SOLAR COMMONS™ FINANCIAL ANALYSIS RESULTS

SOLAR COMMONS PROJECT ANALYSIS PHASE 1 OF 2

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AUTHORS & ACKNOWLEDGMENTS

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SUGGESTED CITATION

Brehm, K., Lillis, G.
Solar Commons Financial Analysis Results: Solar Commons Project Analysis Phase 1 of 2
Rocky Mountain Institute, 2018.

This report was prepared for and on the request of Solar Commons Project as part of the Department of Energy Solar in Your Communities Challenge.

ACKNOWLEDGMENTS

The authors thank the following individuals/organizations for offering their insights and perspectives on this work.

Kathryn, Milun, Solar Commons Project
Timothy Walsh, Henson Efron
Jeannie Oliver, Vermont Law School
Pilar Thomas, Lewis Roca Rothgerber Christie

ABOUT ROCKY MOUNTAIN INSTITUTE

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

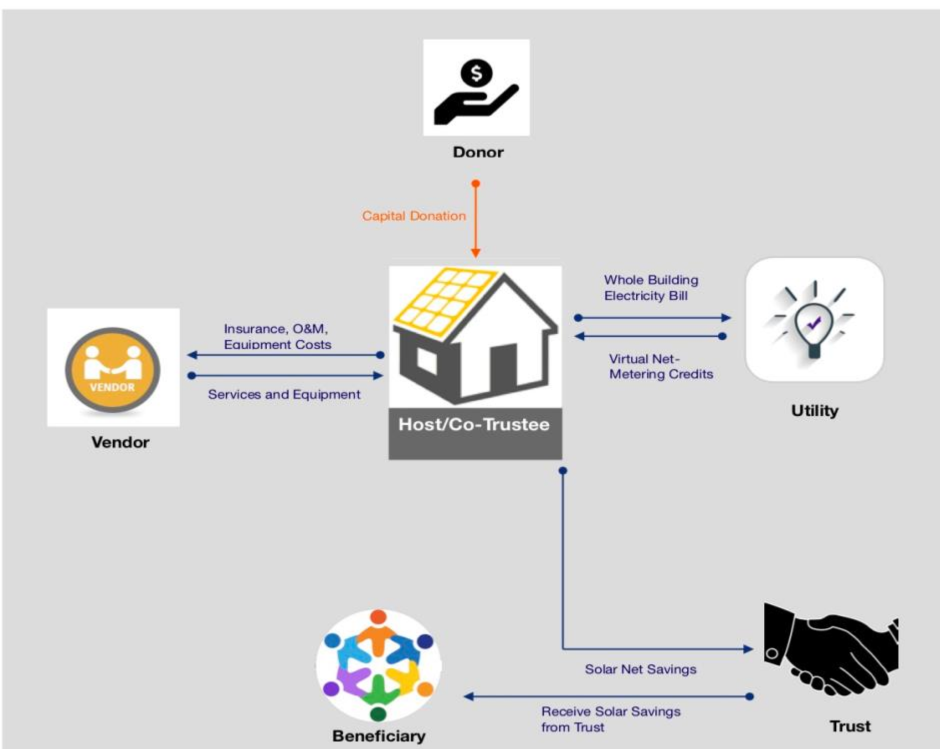
SUMMARY OF KEY FINDINGS

- RMI analyzed the financial and environmental benefits of Solar Commons projects in three states (Arizona, Colorado, and Minnesota), for three system sizes (14.5 kW, 410 kW, and 500 kW[i]) and under two rate options (community solar and behind-the-meter)
- Solar Commons provides significant benefits to the environment and to community beneficiaries (the trust) under all scenarios.
- Solar Commons further provides a positive net present value (NPV) to an impact-focused donor for all system sizes in Arizona.
- Solar Commons provides a positive NPV for community solar projects in Colorado and Minnesota, and for large behind-the-meter systems in Colorado.
- Financial performance of behind-the-meter Solar Commons projects are highly dependent on rate structure, location-specific solar production, and the impact of solar on a system host's monthly peak demand.

OVERVIEW OF THE SOLAR COMMONS MODEL

Figure 1 below shows the basic resource flows of the Solar Commons Model.

FIGURE 1: SOLAR COMMONS MODEL: ACTORS AND RESOURCE FLOWS



[i] 500 kW system was ground-mount fixed-tilt system. All other systems were rooftop.

First, the **donor** provides capital to the **host/trustee** for the construction of the solar array. Then, the host/ trustee pays the **vendor** (or a **co-trustee**), to install and commission the solar array.

Once energized, the host/ trustee monetizes credits associated with the solar energy production in the form of a bill reduction from the **utility**. Instead of directly capturing the utility bill savings, the host transfers these net savings to the trust. The trust in-turn distributes the savings from the solar array to the identified Solar Commons beneficiaries.

As noted in the diagram, **state and city incentives** (including charitable tax deductions) may be provided to enhance project economics.

The Solar Commons model has been piloted in Tucson, Arizona at the Dunbar Coalition and in Minneapolis, Minnesota at Impact Inc. The model described above can be applied to both behind-the-meter rooftop solar as well as community solar. Different rates or credit structures will apply for community solar projects.

OVERVIEW OF FINANCIAL MODEL

Rocky Mountain Institute has created a financial model to analyze financial and environmental benefits of the Solar Commons model given a variety of assumptions and scenarios.

Model Outputs

The model provides basic environmental and financial performance of an *Individual Solar Commons Project* as well as the environmental and financial performance of a *Fixed Donation (*e.g. $500,000 fixed donation*)* to a solar commons project.
Environmental outputs are: lifetime energy production and GHG reduction.
Financial performance outputs are:

1. Benefit to the trust (cumulative and annual) and
2. Benefit to the trust net of donation amount (cumulative net savings and net present value)

Outputs are summarized on the model's dashboard tab.

Model Inputs

The model is designed to test a variety of scenarios, and it is can also be customized and extended to new scenarios.
Primary model inputs include:

- *Location* - used to determine solar production and default utility rates
- *Project size* - used to determine default install and operating costs.
- *Discount rate* - the return on investment that a donor would expect for an alternative investment
- *Rate escalation* - expected annual utility rate increase
- *Demand charge capacity credit* - the expected demand charge reduction from the solar array as a percent of total solar nameplate capacity (discussed further below).

In addition to these primary model inputs, the model can be customized to a variety of rates and cost structures. Inputs to the model are found on the dashboard tab.

Model Limitations and Trade Offs

Like any model, the Solar Commons financial model required trade-offs between precision/ accuracy and the ability to be applied in a variety of situations. Below is a summary of some of the issues encountered during the creation of the model and how they were addressed.

Demand charges and demand charge reductions

The model analyzes rates available to commercial and industrial meters. In all instances, these rates include energy, demand, and fixed components. Modeling bill reductions due to avoided energy purchases was straight-forward. Modeling demand charge reductions proved to be more complex, since demand charge reductions will be a function of project size, location, and host building load profile.

Using data from NREL and Lawrence Berkeley Lab[1] the model estimates the impact of a solar on a facility's demand charge using the *demand charge capacity credit (DCCC)*. As a default, the model assumes a DCCC of 14%. This implies that a 100 kW array would result in a typical reduction of 14 kW to a buildings monthly peak demand. This default assumption is based on typical demand charge reductions from solar hosted at a school building.

While this model provides a tool to estimate total energy and demand savings, accurate and precise modeling of demand-charge reduction at a specific facility will require hourly annual facility load data.

Production and system design

The model used NREL's System Advisor Model (SAM) to model solar output in each state. Annual and monthly production was modeled based on a fixed south-facing array with a 1.3 inverter loading ratio (ILR)[ii]. Tracking arrays or significantly different designs would result in different performance.

System size and rate type interaction

For all behind-the-meter analysis, the model assumed typical rates available to mid- to large commercial customers in a region. These rates were used, because these are rates available to most customers with rooftops large enough to accommodate 400 - 500 kW arrays.

The host of a 14.5 kW array would most likely not be a mid- to large commercial customer, but rather a small commercial customer paying a small commercial rate. Small commercial customers generally pay higher energy charges and get more value from avoided energy purchases (due to solar production). Therefore, the analysis most likely systematically undervalues the financial benefit of a 14.5 kW system because it does not account for the interaction between system size and rate type.

Location and cost interaction

Solar install and operations costs vary considerably from state-to-state. This variability was ignored for the model.

[ii] ILR is ratio of DC solar capacity to AC inverter output. Typical ILR varies from 1.0 to 1.5.

State and local incentives not accounted for

Given the complexity of state and regional variation incentives, incentives have not been included in the model. RMI recognizes, the importance of these incentives. Among the states analyzed, Minnesota has significant incentives for projects 20 kW and smaller. These were not accounted for in the model.

Depreciation tax benefits

This model does not account for accelerated depreciation tax benefits. These benefits can significantly impact project economics by reducing the tax burden of the project owner.

Key Assumptions

A variety of assumptions were used in this model. In all instances the assumptions are transparent and can be manipulated by the user. Some key assumptions include:

- Project install cost
- Operations and maintenance expenses
- Administration costs
- Discount rate
- Cost and rate escalators
- Net metering policies exist
- Investment tax credit (ITC) and ITC basis

RESULTS AND SENSITIVITIES

Baseline Scenario

Below are outputs form the baseline scenario, a 410 kW behind-the-meter array in Arizona[iii]. The project is expected to provide significant benefit to the trust and to be an NPV positive investment for the donor.

TABLE 1: BENEFITS OF 410 KW BEHIND-THE-METER ARRAY IN ARIZONA

Lifetime Energy Production (kWh)	15,777,472
GHG Reduction (Metric tons CO2)	6706
Cumulative Savings (To Distribute) Including ITC	$2,725,791
Annual Benefit to Trust (Including ITC)	$109,032
Install Price	$943,410
Cumulative Net Savings (Minus Donation)	$1,782,381
Net Present Value of Donation	$814,751

[iii] The baseline scenario assumes the TEP export rate of $0.094 kWh introduced in September 2018. An analysis reflecting the net metered rate of $0.14 kWh locked in by the Solar Commons Project in Dunbar is available in the Appendix, Part A

Sensitivity to Project Size

Larger projects tend to have lower install costs, and lower operations costs (as measured by $/kW). The table below summarizes the net benefit of a $500,000 donation given multiple project sizes in Arizona. It shows that the all else being equal, a $500,000 investment will go further if invested in a 500 kW array

TABLE 2: BENEFITS OF $500,000 SOLAR COMMONS INVESTMENT PROJECT SIZE IN ARIZONA

Project Size	14.5 kW	410 kW	500 kW
Number of _ kW projects installed	$9.72	0.53	0.43
Total Capacity Installed (kW-AC)	$140.88	217.30	217.30
Lifetime Energy Production (kWh)	$5,421,479	8,361,938	8,524,193
GHG reduction (tons CO2 lifetime)	2,304	3554	3623
Cumulative Savings (To Distribute) Including ITC	$926,779	$1,444,648	$1,472,028
Average Benefit to Trust	$37,071	$57,786	$58,881
Cumulative Net Savings	$426,779	$944,648	$972,028
Net Present Value of Investment	$116,141	$431,812	$448,434

Sensitivity to Locations, Utilities, and Rate Types

Project benefits will also vary considerably based on location, utility, and rate type. The table below summarizes financial return for a 410 kW array across the three states and five rates analyzed. It's worth noting that while the net present value is negative on the Minnesota behind-the-meter Solar Commons project, it is strongly positive on a Minnesota Solar Commons community solar project. This is due to the community solar tariff available in Minnesota.

TABLE 3: SENSITIVITY OF SOLAR COMMONS PROJECT TO LOCATION AND RATE TYPE

Location/ Utility	Arizona - TEP	Colorado - Black Hills (BTM)	Colorado - Black Hills (CS)	Minnesota - Xcel (BTM)	Minnesota - Xcel (CS)
Lifetime Energy Production (kWh)	$15,777,472	$14,395,018	$14,395,018	$13,550,088	$13,550,088
GHG Reduction (Metric tons CO2)	6706	9650	9650	6271	6271
Cumulative Savings (To Distribute) Including ITC	$2,727,791	$1,860,263	$1,862,901	$975,151	$2,134,565
Annual Benefit to Trust (Including ITC)	$109,032	$74,411	$74,516	$39,006	$85,383
Install Price	$943,410	$943,410	$943,410	$943,410	$943,410
Cumulative Net Savings (Minus Donation)	$1,782,381	$916,853	$919,491	$31,741	$1,191,155
Net Present Value of Donation	$814,751	$280,765	$329,486	-$257,185	$436,994

Combined Sensitivities

The table below shows the net present value of a $500,000 donation among all of the rates and project sizes analyzed.

TABLE 4: NET PRESENT VALUE OF $500,000 DONATION BY PROJECT SIZE, LOCATION, AND RATE

Utility and Project Size	14.5kW	410kW	500kW
Arizona - TEP	$116,141	$431,812	$448,434
Colorado - Black Hills (BTM)	-$67,348	$148,803	$155,818
Colorado - Black Hills (CS)	-$50,607	$174,625	$184,783
Minnesota - Xcel (BTM)	-$252,200	-$136,306	-$132,630
Minnesota - Xcel (CS)	-$13,665	$231,604	$241,557

CONCLUSIONS

Financial analysis indicates that the Solar Commons model provides a positive impact-investment opportunity in multiple states across multiple project sizes. In all projects sizes and locations analyzed, Solar Commons projects will provide community benefit to the trust. In most projects and rates analyzed, Solar Commons further provides a net present value (NPV) positive investment opportunity (assuming 4% discount rate). A positive NPV indicates that a donation to a Solar Commons project would results in a *greater* financial impact over time than would have resulted from the donation if it had been otherwise invested (for example in bonds) with residual income being donated over time to project beneficiaries. This financial benefit does not account for the environmental benefits and local jobs associated with a solar array.

Given the sensitivity of Solar Commons projects to utility rate structure and demand charges, any Solar Commons project should ultimately be evaluated on a project basis. Each project-level analysis could provide an internal rate of return (IRR) for an investment in the project. Donors or funders to the Solar Commons model could consider specifying a required IRR for their investments and contribute to any and all projects that meet that target returns.

APPENDIX

PART A) OUTPUTS FOR NET METERED RATE ($0.14 kWh) LOCKED IN FOR SOLAR COMMONS DUNBAR PILOT PROJECT

Methodology

Energy Rates for TEP included in the summer/winter rate tables below reflect a hybrid between the current TEP retail energy rate and the locked in solar net metering rate for the Solar Commons Dunbar Pilot project. See Rate Summary in the Excel Financial Analysis for the methodology.

The tables below were generated using the "Custom" rate function in the financial analysis and the current demand charge rate used in the Phase 1 Report.

TABLE 5: INDIVIDUAL PROJECT OUTPUTS FOR $0.14 KWH ENERGY RATE, AS LOCKED IN FOR DUNBAR PILOT

Project Size	14.5kW	410kW	500kW
Lifetime Energy Production (kWh)	557,984	15,777,472	19,614,167
GHG Reduction (Metric tons CO2)	237	6706	8337
Cumulative Savings (To Distribute) Including ITC	$108,756	$3,103,860	$3,857,191
Annual Benefit to Trust (Including ITC)	$4,350	$124,154	$154,288
Install Price	$51,461	$943,410	$1,150,500
Cumulative Net Savings (Minus Donation)	$57,295	$2,160,450	$2,706,691
Net Present Value of Donation	$20,106	$1,045,270	$1,318,430

TABLE 6: PROJECT OUTPUTS FROM A $500,000 FIXED DONATION, $0.14 KWH ENERGY RATE AS LOCKED IN FOR DUNBAR PILOT

Project Size	14.5 kW	410 kW	500 kW
Number of _ kW projects installed	9.72	0.53	0.43
Total Capacity Installed (kW-AC)	140.88	217.30	217.30
Lifetime Energy Production (kWh)	5,421,479	8,361,938	8,524,193
GHG reduction (tons CO2 lifetime)	2304	3554	3623
Cumulative Savings (To Distribute) Including ITC	$1,056,692	$1,645,022	$1,676,311
Average Benefit to Trust	$42,268	$65,801	$67,052
Cumulative Net Savings	$556,692	$1,145,022	$1,176,311
Net Present Value of Investment	$195,352	$553,985	$572,981

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