Solar Panel Farm Feasibility Study

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Introduction

Great challenges facing the world today include resource scarcity and climate change, especially as they relate to energy. As large contributors, universities are being called to reduce their carbon emissions and turn to renewable energy. Calvin University would demonstrate care for creation by reducing its footprint, aligning with item 4 of its Statement on Sustainability.

Calvin is facing the need to upgrade its energy infrastructure, with systems degraded by decades of service. This provides a unique opportunity to replace carbon-emitting technology with greener, more sustainable options on campus and even reduce electricity costs. Electricity production from solar photovoltaic (PV) panels is a current consideration. This project explored different solar farm options and presented them to Calvin leadership for energy decision making.

Objectives

This project aimed to identify the following, for various installation sites both on and off-campus:

- Electricity generation rates
- Initial investment cost and Internal Rate of Return (IRR)
- Greenhouse Gas Reduction (GHG) %

Mounting options for solar panels in a solar farm included ground, rooftop, and carpark. For each mounting type, a ranked order, using the metrics above, of proposed locations was produced. A solar farm project progression was recommended to Calvin leadership, who are on a path toward carbon neutrality and enhancing the university's reputation.

Study Findings

Rooftop

Rooftop-mounting PV panels atop the buildings on Calvin's campus required analyzing the buildings first for their structural integrity. Calculations were completed to identify if the Huizenga Tennis and Track Center (TNT), VanNoord Arena, Venema Aquatic Center, Football Locker Room, Covenant Fine Arts Center (CFAC), Prince Conference Center, DeVos/Business, North Hall, Hekman Library, Hiemenga Hall, and Dorm roofs could withstand the additional load of a solar farm. The CFAC and TNT were deemed unsuitable to carry solar panels and were excluded from further analysis. Rooftop mounting utilizes unused space and can capture large quantities of sunlight because roofs do not have many obstructions, however, panel orientation was dependent on roof slope and geographical direction.

Ground On-Campus

The fields near the DeVos Center, on the east side of campus, and the Phi-Chi field were observed for ground-mounted PV panels on campus. The main benefits for these arrays include ease of maintenance and panel orientation flexibility (because there is no pre-existing infrastructure to work with). The lot adjacent to Lake Drive, on the north end of campus, was recommended due to its lack of recreational use and visibility to the public. Two possible PV array designs were considered, one using the existing, unoccupied land and the other requiring tree removal (for greater area coverage). The latter requires more initial investment but was determined as more economically profitable in the long run.

Ground Off-Campus

A twelve-acre property in Allendale, Michigan was analyzed as a possible off-campus Calvin-owned solar farm. The significantly large area available for PV arrays is a benefit, providing the greatest energy production capacity. There are some challenges with large scale PV systems involving soil erosion, water runoff, and maintenance from a distance.

Carpark

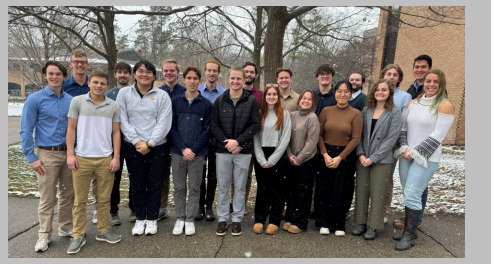
Minimal tree shading and parking lot orientation to the sun were considered for carpark-mounted PV arrays on campus. Parking Lots 1, 8, 13, 14, 15, and 16 were selected for analysis. Carpark systems were designed to maintain the functionality of each parking lot, accounting for the minimum clearance heights of delivery trucks and snowplows. Solar carparks create additional purpose to currently used space on campus and protect student/faculty cars from the elements. This mounting type would provide visible and marketable proof of Calvin's sustainability commitments at the heart of campus.

Infrastructure and Modeling

Using the location and location-specific data given from each mounting group, a PV modeling software, Sunny Design, was used to create virtual models. The total peak wattage from every panel array was then calculated, allowing for the required inverter and transformer infrastructure to be determined. Economic calculations were then evaluated and compared between projects.

Summary of Results

Project	Total Power Output [kWhr/yr]	Inital Investment [$]	Internal Rate of Return [%]	Greenhouse Gas Reduction [%]
Lake Drive	202,076	242,204	3.99	0.39
Lake Drive (tree removal)	629,602	670,106	7.15	1.21
Venema Aquatic Center	500,490	465,725	10.95	0.96
VanNoord	643,508	607,146	10.83	1.24
Prince Conference Center	350,110	351,751	10.02	0.67
DeVos	253,462	290,139	8.54	0.49
Hekman Library	349,410	369,953	9.43	0.67
Lot 1	735,769	772,822	4.72	1.42
Lot 8	737,276	747,855	5.31	1.42
Lot 13	779,332	799,639	4.91	1.50
Lot 14	365,963	405,804	4.35	0.71
Lot 15	504,218	547,390	4.39	0.97
Lot 16	746,297	769,637	5.02	1.44
Ironwood Drive	4,125,036	3,611,084	3.27	7.95



ENGR 333 Section A Class Photo

Conclusion

After evaluating the rooftop, carpark, ground on-campus, and ground off-campus mounting options for PV panels at various locations, rooftop mounting would be the best option for Calvin University. Specifically, the VanNoord Arena and Venema Aquatic Center roofs. Rooftop mounting results in the lowest cost per installed watt and, with the two selected roofs facing directly South, they would produce power the most efficiently. These systems will result in the shortest payback period and the largest return on investment and IRR. Additionally, being systems with large surface area, they will be able to offset a significant amount of Calvin's carbon footprint.

Integrating a solar farm has many financial and environmental benefits, making it a valuable investment for Calvin as we continue to think deeply, act justly, and live wholeheartedly as Christs agents of renewal in the world.

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