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Simplifying Solar

Factsheet FS-956
2013

Homeowner Primer to Residential Solar Installation

Rise of Solar Energy

Across the United States and much of the world solar energy generation is growing. Concerns about environmental impact, energy independence, and improvements in solar technology all play a part in this growth. Additionally, state and federal incentives increase the economic viability of solar energy. This fact sheet is designed to give the layman a basic understanding of residential solar energy.

Panels

Broadly there are two types of solar panels, photovoltaic (PV) and solar thermal. PV panels generate electricity and solar thermal units are used most frequently to heat water. According to the United States Department of Energy, water heating takes up 18% of the home energy budget (Figure 1).

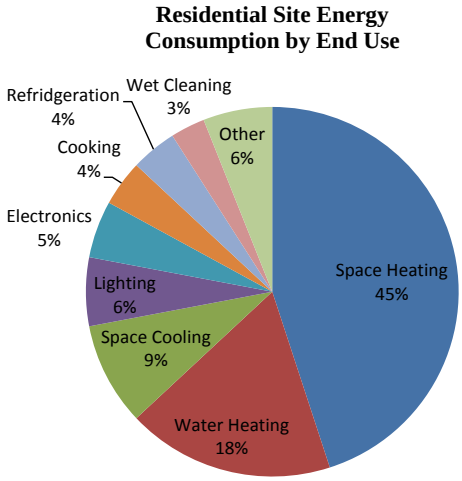

Figure. 1 Source: U.S. Department of Energy

Even though solar thermal units create no electricity, they can considerably reduce the home energy budget by displacing the use of electricity or fossil fuel that would otherwise be used to heat water. Grant incentives typically differ between PV and solar thermal installations. PV installations are usually awarded higher grant incentives than solar thermal systems to compensate for the more expensive PV installation.

Installing Solar Energy Systems

Solar installations, whether PV or solar thermal, are installed as a pole or roof mount (Figure 2). Typical installation time is two to four months for a residential installation once a contract is signed with the solar installation company.

Pole Mount

Roof Mount

Figure. 2

Pole Mount Installation:
There are benefits and disadvantages to both pole and roof mount installations. It is relatively easy to optimize panel location and orientation in a pole mount installation. Pole mount installations are not hampered by roof space or shape. It is also easier to install sun tracking equipment on pole mounted systems, although at this time most residential solar installations do not include tracking equipment. A problem with pole mount systems is they take up extra ground space, which may be less aesthetically pleasing or even cause zoning issues. Pole mounts also tend to require more hardware which can add to the expense of installation.

Roof Mount:
Roof mount installations are advantageous in that the main part of their support structure, the house or garage roof, is already in place. Although some additional mounting brackets are required, roof mount installations generally require fewer materials than pole mount installations. Roof mount systems have the added benefit of not taking up space in the yard or other land. However, roof mounts are disadvantaged in that a roof does not always have sufficient usable space, the correct angle, or face in the right direction for panels to reap maximum energy from the sun. "Racking" hardware can be used to correct some of this directional issue, but at an added expense. Homeowners may also face added expense when doing roof repair on structures equipped with a solar installation.

When choosing between pole and roof mount installations, consideration should be given to available land space, zoning regulations, ideal panel orientation and homeowner preference. The decision making process should also involve discussions with solar installation professionals. Some homeowners choose to install systems incorporating both roof and pole mount installations.

Storing & Using Solar Energy

Physical location of PV and solar thermal systems can be similar. However, in terms of storing and utilizing energy these systems are vastly different.

Solar Thermal:
Solar thermal units store energy, in the form of heated water, in well-insulated storage tanks (Figure 3). This heating process could be the only form of domestic hot water heating a home has. However, due to the intermittent nature of solar energy, most solar thermal installations are supplemented with electric or natural gas hot water heaters. Though recreational uses are typically not funded through government grants and subsidies, solar thermal units also provide a great way to heat swimming pools.

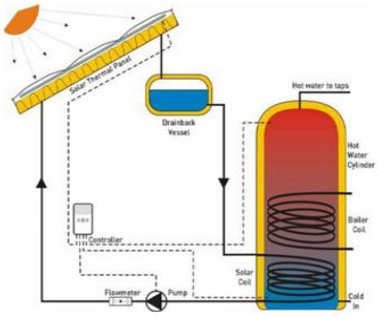

Figure. 3

Source: The Heating Business LTD

Photovoltaic:

PV installations either tie into the electrical grid or use batteries to store electrical power. Houses equipped with grid tie systems "push" electricity not used in the home back into the electrical grid to be used by other electricity consumers. If the grid tie PV installation has an electrical deficit, this deficit will be offset by the utility company. For example, a given residence may use 35 kWh per day. If their solar installation generates 15 kWh their electric meter will show only a 20 kWh daily increase because electricity generated by the solar installation offsets electric purchased. The process of tracking electrical use and generation in this fashion is called net metering. Generally, electricity produced beyond monthly use is carried over on a month to month basis as a credit and electric companies pick a set month to resolve any outstanding balances. The buyback of electricity is only available with grid tie PV installations. Listed below are advantages and disadvantages of grid tie and battery solar installations.

Grid tie systems have the following advantages:

- Less costly to install unless location is not near current electric source
- Can sell excess kWh's back to provider
- Do not require battery maintenance
- Do not require space for battery storage

Grid tie systems have the following disadvantages:

- Does not offer independence of an electricity provider
- Does not provide power during power outages

Off grid systems have the following advantages:

- Power during power outages
- Independence from electric company

Off grid systems have the following disadvantages:

- More expensive installation, except when located far from electrical access
- Need space for battery storage
- Battery maintenance

It is possible to install a smaller number of batteries and still tie to the grid. However, due to the added cost and complexity these installations are rare.

Shading and Inverters

When installing a PV system avoid locations where panels will be shaded. Even partial shading of PV installations has a disproportionate impact on electrical generation. A shadow on a panel can represent a reduction in power over 30 times its physical size. Additionally, if not using micro inverters, shading of one panel can disrupt electrical generation of multiple panels. Inverters convert direct current (DC) electricity, generated by solar panels, to alternating current (AC) electricity capable of powering household devices and entering the electrical grid.

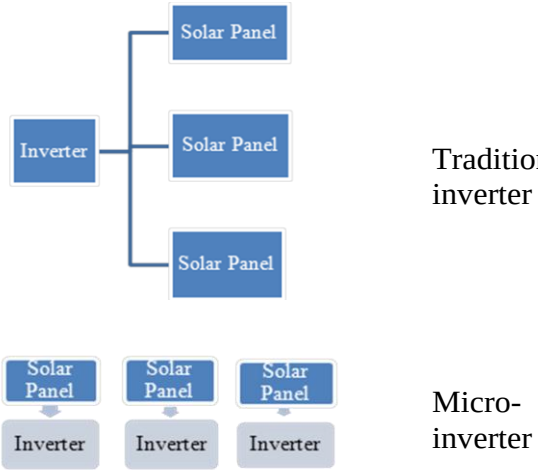

Figure. 3

Choosing between micro inverters or the traditional inverter (Figure 3) makes a difference in solar PV performance under partial shading and in the event of a solar array suffering damage to a portion of its panels. Both traditional and micro inverters are used to convert DC current, produced by the solar panels, to AC current so the electrical power can enter the grid. The difference is that, when using micro inverters, each solar panel has its own inverter. The traditional inverter set up entails attaching many panels to one inverter. Damage or shading to any of the panels, when using a single inverter, will negatively affect electrical generation of all panels. Micro inverters help alleviate this problem because they separate performance of individual panels. If only one panel out of three is shaded or damaged the other two panels will produce as normal. The traditional single inverter does not afford this benefit. Rather, even a small amount of shading or damage to one panel will cause the rest to perform poorly. Determining if the added cost and benefits of micro inverters are worthwhile should be decided on an individual basis. Shading will also reduce the production of solar thermal panels. However, comparatively shading does not reduce the production of solar thermal panels as strongly as PV panels.

Economics:

Initial cost for both PV and solar thermal installations can be quite high. For example, the investment required for a grid tied PV installation sized at 8.93 kW capable of producing electrical needs of the average Maryland family, not using electric as a heat source, may be in the $40,000 – $50,000 range. However, residential solar installation costs are offset by government subsidies and mandates making the payback of initial investment much quicker (Figure 4).

At the state level, as of 2013, there is a $1,000 PV grant for Maryland residents and a $500 solar thermal grant. For current information related to

Payback of Initial Investment

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Total	% of Payback
Cost of installation	$40,000										
Benefits of Installation											
Federal tax credit (30%)	4,000	4,000	4,000							12,000	30.0%
Maryland incentive	1,000									1,000	2.5%
SREC	1,650	1,650	1,620	1,650	1,650	1,650	1,650	1,650	1,650	14,850	37.1%
Value of electricity	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	12,150	30.4%
Total benefits	8,000	7,000	7,000	3,000	3,000	3,000	3,000	3,000	3,000	40,000	100%

Figure 4

* Based on $137.50 SREC sale and $.11 kWh electricity, both subject to change
* Individual results may vary due to changes in SREC market, price of electricity, and other factors
* Typical scenario based on survey results from 35 photovoltaic installations in Washington County Maryland

state incentives on renewable energy visit http://www.dsireusa.org/ . Additionally many companies installing solar energy systems are knowledgeable about state and federal incentives.

Owners of commissioned solar installations, both PV and solar thermal, can also sell Solar Renewable Energy Credits (SREC's). The SREC market fluctuates, but in the fall of 2012 the price per SREC is about $140. One SREC is 1,000 kWh. Homeowners can sell their SREC's themselves. However, most find more success working through a SREC aggregator. SREC aggregators, for a commission, put together SREC's from multiple homeowners making a more attractive offer to utility companies.

To understand what drives SREC markets, keep in mind Maryland utilities are required, by law, to produce a certain percentage of their electricity from renewable sources like wind, hydro, and solar energy. The law governing this percentage is the Renewable Portfolio Standard and it also establishes what portion of this renewable energy must come from solar energy. Rather than produce the required renewable energy themselves, utilities are allowed to purchase renewable energy as "credits". This establishes the Renewable Energy Credit, commonly referred to as REC. Each REC is 1,000 kWh. These credits go towards the Renewable Portfolio Standard set forth by the state of Maryland. Solar Renewable Energy Credits are commonly called SREC's.

As of 2012 there is also a 30% federal tax credit for residential PV installations. Keep in mind federal tax credits are not the same as a grant. Tax credits are monies individuals are not required to pay in taxes they otherwise would have been. For example, a $40,000 PV installation owner would be awarded $12,000 in federal tax credits. Since many Americans do not pay $12,000 annually in federal taxes it is likely it will take several years, of not paying federal income taxes, to realize the benefits of the $12,000 federal tax credit. The example in figure 4 illustrates this by indicating $4,000 in federal tax savings per year, taking three years to realize the $12,000 federal tax credit. Consult your tax professional to better understand how federal tax credits will or will not benefit you.

Without any incentives or rebates, with current pricing and electrical rates, payback of initial investment in PV would likely be 30 years.

CO_2 Emission Advantage

Understanding CO_2 emissions requires looking at the complete life cycle of an energy source, not just the production phase of a fuel. For example, consider a gasoline powered automobile. Measuring exhaust CO_2 while the motor is running would give emission numbers, but would not account for CO_2 emissions during the automobile manufacturing process. Neither would it account for emissions from gasoline production. Life cycle CO_2 emissions for automobiles would account for manufacturing, gasoline production, operation of the automobile, and any other processes emitting CO_2 associated with the manufacturing or operation of automobiles.

Coal fired power plants likely emit 1,000 grams of CO_2 equivalent per kWh of power generation. PV life cycle emission figures, like those for coal, need to account for mining of raw materials, like silicon, and the manufacturing process. Life cycle CO_2 equivalent emissions for PV likely average only 22 grams of CO_2 equivalent per kWh of power production. During actual operation emissions from solar panels are negligible.

Conclusion:

Solar installations provide varying degrees of energy independence, environmental benefits, and with current financial incentives, they are economically viable. Still, deciding to purchase or lease a solar installation is a big decision. Use this document as a guide to determine if and what type of solar installation is right for you.

In conclusion, watch for newer technologies like sun tracking equipment and thin-film technologies. Even though these technologies may not experience a high level of application today they could in the future.

References

- Department of Energy http://energy.gov
- DSIRE, a database of State and Federal Incentives for Renewables & Efficiency available at http://www.dsireusa.org/
- Internal Revenue Service (information on federal tax credits) http://www.irs.gov
- Maryland Clean Energy Center http://mdcleanenergy.org
- Maryland Energy Administration http://energy.maryland.gov
- U.S. Energy Information Administration http://www.eia.gov

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