



# Solar Overview & Power Purchase Agreements 8/4/08

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**GovEnergy**  
[www.govenergy.gov](http://www.govenergy.gov)



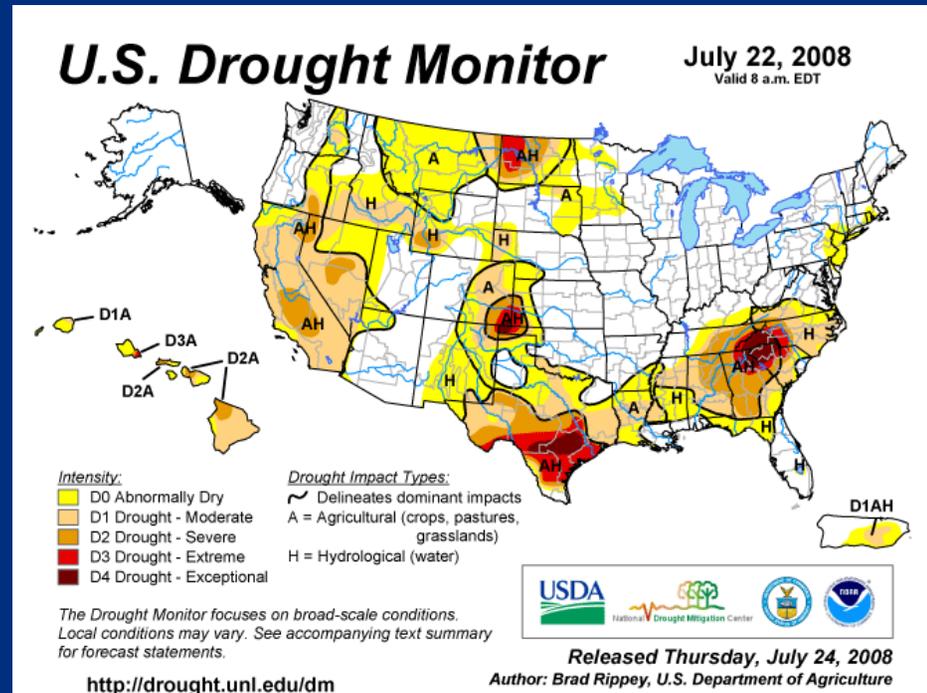
# Presentation Overview

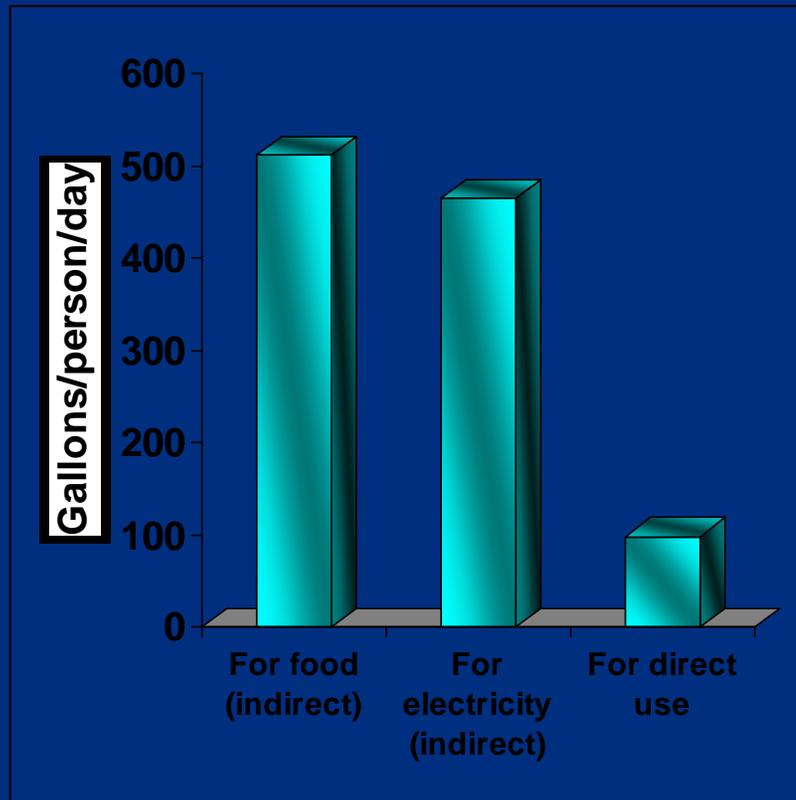
- Electricity and Water Use
- Solar Technologies
  - Photovoltaics
  - Solar Hot Water
  - Solar Ventilation Preheat
  - Concentrated Solar Power (CSP)
- Power Purchase Agreements



# Electricity & Water Use

- Significant water required for cooling in most traditional electricity generation (unless dry cooling is used)
  - An issue for CSP also





## GALLONS PER PERSON PER DAY

- 510 for food production
  - includes irrigation and livestock
- 465 to produce household electricity
  - Range: 30 to 600 depending on technology
- 100 direct household use
  - includes bathing, laundry, lawn watering, etc.

**Water used to produce household electricity exceeds direct household water use**

*Source: derived from Gleick, P. (2002), World's Water 2002-2003*

# Photovoltaics (PV)



- PV converts sunlight directly to electricity
  - Building-Integrated Photovoltaics (BIPV)
- PV Cost Considerations
  - PV modules typically 50% or less of total cost
  - Other costs - installation, inverters, other balance-of-system, batteries for off-grid systems
  - Incentives are key (see <http://www.dsireusa.org/>)
  - Research potential rate impacts (standby charges, tariff changes, etc)

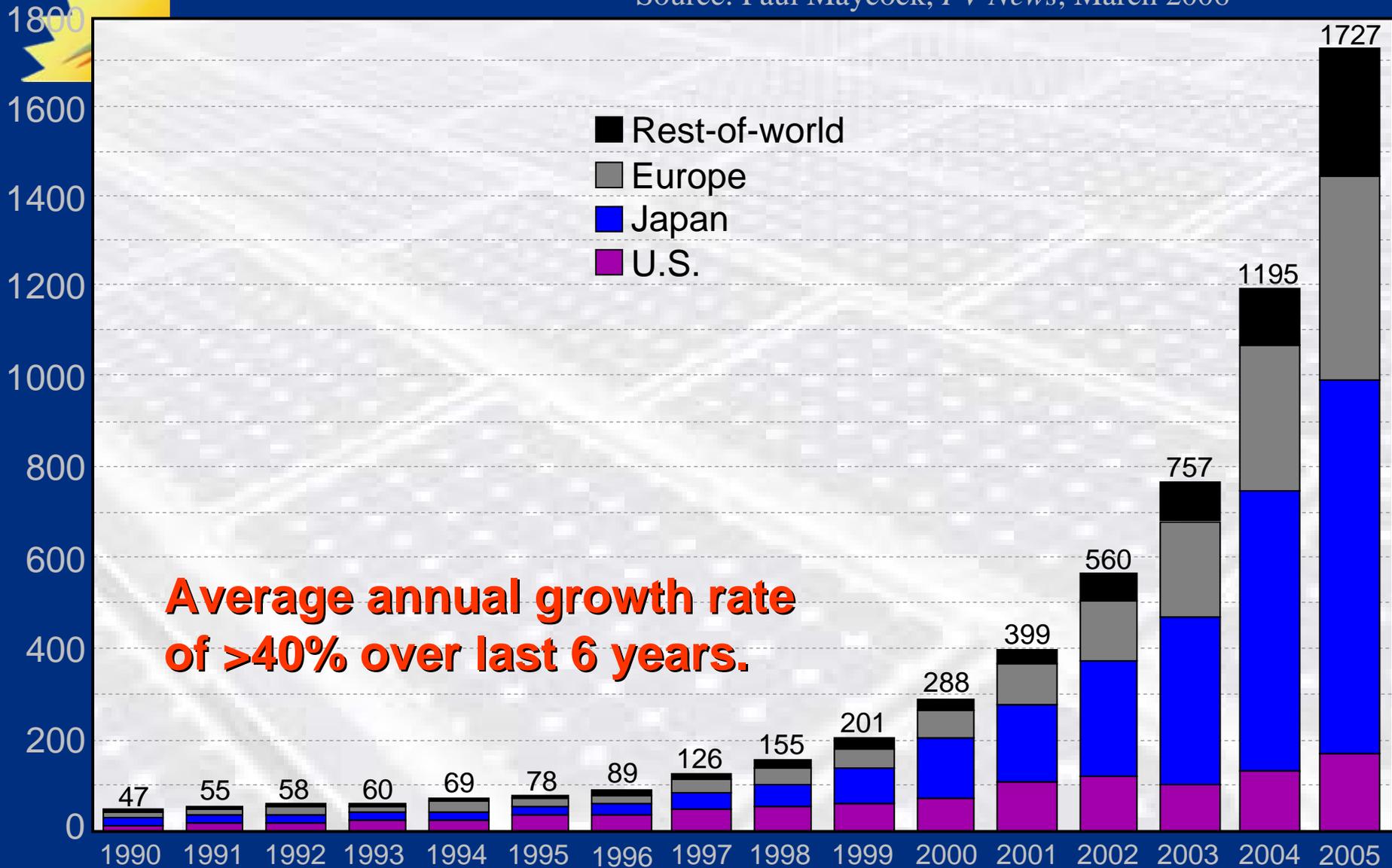
# Photovoltaics (PV)



- Other Considerations
  - Resource quality
  - PV efficiency/power density
  - Area required (lower efficiency modules → more area required for same kWh)
  - Configuration (tilted vs. flat, fixed vs. tracking)
  - Losses

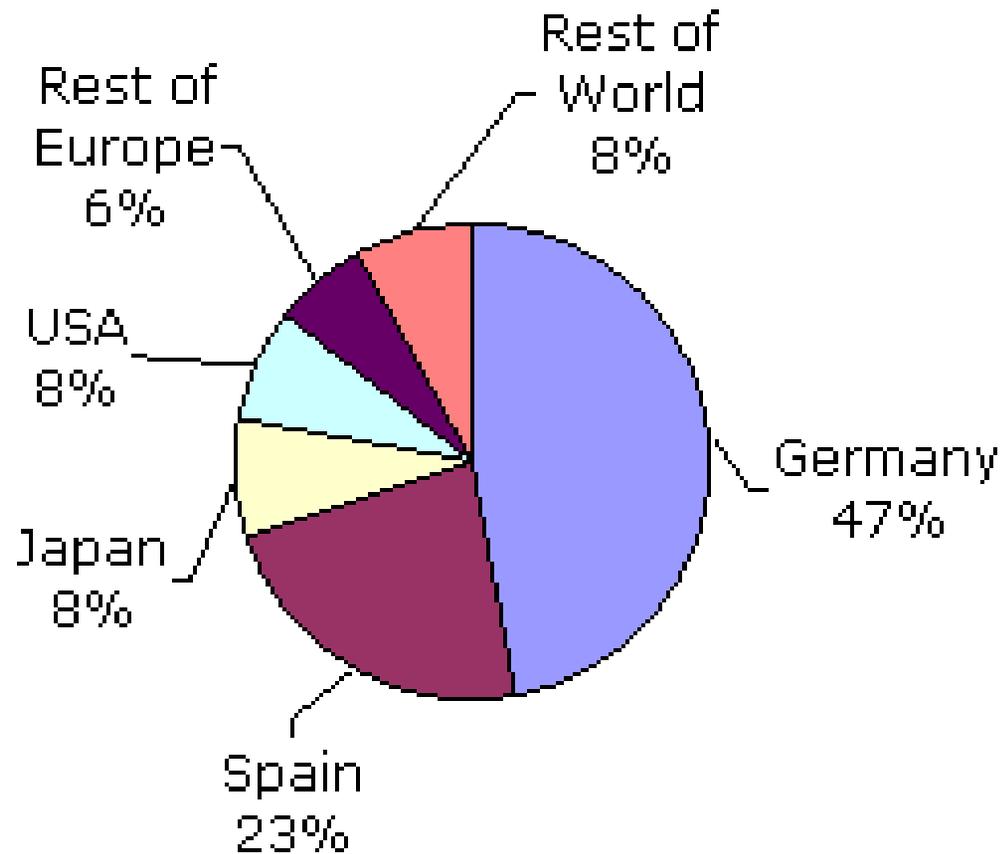
# World PV Cell Production (MW)

Source: Paul Maycock, *PV News*, March 2006





## World Photovoltaic Market in 2007 2826 Megawatts



Copyright: Solarbuzz LLC

# PV/BIPV Examples



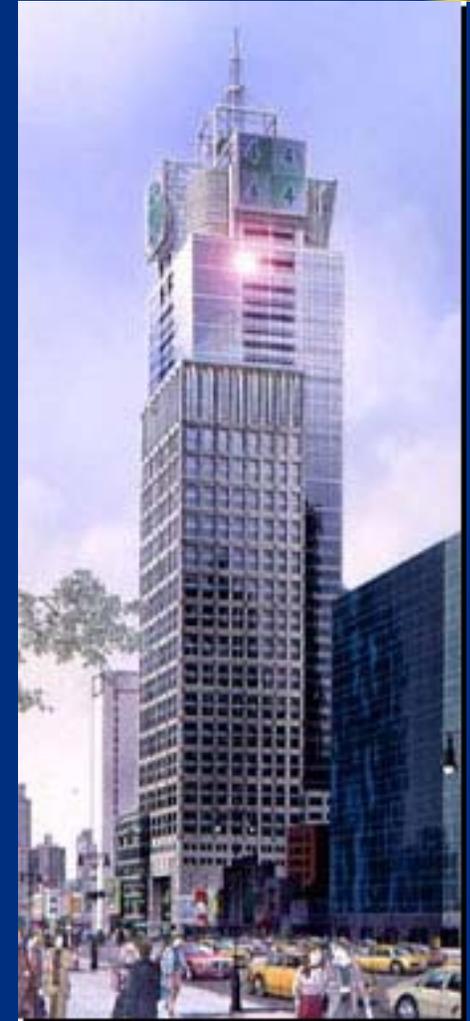
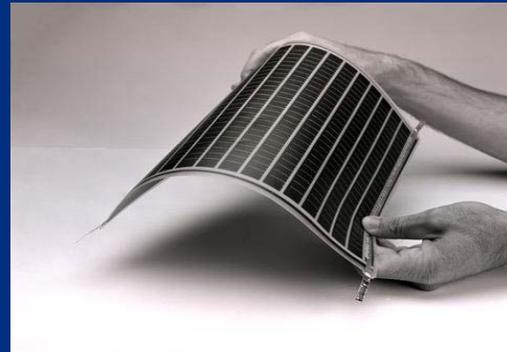
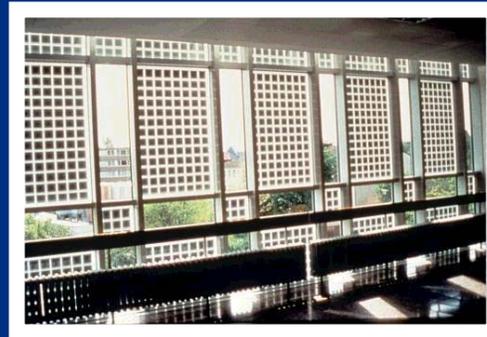
PV Lighting  
PJFK Federal Building, HI



BIPV, Mauna Lani Hotel

BIPV

4 Times Square, NY City  
(Broadway & 42nd Street)



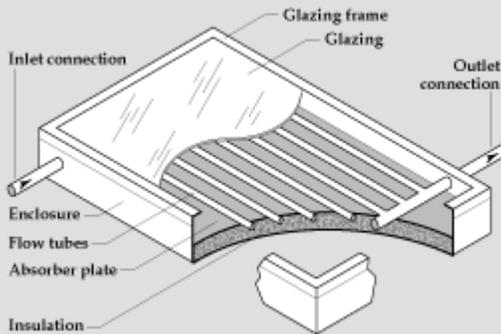


# Solar Hot Water

## Low temperature system

- Unglazed mats
- Glazed and insulated

Flat-Plate Collector

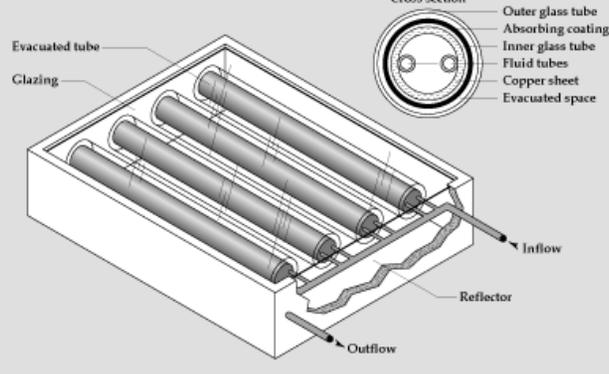


Residential hot water  
Swimming pools

## Medium temperature system

- Evacuated tubes

Evacuated-Tube Collector

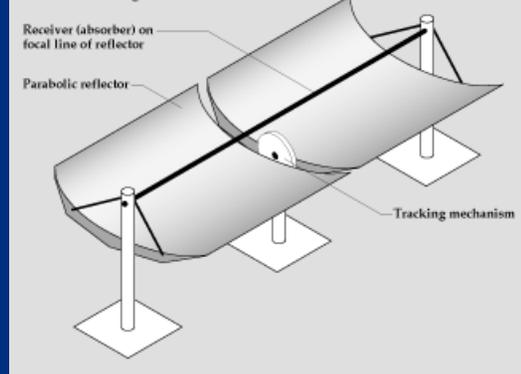


Cafeterias  
Laundries

## High temperature system

- Parabolic Concentrators

Parabolic-Trough Collector



Industrial processes  
Electrical generation

# Solar Water Heating

- Water heating loads constant throughout week and year (or more load in the summer)
- High cost of backup energy (electricity, propane, etc.)
- Sufficient area (1 ft<sup>2</sup>/gal/day)
- Sunny climate helps but not a requirement.



**Drainback Solar Water Heating System**



# Federal SHW Examples



USCG Kia'i Kai Hale Housing Area,  
Honolulu, HI



Barnes Field House, Fort Huachuca, AZ



EPA Edison, New Jersey

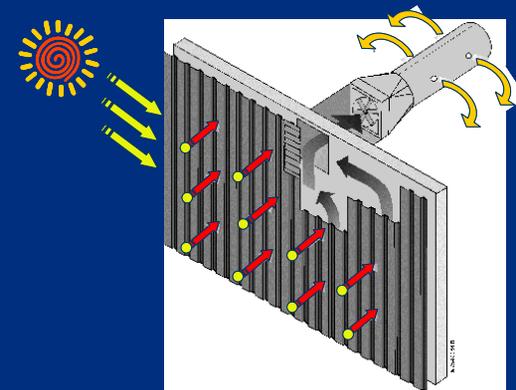


Phoenix Federal Correctional Institution  
<http://www.eere.energy.gov/femp/pdfs/33211.pdf>

# Solar Ventilation Preheat



- High ventilation requirements
- New construction
- Retrofit - available south wall area with fan intake





# Concentrating Solar Power

- Concentrating Solar Power (CSP) Operation
  - Concentrates & focuses sunlight onto a receiver mounted at the system's focal point
  - Receiver absorbs sunlight and heats working fluid
  - Working fluid is used in engine to produce electricity
- Requires a very good, direct solar resource (southwest)
- Technologies
  - Parabolic Troughs
  - Dish/Engine Systems
  - Power Towers
- Concentrated PV



# Concentrated Solar Power

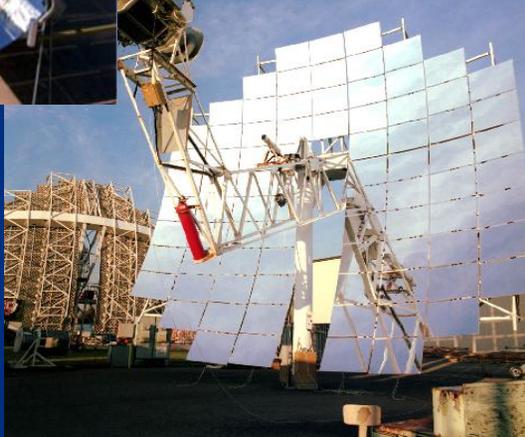
Power Tower



Parabolic Trough



Concentrating  
Photovoltaics



Dish/Stirling





# *Power Purchase Agreements*

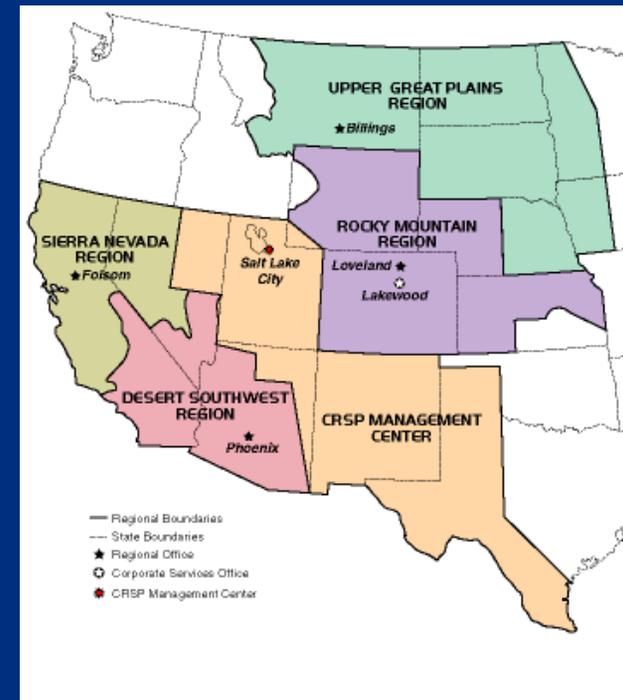
# Customer-Sited Power Purchase Agreement

- Private entity installs, owns, operates and maintains customer-sited (behind the meter) renewable equipment
  - No agency up-front capital required
  - Eligible for tax incentives
- Site purchases electricity through power purchase agreement (PPA)
- Defense Energy Support Center (DESC) – New renewable team for PPA procurements



# Key PPA Issues

- PPA contract length (limited federal authority)
  - Long term best– at least 10 years, preferably 20
  - Western Area Power Administration (Western)
    - Long term (at least 20 yrs) contract authority
    - Will act as contracting agent for sites in their service territory
- Land use agreement – lease, easement, license, other





# Key PPA Issues

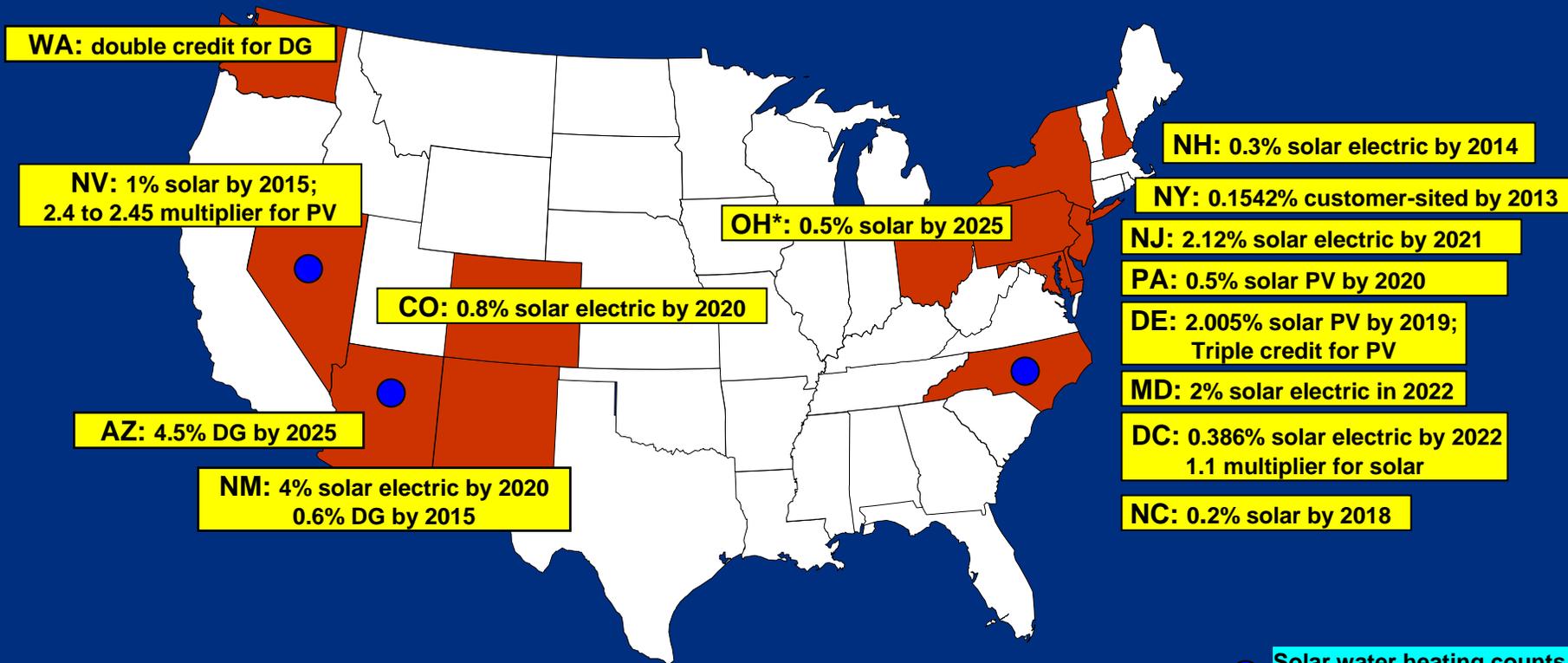
- National Environmental Policy Act (NEPA) requirements
- Renewable energy certificate (REC) ownership and potential sales
- Evaluation criteria and PPA electricity price evaluation
- Other - incentives (see <http://www.dsireusa.org/>), utility rate impacts, infrastructure requirements, interconnection, metering, end of contract options



# Solar/DG Provisions in RPS Policies

DSIRE: [www.dsireusa.org](http://www.dsireusa.org)

June 2008



DG: Distributed Generation

\* It is unclear at this point if solar water heating is eligible for OH's solar carve-out.

Solar water heating counts towards solar set-aside



# Nellis AFB PV Project

- 15 MW on ~140 acres including closed landfill
- Estimated \$1 million electricity savings/year
- FAR Part 41 utility service contract
- Indefinite term, with one year termination notice
- 20-year ground lease
- Ribbon cutting event December 2007
- RECs sold to Nevada Power (for state RPS)





# NREL PV Projects

- 750 kW (1200 MWh) single-axis tracking, ~ 5 acres
- 20 year PPA contract (utilizing Western)
- 20 year easement/access agreement
- RECs sold to Xcel Energy for RPS solar set-aside (20 year contract)
- PPA price equal to or less than utility electricity prices (based on EIA projections)
- Expected construction completion date – Fall 2008
- Phase 2 – three projects, 1.6 MW total





# Fort Carson PV Project

- 2 MW, 3200 MWh in first year (~2% of Ft. Carson's load)
- Fixed, non-escalating energy rate
- 17 year contract, with 3 year option (utilizing Western)
- No cost lease (using 10 USC 2667 lease authority)
- RECs sold to Xcel Energy (20 year contract)
- Ground-mounted, fixed system covering 12 acre former landfill
- First Solar thin film, 25 year warranty
- Came on-line December 2007





# GSA Sacramento PV Project

- .5 MW roof-top PV (thin film)
- 10-year contract
- Price matched to utility energy rate, with price floor
- Utility rebate and federal incentives (30% tax credit & accelerated depreciation) - pay for approximately 1/2 cost
- License for use of roof
- Renewable developer retains RECs
- Came on-line March 2008





# Project Comparison

	<b>Nellis</b>	<b>Fort Carson</b>	<b>NREL</b>	<b>GSA</b>
<b>Size</b>	15 MW	2 MW	.75 MW	.5 MW
<b>Type</b>	Ground Mounted PV	Ground Mounted PV	Ground Mounted PV	Roof-top PV
<b>Contract Length</b>	Indefinite with 1 year termination	17	20	10
<b>Land Use Agreement</b>	Lease	Lease	Easement	License
<b>Procurement and Contracting Agent</b>	Site	Site, in partnership with Western	Site, in partnership with Western	Site
<b>RECs</b>	Sold to utility	Sold to utility	Sold to utility	Retained by renewable developer



# Resources

- Chandra Shah, National Renewable Energy Laboratory  
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- Rich Brown, Lawrence Berkeley National Laboratory  
REBrown@lbl.gov, 510-486-5896
- Mike Warwick, Pacific Northwest National Laboratory  
mike.warwick@pnl.gov, 503-417-7555 (for DOD)
- FEMP Focus article (Fall 2007)  
[http://www1.eere.energy.gov/femp/newsevents/fempfocus\\_article.cfm/news\\_id=11218](http://www1.eere.energy.gov/femp/newsevents/fempfocus_article.cfm/news_id=11218)



# For More Information

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Don't forget to fill out and drop off your  
session evaluations!