

# Residential Solar Workshop

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Presented By



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## Workshop Agenda

- An Overview of Solar Electric Systems
- Sizing a Grid-Tie Solar Electric System
- Purchase Parameters & Environomics
- Example System Impact
- Solar Information Sources





## An Overview of Solar Electric Systems



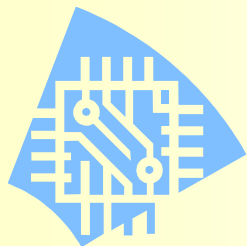
## Photovoltaics or 'PV'

"Photovoltaic" refers to the creation of voltage from light, and is often abbreviated as just "PV."

A more common term for photovoltaic cells is "solar cells," although the cells work with any kind of light and not just sunlight.

## Silicon: The common thread in PV

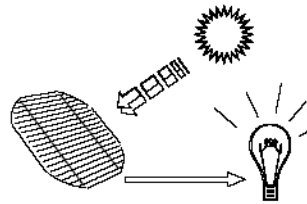
There are many materials that can be used to make solar cells, but the most common is the element silicon.



This is the same silicon that is used to make computer chips, and some of the processing steps involved in making solar cells are similar to the steps in making computer devices.

## What Are Solar Cells?

- **Thin wafers of silicon**
  - Similar to computer chips
  - But much bigger and much cheaper!
- **Silicon is abundant (sand)**
  - Non-toxic, safe
- **Light carries energy into cell**
- **Cells convert sunlight energy into electric current- they do not store energy**
- **Sunlight is the “fuel”**



## PV Modules: i.e. Solar Panels



**Crystal Silicon  
Poly- or Multi-Crystalline**



**Crystal Silicon  
Single- or Mono-Crystalline**

## Varieties of Solar Panels



**Thin-film  
Vapor Deposited  
Amorphous Silicon**



**Thin-film  
Vapor Deposited  
Cadmium Telluride**

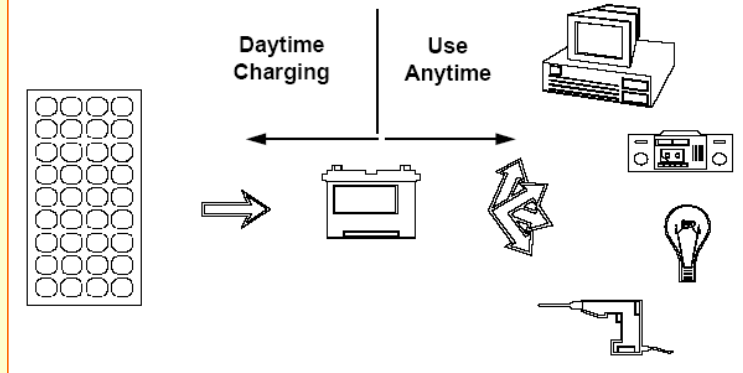


## Solar Electric Systems

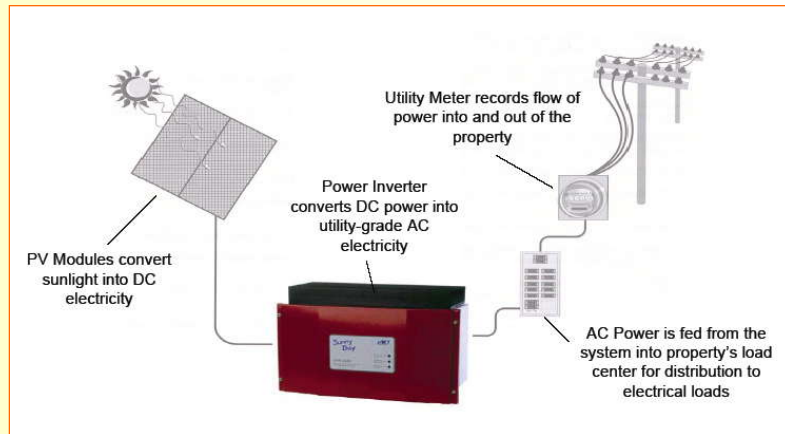
- Battery Back-Up
- Grid-tie

## Basics of a Battery Back-Up System

### Battery and Module Work Together



## How a 'Grid-tie' System works





## Sizing a Grid-tie Solar Electric System

### Sizing A Grid-tie System: Important Terms

**KILOWATT (kW)** 1000 watts. A measure of power - one kilowatt is equal to 1,000 Watts or The power required to run ten 100 Watt light bulbs in any instant.

kW's are the standard method by which solar electric systems are categorized. Most residential systems are between 1kW and 10kW.

**KILOWATT-HOUR (kWh)** Unit of energy used to perform work. A kilowatt hour is the amount of kilowatts of electricity used in one hour of operation.

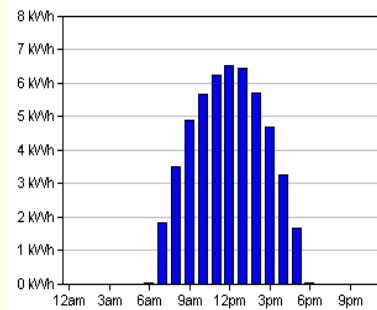
kWh's allow one to compare the output of a solar electric system to how your servicing utility measures your power usage

## Kilowatts to Kilowatt-Hours Translation

As a baseline, a properly installed, south facing grid-tie solar electric system should generate between 1,600 kWh and 1,800 kWh annually per installed 1 kW (1,000 Watts-DC)

A number of factors will reduce the efficiency of a solar electric system from it's ideal output.

- Summer efficiency is generally 70-75% of peak rating
- Winter efficiency is generally 80% to 85% of peak rating



10kW Daily Output – June Average

## Sizing A Grid-tie System

### STEP 1: Collect Data

Sizing your proposed solar electric system requires knowing the answers to the following questions:

#### A. What is your monthly electrical usage?

Your utility bills will show you how many kilowatt-hours of electricity you use on a monthly basis.

#### B. How much can you reduce your electrical use?

In residential settings, it is almost always less expensive to reduce energy use than it is to purchase more renewable energy generating capacity.

#### C. What percentage of electrical needs do you want to meet with your system?

Although you may want to generate all of your electricity with the sun, many solar electric system owners begin with a small system to supplement their main supply of electricity.



## Sizing A Grid-tie System continued

### STEP 2: Use Data to Size System

With the previous information, you can estimate the size of the solar system you need. **These steps should be assisted by your selected solar contractor.**

#### A. Determine number of panels needed.



#### B. Determine inverter size.



#### C. Identify suitable locations for the system



## Physical Site Assessment

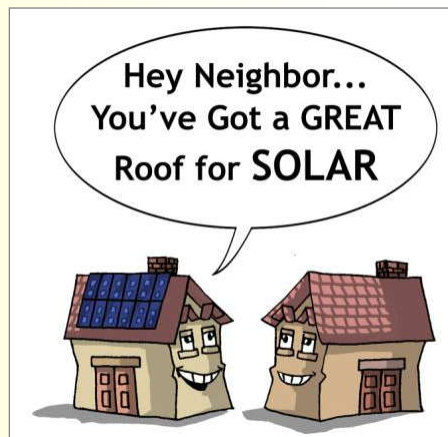
### STEP 3: Evaluation of Site Specific Details

In performing a physical site evaluation, a standardized evaluation is conducted to assess the site for the suitability of integrating a solar electric system.

Two of the high level evaluation factors are as follows:

#### A. Solar Access

#### B. Integration Complexity

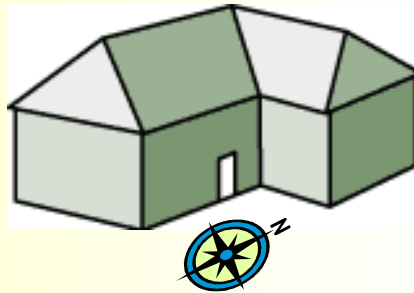


## Physical Site Assessment continued

### A. Solar Access

Solar access is defined as the ability of sunlight to reach a PV module (solar panel) unimpeded by trees, fences, buildings, or other obstruction. Obstructions mean shade, and shade is the bane of PV systems

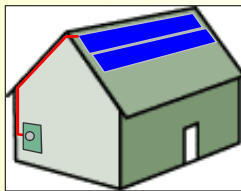
A grid-tie solar electric system is comprised of a number of solar panels that ideally oriented south with a pitch angle between 10 and 33 degrees (west and east orientations are acceptable, north facing PV arrays are unacceptable).



## Physical Site Assessment continued

### B. Integration Complexity

Integration complexity pertains to the intricacy of installing the PV array at a location with suitable solar access what's required to run the solar generated power (back-feed) to the site's electrical service. The site electrical service need also be examined for suitability

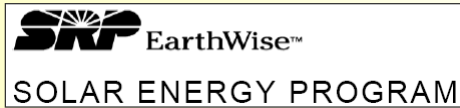


## Design thru Install Milestones

- Site Visit and/or Plan Review, System Sizing and Deposit
- Utility Program Reservation
- **HOA Notification**
- Design & Engineering
- Utility Interconnect Process
- **AHJ\* Building Permit**
- On-Site Construction
- AHJ & Utility Inspection



\* Authority Having Jurisdiction (AHJ); Such as County or Municipal Building Inspection Entity



## Purchase Incentives

## Utility Incentives

### Arizona Public Service – EPS Credit Purchase Program

Applies To: Residential and commercial customers of Arizona Public Service Co.  
 System Type: All Systems (on- and off-grid)  
 Amount: \$3.00 per Watt-DC for grid-tied  
 \$2.00 per Watt-DC for off-grid

### Salt River Project – Solar Incentive Program

Applies To: Residential and commercial customers of the Salt River Project  
 System Type: All Systems (on-grid only)  
 Amount: \$3.00 per Watt-DC up to a max of \$30,000 per system

### Tucson Electric Power – SunShare Program

Applies To: Residential and commercial customers of Tucson Electric Power Co.  
 System Type: Grid-connected systems only – no battery back-up  
 Amount: \$3.00 per Watt-DC up to 15 kW-AC for grid-tied only

## Available Tax Credits

### US – Income Tax Credit

Applies To: Retail sale of solar-electric systems  
 System Type: Residential or Commercial on- and off-grid  
 Amount: 30% of system cost; \$2,000 maximum for residential; one-time

### State of Arizona – Personal Income Tax Credit

Applies To: Retail sale of solar-electric systems used in residential applications  
 System Type: Residential or Commercial on- and off-grid  
 Amount: 25% of system cost; \$1,000 maximum for residential, \$25,000 maximum for commercial; one-time

### State of Arizona – Sales Tax Exemption

The expenditures on the construction of a solar electric power system is exempt from Arizona State & County Sales Tax. The remaining balance is taxed at the standard rate for contracting services. Note: Municipalities do not exempt solar electric power systems from sales tax.

## Example of Purchase Incentives Applied

### 3kW Grid-tie PV System (3,000 Watts)

<b>Installed System Cost:</b>	<b>\$21,000</b>
Utility Rebate (@ \$3 per Watt):	-\$9,000
State Tax Credit (max \$1,000):	-\$1,000
Federal Tax Credit (max \$2,000):	-\$2,000

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**Total Project Cost  
After Incentives: \$9,000**

## Environomics of a 3kW System

**A 3kW System generating 5,400kWh on annual basis  
results in the following Solar Power Environomics:**

lbs/Co2 Annually	Cars not driven	gallons of gasoline	Barrels of Oil	Acres of Pine or Fir storing carbon	BBQ propane cylinders	tons of waste recycled not landfilled
9256	0.77	477	9.8	0.95	175	1.4

\* Figures based on 1800kWh/kW annually

\* Sourced from <http://www.epa.gov/cleanenergy/energy-resources/refs.html#pineforests>

## Payback & Return on Investment

Here are two examples of the costs, incentives and simple payback associated with the installation of a system:

### SRP Example

Size	Typical cost*	SRP EarthWise payment	Arizona tax credit	Federal tax credit	Net cost	Annual savings**	Simple payback****
3 kW	\$21,000	\$9,000	\$1,000	\$2,000	\$9,000	\$510	14 years

### APS Example

Size	Typical cost*	APS Solar Partners payment	Arizona tax credit	Federal tax credit	Net cost	Annual savings***	Simple payback****
3 kW	\$21,000	\$9,000	\$1,000	\$2,000	\$9,000	\$663	11 years

\* Costs may vary depending upon the contractor and materials you select

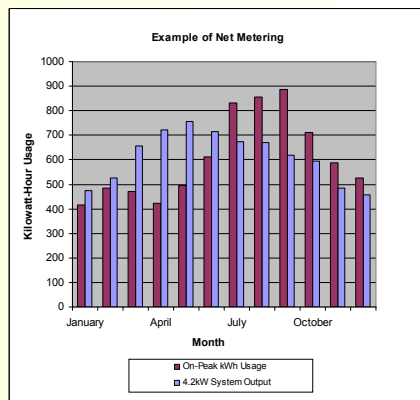
\*\* SRP Savings are calculated based on an annual solar energy production of 1,700 kWh per kW-DC at \$0.10/kWh

\*\*\* APS Savings are calculated based on an annual solar energy production of 1,700 kWh per kW-DC at \$0.13/kWh

\*\*\*\* Simple payback estimates an annual 3% utility rate increase

## What happens if my solar electric system (APS) produces more energy than I use?

Through APS' Net Metering, the customer shall receive the full retail value of the energy components (charges assessed on a kWh basis) of their Standard Retail Rate for the power fed into the system from the customer-owned solar electric system



## What happens if my solar electric system (SRP) produces more energy than I use?

SRP will pay you for any excess energy you generate. At the end of the month SRP's billing department will examine how much your system generated versus how much energy you used from SRP.

If your system generated more electricity than you used, SRP will credit your account a dollar amount based on the applicable wholesale rate.



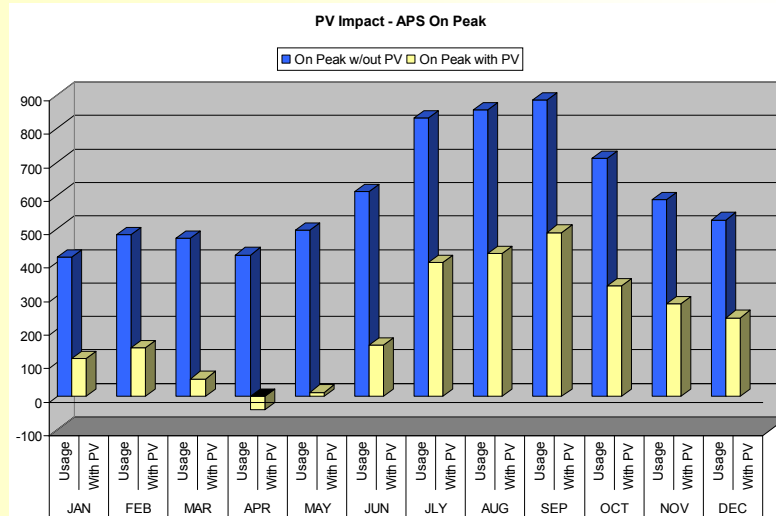
**Example  
4.2kW System  
Usage Offsets**

### Example Grid-tie System Sizing: "The Smiths"



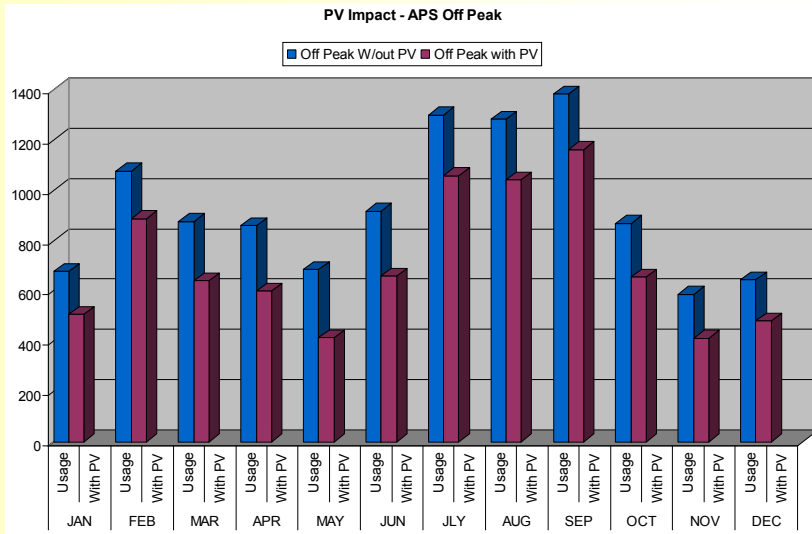
- **Pitched, South Facing Roof (estimated at 1,000 sq ft)**
- **APS Servicing Utility (On-Peak/Off-Peak Rate Schedule)**
- **Annual Usage: 18,459 kWh**
- **Selected System: 4.2kW**

### Impact of 4.2kW System on On-Peak Usage

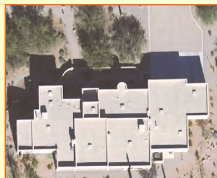




## Impact of 4.2kW System on Off-Peak Usage



## Example Grid-tie System Sizing: "The Jones"

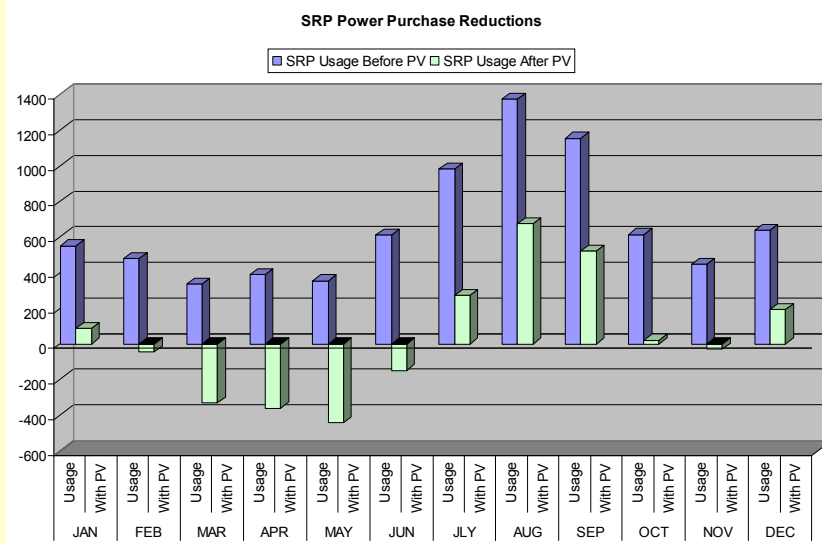


- Flat, Segmented Roof (estimated at 1,000 sq ft)



- SRP Servicing Utility (Standard Rate Plan)
- Annual Usage: 7,936 kWh

## Impact of 4.2kW System on SRP Usage



**Major System Components & Warranties**

## Typical System Warranties

### Solar Panels

- Typically 20 to 25 years

### Inverter

- Generally 5 to 10 years

### Workmanship of Install

- Generally 2 to 5 years



## Solar Information Sources

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### Utilities

- [www.SRP.net](http://www.SRP.net) (Query EarthWise Energy Program)
- [www.APS.com](http://www.APS.com) (Query Solar Partners Program)
- [www.TEP.com](http://www.TEP.com) (Query SunShare Program)

### Industry Websites

- [www.azsolarcenter.com](http://www.azsolarcenter.com) (local solar resources)
- [www.solarbuzz.com](http://www.solarbuzz.com) (solar industry news)
- [www.dsireusa.org](http://www.dsireusa.org) (database of incentives)
- <http://www.rc.state.az.us/> (AZ registrar of contractors)

## Questions/Answers & Next Steps

