



U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

2011

Solar Systems for Residential Installations

Jeramy Freeman

Product Marketing Manager, Schneider Electric

September 24, 2011

Today's Topics

- Today's Solar Market
- Basics of a Solar Photovoltaics (PV) System
 - System Components
 - Grid-Tie vs. Off-Grid PV System
- Installing a PV System
 - Is my house a good candidate?
 - Who's Involved?
 - Sizing your PV System
 - PV by the Numbers – Cost considerations
- Frequently Asked Questions
- Questions?

Today's Solar Market

Growth

- The total size of the U.S. solar market grew 67% from \$3.6 billion in 2009 to \$6.0 billion in 2010.
 - Compared to 2.8% US GDP growth.
- Solar electric installations in 2010 totaled 956 megawatts (MW) to reach a cumulative installed capacity of 2.6 gigawatts (GW).
- The US is expected to be the world's largest solar producer by 2015

Economic Impact

- The US employed 95,000 solar workers in 2010. That's roughly double the number from 2009.
- Anticipated Job Growth Rate, 2011: 26%
 - Compared to 2% for US economy-wide projection

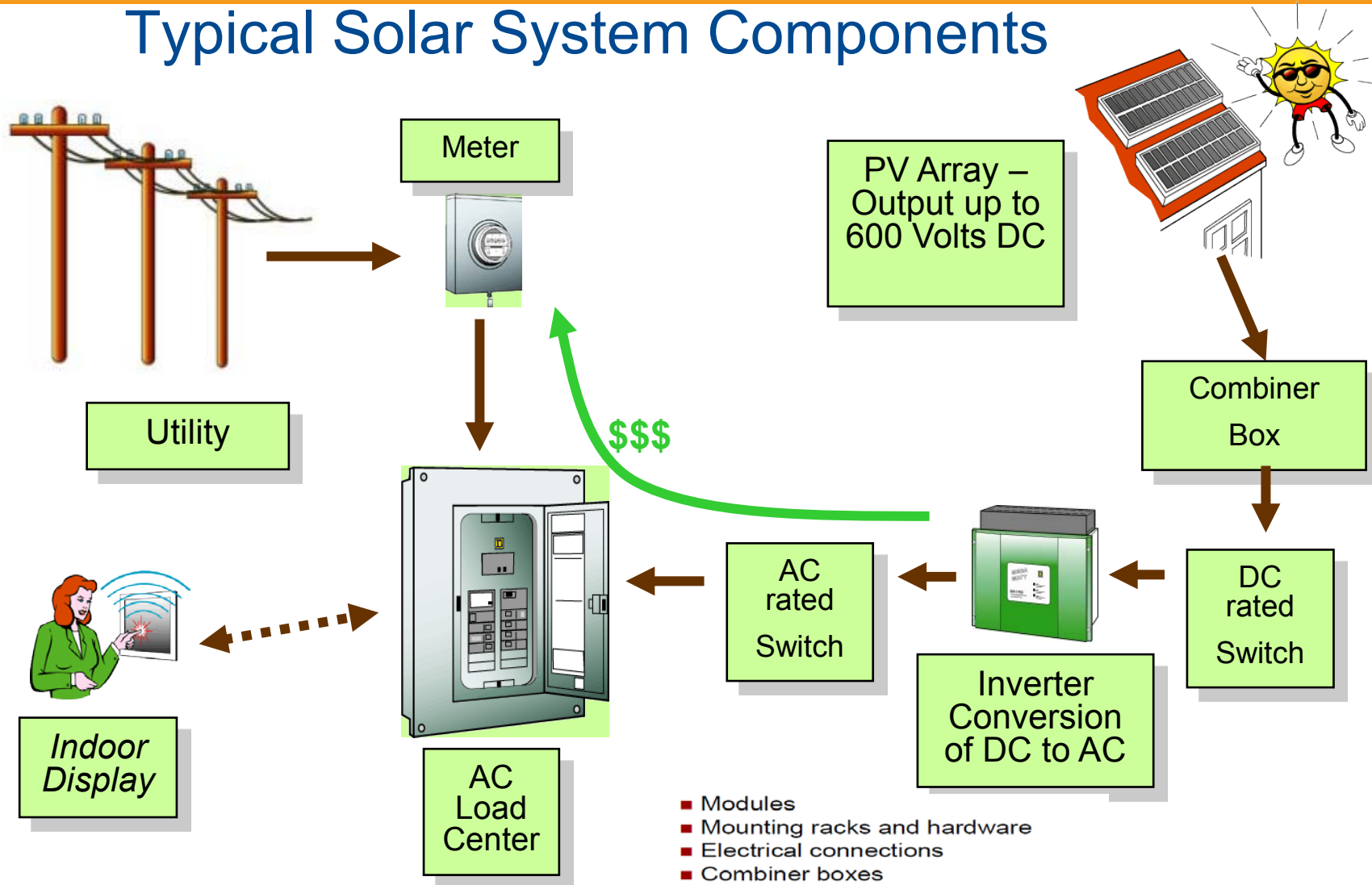
Top 10 States – Installed PV Capacity (2010)

1. California
2. New Jersey
3. Colorado
4. Arizona
5. Nevada
6. Florida
7. New York
8. Pennsylvania
9. New Mexico
10. North Carolina



*The top 10 states represent
85% of installed capacity in
the US*

Typical Solar System Components



- Modules
- Mounting racks and hardware
- Electrical connections
- Combiner boxes
- AC/DC disconnect switches
- Inverters
- Charge Controllers
- Batteries
- Balance of system components

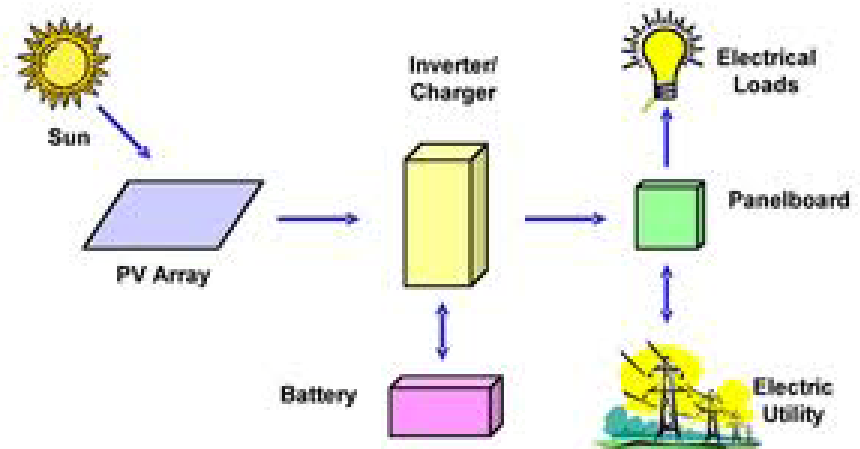
Grid-Tie vs Off-Grid PV System

Grid-Tie (GT) System

- PV System will feed excess power to the Utility Grid
- Grid-tie represents 90% of solar PV market.

Off-Grid System

- Utility connection may not be available
- Battery bank required to support solar components
- Backup generator maybe used for peak load requirements



Is my house a good candidate for solar?

- Location
- Weather
 - Clear, sunny skies better than cloudy skies
 - Temperature not critical for well designed installations
- Direction solar arrays face
 - South preferred, east and west acceptable
- Absence of shade
 - Trees, Flatirons, etc.
- Latitude
 - Lower latitudes better than higher latitudes

Appearance of Typical Residential Installation



$\text{kW output} / 200 = \text{Number of modules}$

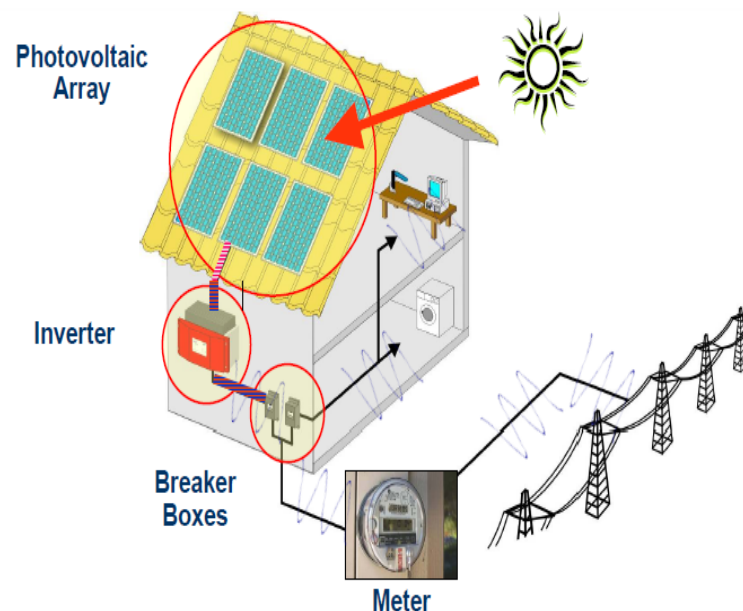
Ex. $5,000\text{W} / 200 = 25 \text{ modules}$

Who is Involved in the Purchase and Installation Process?

- **PV Certified Installer**
 - May be Electrical Contractor, Roofing Contractor or other (NABCEP certification)
- **PV Distributor**
 - Maintains products and components for complete installation
- **Building and Electrical Inspectors**
 - System must be installed in accordance with Local and National Codes
 - NEC Article 690
- **Local Electrical Utility**
 - Awareness that PV system will be connected to the Utility Grid
- **Certifying Agency**
 - Required for Compliance and Rebates, Incentives and other Funding

Sizing your PV System – 3 Easy Steps

1. Determine your energy needs
2. Determine the daily amount of sunlight in your region
3. Calculate portion of your home's energy that you want to power via solar energy

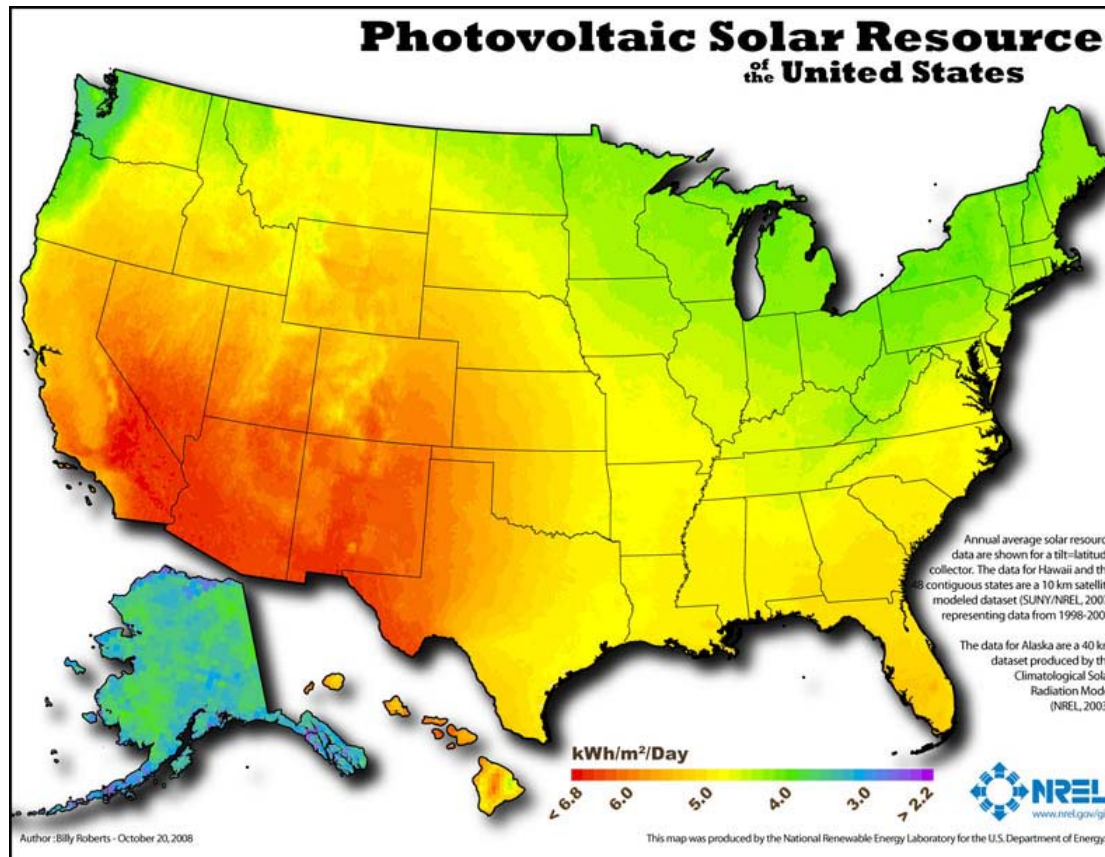




1. Determine your energy needs

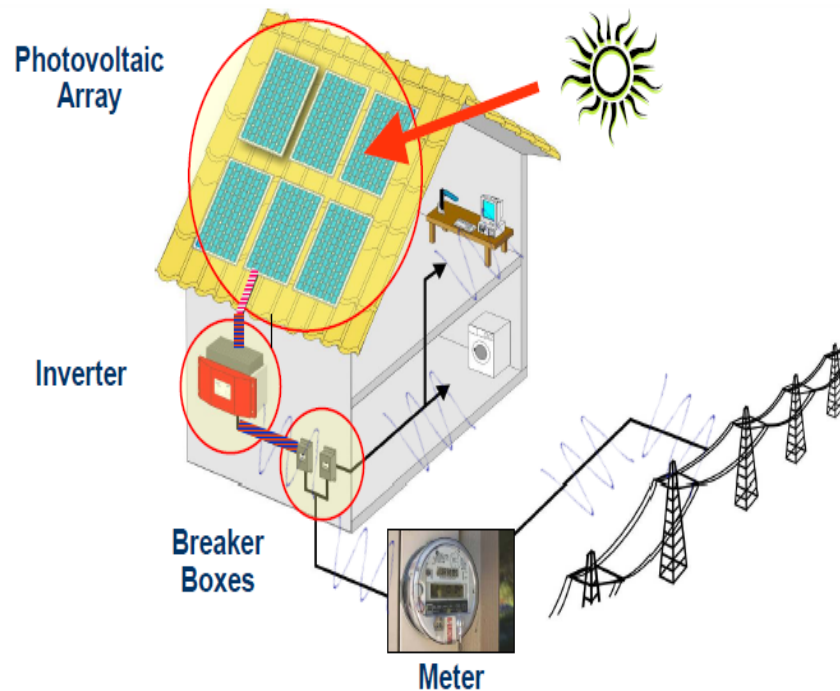
Appliance	AC or DC Watts		Hours Used/Day		Watt Hours/Day
Ceiling Fan	100	x	8.0	=	800
Coffee Maker	600	x	0.3	=	180
Clothes Dryer	4,856	x	0.8	=	3,885
Computer	75	x	2.0	=	150
Computer Monitor	150	x	2.0	=	300
Dishwasher	1,200	x	0.5	=	600
Lights, 4 Compact Fluorescents	4x15	x	5.0	=	300
Microwave Oven	1,300	x	0.5	=	650
Radio	80	x	4.0	=	320
Refrigerator	600	x	9.0	=	5,400
Television	300	x	8.0	=	2,400
Vacuum Cleaner	600	x	0.2	=	120
VCR	25	x	8.0	=	200
Washing Machine	375	x	0.5	=	188
Total					15,493

2. Determine the daily amount of sunlight in your region



The PV Module will produce an average of “x” watt-hrs of electricity daily depending on location (www.nrel.gov)

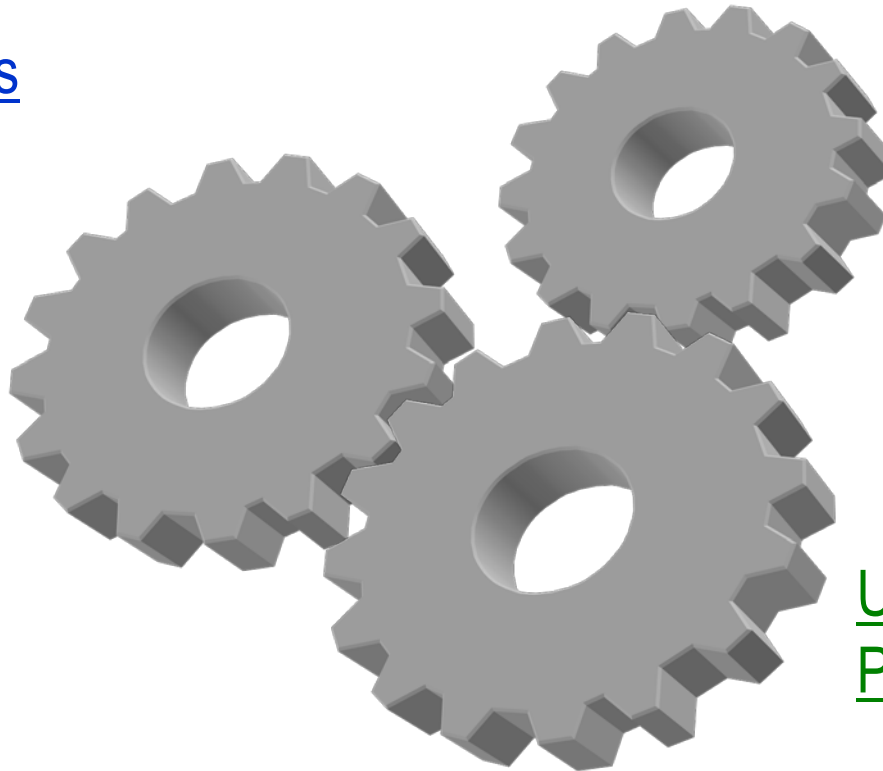
3. Calculate portion of your home's energy that you want to power via solar energy



GT PV System Cost Drivers

State Incentives

- Rebates
- FIT Payments
- Tax Credits
- Tax Exemptions



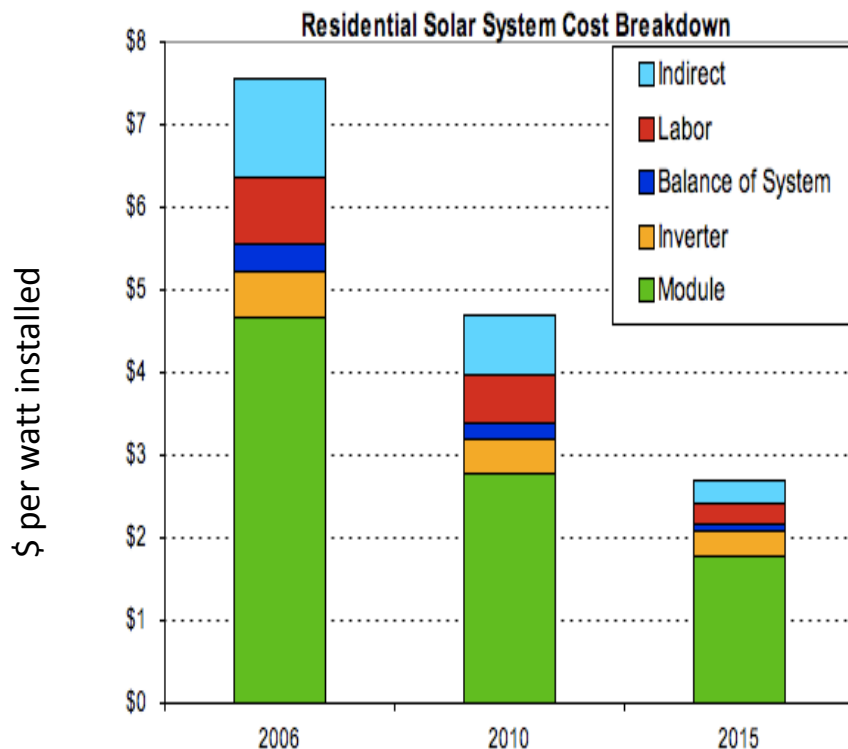
Local Utility Rates

- How much are you being charged per kWh?
- Flat rate or time-of-use?

Utility Clean Power Purchasing

- How much will you get paid for power your PV system produces?

Solar PV System Costs



- Total system cost: ~\$3.00-\$5.00/ watt
- Established solar manufacturers are realizing cost reductions across the value chain and will reduce installed system cost by approximately 40% by 2015



Financing Options for Residential PV Systems

FINANCING OPTION:	Purchase with Cash	Home Equity Loan	Other Loans	Solar Lease	Residential PPA	PACE
Upfront Costs	High Cash purchase includes the full cost of the PV system minus any upfront rebates.	Low There may be fees at the loan closing.	Low There may be fees at the loan closing.	Low Certain plans may also have a down payment option.	Low Certain plans may have a down payment or a prepayment of electricity option.	Low Likely to have an upfront fee; usually less than \$100.
Who owns system?	Homeowner	Homeowner	Homeowner	Solar company	Solar company	Homeowner
Ongoing payments	None	Yes – monthly loan payments	Yes – monthly loan payments	Yes – monthly lease payments	Yes – monthly electricity payments	Yes – monthly escrow payments as part of mortgage*
Who maintains the PV system (or pays to maintain it)?	Homeowner (maintenance contracts usually available)	Homeowner (maintenance contracts usually available)	Homeowner (maintenance contracts usually available)	Usually the solar company but not always	Solar company	Homeowner
Can homeowner take the federal tax credit?	Yes	Yes	Yes	No	No	Yes
Tax deductibility	N/A	Interest on loan	No	N/A	N/A	Interest portion of the assessment
Term of financing	N/A	5-30 years	Up to 10 Years	Up to 20 years	Up to 20 years	10-20 years

*Homeowners without a mortgage will pay their special assessment at the same time as other property taxes are due (annually or bi-annually).

Frequently Asked Questions

What is the payback period of a PV system?

Payback period will vary based on:

- local tax incentives/rebates
- net metering policy
- system location conditions
- system sophistication

How much maintenance is required for PV systems?

A PV system has no moving mechanical parts, so there is typically very little maintenance required. For most people, the only maintenance required is washing off the modules a couple times a year. If you do not want to deal with maintaining your PV system, there are often options to lease a system, where the solar company handles maintenance.

PV Technology is so new. Can it be trusted as reliable?

A PV module has no moving pieces and parts which means there is very little that can go wrong. The solar modules are the most expensive part of a system and in most cases have a warranty of 25 years. That 25-year warranty requires the module to produce 80% of the power in year 25 that they produced in year 1. What other technology offers a 25 year warranty?

Frequently Asked Questions

What is the warranty on PV Solar System?

All Solar modules carry the manufacturers' limited warranty covering them ordinarily for up to 25 years. Inverters carry the manufacturer's limited warranty covering them for 10 years. The installation company warrants the system for 10 years.

What happens at night?

Since solar or PV panel technology requires sunlight to produce electricity, your system will not produce electricity during the dark hours of the night. Your local utility will continue to supply your electricity at night by using up the electrical credit your PV system has built up on the meter.

What happens on cloudy days?

Since solar or PV panel technology requires sunlight to produce electricity, the bulk of your electricity production will take place in sunny conditions. Output is directly proportionate to the amount of sunlight available at any given moment, so systems can generate 50 – 70% of their typical output under bright overcast conditions but production will continue to diminish as less light reaches the surface of the solar panel modules.

In what temperatures will PV System operate?

Most PV Systems will operate efficiently in temperatures ranging from approximately -13 to 122 degrees F (-25 to 50 degrees C). Since PV panels are electronic devices that generate electricity directly from light, not heat, solar panels actually work better in cooler temperature.

Summary

- PV is one of the fastest growing sectors of the US GDP
- The US is poised to take the #1 position in the solar PV market
- Site location is critical to the performance of the PV system
- Residential PV system costs are declining rapidly
 - Currently ~ \$3.00-\$5.00/watt as of 2010
 - Local incentives may reduce system costs by as much as 50%
- PV is a reliable, low-maintenance way to produce clean energy

What Questions Do You Have ?



Where to go for more info on the solar market:

- Solar Research: [NREL: Solar Research Home Page](#)
- Solar Energy News: <http://www.renewableenergyworld.com/rea/home/solar-energy>
- Solar State Incentives: <http://dsireusa.org>



APPENDIX

FAQ

- **Do I have a good site for a solar system?** Your site must have clear, unobstructed access to the sun. Buildings, other houses, trees or other type of obstruction should not shade your site. In the Northern Hemisphere, a South-facing roof exposure is best, but roofs facing east and west may be OK. If a rooftop is not available, a solar system can also be mounted on the ground.
- **How can I calculate the approximate size of a solar system for my site?** You can match the size of your system to your electricity needs and budget. The average household in California uses about 6,500 kilowatt-hours (kWh) per year. If your usage is typical of the average household, a system in the 3 to 4 kilowatt (kW) range would be adequate to meet most of your electricity needs. To estimate the best system size for your home or business, divide your annual electricity usage (in kWh per year) by 1,825 kWh (average annual output of a 1 kW system) to get the system size (capacity in kilowatts) that would meet most of your electricity needs. Because of budget or space limitations, a smaller system could be taken under consideration to meet a determined percentage of the total electricity usage.

FAQ

- **Can I increase the size of the PV Solar System panels at a later date?**

A: Yes, provided you have the available space at your location.

Will I need approval from my homeowners association for a residential solar system?

A: Normally you will need approval from your architectural committee (consult your CC&R's and Association By-Laws). However, in the State of California any covenant or restriction that effectively prohibits or restricts the installation or use of a solar energy system is void and unenforceable as a matter of law. California Civil Code 714.

Can I add battery back up at a later date?

A: If you start out with a system that utilizes battery backup, it is easy to add more. However, if you start without backup, it will be rather expensive to add batteries due to the high cost of adding a different type of inverter. A system without battery-backup uses a different inverter than those with battery backup. A PV Solar Energy System available through Solar Energy Exchange, Inc. is designed without battery back-up. For more information on solar battery back up, call Solar Energy Exchange, Inc. at (888) 323-7782.

How long will it take to install?

A: It typically takes 2-3 days for the professional installation of PV Solar Energy System. Solar Energy Exchange, Inc. has a team of reputable and professional installers that will complete the job to your satisfaction. Solar Energy Exchange, Inc. will assist you from the purchase of your system to the flick of the switch that turns it on.

What about the environment?

A: A PV Solar Energy System uses no fuel and produces no pollutants. Our smallest systems reduce greenhouse gas emissions as effectively as planting a grove of 50 mature trees.

FAQ

- **What is Net Metering?**

Net metering is a result of regulations that obligate utilities to allow excess energy generated by solar PV systems to be sent to the grid, thus spinning the meter backward. This arrangement allows all electricity produced by your PV Solar Power System to be used to offset your utility bill. When your PV Solar Power System produces more electricity than you consume, your meter will spin backwards.

What happens during a power outage?

Your PV System is designed to shut down during a power outage to prevent possible injury to those working to restore power.

Questions for your solar installer

- <http://www.sfenvironment.org/downloads/library/installingsolarfaq.pdf>

Certification - NABCEP

- NABCEP – North American Board of Certified Energy Practitioners
- Certification not required to become dealer, but we do recommend becoming NABCEP certified.
- 2 tests are administered:
 - NABCEP entry level test – passing this test provides no certification
 - Offered during annual AEE Solar Dealer Conference
 - NABCEP Certified PV installer test - must complete education component and job experience component to qualify to take the NABCEP Certified PV Installer test
- There are 7 different paths you can follow to qualify to take test.
 - Refer to www.nabcep.org for details
 - Simplest path for newcomers is completing SEI Beginning AND Advanced classes and perform 2 system installs as the project lead.

How A Solar Cell Works

- Light energy is the fuel that frees electrons, creating voltage
- Internal electric field pushes electrons to front of the solar cell
- Voltage potential (DC) is created when exposed to sunlight
- Direct current (DC) flows when a load is connected
- Solar cells never “run out” of electrons
- Solar cells do not store energy

