1. Introduction

In 2006, the University of Michigan established a target of 25% greenhouse gas emissions reduction by 2025. While the University has done much to reduce its emissions, the year 2025 is quickly approaching and there remains much work to be done. As the University continues to push towards this goal, it is important that sources of renewable energy are considered as part of the solution. The unprecedented decline in price for both large and small scale solar PV projects makes it a more appealing option than ever. The University owns much land that is used for parking near its campuses. These parking lots generally lack nearby obstructions such as trees or large buildings which would reduce solar energy potential. Due to this, the parking lots are an attractive space to install solar PV carports. However, before installing a solar PV carport, it is important to understand the costs, cash flows, and overall value associated with the system. In this study, a Net Present Value (NPV) calculation is employed to determine the value of a 2MW solar PV carport at the University’s NC 51 parking lot over 25 and 30 year lifetimes and under different economic conditions.

2. Methodology and Model Assumptions

In this model, the system cost, operating and maintenance expenses, and the inverter replacements are evaluated as cash outflows. The avoided cost of energy as a result of the solar energy generation is evaluated as a cash inflow. Tax exemptions from the Investment Tax Credit for renewables and equipment depreciation according to the Modified Accelerated Cost Recovery System are modelled as recoverable costs. Third party ownership is assumed as that would be needed to claim these tax exemptions. A discount rate is then applied to cash flows over time to account for the time value of money. The difference between the value of the avoided cost of electricity and the value of the total costs gives the NPV. Results are presented for 25 and 30 year system lifetimes.

Assumptions:
- $2 25/KW System cost
- 6.3% Discount rate
- $125/kW-y O&M expense
- 0.75% Yearly degradation rate
- 25.7% Combined corporate tax rate
- Ability to claim investment tax credit
- $0.07/kWh Cost of electricity
- 16.4 kWh/m2-y of electricity generated

3. NPV of a Solar Carport

The NPV results for the parking lot NC 51 solar carport project are shown below. The figure on the right shows a breakdown of the costs over the projects lifetime. Recoverable costs are capital that would be spent at the project’s start and later recovered through tax exemptions. Recoverable costs are not included in the total cost.

25 Year Total Cost: $3,803,291
30 Year Total Cost: $3,825,098
25 Year Avoided Electricity Cost: $2,090,562
30 Year Avoided Electricity Cost: $2,138,694
25 Year Project Lifetime: -$1,722,569
30 Year Project Lifetime: -$1,635,403

4. Internal Rate of Return

The discount rate of return reflects the opportunity cost of capital. It accounts for the fact that capital expended on this project can’t be put to use in other applications with revenue streams of their own. Cash flows are discounted over time according to the discount rate to reflect that capital available today is more valuable than capital available in the future. The internal rate of return is the discount rate needed for a project’s NPV to equal zero. In the graph to the right, the 25 and 30 year NPVs are shown as a function of the Discount Rate, and the corresponding rates of return are below.

25 year Internal Rate of Return: 0%
30 year Internal Rate of Return: 1.13%

5. Accounting for Variability

While much of the focus in this study is on the University’s NC 51 parking lot, the NPV model that has been created is capable of a more dynamic analysis. System costs vary by project size, location and many other factors; meanwhile, different companies and institutions use different discount rates. In the graph to the left, the 25 year system lifetime NPV results are plotted in three dimensions against both system cost and discount rate.

6. Conclusion

This study demonstrates that a 2MW solar carport project at the NC 51 parking lot would cause a loss of about $1.6-1.7 million dollars for the University over its lifetime using the model inputs from section two. To break even, the University’s internal rate of return would need to be as low as 0.1%. The system would require a large initial capital investment; however, some of that could be recovered through tax exemptions. After the initial investment, the operation and maintenance of the system could be paid for with the revenue generated in the form of avoided electricity costs. By examining different discount rates and system sizes, a range of NPVs are provided which may help to determine the value of projects of different scales for the University and perhaps for others as well. This three dimensional analysis also implies that despite declining costs of solar PV systems, a solar carport may not achieve a positive NPV in this region without a very low discount rate. However, climate change is a pressing issue and this is an investment that could offset upwards of 1,500 MTCO2 each year. It may be a price worth paying.

7. Acknowledgements and References

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