



U.S. Department of Energy  
Energy Efficiency and Renewable Energy

# HUD ONAP Greener Homes Summit

## Solar & Small Wind Systems

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Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC-04-94AL85000.



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# Renewable Energy Resources

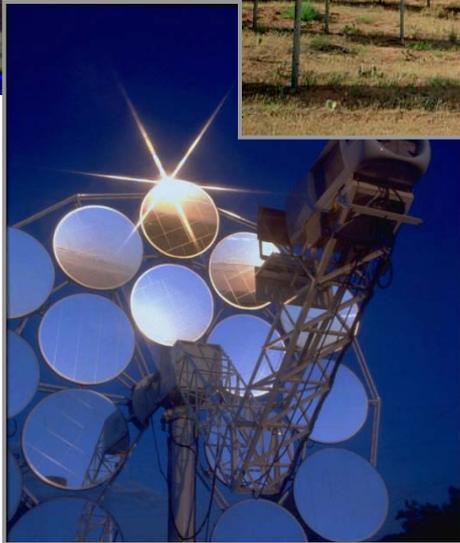


- Using the Sun, Wind, Water, and Earth



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# Renewable Energy Technologies





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# DOE's Tribal Energy Program

- **Promote tribal energy sufficiency, economic development and employment on tribal lands through the use of renewable energy and energy efficiency technologies**



- **Title V of the Energy Policy Act (EPAAct 2005)**



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# Photovoltaics (PV)

**Ramona Band - Cahuilla  
Off-grid PV System**



Photovoltaics  
directly convert  
sunlight into  
Direct Current (DC)  
electricity.

**EMCORE Concentrating PV**



**Grid Connected Roof-Mounted PV**





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# Building-Integrated PV (BIPV)

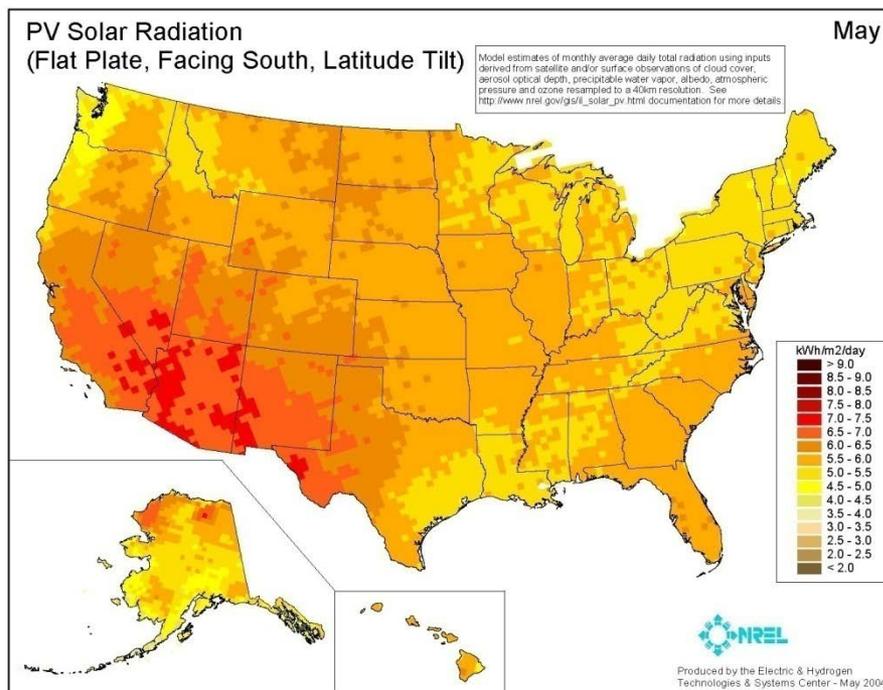
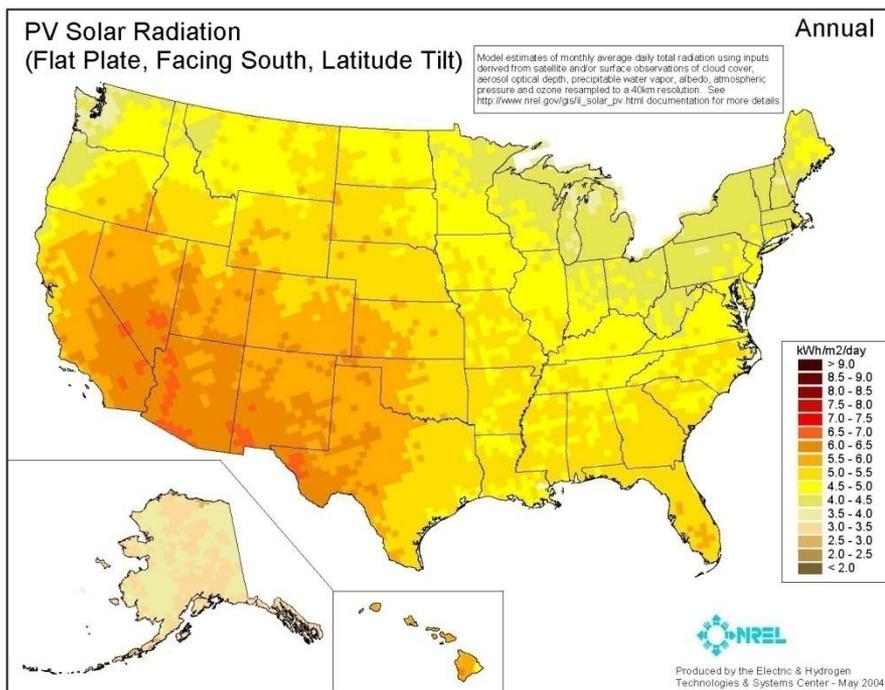




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# PV Solar Resource

## Flat Plate, Facing South, Latitude Tilt



Data and maps from the Renewable Resources Data Center

at the National Renewable Energy Laboratory

<http://www.nrel.gov/gis/solar.html#collector>

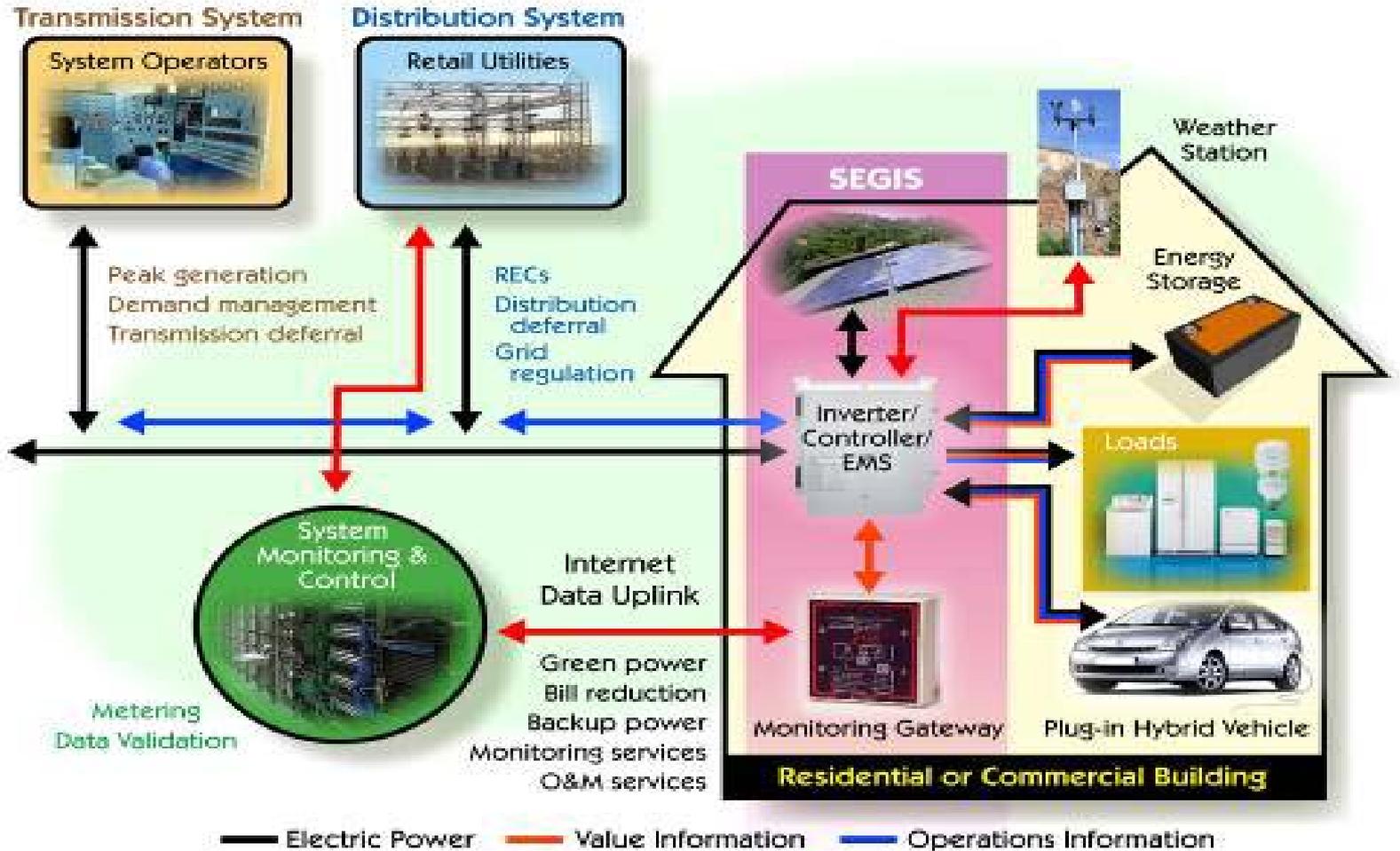


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# Solar Energy Grid Integration Systems (SEGIS)

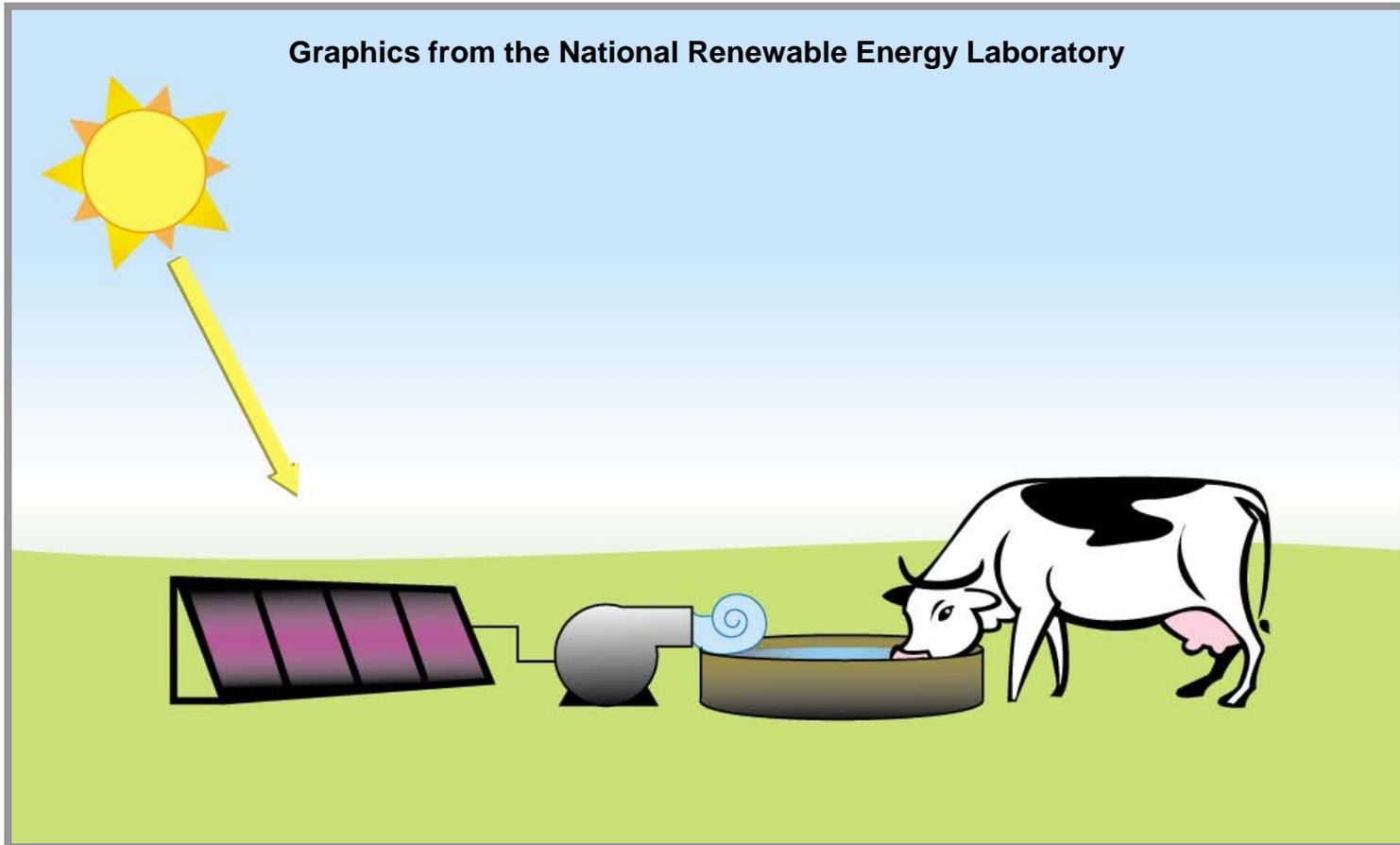




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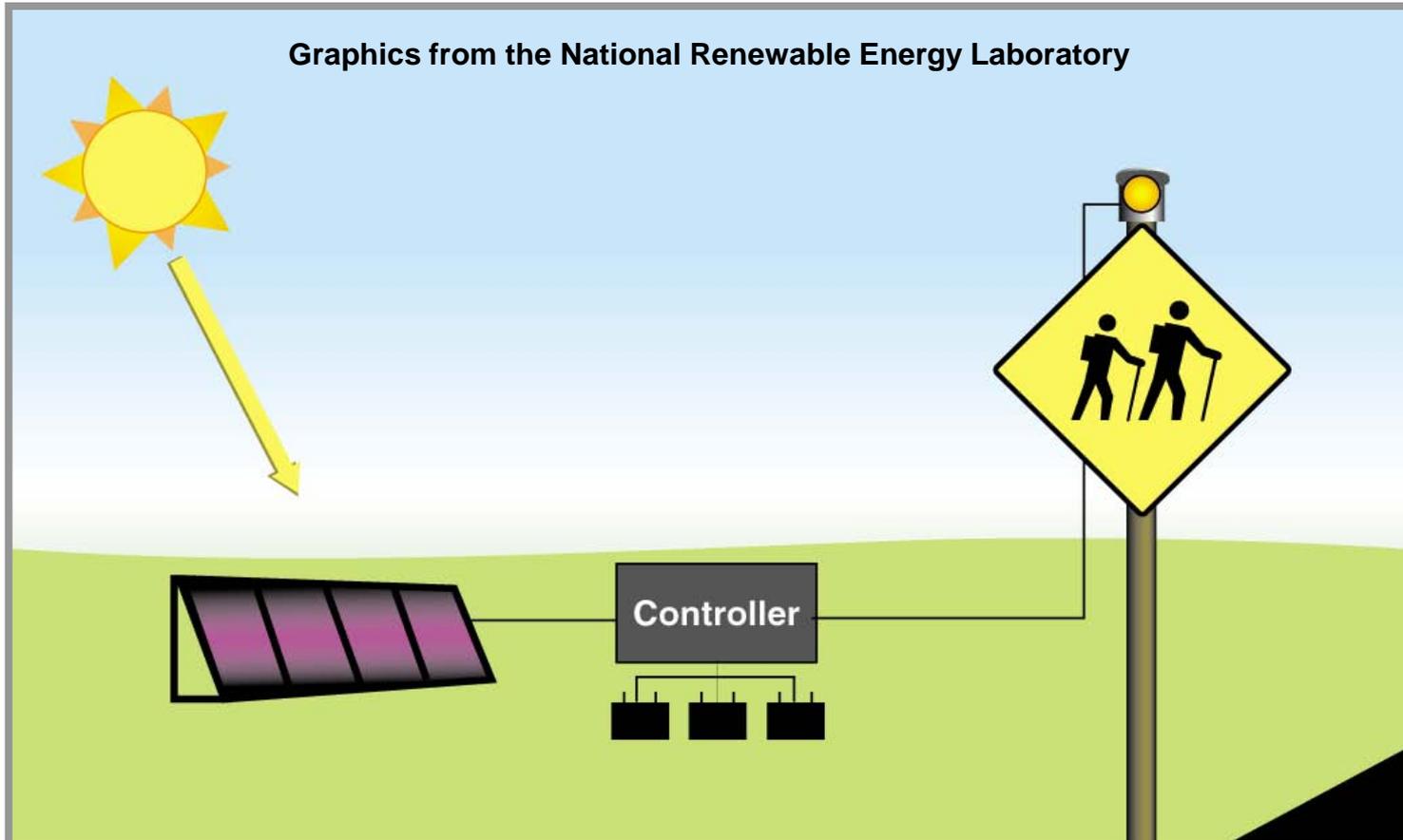
# Simple Direct Drive PV System

Graphics from the National Renewable Energy Laboratory



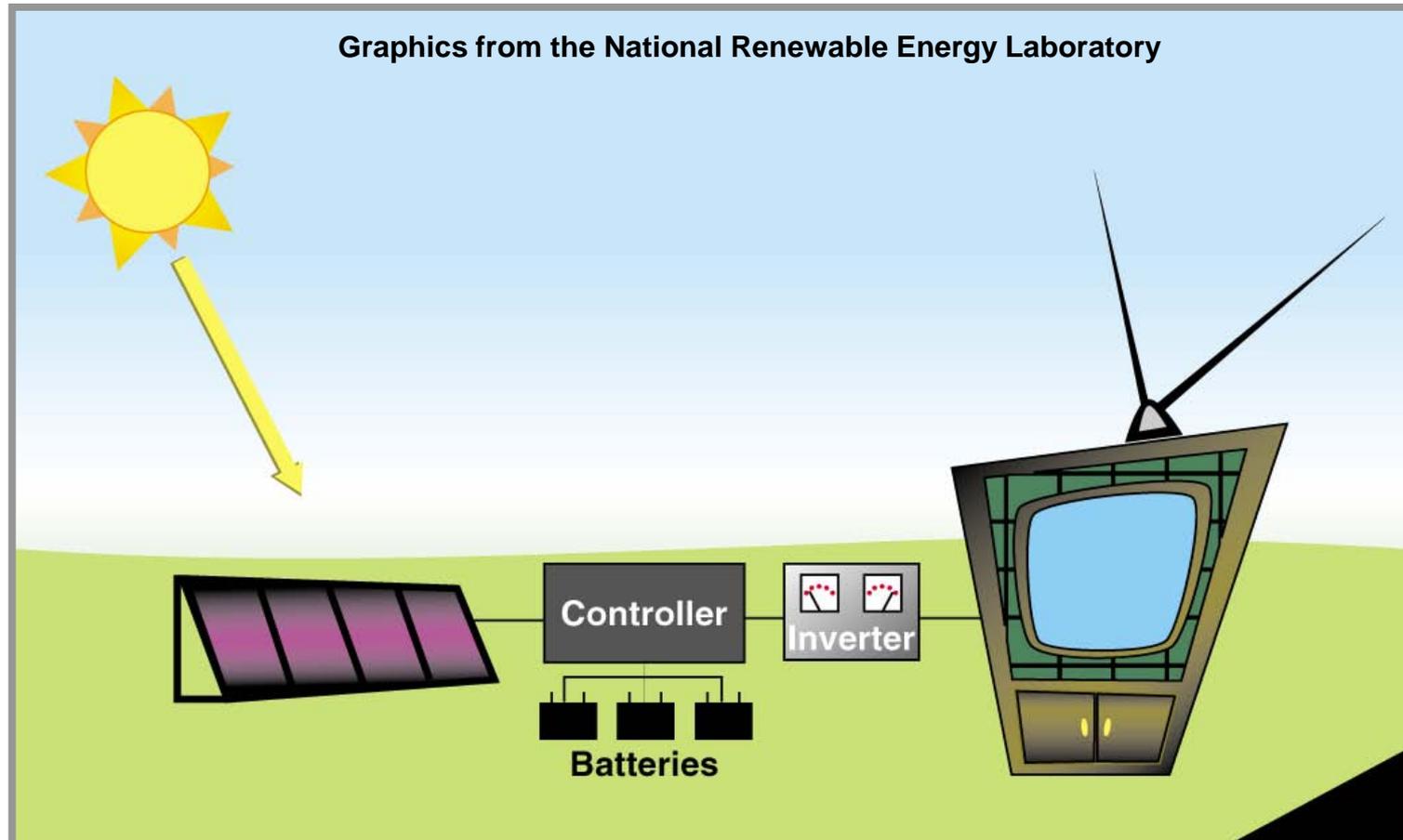


# Simple DC PV System with Battery Storage



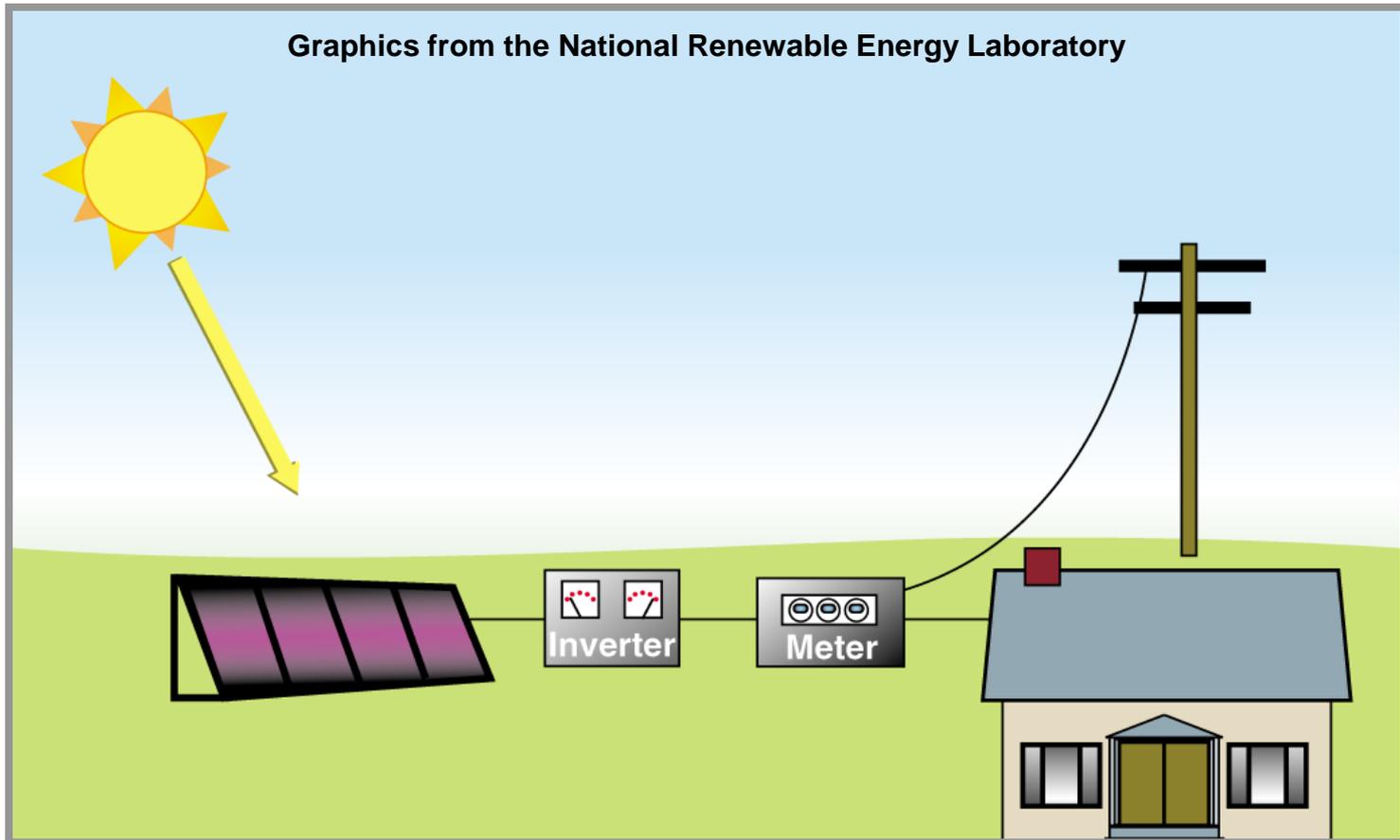


# AC PV System with Inverter



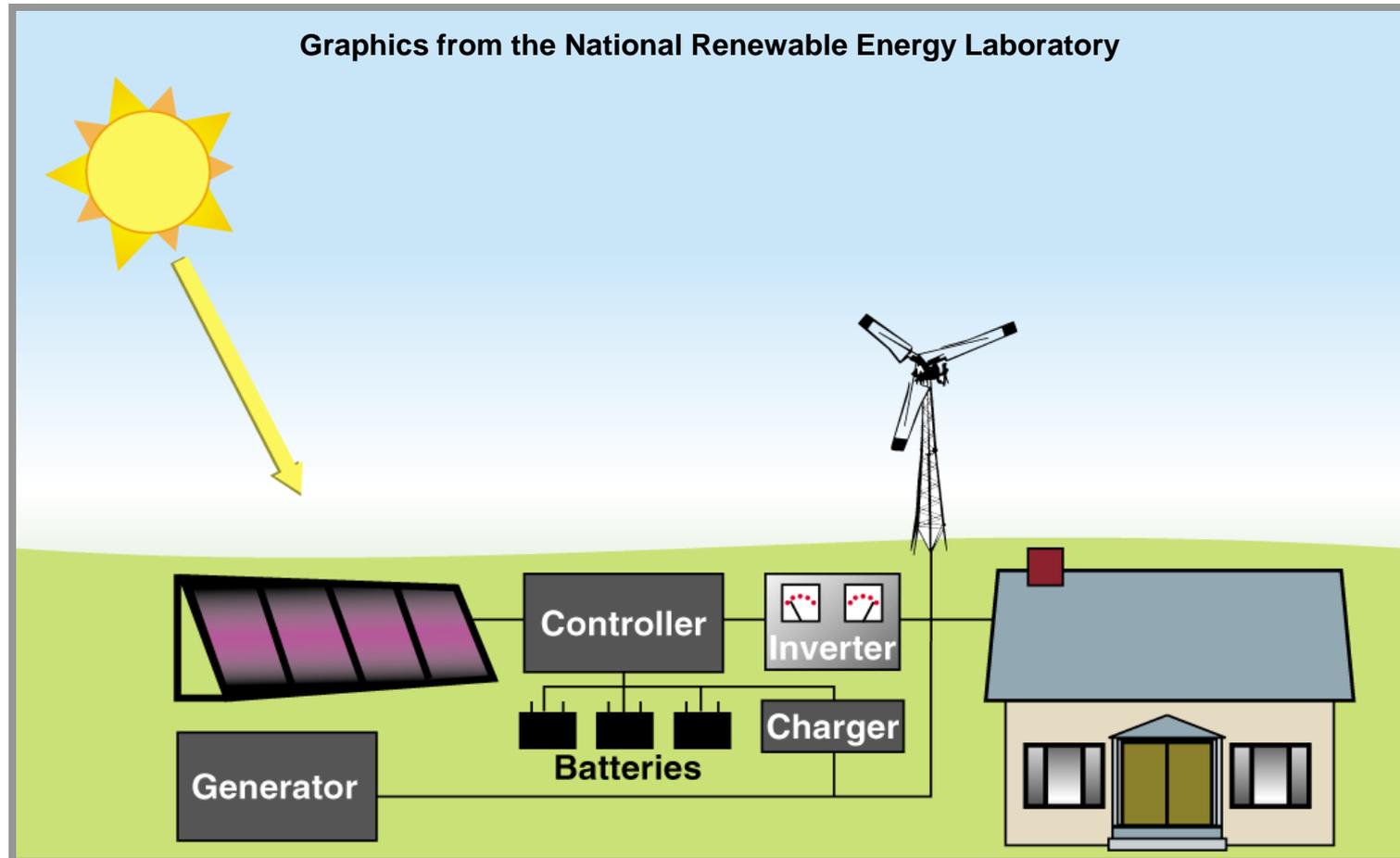


# Utility-Connected (Grid-Tied) PV System





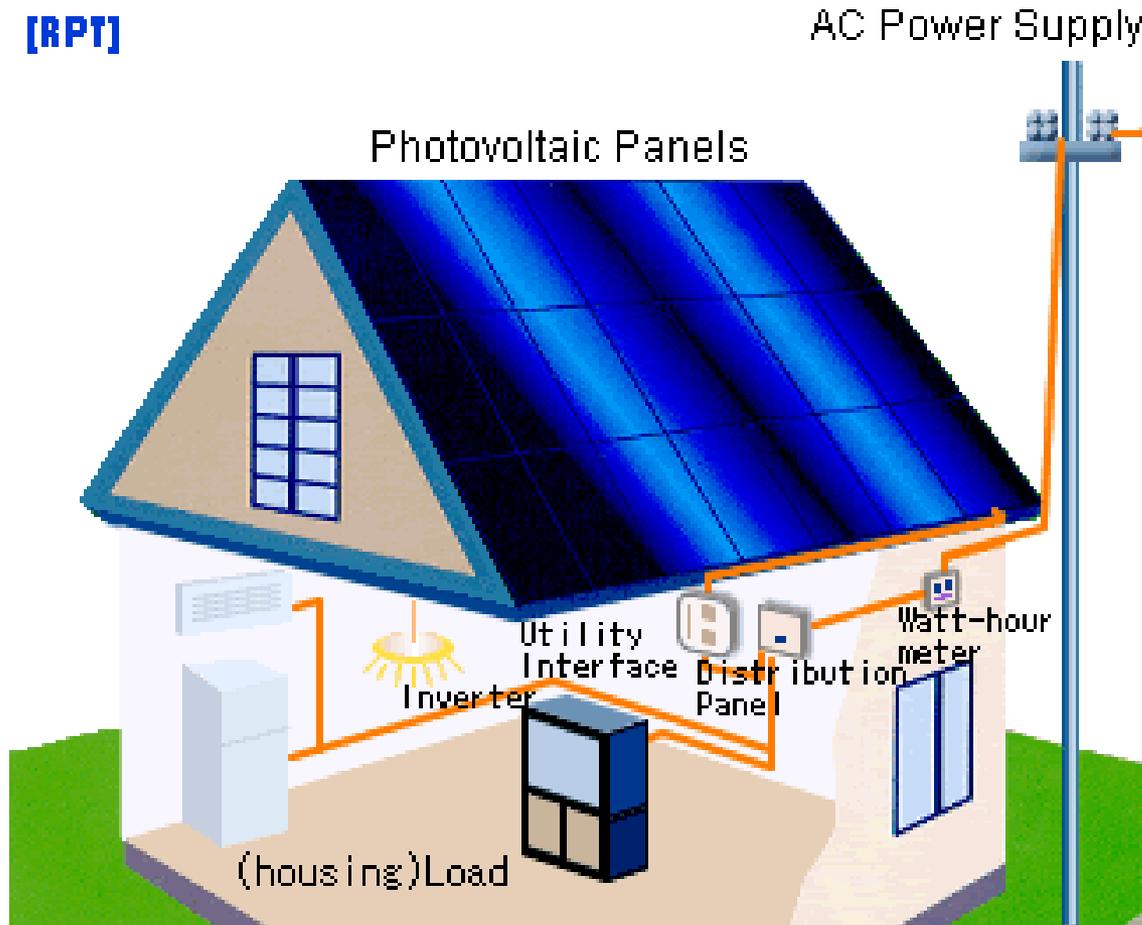
# Hybrid PV/Generator System





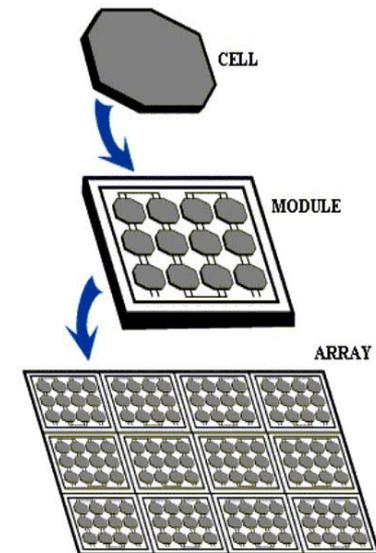
# Simple PV house system

[RPT]



## System

- Array
- Inverter
- Utility Interface/Control
- Meters
- Storage batteries (optional)





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# Navajo Nation Residential PV Navajo Tribal Utility Authority

..1993.....1999-2001.....2002-2003.....2003-2004.....

240-260 Watt



Business potential realized

1999-2001

640 Watt



Standardization achieved

2002-2003

Phase I 880 Watt Hybrid



Battery bank powered by hybrid design

2003-2004

Phase II 880 Watt Hybrid



Economic Development: Units assembled on Navajo Nation



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# Lakota Solar Enterprises (LSE)

- One of the nation's first 100% Native American owned and operated renewable energy companies.
- LSE began as an expansion of Trees, Water & People solar heater work on Pine Ridge.
- Straightforward technology:
  - Sunlight falling on the glass panels is routed into the home via ductwork and a fan;
  - inside the house a thermostat controls the fan and another duct carries cold air out of the house and into the back of the solar panel where it is warmed and blown into the house.
  - The fan is the only moving part. The panels and support structures are manufactured at LSE and installed by the LSE crew.



LSE is headed by Henry Red Cloud, a respected Lakota elder and a fifth-generation descendent of Chief Red Cloud, the last Lakota war chief.



# A process of technology implementation



A process of technology implementation over several housing development projects is recommended.

Each set of recommendations are ranked from very cost efficient approaches to conventional technology demonstrations to advanced technology demonstrations.

It is understood that additional funding will be needed for first cost of many technologies and energy efficient features.

**The model process developed would provide a progression of lessons learned which have been implemented by Sandia's military customers.**





# U.S. PV Large-scale Installations

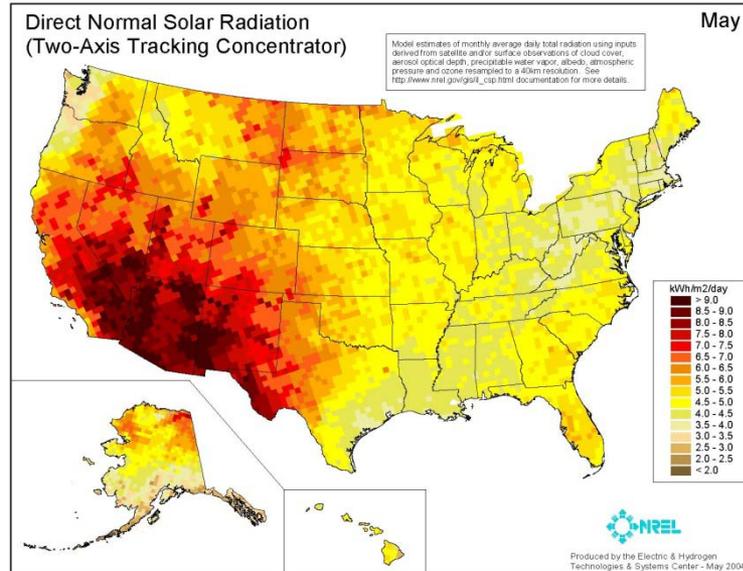
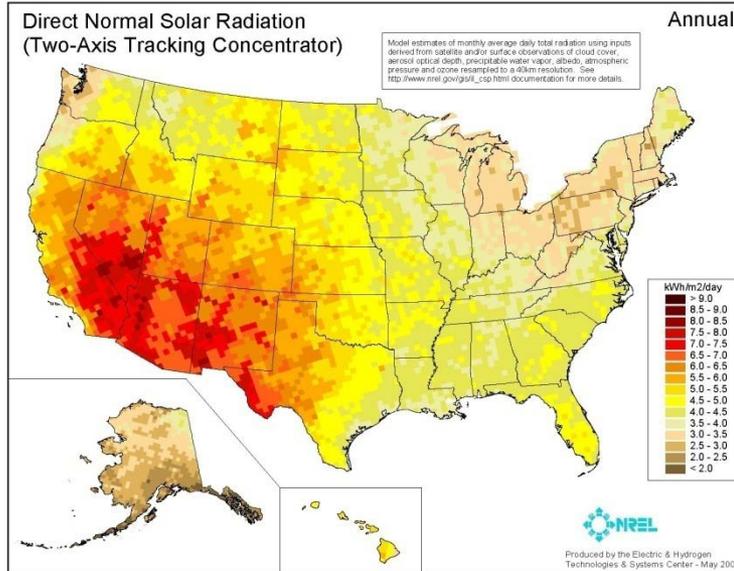
- **Nellis Air Force Base, NV**  
**14.2 MW**
- **Alamosa, CO**  
**8 MW**
- **Arizona Public Service - Prescott, AZ**  
**6 MW**
- **Tucson Electric Power, AZ**  
**~ 4 MW**
- **Orange County Center, CA**  
**2 MW**
- **Santa Rita Jail, CA**  
**1.5 MW**



The largest PV solar power plant in the U.S. is a reality at Nellis Air Force Base. Completed in December 2007.



# Solar Resource



## Filters applied:

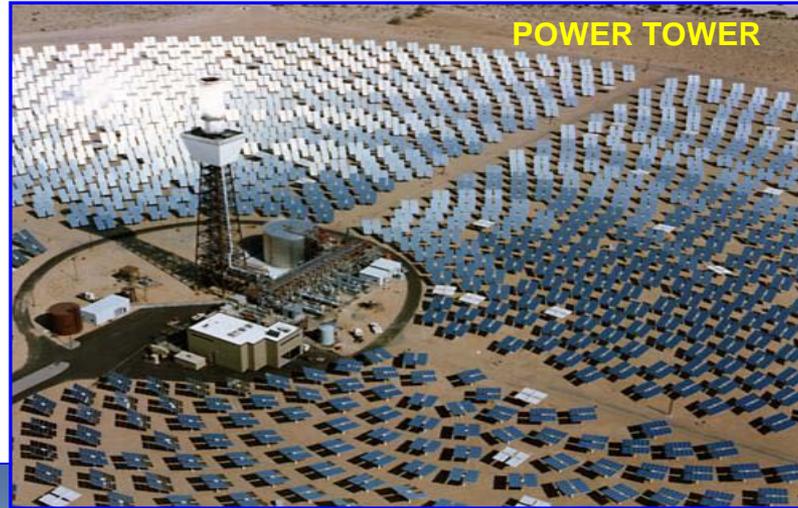
- Direct-normal solar resource.
- Sites > 6.75 kwh/m<sup>2</sup>/day.
- Exclude environmentally sensitive lands, major urban areas, etc.
- Remove land with slope > 1%.
- Only contiguous areas > 10 km<sup>2</sup>

Data and maps from the Renewable Resources Data Center at the National Renewable Energy Laboratory

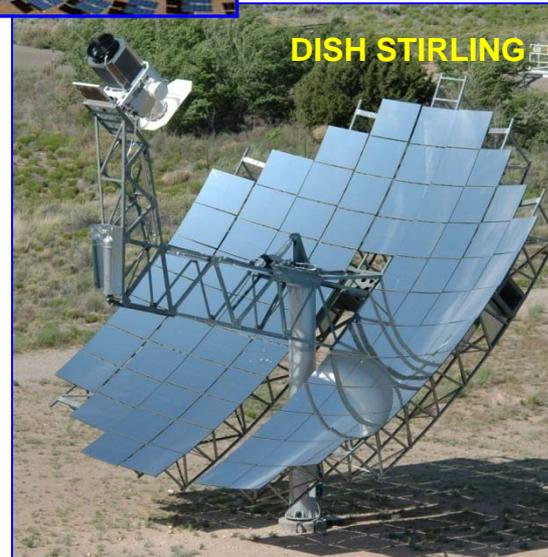
<http://www.nrel.gov/gis/solar.html#collector>



# Concentrating Solar Power



**Concentrating Solar Power (CSP) is also referred to as Solar Thermal Electric Power.**





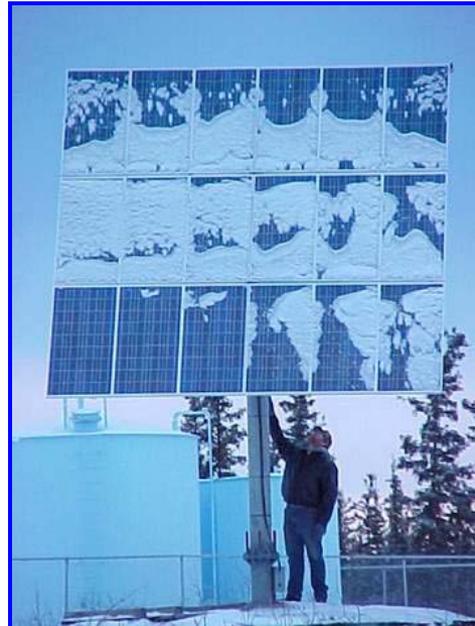
# Alaska Native Accomplishments

## "Powering Remote Northern Villages with the Midnight Sun"

The villages of Venetie and Arctic, located above the Arctic Circle in northeast Alaska, studied the feasibility of powering the villages using renewable solar energy during the season of the midnight sun.

- Native Village of Venetie Elders have chosen to:
- Adopt renewable energy and efficiency; and
- Banish oil dependency

Worlds Northern most  
Tribally owned Solar  
tracker



Solar System Maintenance



Arctic Village Solar Arrays





# Making a Commitment to the Future

## Augustine Band of Cahuilla Indians (California)

- Installed the one of the “largest” (1.1 MW) solar electric system in Indian Country (February 2009)



•“It's an important component of the tribe's effort to eliminate its overall energy footprint, and is consistent with our centuries-old commitment to living in harmony with nature,” Chairwoman Green said in a statement.

- After receiving a DOE “First Steps” grant to develop an energy plan, the Tribe moved forward with the installation of this \$7 million system.





# Alternative Energy Powering a Reservation

## Ramona Band (California)

Renewable power for the Tribe's ecotourism business – Planned as the first Reservation to be completely off-grid

