Financing Option Comparison Tool
Created by the City of San José
June 2009

Note to Readers

This user guide is intended primarily for the finance tool itself rather than an introduction to photovoltaics (PV) and PV finance. Users who do not have a basic understanding of PV systems, terminology, and financing structures are encouraged to review the documents referenced at the end of the guide. This finance tool can be located at the Resource Center on the Solar America Cities Intranet.

Disclaimer

While the tool was created by the City of San José, the City does not assume any responsibility for how others may use it to make decisions. In addition, while no errors or bugs have been detected in the tool, each user is responsible for independently confirming the accuracy of the results.

Introduction

When faced with the decision of whether or not to acquire a PV system, cities must consider a series of options.

- What is the cost of doing nothing and continuing to purchase electricity from the utility for all of a particular building or site's needs?
- What is the cost of directly purchasing a PV system?
- What is the cost of entering into a third party financed, Power Purchase Agreement?

The ability to compare all three of these options using a single set of assumptions can assist a city with this decision on a project by project basis. While there are other analytic tools available, having a simple one developed from the city's perspective is important.

As a component of this decision-making process, the finance department at the City of San José, and in particular, Charlene Sun, developed a finance tool to assist with the aforementioned analysis. This tool has then been modified so that other Solar America Cities can use it.

Based on a series of user inputs, the three options described above can be considered simultaneously. In addition, scenario buttons allow the user to calculate the annual rate at which future retail electricity prices must increase for both the direct purchase of a PV system and the PPA model to be cost effective (i.e. cheaper than buying the electricity from the utility).

As the tool is designed from the city's perspective, the user can input cost assumptions such as:

- the city's cost of capital;
- the city's discount rate;
- the cost to manage the installation of a PV system;
- the on-going cost to manage a city-owned PV system;
- the cost to enter into a PPA;
- the on-going cost to manage a PPA;

If a city has already decided that it will pursue a third party PPA-financed system, the tool can also be used to quickly evaluate bids from solar developers by entering the proposed price of electricity in the PPA for the first year and the annual escalation rate, if any.

It is important to stress that the tool should be viewed as one element of an integrated decision-making process and not the sole criteria per se. As with any model that incorporates numerous assumptions, the outputs are only as good as the quality of the inputs entered.

Buyout option and end of term issues

It is important to note that the tool does not take into account any potential buyout options that might be available to the city during the life of the PPA and/or at the end of the term of the PPA. Given that these buyout options and other end of life options such as purchasing the system at fair market value (FMV) can be structured and priced in a variety of ways, they are excluded from the tool. The assumption is that at the end of the PPA, the system is removed at no cost to the city.

Output Screen for the Finance Tool

Before examining some of the inputs in greater detail, an example of both the output screen and the input screen are provided below. As illustrated, the output screen provides the present value of the three options under consideration; the status quo; a direct purchase of the PV system; and entering into a PPA.

OPTION A - STATUS QUO

Continue to pay retail energy cost as the Agency currently does.

PV of Retail Energy Cost	**$1,040,195**

OPTION B - Agency Buys Solar Panel System

Agency purchases and operates the Solar Panel System.

PV of Cost to Buy the Solar System	$1,796,193
PV of Ongoing Operations & Maintenance	$59,130
PV of One Time Inverter Replacement in Yr 15	$85,952
PV of Ongoing Management Costs	$289,855
Initial Project Mgmt & Installation Costs (one time cost)	$90,000
PV of State/Federal Solar Initiative PBI per kWh	($536,648)
PV Cost for Option B - Cost to Buy and Operate the System	**$1,784,483**
Payback (years)[2]	**NA**

OPTION C - Agency Enters into 3rd Party PPA

Agency enters into a 3rd party Power Purchase Agreement (PPA) and procures electricity at the PPA rate.

PV of PPA	$693,722
PV of Ongoing Management Costs	$193,237
Initial Project Mgmt & Installation Costs (one time cost)	$90,000
PV Cost for Option C - Cost for PPA	**$976,959**
Payback (years)[2]	**17**

Option B Break-Even[3] GO

Option C Break-Even[3] GO

Input Screen for the Finance Tool

Most of the inputs are relatively straightforward and an explanation is provided within the tool for each one. Certain inputs do require calculations and/or data from outside sources and these are identified at the end of the input screen which is shown below.

KEY ASSUMPTIONS	
System Production Date	6/1/2009
Term (years)	20
Total System Size (kW)	225
Cost per Watt	$8.00
Gross Installed Cost of System	$1,800,000.00
Rebates/Incentives per Watt	$1.00
Net Installed Cost of System	$1,575,000.00
Electricity Production (kWh) in year 1	328,000
Annual System Production Degradation	0.50%
Current Retail Electricity Cost (per kWh)	$0.130
Annual Increase in Retail Electricity (per kWh)	6.50%
Discount Rate	3.50%
Agency's Cost of Borrowing Funds (financing cost)	5.00%
Annual O&M as a % of Installed Cost	0.17%
O&M Inflation Rate	3.50%
Inverter Replacement in year 15 (per KW)	640
Agency's Annual Management Cost (Buy)	$15,000.00
Agency's Annual Management Cost Inflator	3.50%
One-time Project Mgmt Cost as a % of Install Cost (Buy)	5.00%
State/Federal Solar Initiative PBI per kWh	$0.120
Solar Initiative Availability (years)	20
One-time Project Mgmt Cost as a % of Install Cost (PPA Option)	5.00%
Agency's Annual Management Cost (PPA)	$10,000.00
PPA Rate (per kWh)	$0.120
PPA Annual Escalator	3.00%

Inputs requiring outside calculation and/or data

Electricity Production (kWh) in year 1: The electricity that a particular system will produce in a given location must be calculated using an outside solar performance calculator. For example, PV Watts (Version 1.0)[1] is a common source of production data. At the end of this guide, there is a sample print out from PV Watts for the city of Milwaukee. The total for the AC Energy column over a 12 month period would be the input for the finance tool. A city can also commission a site assessment for a proposed PV installation in order to determine a more detailed assumption of expected electricity production at a specific location.

Inverter Replacement in year 15 (per kW): As inverters traditionally carry 10 year warranties, it is common to budget for an inverter replacement sometime after year 10 so that the city is prepared for it when the need arises. However, in a dynamic market such as the PV market, estimating the cost of an inverter 15 years out into the future is difficult. It is up to the city to determine whether to enter today's prices for the future purchase of an inverter or attempt to predict what future inverter prices may be by talking to the local installer community. To be conservative, using today's prices as the input for year 15 may be the most appropriate way to approach this input. NREL has calculated the following costs for inverters based on 2007 prices. In the absence of better data from local sources, these estimates will be useful.

Large Inverter Costs

Inverter Size (kW)	Installed Cost ($/DC-kW)
75	$990
100	$840
135	$790
225	$640
500	$550

NREL: Based on 2007 data from CA and NJ

Enter the installed cost of the inverter (per kW basis) in cell G31 of the worksheet and it will calculate the present value of the cost of the inverter replacement in year 15 based on the size of the PV system entered in cell G10.

Annual O&M as a % of Installed Cost: If the city is going to own the PV system, estimating the annual Operations and Maintenance cost will provide a sense of the cash needed for this line item. Similar to the inverter data above, NREL has calculated averages for O&M costs based on 2007 data.

[1] http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/

O&M Costs

System Type	Annual Cost as a Percentage of Total Installed Cost
Ground Mounted - Fixed	0.17%
Ground Mounted w/Tracking	0.35%

NREL: Based on 2007 data from CA and NJ

It should be noted that the California Energy Commission recommends an annual O&M expense of 1% of the initial investment.[2]

O&M Inflation Rate: This input relates to an assumption that O&M costs will increase over time. This can simply be expected inflation unless the city has more accurate data on PV O&M per se.

State/Federal Solar Initiative PBI per kWh: This would also be the cell to enter any on-going Production Based Incentives (PBI), Feed-in-tariff payments (FIT) or Renewable Energy Certificates payments (REC) that a City might receive. If a city-financed project receives only upfront rebates, enter "0" for this input. REC payments may need to be converted to kWh from MWh.

Solar Initiative Availability (years): Enter the number of years that a PBI, FIT, or REC payment will be paid to the City if it owns the system.

[2] California Distributed Energy Resource Guide. Operations and Maintenance Costs. Accessed February 2009 at http://www.energy.ca.gov/distgen/economics/operation.html

Using the Finance Tool

Returning to the output screen from page 3, once the inputs have been entered, the user will have three different present value calculations; the cost of continuing to purchase electricity from the local utility (Option A), the cost to own and operate a PV system (Option B), and the cost to enter into a third party PPA (Option C).

OPTION A - STATUS QUO	
Continue to pay retail energy cost as the Agency currently does.	
PV of Retail Energy Cost	**$1,040,195**
OPTION B - Agency Buys Solar Panel System	
Agency purchases and operates the Solar Panel System.	
PV of Cost to Buy the Solar System	$1,796,193
PV of Ongoing Operations & Maintenance	$59,130
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PV Cost for Option B - Cost to Buy and Operate the System	**$1,784,483**
Payback (years)[2]	**NA**
OPTION C - Agency Enters into 3rd Party PPA	
Agency enters into a 3rd party Power Purchase Agreement (PPA) and procures electricity at the PPA rate.	
PV of PPA	$693,722
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Initial Project Mgmt & Installation Costs (one time cost)	$90,000
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Payback (years)[2]	**17**
Option B Break-Even[3]	GO
Option C Break-Even[3]	GO

Annual Increase in Retail Electricity (per kWh) (copied from the Input screen)	**6.50%**

In this example, over a 20 year period and assuming a 6.50% annual increase in electricity prices, the 3rd Party PPA is the cheapest of the three alternatives for a 225 kW system with a payback period of 17 years. The "NA" for Option B implies that purchasing the system outright will be

more expensive than both the PPA option and continuing to purchase electricity from the utility during a 20-year time period.

Break-even Options

By selecting the break-even option button, the user can calculate the annual rate at which retail electricity prices have to increase for Option B and C to be cheaper than Option A over a 20 year period. Given the scenario presented above, although the PPA (Option C) is the cheapest of the three options, a city may want to calculate the rate at which retail electricity prices have to increase annually over the 20-year time horizon for the direct purchase of the PV system (Option B) to also be cheaper than continuing to purchase all electricity from the utility.

Selecting the GO button for Option B provides the following results.

OPTION A - STATUS QUO	
Continue to pay retail energy cost as the Agency currently does.	
PV of Retail Energy Cost	**$1,784,483**
OPTION B - Agency Buys Solar Panel System	
Agency purchases and operates the Solar Panel System.	
PV of Cost to Buy the Solar System	$1,796,193
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PV Cost for Option B - Cost to Buy and Operate the System	**$1,784,483**
Payback (years)[2]	**NA**
OPTION C - Agency Enters into 3rd Party PPA	
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PV of PPA	$693,722
PV of Ongoing Management Costs	$193,237
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PV Cost for Option C - Cost for PPA	**$976,959**
Payback (years)[2]	**9**

Annual Increase in Retail Electricity (per kWh)	**11.82%**

What the output implies is that if retail electricity prices increase at an annual rate of 11.82%, the cost to the city of owning and operating a PV system will be equal to the cost of continuing to buy electricity from the utility at retail rates over a 20-year period. However, under this scenario, Option C is even more attractive than it was under the 6.50% annual rate increase scenario as the payback period has declined from 17 years to 9 years.

If the user were to select the GO button for Option C, rather than Option B, the results would indicate that as long as retail electricity prices increase at a rate of at least 5.85% on an annual basis over the 20-year period, the PPA would always be less costly than continuing to purchase electricity from the utility.

OPTION A - STATUS QUO	
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Payback (years)[2]	**19**

Annual Increase in Retail Electricity (per kWh)	**5.85%**

Conclusion

The finance comparison tool provides cities pursuing public installations of PV systems with a straightforward method to compare the cost of continuing to purchase electricity from the utility with the cost of purchasing a system and the cost of signing a PPA. Even prior to analyzing the outputs, the process of determining the inputs to the model, in and of itself, forces the city to think through the many cost elements that go into the decision. Ideally, the use of the tool will assist cities make the appropriate decision when pursuing the installation of a PV system. .

Reference Documents

As noted at the outside of the guide, users new to PV and PV finance, should familiarize themselves with the following documents so that they better understand the inputs and outputs of the finance tool.

Financing Non-Residential Photovoltaic Projects: Options and Implications (January 2009)
Bolinger, M. Lawrence Berkeley National Laboratory (LBNL). Accessed at: http://eetd.lbl.gov/ea/emp/reports/lbnl-1410e.pdf

Solar Photovoltaic Financing: Deployment on Public Property by State and Local Governments (May 2008)
Cory, K.; Coughlin, J.; Coggeshall, C. National Renewable Energy Laboratory (NREL). Accessed at: http://www.nrel.gov/docs/fy08osti/43115.pdf

For additional guidance on using the finance tool, or to suggest any modifications, please contact Jason Coughlin at the National Renewable Energy Laboratory (NREL) at 303-384-7434 or jason.coughlin@nrel.gov

Example of PV Watts Output for System Production Data

AC Energy & Cost Savings

Cautions for Interpreting the Results

Station Identification	
City:	Milwaukee
State:	Wisconsin
Latitude:	42.95° N
Longitude:	87.90° W
Elevation:	211 m
PV System Specifications	
DC Rating:	100.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	77.0 kW
Array Type:	Fixed Tilt
Array Tilt:	43.0°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	9.1 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.32	8584	781.14
2	3.96	8973	816.54
3	4.28	10360	942.76
4	5.11	11482	1044.86
5	5.58	12627	1149.06
6	5.88	12396	1128.04
7	5.66	12095	1100.65
8	5.60	12111	1102.10
9	5.19	11144	1014.10
10	4.34	9921	902.81
11	2.96	6812	619.89
12	2.49	6235	567.39
Year	4.53	122739	11169.25