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ibc engineering services, inc.

Photovoltaic Energy Feasibility Study

April 2, 2019

The Avenue

N8 W22195 Johnson Drive, Suite 180 Waukesha, WI 53186 P 262.549.1190 F 262.549.1620 Wisconsin • Illinois • Florida ibcengineering.com

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Executive Summary

The Avenue seeks to understand the feasibility of photovoltaic (PV) energy production and use. IBC Engineering has been requested to perform a study to recommend the approximate capacity of a PV array based upon roof availability and review the potential system as it applies to existing utility services, rates, and expenditure.

Results of the study are as the following:

1. Approximate Total Roof Availability: Two roofs with total 10,000 sq. ft available for PV installation without shading from adjacent building and with minimum equipment on the roof.
2. Average roof area utilization: 70% (provisions for the maintenance around the panels).
3. Panel size: 39" x 66". Roof area required per panel with 30 deg incline is assumed to be 12 sq. ft.
4. Number of panels to fit on the roof: 440
5. Nominal peak production per sq. ft of the solar panel: 250 W/panel
6. Array size: 110 KW.
7. Average Production per KW of installed solar PV a year: 1,290 KWH/KW
8. Annual production of the solar array(s): 110 KW * 1,290 KWH/KW = 141,900 KWH

Notes:

- PV production is based on average weather data and optimized for summer on peak production (30 deg incline).

Financial performance:

1. Annual Solar PV production – $6,320
2. Installation cost at $3.00/W of PV system = $330,000
3. Simple payback: 52 years.

Disclosure:

- This study does not address any Tax (Federal or State) credits, energy grants (federal State or local) nor Programs such as Focus on Energy.
- Energy tariffs are based on the published data and actual production rates (as high as "Net" metering) could be negotiated with WE energy at the time of feasibility study.

- Since cost of capital or inflation projections or utility rates escalation nor life cycle of building is established, simple payback is the only performance evaluation criteria applicable at this time.

Methodology

This study has consisted of the following steps:

1. Obtain energy tariff system, as it applies for WE Energies electrical services, for the on-site PV electrical generation.

2. Identify recommended capacity of the PV system that optimize tariff structure within consumption pro-forma of the building.
    a. Size of solar system is based on the following:
        i. Maximum size of installation shall be less than 300 KW connected AC power as WE Energies has identified that any generation 300KW or greater is not available for net metering and will be required to be connected to the utility grid with generated energy purchase at wholesale market rates.
        ii. System shall not produce more power than consumed in any single month of the year as a condition of net metering.
        iii. System shall not produce more power than building consumed during on-peak hours of operation in any single month of the year as a condition of net metering.

3. Review building roof structures for its ability to support the intended type and size of the PV array recommended.

Tariff Structure

The District electric utility service is provided by WE Energies. Customer Generation Rates (CGS) were obtained from WE Energies, effective as of June 2018. All rates or projected savings are based upon these rates and are subject to change as deemed necessary by WE Energies.

Rate structure applicable to the schools included within the study is one of the following:

- CGS – Direct Sale – Fixed Price
- CGS -1 – Net Metered, greater than 20 KW and less than 300 KW.

For purposes of the study IBC uses CGS – Net Metered, Less than 300 KW rate structure, with Demand Secondary rates.

Rate structure utilized for the analysis is as follows, unless noted otherwise:

- Generation Facility Charge (meter charges) –
  - $0.15255/day ($55.68 per year) for demand secondary customers
  - $3.14334/day ($1,147.32/year) for primary customers
  - On Peak Energy - $0.04982/KWH
  - Off-Peak Energy - $0.03849/KWH
- Customer Buy-Back rate - $0.04245/KW – flat rate purchase when production of electricity within facility exceed consumption during any billing cycle.
- "Equal rates": Rates used for the production are the same as rates used for consumption.
- Please note:
  - Any production of electricity during weekends or holidays will be purchased at off-peak rates.
  - Any production in excess of consumption during summer school (July and August) will be purchased at customer Buy-Back rate.
  - Rate structures CGS 1, 2, 3, 4, 5, 6, 7, 8 & PV are not applicable to the new accounts and additional generation.

Solar Panel Basis of Design

For the purposes of this study, as a basis of design, Kyocera KD 260GX -LFB2 has been selected anticipating an average nominal performance of 250 watts per panel. See Appendix for solar panel technical data available from the manufacturer.

Each panel is assumed to be capable to producing 260 watts nominal DC power at 600V DC and 187 watts connected AC power given losses in efficiency with transformers and additional equipment. Each module is 65.43" in length, 38.98" in width, and 1.81" in height or approx. 17.7 sq. ft, weighing 44.1 lbs.

Electrical Energy Consumption Analysis:

Electrical demand and consumption of the facility could be established from Energy Modeling and it is not part of this study.

Roof structure analysis:

Roof consists of flat roof with limited skylights, mechanical equipment and roof hatches. Roof will have "east-west" style mounting frames similar to "Kinetic"

Aerocompact or "Mounting Systems" Lambada Light LW ballasted which offer minimum wind and ballast load requirements. Total assembly includes 440 solar panels – 7.080 sq ft of PV gross area).

Remaining roofs are assumed not suitable for the large PV arrays installation due to external shading, mechanical equipment, access, etc.

Total maximum generating gross capacity at connected AC power – 110 KW.

Nominal Size of Solar PV Array analysis.

While actual minimum and maximum demands of the facility should be determined by the energy model, for the purposes of the study, we assume that minimum demand of the facility will be in excess of the peak generation of the PV system.

The peak production is approximately during month of July at 8,800 KWH on peak and 7,340 KWH off-peak.

Solar PV annual production distributes as the following:
"On- peak" = 141,800 KWH * (5/7) * 80% = 81,000 KWH
"Off-peak" = 141,800 KWH – "On-peak" = 60,800 KWH

Cost of electrical energy and energy savings

PV production savings:

- PV production savings during on-peak hours: 81,000 KWH *$0.04982 = $4,035
- PV production during off peak hours: 60,800 KWH * $0.03849 = $2,340
- Fixed charges PV meter ($55)
- Total $6,320

Appendix A: WE Energies Tariff Structure

Customer generation rates

January 2016

The customer generation (CGS) rates listed in this brochure reflect the rates and prices effective Jan. 1, 2016, as authorized by the Public Service Commission of Wisconsin for Wisconsin Electric Power Company, doing business under the name of We Energies.

We Energies – Energy You Can Depend On

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

CGS – Net Metered (CGS NM) Less than 300 kW

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

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.

The monthly minimum charge is the Generation Facilities Charge.

Energy Rate

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.

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.

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

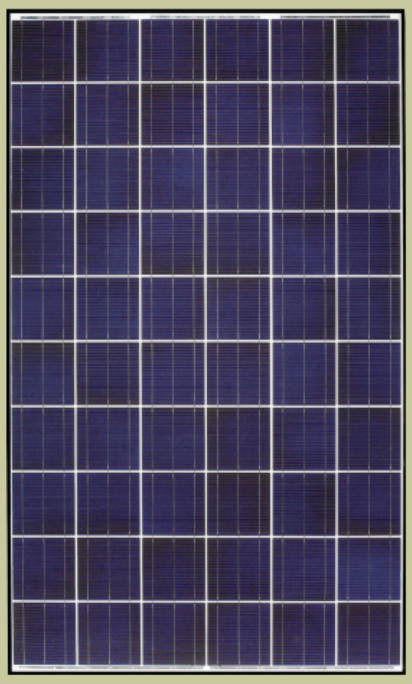
	Equal to or less than 12,470 volts	Greater than 12,470 volts and less than 138,000 volts	Equal to or or greater than 138,000 volts
Primary customers summer energy rate:			
All on-peak energy, per kWh	$.05572	$.05491	$.05422
All off-peak energy, per kWh	$.03780	$.03725	$.03678
		Greater than	Equal to or

Appendix B: Photovoltaic Panel

KYOCERA

KD 200-60 F Series

KD255GX-LFB2 KD260GX-LFB2



CUTTING EDGE TECHNOLOGY

As a pioneer with four decades of experience in the development of photovoltaic systems, Kyocera drives the market as a leading provider of PV products. We demonstrate our *Kaizen* philosophy, or commitment to continuous improvement, by setting the industry standard in the innovation of best-in-class solar energy equipment.

QUALITY BUILT IN

- UV-stabilized, anodized aluminum frame in black
- Supported by major mounting structure manufacturers
- Easily accessible grounding points on all four corners for fast installation
- Proven junction box technology with 12 AWG PV wire works with transformerless inverters
- Locking plug-in connectors provide safe, quick connections

PROVEN RELIABILITY

- Kyocera modules confirmed by the Desert Knowledge Australia Solar Centre to have the highest average output of any crystalline module
- First module manufacturer in the world to pass long-term sequential testing performed by TÜV Rheinland
- This series construction also passed TÜV Rheinland's Salt Mist Corrosion Test at Severity Level 6, the most intense test conditions available
- Only module manufacturer to achieve the rank of "Performance Leader" in all six categories of GTM Research's 2014 PV Module Reliability Scorecard

CERTIFICATIONS

- UL1703 Certified and Registered, UL Module Fire Performance: Type 2, CEC
- NEC2008 Compliant, IEC 61215/61730, and ISO 14001
- IEC61701 Ed.2 Severity 6 (Salt Mist Corrosion Test)

HIGH EFFICIENCY MULTICRYSTAL PHOTOVOLTAIC MODULE

SOLAR by KYOCERA

KD 200-60 F Series

ELECTRICAL SPECIFICATIONS

Standard Test Conditions (STC) *STC=1000 W/M² irradiance, 25°C module temperature, AM 1.5 spectrum**	KD255GX-LFB2	KD260GX-LFB2	
P_{max}	255	260	W
V_{mp}	30.4	31.0	V
I_{mp}	8.39	8.39	A
V_{oc}	37.6	38.3	V
I_{sc}	9.09	9.09	A
$P_{tolerance}$	+5/-0	+5/-0	%
Nominal Operating Cell Temperature Conditions (NOCT) *NOCT=800 W/M² irradiance, 20°C ambient temperature, AM 1.5 spectrum**			
T_{NOCT}	45	45	°C
P_{max}	184	187	W
V_{mp}	27.4	27.9	V
I_{mp}	6.72	6.71	A
V_{oc}	34.4	35.1	V
I_{sc}	7.36	7.36	A
PTC	228.3	232.9	W
Temperature Coefficients			
P_{max}	-0.46	-0.45	%/°C
V_{mp}	-0.52	-0.48	%/°C
I_{mp}	0.0065	0.02	%/°C
V_{oc}	-0.36	-0.36	%/°C
I_{sc}	0.06	0.06	%/°C
Operating Temp	-40 to +90	-40 to +90	°C

System Design	
Series Fuse Rating	15 A
Maximum DC System Voltage (UL)	600 V
Hailstone Impact	in (25mm) @ 51mp (23m/s)

*Subject to simulator measurement uncertainty of +/- 3%.
KYOCERA reserves the right to modify these specifications without notice.

NEC 2008 COMPLIANT
UL 1703 LISTED
070914

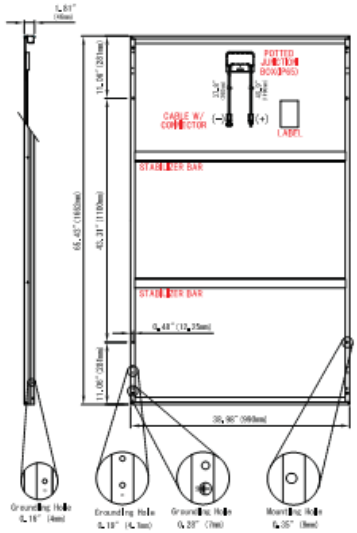
WARNING: Read the instruction manual in its entirety prior to handling, installing & operating Kyocera Solar modules.

MODULE CHARACTERISTICS

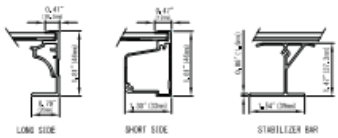
Cells per module:	60 (6 x 10)
Dimensions: *length/width/height*	65.43in/38.98in/1.81in (1662mm/990mm/46mm)
Weight:	44.1lbs (20.0kg)

PACKAGING SPECIFICATIONS

Modules per pallet:	20
Pallets per 53' container:	36
Pallet box dimensions: *length/width/height*	66in/40in/47in (1675mm/1005mm/1175mm)
Pallet box weight:	990lbs (450kg)



FRAME CROSS SECTION DIAGRAM



OUR VALUED PARTNER

KYOCERA Solar, Inc. 800-223-9580 800-523-2329 fax www.kyocerasolar.com

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Appendix C: Roof Area of PV Array

Google Maps The Shops of Grand Avenue