# Residential Photovoltaic (Solar Electric) Grid Tie Systems

Residential photovoltaic systems are appearing across the Arizona landscape. Current trends show an increasing number of urban and rural installations as Arizonans search for energy stability and security. Both Remote location and Grid-Tie photovoltaic systems are incorporated into Arizona lives, even when costs of local energy supplied by utilities is lower.

In response to the Arizona Corporation Commission implementation of the Environmental Portfolio Stand-ard directing Arizona utilities to provide a portion of their energy from renewable sources, utilites are providing incentives and buydowns to their customers who purchase and install solar systems.

## HOW TO CHOOSE A PHOTOVOLTAIC (P.V.) SYSTEM

**DO NOT THINK ABOUT PV WITHOUT CONSIDERING ENERGY EFFICIENCY .**

PV only makes sense when electricity is consumed efficiently. Energy efficiency is the key goal before considering any PV system, since it will have a direct impact upon the type and quantity of PV equipment needed.

## FIRST STEPS

* Consider an energy audit which is
* Consider energy efficiency
  - Insulation
  - Effective windows and covers
  - Roof exposure and impacts
  - Efficient appliances
  - Time of use utility rates
  - Site conditions
  - Architecture and construction
* Use Passive solar techniques to mitigate negative conditions, and take advantage of site resources to reduce power requirements.

There are 2 types of photovoltaic applications: those connected to an existing power grid (Grid-Tie), and those independent from any power grid (Stand Alone).

## GRID TIE SYSTEM TYPES

There are two applications
**GRID-TIE**
**GRID-TIE WITH BACKUP**

### Choosing a System

System choice is based on
*What do you need it to do?
*How much power do you want?
*What is the daily & annual profile of power use and projected need?.
*What happens if the power system (Utility or PV) fails?

## GRID TIE SYSTEMS

Grid tie systems are connected to the utility grid system, generate electricity during daylight hours, and rely on utility provided power at night.

Grid-Tie Systems
* The simplest & the cheapest,
* Provide power whenever the sun is shining, reducing use of utility provided electricity and reducing utility bills
* Relies on the utility connection to provide energy at night or if the PV system is down
* Excess energy can be sold back to the utility (net metering)
* There is no back-up if the Utility has a power failure.

NOTE: Each utility has its' own policy regarding: buy-back energy. While Net Metering is the ideal (value of energy from the Utility is the same as that from the Owner) this is not the case with some Arizona utilities, where buy-back energy is valued at a lower rate,

### GRID TIE COMPONENTS

PV array – The part of the system that converts sunlight to electricity

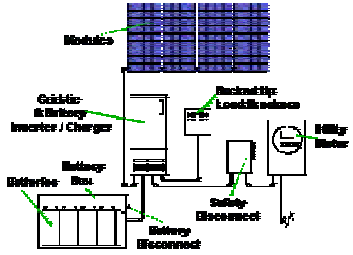
Inverter – The part of the system that changes the quality of the electricity the panel produces DC (Direct Current) to the quality required by the building equipment. AC (120 volt Alternating current)

Safety Switch – So the Utility can shut system off in emergencies or work

## GRID-TIE WITH BATTERY BACKUP SYSTEMS

Systems connected to the utility grid but have energy storage in case of utility power failure.

Grid-Tie with battery systems
* Provide power whenever the sun is shining, reducing dependency on utility provided electricity, and reducing utility bills.
* Provide additional security should utility energy delivery system fail
* Provide more flexibility on power management
* Provide limited power for critical uses in case of utility power failure Back-up power and time depend on Battery and Inverter choices.
*Require battery maintenance
*Amount of solar power available depends on array and inverter




## GRID TIE WITH BATTERY BACK-UP COMPONENTS

* PV array – Converts sunlight to electricity
* Inverter – Changes PV direct current to 120vAC used by house
* Safety Switch – Shut system off in emergencies or work
* Batteries – Store energy for night use or utility power failure
* Battery Cut-Off switch – Shut off battery connections for maintenance and safety.

## SYSTEM INFO

Both Grid-Tie and Grid-Tie with Batteries applications utilize the same type of Photovoltaic equipment - panel modules and arrays, and Inverters.

### SOLAR MODULES

Solar modules that convert sunlight to electricity are very similar for all systems, with larger modules being normally cheaper in terms of dollars per watt delivered. oler.

Module mounting for the panels and arrays can be fixed or tracking. In both cases, modules should be oriented facing the sun, and tracking the sun increases the amount of power from an array.

A current development in photovoltaic modules and engineering plastics is toward Building Integrated PV (BIPV), that makes the systems a part of the building structure, so the PV system is both the roof, or wall, as well as the power generator of the building.

### INVERTERS

Inverters convert DC (direct Current) electricity to AC (alternating current) electricity.

### Grid-Tie Inverter choice considerations

Power – Maximum high and low voltage power the Inverter can handle

Efficiency – How efficiently does the Inverter convert solar power to utility power?

Nighttime Power – How much power does the Inverter consume from the utility grid when there is no sunshine?

### Grid-Tie with Battery Backup Inverter considerations

* How much power is needed.
* How efficient is the battery charger?
* Will the Inverter control a backup generator?
* What other equipment will be a part of the system?

Additionally, there are application elements to be considered.

### MODULE MOUNTING

Module mounts are used to position the collector relative to the sun. There are fixed mounts and trackers (which increase the amount of power from an array). Where these are placed affects performance and aesthetics.

### BATTERIES

Batteries store DC electricity for later use.

*Use ONLY deep cycle batteries.
*Wet batteries need to be checked for fluids and tightness at least every 6 months
*Sealed batteries do not need water but may not last as long as wet batteries.

*Capacity – Larger capacity stores more energy and are more expensive.
*Voltage of the batteries MUST ALWAYS be matched to the iinverter.
*Never run more than 4 parallel strings of batteries. Since batteries do not share loads equally, the life of the battery bank may suffer.
* Safety –
Keep in a well ventlated area
Use insulated tools

## OTHER COMPONENTS

### Charge Controllers –

(Solar Battery Charger) Conditions the power from the solar module to charge a battery.

### Disconnects and Switches –

National Electric Code requires disconnect for safety of owners and workers.

### Remote Controls –

Many systems offer remote controls for convenience.

### Meters –

Collects data about the system's performance Useful for isolating performance problems Often linked to the Remote Control package.

## COMMON QUESTIONS

**Can run my air conditioner on solar?**

In principle yes, but in practice it is not economically feasible. In a line tie system the energy savings realized by the solar power generated will offset some of the power needed to run an A/C unit

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**How Much Does a Solar System Cost?.**

Currently installed cost is about $8 to -$9 per watt, before incentives. Incentives include a State tax credit; a State sales tax exemption ;and utility buy-down programs which significantly reduce the overall cost of a photovoltaic system.

**What is the Payback Time?**

With a solar PV system you are buying power at a known fixed cost of todays market. Payback can be calculated by guessing future energy value impacted by supply,, inflation rates, and other market factors.

**Can the Meter Spin Backwards?**

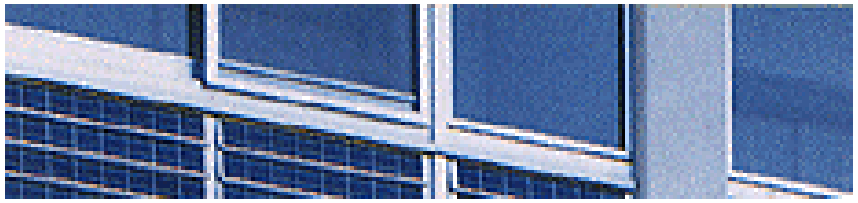
Yes, if more energy is generated than used, it can be put into the utility grid and the Owner compensated. The compensation rate depends on the utility company and State requirements and law.

## How Do I Get More Information?

* Ask PV system owners .
* Call the utility company.
* Find a local PV dealer in the phone book.
* Check Magazines – Solar Today and Home power magazines are the most widely available sources of information on photovoltaic systems.

Check the Internet

Arizona Solar Center www.azsolarcenter.com
Az. Dept. of Commerce Energy Office
www.commerce.state.az.us/energy
PV & systems manufacturers sites
National Renewable Energy Lab
www.NREL.gov
U.S. Dept. of Energy www.doe.gov
California Energy Commission
www.energy.ca.gov
Florida Solar Center
www.fsec.ucf.edu



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