

U.S. DEPARTMENT OF ENERGY



# SOLAR DECATHLON 2009

## Solar Systems for Existing Residential Installations

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Innovation for Our Energy Future



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## Overview

Historically, Solar systems have been very expensive and complicated to install. Recent technology improvements and federal/ state incentives have improved resulting in increased awareness and demand. The majority of the residential Solar photo voltaic systems being installed today are placed in existing homes This information is targeted at homeowners and builders interested in purchasing a solar system for their application.

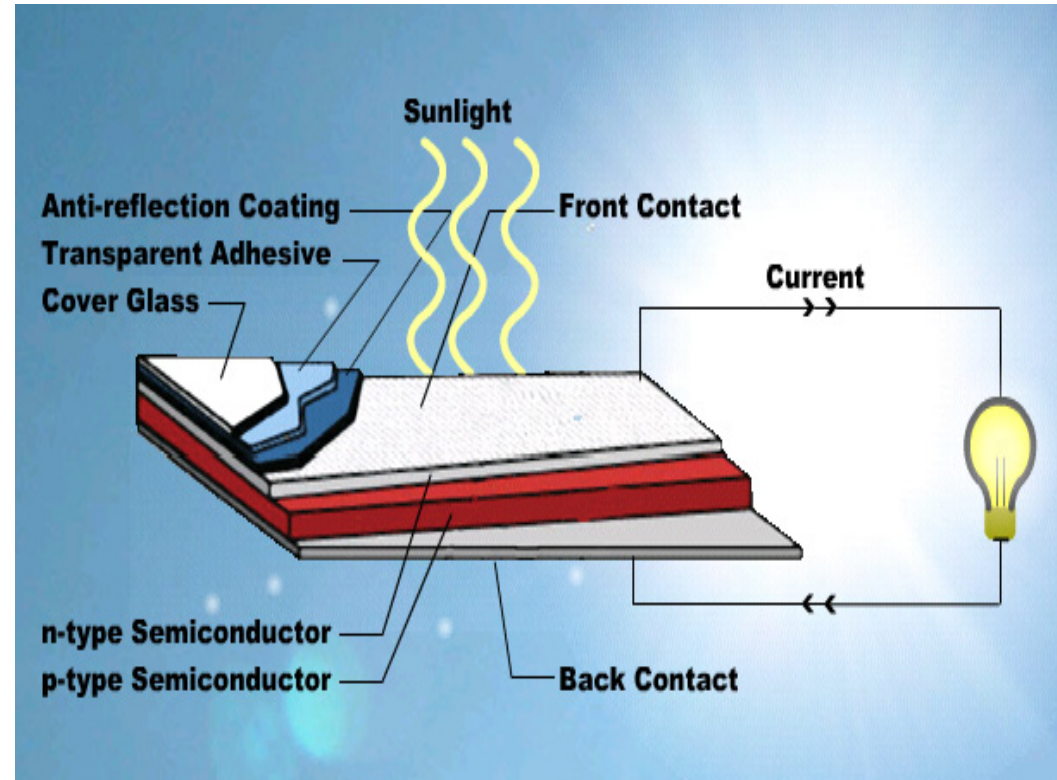
The presentation will include:

- Basics of the Solar PV System
  - System components
  - How the system works
  - Power generated by the PV System
- Understanding the investment and benefits
  - Awareness of incentives and tax credits
  - Typical cost for an average home
- Site location and Aesthetics considerations
- Selection of a Certified Installer
  - Installation steps
- Monitoring and maintaining the system



## First - How Does A Solar Cell Work?

- 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

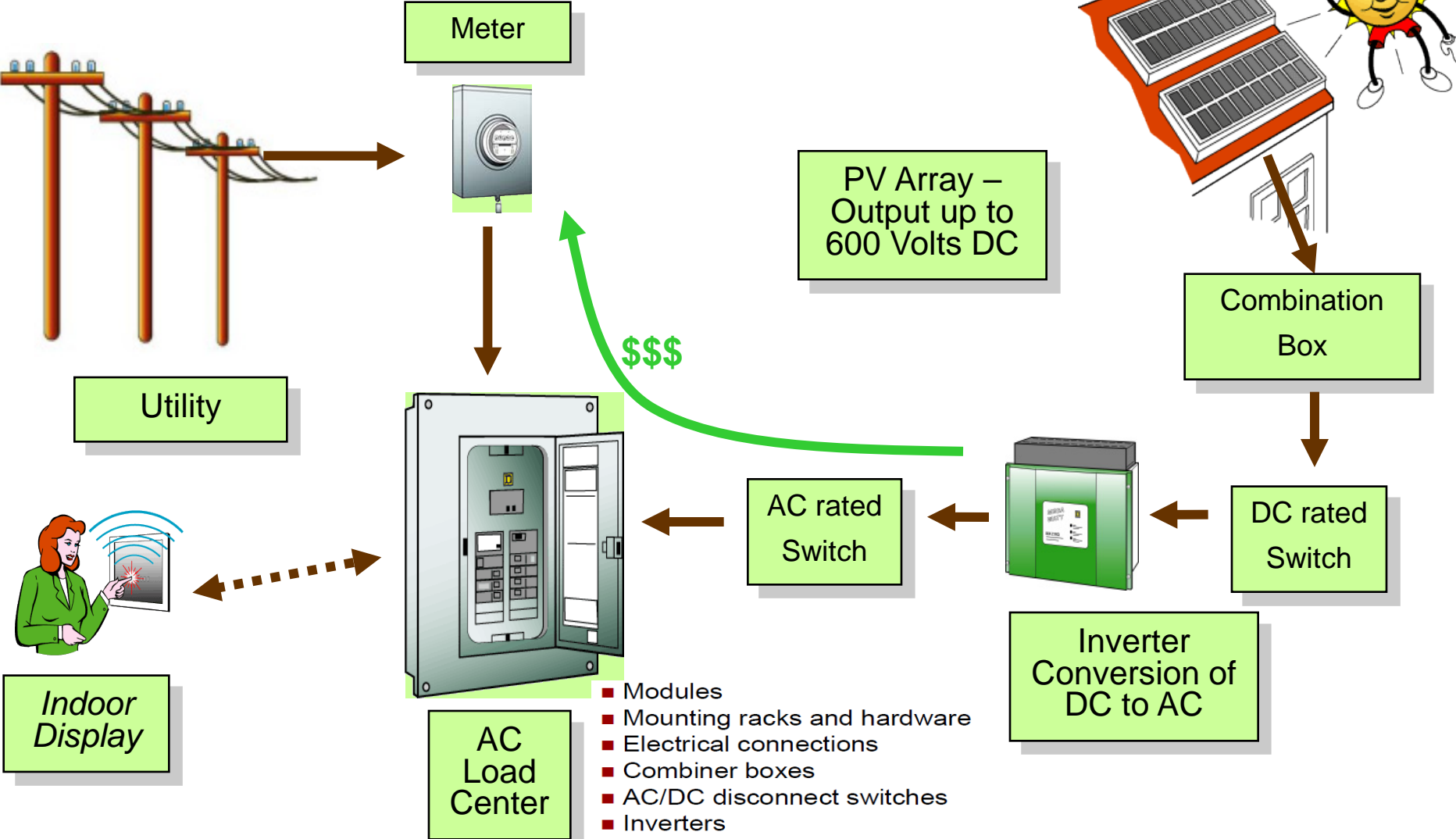




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## Typical Solar System Components



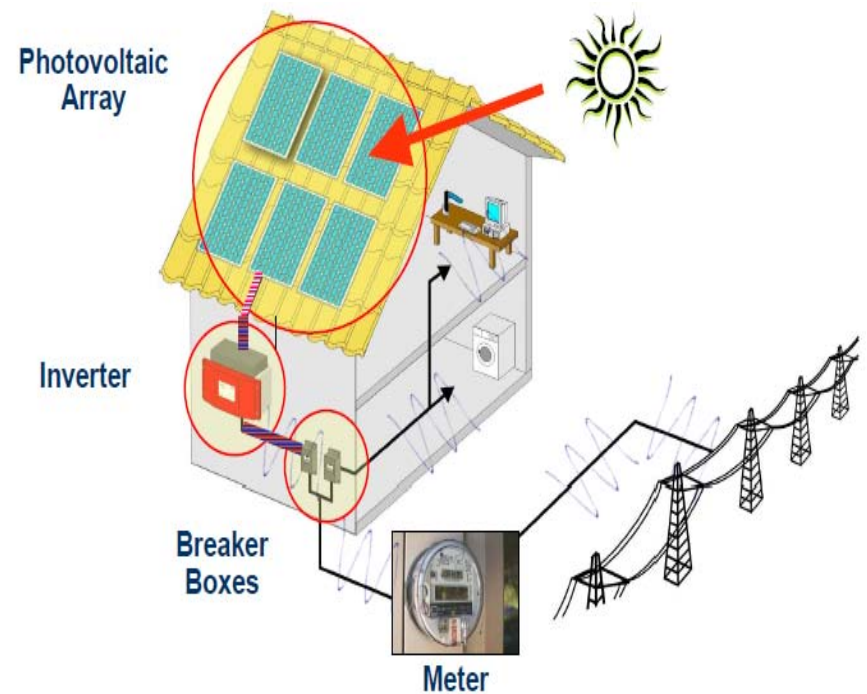
- Modules
- Mounting racks and hardware
- Electrical connections
- Combiner boxes
- AC/DC disconnect switches
- Inverters
- Charge Controllers
- Batteries
- Balance of system components





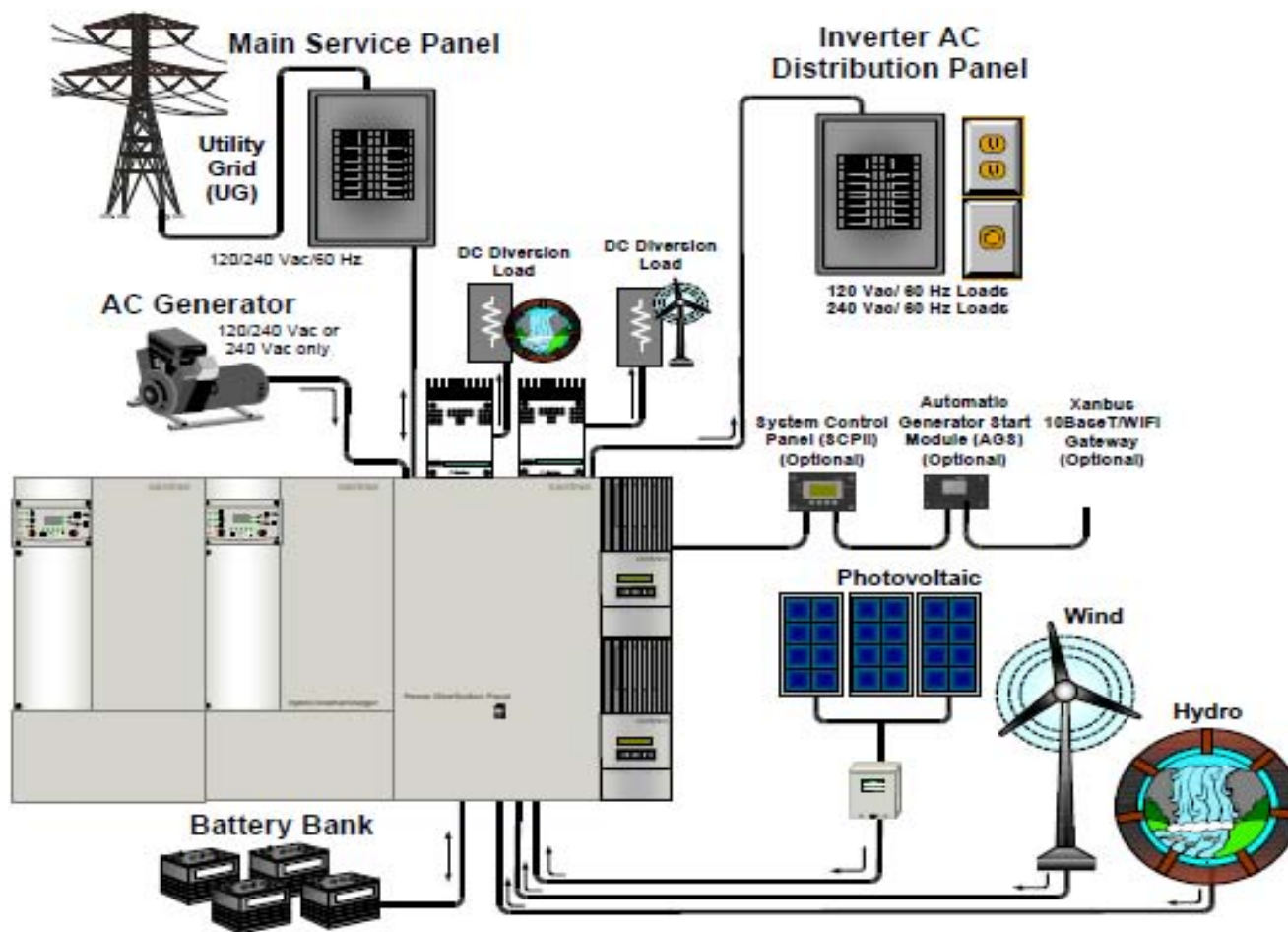
## Grid Tie vs Off Grid System

- Grid Tie 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





## Grid Tie PV System with Backup Power





## How to Get Started

- Obtain information at this event
- Inquire local or state energy agency
- Certification agencies –
  - North American Board of Certified Energy Practitioners ([www.nabcep.org](http://www.nabcep.org))
  - Univ of Central Florida Solar Research Center ([www.fsec.ucf.edu](http://www.fsec.ucf.edu))
- Federal Government information – Dept of Energy and National Renewable Energy Labs



## Who is Involved in the Purchase and Installation Process?

- **PV Certified Installer**
  - May be Electrical Contractor, Roofing Contractor or other
- **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





## System Sizing and Cost Considerations

- Typical residential system size is 3,000 – 5,000 Watts
- Residential systems average \$6-\$8/Watt installed based on size of system
- Federal and State Incentives can reduce cost by 50%
- Map indicates the avg hours of solar available/day
- A Grid Tie System will not produce power when grid is down due to safety considerations



Above diagram shows average sunhours for month of December



## Appearance of Typical Residential Installation





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# Enhanced System Installation







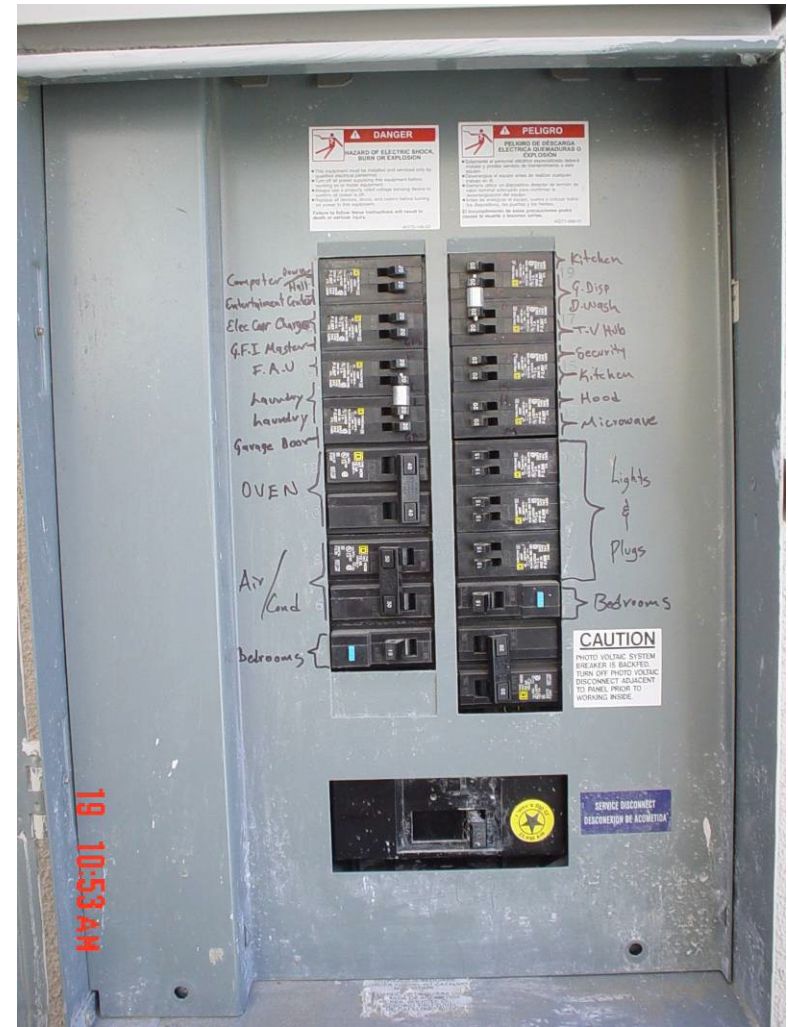
## Installation of PV Modules



Photos courtesy of Solar Energy International



## Installation of AC Electrical Components







## Steps in the Process Site Analysis & System Design

- Site analysis and system design should be conducted by properly trained PV designer
  - AEE Solar offers design assistance, but design is ultimately the responsibility of the dealer
  - Beginning and Advanced PV training are very important
- Solar Site Analysis
  - **Shade is the enemy of PV** - small area of shading on only one module can cut production of an entire string by 90%!
  - Best to have no shade anywhere on array from 9 AM to 3 PM
  - Enphase & National Semiconductor have products to mitigate the effects of shade
  - Proper site analysis required for power production estimates.
- System sizing criteria
  - Budget
  - Available mounting area
  - Usage - Offset entire annual usage.
  - Usage - Offset highest bracket for fast ROI on tiered rate users



## System Design (cont.)

- Array orientation
  - South facing arrays best, southeast & southwest facing arrays are good, and east and west facing arrays may be acceptable if using “time of use” metering.
- Tilt angle
  - Roof mounts - in urban/suburban areas, solar arrays are normally mounted at the same pitch as the roof with a 4-inch minimum airspace under array for convective cooling.
  - Ground or pole mounts - Determine optimum tilt angle from design books or web tools for best year-round production.
  - Adjustable racking allows varying tilt to maximize summer vs. winter production – common in off grid systems, rare in grid tie applications.
  - Trackers are common in pole mount systems in rural areas, or with direct PV water pumping systems. Trackers are generally not advisable in grid tie or urban areas.
- Use **Google Earth** to determine if suitable unshaded mounting area is available (high-resolution images not yet available for all areas).



## PV System Training

- Initial training and ongoing training are both very important!
- Solar Energy International (SEI) - [www.solarenergy.org](http://www.solarenergy.org)
  - AEE Solar training partner
  - The **premier training institute** for solar and renewable energy
  - Grid-tie, off-grid, wind, micro-hydro, water pumping, sustainable building
  - Top-notch hands-on training facilities in Carbondale & Paonia, CO
  - Hands-on classroom trainings conducted regionally in the US
  - Online trainings available 8 times per year (Beginner & Advanced)
  - Discount on SEI **online** PV courses for AEE Dealers - *must be dealer*
- Solar Living Institute (SLI) [www.solarliving.org](http://www.solarliving.org) – Hopland, CA
- Midwest Renewable Energy Agency (MREA) – [www.the-mrea.org](http://www.the-mrea.org) – Custer, WI
- Florida Solar Energy Center (FSEC) - [www.fsec.ucf.edu/](http://www.fsec.ucf.edu/) – Cocoa, FL



## 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](http://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.

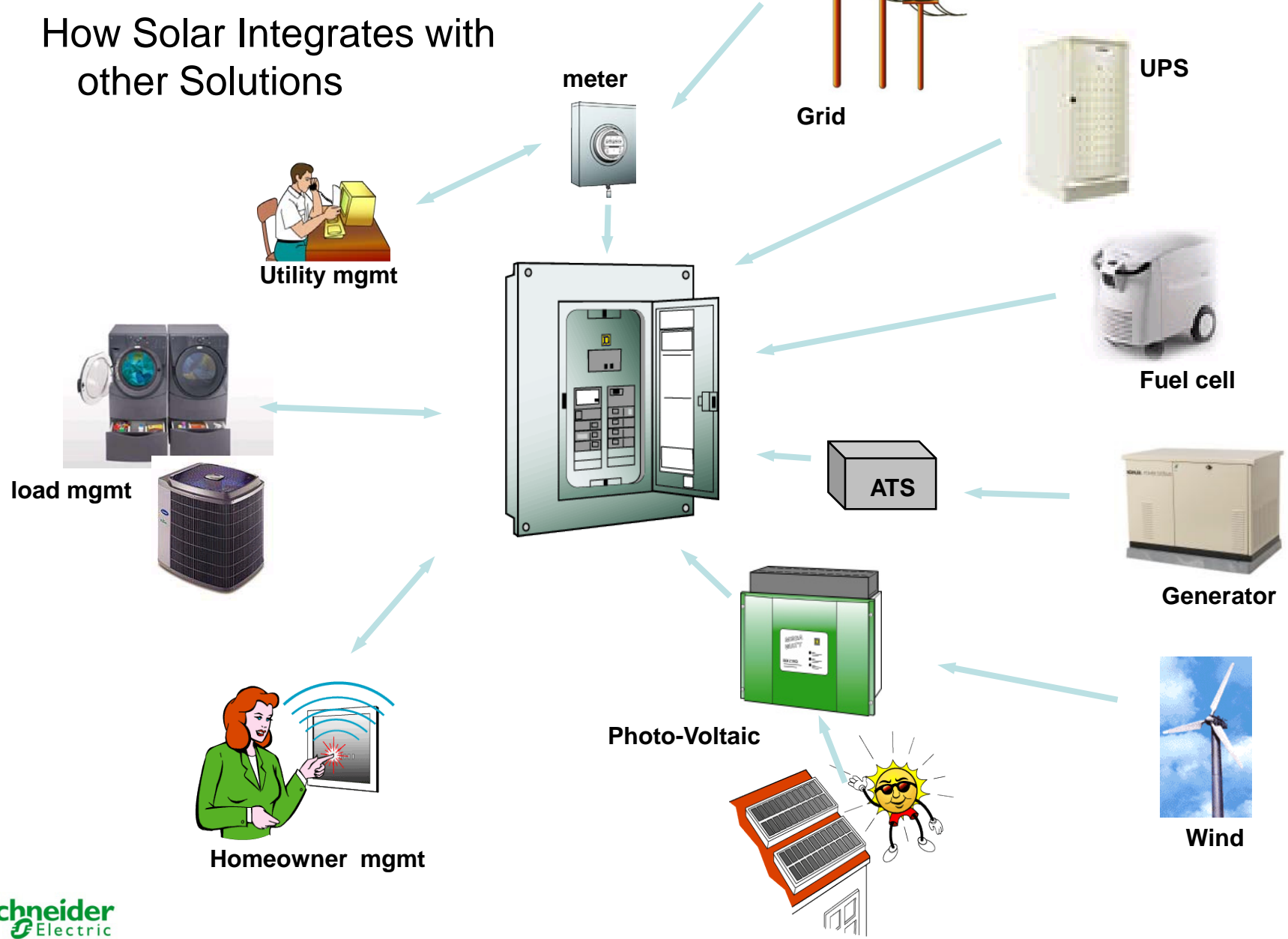




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## How Solar Integrates with other Solutions







## Summary

- **PV are continuing to gain popularity due to energy awareness and concerns over the environment**
- **Installations are becoming easier and lower cost**
- **PV System cost is favorably influenced by Federal, State and energy purchase rebate (Green Certificate, etc)**
- **Site location is critical to the performance of the PV system**
- **The US lags other countries in PV installations, but has the largest available market of existing and new homes**



# Questions?

Note – Information used for this presentation was provided in part by the University of Central Florida Solar Research Center and AEE Solar Distributors