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Utility-scale solar power. Market prices. Now.

SolarPACES Symposium, Las Vegas, March 5, 2008

**SOLAR THERMAL ELECTRICITY AS
THE PRIMARY REPLACEMENT FOR
COAL AND OIL IN U.S. GENERATION
AND TRANSPORTATION**

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Fossil fuel must be abandoned; but can it be replaced by solar power?

- Fossil fuel must be quickly displaced to ensure climate stability, yet renewable energy is often claimed by the conventional fuel lobby to be unable to run modern society.
- This paper looks at the underlying feasibility of Solar Thermal Electricity (STE) technology as a basis for both the US electricity grid and the US vehicle sector.


USA greenhouse emissions

- 7.1 billion tonnes of CO₂_e total.
- 2.3 billion for electricity generation.
- Higher proportion of transportation emissions than in other countries at 2.0 billion tonnes of CO₂_e per year.
- Roughly 1.54 billion tonnes of CO₂_e building heating and industrial process heat.
- Remainder is largely methane/nitrous oxide emissions from industry/agriculture

Replacing Coal and Gas



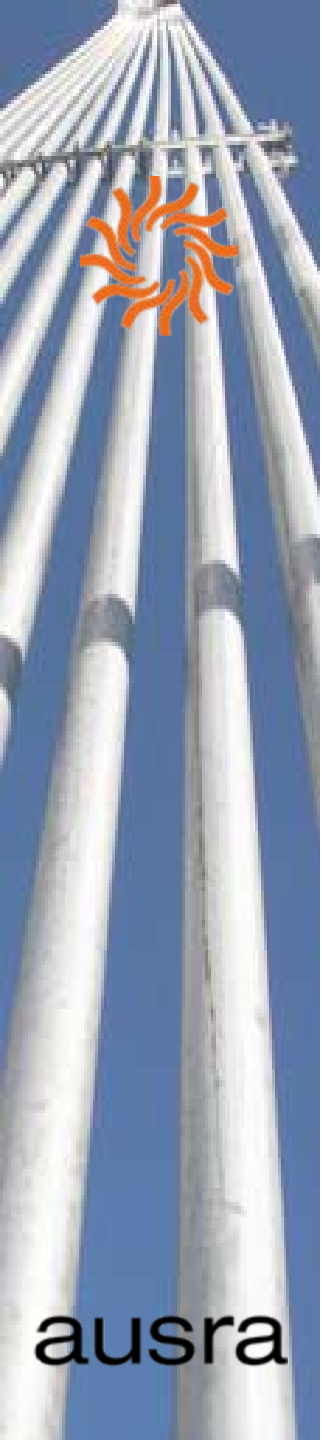
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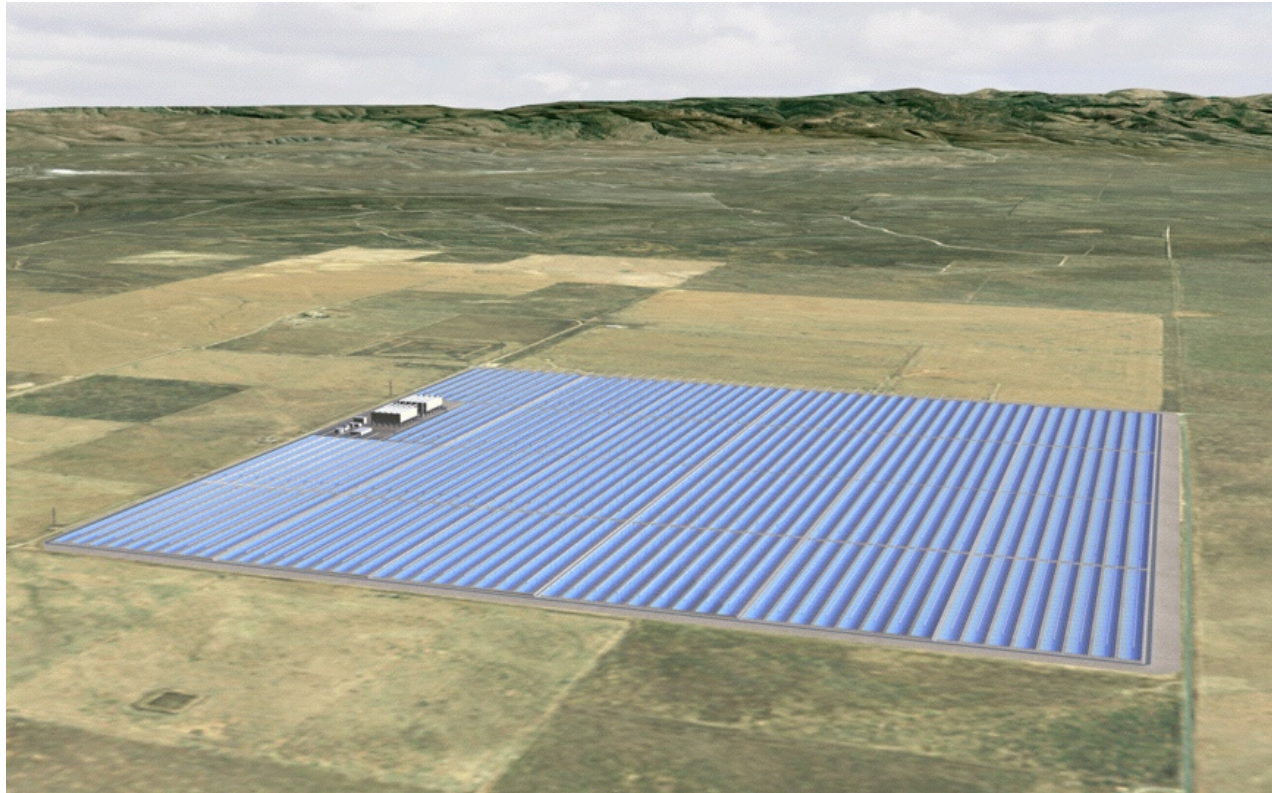
Requirements for a new sustainable generation technology as the basis of grid generation

- Market will prefer emissions-free technology which
 - has a sufficient and sustainable resource
 - is technically advanced enough replace existing generation before 2050
 - has 24 hour availability
 - has a competitive cost to current generation
 - exhibits zero pollution

Largest resource? No contest.



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- 175 MW CLFR plant in permitting for California site on 2.6 km² (square mile)
- 145 km x 145 km will generate US 2006 total electricity requirement



How much can STE supply?

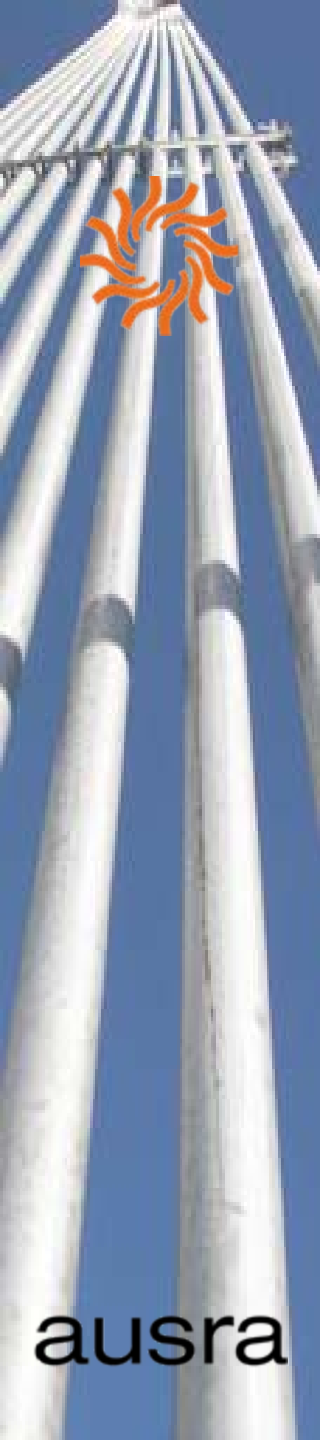
Examples: California and Texas

- Load data: California and Texas Electricity Grids (CAISO and ERCOT) hourly data for 2006
- 50 GW Turbine capacity in California, 63 GW in Texas (equal to current peak annual load)
- 1067 GW installed and 789 GW non-coincident peak load for the USA (2006 data year).



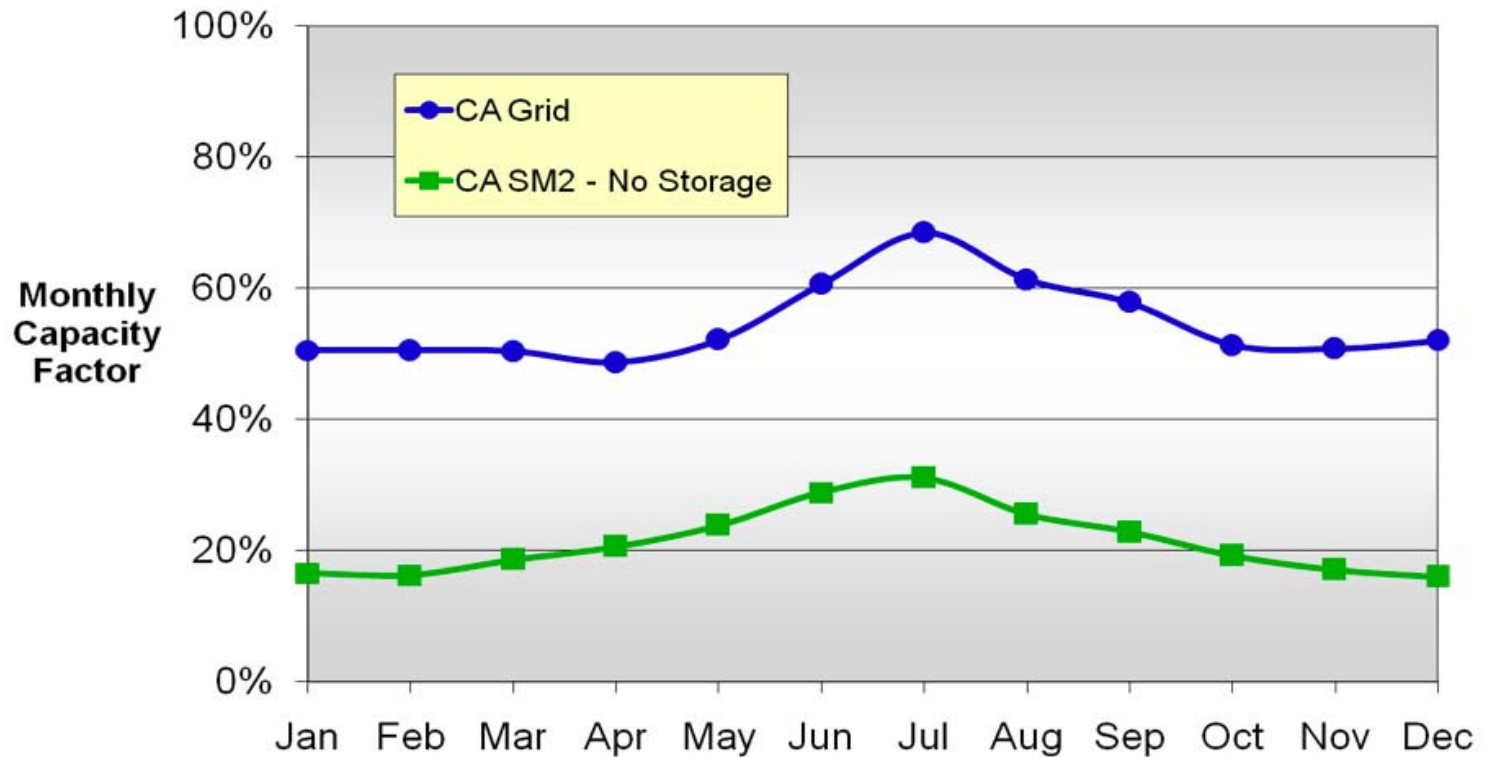
How much can STE supply? Examples: California and Texas

- Example collector: CLFR with 16 hours thermal storage
 - SM1 means array produces at peak exactly the energy required by the turbine at peak
 - SMx array have x times the area of SM1
- Calculation hour by hour for whole year



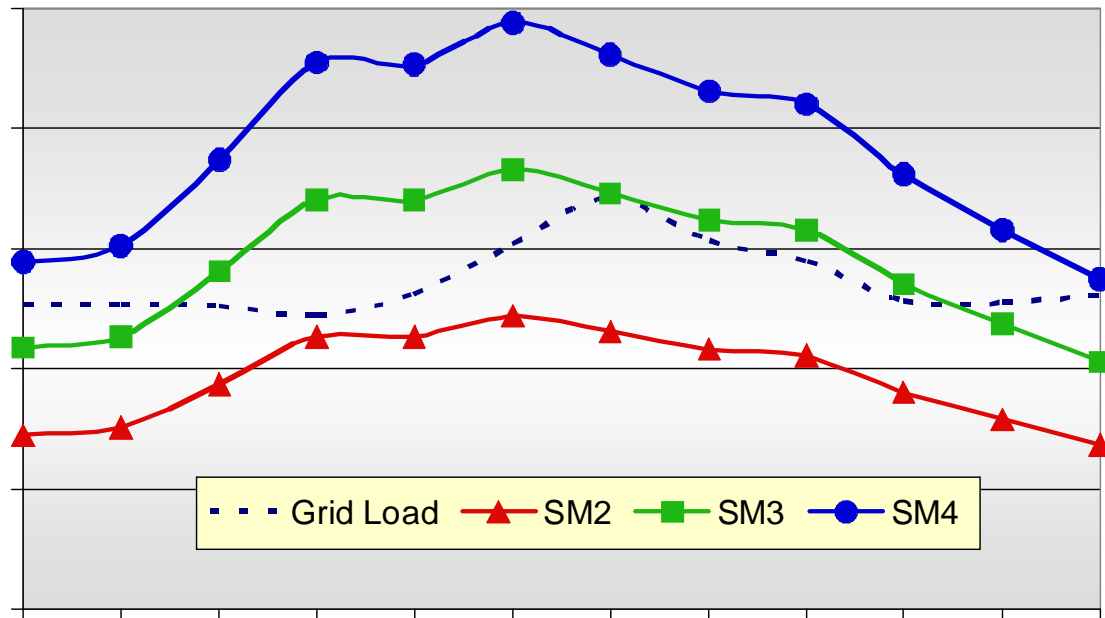
California, with no storage, 40% correlation with SM2 (CLFR)

Solar Contribution to 2006 CAISO Load





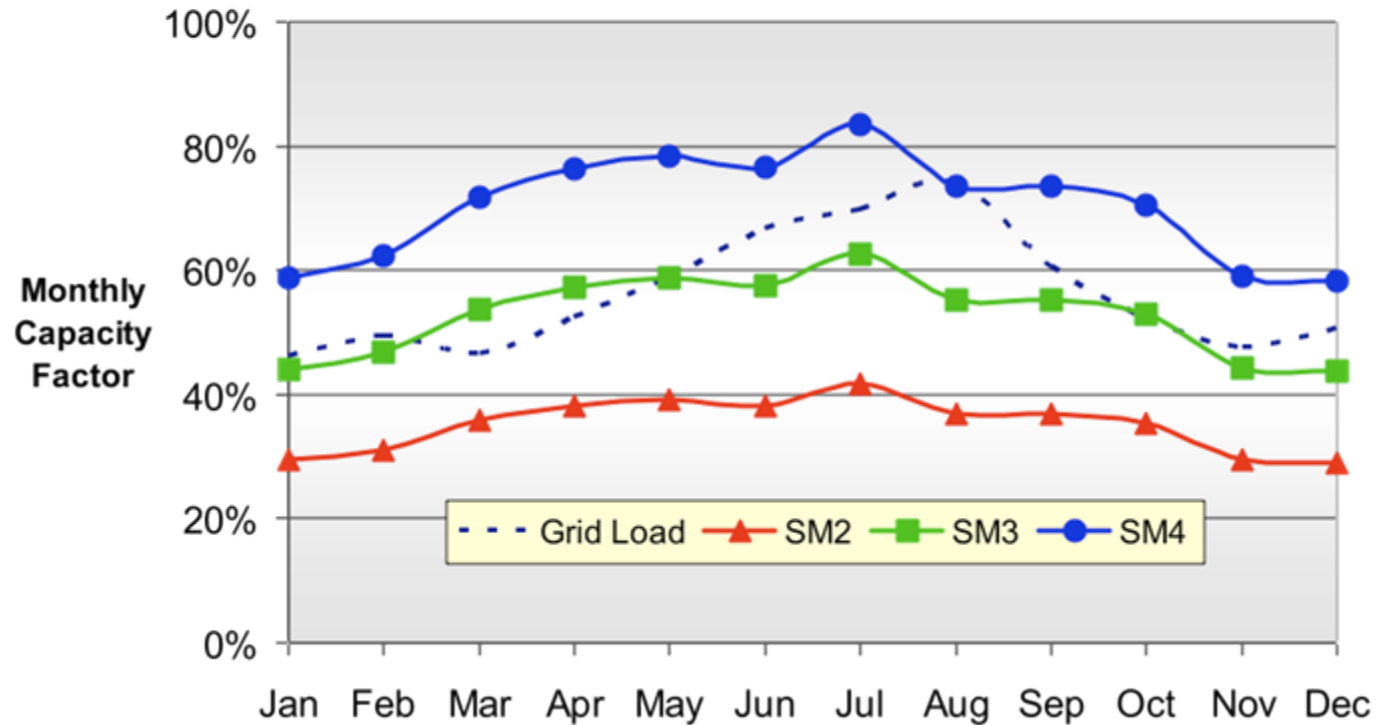
California, with 16 hours storage, 92% correlation with SM3, no costly peaking plant needed





Texas: 91%

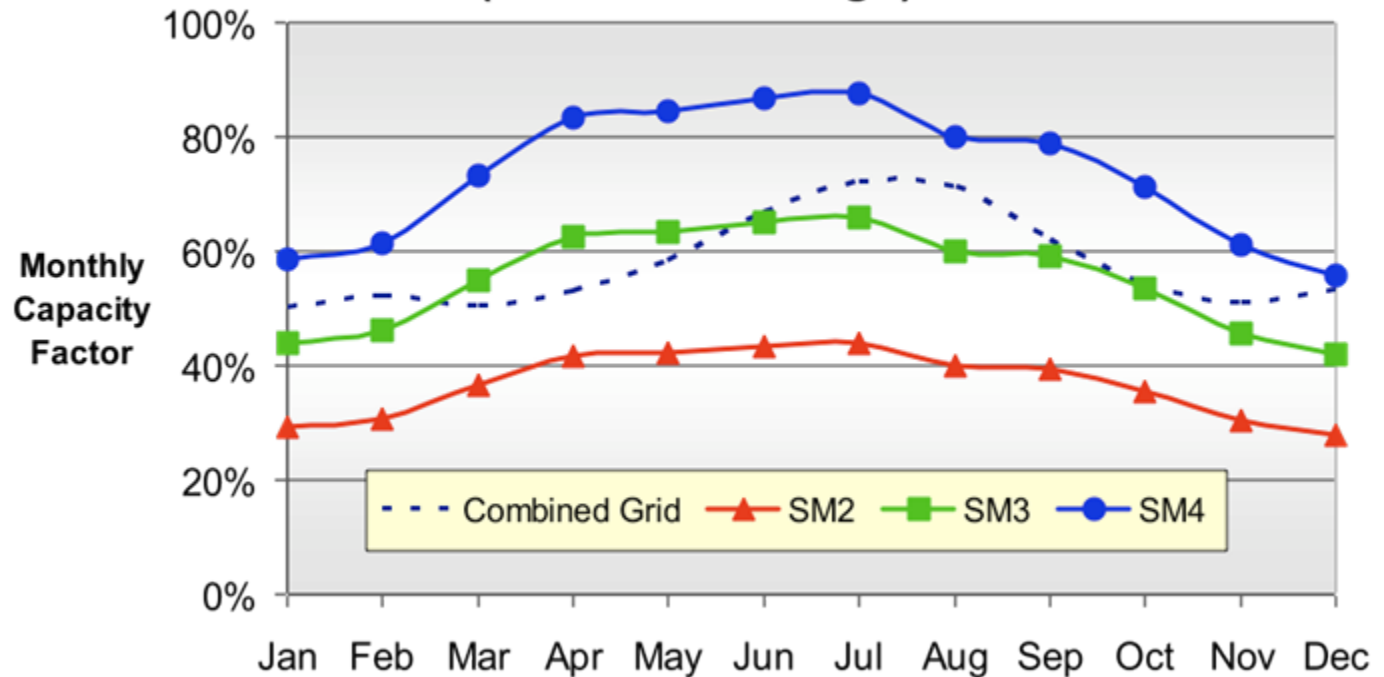
Solar Contribution to ERCOT Annual Loads (16 hours storage)





California and Texas: 92%

**Solar Contribution to CAISO-ERCOT
Combined Annual Load
(16 hours storage)**



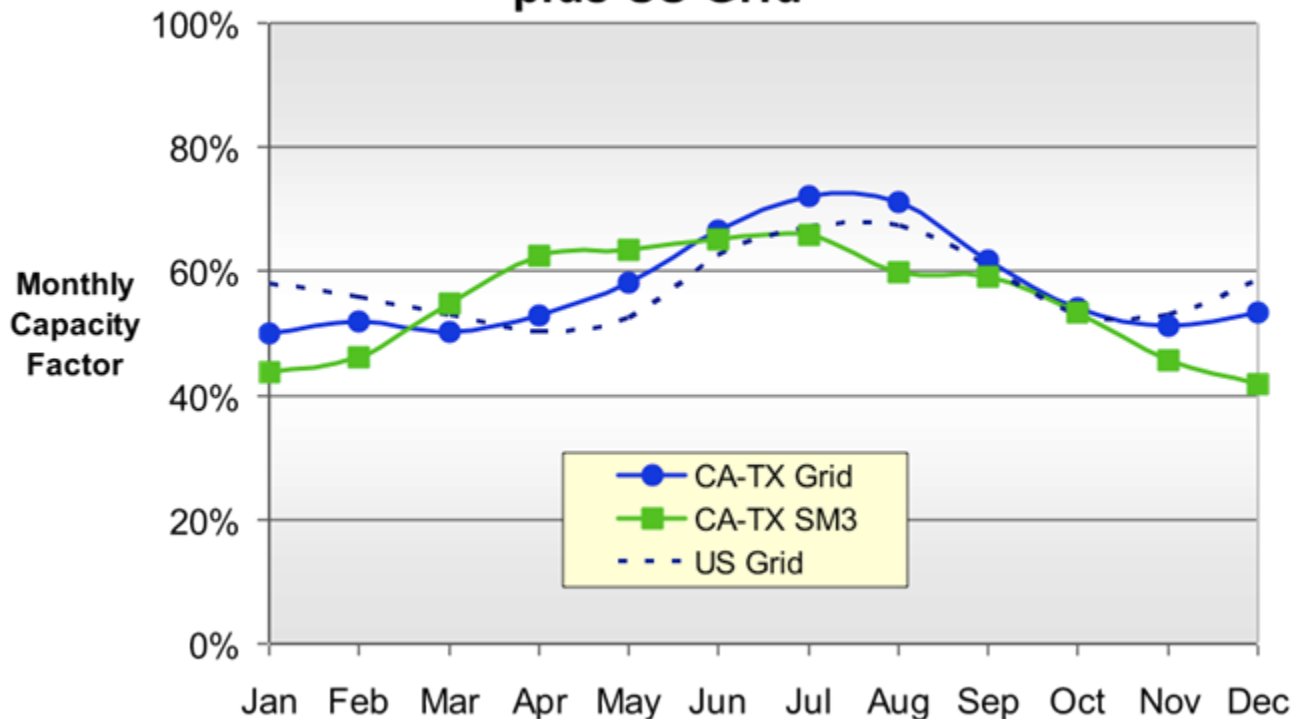


Summary of California and Texas combined

	Grid Load Served	Dumped Energy
Solar Multiple		
4	100%	22%
3	92%	3%
2	63%	0%

Entire USA grid, supplied from California and Texas: 96%

**CAISO & ERCOT Combined Grid & Solar Park
plus US Grid**



Replacing Oil



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Plug-in Electric Vehicles

- Electric car becoming reality
- Progress on fast charge (15 minutes)



Changing Perceptions

Introducing the Tesla Roadster:

- 100% electric
- 0 to 60 mph in under 4 seconds
- 135 mpg equivalent
- 220 miles per charge*
- less than 2¢ per mile*

[more images](#)



Imagine: A 40 mile or less daily commute without a drop of gas.



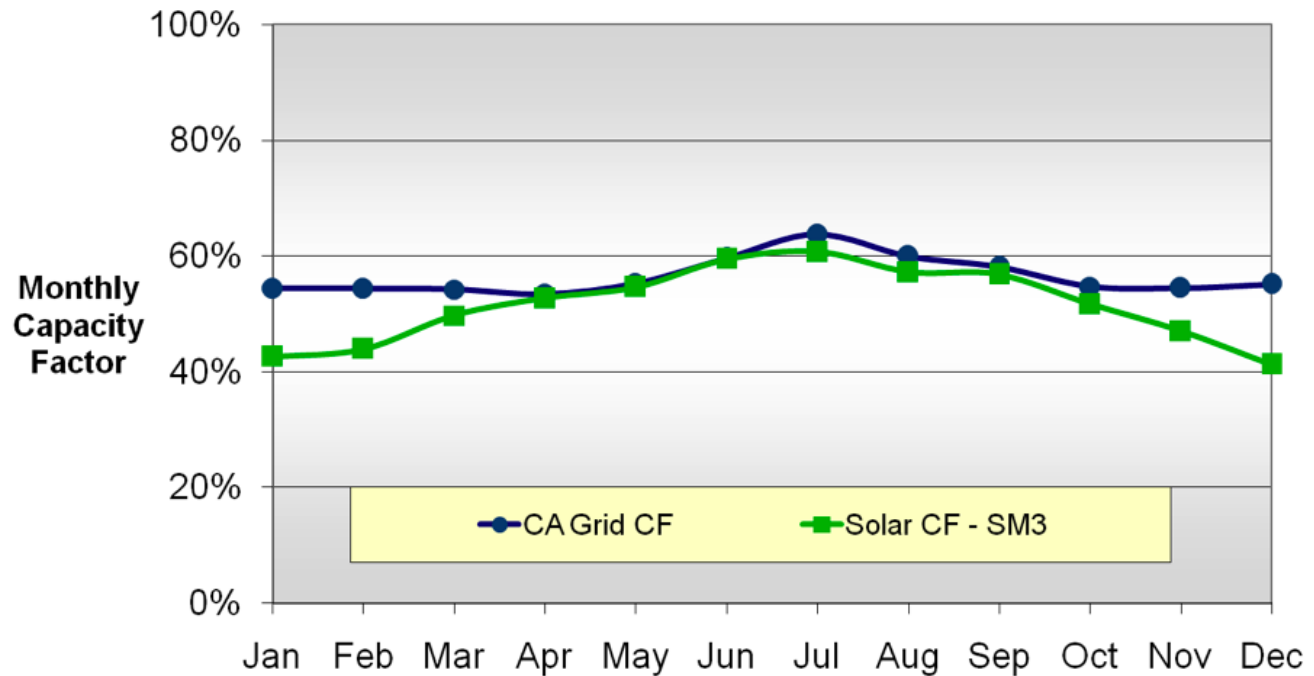


Assumptions

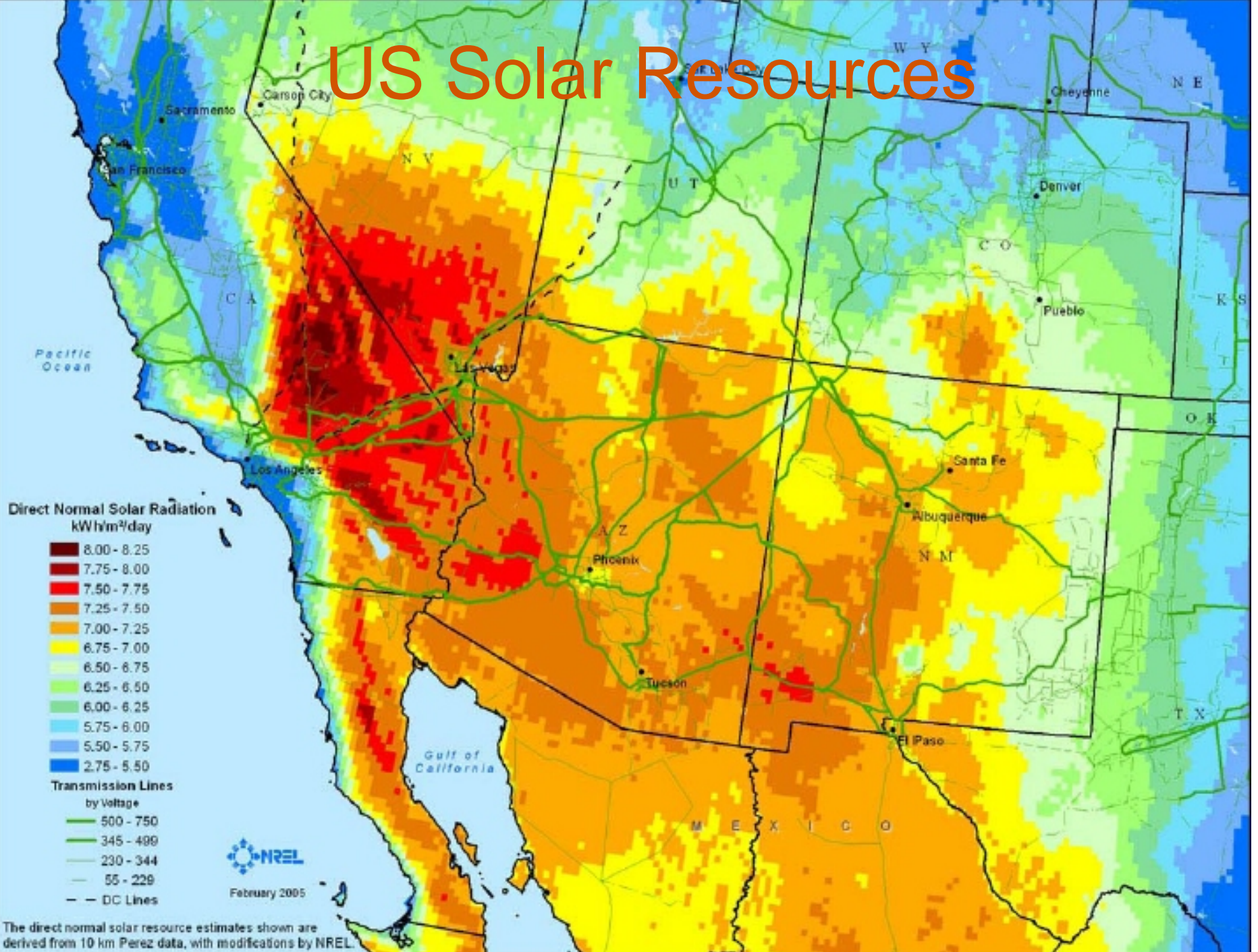
- 0.17 and 0.37 kWh_e per mile
- Overnight fleet charge averaged 9 PM to 9 AM
- 10¹³ fleet-miles of travel
- 1.7-3.7 x 10⁶ GWh to fully eliminate vehicle emissions from fuel use.
- CLFR national generation plant increased by 42-91% to square of land between 182 and 211 km on a side.

Entire USA grid + transport, supplied from California and Texas: 93%

**Solar Contribution to CAISO Annual Load
With Oil Use Converted to Electric Load**

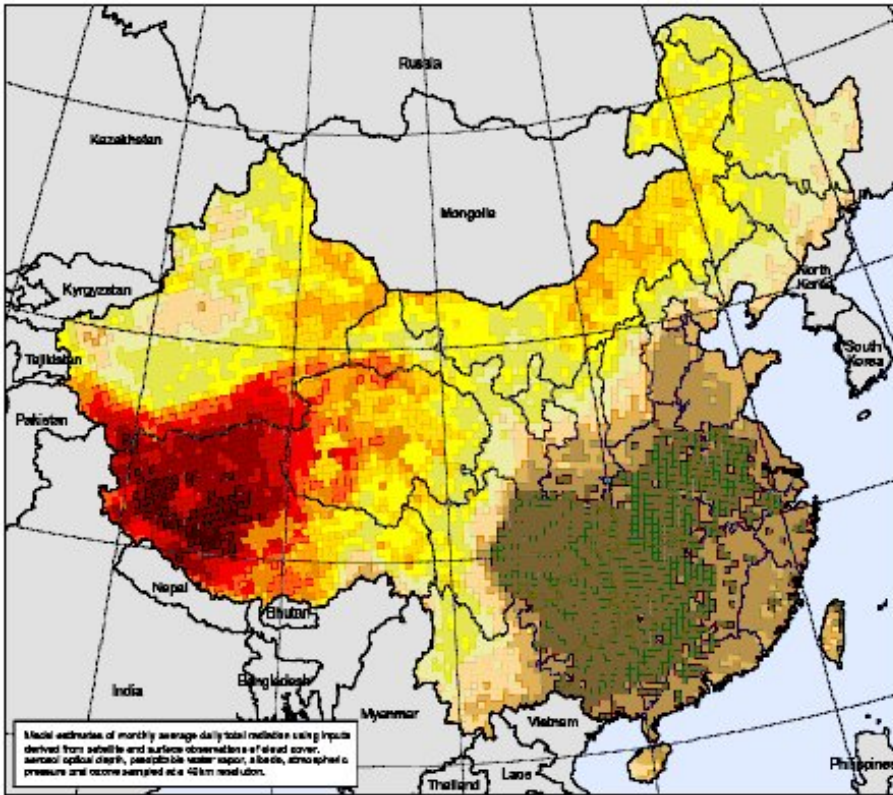


US Solar Resources



US Solar Park

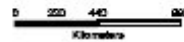
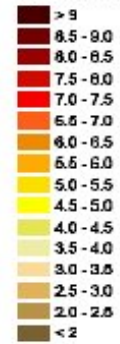




**China
Direct Normal
Solar Radiation**

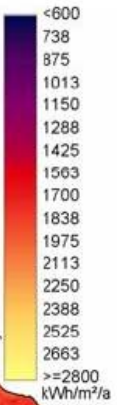
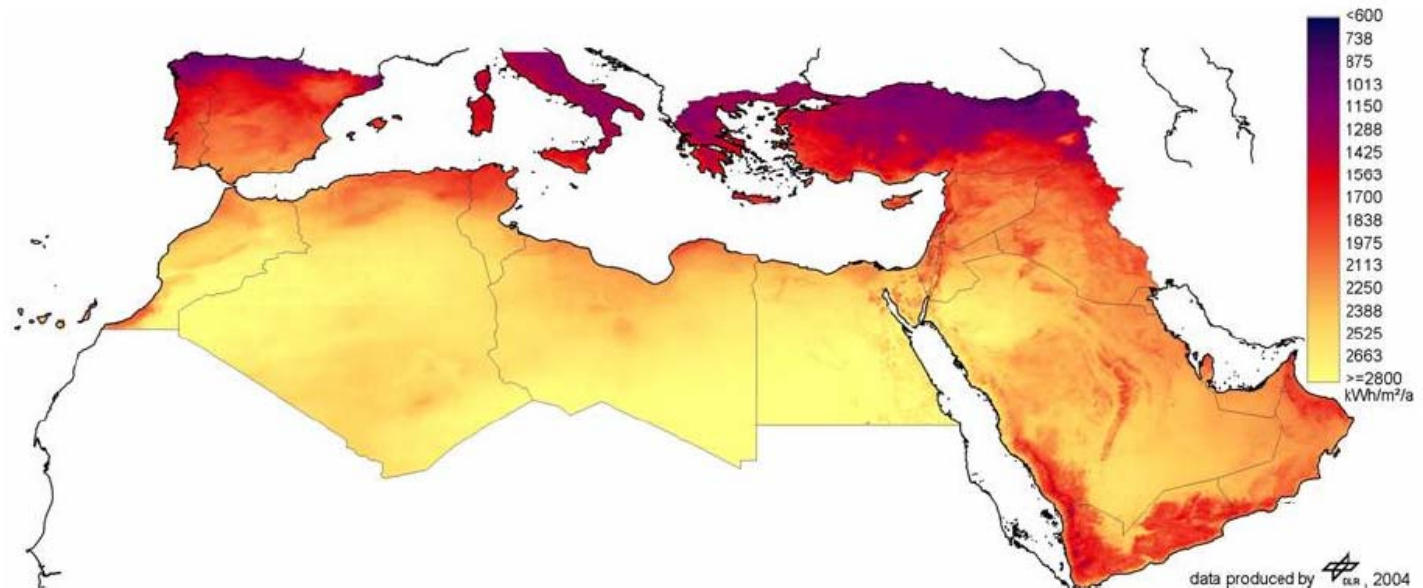
Annual

kWh/m²/day



Global Power

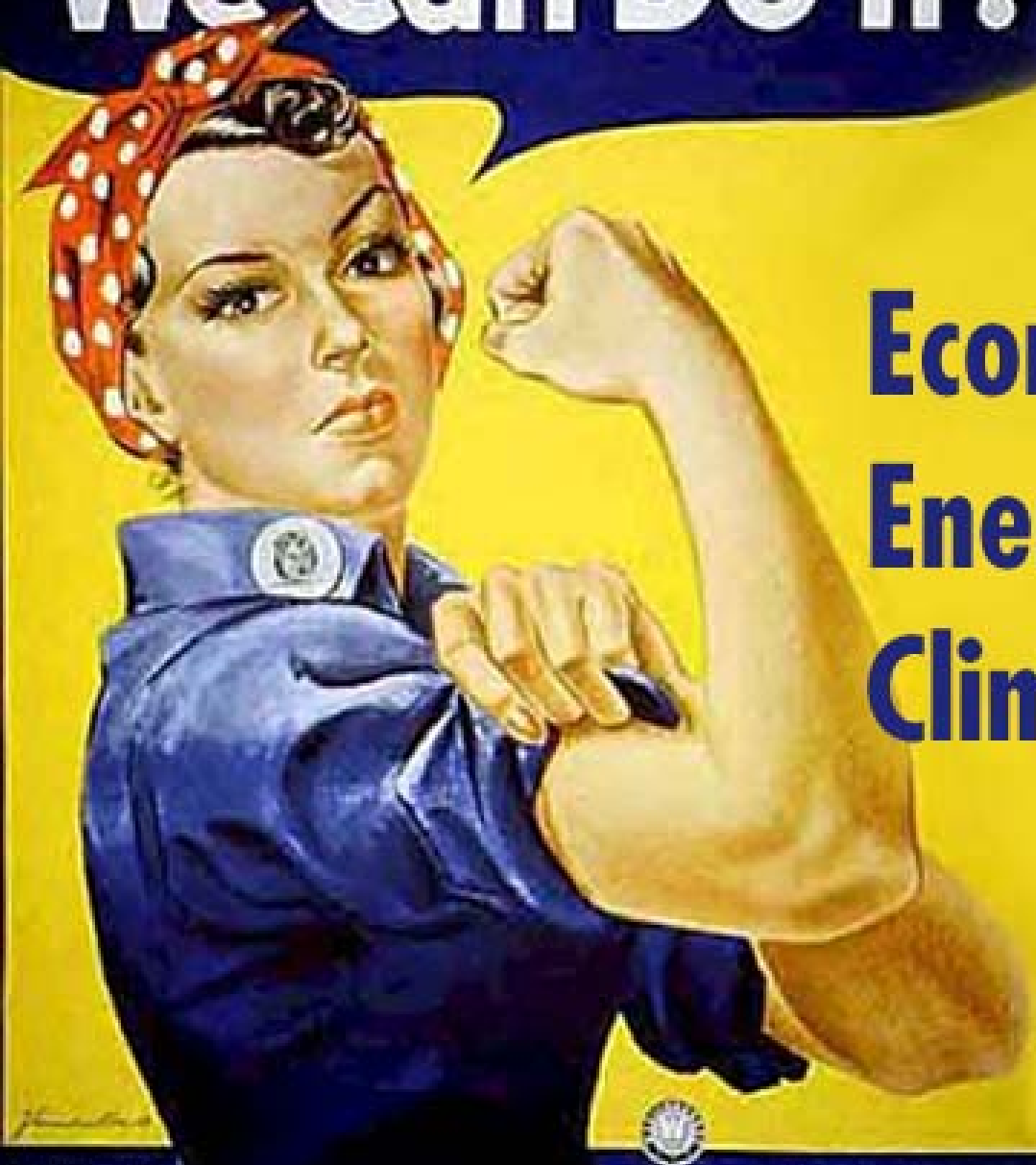
Model estimates of monthly average daily total radiation using inputs derived from satellite and surface observations of cloud cover, aerosol optical depth, precipitable water vapor, surface atmospheric pressure and ozone averaged at a 40 km resolution.



Lesson: Solar Correlates with Human Energy Use.

- Big Solar makes “Base Load” is an obsolete concept. Solar is load following.
- Solar has natural daily and seasonal correlations; coal and nuclear do not.
- Little or no costly peaking plant required for solar (use existing Hydro).
- Reliable annual power for the entire USA grid technically feasible.
- Reliable powering of electric vehicle fleet also technically feasible.
- Solution needs HVDC.

We Can Do It!



Economic Security
Energy Security
Climate Security



WAR PRODUCTION CO-ORDINATING COMMITTEE