$30,655	$30,959	$31,267	$31,577	$ 31,890	$32,207
Demand Savings	$10,574	$10,732	$10,893	$11,057	$11,222	$ 11,391	$11,562
Maintenance, Replacements & Insurance	$(3,938)	$(3,977)	$ (4,056)	$ (4,117)	$(4,200)	$(4,284)	$(4,369)
Annual Cash Flow	$(347,010)	$37,410	$37,796	$38,206	$38,600	$38,998	$39,399
Discounted Annual Cash Flow	$(347,010)	$33,932	$32,650	$31,432	$30,244	$29,101	$28,000
Cumulative Cash Flow	$(347,010)	$(309,600)	$(271,803)	$(233,597)	$(194,997)	$(156,000)	$(116,601)
Discounted Cumulative Cash Flow	$(347,010)	$(313,078)	$(280,428)	$(248,996)	$(218,752)	$(189,651)	$(161,651)

Year	8	9	10	11	12	13	14
kWh Savings	$32,527	$32,849	$33,175	$33,505	$33,837	$ 34,173	$34,512
Demand Savings	$11,735	$11,911	$12,090	$12,271	$12,455	$ 12,642	$12,832
Maintenance, Replacements & Insurance	$(4,457)	$(4,546)	$(4,637)	$(4,729)	$(4,824)	$(4,921)	$(5,019)
Annual Cash Flow	$39,805	$40,215	$40,628	$41,046	$41,468	$41,895	$42,325
Discounted Annual Cash Flow	$26,942	$25,923	$24,942	$23,999	$23,091	$22,218	$21,377
Cumulative Cash Flow	$(76,796)	$(36,581)	$4,048	$45,094	$86,562	$28,457	$170,782
Discounted Cumulative Cash Flow	$(134,709)	$(108,786)	$(83,844)	$(59,845)	$(36,754)	$(14,536)	$6,841

Year	15	16	17	18	19	20
kWh Savings	$34,855	$35,201	$35,550	$35,903	$36,259	$36,619
Demand Savings	$13,024	$13,220	$13,418	$13,619	$13,823	$14,031
Maintenance, Replacements & Insurance	$ (5,119)	$(5,222)	$(5,326)	$(5,433)	$(5,541)	$(5,652)
Annual Cash Flow	$42,760	$43,198	$43,642	$44,089	$44,541	$ 44,998
Discounted Annual Cash Flow	$20,568	$19,790	$19,041	$18,320	$17,626	$ 16,959

Cumulative Cash Flow	$213,541	$256,740	$300,382	$344,471	$389,012	$434,010
Discounted Cumulative Cash Flow	$27,409	$47,198	$66,239	$84,559	$102,186	$119,145

300 kW AC PV System Cash Flow Diagram



Example Year 1 to 20 Cash Flows for the 10 kW AC Ballast-Mounted PV System

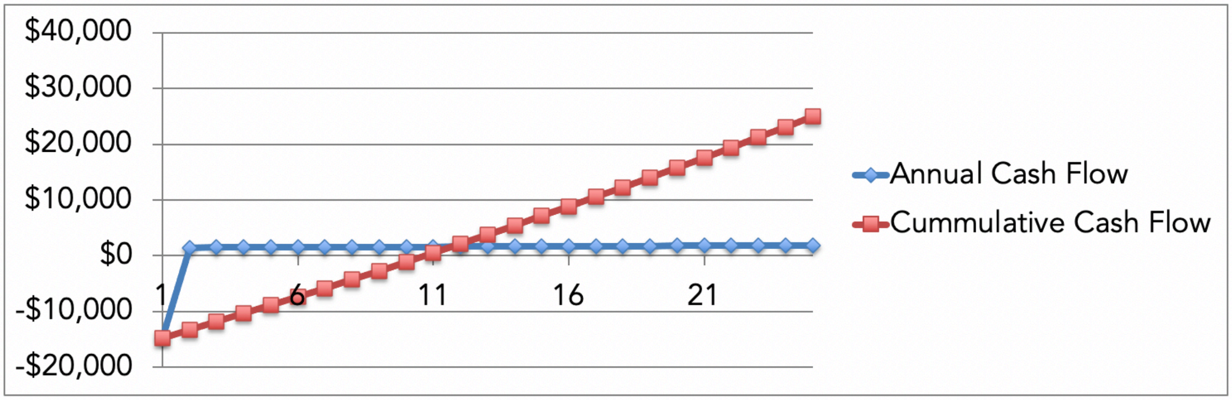
Year	1	2	3	4	5	6	7
System Cost	$(25,800)						
Focus Incentives	$9,550						
kWh Savings	$942	$951	$961	$970	$980	$990	$999
Demand Savings	$677	$687	$697	$708	$718	$729	$740
Maintenance, Replacements & Insurance	$(181)	$(182)	$(186)	$(189)	$(193)	$(196)	$(200)
Annual Cash Flow	$(14,812)	$1,456	$1,472	$1,489	$ 1,505	$1,522	$1,539
Discounted Annual Cash Flow	$(14,812)	$1,320	$1,271	$1,225	$ 1,180	$1,136	$1,094
Cumulative Cash Flow	$(14,812)	$(13,356)	$(11,885)	$(10,396)	$(8,890)	$(7,368)	$(5,829)
Discounted Cumulative Cash Flow	$(14,812)	$(13,492)	$(12,220)	$(10,995)	$(9,816)	$(8,680)	$(7,587)

Year	8	9	10	11	12	13	14
kWh Savings	$1,009	$1,019	$1,029	$1,040	$1,050	$1,060	$1,071
Demand Savings	$751	$762	$774	$785	797	$809	$821
Parallel Generation Charge	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance, Replacements & Insurance	$ (204)	$ (209)	$ (213)	$ (217)	$ (221)	$(226)	$(230)
Annual Cash Flow	$1,556	$1,573	$1,590	$1,608	$ 1,626	$1,644	$1,662
Discounted Annual Cash Flow	$1,053	$1,014	$976	$940	$ 905	$872	$839
Cumulative Cash Flow	$ (4,274)	$ (2,701)	$ (1,110)	$498	$ 2,124	$3,767	$5,429
Discounted Cumulative Cash Flow	$(6,533)	$(5,519)	$ (4,543)	$(3,603)	$(2,698)	$(1,826)	$ 986)

Year	15	16	17	18	19	20
kWh Savings	$1,081	$1,092	$1,103	$1,114	$1,125	$1,136
Demand Savings	$834	$846	$859	$872	$ 885	$898
Maintenance, Replacements & Insurance	$(235)	$(240)	$(244)	$(249)	$(254)	$(259)
Annual Cash Flow	$1,680	$1,699	$1,718	$1,736	$1,756	$1,775

Discounted Annual Cash Flow	$808	$778	$749	$722	$695	$669
Cumulative Cash Flow	$7,110	$8,808	$10,526	$12,262	$14,018	$15,793
Discounted Cumulative Cash Flow	$(178)	$600	$1,349	$2,071	$ 2,766	$3,435

10 kW AC Ballast-Mounted PV System Cash Flow Diagram



Sensitivity Analysis

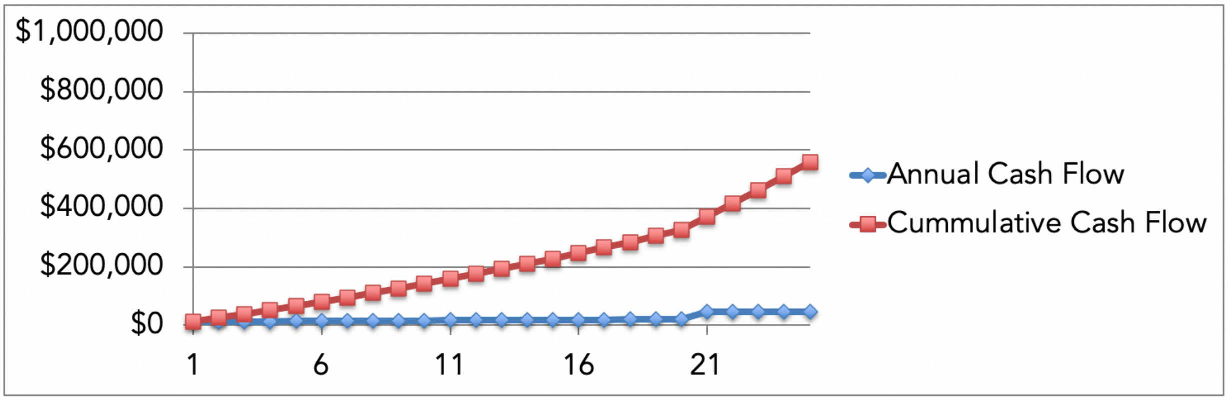
Sensitivity scenarios, based on key assumptions that may change are:

- No OEI EIGP funding
- No Solar on Schools module donation
- No OEI EIGP funding and no Solar on Schools donation
- PV system cost decreases by 10%
- PV system cost increases by 10%
- Electric rates increase by 3%/year (base case assumption: 1.5%/year)
- The project 20-year financing, at an interest rate of 2.5% with the loan covering the system's cost less the incentives (or $384,000)

Sensitivity Analysis for the 300 kW AC PV System

Scenarios	25 Year IRR	25 Year NPV	Comments
Base Case Scenario	10.6%	$194,779	
No OEI funding	7.2%	$82,279	Total incentives $66,000
No Solar on Schools donation	9.4%	$161,779	Total incentives $145,500
No OEI funding and no Solar on Schools donation	6.5%	$49,279	Total incentives $33,000
PV system cost decreases by 10%	13.2%	$257,724	To $1,350/kW DC
PV system cost increase by 10%	8.6%	$131,835	To $1,650/kW DC
Electric rates increase by 3%/year	12.4%	$300,545	Base Case assumption 1.5%/year
20-year financing	Cashflow positive from year one	$270,631	Unable to determine the IRR - because the project is cash flow positive from year one

Cash Flow Diagram of the 300 kW AC PV System with 20-Year Financing



Annex 1. CP 1 WE Electricity Purchase Rate Sheet

WISCONSIN ELECTRIC POWER COMPANY
Volume 19 – Electric Rates — Revision 11 Sheet 65
Amendment No. 776
Effective In All Areas Served In Wisconsin — Rate Schedule Cp 1

GENERAL PRIMARY SERVICE -- TIME-OF-USE

AVAILABILITY

To customers contracting for three-phase, 60 hertz power service at approximately 3,810 volts or higher for periods of one year or more. Customers are required to remain on the selected on-peak period for at least one year.

RATE

Facilities Charge	$19.76010 per day			R

Demand Charges — For Service at Primary Voltages

	Equal to or Less than 12,470 volts	Greater than 12,470 volts and Less than 138,000 volts	Equal to or Greater than 138,000 volts	
All billed on-peak demand per kW, Subject to a monthly minimum on-peak billed demand of 300 kW				
Summer on-peak demand	$17.699	$17.440	$17.222	N
Non-summer on-peak demand	$12.733	$12.547	$12.390	N
All customer maximum demand per kW, Subject to a monthly minimum customer maximum demand of 300 kW	$2.25	$2.23	$0.000	R

For Determination of Demand, see Sheet Nos. 67 and 68.

Energy Charge — For Service at Primary Voltages

	Equal to or Less than 12,470 volts	Greater than 12,470 volts and Less than 138,000 volts	Equal to or Greater than 138,000 volts	
Summer Energy Charge				N
All on-peak energy, per kWh (a)	$.07808	$.07687	$.07591	N
All off-peak energy, per kWh (b)	$.05028	$.04949	$.04887	N
Non-Summer Energy Charge				N
All on-peak energy, per kWh (a)	$.06777	$.06672	$.06588	N
All off-peak energy, per kWh (b)	$.05028	$.04949	$.04887	N

Summer Energy rates apply from June 1 through September 30. Non-summer Energy rates apply from October 1 through May 31.

(Continued to Sheet No. 66)

Issued: 12-23-19
Effective: For service furnished on and after 1-1-20
PSCW Authorization: Docket No. 05-UR-109 Order dated 12-19-19

GENERAL PRIMARY SERVICE -- TIME-OF-USE

(Continued from Sheet No. 65)

(a) General Primary on-peak energy usage is the energy in kilowatt-hours delivered during the on-peak period selected by the customer. The two on-peak periods available are:

8:00 a.m. to 8:00 p.m.
10:00 a.m. to 10:00 p.m.

prevailing time, Monday through Friday, excluding those days designated as legal holidays for New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day.

(b) General Primary off-peak energy usage is the energy in kilowatt hours delivered during all hours other than on-peak hours.

Adjustment for Cost of Fuel

See Sheet No. 19.

2017 Tax Cut- Deferred Tax Credit **R**

See Sheet No. 20.

Minimum Charge
The monthly minimum charge is the sum of the following:
(a) Facilities charge,
(b) The greater of the charge for 300 kW of billed on-peak demand or the minimum on-peak demand as stated in a contract,
(c) The greater of the charge for 300 kW of customer maximum demand or the customer's maximum demand.

Late Payment Change
A one percent (1%) per month late payment charge will be applied to outstanding charges past due.

CONDITIONS OF DELIVERY

See Sheet Nos. 69 through 71

(Continued on Sheet No. 67)

Issued: 12-23-19
Effective: For service furnished on and after 1-1-20
PSCW Authorization: Docket No. 05-UR-109 Order dated 12-19-19

GENERAL PRIMARY SERVICE

DETERMINATION OF DEMAND

(1) Measured Demands

(a) For service at primary voltages less than 138,000 volts, measured demand shall be the average rate at which energy is used for a period of 15 consecutive minutes as ascertained by a watthour meter and an associated electronic recorder or other standard measuring device. For service at primary voltages equal to or greater than 138,000 volts, measured demand shall be the average rate at which energy is used for a period of 60 consecutive minutes, as measured at the top of the hour, as ascertained by a watthour meter and an associated electronic recorder or other standard measuring device. **R**

(b) Measured on-peak demand shall be the maximum measured demand established during on-peak hours within the billing period. On-peak hours shall be either from 8:00 a.m. to 8:00 p.m. or from 10:00 a.m. to 10:00 p.m., as selected by the customer, prevailing time, Monday through Friday, excluding those days designated as legal holidays for New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day. **R**

(c) Measured off-peak demand shall be the maximum demand within the billing period which is established during off-peak hours for the billing period. Off-peak hours are those hours not designated as on-peak hours.

(d) Customer maximum demand shall be the maximum measured demand, not adjusted for power factor, which occurs during either the on or off-peak period, in the current or preceding 11 billing periods.

(2) Billed On-Peak Demands

The demand charges herein are based on a standard power factor of 85 percent. Billed on-peak demand shall be determined by the following formula less any amount calculated in No. (3) below related to new equipment testing demand:

(a) For power factors at 85%

Billed on-peak demand = measured on-peak demand

(b) For power factors below 85%

Billed on-peak demand =
(measured on-peak demand) [1 + (0.65)(0.85 – peak power factor)]

(Continued to Sheet No. 68)

Issued: 12-23-14
Effective: For service furnished on and after 1-1-15
PSCW Authorization: Docket No. 05-UR-107 Order dated 12-23-14

GENERAL PRIMARY SERVICE

(Continued from Sheet No. 67)

DETERMINATION OF DEMAND

(c) For power factors above 85%

Billed on-peak demand = (measured on-peak demand) [1 – (0.5) (peak power factor – 0.85)] **R**

The peak power factor shall be calculated from the kilowatt hours "A", as obtained from the watt-hour meter, and the use of lagging kilovolt-ampere reactive hours "B", as obtained from a ratcheted reactive component meter, which are used during the same period in which the measured on-peak demand occurs by the following formula: **R**

Peak power factor = A divided by square root of ($A^2 + B^2$)

(3) New Equipment Testing Demand

Any customer installing new equipment requiring on-peak testing, may request adjustment of billed demands, for a period not to exceed 120 continuous days, when testing loads have on-peak hours of use less than 100. Where a customer so requests and has provided, to the approval of the Company, isolation of the testing load and payment of all costs of metering (sub-metering), the monthly billed on-peak demands during pre-approved testing periods will be adjusted by application of the following formula:

Billed on-peak Demand = A + B, where

A = The difference between total Company supplied power, as measured at the point of the customer's interconnection with the Company, and the separately metered test load.

B = The difference between measured on-peak demand adjusted for power factor as determined in (2) above and A as calculated above, multiplied by a factor of [on-peak hours of use x .0075) + .25].

During to preapproved testing period, there will be no adjustments for the customer maximum demand occurring during the billing period, however, the customer maximum demand during this period will not be used in establishing the 12 month ratchet.

Issued: 12-23-14
Effective: For service furnished on and after 1-1-15
PSCW Authorization: Docket No. 05-UR-107 Order dated 12-23-14

GENERAL PRIMARY SERVICE -- TIME-OF-USE

CONDITIONS OF DELIVERY

(1) The Company will furnish three-phrase 60 hertz power service at its most conveniently available primary voltage but in no case less than approximately 3810 volts, at someone convenient point on the premises of the customer nearest the lines of the Company. The supply voltage will depend upon the location of the customer and the size and characteristics of his load. At the option of the Company, a customer receiving service under this rate at more than one voltage on the same premises may be billed on a conjunctive basis if the customer was required to change voltage due to the limitations of the Company's distribution system. If the customer elects to serve additional load at a higher voltage and the Company has distribution facilities at the existing voltage adequate to serve the additional load, then the Company shall bill the customer separately at each voltage.

(2) The customer shall contract with the Company to receive General Primary Service for a maximum measured demand as defined in the Determination of Demand section. Such maximum measured demand shall exclude that portion of the customer's load normally served by the customer's generation source. **R**

(3) Service under this rate is primarily for customers who use it in manufacturing and industrial operations. Any customer receiving service under this rate who requires lighting regulation shall furnish, install, operate and maintain the necessary regulating equipment at his expense.

(4) The customer shall, at his expense, install all apparatus and materials necessary for the proper utilization of the power furnished by the Company. All such apparatus shall conform to the Company's rules and regulations pertaining to primary substation installation and shall at all times be kept suitable for operation by the power furnished.

(5) If the customer's off-peak demand exceeds the on-peak demand to the extent that the installation of additional facilities are required, then the customer shall pay for such additional facilities.

(Continued to Sheet No. 70)

Issued: 12-23-14
Effective: For service furnished on and after 1-1-15
PSCW Authorization: Docket No. 05-UR-107 Order dated 12-23-14

GENERAL PRIMARY SERVICE -- TIME-OF-USE

(Continued from Sheet No. 69)

CONDITIONS OF DELIVERY

(6) Customers who wish to operate electric generation equipment in parallel with the Company's system shall abide by the conditions of purchase for the Company's generating system tariff under which the customer is serviced . **R**

(7) Should the customer, because of fire, strike, demonstrations, casualties, civil or military authority, insurrection or riot, the actions of the elements, or any other like causes beyond his control, be prevented from utilizing the power service contracted for, the Company will waive the monthly minimum demand charge for such period; provided, however, that the period of time of such suspension of use of power shall be added to the period of the contract; and further, provided that the customer notifies the Company in writing within six days of his inability to use said power service, specifying reasons therefor.

(Continued to Sheet No. 71)

Issued: 12-21-12
Effective: For service furnished on and after 1-1-13
PSCW Authorization: Docket No. 05-UR-106 Order dated 12-21-12

GENERAL PRIMARY SERVICE -- TIME-OF-USE

(Continued from Sheet No. 70)

CONDITIONS OF DELIVERY

(8) The Company shall use reasonable diligence in furnishing an uninterrupted and regular supply of power, but it shall not be liable for interruptions, deficiencies, or imperfections in service, except to the extent of a prorated reduction of the demand charge provided for herein.

(9) Service under this rate shall be furnished only in accordance with the Electric Service Rules and Regulation of the Company.

(10) Energy furnished under this rate shall not be resold, except as provided in the Electric Service Rules and Regulations of the Company.

D

Issued: 12-23-14
Effective: For service furnished on and after 1-1-15
PSCW Authorization: Docket No. 05-UR-107 Order dated 12-23-14

Annex 2 CGS NM, WE Electricity Sales Rate Sheet

WISCONSIN ELECTRIC POWER COMPANY

Volume 19 – Electric Rates	Revision 0 Sheet 201.6
	Amendment No. 759
Effective In All Areas Served In Wisconsin	Rate Schedule CGS NM

N

CUSTOMER GENERATING SYSTEMS - NET METERED (CGS NM) Less than 300 KW

AVAILABILITY

Mandatory for customers who purchase power from the Company under a tariffed rate, with generating systems located on the customer's premise with an aggregate nameplate rating of less than 300 kW, who desire to sell electrical energy to Wisconsin Electric Power Company and offset their usage from the Company. This tariff is for those customers who wish to have their generation connected to their load and sell any excess energy to the Company. Customers on this rate are not eligible for budget billing. This rate schedule is available beginning January 1, 2016.

Customers must remain on this rate for 12 months before they are able to switch to another of the Company's available customer generation rate schedules.

CUSTOMER ELIGIBILITY

The generation equipment must be located on the customer's premises, serving only the customer's premises, and must be intended primarily to offset a portion or all of the customer's requirements for electricity. The generation capacity shall be determined by the aggregate nameplate capacity of the generator(s) and said nameplate capacity shall be stated in the customer's Generation Interconnection Agreement. The aggregate nameplate capacity shall be determined using one of the following methods:

A) The AC Nameplate Rating of the generator(s)

B) If the generating system is an inverter based DC generating system, the conversion of the DC nameplate rating to an AC nameplate rating shall be accomplished by multiplying the DC rating by a factor of 0.77, to account for DC to AC conversion efficiency.

C) If the customer's generating system is configured such that the nameplate rating of the generating system does not accurately reflect the output of the system, then the Company and the customer shall mutually agree on a method to determine the customer's generating capacity.

RATE

Generation Facilities Charge

Residential and non-demand Secondary Customers	$0.05951 per day
Demand Secondary Customers	$0.15255 per day
Primary Customers	$3.14334 per day

This Generation Facilities Charge is in addition to the facilities charge required for the customer to purchase energy from the Company under a tariffed rate.

(Continued to Sheet No. 201.7)

Issued: 12-23-14
Effective: For service furnished on and after 1-1-15
PSCW Authorization: Docket No. 05-UR-107 Order dated 12-23-14

CUSTOMER GENERATING SYSTEMS - NET METERED (CGS NM) Less than 300 KW

(Continued from Sheet No. 201.6)

D

Energy Rate

If the kilowatt-hours consumed by the customer for the billing period exceeds the kilowatt-hours supplied to the Company, the customer will be billed for these kilowatt-hours supplied to the customer at the customer's rate schedule as a purchaser of energy from the Company.

If the kilowatt-hours supplied to the Company for the billing period exceeds the kilowatt-hours consumed during the billing period, the customer will receive a credit on their bill equal to these kilowatt hours supplied to the Company multiplied by the Customer's Buy-Back Energy Rate (shown below).

The Customer's Buy-Back Energy Rate is not subject to any adjustments, such as the adjustment for cost of fuel, or any other miscellaneous surcharges or adjustments. This tariff is intended to provide payment for energy sent to the Company. There is no provision for payment for a reduction in electrical demand.

The Demand Charge was vacated pursuant to a Court order in Dane County Case No. 15-CV-153, and consequently is not in effect and is not being collected from customers. N

Customer's Buy-Back Energy Rate:

Residential and secondary customers on a flat rate:

All Energy (flat rate, all hours)	$0.04245 per kWh

Residential and secondary customers on a time-of-use rate:	Summer	Non-Summer
All on-peak energy, per kWh	$.05714	$.04608
All off-peak energy, per kWh	$.03876	$.03836

Primary Customers:	Equal to or Less than 12,470 volts	Greater than 12,470 volts and Less than 138,000 volts	Equal to or Greater than 138,000 volts
Summer Energy Rate			
All on-peak energy, per kWh	$.05572	$.05491	$.05422
All off-peak energy, per kWh	$.03780	$.03725	$.03678
Non-Summer Energy Rate			
All on-peak energy, per kWh	$.04493	$.04427	$.04372
All off-peak energy, per kWh	$.03741	$.03686	$.03640

Summer Energy rates apply from June 1 through September 30. Non-summer Energy rates apply from October 1 through May 31.

(Continued to Sheet No. 201.8)

Issued: 12-18-15
Effective: For service furnished on and after 1-1-16
PSCW Authorization: Docket No. 05-UR-107 Order dated 12-23-14

CUSTOMER GENERATING SYSTEMS - NET METERED (CGS NM) Less than 300 KW

(Continued from Sheet No. 201.7)

Customer's Buy-Back Energy Rate (continued):

The on-peak and off-peak time periods will correspond to the tariffed rate schedule under which the customer purchases energy from the Company. If the underlying consumption rate schedule is not a time of use rate, then the customer will be paid for their generation at the flat rate (above). Time-of-Use customer's on-peak kilowatt-hour purchases and sales will be netted separately from off-peak kilowatt-hour purchases and sales.

Customers will be paid by check whenever the accumulated value of their generation at the end of a billing period exceeds $100. Until such time as the accumulated value exceeds $100, the accumulated credit will be shown on the customer's bill.

Minimum Charge

The monthly minimum charge is the Generation Facilities Charge.

Late Payment Charge

A one percent (1%) per month late payment charge will be applied to outstanding charges past due. **R**

CONDITIONS OF PURCHASE

See Sheet Nos. 135 through 138.

Issued: 12-23-19
Effective: For service furnished on and after 1-1-20
PSCW Authorization: Docket No. 05-UR-109 Order dated 12-19-19

Annex 3. CCGS-NP Rate Sheet

WISCONSIN ELECTRIC POWER COMPANY
Volume 19 – Electric Rates | Revision 0 Sheet 201.4
Amendment No. 759
Effective In All Areas Served In Wisconsin | Rate Schedule CGS NP

N

CUSTOMER GENERATING SYSTEMS NON-PURCHASE (CGS NP) - UP TO 15 MW

AVAILABILITY

Mandatory for customers who purchase power from the Company under a tariffed rate, who have a generating system or systems on site, who do not desire to sell electrical energy to the Company. Customers on this rate are not eligible for budget billing. This rate schedule is available beginning January 1, 2016.

Customers must remain on this rate for 12 months before they are able to switch to another of the Company's available customer generation rate schedules.

CUSTOMER ELIGIBILITY

The generation equipment must be located on the customer's premises and serve only the customer's premises. The generation capacity shall be determined by the aggregate nameplate capacity of the generator(s) and said nameplate capacity shall be stated in the customer's Generation Interconnection Agreement. The aggregate nameplate capacity shall be determined using one of the following methods:

A) The AC Nameplate Rating of the generator(s)

B) If the generating system is an inverter based DC generating system, the conversion of the DC nameplate rating to an AC nameplate rating shall be accomplished by multiplying the DC rating by a factor of 0.77, to account for DC to AC conversion efficiency.

C) If the customer's generating system is configured such that the nameplate rating of the generating system does not accurately reflect the output of the system, then the Company and the customer shall mutually agree on a method to determine the customer's generating capacity.

(Continued to Sheet No. 201.5)

Issued: 12-23-14
Effective: For service furnished on and after 1-1-15
PSCW Authorization: Docket No. 05-UR-107 Order dated 12-23-14

CUSTOMER GENERATING SYSTEMS NON-PURCHASE (CGS NP) - UP TO 15 MW

(Continued from Sheet No. 201.4)

RATE

Energy Rate

Deliveries from the Company to the customer shall be billed in accordance with the standard applicable rate schedules of the Company.

Any inadvertent flow of energy from the customer's generation facilities into the electrical system of the Company shall be supplied by the customer without charge to the Company.

The Company shall install appropriate devices on the Company's metering facilities to prevent the customer use meter from recording any flow of energy from the customer's generation facilities into the electrical system of the Company.

The Demand Charge was vacated pursuant to a Court order in Dane County Case No. 15-CV-153, and consequently is not in effect and is not being collected from customers.

Late Payment Charge

A one percent (1%) per month late payment charge will be applied to outstanding charges past due. **R**

CONDITIONS OF PURCHASE

See Sheet Nos. 135 through 138.

Issued: 12-23-19
Effective: For service furnished on and after 1-1-20
PSCW Authorization: Docket No. 05-UR-109 Order dated 12-19-19

Annex 4. Electricity Monitoring Systems

An electricity monitoring system that MSC clients have had good success with is eGauge.

There are other manufacturers with similar products. A few of MSC clients switched from other providers to eGauge. MSC has contacted customer service at eGauge and found them very responsive and helpful.

An electricity monitoring system as two basic components:

- The power and energy meter, which is also a data logger and web server
- Current transformers, which are placed around the electric wire to be measured
    - A site with three-phase power requires three current transformers

The monitoring system is revenue grade. After the PV system is installed additional current transformers can be added to measure the output of the PV array. It is best to plug the power and energy meter directly into the site's internet service.

From eGauge's marketing materials:

- Each eGauge unit combines an energy meter, data logger, and a web server. This powerful combination lets you measure, store and retrieve data directly from the device or from a remote location
- You can view historical and live data for up to 30 years with the unit's convenient user interface (UI).
- The UI can be accessed on a local network or via the internet from a computer, tablet, or smartphone.
- Once connected, you have access to real-time values, long-term reports, an interactive graphical interface, and many other tools.
- You pay nothing for the user interface because you retrieve data directly from your own eGauge hardware
- The eGauge UI presents a powerful and straightforward graph to visualize energy data.
- The graph is highly customizable and can be set to display (or hide) any number of monitoring points.
- The monitoring points are shown with user defined time periods so it's easy to analyze data ranging from minutes to months, or even years.

eGauge provides each power and meter owner with their own website where the system owner can view their power use and have access to many monitoring tools (all free of charge).Data can be shown on a kiosk for use by the site's energy managers or for public education.

An eGauge system, or similar, costs $700 to $1000 per site for electricity use monitoring.

Installation is relatively simple. A few photos from Bill Bailey, of Cheq Bay Renewables, of a system he installed, are show below.

The power and energy meter is in its own box and wiring is run to the electrical panel in conduit.

The eGauge power and energy meter

Current transformers (with the white labels) measuring two legs of the site's two-phase power.