



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

# Why Arizona Should Develop Its Solar Energy Resource

prepared and presented by:

**The Solar Energy Industries Assn. (SEIA), Solar Thermal Power Div.**

**The DOE Concentrating Solar Power (CSP) Program**

**SunLab, a virtual laboratory comprising groups at Sandia National  
Laboratories and the National Renewable Energy Laboratory (NREL)**

**August 21, 2003**

**Phoenix, Arizona**



# Summary

- **Arizona can add another engine for its economy by developing its solar energy resource.**
- **The economic benefits to Arizona far exceed the cost to develop its clean and renewable solar energy resource.**

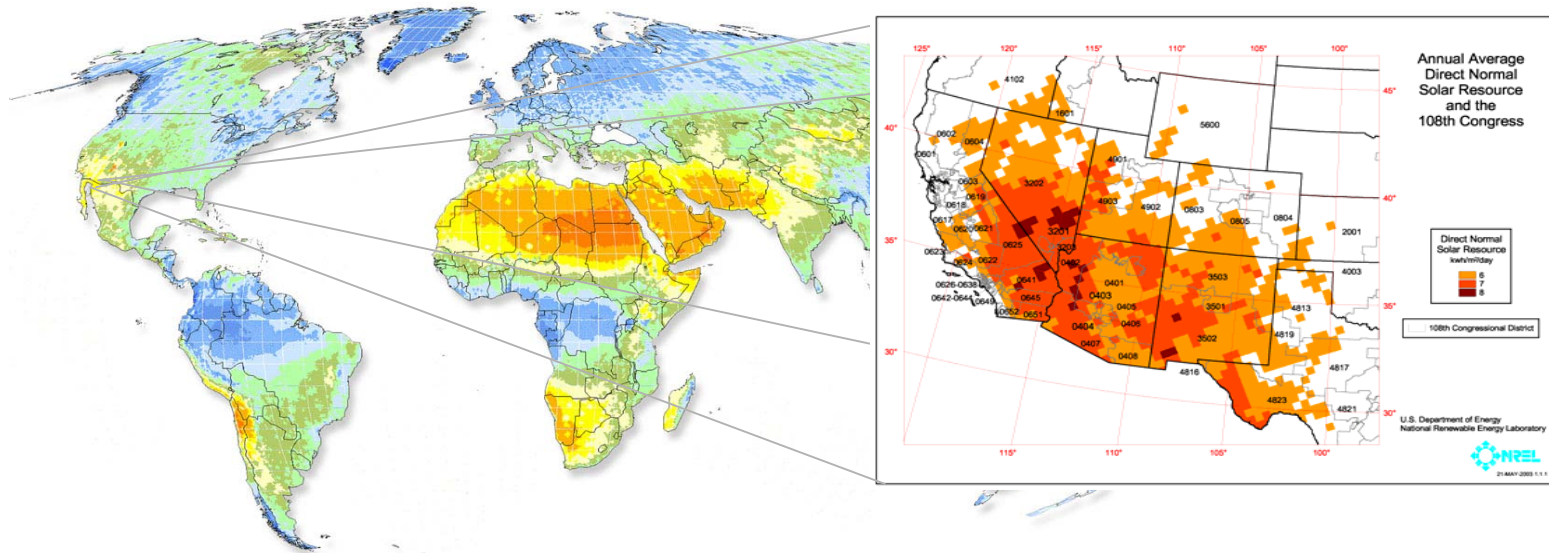


# Background

- **In 2001 Congress asked DOE to determine what would be required to deploy 1000 MW of Concentrating Solar Power in the Southwest U. S.**
- **DOE and the CSP industry approached the Western Governors' Association through the Western Interstate Energy Board to explore implementation.**
- **Four states - AZ, CA, NM, and NV - have the highest solar potential, the best renewable energy portfolio standards, and the most to gain from development of their solar energy resources.**

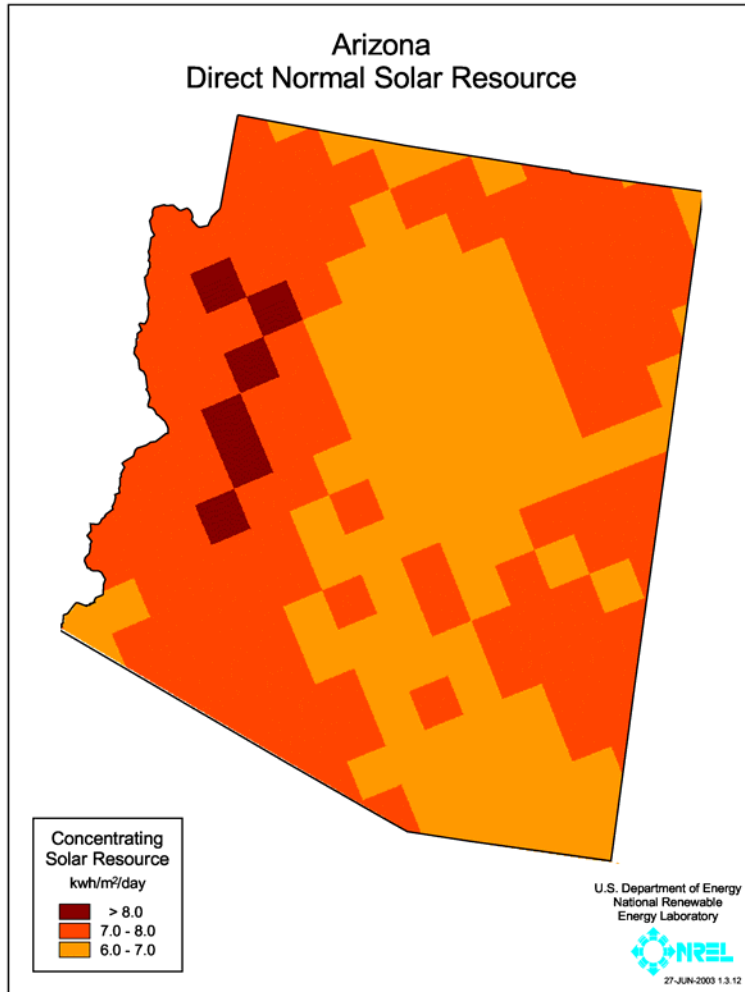


## Solar energy resources in the Southwest U.S. are among the finest in the world





# Arizona's Solar Resource



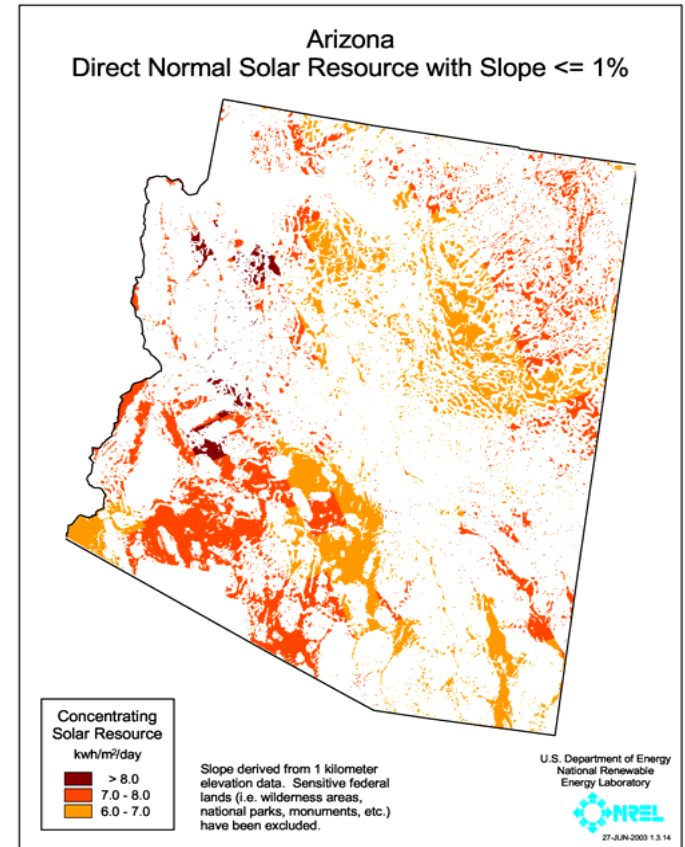
- **Less than one quarter of one percent of Arizona's land could generate all of the state's current electricity needs**
- **This area is 285 mi<sup>2</sup> (about 14 miles by 20 miles) which is roughly the size of Lake Powell.**
- **One "solar dam" could do it all.**



# AZ's Solar Energy Potential

The table and map represent land that has no primary use today, exclude land with slope > 1%, and do not count sensitive lands.

	Resource kWh/m <sup>2</sup> /day			Total
	> 8.0	7.0 – 8.0	6.0 – 7.0	
Available Area* (mi <sup>2</sup> )	680	12,110	11,100	23,890
Capacity (MW)	88,000	1,564,000	1,434,000	3,086,000
Generation (MWh/year)	207,798,000	3,701,306,000	3,392,854,000	7,301,958,000





# AZ's Generation Mix-2001

<u>Technology</u>	<u>Capacity (MW)</u>	<u>Energy Delivered (MWhr)</u>
Coal	5,384	39,848,000
Natural Gas	5,044	12,199,000
Nuclear	3,730	28,724,000
Hydro	2,927	7,835,000
Other	<u>119</u>	<u>348,000</u>
State Total	17,204	88,954,000

**Coal, natural gas, and nuclear represent 82% of Arizona's generation mix in 2001.**

Source: RDI BaseCase, NewGen and PowerDat Databases



## New Capacity 2002 through 2008

<u>Technology</u>	<u>(MW)</u>
Coal	760
Natural Gas	10,614
Solar	6
Other	<u>566</u>
Total	11,946

**Future planned capacity will result in an even greater dependence on natural gas and subject rate payers to price volatility and increases.**

*Source: RDI BaseCase, NewGen and PowerDat Databases*



# Solar Resource and Land

- **Arizona’s solar resource potential is very large and should be developed.**
- **Arizona’s planned new capacity (in fact total energy usage) is very small relative to that potential.**
- **This small “solar dam” would need 1.9 mi<sup>2</sup> (Area 1 by 2 mi)**

<b>CSP Capacity (MW)</b>	<b>Land Requirement (mi<sup>2</sup>)</b>	<b>% of Premium</b>
<b>250</b>	<b>1.9</b>	<b>0.3%</b>
<b>1000</b>	<b>7.7</b>	<b>1.1%</b>
<b>6000</b>	<b>46.4</b>	<b>6.8%</b>

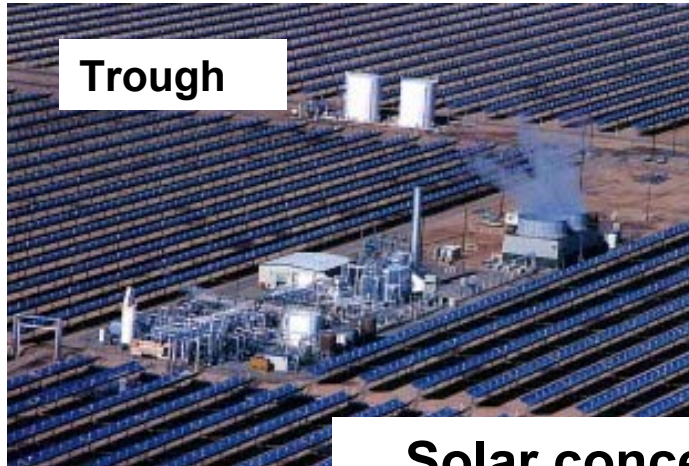


# How do we develop this resource?

- **Concentrating Solar Technologies can be used to “mine” this resource.**
- **Some of these technologies use curved mirrors to focus the sun’s rays and to make steam, others directly produce electricity.**
- **This steam is used to produce electricity via conventional power equipment.**
- **In multi-Megawatt plants, CSP provides the lowest cost solar electricity.**



# What is CSP?



**Solar concentration allows tailored design approaches**





# Movie of three CSP technologies

**This film clip shows**

- **The Solar Two Power Tower experiment at Barstow, CA**
- **The Solar Energy Generating Systems (SEGS) at Kramer Junction, CA**
- **Two Stirling Energy Systems  
10 kW Dish Stirling systems  
operating in Albuquerque,  
NM**





**Concentrating Solar Power (CSP) is .....**

- **ideally suited for multi-megawatt central power plants**
- **dispatchable power for peaking and intermediate loads through hybridization and/or thermal storage**
- **distributed power for grid support and remote applications**
- **proven technology with 354 MW operating successfully in California for the past 15 years**
- **rapidly deployed because it uses conventional items such as glass, steel, gears, turbines, etc.**
- **water requirements similar to a coal-fired plant**



# Benefits to Arizona from Development of its Solar Thermal Resource

## Economy

- **Create new jobs in rural areas**
- **Reduce cash outflow for energy**
- **Increase capital investment in the state**
- **Increase state GSP**

## Environment

- **Reduce air pollutants**
- **Reduce greenhouse gas emissions**

## Energy

- **Produce clean power in the state**
- **Hedge against NG price increases and volatility**
- **Hedge against hydropower fluctuations**
- **Reduce or mitigate transmission problems**





## Economy

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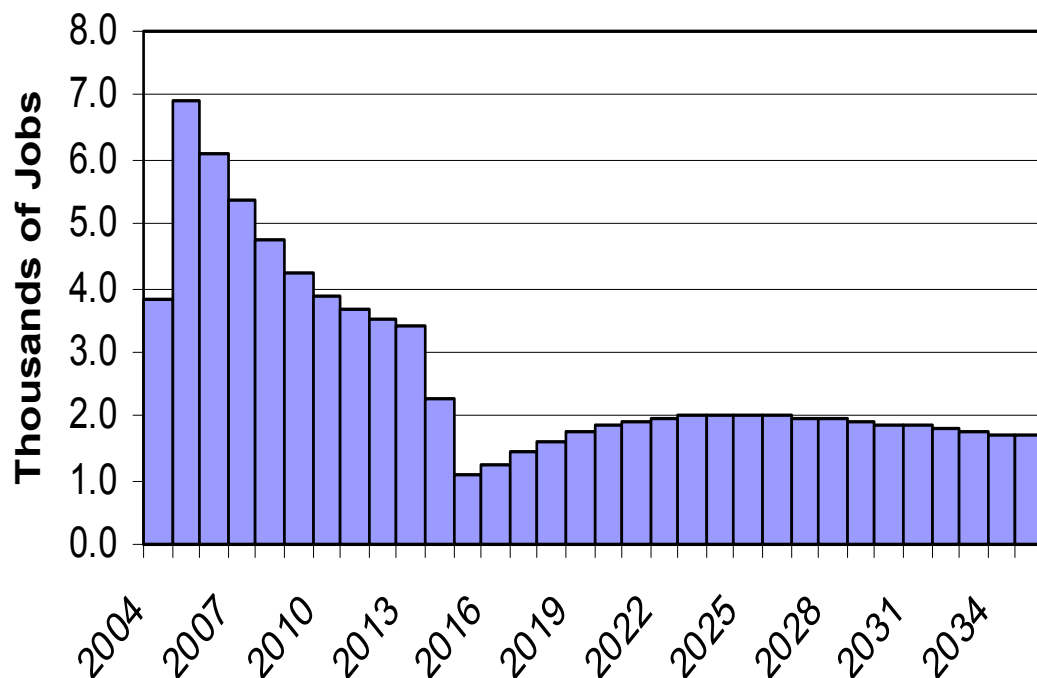
## **Create New Jobs in Rural Areas**

- **At its peak, installation of 1000 MW of CSP power plants would create nearly 7,000 new jobs.**
- **New jobs will be created to build, assemble and operate the CSP plants.**
- **These jobs can readily be created near Vicksburg, Yucca, Kingman, Dolan Springs and other rural areas.**
- **With the location of CSP plants in AZ, manufacturing and assembly plants can be expected to locate in the State.**



# Economic Benefits to AZ

## Employment Impact of Constructing, Operating, and Maintaining 1000 MW CSP Generation Facilities in Nevada



**Detailed Study  
for Nevada**

**Similar study  
could be done to  
evaluate  
economic impact  
in Arizona.**

\*Based on UNLV Center for Business and Economic Research study on the potential impact of constructing and operating solar power generation facilities in Nevada.



## Reduce Cash Outflow For Energy

- **Arizona must purchase fuels for its coal and natural gas power plants.**
- **This contributes to the state's \$5 billion cash outflow for energy**
- **250MW CSP plants will save Arizona about \$15 million per year in reduced energy or fuel imports**
- **1000MW CSP plants will save about \$64 million per year**
- **6000MW CSP plants will save about \$381 million per year**



## Increase Capital Investment in the State

- **CSP Plants built in Arizona will bring substantial private investment.**
  - **250 MW – \$750 Million**
  - **1000 MW - \$2 Billion**
  - **6000 MW - \$11 Billion**
- **Should increase income to the state through increased tax base.**



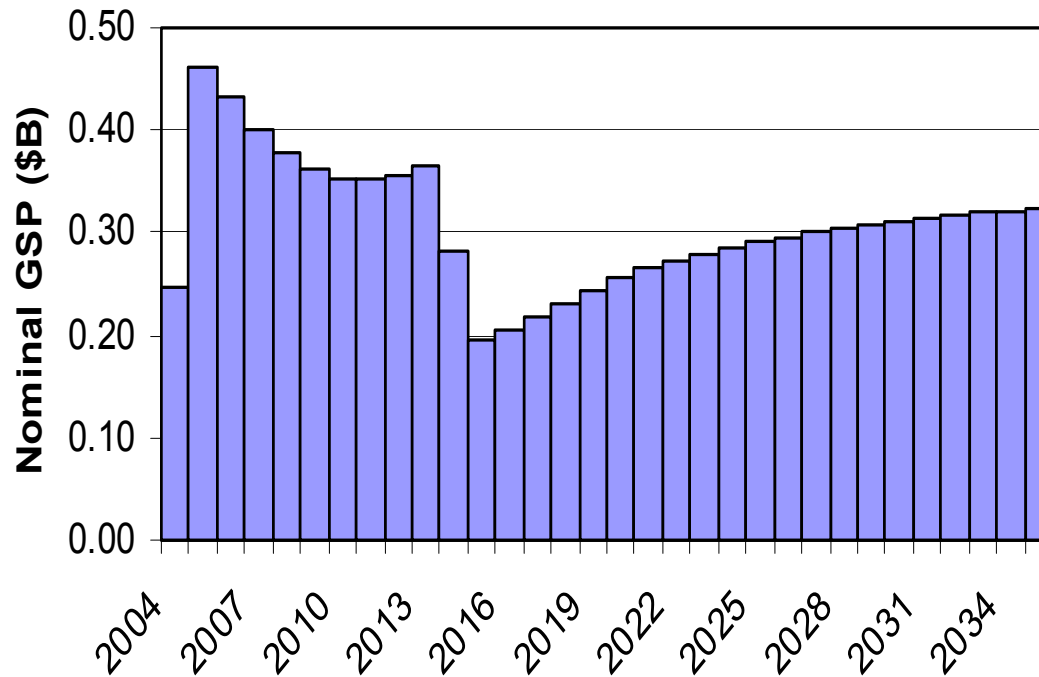
## Increase State's GSP

- **Arizona's GSP has been increasing by about \$11 Billion or 7% per year for the past few years.**
- **1000 MW would result in \$300 - \$500M increase to Arizona's annual GSP.**
- **1000 MW will result in local CSP design, construction, and operating experience, allowing Arizona to export these services to neighboring states.**



# Economic Benefits to AZ

## Impact on Nevada Gross State Product of Constructing, Operating, and Maintaining 1000 MW CSP Generation Facilities



**Detailed Study  
done for Nevada**

**Similar study  
could be done to  
evaluate impact  
on Arizona GSP.**



## Environment

- **Reduce air pollutants**
  - **Improve air quality**
  - **Increase public health**
  - **Reduce haze and increase tourism**
- **Reduce greenhouse gas emissions**



## Arizona Emissions in 2001

**Million lbs.**

<b>Technology</b>	<b>Generation (MWh)</b>	<b>CO<sub>2</sub></b>	<b>SO<sub>2</sub></b>	<b>NO<sub>x</sub></b>
<b>Coal</b>	<b>39,847,000</b>	<b>79,497</b>	<b>94.6</b>	<b>15.1</b>
<b>Nat. Gas</b>	<b>12,199,000</b>	<b>13,445</b>	<b>0.0</b>	<b>2.3</b>
<b>State Totals</b>		<b>92,942</b>	<b>94.6</b>	<b>17.4</b>

Source: RDI PowerDat Database



# Environmental benefits to Arizona

## Displacement (millions of lbs)

CSP Capacity (MW)	CO <sub>2</sub>	SO <sub>2</sub>	NO <sub>x</sub>
250	1,100	1.0	0.9
1000	4,600	3.8	3.6
6000	27,400	23.0	21.6

Based on displacement of best available coal technology

## Emissions Based on Planned New NG and Coal Gen (millions of lbs)

Planned Capacity (MW)	CO <sub>2</sub>	SO <sub>2</sub>	NO <sub>x</sub>
11,360	51,900	3.2	8.0



Photo Source: Western Regional Air Partnership

**CSP will contribute to the WRAP goals of cleaner air, reduced air pollution, and haze reduction.**



## Energy

- **Produce** clean power in the state
- **Hedge** against **NG price increases** and volatility
- **Hedge** against hydropower fluctuations
- **Reduce or mitigate** transmission problems



## Produce Clean Power in State

- **250 MW of CSP by 2005 could displace 2.2% of Arizona's planned capacity additions**
- **1000 MW of CSP by 2008 could displace 8.8% of Arizona's planned capacity additions**
- **6000 MW of CSP by 2012 could provide 52.8% of Arizona's planned capacity additions**

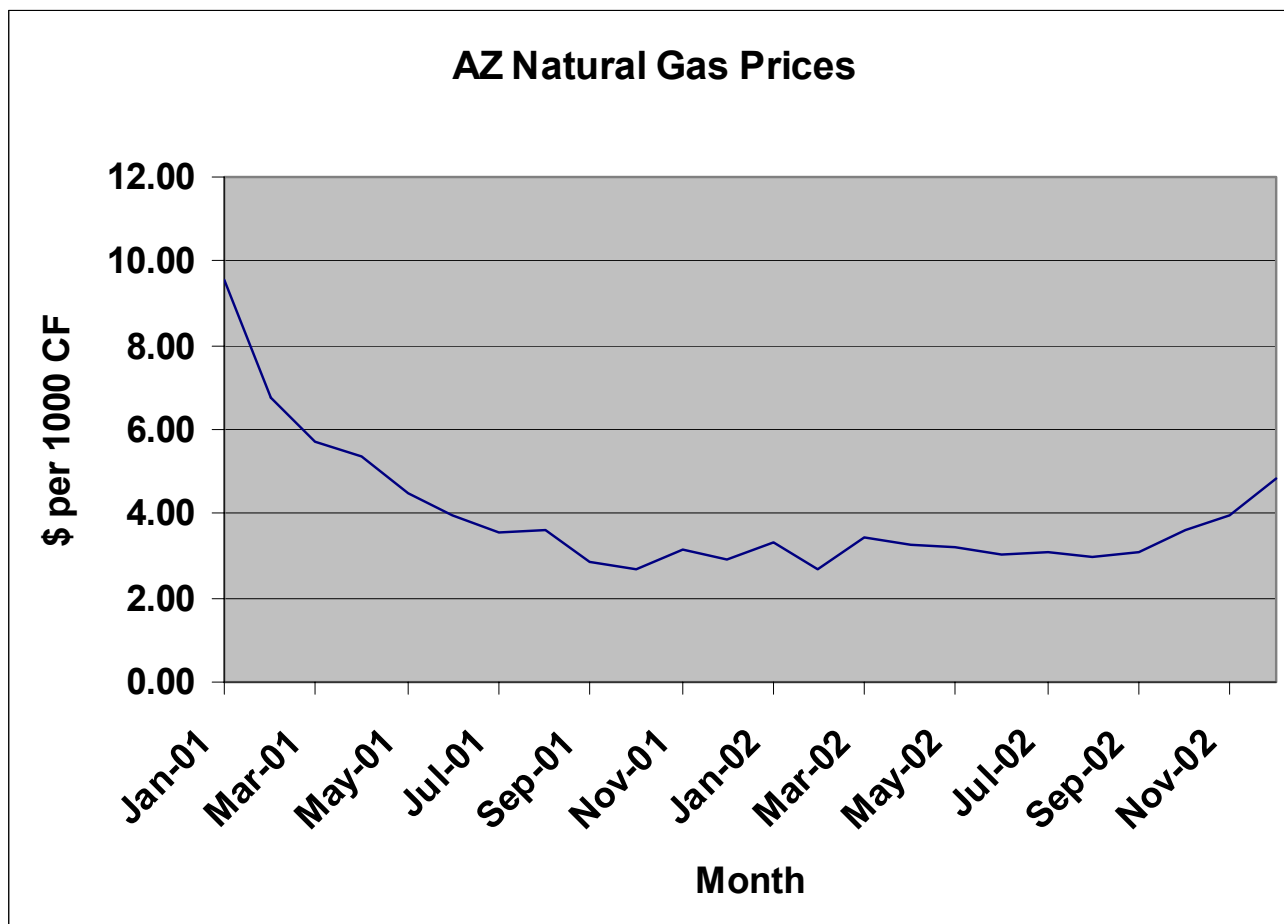


## Hedge Against Natural Gas Price Volatility

- **The price of natural gas has a long history of volatility**
- **Arizona has seen its gas prices fluctuate between \$3 and \$9 per thousand cubic feet in the last two years.**
- **The price of natural gas has been rising for the past year.**
- **New natural gas-based generation will increase natural gas price instabilities.**



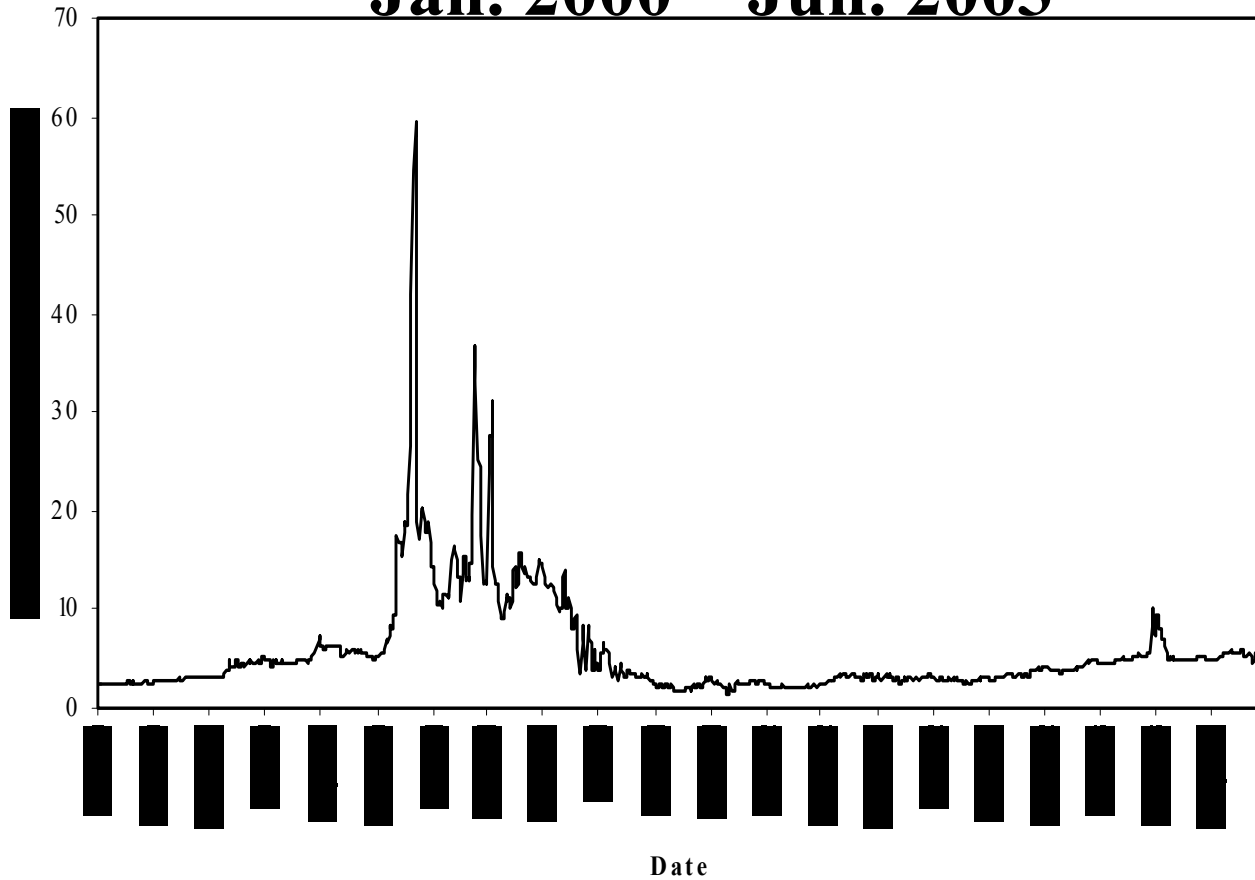
## Natural Gas Prices in Arizona





# Natural Gas Price Volatility

## Southern California Hub Nat. Gas Price: Jan. 2000 – Jun. 2003

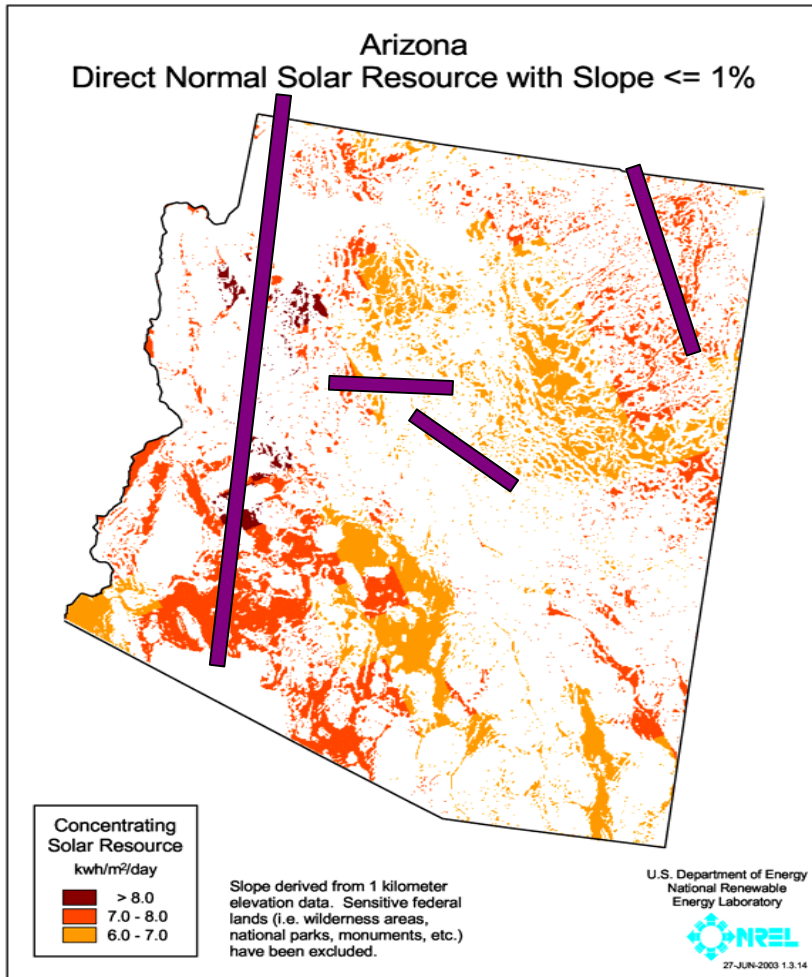




# Ease Transmission Barriers

## Reduce or Mitigate Transmission Problems

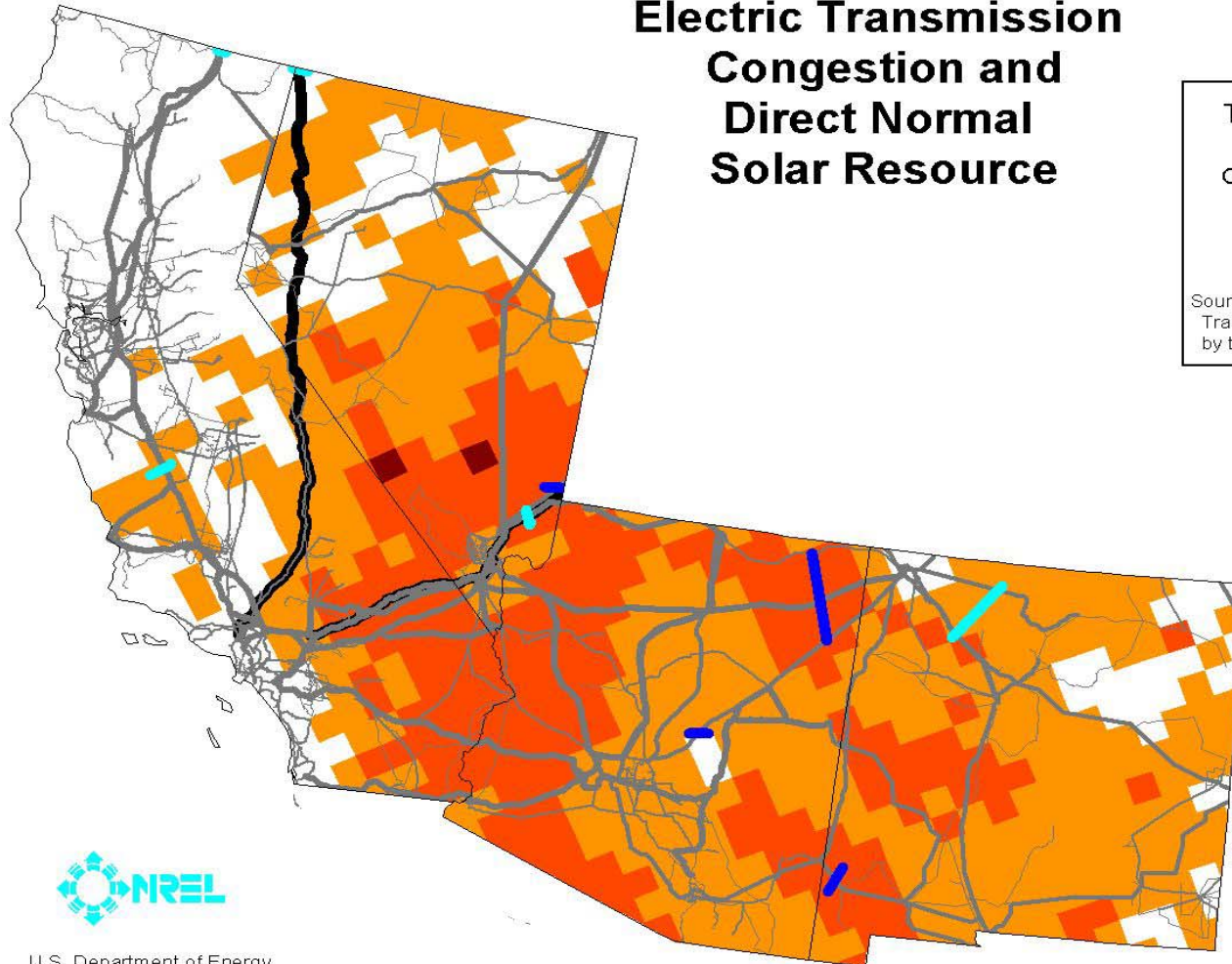
- **Transmission constraints in Arizona have been identified.**
- **Locating CSP plants appropriately may help alleviate related problems.**





# SW Transmission Barriers

## Southwest United States Electric Transmission Congestion and Direct Normal Solar Resource



Transmission Path Load  
Time over 75% of  
Operational Transfer Capacity  
(in at least one season)

- > 50%
- 25 - 50%

Source: Draft Western Interconnection  
Transmission Path Flow Study (Jan 2003)  
by the Seams Steering Group

Transmission Line  
Voltage

- Below 230kV
- 230kV - 344kV
- 345kV - 499kV
- 500kV - 734kV
- 735kV - 999kV
- DC

Source: PowerMap, ©2002  
Platts, a Division of the  
McGraw-Hill Cos.

Concentrating  
Solar Resource  
kwh/m<sup>2</sup>/day

- > 8.0
- 7.0 - 8.0
- 6.0 - 7.0





## **An example of what it could cost to develop Arizona's solar energy resource.**

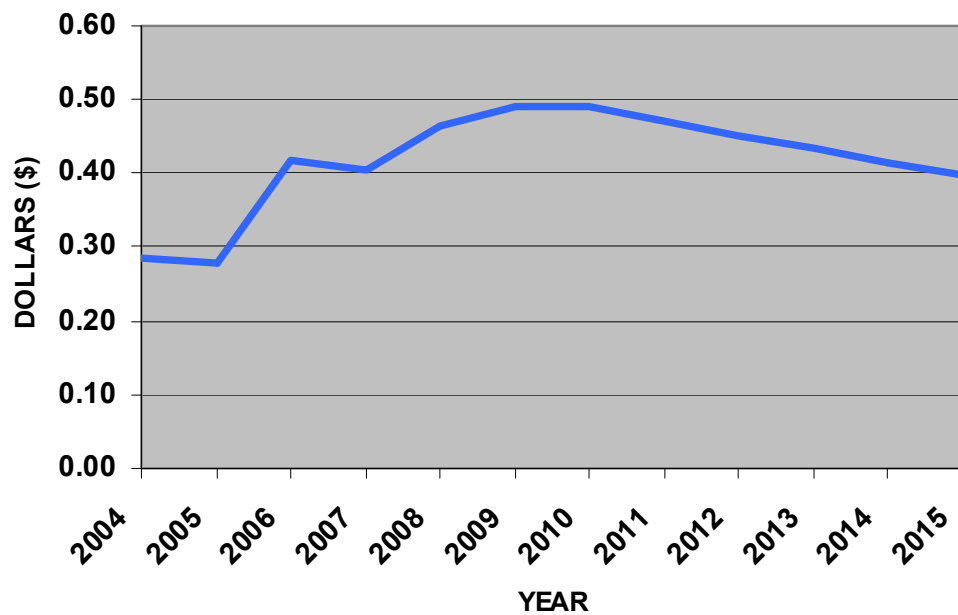
- **The investment to build the CSP plants will could come from private money – not from the state's treasury.**
- **The kWh premium to cover this investment is could be shared among rate payers in the existing RPS.**
- **If rate based, the monthly cost to the ratepayer could be 40-60 cents/month to support 250 MW of CSP power.**
- **The monthly amounts need to be applied as a premium to the kWh purchases from the plant to support the plant developers debt and equity payments.**
- **This premium is smaller than many typical fuel adjustment charges.**



# Cost to AZ Ratepayers

**If rate based, the cost to the AZ ratepayer of deployment of 250 MW of CSP Power.**

**MONTHLY COST TO AZ CONSUMER --  
250 MW BY 2010**



**Assumes:**

**250 MW deployment  
in four states**

**Costs distributed to  
customers of**

**1% per year cost  
increase of  
conventional power**



# Cost to AZ Ratepayers

**If AZ installs 250 MW of CSP power .....**

- The average cost to ratepayers is about 40 cents per month for 15 years.**
- If other states (and countries) also install CSP capacity, the price will decline faster and the cost to ratepayers will also decline.**
- Austin Energy offers a voluntary premium of \$2.85 for green power and holds it fixed for 10 years. It's very popular and responsible for that firm being the leader in green power in the US.**

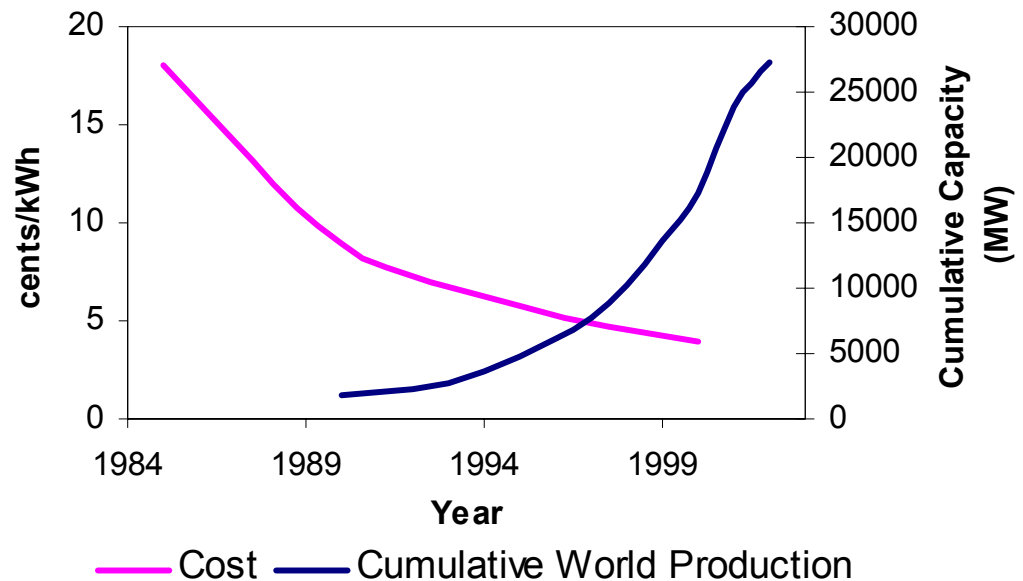


# CSP Costs Will Decline

**Cost reductions realized by wind power are good examples for CSP.**

- **Initial cost of wind power was high but decreased as installed capacity increased.**
- **The same trend will occur for CSP technologies.**

**Wind Power Costs and Capacity**



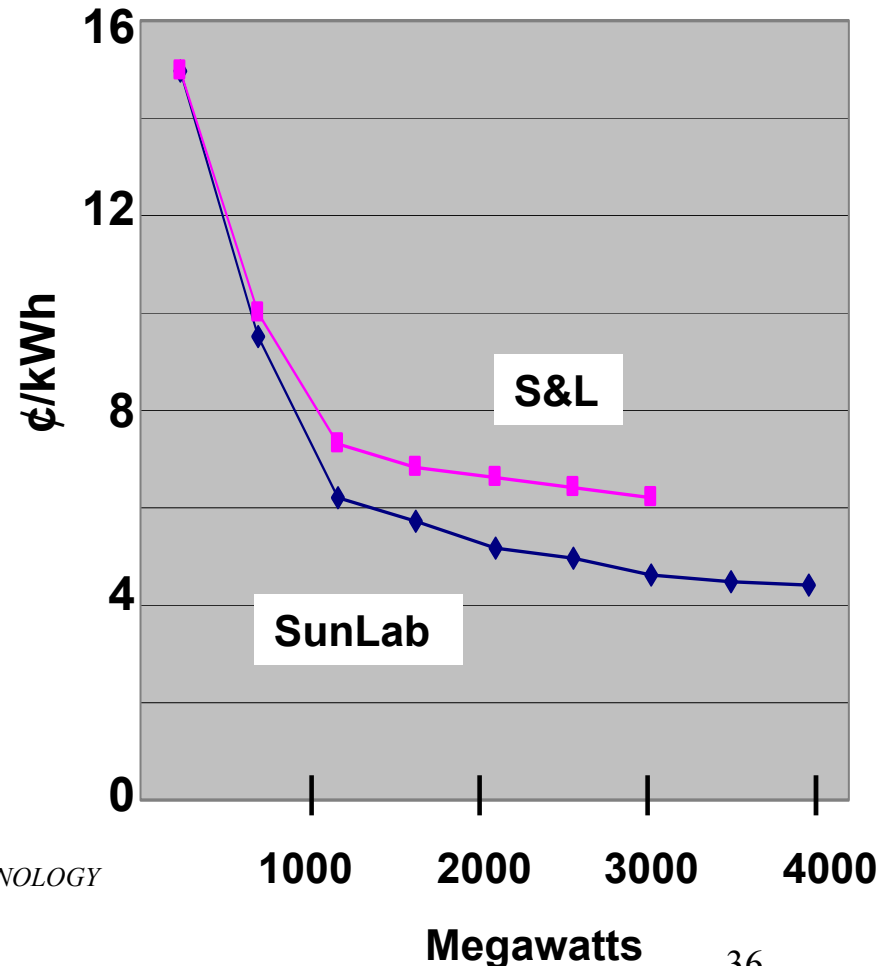


## Projected Costs of CSP Generation

**Sargent & Lundy\* and SunLab each evaluated the potential cost reductions of CSP.**

**Cost reductions for trough technology will result from deployment, scale and R&D**

**Cost reductions are accelerated with faster deployment schedule**



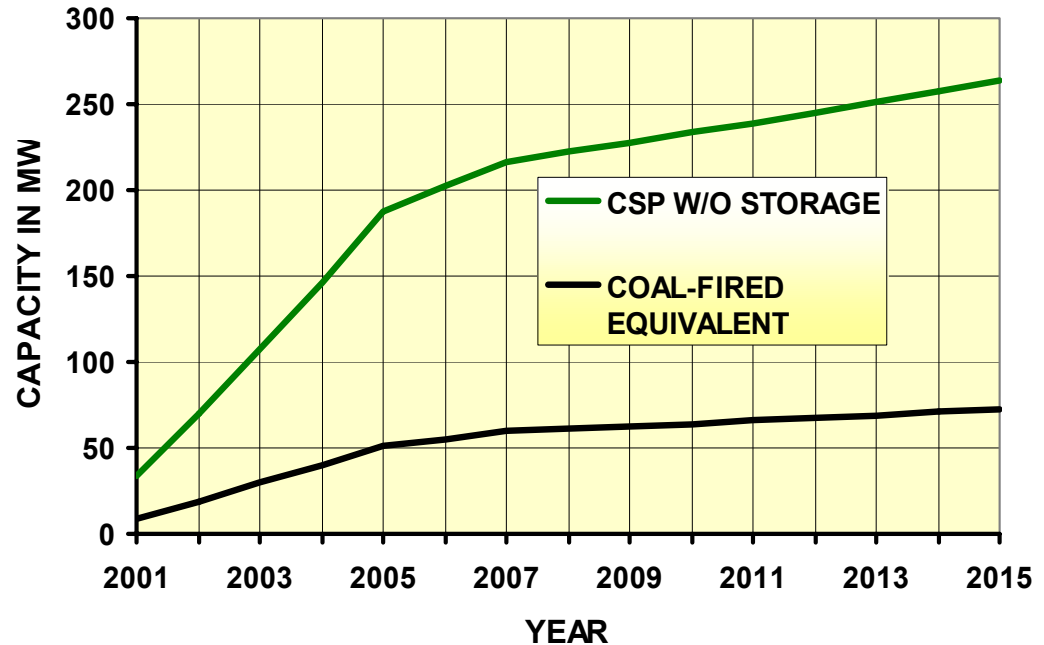
*\* ASSESSMENT OF PARABOLIC TROUGH AND POWER TOWER SOLAR TECHNOLOGY COST AND PERFORMANCE FORECASTS, SL-5641 MAY 2003.*



# AZ Renewable Incentives

- Qualifying Wood Stove Deduction (Biomass)
- Solar and Wind Energy Systems Credit (Res)
- Solar and Wind Equipment Sales Tax Exemption
- APS - Solar Hot Water System Credit
- APS - Solar Partners Plus - EPS Credit Purchase Program (5 kW or less)
- TEP - SunShare PV Buydown (PV only)
- APS - Solar Partners
- SRP - EarthWise Energy
- TEP - GreenWatts
- Arizona Million Solar Roofs Partnership
- North East Arizona Energy Services Company - Million Solar Roofs Partnership
- Scottsdale - Green Building Program
- Tucson - Million Solar Roofs Partnership
- Scottsdale - PV Permitting Standards
- Tucson - Sustainable Energy Standard
- Fuel Mix and Emissions Disclosure
- Scottsdale - Green Power Purchasing (PV only)
- Line Extension Analysis for PV (PV only)
- Net Metering (< 100 kW TEP, < 10 kW APS)
- Environmental Portfolio Standard**

## Arizona RPS Requirement



**Of more than 21 mandatory and voluntary programs, regulations, and incentives for using renewable energy, Only ONE applies to CSP technology.**

**The maximum capacity of the AZ RPS is less than 75 MW base-load equivalent in 2015.**

# What Needs to be done?

## **CSP Industry recommendations:**

- **Leadership by the Governor to develop the state's solar energy resource.**
- **Amend the Arizona EPS to increase the solar capacity proportionate to the State's resource.**
- **Participate in the 1000 MW Initiative by deploying a minimum of 250 MW of CSP power over the next 5 years.**
- **Gain ACC approval and support for the required premium.**


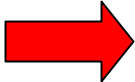
# What needs to be done? (2)

## **CSP Industry recommendations:**

- **Encourage continued congressional support for DOE's CSP R&D program.**
- **Support a Federal production tax credit (PTC) for CSP to reduce the burden on AZ's rate payers.**
- **Work with WIEB and WAPA to aggregate CSP power plant purchases in the four SW states**
- **Encourage WAPA to aggregate CSP demand and bid to meet this demand.**
- **Explore ways to use federal and tribal lands to site CSP plants.**



## Post-1000 MW Situation and Opportunities

- **CSP electricity costs declines to single digit c/kWh.**  **AZ has access to a clean, in-state energy source at competitive prices.**
- **AZ CSP leadership solidified, US companies positioned to capture international projects.**  **AZ businesses gain major market share.**



**Arizona can add another engine for its economy by developing its solar energy resource.**

**The economic benefits to Arizona far exceed the cost to develop this clean and renewable resource.**