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Article

Economic performance of solar energy systems financed with green bonds in New Jersey

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SUMMARY

Global reliance on extractive energy sources has many downsides, among which are inconsistent supply and consequent price volatility that distress companies and consumers. It is unclear if renewable energy offers stable and affordable solutions to extractive energy sources. The cost of solar energy generation has decreased sharply in recent years, prompting a surge of installations with a range of financing options. Even so, most existing options require upfront payment, making installation inaccessible for towns with limited financial resources. The primary objective of our research is to examine the use of green bonds to finance solar energy systems, as they eliminate the need for upfront capital and enable repayment through revenue generated over time. We hypothesized that if we modeled the usage of green bonds to finance the installation of a solar energy system in New Jersey, then the revenue generated over the system's lifetime would be enough to repay the bond. After modeling the financial performance of a proposed solar energy-producing carport in Madison, New Jersey, financed with green bonds, we found that revenue from solar energy systems successfully covered the annual green bond payments and enabled the installers to obtain over 50% of the income for themselves. Our research demonstrated green bonds as a promising option for New Jersey towns with limited financial resources seeking to install solar energy systems, thereby breaking down a financial barrier.

INTRODUCTION

Solar energy is an emerging alternative to conventional extractive energy sources. In the 21st century, solar costs have gone down over 90% and are projected to further decrease by 25% by 2030 (1). With declining costs and government subsidies, using solar power as an alternative to traditional energy sources can not only reduce prices but potentially generate income for the installer, whether that be an individual, a business, a utility, or a town. Additionally, while the prices of fossil fuels fluctuate due to their status as a global commodity, the influence of geopolitical events and natural disasters, etc., solar energy eliminates that instability and provides a predictable, stable cost to customers because it relies on the abundant and free sunlight resource and involves predictable installation and operation costs (2).

There are two main ways town officials can finance a solar energy system. The first way is called a power purchase agreement. This involves a town contracting with a developer to build and own an electricity system for the duration of the contracted term, which is generally half of the system's lifespan (3). In this arrangement, the developer sells all the generated power to the town at some predetermined rate that is lower than the price previously paid by the town (3). Alternatively, the town can become the owner and installer by contracting with a construction company, which requires upfront capital for construction (4). These options both have disadvantages, either financially (the upfront cost and/or revenue) or in the municipality's control of the system.

Green bonds (issued by governments, multilateral development banks, and public and private municipalities) offer a solution to both problems by eliminating the need for upfront capital while still giving the issuer full control of the solar power system (5). Like conventional bonds, green bonds raise initial capital for the issuer, and in return, the issuer pays back fixed fractions of the principal and interest yearly over a specified period (5). These bonds are exclusively used to fund projects that work to better the environment (5). As an incentive for environmentally favorable projects, green bonds have a yield spread (modeled by taking the difference in yield to maturity) that is, on average, eight basis points lower than conventional bonds, which results in a 5% decrease in the borrowing costs to the issuer (5). Certain agencies will be commissioned to study the bond and certify its status as a green bond (5). Green bonds' environmental focus makes them appealing to a new generation of investors interested in building sustainable investment portfolios, which widens the possible audience for the bonds and burnishes the public image of both investors and issuers (6).

In terms of the scope of environmentally friendly projects green bonds can finance without burden on the installer, there are a few existing studies on the effectiveness of green bonds in facilitating the implementation of solar energy technology, possibly because there are many varying components within solar energy. Albeit limited, the available research, overall, suggests that green bonds are effective in financing solar energy projects since green bonds are specifically designed to be paid back with the revenue from energy generated, and more and more governmental incentives make this repayment possible (6). As solar energy generation matures, green bonds may increase by financing new investments in this renewable energy area (7). Hence, they will be even more effective in supporting future solar energy generation. Therefore, the present research aims to examine the use of green bonds to finance solar energy systems as an alternative to traditional upfront payment methods in New Jersey, making installation accessible for towns with limited financial resources.

New Jersey's strong solar incentives and high electricity costs make it an ideal focus for this research. However, the state has a higher price per watt for solar energy systems compared to the national average, making paying back its green bond potentially more difficult (4). We hypothesized

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that if green bonds were utilized to finance the expenses of installing a solar energy system in New Jersey, then the revenue generated from selling the energy produced would be enough to repay the bond. To examine this hypothesis, we first investigated how solar carports generated revenue using a solar carport currently being implemented in Madison, New Jersey. After finding how to calculate gross revenue from solar power systems, we modeled the performance of two other proposed solar carport projects in Madison if financed with green bonds. We discovered that the total income generated during the lifetime of the carport would not only cover the cost of the green bond but also enable the installers to obtain over 50% of the income for themselves. This promising finding could unlock a near-cost-free way to adopt solar energy solutions for New Jersey towns.

RESULTS

We performed a financial analysis to determine if solar energy systems could pay back the year-by-year debt service green bonds impose. This analysis included calculating building costs, yearly income from power generation, yearly income from Transition Renewable Energy Certificates (TRECs), and yearly debt service from the green bond. We chose these factors because they are the key financial components that influence the feasibility and sustainability of a solar energy project. There may also be costs not included in this analysis, such as administrative costs and legal and underwriting fees incurred during the green bond issuance process because they are variable and relatively inconsequential. To conduct this analysis, we used data from solar carport projects in Madison, New Jersey.

There are three proposed solar carport projects in Madison: Madison's Recreational Center, Madison Community Pool, and Madison's Department of Public Works. We first examined the carport at Madison's Recreational Center to understand how gross revenue would be calculated. It had an estimated cost of $1.7 to $1.8 million as of 2023 (8). However, that cost is lowered by 30% to 40% because of aid supplied by the Federal Inflation Reduction Act (8). We conducted a worst-case scenario analysis by using the highest building cost estimate of $1.8 million and the least amount of aid provided by the Federal Inflation Reduction Act of 30%, which returned $1,260,000 as the initial capital outlay for the carport at Madison's Recreational Center. We then calculated the gross revenue of energy sold to the grid over 30 years to be $1,972,206.25 (**Table 1**). Equation 1 and other equations used for the calculations are explained further in the Materials and Methods section.

In New Jersey, builders of solar generation projects like these solar carports can also benefit from a state renewable energy certificate program now called Transition Renewable Energy Certificates (9). TRECs offer approximately $0.10 per kWh of energy produced for the first 15 years of the carport (9). Other states offer their own solar and renewable energy incentive programs that municipalities can use. We found that TRECs can potentially help the project generate an estimated $1,236,165 over 15 years using Equation 2 (**Table 1**).

Then, using the data and methods from the as-examined carport at Madison's Recreational Center, we looked at Madison's two additional proposed solar arrays to analyze their year-by-year outcome if green bonds were used to finance them (8). Using these two carports, we can answer our hypothesis of whether the carports' gross revenue is able to pay back the debt of green bonds.

Year	Expenditure	Energy Revenue	NJ Renewable Energy Certificates	Total Cash Flow - Expenditure
0	$1,260,000	$0	$0	-$1,260,000
1	$5,000	$51,240	$85,400	-$1,128,360
2	$5,110	$52,105	$84,973	-$996,392
3	$5,222	$52,984	$84,546	-$864,084
4	$5,337	$53,876	$84,119	-$731,426
5	$5,455	$54,782	$83,692	-$598,406
6	$5,575	$55,702	$83,265	-$465,014
7	$5,697	$56,635	$82,838	-$331,239
8	$5,823	$57,583	$82,411	-$197,068
9	$5,951	$58,545	$81,984	-$62,490
10	$6,082	$59,521	$81,557	$72,507
11	$6,216	$60,512	$81,130	$207,933
12	$6,352	$61,518	$80,703	$343,802
13	$6,492	$62,539	$80,276	$480,124
14	$6,635	$63,574	$79,849	$616,913
15	$6,781	$64,626	$79,422	$754,179
16	$6,930	$65,692	$0	$812,942
17	$7,082	$66,775	$0	$872,634
18	$7,238	$67,873	$0	$933,268
19	$7,398	$68,987	$0	$994,858
20	$7,560	$70,117	$0	$1,057,415
21	$7,727	$71,264	$0	$1,120,952
22	$7,897	$72,427	$0	$1,185,482
23	$8,070	$73,607	$0	$1,251,019
24	$8,248	$74,804	$0	$1,317,575
25	$8,429	$76,017	$0	$1,385,163
26	$8,615	$77,248	$0	$1,453,797
27	$8,804	$78,497	$0	$1,523,489
28	$8,998	$79,763	$0	$1,594,254
29	$9,196	$81,046	$0	$1,666,104
30	$9,398	$82,348	$0	$1,739,054

Table 1: Estimated income and outgo 30-year outlook for Madison Recreational Center solar carport. This table compiles the revenue and expenditure of the recreational center carport without the repayment of any debt securities. The expenditure includes the building cost and yearly maintenance costs. The revenue includes revenue from energy and TRECs. Every year is scaled by inflation predictions, and the energy revenue is affected by the deterioration rate of solar panels.

We examined the additional site at the Madison Community Pool with a power generating capacity of 707,000 watts of direct current power (DC) (4, 10). We multiplied this power-generating capacity by the estimate of $2.50 per watt to get a purchasing price of $1,767,500 for the carport at Madison's Community Pool. As for the building cost, we estimated the worst-case scenario with minimum (30%) aid from the Inflation Reduction Act and arrived at $1,237,250. This cost is the principal of the green bond in our analysis. Accordingly, if financed with a green bond, the total debt for the carport at the Madison Community Pool would come to $1,753,459.98 over 30 years, according to the calculation using Equation 3 (**Appendix A Table 1**).

Then, we calculated the operating income for each year using Equations 1 and 2 and compared it with the yearly debt service (principal and interest) that must be paid. The gross revenue of energy sold would come out to $2,388,155.63 over 30 years, while TRECs contributed $1,011,712.50 during the first 15 years (**Appendix A Table 1**). TRECs would have a significant positive impact on income in the first 15 years (**Figure 1**). Even after the TRECs expire in year 16, the project would remain profitable for the remainder of its lifetime (**Figure 1**). This can be ascribed to the declining interest payment caused by decreasing principal outstanding and greater estimated revenue resulting from energy price inflation. Operating income increased every year except from years 9-10 because of inflation predictors, while debt service decreases every year because interest is taken from a smaller pool of principal as a fixed fraction of the principal is

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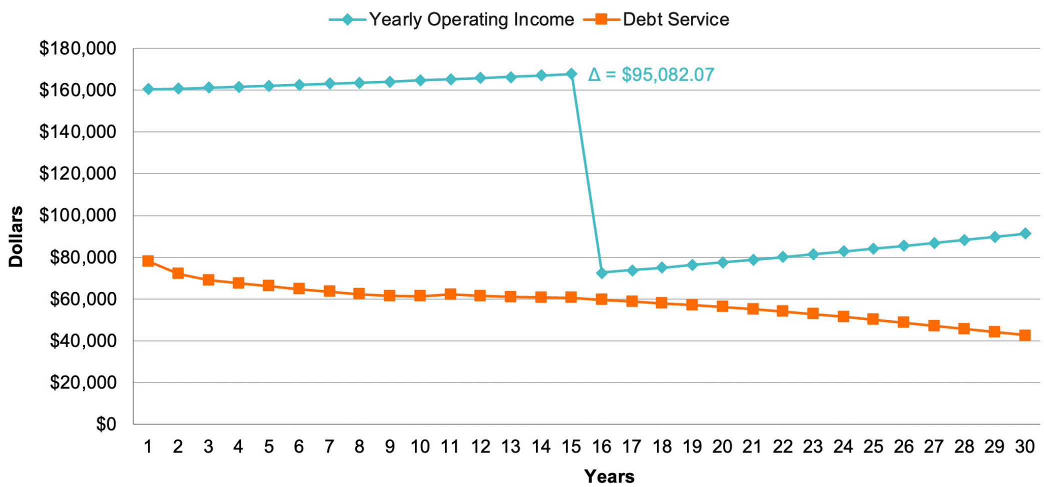

Figure 1: Annual operating income and debt service for Madison Community Pool solar carport. The line graph compares the yearly income (blue) and debt service (red) of a potential solar carport at Madison's Community Pool if financed with green bonds. Operating income includes annual energy sales and income from Transition Renewable Energy Certificates (TRECs), and debt service consists of principal and interest to be paid each year. The figure illustrates the two's year-by-year values for comparison and the magnitude of the drop in operating income after TRECs end.

paid every year (**Figure 1**).

Operating income had a somewhat linear increase (**Figure 2**). This is because the deterioration rate of the solar panels, which negatively affects revenue from TRECs and energy, negates the growth from inflation, which positively affects the cost of maintenance and revenue from energy. The amount earned through the carport at Madison's Community Pool and incentives would exceed the financing expenses, which include the principal as a fixed cost and interest and maintenance as variable costs, in year 9 (**Figure 2**). This breakeven point represents the point at which the accumulated revenue and the expenses are equal. By the end of the 30-year issuance period, the amount earned through the carport at Madison's Community Pool would exceed financing expenses by 74% (**Figure 2**).

We found that green bonds can pay back solar energy systems in New Jersey with almost no cost for the installer. Through modeling the year-by-year financials of the proposed solar carport at Madison's Community Pool if financed with green bonds, we found that 34% of the generated income during the carport's lifetime would go to paying the principal of the green bond, 14% would be used to pay off the interest on the bond, and 52% would be the revenue gained by the installer (**Table 1**).

To compare the financial performance of different sites under similar conditions and validate the initial assumptions and calculations made for the first site, we then modeled the performance of the second additional site being considered at Madison's Department of Public Works, which includes not only carports but also rooftop arrays, so the cost of building

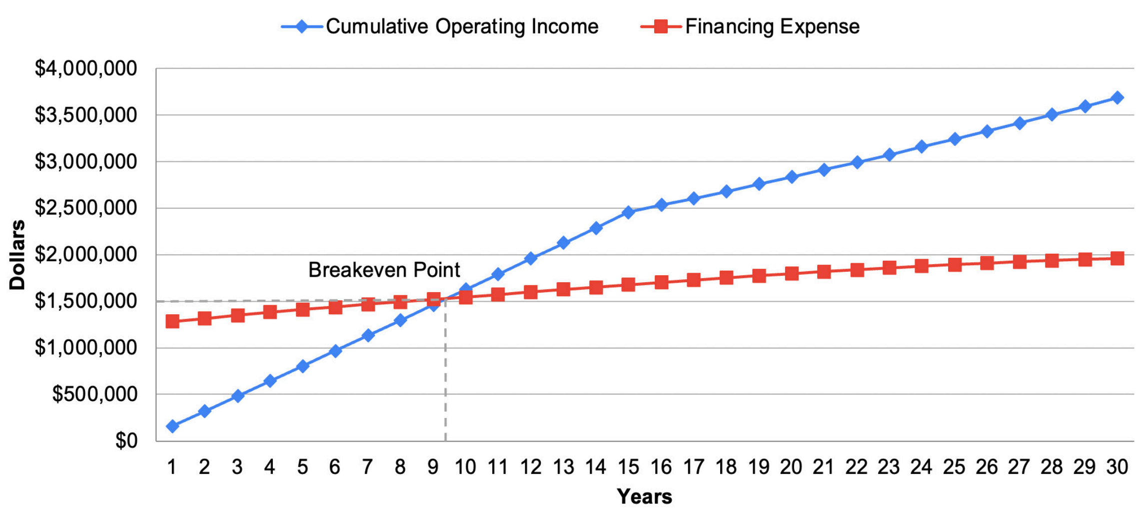

Figure 2: Breakeven analysis for Madison Community Pool solar carport. The line chart shows incomes and expenses fluctuate throughout 30 years, and the approximate time income and expenses break even for a potential solar carport at Madison's Community Pool if financed with green bonds. Cumulative operating income (blue), comprising energy sold and income from TRECs cumulated year-by-year, along with financing expenses (red), which include the initial building cost and cumulative bond interest, is represented on the line chart.

is not as expensive for the energy produced (4). We found that the installer gains approximately 59% of the generated income as revenue (**Appendix A Table 2**). After building the breakeven analysis chart and annual operating income and debt service chart for Madison's Department of Public Work's proposed carport, we saw that the patterns in both the Department of Public Work's and Madison Community Pool's charts were almost identical (**Appendix A Table 1, Table 2**). As a result, in a region with identical incentives, a single version of a chart suffices to estimate the financials of solar energy systems of varying costs.

DISCUSSION

This simulation project aimed to understand the process of calculating the income and expenses of a solar energy system and the process of creating the repayment schedule for a green bond issuance. We hypothesized that if green bonds were utilized to finance the expenses of installing a solar energy system in New Jersey, then the revenue generated from selling the energy produced would be enough to repay the bond. Therefore, there should be no burden on taxpayers since the money does not come from the town budget. To test this hypothesis, we developed Equations 1 and 2 to calculate income from TRECs and energy, which constitutes the operating income from a carport. Then, we compared that income with the debt from the green bond, calculated with Equation 3. Through our analysis, we found that solar energy systems, financed using green bonds, can generate positive cash flow even in the case of a town that does not have the upfront capital to fund a solar project. Furthermore, green bonds would enable the installers to obtain over 50% of the income for themselves. Our analysis and visualizations can be used to estimate the financial performance of other solar energy systems financed with green bonds in New Jersey.

Solar carports cost 30% to 40% more to install than ground-mounted solar panels (11). If a town already owns the carport property and could benefit from the main use as a carport as well as by the power generation of the solar panels, carport solar can be a good choice despite the added cost of building the overhead panels in the carport roof. We focus on carports in our research; other forms of solar, such as ground-mounted solar or rooftop solar, may yield different results. However, because an expensive form of solar power system like carports can repay their green bond in New Jersey, other forms of solar power systems may also have no problem doing so. Nevertheless, our research could benefit from experiments showing the distribution of revenue of other inexpensive solar panel arrangements like ground-mounted solar or rooftop solar financed by green bonds. By comparing financial outcomes, towns would be able to better discern the optimal arrangement for their situation. Our research could also benefit from more comparisons between alternative methods of financing solar power systems, like using a power purchase agreement or contracting with a construction company, which are unlike green bonds that require upfront costs and may generate greater revenue. These options present an appealing choice for towns with the financial means to pay the upfront cost.

We studied three carports in Madison, New Jersey. Madison has a municipal bond rating of AAA, which is the highest bond rating (12). Because high bond ratings allow municipalities to have slightly lower interest ratings, our method may not represent all towns in New Jersey, as approximately 5% of New Jersey municipalities hold a AAA rating (12). Our current method also requires a 30-year commitment for the municipality to repay the bond. Such long-term debt securities may appear less appealing than short-term commitments like a power purchase agreement. In addition, more precise estimates of the cost of the three carports will not be available until the systems are bid on. New Jersey has a higher price per watt for solar energy systems compared to national averages, making paying back its green bond potentially more difficult (13). We cannot predict what the economic landscape will be like over the next 30 years, so the inflation percentage we used in our research is solely an estimate based on currently available information. A more complex analysis may consider more factors, such as the potential impact of macroeconomic events, changes in monetary policy, supply chain disruption, or geopolitical tensions that could significantly alter inflation rates.

To reap the economic benefits, it is essential to act when bond yields are lower, and incentives are still present. Undoubtedly, some statistics provided in this paper will change over time, but because of the credibility of their sources, these projections should provide a reliable estimate. Note that the issuance of municipal bonds may entail significant underwriting expenses, often making it uneconomical to issue bonds in small principal amounts (5). In states with insufficient incentives, debt service may exceed operating income until the breakeven point, so towns will have to cover that gap and expect to be paid back after the respective projects reach the breakeven point. Even in such a scenario, this system will almost always be cash flow positive at the end because we saw in our analysis that even without TRECs, the installer will still earn revenue unless there are major changes to inflation or the price of electricity, no aid from the Federal Inflation Reduction Act, or if the solar power system sustains damage. Further work may cover using green bonds to finance other forms of solar energy in other states or further study into incentives like TRECs on their effectiveness. Ultimately, our results suggest that green bonds are a viable financing option for communities in New Jersey seeking solar energy solutions without the restraining upfront cost. By increasing the accessibility of solar energy, green bonds have the potential to contribute significantly to the state's sustainability goals.

MATERIALS AND METHODS

Madison Recreational Center preliminary investigation

Originally, Madison, New Jersey, was considering plans to install three carports by collaborating with companies that develop, construct, and maintain them and to buy the solar energy generated at a low kWh rate (8). This had the possibility of creating very little income for Madison. However, the Federal Inflation Reduction Act, which would supply 30% to 40% of the initial cost of construction, made it possible for the borough to build one carport itself, so Madison decided to build one of the three planned carports, specifically the one at the Madison Recreational Center (8).

To see if solar energy systems can pay back their year-by-year debt, we first calculated the gross revenue the system produces over its lifetime. We used the carport that is being built at the Madison Recreational Center to model how gross revenue from a solar power system is calculated. The gross

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revenue, in this case, includes income generated by selling the electricity produced and the value of the certificates earned through the TREC program.

The cost to the borough of building the carport at the Madison Recreational Center is estimated to be between $1.7 and $1.8 million (8). The town can apply for funding through the Inflation Reduction Act, which will cover 30% to 40% of the initial cost through direct payments from the federal government (8). As for the attributes of the solar panel system, our analysis utilized estimates of a 30-year lifespan, a 0.5% annual deterioration rate, and $5,000 of maintenance costs per year (4). Inflation also needed to be considered in the economic analysis. While inflation was 6% in 2022, the U.S. Energy Information Administration predicts long-term residential energy inflation rates of 2.2% yearly until 2050 (14).

We conducted a worst-case scenario analysis by using the highest building cost estimate of $1.8 million and the least amount of aid provided by the Federal Inflation Reduction Act of 30%. In our analysis, this gave $1,260,000 as the initial capital outlay for the carport at the Madison Recreational Center. To create a comparative cost distribution chart (**Figure 3**), we also calculated the best-case scenario with 40% of aid and a $1.7 million installation, indicating a net capital outlay of $1,020,000. The analysis then averaged the worst and best cases to find the baseline case, which was $1,140,000 in capital expenses. After considering the capital costs and maintenance, we calculated the revenue generated by the carport at Madison's Recreational Center over its lifespan.

The annual energy output of the carport is estimated to be 854,000 kWh, which has the capacity to power around 80 homes (4). This energy would be transported to the local grid and sold to residents for $0.17 per kWh (4). Note that this $0.17 per kWh does not exactly reflect the cost of producing 1 kWh of energy. Out of the total $0.17 per kWh, $0.11 will be used for the transmission, storage, and distribution of energy through Madison's municipally owned electrical grid, which is a system of transmission lines, substations, and distribution lines that work to transport energy to customers (3, 15). Madison will fulfill a fraction of its electricity demand through this carport at Madison's Recreational Center, but for remaining households, Madison buys energy from outside companies like PSE&G for $0.06 per kWh (4). The carport eliminates the need to buy energy from external suppliers for $0.06 per kWh. Actual savings will accrue when the generating cost of the solar energy is less than the $0.06 per kWh price of externally generated power.

Using these data, we developed Equation 1, which gives the estimated gross revenue of the energy sold to the grid over *n* years:

$$\sum_{i=1}^{n}(R_i) = \sum_{i=1}^{n}\left[O_1 P(1-D)^{i-1}(1+I)^{i}\right] \qquad (1)$$

R_i represents the revenue generated from the operation of the carport in year *i*, where *i* is the number of years since the start of operation—for each year, the calculation is performed, and its result is added to the sum. *O1* represents the estimated kWh of energy produced every year. *P* is the price per kWh. *D* is the deterioration rate. *I* represents the expected inflation rate.

Because New Jersey also offers TRECs, which provide about $0.10 per kWh of energy produced for the first 15 years of the carport, we also created Equation 2 to calculate gross revenue from TRECs (9):

$$\sum_{i=1}^{\begin{cases} n, & if\ n\leq 15 \\ 15, & if\ n>15 \end{cases}} (T_i) = \sum_{i=1}^{\begin{cases} n, & if\ n\leq 15 \\ 15, & if\ n>15 \end{cases}} \left(0.1 O_1 (1-D)^{i-1}\right) \qquad (2)$$

T_i represents the revenue generated by TRECs in year *i*. *i* is the number of years since the start of operation—for each year, the calculation is performed, and its result is added to the sum. $0.10 is the revenue brought in by the TRECs per kWh. *O1* is the estimated kWh of energy produced every year. *D* represents the deterioration rate.

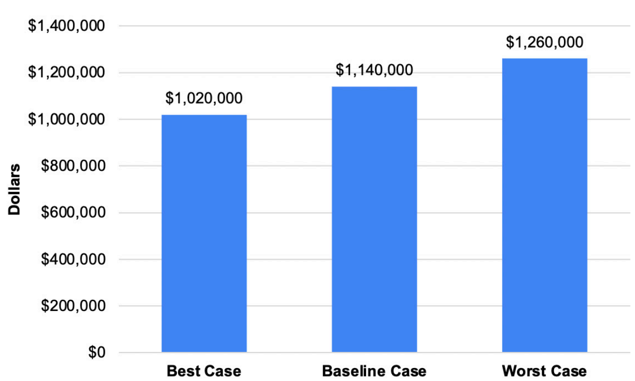

Figure 3: Installation cost distribution for Madison Recreational Center solar carport. Bar graph showing the range of potential purchasing prices for Madison's recreational center carport. The worst case was based on the highest building cost estimate of $1.8M and the least amount of aid, 30%, from the Federal Inflation Reduction Act. The best-case scenario was calculated with a maximum of 40% aid and the lowest $1.7M installation cost. The baseline case was calculated by averaging the worst and best scenarios.

Madison Community Pool

We further examined the feasibility of using green bonds to finance the two additional uncompleted carports. Knowing that the power generating capacity is 707,000 watts (DC) for the proposed carport at Madison's Community Pool and using an estimated cost of $2.50 per watt (DC) of power for the construction, we obtained $1,767,500 as the estimated price of the solar array at the pool. Applying that purchasing price with the least amount of aid, 30%, from the Federal Inflation Reduction Act, we determined the remaining final cost for the borough and the principal of our green bond to be $1,237,250.

A serial bond is an issuance with multiple maturity dates. In this case, we assumed that an equal amount of the principal owed would come due in each of the 30 years. This means the yearly principal debt is $1,237,250 divided by 30, which is $41,241.67. Yearly interest debt is the unpaid remaining principal for the year multiplied by the corresponding interest rate (**Appendix A Table 1**). Yearly interest rates are taken from the yield curve on Tradeweb's AAA Municipal Yield chart because Madison currently has a AAA bond rating (12). Principal debt plus debt from interest becomes the total debt from the green bond, which was calculated using Equation 3:

$$\sum_{i=1}^{n}(D_i) = \sum_{i=1}^{n}\left(\frac{P}{n} + R_i \cdot \frac{(n-i+1)P}{n}\right) \quad (3)$$

The debt from the green bond in year i is represented by D_i. i is the number of years since the start of operation—for each year, the calculation is performed, and its result is added to the sum. P represents the principal of the bond. R_i represents the interest rate for that year.

Then, we used Equation 1 and Equation 2 to calculate the gross revenue this solar array would generate over its lifetime using the same assumptions of a 30-year lifespan, 0.5% annual deterioration rate, $5,000 of maintenance costs per year, and energy inflation rates of 2.2% yearly until 2050 (4, 14).

Madison Department of Public Works

Proposed in 2022, the solar array planned to be built on Madison's Department for Public Works provides an opportunity to turn the town recycling center and Department of Public Works building into renewable energy producers (10). We obtained the figures mentioned in the Results section from Appendix A using the same methods utilized for the carport at Madison's Community Pool's green bond.

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APPENDIX

Year	Interest Rates*	Interest Paid	Principal Paid	Remaining Principal	Total Debt Service	Expenditure	Energy Revenue	NJ Renewable Energy Certificates	Total Cash Flow - Expenditure
1	2.977	$36,833	$41,242	$1,196,008	$78,075	$1,278,993	$61,790	$103,500	-$1,113,703
2	2.581	$30,869	$41,242	$1,154,767	$72,111	$1,314,879	$62,833	$102,983	-$983,774
3	2.409	$27,818	$41,242	$1,113,525	$69,060	$1,347,826	$63,894	$102,465	-$850,361
4	2.363	$26,313	$41,242	$1,072,283	$67,554	$1,379,379	$64,974	$101,948	-$714,994
5	2.324	$24,920	$41,242	$1,031,042	$66,162	$1,409,655	$66,071	$101,430	-$577,769
6	2.269	$23,394	$41,242	$989,800	$64,636	$1,438,524	$67,187	$100,913	-$438,538
7	2.248	$22,251	$41,242	$948,558	$63,492	$1,466,369	$68,322	$100,395	-$297,667
8	2.225	$21,105	$41,242	$907,317	$62,347	$1,493,192	$69,476	$99,878	-$155,136
9	2.224	$20,179	$41,242	$866,075	$61,420	$1,519,214	$70,649	$99,360	-$11,149
10	2.304	$19,954	$41,242	$824,833	$61,196	$1,545,141	$71,842	$98,843	$133,609
11	2.541	$20,959	$41,242	$783,592	$62,201	$1,572,203	$73,056	$98,325	$277,928
12	2.577	$20,193	$41,242	$742,350	$61,435	$1,598,634	$74,290	$97,808	$423,594
13	2.664	$19,776	$41,242	$701,108	$61,018	$1,624,785	$75,544	$97,290	$570,277
14	2.778	$19,477	$41,242	$659,867	$60,718	$1,650,776	$76,820	$96,773	$717,878
15	2.917	$19,248	$41,242	$618,625	$60,490	$1,676,683	$78,118	$96,255	$866,345
16	2.977	$18,416	$41,242	$577,383	$59,658	$1,701,905	$79,437	$0	$920,560
17	3.034	$17,518	$41,242	$536,142	$58,759	$1,726,377	$80,779	$0	$976,867
18	3.122	$16,738	$41,242	$494,900	$57,980	$1,750,223	$82,143	$0	$1,035,164
19	3.221	$15,941	$41,242	$453,658	$57,182	$1,773,428	$83,531	$0	$1,095,490
20	3.313	$15,030	$41,242	$412,417	$56,271	$1,795,881	$84,942	$0	$1,157,979
21	3.387	$13,969	$41,242	$371,175	$55,210	$1,817,437	$86,376	$0	$1,222,799
22	3.448	$12,798	$41,242	$329,933	$54,040	$1,837,989	$87,835	$0	$1,290,082
23	3.495	$11,531	$41,242	$288,692	$52,773	$1,857,444	$89,319	$0	$1,359,945
24	3.527	$10,182	$41,242	$247,450	$51,424	$1,875,726	$90,827	$0	$1,432,491
25	3.546	$8,775	$41,242	$206,208	$50,016	$1,892,777	$92,361	$0	$1,507,801
26	3.556	$7,333	$41,242	$164,967	$48,574	$1,908,569	$93,921	$0	$1,585,930
27	3.561	$5,874	$41,242	$123,725	$47,116	$1,923,089	$95,508	$0	$1,666,918
28	3.562	$4,407	$41,242	$82,483	$45,649	$1,936,332	$97,121	$0	$1,750,796
29	3.563	$2,939	$41,242	$41,242	$44,181	$1,948,300	$98,761	$0	$1,837,589
30	3.563	$1,469	$41,242	$0	$42,711	$1,958,998	$100,429	$0	$1,927,320
Total		$516,210	$1,237,250		$1,753,460	$1,958,998	$2,388,156	$1,011,713	$1,927,320

* Interest rate represents Tradeweb AAA Municipal Yield as of Monday, May 8, 2023

Table 1: Sample repayment schedule of the issuance of a green bond for the Madison Community Pool solar carport. The interest rates represent Tradeweb AAA Municipal Yield as of Monday, May 8, 2023. Interest paid per year is determined by multiplying the interest rate and the remaining principal. Total debt service is calculated by adding interest and principal. These figures will not be affected by inflation because the amount to be paid is fixed when the bond is issued.

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Year	Interest Rates*	Interest Paid	Principal Paid	Remaining Principal	Total Debt Service	Expenditure	Energy Revenue	NJ Renewable Energy Certificates	Total Cash Flow - Expenditure
1	2.977	$18,338	$20,533	$595,467	$38,872	$634,338	$35,640	$59,400	-$539,298
2	2.581	$15,369	$20,533	$574,933	$35,902	$649,707	$36,242	$59,103	-$459,322
3	2.409	$13,850	$20,533	$554,400	$34,383	$663,557	$36,854	$58,806	-$377,512
4	2.363	$13,100	$20,533	$533,867	$33,634	$676,658	$37,477	$58,509	-$294,627
5	2.324	$12,407	$20,533	$513,333	$32,940	$689,065	$38,110	$58,212	-$210,713
6	2.269	$11,648	$20,533	$492,800	$32,181	$700,713	$38,753	$57,915	-$125,692
7	2.248	$11,078	$20,533	$472,267	$31,611	$711,791	$39,408	$57,618	-$39,745
8	2.225	$10,508	$20,533	$451,733	$31,041	$722,299	$40,073	$57,321	$47,142
9	2.224	$10,047	$20,533	$431,200	$30,580	$732,345	$40,750	$57,024	$134,869
10	2.304	$9,935	$20,533	$410,667	$30,468	$742,280	$41,438	$56,727	$223,100
11	2.541	$10,435	$20,533	$390,133	$30,968	$752,715	$42,138	$56,430	$311,233
12	2.577	$10,054	$20,533	$369,600	$30,587	$762,769	$42,850	$56,133	$400,163
13	2.664	$9,846	$20,533	$349,067	$30,379	$772,615	$43,574	$55,836	$489,726
14	2.778	$9,697	$20,533	$328,533	$30,230	$782,312	$44,310	$55,539	$579,878
15	2.917	$9,583	$20,533	$308,000	$30,117	$791,895	$45,058	$55,242	$670,595
16	2.977	$9,169	$20,533	$287,467	$29,702	$801,064	$45,819	$0	$707,245
17	3.034	$8,722	$20,533	$266,933	$29,255	$809,786	$46,593	$0	$745,116
18	3.122	$8,334	$20,533	$246,400	$28,867	$818,120	$47,380	$0	$784,163
19	3.221	$7,937	$20,533	$225,867	$28,470	$826,056	$48,180	$0	$824,406
20	3.313	$7,483	$20,533	$205,333	$28,016	$833,539	$48,994	$0	$865,917
21	3.387	$6,955	$20,533	$184,800	$27,488	$840,494	$49,822	$0	$908,784
22	3.448	$6,372	$20,533	$164,267	$26,905	$846,866	$50,663	$0	$953,075
23	3.495	$5,741	$20,533	$143,733	$26,274	$852,607	$51,519	$0	$998,853
24	3.527	$5,069	$20,533	$123,200	$25,603	$857,677	$52,389	$0	$1,046,172
25	3.546	$4,369	$20,533	$102,667	$24,902	$862,045	$53,274	$0	$1,095,077
26	3.556	$3,651	$20,533	$82,133	$24,184	$865,696	$54,174	$0	$1,145,600
27	3.561	$2,925	$20,533	$61,600	$23,458	$868,621	$55,089	$0	$1,197,764
28	3.562	$2,194	$20,533	$41,067	$22,728	$870,815	$56,019	$0	$1,251,589
29	3.563	$1,463	$20,533	$20,533	$21,997	$872,278	$56,965	$0	$1,307,091
30	3.563	$732	$20,533	$0	$21,265	$873,010	$57,927	$0	$1,364,286
Total		$257,010	$616,000		$873,010		$1,377,481	$580,635	$1,364,286

* Interest rate represents Tradeweb AAA Municipal Yield as of Monday, May 8, 2023

Table 2: Sample repayment of a potential carport at Madison's Department of Public Works if financed with green bonds. The interest rates represent Tradeweb AAA Municipal Yield as of Monday, May 8, 2023. Interest paid per year is determined by multiplying the interest rate and the remaining principal. Total debt service is calculated by adding interest and principal. This table provides a comparison with the schedule of the bond with a higher principal.