Photovoltaic Payback Realities

Conventional wisdom stipulates that photovoltaic (PV) panels do not meet standard accounting financial model requirements for payback. This article will attempt to dispel that myth and provide some easy-to-use tools to demonstrate this assertion.

Payback is the time necessary for an investment to return the value of the investment. There are a number of complicated ways, e.g., involving present value or future value of money, internal or external rate of return, to calculate the time required, however, I will use a simple model. The payback will be the time necessary to recover the initial cost based on the electricity cost avoided.

Payback is an important consideration for the investor in a PV system. One should immediately verify the payback is less than the expected lifetime of the system. After that one needs to consider one's own specific circumstances. These could include: the expected time to abide in the house where the system is installed; the length of time to borrow money for the buy the system (especially compared to alternate investments); quantifying a measure of energy independence; or quantifying a contribution of the reduction of the use of nonrenewable energy sources or improving the environment.

The model will use the following assumptions:

1. The cost of a grid-tie PV system including installation on a roof with fixed mounts is based on standard materials meeting all safety and other requirements. There is generally no maintenance, especially for fixed installations.
2. The cost of electricity is the price per kWh from the local utility. This assumes net metering. This price may (and should) be increased to account for the actual cost to our civilization of using nonrenewable energy sources.
3. The total kWh per year generated will be estimated, noting the actual value will vary by a number of factors, e.g., geographic location, PV placement, wire length. Use http://rredc.nrel.gov/solar/codes_algs/PVWATTS/ to get an estimate for your geographic location and installation parameters.
4. The model does not assume any present value of future avoided cost, future value of the present investment, increasing cost of electricity, depreciation, resale vale, or other financial variables. Although these items would affect the calculation, the amount of variability in electricity generated, probably more than offsets the improved accuracy of the payback prediction using these tools. Note, the increasing cost of energy from nonrenewable sources in the near future is a reality and should be factored in by entering a higher cost per kWh than the actual price now paid.

In simple terms, the idea is to make an estimate of how much time is required to recover the investment in a PV system. The total cost of the system is divided by the value of the electricity produced per year. The payback is the number of years for the value of the produced electricity to equal the cost of the system.

This model will look at a grid-tie system, which is applicable to most homes. Considerations for off-grid systems are not normally financial in nature, so the payback period is not as relevant. A grid-tie system does not require battery backup and the model assumes net metering. Net metering makes the most economic sense for both the PV owner and the utility for small systems, where the total PV generation capacity is only a fraction of the total usage. This means that for the calculation of payback, the price per kWh is the same whether buying or selling (note, this may not be true in some locations where buy/sell meters are installed and the utility only has to pay the avoided cost, which is some fraction of the sell price).

Complete systems can be bought off-the-shelf. This model will use the Kyocera (http://www.kyocerasolar.com/) MyGen™ 24 system as an example, because this is a complete off-the-shelf system that contains all necessary components to install in a typical residential application. Other systems are available. The example system uses 24 each 120-watt panels that are connected to a nominal 2500-watt inverter. This maximizes utilization of all components, i.e., the inverter does not have any unused capacity at peak panel output. The 120-watt panels are the typical DC wattage rating of a panel at standard temperature conditions (STC) and must be de-rated for actual conditions and conversion to AC watts as used in grid connected homes.

Appendix A provides an example of how much electricity can be produced by a MyGen™ 24 system at the given location based on the PVWATTS program. Since the input to the PVWATTS program is in AC watts and solar panels are rated in DC watts, the output of the PVWATTS program must be de-rated to account for inverter efficiency and line loss to convert DC watts to AC watts.

Appendix B provides a table (in Excel format, available at http://www.homepower.com/) that shows payback and the pertinent variables. One can vary each of the variables for a given system cost, location, and electricity cost to estimate payback. Various nationwide locations are considered, to show the differences in available solar radiance.

The installed system cost is based on an industry typical value of $8.50/watt (the rated STC watts of the panel). Depending on system type, location, and owner involvement, the total system cost could be changed. Since some states now have a rebate program for home installation of renewable energy systems, a rebate factor is considered. If no rebate is available then the factor is 1. The example uses a rebate factor of 40%, i.e., the owner does not have to pay 40% of the cost. Rebates are typically 50%, so this is conservative. The costs of electricity used of $0.15 and $0.25 are representative of the range of values in many urban areas. The system efficiency was shown at 90%, this could change depending on inverter type and length of system wiring.

Conclusion:

This model clearly shows that a domestic PV system is a good economic investment, even given today's artificially low cost of nonrenewable energy, i.e., the system will payback the cost of the system in less than the lifetime of the system. Of course, the use of a rebate significantly improves the financial return.   Systems are obviously more effective in “high” sunshine areas, but even in “low” sunshine areas, they systems will pay for themselves.

Appendix A: Example of Watts generated for a MyGen 24 system

This system is at a longitude of 38ºNorth, latitude of 117ºWest, and altitude of 1653 meters. The panels are fixed with and elevation of 38º and an azimuth of 180º (true south).

A	B	C	D
Month	Energy (kWh)	Effective Hrs/month	Effective Hrs/day
1	391	135.76	4.38
2	411	142.71	5.10
3	518	179.86	5.80
4	533	185.07	6.17
5	524	178.72	5.77
6	526	182.63	6.09
7	541	187.85	6.06
8	550	190.97	6.16
9	531	184.37	6.15
10	524	178.72	5.77
11	408	141.67	4.72
12	394	136.81	4.41
Year	5852		

Explanation of the table:

1. Columns A and B are directly from the PVWATTS program.
2. Column B is the essence of the PVWATTS program, which predicts the PV panel output based on geographic location and installation parameters.
3. Column C is derived from column B and the rated value of the PV panels entered into the PVWATTS program.
4. Column D is column C divided by the number of days per applicable month.

Appendix B: Payback Calculation Table

A	B	C	D	E	F	G
System Cost ($)	Rebate Factor	Price per kWh ($/kWh)	Location	Annual kWh from PVWATTS (kWh)	Efficiency Factor	Payback (Years)
24480	0.6	0.15	Los Angeles, CA	5335	0.9	20.4
24480	0.6	0.25	Los Angeles, CA	5335	0.9	12.2
24480	0.6	0.15	San Francisco, CA	5248	0.9	20.7
24480	0.6	0.25	San Francisco, CA	5248	0.9	12.4
24480	0.6	0.15	Phoenix, AZ	5867	0.9	18.5
24480	0.6	0.25	Phoenix, AZ	5867	0.9	11.1
24480	0.6	0.15	Albuquerque, NM	6098	0.9	17.8
24480	0.6	0.25	Albuquerque, NM	6098	0.9	10.7
24480	0.6	0.15	Boulder, CO	5296	0.9	20.5
24480	0.6	0.25	Boulder, CO	5296	0.9	12.3
24480	0.6	0.15	Atlanta, GA	4886	0.9	22.3
24480	0.6	0.25	Atlanta, GA	4886	0.9	13.4
24480	0.6	0.15	Chicago, IL	4277	0.9	25.4
24480	0.6	0.25	Chicago, IL	4277	0.9	15.3
24480	0.6	0.15	Fort Worth, TX	5097	0.9	21.3
24480	0.6	0.25	Fort Worth, TX	5097	0.9	12.8
24480	0.6	0.15	New York, NY	4430	0.9	24.6
24480	0.6	0.25	New York, NY	4430	0.9	14.7

Explanation of the table:

1. Column A is the total system cost, including installation.
2. Column B is the rebate factor offered by many states to offset part of the system cost.
3. Column C is the cost of electricity, using the price from the grid as a starting point.
4. Column C is the output of the PVWATTS program for the annual electricity production based on geographic location and installation parameters.
5. Column C is the efficiency factor of 85% to convert PV panel output in DC watts to normal usage of AC watts.
6. Column F is Column A times Column B divided by the product of Columns C, D, and E.