AR #1: Install Solar Photovoltaic (PV) Panels

Recommended Action

Install solar photovoltaic (PV) panels on the available land area in the wastewater treatment plant, so that the energy generated by solar panels can partially substitute the electricity provided by the utility provider, and thus save in the annual electricity bill.

Summary of Estimated Savings and Implementation Costs

Annual Cost Savings:	**$20,527**
Implementation Cost:	**$105,000 (Including Focus on Energy incentives)**
Payback Period:	**5.10 years**
Electricity Savings:	**276,867 kWh/year**

Expected Saving

Since the rising and setting of the sun is extremely consistent, the energy produced by solar panels is fully reliable. High-quality solar panels are nearly maintenance-free, do not create pollution, and operate without noise. With government subsidies, tax credits, and improved performance, solar energy is seeing significant growth in the U.S. and abroad.

Figure 8 shows an aerial view of the facility. Using the Google Map Area Calculator Tool[1], the total unoccupied/unobstructed area was estimated at 8,000 m^2 (86,100 ft^2). Since 1 kW of solar modules needs approximately 10 m^2 (~108 ft^2) [2] of area, the 8,000 m^2 area is suitable for about 800-kW_{dc} of solar modules. However, an 800-kW_{dc} solar PV system would be a very expensive project. Thus, the IAC team -conservatively- recommends a 200-kW_{dc} solar PV system. A

[1] https://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm
[2] Information from "5 things to consider before you plan for a rooftop PV plant". http://www.sustainabilityoutlook.in/content/5-things-consider-you-plan-rooftop-pv-plant

proposed location is shown in Figure 8. A 200-kW_{dc} solar PV system could be considered as a pilot project for implementing a larger solar PV system in the future.

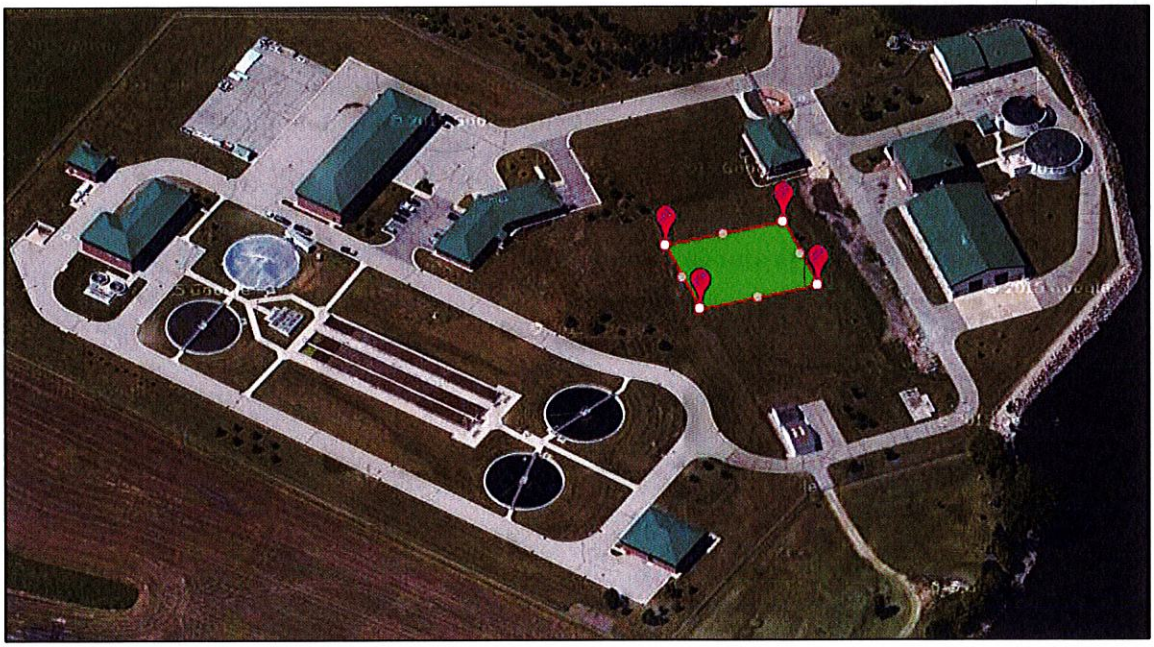


Figure 8: Aerial view of the facility with the proposed area for the solar PV system[3]

The System Advisor Model (SAM)[4] software, provided by the National Renewable Energy Lab (NREL) was used to predict the performance and cost of energy estimates for this recommendation. Using local weather and solar irradiation data for Watertown (WI), SAM software estimated the total square footage at 1,100 m^2. Figure 9 shows sample parameters for the simulated system. Final system configuration details (number of modules, modules per string, strings in parallel and number of inverters) are to be determined later by the solar PV system supplier.

[3] https://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm
[4] https://sam.nrel.gov

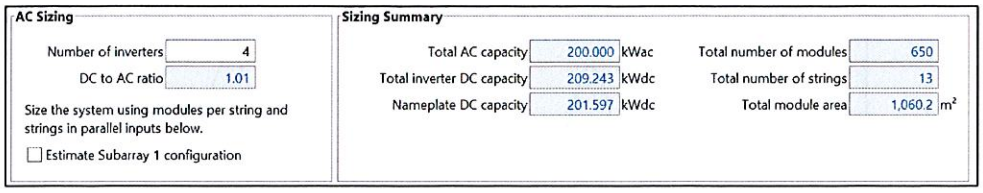


Figure 9: Some parameters of the solar PV system

Figure 10 shows the monthly energy production from the proposed system based on the simulation results. The average annual energy production is calculated at 276,867 kWh, which is the annual energy savings. Annual cost savings can be calculated based on the time-of-use charges (On-peak & off-peak rates) by the utility provider and on the average hourly energy production by the solar system as shown in Figure 11. The energy production schedule and monthly cost savings are presented in Table 4. The annual cost savings is calculated as $20,527.

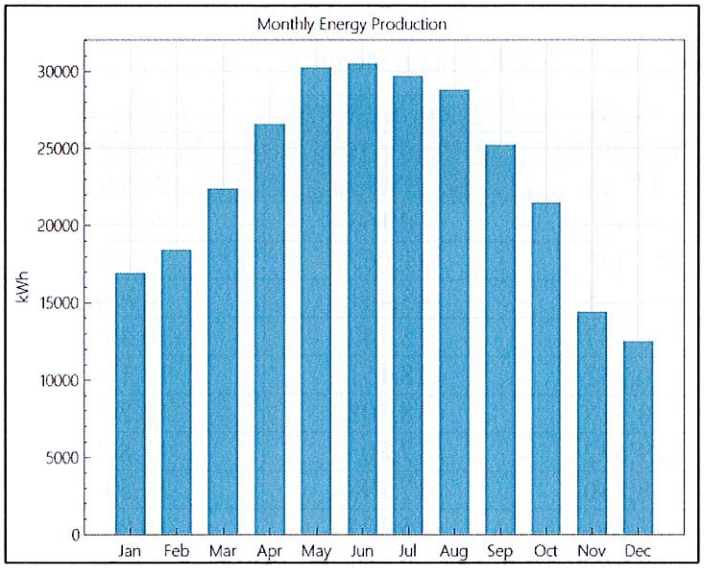


Figure 10: Monthly energy production of the proposed system (in kWh)

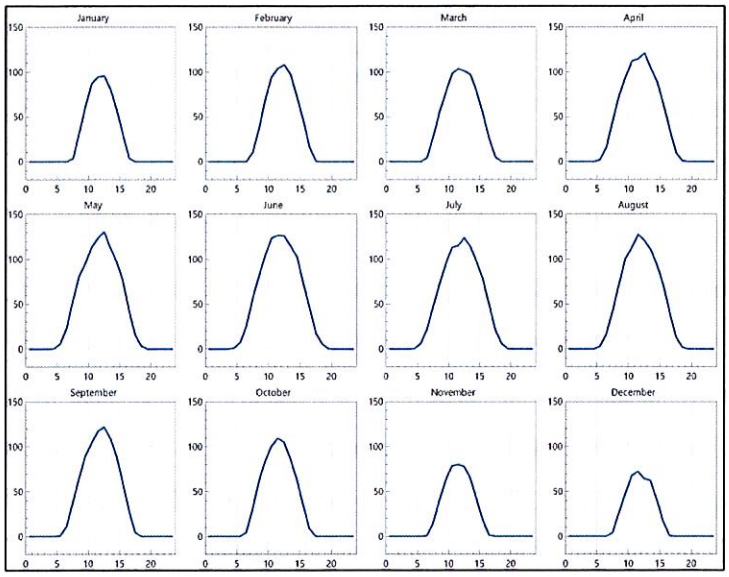


Figure 11: Average hourly energy production of the proposed system (in kWh)

Table 4: Energy production schedule based on the utility's energy pricing periods and rates

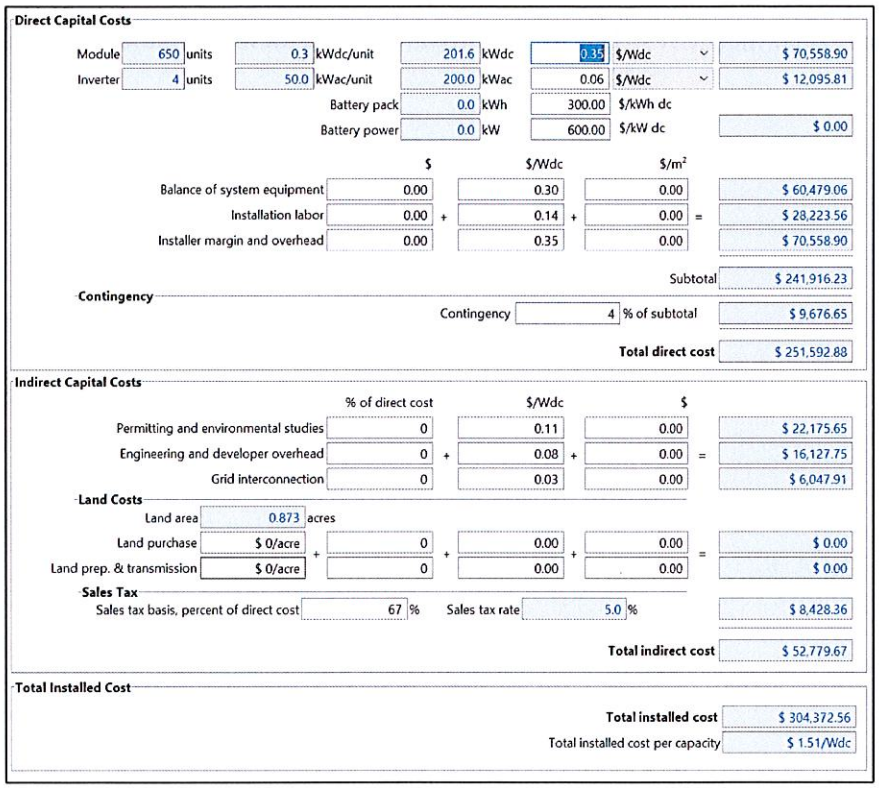
Month	Total Production (kWh)	On-peak[5] Production (kWh)	Off-peak Production (kWh)	Cost Savings ($)[6]
January	16,939	10,163	6,776	1,256
February	18,445	11,067	7,378	1,368
March	22,401	13,441	8,960	1,661
April	26,237	15,742	10,495	1,945
May	30,252	18,151	12,101	2,243
June	30,513	18,308	12,205	2,262
July	29,672	17,803	11,869	2,200
August	28,830	17,298	11,532	2,138
September	25,211	15,127	10,084	1,869
October	21,469	12,881	8,588	1,592
November	14,390	8,634	5,756	1,067
December	12,508	7,505	5,003	927
Total	**276,867**	**166,120**	**110,747**	**$20,527**

[5] On-peak hours are 8 am to 8 pm Monday through Friday, excluding holidays. Off-peak hours are all times not specified as On-peak.

[6] From utility bills; the On-peak rate is $0.08521, and the Off-peak rate is $0.05754.

Implementation Cost and Payback Period

The total cost of installing a solar PV power system includes both direct and indirect capital costs. Direct capital costs include material, installation, and labor costs. Indirect capital costs include permitting, engineering development and sales tax [see Figure 12]. The total installed cost of the system is estimated to be $305,000. There is an incentive program through Focus on Energy (FoE)[7] to help businesses reduce energy consumption. Through a competitive request for proposals (REP) process, a cost-effective renewable energy system can have an incentive of up to $200,000[8,9]. With an FoE incentive, the total installed cost for the solar PV system could be as low as $105,000.



Direct Capital Costs

Module	650 units	0.3 kWdc/unit	201.6 kWdc	0.35 $/Wdc				$ 70,558.90
Inverter	4 units	50.0 kWac/unit	200.0 kWac	0.06 $/Wdc				$ 12,095.81
		Battery pack	0.0 kWh	300.00 $/kWh dc				
		Battery power	0.0 kW	600.00 $/kW dc				$ 0.00

	$		$/Wdc		$/m²		
Balance of system equipment	0.00		0.30		0.00		$ 60,479.06
Installation labor	0.00	+	0.14	+	0.00	=	$ 28,223.56
Installer margin and overhead	0.00		0.35		0.00		$ 70,558.90
						Subtotal	$ 241,916.23

Contingency

Contingency	4 % of subtotal	$ 9,676.65
	Total direct cost	$ 251,592.88

Indirect Capital Costs

	% of direct cost		$/Wdc		$		
Permitting and environmental studies	0		0.11		0.00		$ 22,175.65
Engineering and developer overhead	0	+	0.08	+	0.00	=	$ 16,127.75
Grid interconnection	0		0.03		0.00		$ 6,047.91

Land Costs

Land area	0.873 acres						
Land purchase	$ 0/acre	+	0	+	0.00	+	0.00	=	$ 0.00
Land prep. & transmission	$ 0/acre		0		0.00		0.00		$ 0.00

Sales Tax

Sales tax basis, percent of direct cost	67 %	Sales tax rate 5.0 %	$ 8,428.36
		Total indirect cost	$ 52,779.67

Total Installed Cost

Total installed cost	$ 304,372.56
Total installed cost per capacity	$ 1.51/Wdc

Figure 12: Total installed cost of the system

[7] https://focusonenergy.com/rfp-postings
[8] https://www.focusonenergy.com/RECIP
[9] https://www.focusonenergy.com/sites/default/files/inline-files/RECIPOverview_WII_interactive.pdf

The payback period is the amount of time it will take to recoup the implementation cost. The simple payback period is calculated as follows:

$$\text{Payback Period} = \frac{\text{Implementation Cost (\$)} - \text{FoE Incentives (\$)}}{\text{Annual Cost Savings } (\frac{\$}{\text{year}})}$$

$$\text{Payback Period} = \frac{\$305{,}000 - \$200{,}000}{\$20{,}527/\text{year}}$$

Payback Period = 5.10 years

This payback period is an estimate based on the simulated system and FoE incentives. The true payback period may be longer or shorter than 5.10 years on final system characteristics, vendor costs, and final incentives. The SAM software is considered reliable in estimating system costs.