MID Modesto Irrigation District
Water and Power

MPOWER

Solar Photovoltaic (PV) Program
Educational Guide

This educational guide provides basic technical, economic and regulatory information that should be considered before making an investment in a solar photovoltaic (PV) electric generation system. Consult an experienced PV contractor or supplier for detailed information regarding specific system design considerations, economics and costs based on your individual circumstances. Additional information can be found by accessing the internet links at the end of this guide.

Why go solar?

Electricity generation utilizing PV solar technology is an effective way to reduce electricity costs and increase the use of renewable energy while dramatically reducing greenhouse gas emissions and decreasing our nation's dependence on fossil fuels.

PV systems require very high upfront investments— about $15,000 to $50,000 or more for a typical two to six kilowatt residential system. Utility rebates and Federal tax credits are available, that in most cases, will cover about half of the initial cost; however, even after utility rebates and federal tax incentives, it may take over 10 years for homeowners to recover their investment in PV systems. This is particularly the case within the Modesto Irrigation District (MID) service area due to the electricity rates charged to MID customers.

While PV systems are expensive, costs have dropped significantly over the last twenty years. It is likely that the cost of PV systems will continue to drop over time. MID rebate incentives and Federal tax credits are available for qualified PV systems and will reduce the net cost for a solar electric system. These incentives should be available for many years. Still, if the primary motivation for installing a PV system is to reduce electricity costs, traditional energy conservation measures such as high-efficiency appliances, efficient lighting and weatherization are more cost-effective and should be considered first.

How do solar PV systems work?

PV technology produces electricity directly from the electrons freed by the interaction of sunlight with certain semiconductors materials (usually silicon-based) in a PV module or panel. These freed electrons are collected to form a direct current (DC) of electricity that is then converted into alternating current (AC) that is usable in your home.

PV systems typically consist of three key components:

- **PV modules**, which consist of solar "cells" wired together into a panel or module. Multiple modules are wired together to form a solar array that collects sunlight that in turn generates useful electric current. Individual modules are sized by their direct-current (DC) wattage rating which is typically 10-15% greater than their net alternating-current (AC) wattage rating. Individual modules are typically 8-12 square feet in size with a DC watt rating of about 140-240 watts each.
- A support or **"rack" system** onto which the modules are affixed. Most solar arrays are mounted onto a home's or business's roof using an aluminum rack, which is fastened to the roof supports.
- An **inverter** is an electronic device that converts the direct current (DC) produced by the array into 60 cycle (Hertz) 120-volt alternating current (AC) that is usable in your home. The AC power output from the array is wired into the home's electric service panel.

NOTE: The use of **batteries** in "Grid-Connected" PV systems has become rare due to the use of utility net-metering (see discussion of net-metering below). Batteries are often desirable or necessary in off-grid systems that are remote from utility grids or where back-up power is desired in case of utility power outages. The use of batteries with PV systems adds significant cost and complexity. Grid-connected PV with net-metering makes the need for batteries unnecessary, particularly within the MID service area where electric reliability is very high.

How much electricity will a solar PV system generate?

That depends on several factors, most importantly, the size of the PV system (array and inverter) as well as design factors such as available sunlight and the system's orientation to the sun. South-facing arrays are usually most ideal since they receive the most amount of electricity throughout the day. A PV system will generate the most energy when the sun is most perpendicular to the array. This usually occurs around noon when the sun is at its highest point in the sky.

In central California, south-facing PV systems in unshaded locations generate about 1,500 - 1,700 kilowatt-hours (kWh) per year for each kilowatt (DC) of array installed. Thus, a 2.0 kilowatt (DC) PV system should generate about 3,200 kWh per year. Several additional site and array-specific factors such as orientation sun (mounting) angle, panel efficiency, and site shading issues can and will affect actual output production.

How much does a PV system cost?

PV modules require the use of very refined semiconductor materials that are costly to manufacture. Primarily for this reason, PV systems are very expensive. Generally, each kilowatt (DC) of generating capacity will cost about $6,000 - $8,000 (installed) before utility rebates and federal tax credits. Therefore, a 2.0 kW (DC) system might cost about $14,000 before incentives. Many specific factors will dictate actual costs.

A typical MID residential customer consumes approximately 9,800 kWh of electricity each year. Of course, this number varies widely depending on several dwelling and lifestyle factors. A typical MID customer with a 2.0 kW south-facing PV system should generate about 3,400 kWh or a little over one-third of their annual electricity needs. At current MID residential rates, this system reduces the customer's electricity costs by approximately $500 a year.

What is net-metering?

California law requires all electric utilities to offer residential and small commercial customers with PV systems of 10 kilowatts or smaller the option of interconnecting to their utility's electric distribution system on a "net-metering" basis.

From the customer's perspective, net-metering allows your electric meter to spin forward when electric current flows from MID into your home. Conversely, when your PV system is generating more electricity than your home is using, your electric meter spins backward, allowing current to flow from your home outward onto the grid helping to supply power to other MID customers. Under MID's net-metering rule, a customer pays for only the net amount of energy they consumed over a 12-month period; that is, the total amount of energy generated by his PV system less the total amount of energy used by his home. With net-metering MID essentially becomes a "battery" when your PV system generates more electricity than your home consumes. Customers with PV systems are credited with the full per kilowatt-hour retail value of the energy generated by their PV systems.

To better understand net-metering, consider the following example. On a clear spring day, a home equipped with a PV system might be unoccupied when the residents are working and their children are in school. On such a day, this home would likely consume only a small amount of electricity—perhaps to operate the refrigerator and maybe a few other small electronic devices. A PV system, especially at mid-

day would likely generate more electricity than the home uses in real time and the customer's meter would spin backwards, essentially *crediting* the customer for excess generation. The customer's' excess generation is fed into MID's distribution system to help supply neighboring homes and businesses.

Later in the day, when family members return home, they turn on lights and appliances and start cooking dinner. Depending on the available sunlight, the PV system will generate little or no electricity (after sunset) and the customer draws power from the MID grid, re-capturing the excess energy that was generated earlier.

In billing periods where the customer has generated more power than they have consumed, his account is credited or "banked" with this excess generation. This banked (or credited) energy can be carried over and used in a subsequent month. MID reviews the customers' net consumption at the 12-month anniversary of the PV systems' startup. If the customer has generated more power than they have consumed (on a 12-month basis), any excess power generated is essentially donated to MID. MID does NOT pay customers for PV generation in excess of a customer's annual usage. Recent legislation will require MID to either pay or credit customers for net annual excess generation beginning in 2011. MID will only allow an incentive based on a PV system sized to meet no more than a customers expected historical annual usage. It is important that customers size their PV systems' appropriately to not exceed their expected annual usage.

NOTE: One common misconception regarding PV systems is that power will remain on when utility power outages occur. This is absolutely UNTRUE. All modern grid-connected PV systems immediately disconnect from the grid (stop generating power) when utility service to the home is interrupted regardless of the amount of sunlight available. This is to insure that utility lineworkers are not put at risk by a PV system that could "backfeed" into the grid. When power is restored to a home with a PV system, the inverter automatically senses that power has been restored and allows the PV system to safety generate electricity- provided of course that sunlight is available.

Is my home or business a good candidate for a PV system?

For a PV system to be effective, the solar array requires clear, unobstructed access to the sun for most of the day, particularly from about 9 a.m. through 4 p.m. California's Central Valley is blessed with many clear sunny days, particularly in the spring through fall months. In the Northern hemisphere, the sun is always in the southern half of the sky. For fixed array PV systems, that is PV systems that do not track the suns movement, power generation is maximized on south-facing roof areas. East- or west-facing roof areas may also be acceptable, but the amount of energy generated for system on these orientations will be somewhat less (+/- 15% or so) than for south-facing arrays. PV arrays can also be placed on the ground or on poles anchored to the ground.

Most PV arrays are mounted in fixed positions with a constant angle- generally similar to common roof pitches of 20-45%. PV systems mounted horizontally on flat roofs will perform somewhat less than those with normal roof pitches. Tracking systems that direct the array towards the sun as it moves through the sky maximize the amount of electricity generated but at higher initial cost. Such systems generally require mechanical systems to keep the array directed toward the sun and are more complex and require more maintenance.

A small "starter" home PV system requires as little as 100 square feet of PV panel mounting area or as much as 500 -1,000 square feet for an array that would provide most or all of a typical home's electric needs. MID requires a minimum of one kilowatt of PV system size to qualify for program rebate incentives.

MID PV Rebate Program

MID offers rebate incentives for customers who install qualified PV systems. Customers should visit the MID website below for important details regarding MID's PV rebate programs:

http://www.mid.org/rebates/solar/default.htm

Finding a dependable PV vendor/contractor

PV systems are relatively expensive with systems easily costing $15,000 - $50,000 or more. It is important that customers choose competitively priced, competent vendors who do high quality work.

Some questions to ask:

- How long has the company been in business?
- How many years of experience does the company have installing PV systems?
- Is the company licensed and bonded? Licensed California contactors or subcontractors with A, B, C-10 or C-46 licenses are required to be eligible for MID rebate incentives.
- Can the company refer you to customers for whom they have recently installed PV systems?
- Does the company have pending or active judgments or liens against it?

For more information on solar PV systems

Solar Electric Power Association (SEPA): www.solarelectricpower.org

California Public Utility Commission: http://www.cpuc.ca.gov/PUC/energy/Solar/aboutsolar.htm

California Energy Commission "Go Solar": http://www.gosolarcalifornia.ca.gov/index.html

U.S. Department of Energy: http://www.nrel.gov/solar

The MID PV Program Coordinator can be reached at: (209) 526-7455