Solar Power & Demand Charge Reduction Analysis

PREPARED FOR:
Boxely Materials Company
Lawyers Road Quarry

Project Summary

OVERVIEW & FINDINGS

This report provides an initial technical and financial feasibility analysis for the installation of a Solar PV System at Boxely Materials Company's Lawyers Road Quarry. This preliminary investigation for the installation of a Solar PV System did not return economically favorable results.

System Design

Initial placement of a 2,284 kW-DC Solar PV System is located at the north entrance of the quarry and requires approximately 4.51 acres of land for development. The system was designed in this location for initial assessment and does not generate the same annual electricity the quarry currently consumes from the grid (Net-Zero Energy), which is around 3,800,000 kWh. Future analysis should include the selection of a feasible location to construct the system. From the satellite imagery there looks to be other suitable locations at the quarry site that are large and also have a southward facing slope.

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Energy Data

15-minute interval electricity usage data was used to model the Solar PV System for the calendar year of 2021. Hours of operation generally took place between 7:00 – 24:00 with a peak usage of around 2,000 kW.

Utility Tariff

The utility tariff that Lawyers Road Quarry is currently charged with is VA. S.C.C Tariff No. 26 Schedule L.P.S. (Large Power Service) 306 Primary Voltage. The Tariff is quite complicated and includes a number of additional charges and riders, but a generalized rate was developed for the model and is outlined in the table below. Note that the energy charge is less than 1 cent/kWh, while demand charges approach $25/kW. This equates to nearly all of the quarry's electric bill coming from demand charges, about 90%. Solar power is intermittent by nature and is not suitable for reducing demand charges as noted in the last column of the table below. This means if there is 30 minutes of stormy/cloudy weather during the day then the quarry's maximum demand charge is established for the entire year. The Solar PV System will provide little energy savings once this demand charge is set. Energy storage options are discussed below as a way to offset the intermittency of solar power.

Basic Service	$	276.49	On-Peak Demand set on highest 30 minutes during on-peak period. Minimum is 60% of the previous 11 months.
On-Peak Demand	$/kW	23.64	
Off-Peak Excess Demand	$/ kW	2.7	Off Peak Demand set on the highest 30 minutes during off-peak period. Minimum is 60% of the previous 11 months.
Energy Charge	$/ kWh	0.00977	
Reactive Demand	KVAR	0.69	Off-Peak excess demand = Annual off-peak max minus current off-peak.

On-Peak 7am - 8pm M-F
Off-Peak 8pm - 7am M-F; All S/Su; Holidays

Opportunities to save on energy cost exist by switching solely to night operations or "Off-Peak", but this is not likely a practical solution. On-Peak Demand charges are nearly 8X higher than Off-Peak Demand charges.

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Load Shifting Analysis

Schedule	Days & Times	Peak Demand
Shift #1	M-F: 7am – 3pm	1362 kW
Shift #2	S/Su & M-F: 4pm – 11pm	2112 kW
Proposed Shift #3	M-F: 7am – 5pm	2112 kW

Currently the quarry runs two shifts, as listed in the table above. The quarry runs full capacity on the weekends to take advantage of low demand charges, while running partial capacity over the course of two shifts during the week. Management at the quarry wished to investigate shifting all operations to the weekday shift where equipment would run from the hours of 7am – 5pm M-F (proposed shift #3). The table below depicts the average and maximum annual hourly loads (kW) when combining shifts #1 and #2 into shift #3. Note the average hourly loads are less than the maximum hourly loads because the quarry didn't run full capacity everyday of operation during the year. However, 15-minute interval peak demand (maximum) values will be captured in the billing cycle as discussed next.

Time	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**	**12:00**
Avg. kW	150	150	150	150	150	200	789	1,130	1,176	1,203	1,209	1,211
Max kW	135	180	180	180	180	180	1,880	2,105	2,112	2,089	2,090	2,092
Time	**13:00**	**14:00**	**15:00**	**16:00**	**17:00**	**18:00**	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**	**24:00**
Avg. kW	1,209	1,171	1,034	1,001	165	164	164	164	163	161	155	150
Max kW	2,078	2,098	2,072	2,020	612	180	180	180	180	180	180	180

The model results are presented in the table below depicting the increased annual cost associated with switching all quarry operations to one day shift. The quarry could expect to see an increase of $125k or 29% in annual electricity cost by moving to the proposed shift #3. Nearly all the increased cost are associated with on-peak demand charges discussed above in the Utility Tariff section.

	Consumption Charge	Demand Charge	Fixed Rate	Total
Shifts #1 & #2	$41,459	$380,122	$15,390	$436,972
Shift #3	$42,224	$504,342	$15,390	$561,956
Annual Cost	**$765**	**$124,220**	**$0.00**	**$124,985**

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