



Why California 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)**

September 08, 2003



Summary

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

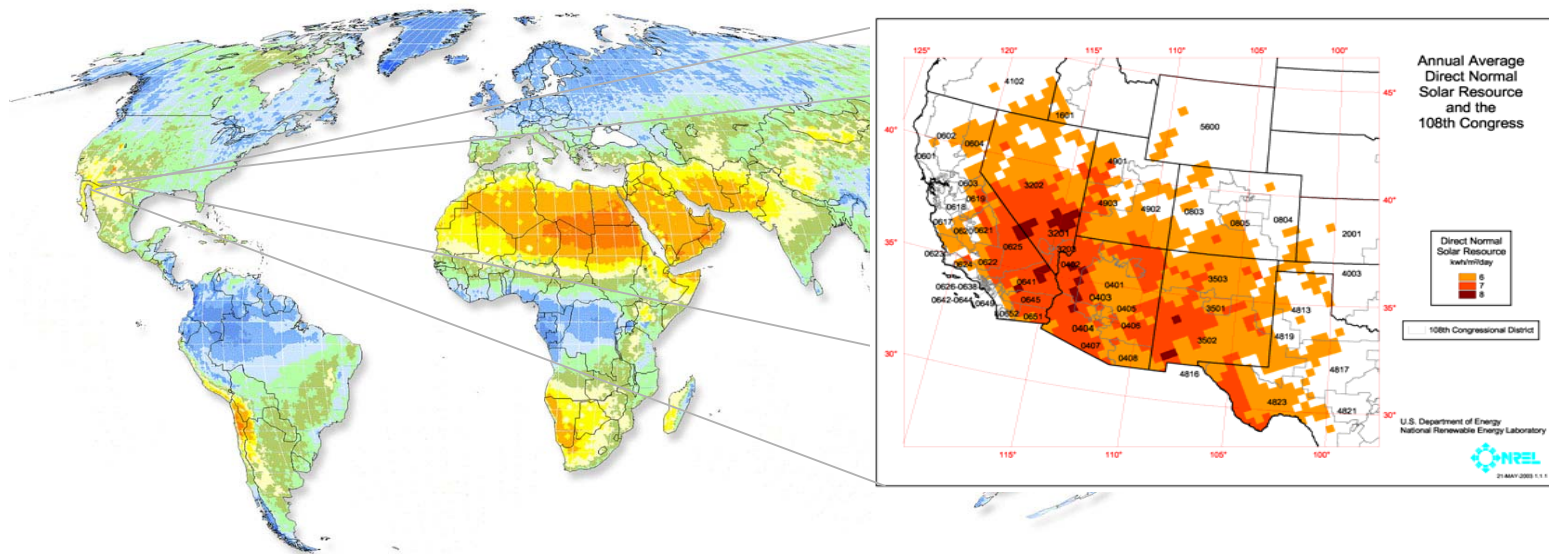


Background

- **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 & 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.**

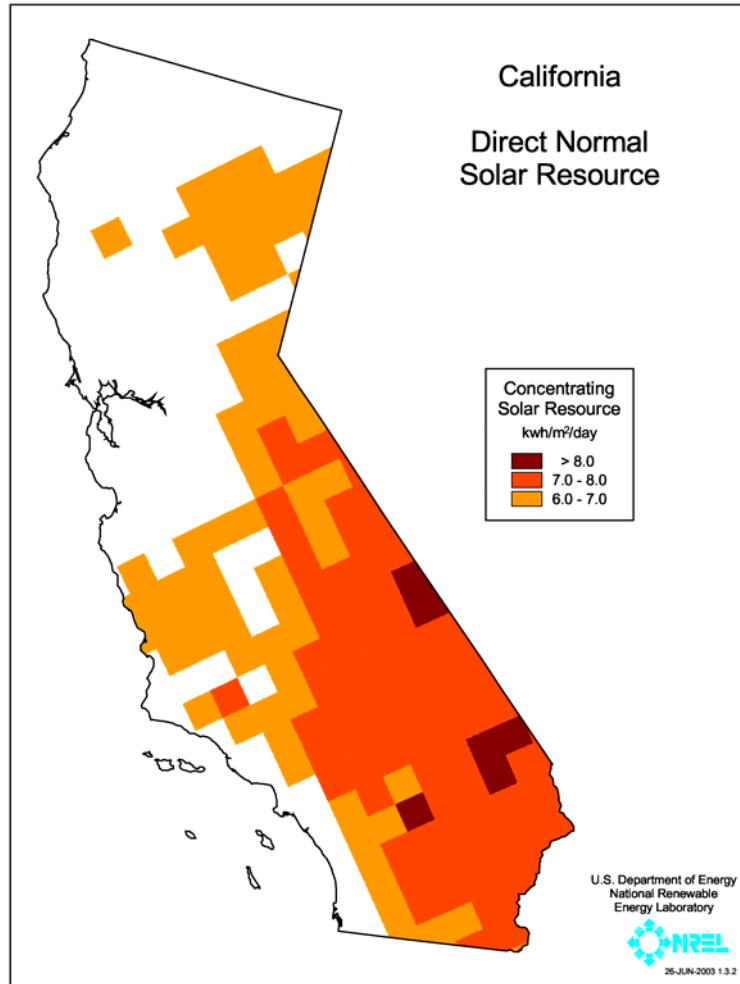


Solar energy resources in the Southwest U.S. are among the finest in the world





California's Solar Resource



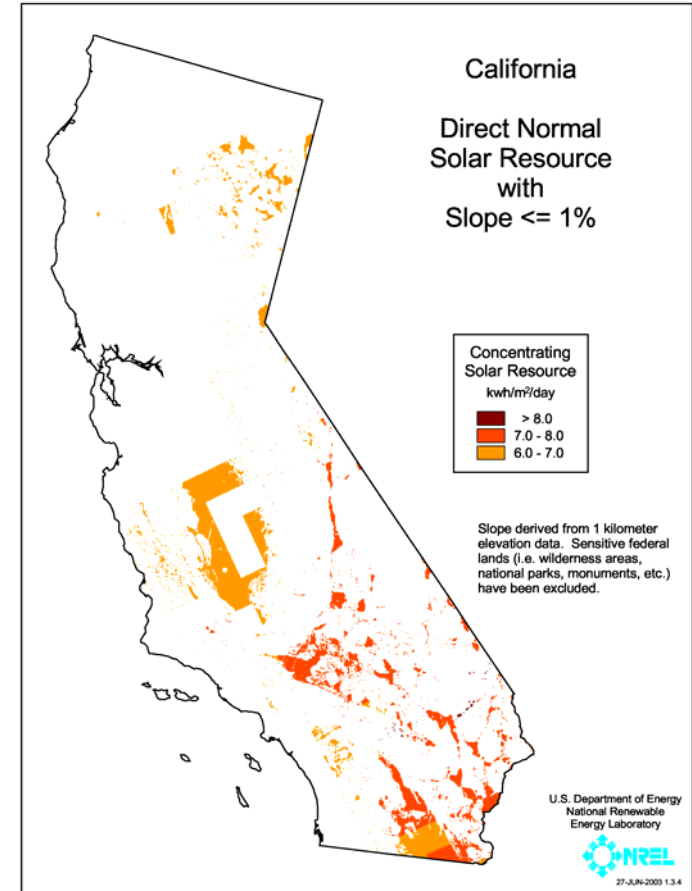
- **Approximately one third of one percent of California's land could generate all of the state's current electricity needs**
- **This area is 600 mi² (little more than 20 miles by 30 miles) which is fifty percent larger in area than the Salton Sea**
- **One "solar dam" could do it all.**



California'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 federal lands.

	Resource kWh/m ² /day			
	> 8 kW	7.0 – 8.0	6.0 – 7.0	Total
Available Area (mi ²)	50	5,700	7,190	12,940
Capacity (MW)	6,731	735,574	928,168	1,670,473
Generation (MWh/year)	15,930,000	1,740,972,000	2,196,806,000	3,953,708,000





California's Generation Mix-2001

<u>Technology</u>	<u>Capacity (MW)</u>	<u>Energy Delivered (MWhr)</u>
Coal	365	1,985,487
Natural Gas	28,801	102,398,476
Hydro	13,808	23,966,417
Geothermal	1,932	12,198,947
Nuclear	4,310	33,219,520
Wind	1,795	29,55,665
Other	2,629	6,745,222
State Total	53,640	183,469,734

Natural gas and hydro represent 70% of California's generation mix in 2001.

Source: RDI BaseCase, NewGen and PowerDat Databases



California's Planned Generation

New Capacity 2002 through 2008

<u>Technology</u>	<u>(MW)</u>
Coal	0
Natural Gas	16,868
Hydro	70
Wind	483
Other	<u>1,331</u>
Total	18,753

Future capacity increases dependence on natural gas and subjects rate payers to price volatility and increases



Solar Resource and Land

- **California's solar resource potential is very large and should be developed.**
- **California's planned new capacity is very small relative to that potential.**
- **A 250 MW CSP plant is an affordable and prudent first step.**
- **This small “solar dam” would need 1.9 mi² (1 by 2 miles)**

CSP Capacity (MW)	Land Requirement (mi²)	% of Excellent and Premium
250	1.9	0.03%
1000	7.7	0.1%
3000	23.2	0.4%

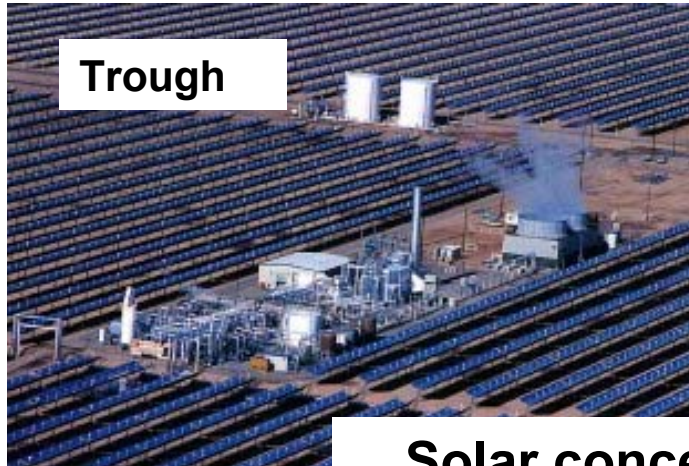


How do we develop this resource?

- **Concentrating Solar Technologies can be used to “mine” this resource.**
- **These technologies use curved mirrors to focus the sun’s rays and to make steam.**
- **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 Energy Generating Systems (SEGS) at Kramer Junction, CA**
- **The Solar Two Power Tower experiment at Barstow, 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 coal-fired plant.**



Benefits to California 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**





Economic Benefits to California

Economy

- **Create new jobs in rural areas**
- **Reduce cash outflow for energy**
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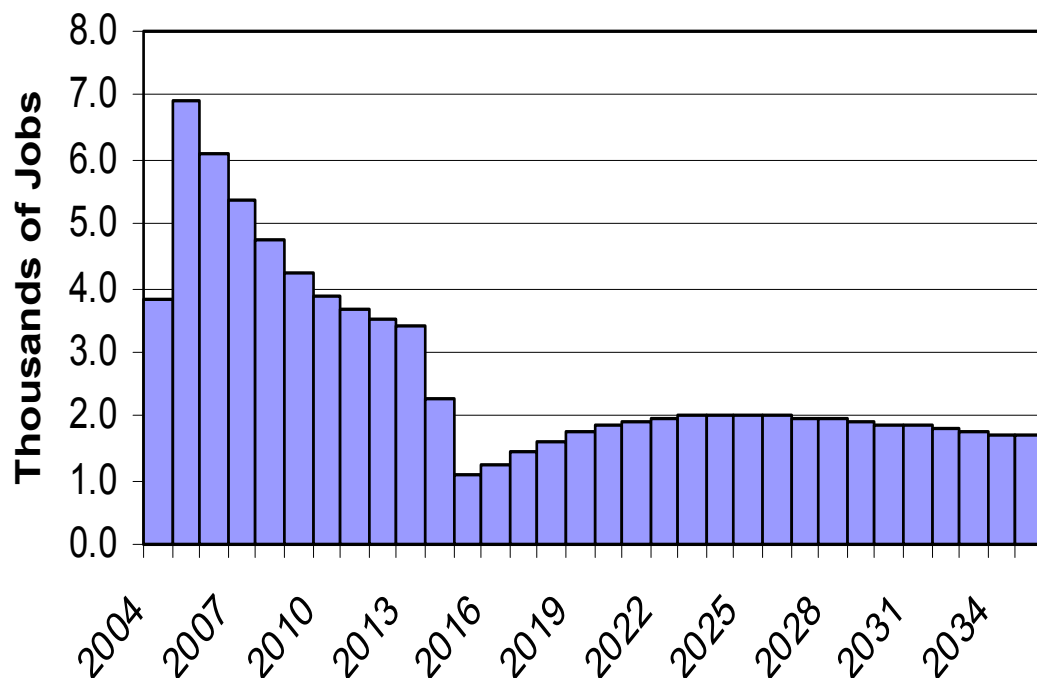
Create New Jobs in Rural Areas

- **At it's 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 California's rural areas throughout the southern portion of the state.**
- **With the location of additional CSP plants in California, manufacturing and assembly plants can be expected to locate in the State.**



Economic Benefits to CA

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 California**

*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

- **California must import 85% of the natural gas used in the state**
- **California n.g. demand for generation is projected to increase to 1,574 MMcf/d, resulting in a cash outflow of nearly \$3B/year for natural gas alone (assumes CEC nat. gas price projection of \$4-6/Mcf)***
- **250MW CSP plants will save California \$15 million per year in reduced Natural Gas imports**
- **Development of CSP plants along the border could increase economic development and trade with Mexico.**
- **Development of CS Power Plants on native American lands could provide development and jobs.**



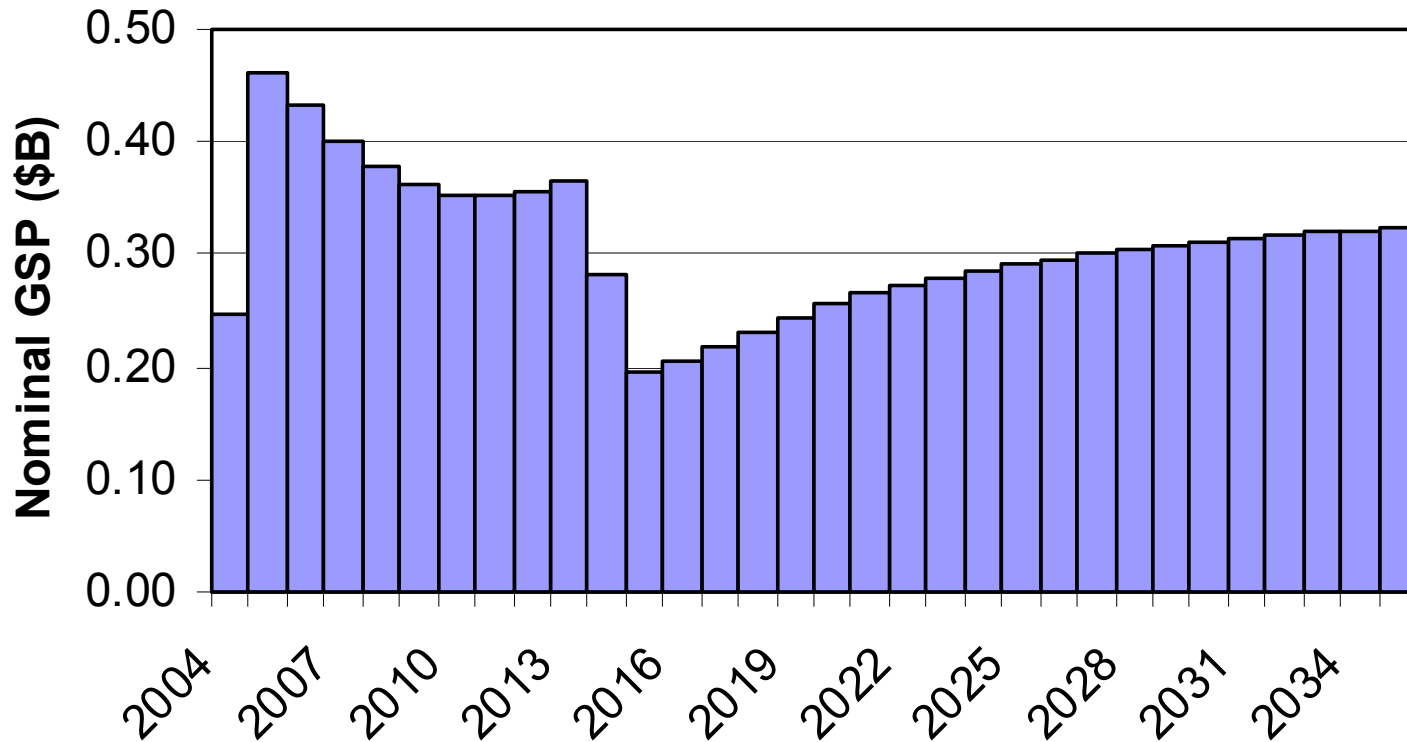
Increase Capital Investment in the State

- **CSP Plants built in California 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.**



Economic Benefits to California

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



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



Environment

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



California Emissions in 2001

Million lbs.

Technology	Generation (MWh)	CO₂	SO₂	NO_x
Coal	1,985,487	396	4.7	0.8
Nat. Gas	102,398,476	128,442	0.0	22.0
State Totals	104,383,963	128,838	4.7	22.8

Source: RDI PowerDat Database



Environmental Benefits

Displacement (millions of lbs)

CSP Capacity (MW)	Displacement (millions of lbs)		
	CO ₂	SO ₂	NO _x
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 Gen (millions of lbs)

Planned NG Capacity (MW)	Emissions Based on Planned New NG Gen (millions of lbs)		
	CO ₂	SO ₂	NO _x
16,868	33,100	0.4	8.4



Photo Source: Western Regional Air Partnership

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



Energy Benefits to CA

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 will displace 1.3% of California's planned capacity additions.**
- **1000 MW of CSP by 2007 will displace 5% of California's planned capacity additions.**

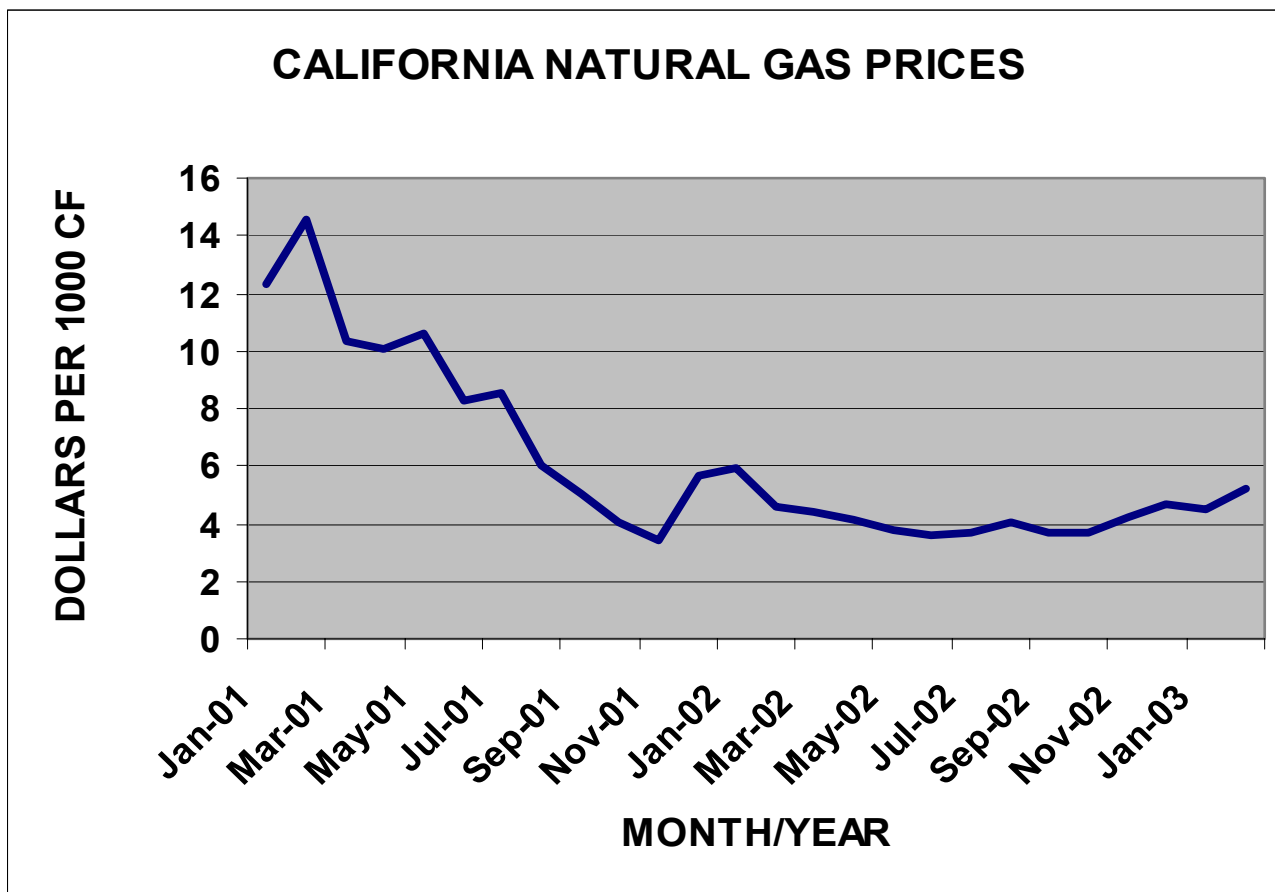


Hedge Against Natural Gas Price Volatility

- **The price of natural gas has a long history of volatility**
- **The price of natural gas has been rising for the past year and is not expected to return to its recent low levels.**
- **New natural gas-based generation will increase natural gas price instabilities.**



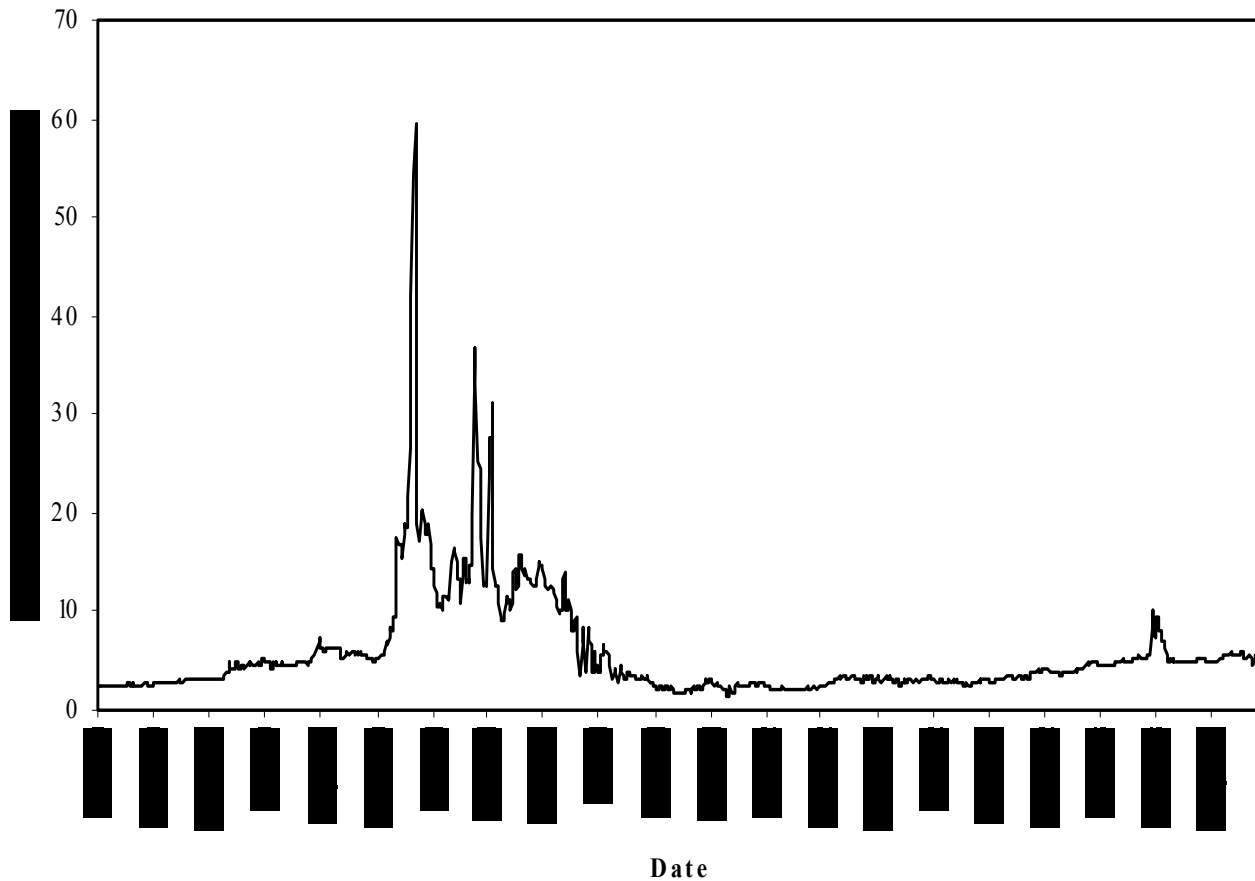
Natural Gas Prices in California





Natural Gas Price Volatility

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

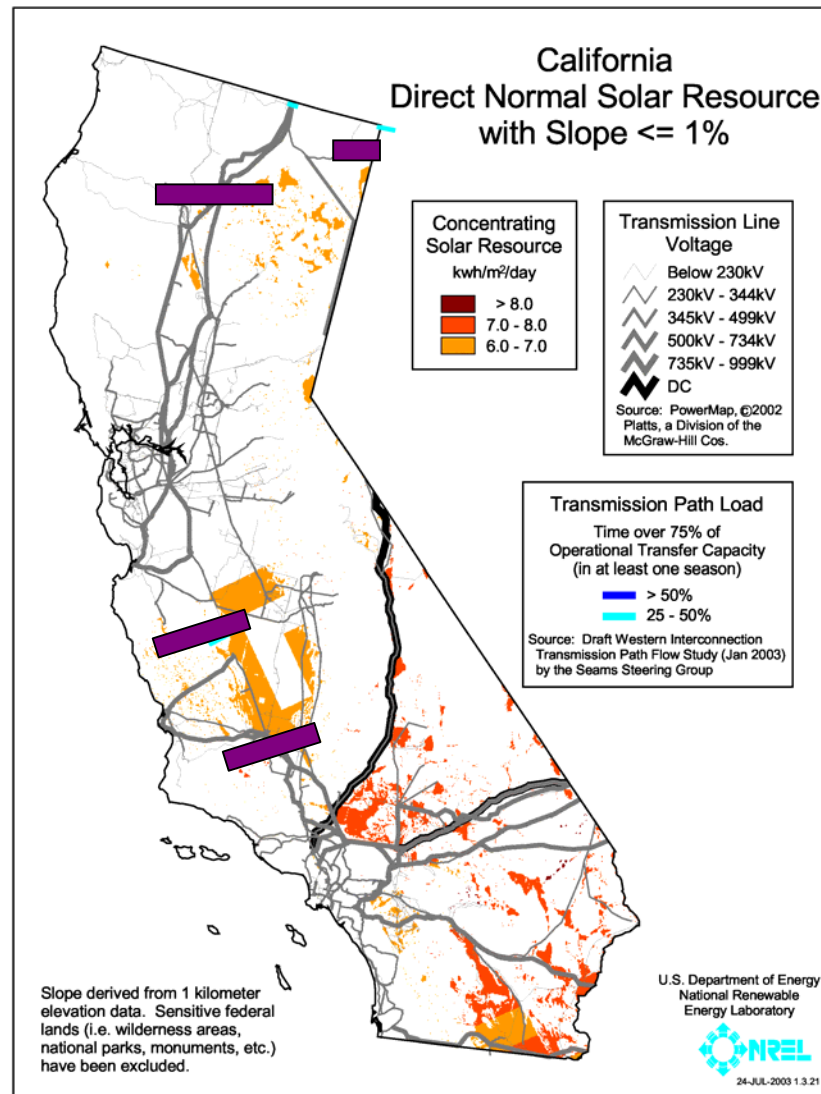




Ease Transmission Barriers

Major Transmission Constraints

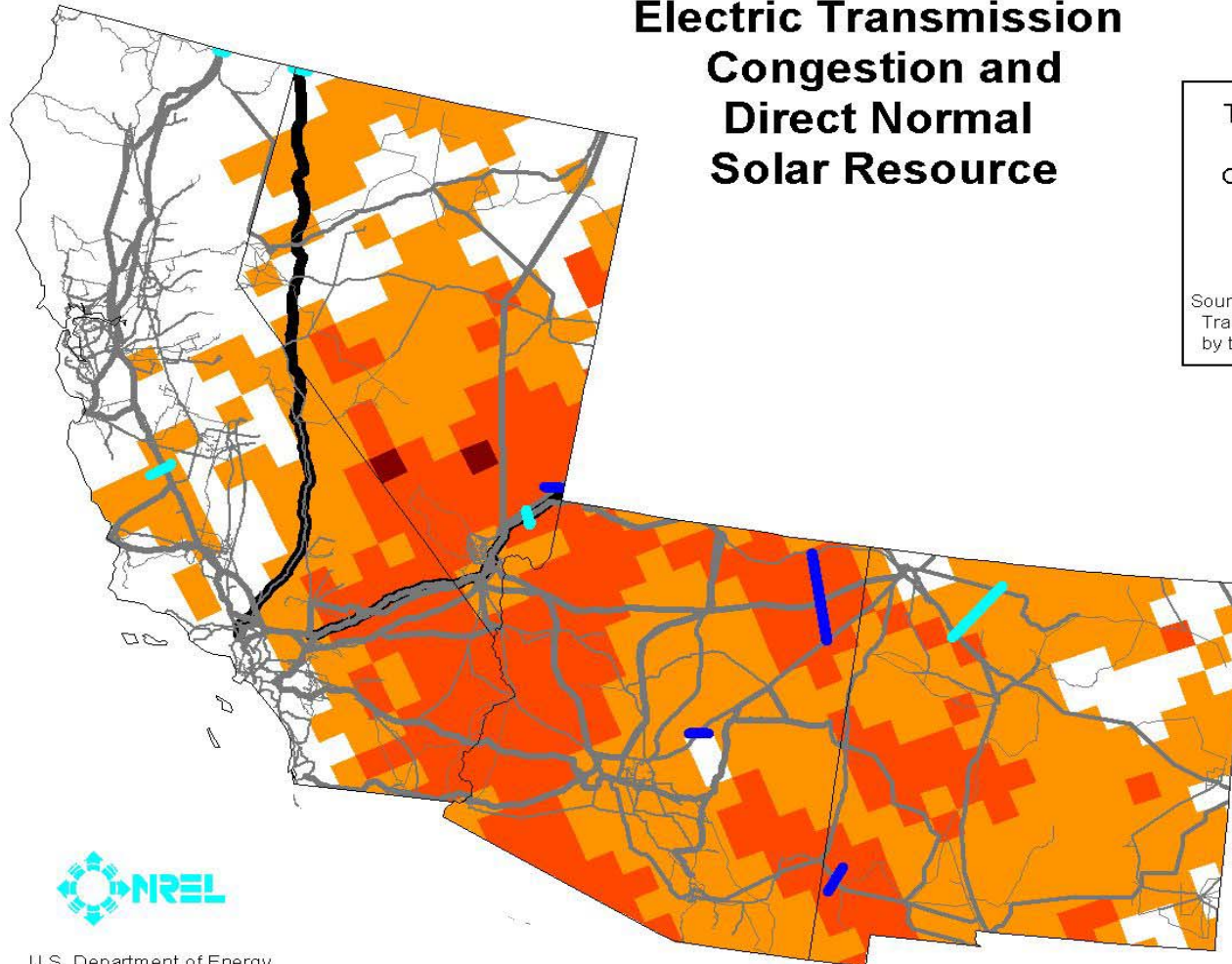
- **Transmission constraints in California have been identified.**
- **CSP plants may help alleviate related problems.**
- **CSP plants can be located throughout the southern part of the state to best deal with transmission and pipeline constraints.**





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/m²/day
- > 8.0
 - 7.0 - 8.0
 - 6.0 - 7.0





Cost to Develop CSP

An example of what it would cost to develop California's solar energy resource.

- **The investment to build the CSP plants could come from private money – not from the state's treasury.**
- **The kWh premium to cover this investment is shared among rate payers in the existing RPS.**
- **The incremental cost of cents/month could be required of ratepayers to support 250 MW CSP.**
- **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 CA Ratepayers

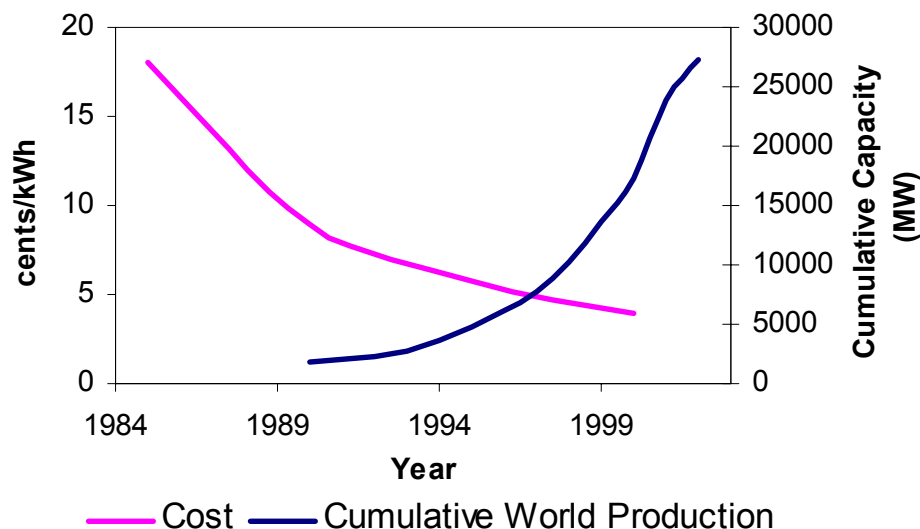
If California installs 250 MW of CSP power

- **The average cost to ratepayers is less than 10¢ per month for 10 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.**



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

Wind Power Costs and Capacity



Initial cost of wind power was high but decreased as installed capacity increased.

The same trend will occur for CSP.

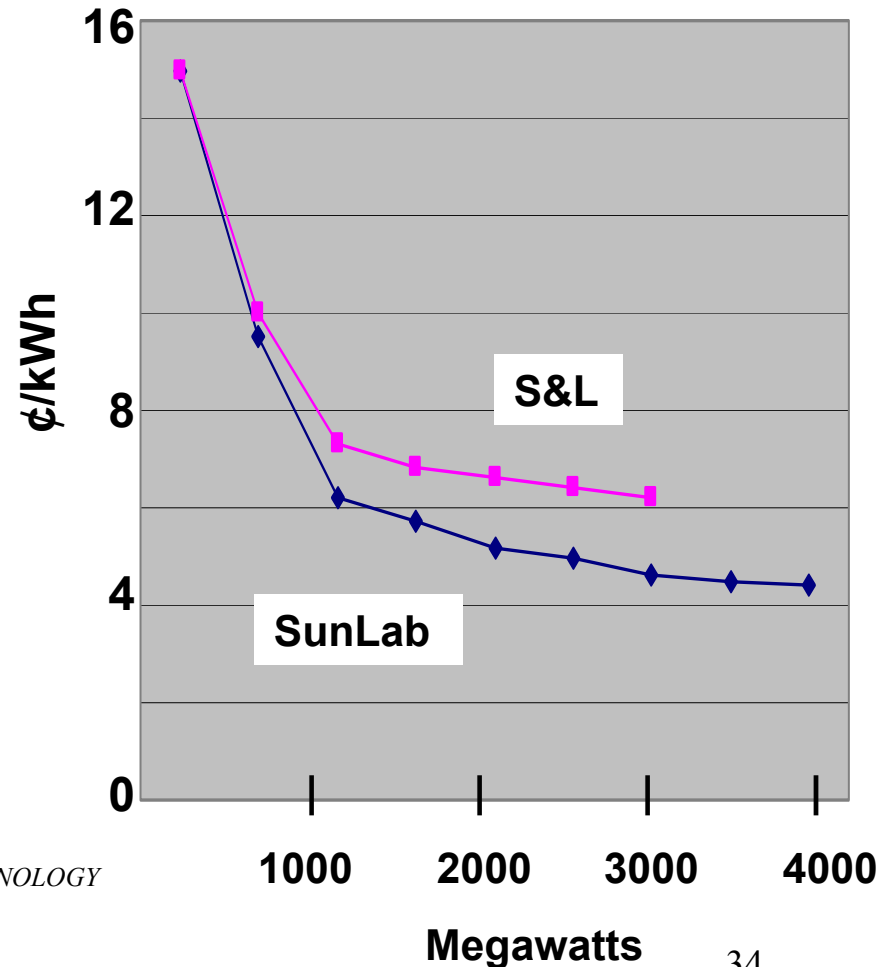


Projected Costs of CSP Generation

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.



CA Renewable Incentives

Tax Rate on Ethanol or Methanol
Solar or Wind Energy System Credit - Corporate
County of Marin - Marin's Best! Energy Incentive Program
Energy Technology Export Program
Plumas-Sierra REC - Geothermal and Photovoltaic Leasing Program
Santa Clara Water & Sewer - Solar Water Heating Program
Solar Tax Deduction
Solar or Wind Energy System Credit - Personal
California Property Tax Exemption for Solar Systems
Energy Financing Industrial Development Bond Program
Emerging Renewables Program
SELFGEN - Self-Generation Program
SMUD - PV Pioneer II Loan
SMUD - Solar Water Heater Program Loan
Anaheim Public Utilities - PV Buydown Program
Burbank Water & Power - Residential Solar Support
City of Palo Alto Utilities- PV Partners
LADWP - Solar Incentive Program
Redding Electric - Vantage Renewable Energy Rebate Program
SMUD - Solar Water Heater Program Rebate
Alameda - Clean Future Fund
Anaheim Public Utilities - Green Power for the Grid
Anaheim Public Utilities - Sun Power for the Schools
Burbank Water & Power - Clean Green Support
City of Palo Alto Utilities - Palo Alto Green
LADWP - Green Power for a Green LA
Roseville Electric - Green Energy
SMUD - Community Solar
SMUD – Greenergy
Turlock Irrigation District - Green Valley Energy
Alameda County - Million Solar Roofs Partnership Bay Area Solar Consortium - Million Solar Roofs Partnership
California Clean Energy Partnership (CCEP) - Million Solar Roofs Partnership
City of Santa Monica - PV Ferris Wheel & SolarPort
City of Santa Monica - Sustainable City Program
County of Santa Barbara - Innovative Building Review Program
Marin County SOAR - Million Solar Roofs Partnership

San Diego - Million Solar Roofs Partnership
San Francisco - Million Solar Roofs Partnership
San Francisco Public Utilities Commission - Million Solar Roofs Partnership
Solar Practitioner Certification
City of San Jose - Green Building Program
City of San Jose - Solar Hot Water Heaters & Photovoltaic Systems Permit Requirements
City of Santa Monica - Green Building Program
Solar Contractor Licensing
Retail Electricity Disclosure Program and Green Labeling
City of Santa Monica - Green Power Purchasing
Los Angeles - Green Power Purchasing
Oakland - Green Power Purchasing
Interconnection Standards
Net Metering
Renewable Resources Trust Fund
Renewables Portfolio Standard
City of Palo Alto Utilities - Solar Access
City of San Jose - Solar Site Design Guidelines
Los Angeles - Zoning Code
Sacramento - Zoning Regulation
San Diego - Planned Development Regulations
Solar Access Laws and the Solar Shade Control Act
Small Wind Access Law
State Standards for Local Government Review of Small Wind Systems
Existing and New Building Construction Requirements
Bay Area Solar Consortium - Million Solar Roofs Partnership
California Clean Energy Partnership (CCEP) - Million Solar Roofs Partnership
City of Santa Monica - PV Ferris Wheel & SolarPort
City of Santa Monica - Sustainable City Program
County of Santa Barbara - Innovative Building Review Program
Marin County SOAR - Million Solar Roofs Partnership
San Diego - Million Solar Roofs Partnership
San Francisco - Million Solar Roofs Partnership
San Francisco Public Utilities Commission - Million Solar Roofs Partnership
Solar Practitioner Certification
City of San Jose - Green Building Program
City of San Jose - Solar Hot Water Heaters & Photovoltaic Systems Permit

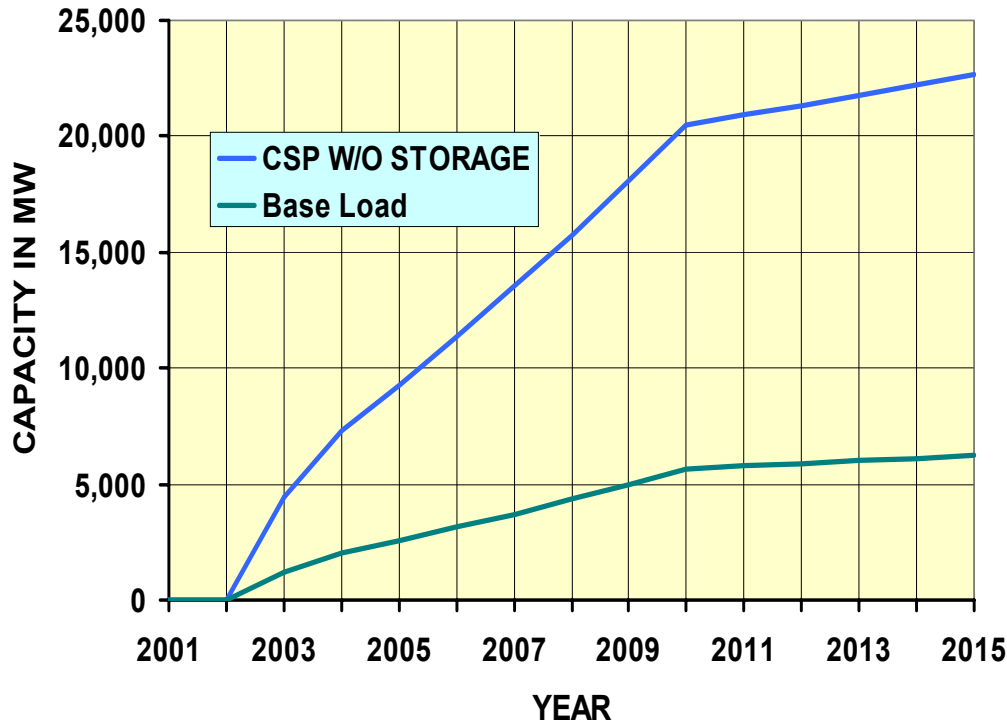
California has more than 60 mandatory and voluntary programs, regulations, and incentives for using renewable energy. Only 6 apply to CSP technologies.

City of Santa Monica - Green Building Program
Solar Contractor Licensing
Retail Electricity Disclosure Program and Green Labeling
City of Santa Monica - Green Power Purchasing
Los Angeles - Green Power Purchasing
Oakland - Green Power Purchasing
Interconnection Standards
Net Metering
Renewable Resources Trust Fund
Renewables Portfolio Standard
City of Palo Alto Utilities - Solar Access
City of San Jose - Solar Site Design Guidelines
Los Angeles - Zoning Code
Sacramento - Zoning Regulation
San Diego - Planned Development Regulations
Solar Access Laws and the Solar Shade Control Act
Small Wind Access Law
State Standards for Local Government Review of Small Wind Systems
Existing and New Building Construction Requirements



CA Renewable Portfolio

California RPS Requirement



Fred, you may want to add different words on this slide to address the CA RPS situation.

RPS provides for more than 22,000 MW of renewables by 2015

RPS treats CS Power as “peaking” power

It does not provide incentives for bulk power purchase and/or deployment

What Needs to be done?

CSP Industry recommendations:

- **Leadership by the Governor to develop the state's solar energy resource.**
- **Amend the California's RPS 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 PUC approval and support for the required premium.**


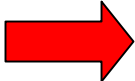
What needs to be done? (2)

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 NV'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.**  **CA has access to a clean, in-state energy source at competitive prices.**
- **CA CSP leadership solidified, US companies positioned to capture international projects.**  **CA businesses gain major market share.**



California can add another engine for its economy by developing its CSP resource.

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