Distributed solar or utility-scale solar with major transmission build-out?

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California Renewable Energy Scorecard

- Dysfunctional utility renewable energy program – only 900 MW in 8 years
  - Largely a failure to date
  - Lots of contracts signed, few projects built
  - Contract payment terms inadequate to secure financing

- Non-utility distributed PV program is successful – ~600 MW, 2/3 installed in last 3 years
  - California Solar Initiative on target to add regulatory target of 3,000 MW by 2017
  - Net-metering is benefit to utilities and non-PV ratepayers: PV system operators provide primarily high value on-peak power

PV net metering – swapping kWh with utility

- Net metering has been prime reason California on-track to install 3,000 MW distributed PV by 2016.
- PV system owner produces during day, draws from grid at night.
- Straight swap with utility at retail energy rate.
- PV system owner can swap up to 100% of usage on annual basis.
- However, much roof area goes un-utilized under net metering.
- Feed-in tariff system, like Germany and Ontario, would allow full rooftop PV potential to be realized.

San Diego
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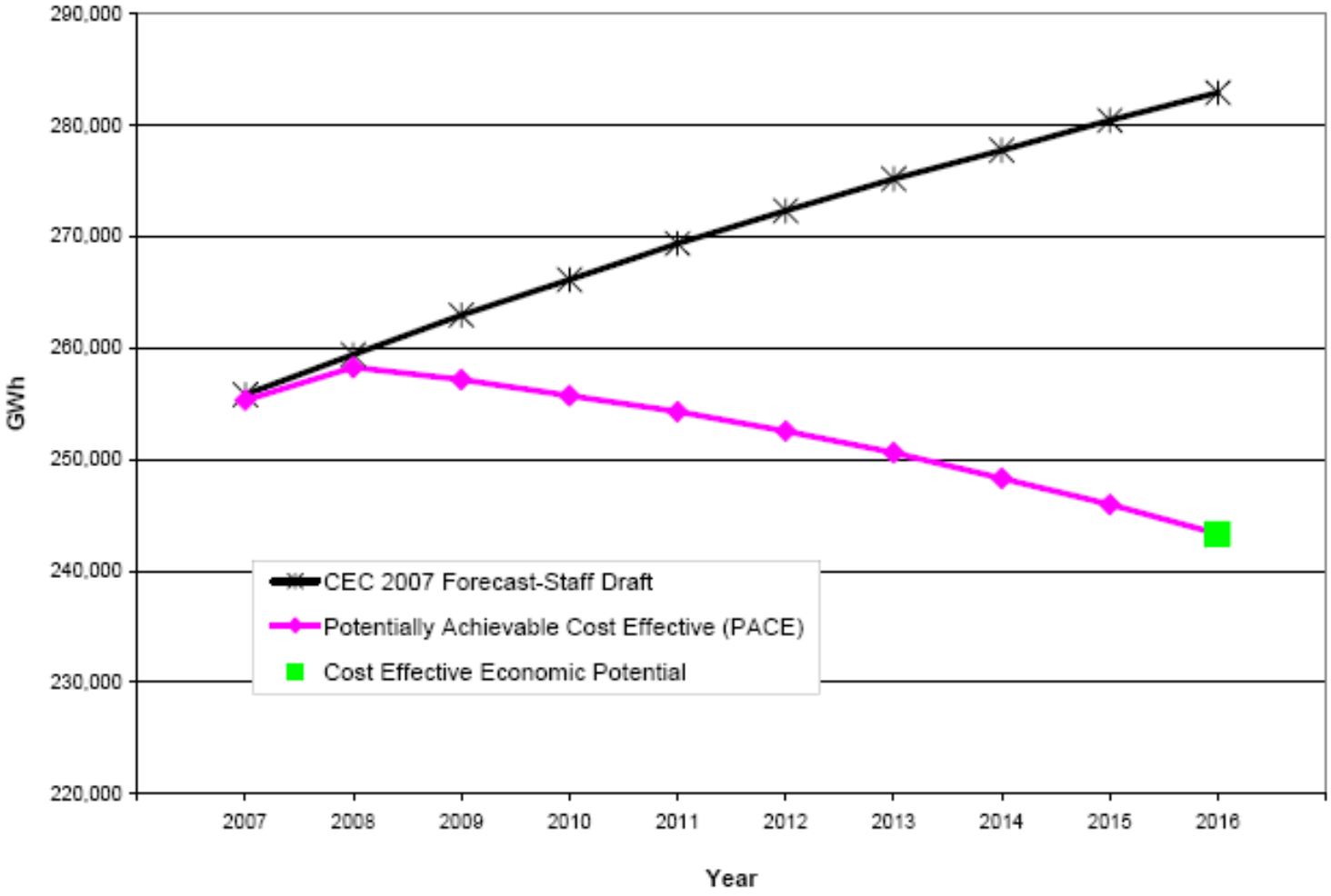
PV and energy storage in plan

- PV augmented by limited energy storage for reliability and to provide peak demand capacity to utility (like gas turbine).
- System owner paid for peaking capacity just as gas turbine owner is paid for capacity.
- Bill introduced in California (Feb 2010) to require energy storage standard, 5% of peak.
- Southern California Public Power Authority signed agreement for 53 MW of energy storage (Jan 2010).
- Federal Energy Regulatory Commission authorizes incentive rates for utility energy storage in CA (Nov 09).

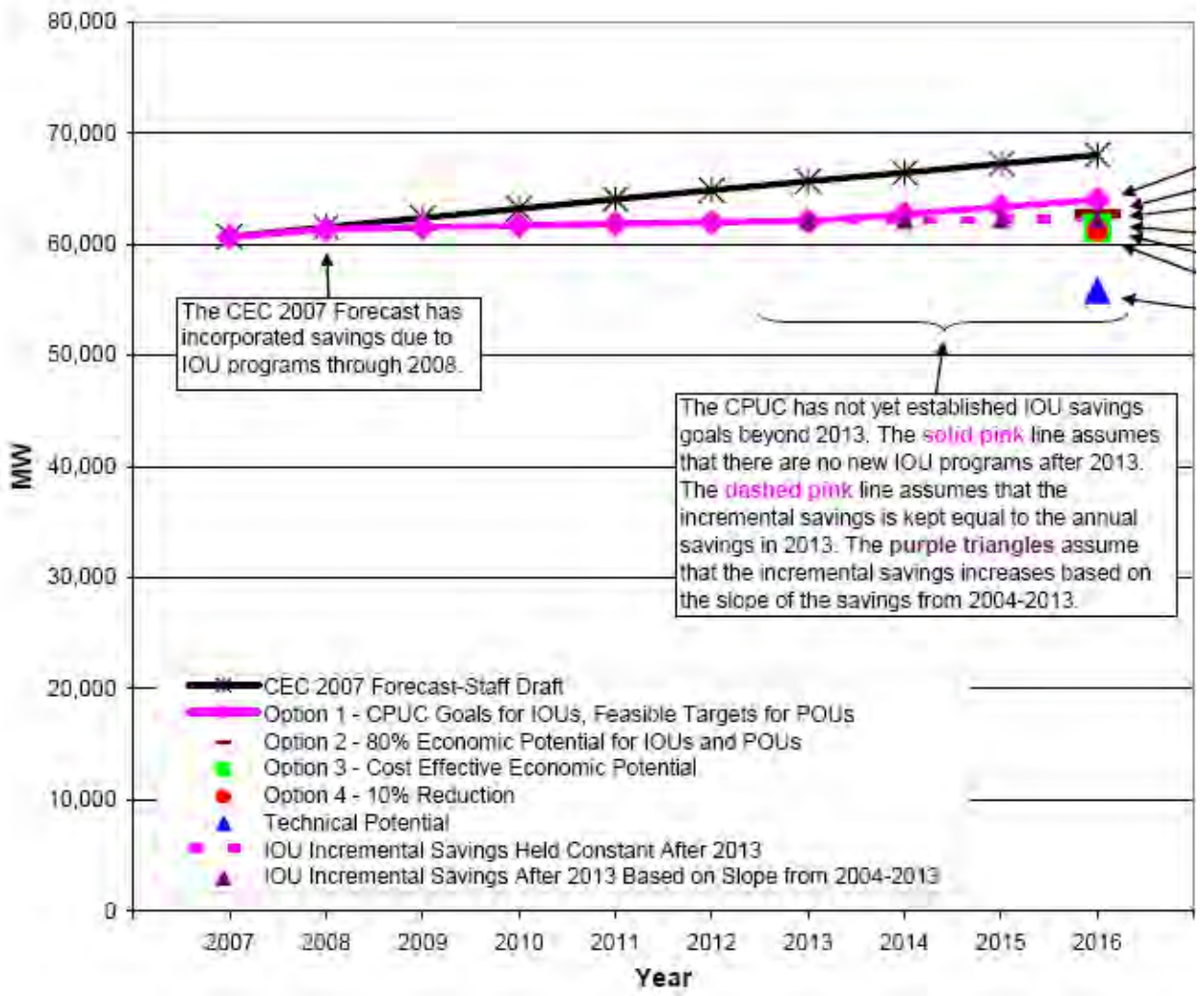
October 2007 energy efficiency decision – California Public Utilities Commission gets serious and energy usage projected to drop continuously over time

source: CEC, Achieving All Cost-Effective Energy Efficiency for California, December 2007, Figure 38, p. 103.



Peak demand stays flat for foreseeable future as result of Utilities Commission 2007 decision

source: CEC, Achieving All Cost-Effective Energy Efficiency for California, December 2007, Figure 33, p. 96.



Comverge smart thermostat – smart, low cost solution to peak demand

- Utility signals thermostat during peak demand.
- Thermostat modulates on/off cycle, little or no change in customer comfort level.
- Austin, TX utility installs 45,000 smart thermostats, $200 each, at no charge to customers.
- Reduces peak load by 45 MW at less than 1/5th cost of 45 MW peaking gas turbine w/ no greenhouse gas emissions.
- SDG&E initiating program utilizing Comverge smart thermostat – Summer Saver Program.

“Net zero” concept is critical component of California greenhouse gas emission reduction strategy

- All new residential net zero by 2020.
- All new commercial net zero by 2030.
- Rooftop PV is essential element of net zero concept.
- Existing solar programs, primarily 3,000 MW California rooftop solar initiative, directed at retrofitting existing residential/commercial structures to net zero (or close).
- This a simple approach that is applicable nationwide for driving grid-supplied electricity consumption and peak loads downward over time.

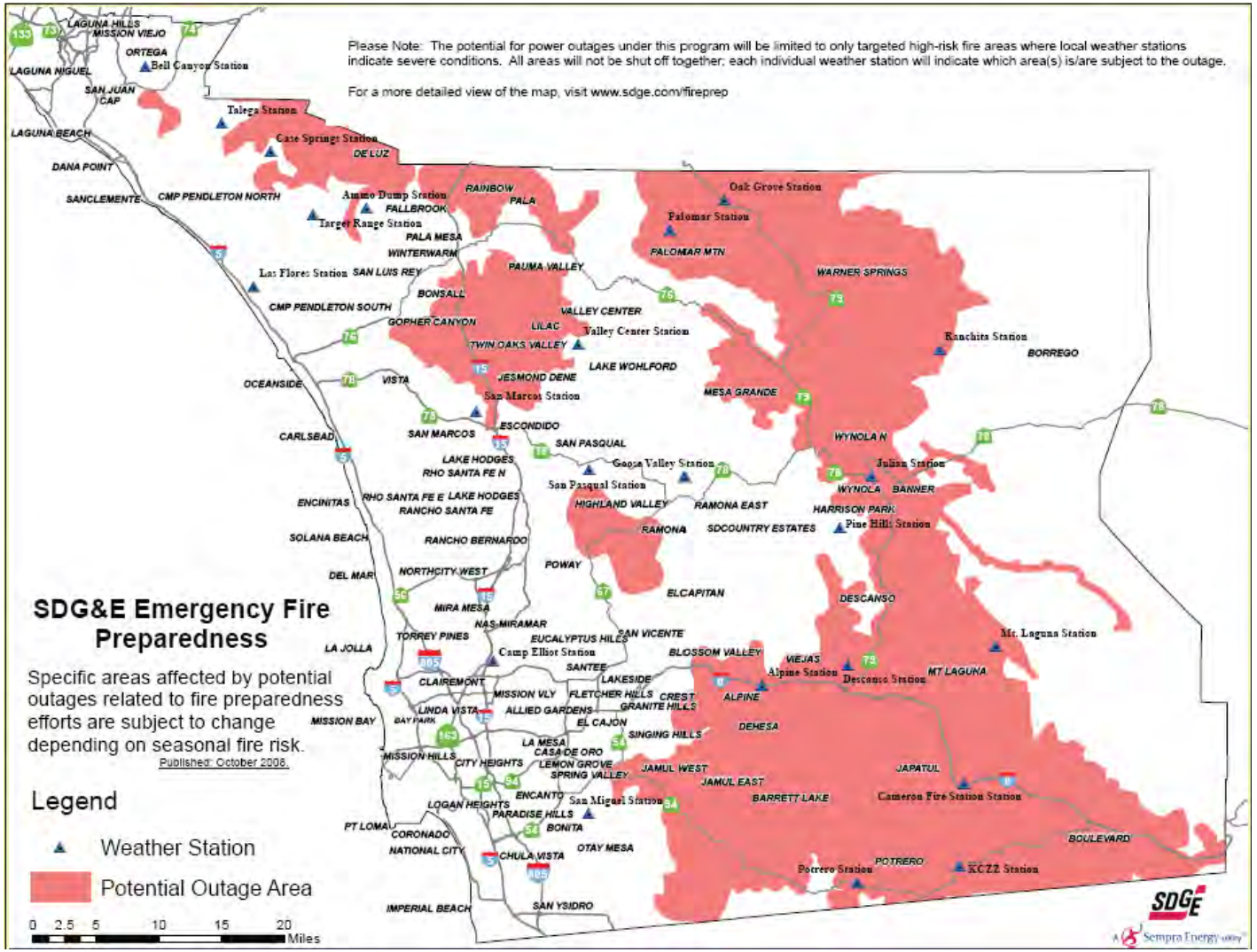
PACE: Energy efficiency & rooftop solar loan program – Palm Desert example

- Property Assessed Clean Energy (PACE) low interest loans, 7% over 20 years, for energy efficiency and solar PV repaid along with property tax payments.
- Reduced electric bill with no out-of-pocket expense.
- Loans have a minimum value of $5,000, no maximum limits, and can be used for:
  - air conditioning and ventilation systems
  - pool pumps
  - energy efficient windows, doors and skylights
  - window films
  - tankless water heating equipment
  - white-roofs and coatings
  - solar PV, natural gas fuel cells

City of San Diego announces PACE property tax fund – December 2009

- $20 million fund.
- Sufficient to put solar PV on 800 to 900 homes initially.
- Could sustain future installations at around 80 to 90 per year.
- San Diego Gas & Electric (SDG&E) has 1.4 million customers.
- 45,000 to 60,000 of these customers potentially subject to power cut-off during fire conditions.

SDG&E map of areas subject to fire cut-off



Combining PACE funding with solar company financing

- Some solar PV firms, like Sun Run, finance residential PV systems for as little as $1,000 down.

- Under this financing approach, if County PACE fund paid the down payment, all 45,000 to 60,000 customers subject to cut-off could be equipped with PV systems for $45 to $60 million.

Investor-owned utility model: protect investors through regulated monopoly structure

- Investor-owned utilities given monopoly in exchange for regulation by utilities commission, ratepayers assure profitability.
- Assures market and good profit with little or no risk, effectively bars competition.
- Profits generated by building infrastructure (transmission lines, power plants, meters).
- Highest profit for transmission lines, 11 -12 percent return.
- Example: San Diego Gas & Electric will receive $1 billion in profit (2010 dollars) over 40-year life of $2 billion 1,000 MW Sunrise Powerlink transmission line.

Community choice aggregation (CCA) option in California, but fought by investor-owned utilities

- California law, in response to 2000-2001 energy crisis, allows cities and counties to take over power generation function.
- Local control, more rapid introduction of renewable energy.
- Investor-owned utility continues to provide transmission & distribution function.
- Marin County, San Francisco, San Joaquin Valley communities and counties moving on CCA.
- Pacific Gas & Electric (PG&E) funded Proposition 16 with $46 million to stop CCAs and municipalization. Proposition failed.
- At same time, PG&E holding company is financing $60 million worth of solar PV through Solar City.

Effective feed-in tariff needed to regain world leadership in renewable energy

- California's Standard Offer-4 (SO-4) tariff, a simple long-term FIT imposed on the utilities that provided a fair return to investors, converted California into a world leader in renewable energy in the 1980s.

- Germany has become the new world leader with a similar FIT imposed on German utilities. Germany added approximately 3,800 MW of distributed PV in 2009 and is expected to add 6,000 MW in 2010.

- Spain, with a similar population to California and a smaller economy, added 2,500 MW of PV in 2008.

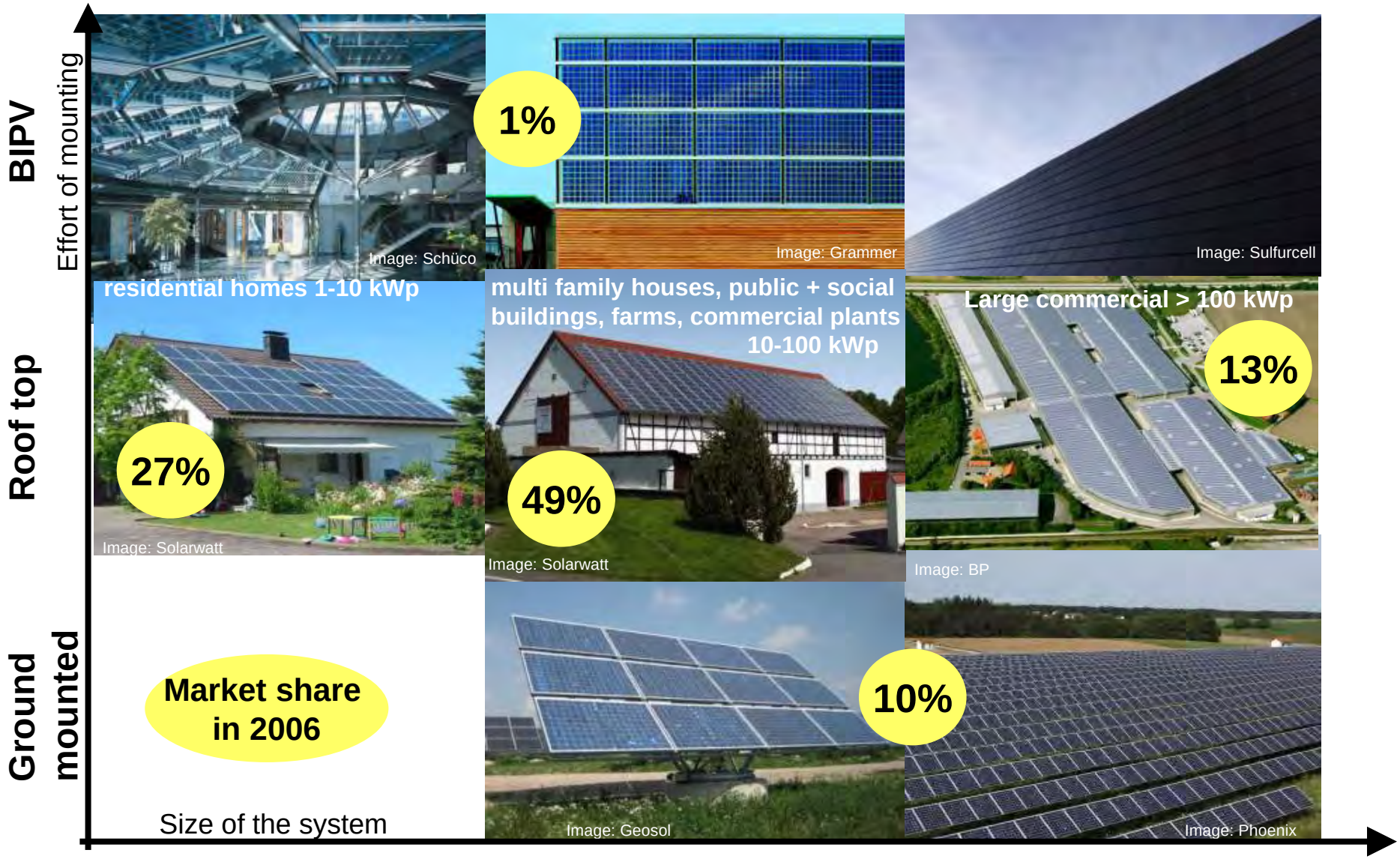
- California would need to add about 20,000 MW of distributed PV over 10 years, an install rate of 2,000 MW per year, to meet 33% by 2020 exclusively with PV.

Germany: PV boom by feed-in tariff

Small, Medium and Large Rooftop Installations

Germany: Market segments of on-grid PV systems

source: Gerhard Stryi-Hipp, Comparison of the Incentive Systems of the World's leading PV Markets – Conclusions and Consequences, 5th Germany California Solar Day, June 16, 2009.



Germany's distributed PV success story

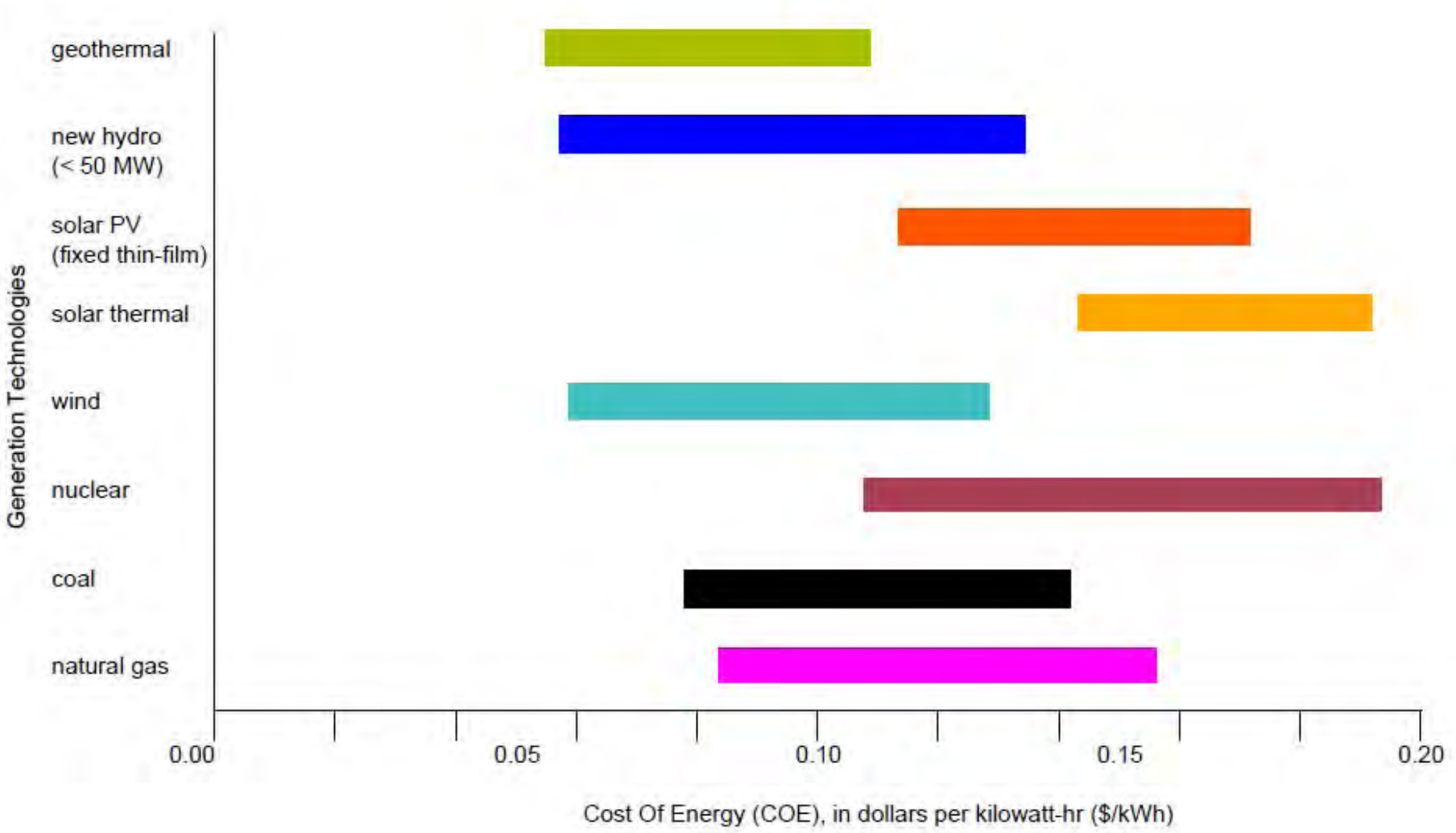
- 2008: 1,500 MW
- 2009: 3,800 MW
- 2010, first 6 months: 3,000 MW
- 2010 projection for year: 6,000 MW

- Time to reach full 2020 target of 2,000 MW of local PV in *San Diego Smart Energy 2020* plan at current German PV installation rate: 4 months

Sacramento Municipal Utility District – out-in-front in California with 100 MW feed-in tariff

- Average SMUD load ~1,300 MW.
- Peak SMUD load ~2,000 MW.
- 100 MW feed-in tariff, PV systems up to 5 MW
- Tariff for 20-yr contracts (online 2012), ~0.17/kWh.
- Entire 100 MW was fully subscribed with bids within a few hours of bid opening in January 2010.

2009 cost-of-energy (COE) comparison

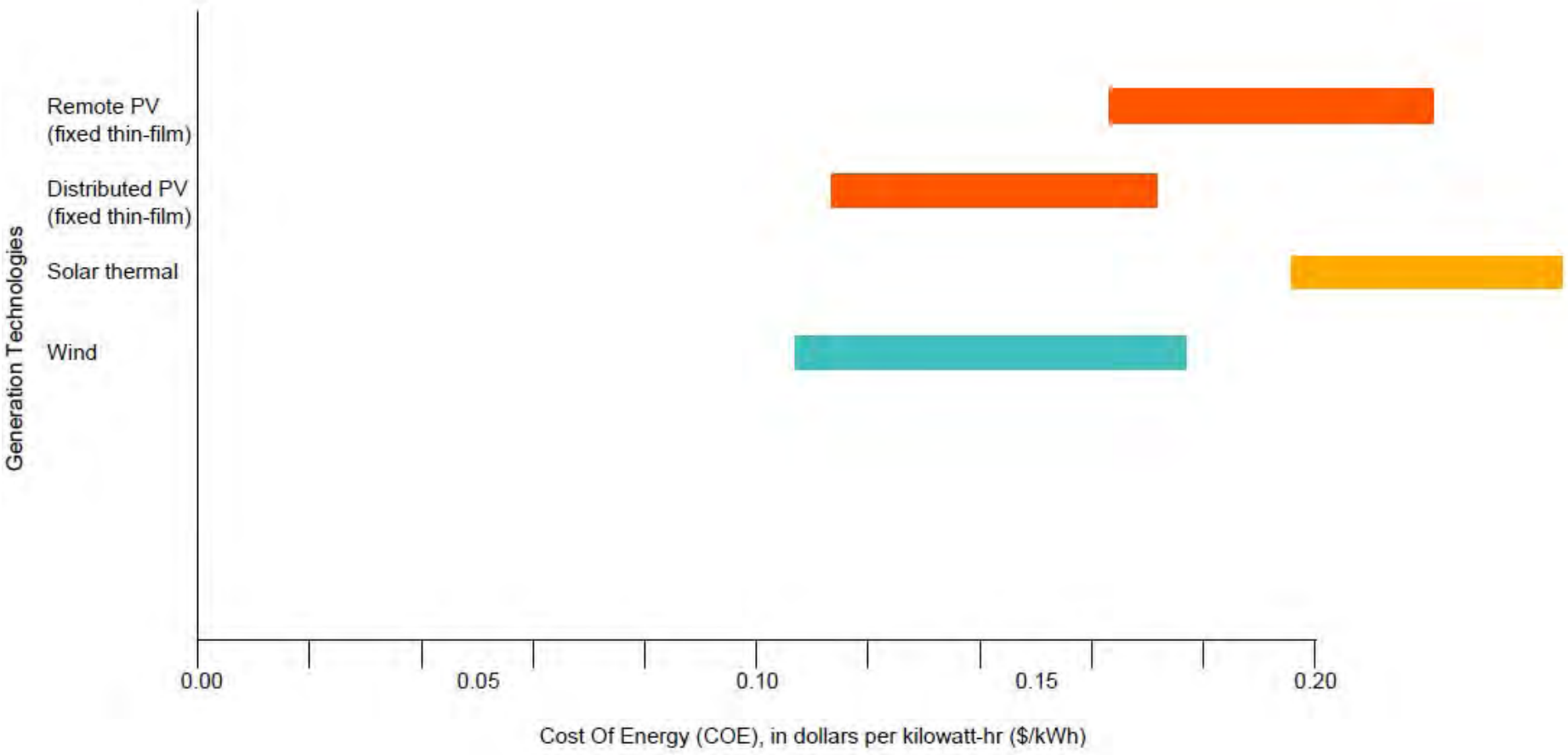


a. COE for new natural gas, new coal, and new nuclear: *Moody's Corporate Finance, New Nuclear Generating Capacity: Potential Credit Implications for U.S. Investor-Owned Utilities*, May 2008, Table 9, p. 15.

b. COE for renewable energy generation except thin-film solar PV: *RETI Phase IA Final Repor*t, August 2008, Table 1-1, p. 1-8.

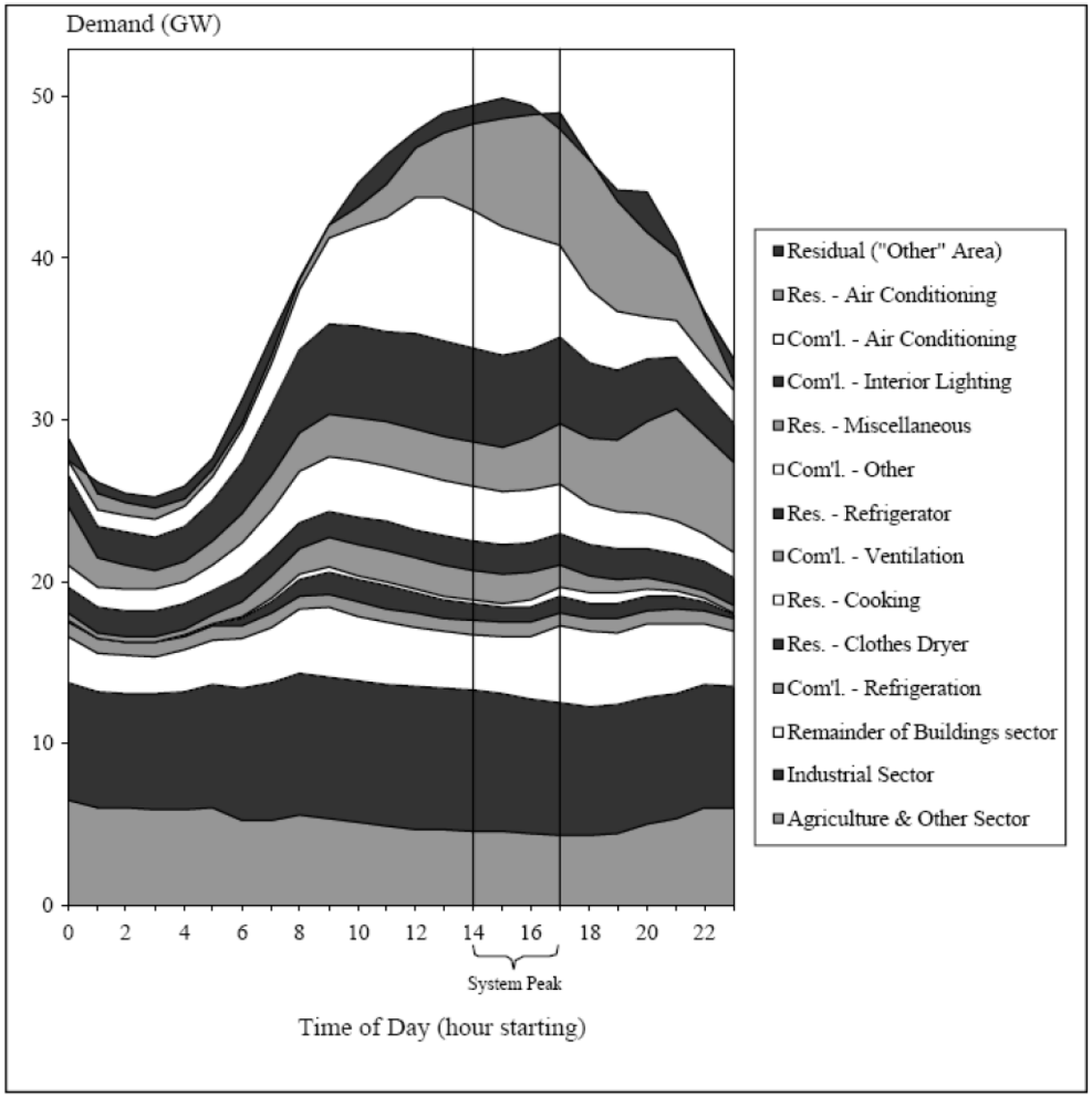
c. COE for thin-film solar PV: *RETI Phase 1B Final Report*, January 2009, p. 6-24.

Remote vs DG: Transmission penalty effect on COE

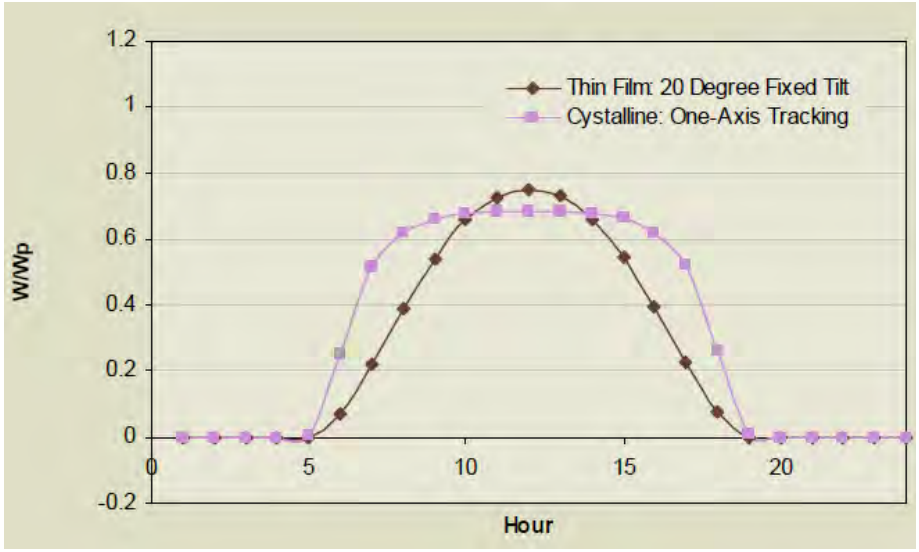


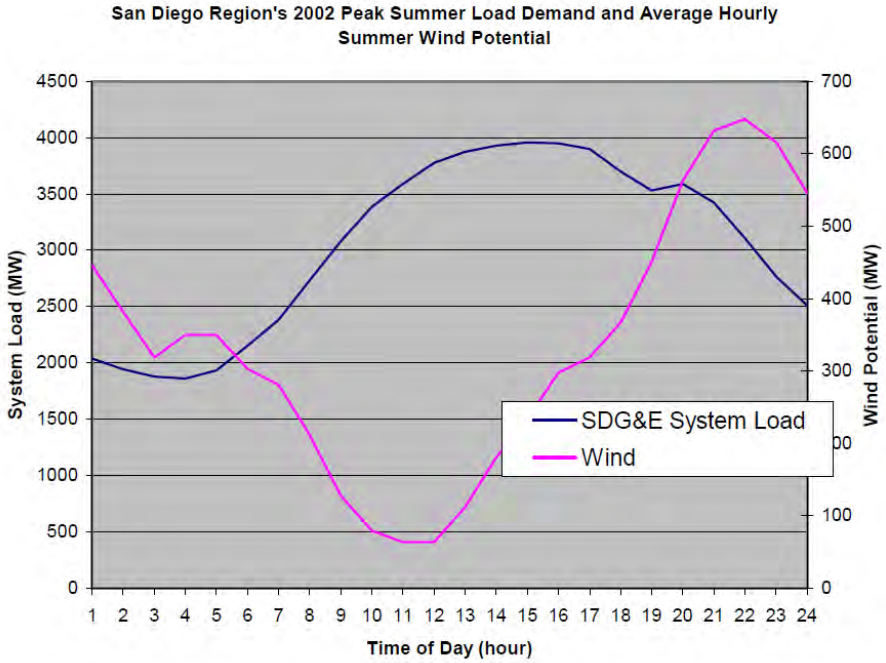
The June 2009 CPUC preliminary assessment of cost to reach 33% by 2020 assumes $1.27 billion in additional levelized annual transmission capital expense (beyond the new transmission needed to reach 20%) to add 36,870 GWh/yr of remote renewable resources by 2020. This equals a transmission penalty of $1,270,000,000/36,870,000 MWh = $34.45/MWh. However, the transmission expense is levelized over 40 years while renewable generation cost is levelized over 20 years. In reality, both generation and transmission should/will last 40 years or more. A project's useful lifetime and its financing term are not directly linked. When the transmission finance period is adjusted to 20 years using the E3 RPS Calculator, a necessary step to allow a direct comparison of the annualized transmission and generation costs in 2020, this increases the annual cost factor from 0.1246 to 0.1676, a 34.5% increase in the annualized cost of transmission. As a result, the transmission penalty must be adjusted upward by an equivalent amount. The adjusted transmission penalty is $34.45/MWh x (0.1676/0.1246) = $46.34/MWh.

Representative California peak load profile



PV and wind: summer output profiles





Transmission line losses largely negate better solar resource in desert relative to San Diego

- Mojave Desert or Imperial County solar resource is 10-15% better than coastal or Central Valley cities (LA, San Diego, Riverside, Bakersfield).
- However, transmission line losses are 7.5% on average and 14% at peak demand (source: California Energy Commission). Solar power is disproportionately transmitted during peak hours.
- Most of the solar power increment from a desert location is lost on the transmission system before ever reaching customers.
- In contrast, there are no transmission losses with distributed PV and minimal distribution losses.

Sacramento Municipal Utility District – electric power 3x more valuable on summer afternoons

Time-of-use period	Time of day	2012 rate ($/kWh)
Winter onpeak	6 am – 2 pm	0.1126
Winter super onpeak	2 pm – 8 pm	0.1361
Summer offpeak	10 pm – 6 am	0.1008
Summer onpeak	6 am – 2 pm	0.1078
Summer super onpeak	2 pm – 8 pm	0.3396

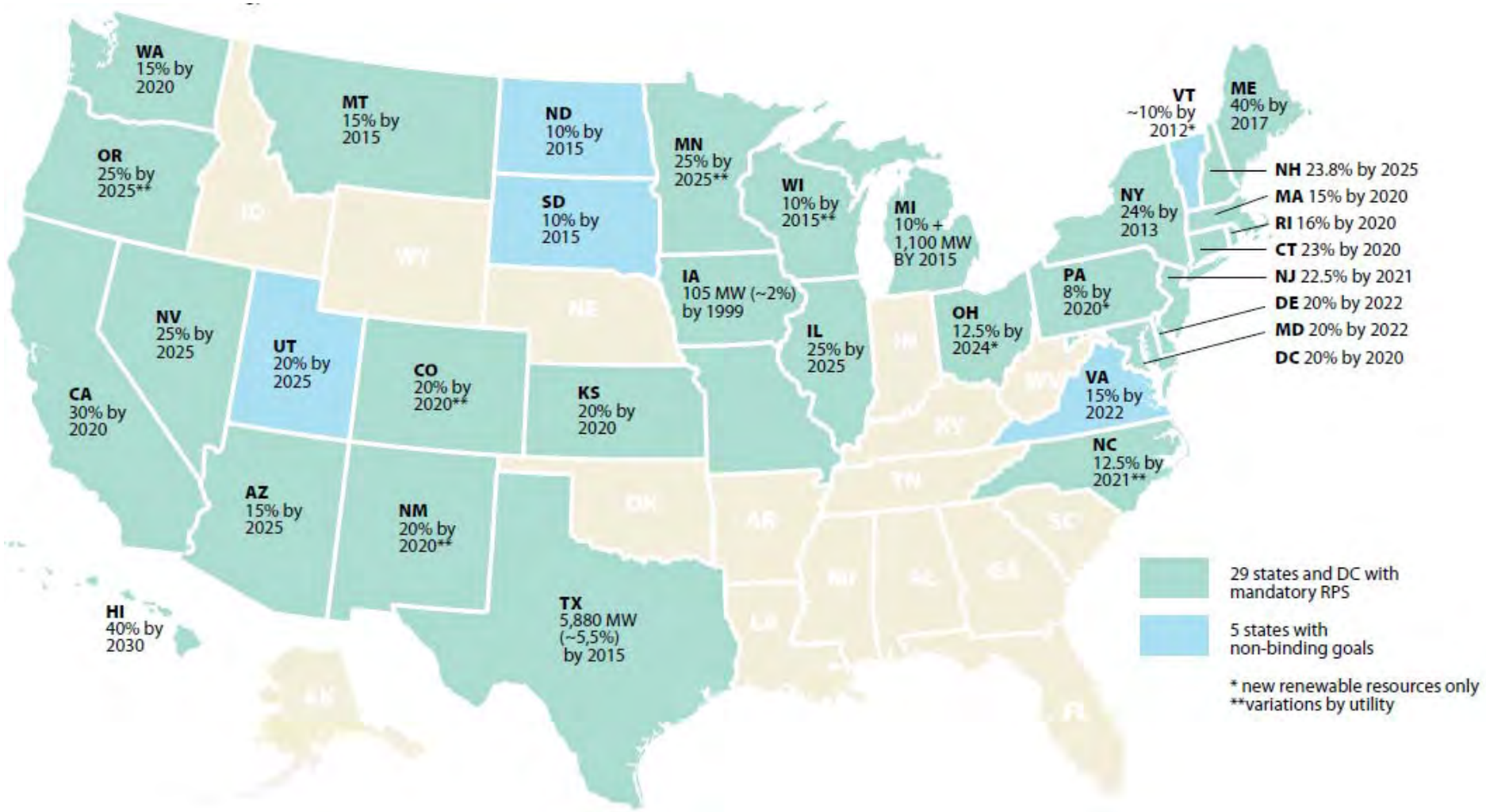
COE and “value of power” comparison: DG PV, remote solar thermal, remote wind

	DG PV	remote solar thermal	wind
Time-of-use value multiplier[1]	1.39	1.39	<1.0
Relative overall revenue-to-cost value	at least 39% better than wind, 50% better than solar thermal	same time-of-delivery value as DG PV, but 50% higher net costs	same net costs as DG PV, but lower average revenue due to high proportion of off-peak production

1. Source of DG PV time-of-use adjustment factor: Southern California Edison Application A.08-03-015, *Solar Photovoltaic (PV) Program Supplemental Rebuttal Testimony*, October 14, 2008, p. 3, footnote 2

State renewable energy requirements

source: Renewable Energy Development Infrastructure, Colorado Governor's Energy Office, December 2009, p. 51.



Local Solar, Big Solar, Wind, and Jobs

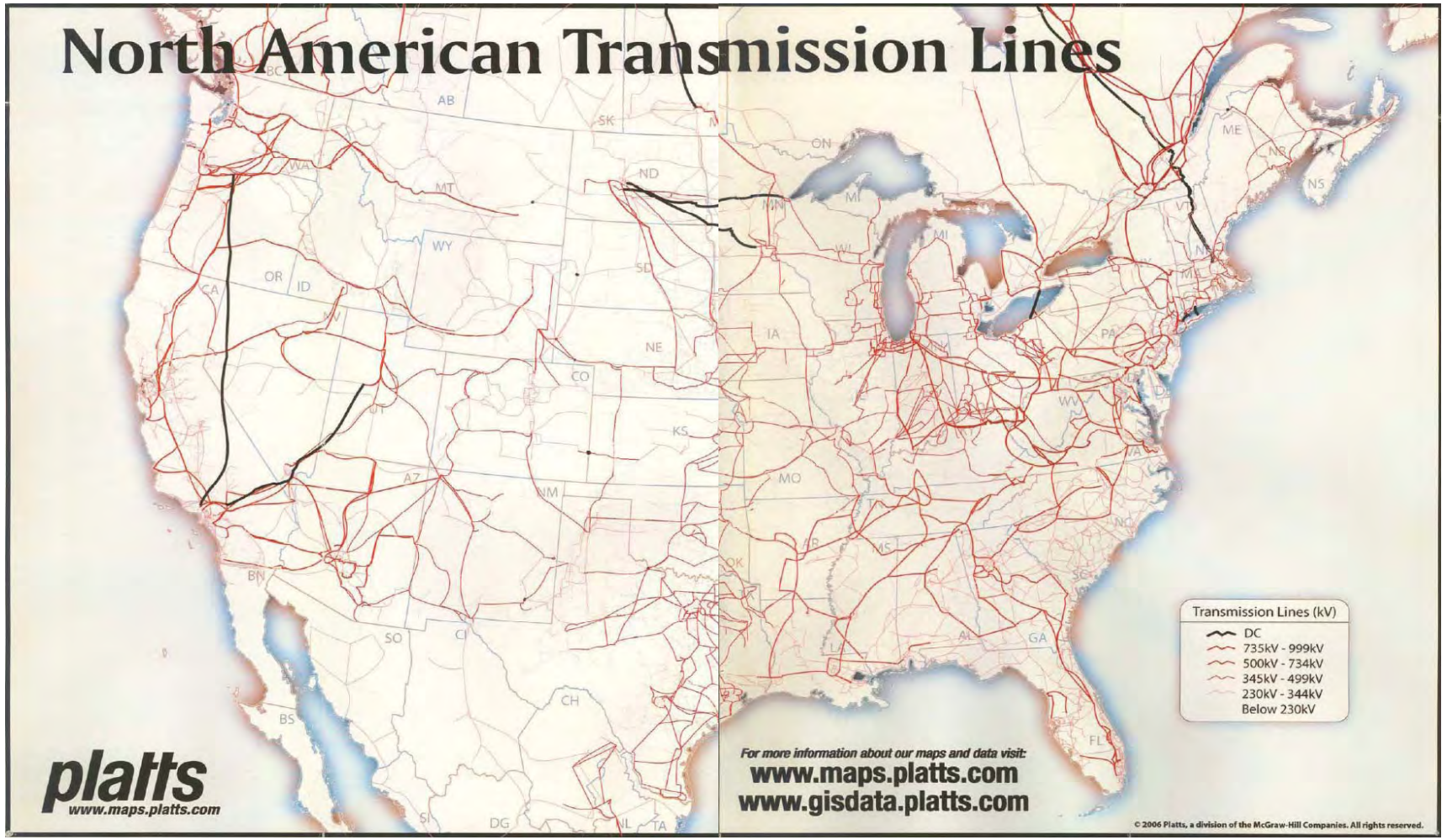
source: California Air Resources Board, *Proposed Regulation for a California Renewable Electricity Standard, Staff Report: Initial Statement of Reasons*, June 2010, Table X-11, p. X-19.

Permanent Jobs Created per Peak MW of Renewable Resource Added

Resource Type	Jobs Created
Solar PV	1.52
Solar Thermal	0.81
Wind	0.52
Geothermal	1.95
Landfill/Digester Gas	5.35
Solid-Fuel Biomass	1.53
Small Hydro (< 30 MW Capacity)	1.28

527,000 miles of existing high voltage transmission – Is it being used efficiently?

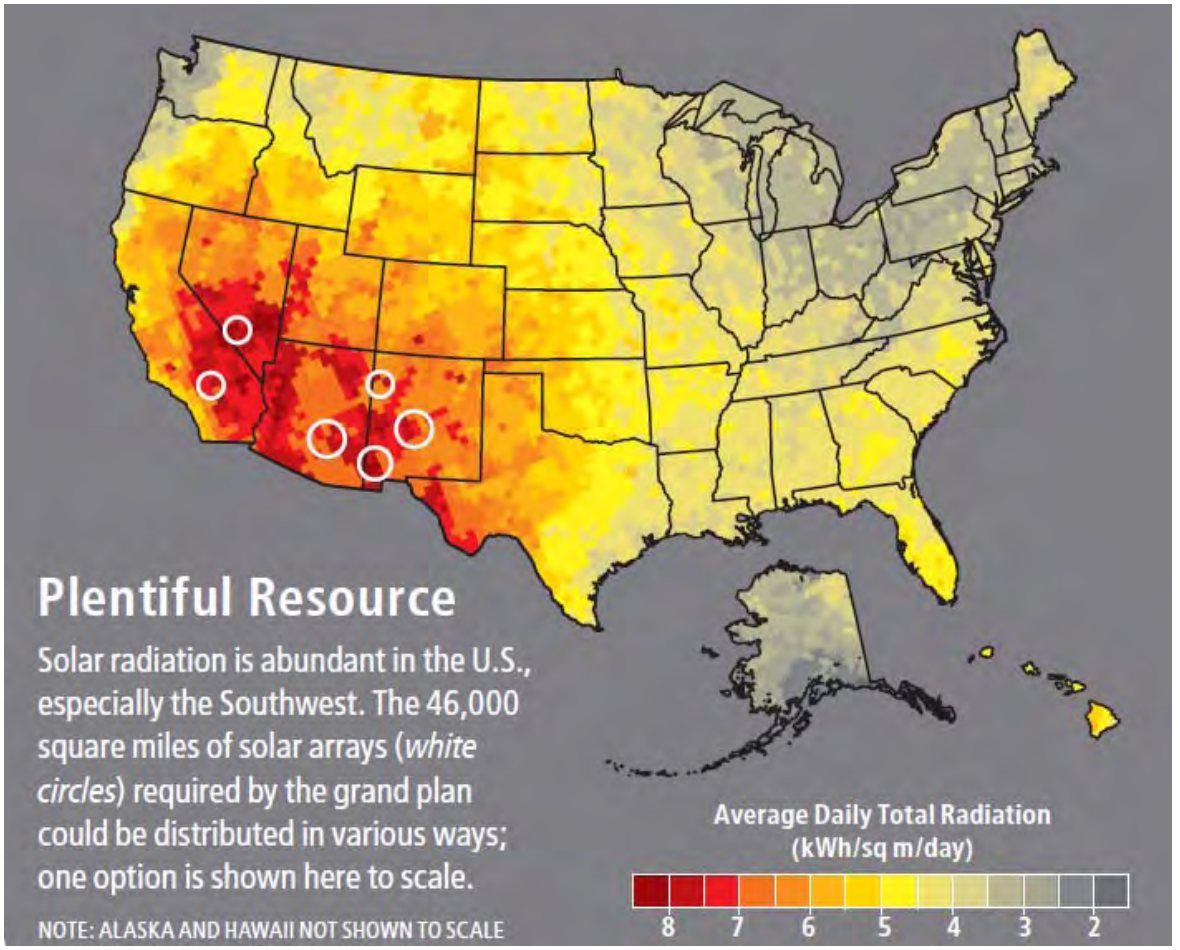
source of 527,000 miles: NYT, Hurdles (Not Financial Ones) Await Electric Grid Update, February 7, 2009



Scientific American: “A solar grand plan”

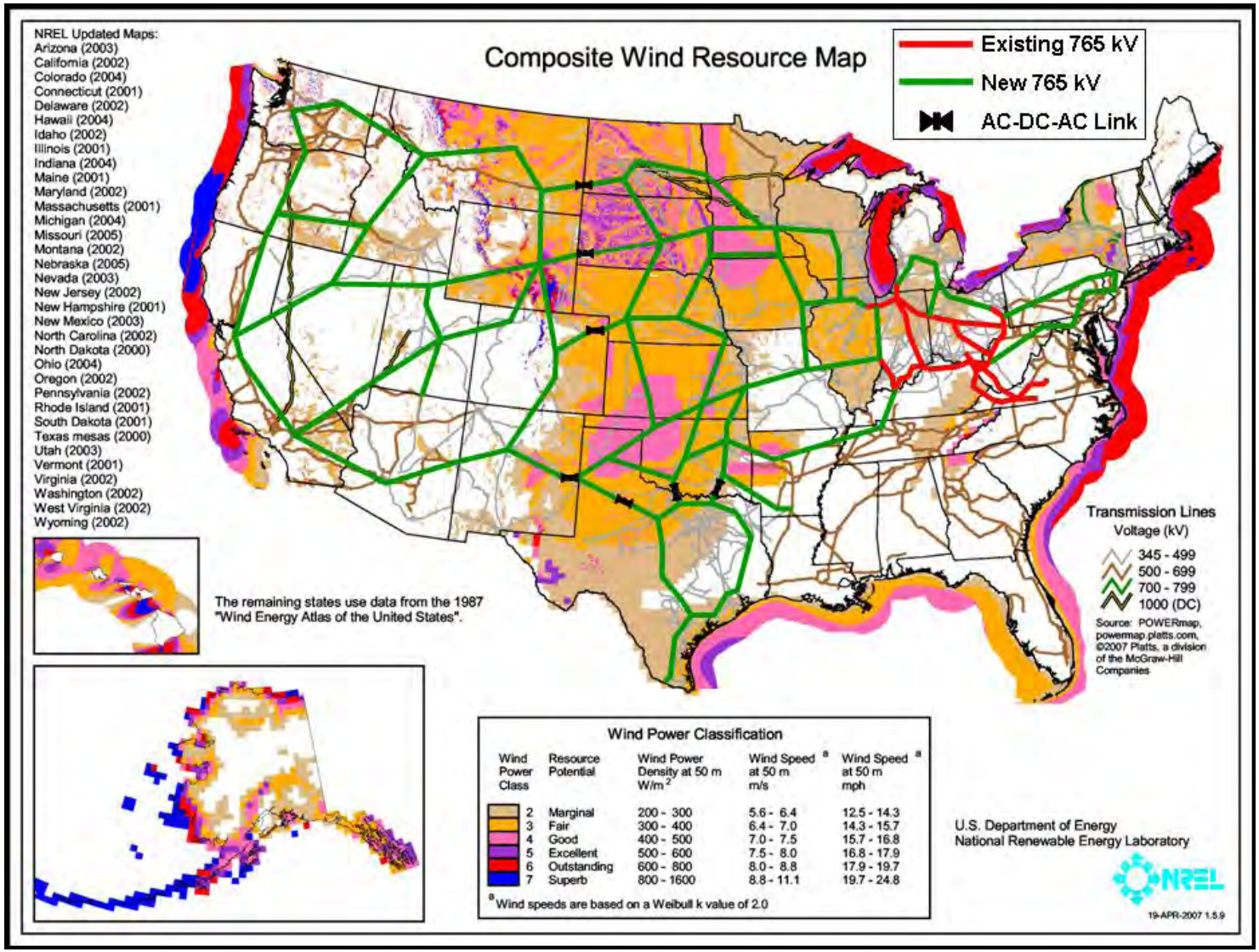
source: Scientific American, *A grand plan for solar energy*, January 2008.

- “To convert the country to solar power, huge tracts of land would have to be covered with photovoltaic panels and solar heating troughs.”
- “A direct-current (DC) transmission backbone would also have to be erected to send that energy efficiently across the nation.”
- “The AC system is also simply out of capacity, leading to noted shortages in California and other regions.”
- 100,000 to 500,000 miles of new high voltage DC grid.
- $420 billion in subsidies needed for solar plan.
- “The HVDC transmission companies would not have to be subsidized, because they would finance construction of lines and converter stations just as they now finance AC lines, earning revenues by delivering electricity.”

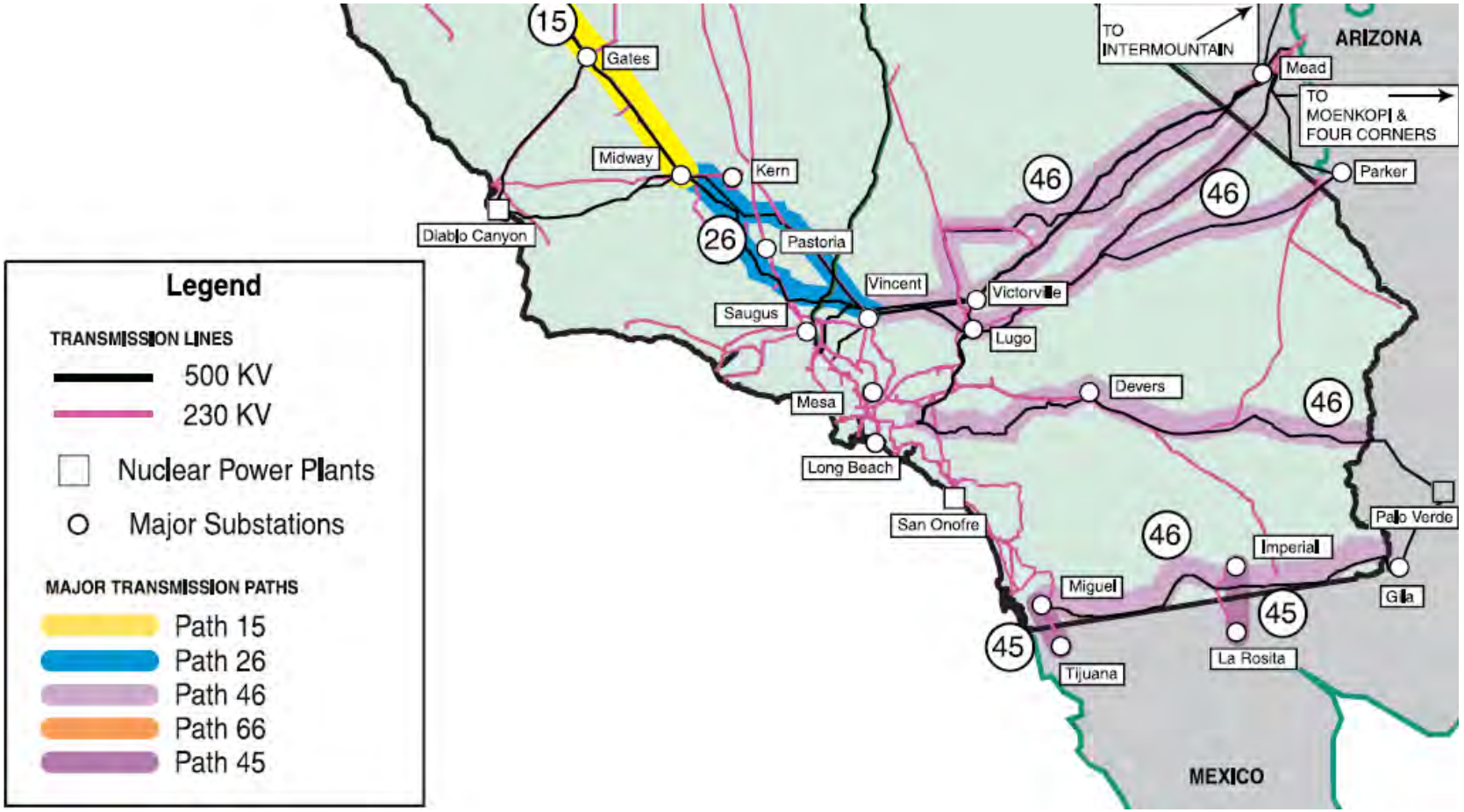


Utility view of the renewable energy future: National solar/wind high voltage transmission grid

source: American Electric Power, Interstate transmission vision for wind integration – white paper, 2008.



Adequate high voltage transmission: 20,000 MW supplying SoCal today, average load is 14,000 MW



Low cost PV: preferred solar option whether remote and utility-scale or urban and distributed

- 21,000 MW of thin-film PV projects in BLM queue alone (RETI, August 08).
- PV is more cost-effective than solar trough at current thin-film PV pricing of $3,700/kW a/c (RETI, January 09)
- Sempra has announced ~1,000 MW of thin-film PV projects/applications using First Solar PV.
- Sempra will be operator of largest thin-film PV installation in country by end of 2010, 58 MW, producing “lowest cost solar power in world” – according to Sempra (Boulder City, NV).

Southern California Edison 500 MW urban warehouse PV project using low-cost thin-film PV

1.2 MW Non-Penetrating Solar PV System on Commercial Rooftop in Sacramento, CA

California now evaluating high DG PV alternative to reach 33% by 2020

- Cost-competitiveness of DG PV is driver.
- Relative lack of environmental or siting issues.
- No new transmission siting or cost issues.
- 15,000 MW of DG PV to largely substitute for remote solar and wind to reach 33% by 2020

Related news:

- SDG&E received approval from utilities commission in September 2010 to build 100 MW of solar PV in San Diego area.

Cost for thin-film PV is one-half cost of dish Stirling (Tessara) solar power without considering cost of transmission

- RETI estimate for thin-film PV: $3,700/kW a/c
- CEC estimate for dish Stirling: $6,000/kW a/c
- Cost of transmission: ~$2,000/kW
- Combined cost, dish Stirling + Powerlink: ~$8,000/kW

sources:

1. CEC thin-film cost estimate: RETI Phase 1B final report, Jan 09, p. 5-27.
2. CEC dish Stirling cost estimate: CEC Comparative Costs of California Central Station Electricity Generation Technologies, December 2007, Appendix B, p. 49.
3. Sunrise Powerlink cost esdtimate: SDG&E ex parte notice, CPUC proceeding A.06-08-010, Nov. 14, 2008, p. 2, $1.883 billion.

Los Angeles Solar Energy Plan:
400 MW PV by 2014, 780 MW by 2020

Los Angeles Solar Energy Plan vs. San Diego Gas & Electric's San Diego Solar Project

- Los Angeles Dept. Water & Power (public utility)
- Peak load: 6,000 MW
- Ave. load: 3,000 MW
- Urban PV by 2014:
  400 MW – feed-in tariff
- Urban PV by 2020:
  780 MW

- San Diego Gas & Electric
- Peak load: 4,500 MW
- Ave. load: 2,500 MW
- Urban PV by 2015:
  100 MW
- Urban PV by 2020:
  no target

SDG&E example: urban PV potential is vast

Commercial buildings: 1,600 to 1,800 MW (www.renewablesg.org)
Commercial parking lots: 3,000 MW
Residential: 2,800 MW
Total PV potential: ~7,500 MW
Highest demand ever recorded in SDG&E territory: 4,600 MW

PV and parking lots – smart dual use

Presentation by Chevron Energy Solutions, Solar Forum at Diablo Valley College, Feb. 8, 2008

PV for parking lot- shade is added value

Presentation by Chevron Energy Solutions, Solar Forum at Diablo Valley College, Feb. 8, 2008

Smart energy - energy efficiency and local PV is least-cost, lowest greenhouse gas, most local jobs

- No technical or economic impediments.
- PV at the point-of-use is more cost-effective than other forms of remote solar power like Tessara dish Stirling.
- Hurdles are institutional – investor-owned utility model has not yet been re-aligned to advance distributed energy future.