Solar Overview

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Presentation Overview

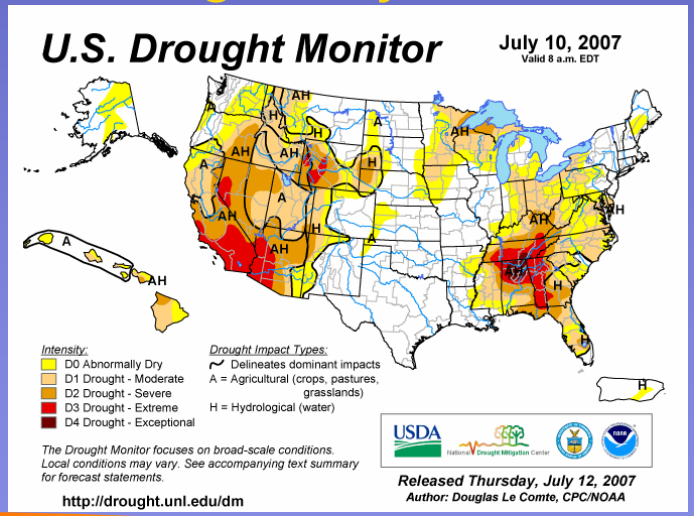
- Why Use Solar
- Solar Technologies
  - Photovoltaics
  - Solar Hot Water
  - Solar Ventilation Preheat
  - Concentrated Solar Power (CSP)
- Solar Research
- Innovative Project Financing Examples

Why Use Solar?

- Energy security - reduce dependence on fossil fuel imports, "homegrown" energy instead
- Fuel diversity
- Economic development
- Market transformation
- Lead by example/demonstrate environmental stewardship
- Reduced air emissions

Why Use Solar?

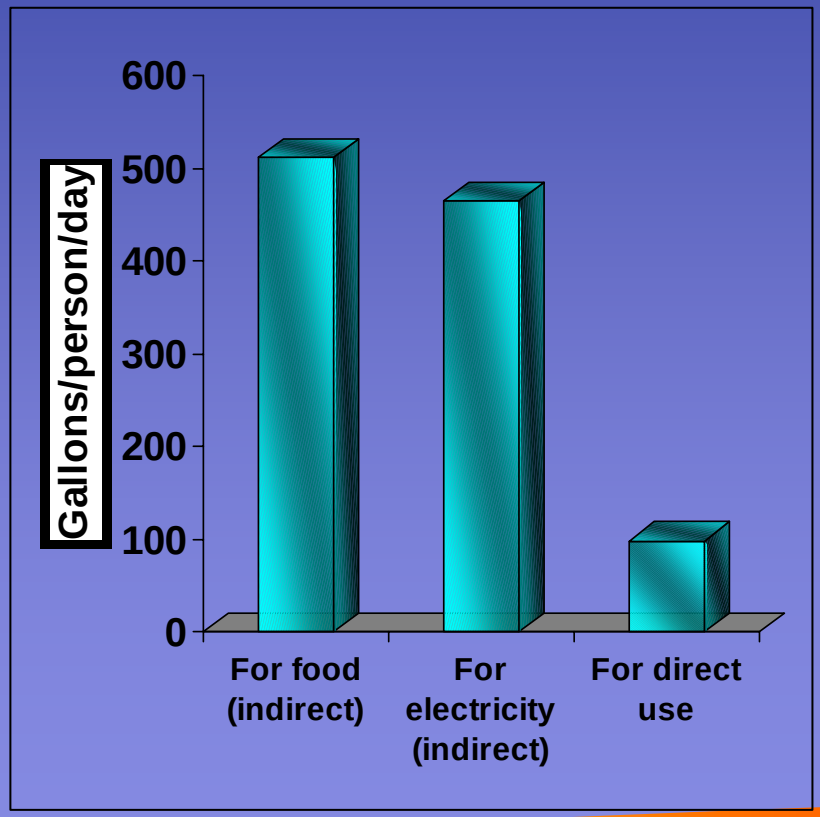
- Volatile energy market – price risk management
- Peak energy supply
- CSP dispatchable with thermal storage or hybrid system
- Possible back-up power source – must configure system for operation when grid is down
- Water (except most CSP)
  - Significant water required for cooling in most traditional electricity generation



Energy Requires Water

Water used to produce household electricity exceeds direct household water use

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



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.

Photovoltaics (PV)

- PV converts sunlight directly to electricity
  - Building-Integrated Photovoltaics (BIPV) - PV integral part of building

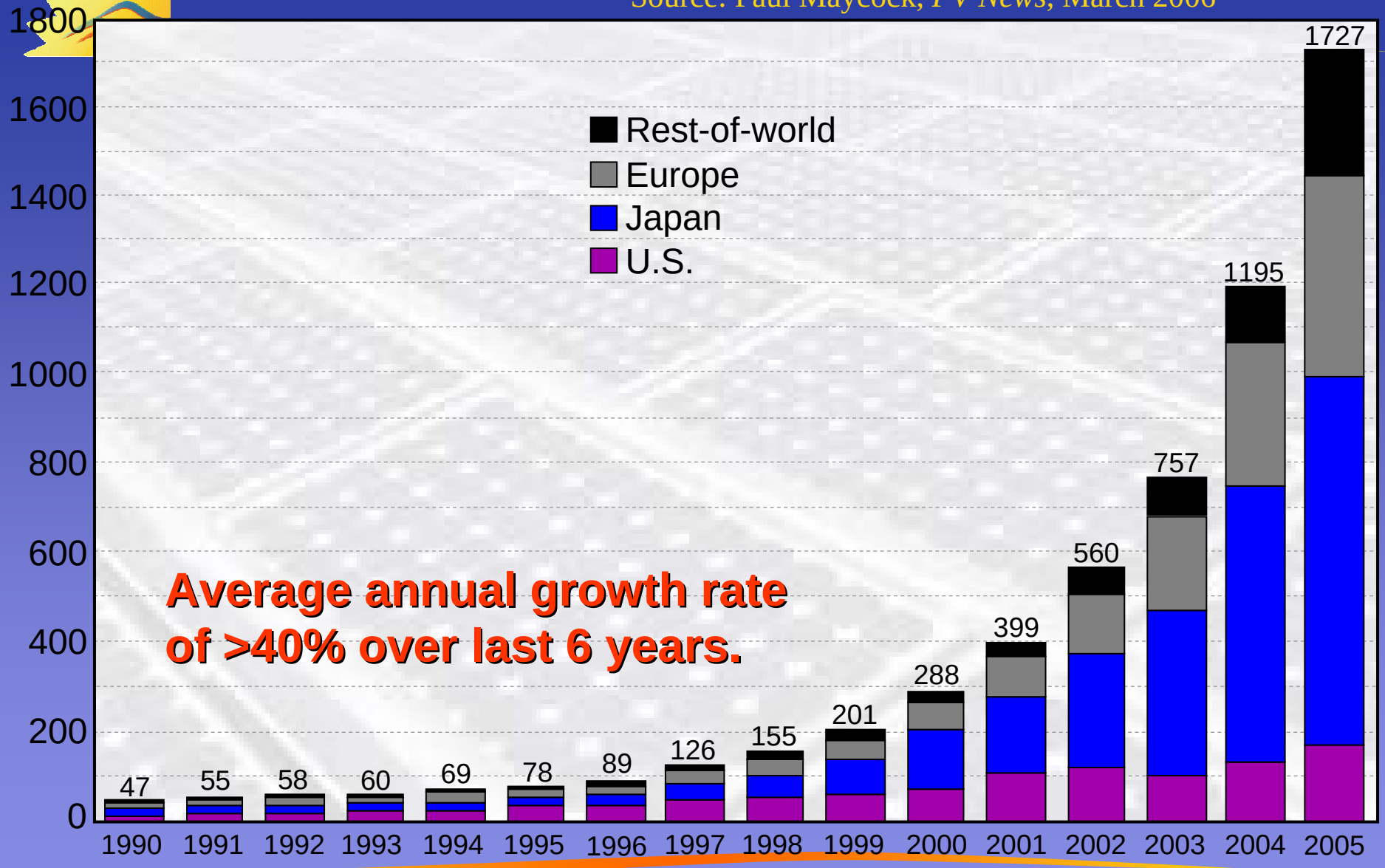
- PV Cost Considerations
  - PV modules typically 50% or less of total cost
  - Other costs - inverters, other balance-of-system, installation, batteries for off-grid systems
  - Incentives are key (see http://www.dsireusa.org/)
  - Cost of alternatives - utility rates/demand charge (rate structure impacts cost-effectiveness), diesel, utility line extension, 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



PV/BIPV Examples

PV Lighting
PJKK Federal Building, HI

BIPV, Mauna Lani Hotel

BIPV

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

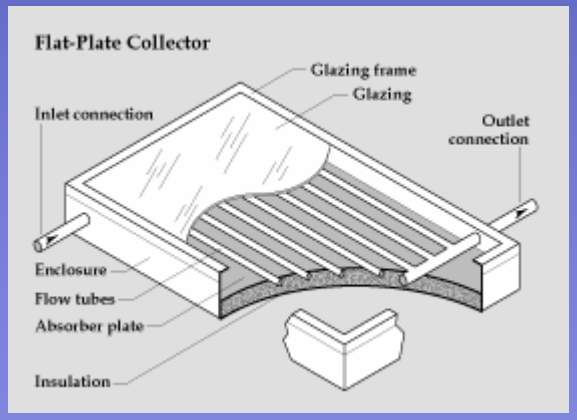
Naval Air Station N. Island

924 kW PV system providing shaded parking for 444 vehicles.

Solar Hot Water

Low temperature system

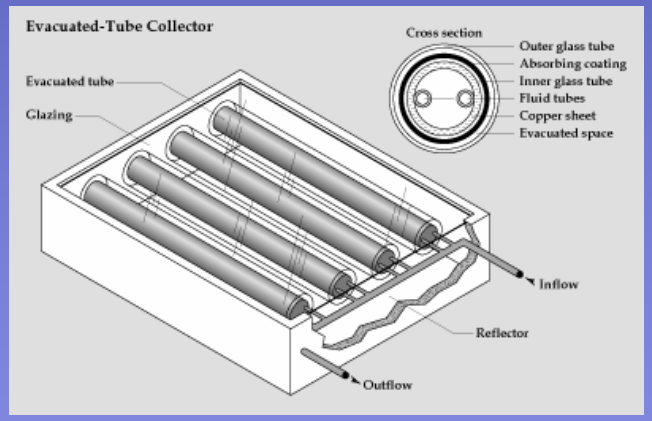
- Unglazed mats
- Glazed and insulated



Residential hot water
Swimming pools

Medium temperature system

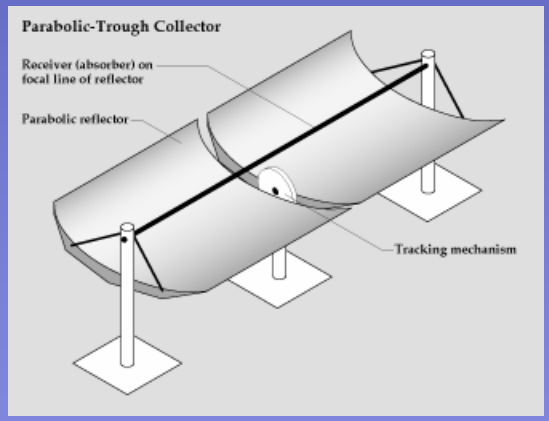
- Evacuated tubes



Cafeterias
Laundries

High temperature system

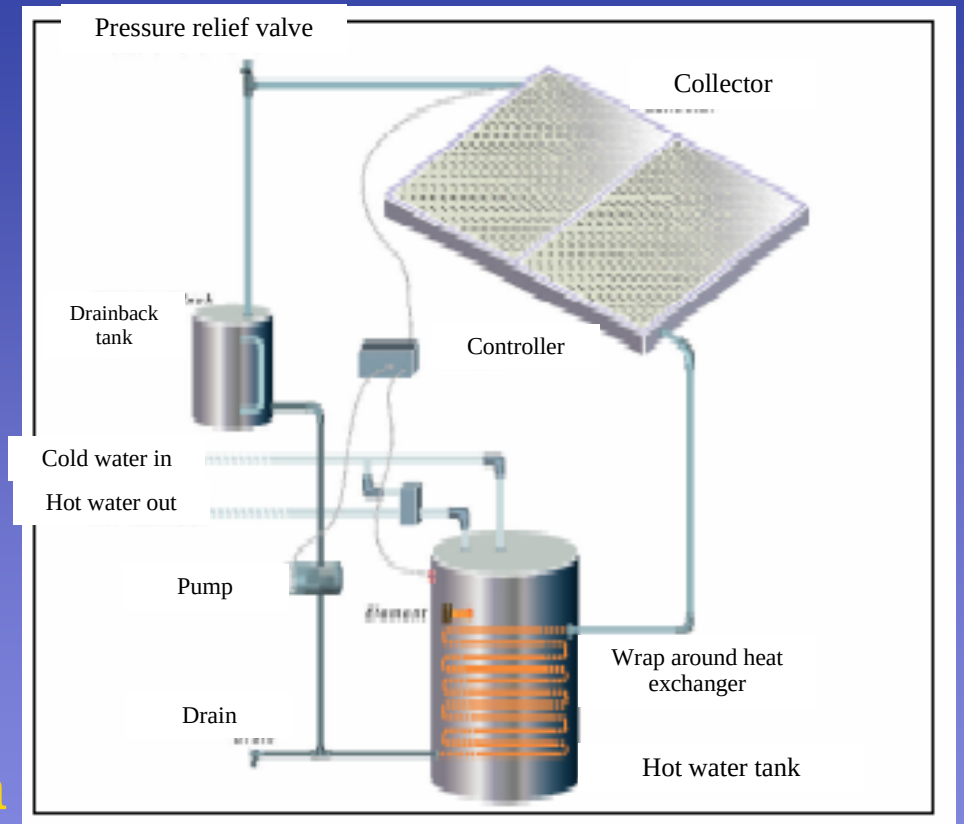
- Parabolic Concentrators



Industrial processes
Electrical generation

When to Use 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 to site collectors (1 ft^2/gal/day)
- Sunny climate helps but is not a requirement. Solar hot water works in cold & warm climates.



Drainback Solar Water Heating System

Federal SHW Examples

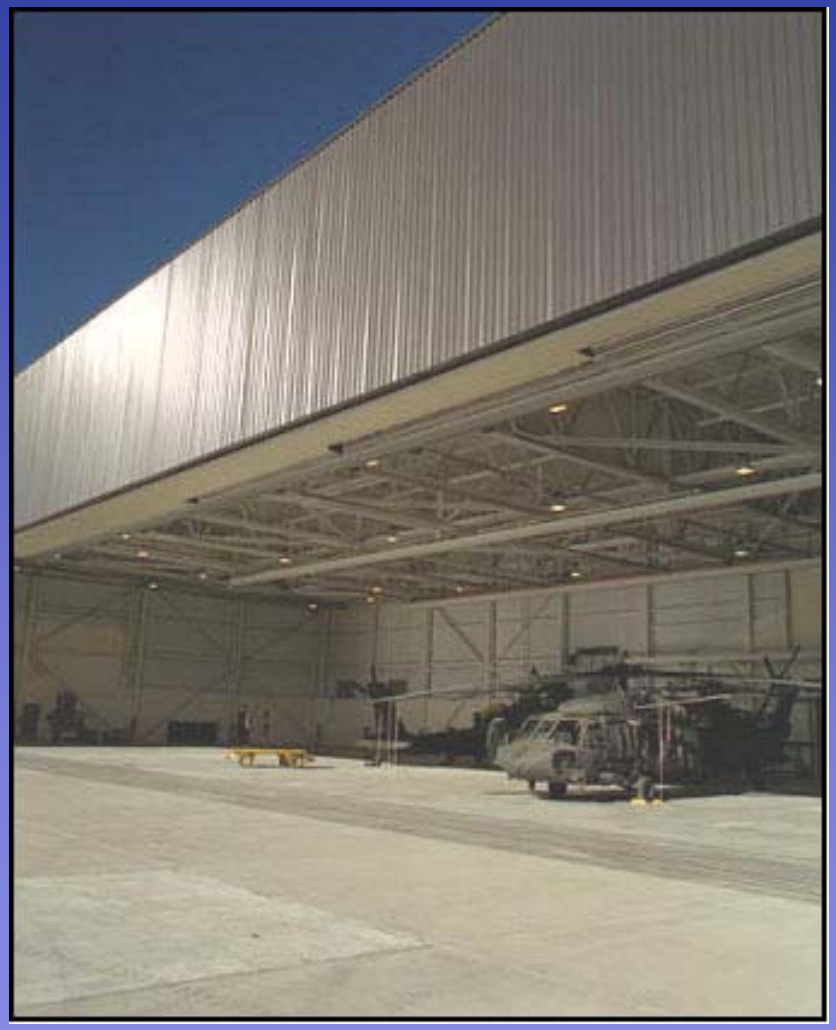
USCG Kia'i Kai Hale Housing Area, Honolulu, HI

Barnes Field House, Fort Huachuca, AZ

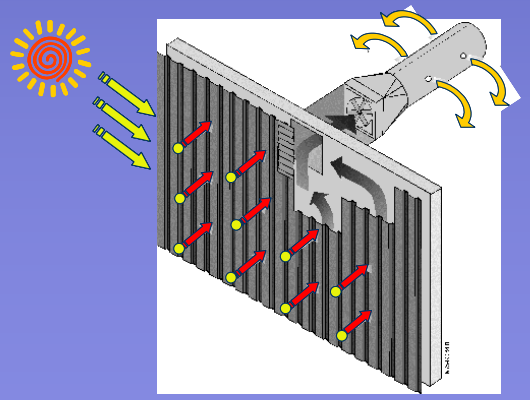
EPA Edison, New Jersey

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

Solar Ventilation Preheat



- High ventilation requirements
- New construction
- Retrofit - available <u>south</u> 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

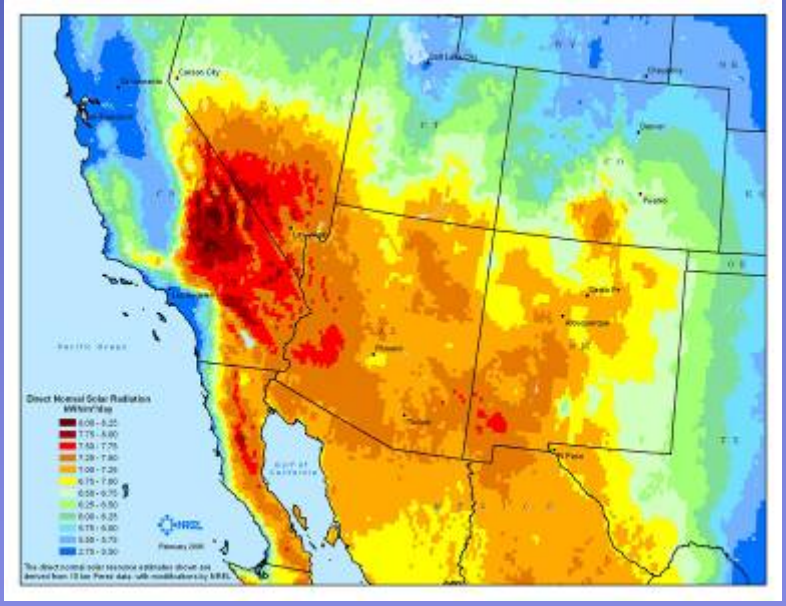
Concentrating Photovoltaics

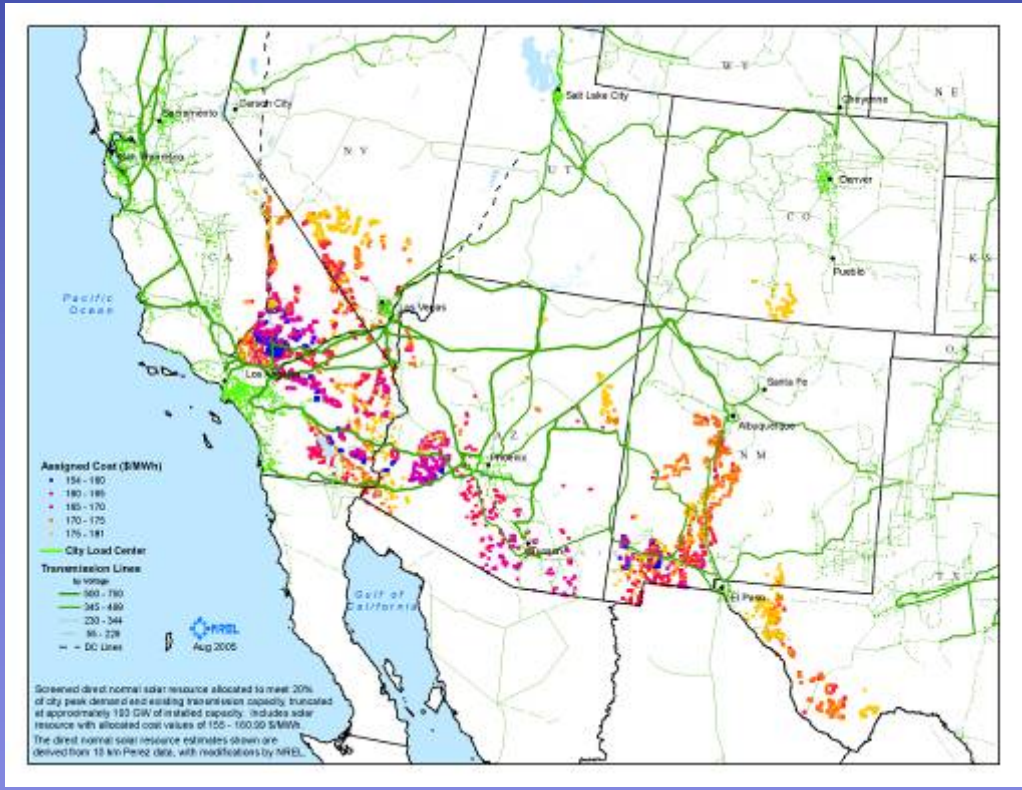
Dish/Stirling

Concentrating Solar Power

- Western Governor's Association (WGA) - 30GW of clean energy by 2015 goal, including 1 GW CSP

- Solar assessment



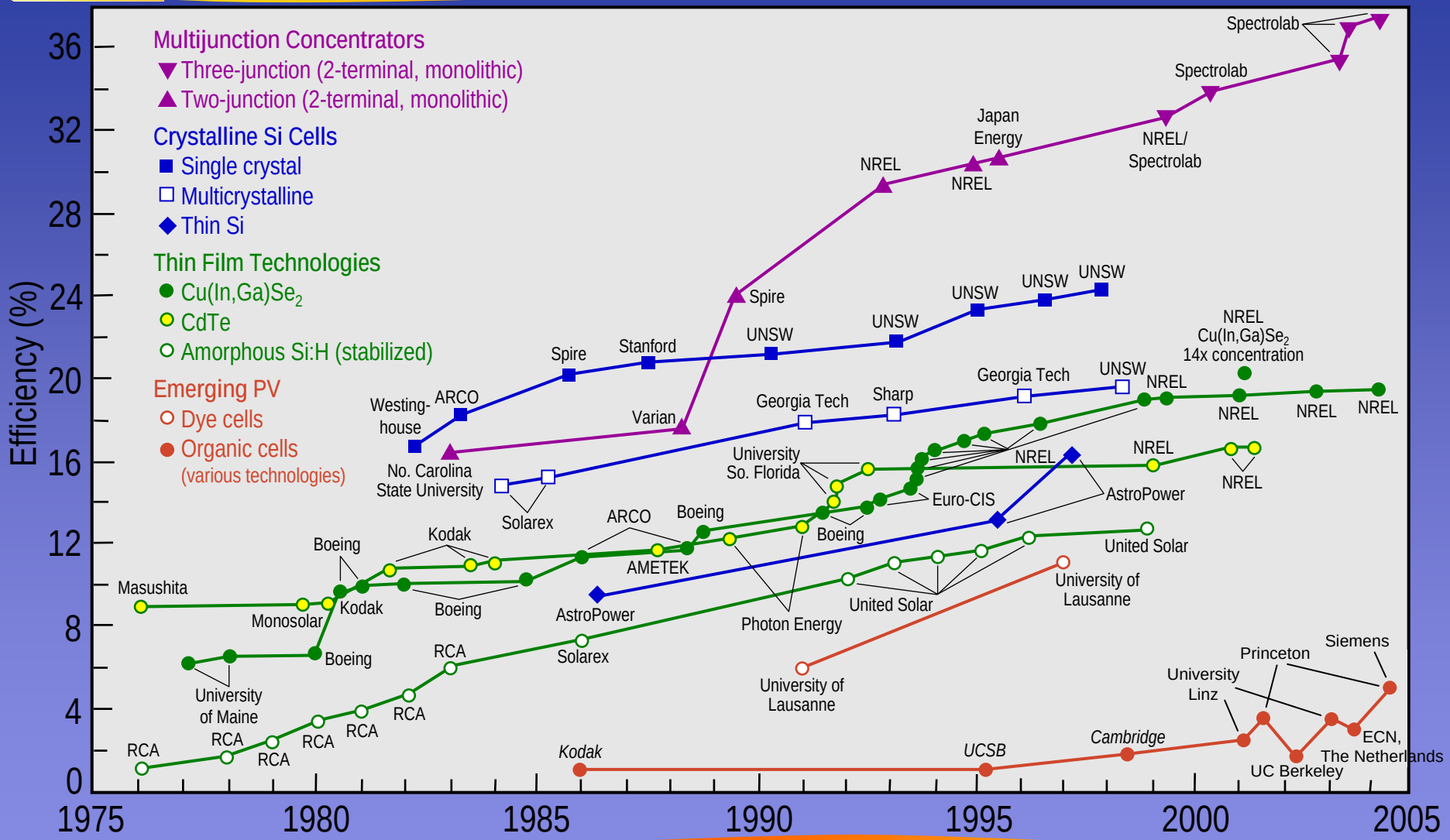


Research Focus in Solar

- Higher efficiency cells
- Advanced manufacturing techniques & lower production costs
- Cheaper/less material
- New nanomaterials applications
- Concentrating PV

Bottom line – reduce ¢/kWh

Best Research Solar Cell Efficiencies



Advanced "3rd-Generation" Solar

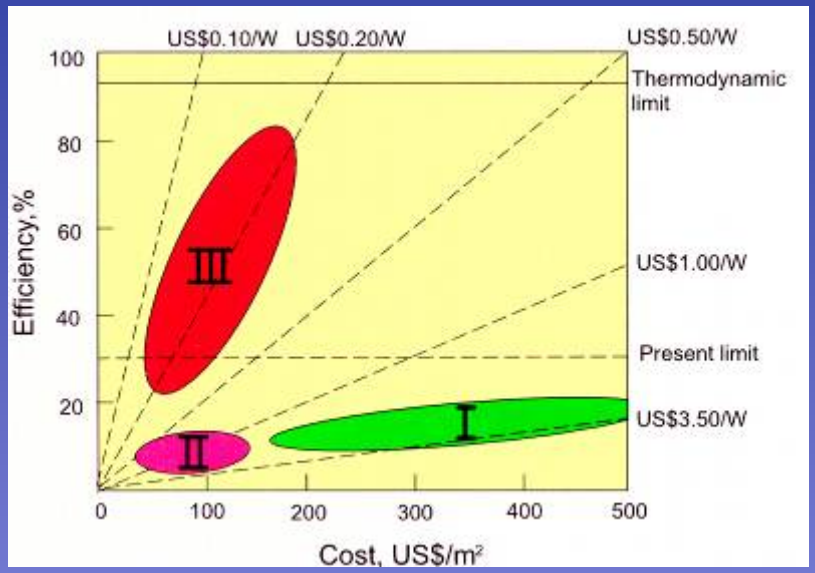
Current Technologies

I. 1st Generation – Crystalline
   - Expensive & low efficiency

II. 2nd Generation (Polycrystalline Thin Film)
   - Cheaper, but still low efficiency

Future Possibilities

I. 3rd Generation
   - Multi-junction cells (>30% efficiency)
   - Quantum dots (>60% efficiency)



Region III indicates potential efficiencies higher than previous theoretical limits, at lower costs, made possible by nanostructures such as quantum dots

Innovative Renewable Projects

- On-site renewable projects
  - Private entity installs, owns, operates and maintains equipment (no agency up-front capital required)
  - Site purchases electricity through power purchase agreement (PPA)
  - Private entity eligible for tax and other incentives
  - Exploring the use of Western Area Power Administration (and possibly other Power Marketing Administrations) due to long term contract authority benefit
- Examples - Nellis AFB, GSA Sacramento, Fort Carson
- FEMP Focus article

Nellis AFB PV Project

- 15 MW
- $1 million electricity savings/year
- FAR Part 41 utility contract, indefinite term
- One year termination notice
- 20-year ground lease

Nellis Air Force Base, Nevada

- RECs sold to Nevada Power (for state Renewable Portfolio Standard)

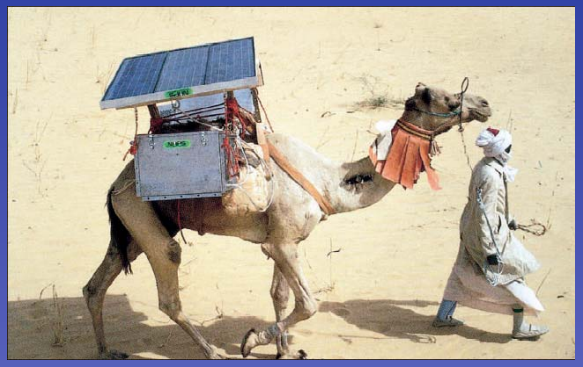
Fort Carson 2 MW PV Project

- 2 MW array will generate ~3,200 MWh/year
- Array will be ground-mounted, fixed-tilt covering ~15 acres of former landfill
- First Solar thin film PV technology (9.5% efficiency)
- Fixed, non-escalating energy rate for 18 years
- Western Area Power Administration is contracting agent
- Project will serve 4% of Ft. Carson's load
- Project construction August – December 2007

GSA Sacramento 1 MW PV Project

- 1 MW roof-top PV
- 10-year contract
- Price matched to SMUD time-of-use tariff with price floor
- PG&E rebate and federal incentives (30% tax credit & accelerated depreciation) - pay for approximately 1/2 cost
- Used modified FAR Part 41 with Part 12 (Acquisition of Commercial Items)
- License for use of roof
- Private entity retains RECs
- Installation should begin this fall

For More Information



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New Orleans

August 5-8