
Concept to Commerce: Emerging Energy Technologies Summit

UC Santa Barbara
Technology Management Program
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PG&E and Our Business

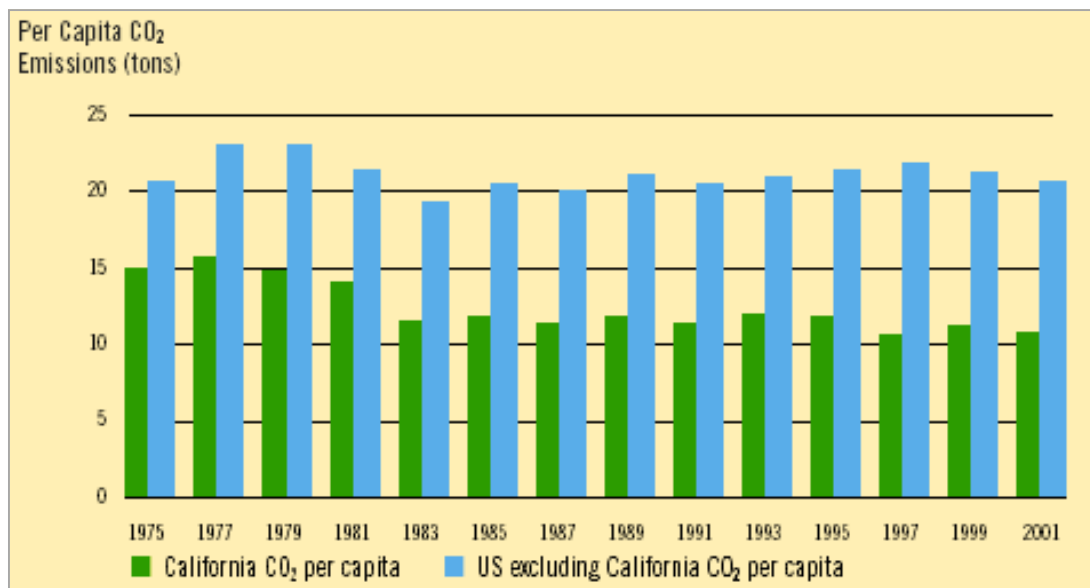
- PG&E Corp is an energy holding company based in San Francisco
- PG&E Corporation's core holding is Pacific Gas and Electric Company



What Makes California Different?

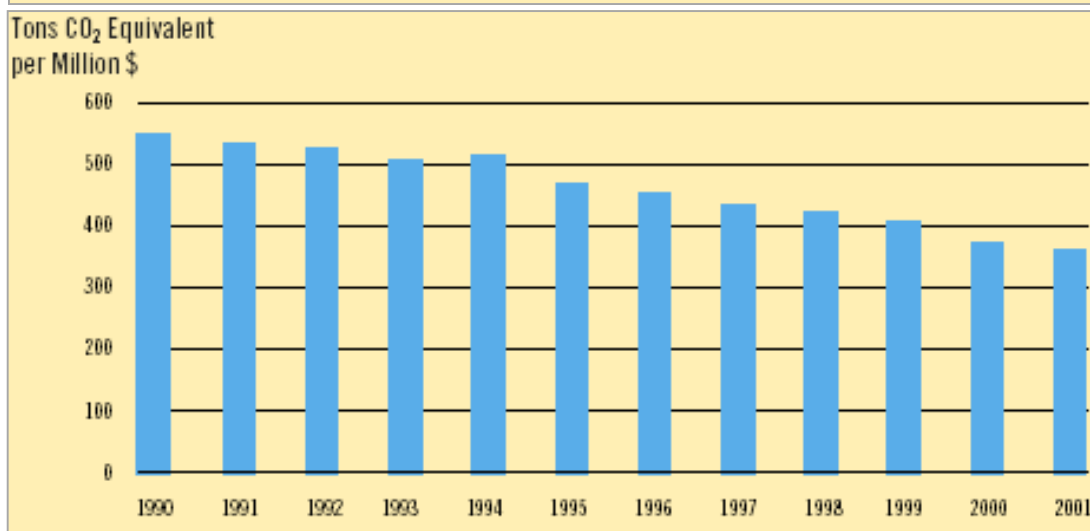
CO₂ emissions per capita in California have decreased by 30% from 1975 to 2001, while emissions in the rest of the U.S. have stayed constant.

Source: Oak Ridge National Laboratory, 2005 (cdiac.esd.ornl.gov/trends/emis_mon/stateemis/emis_state.htm).



GHG Emissions per unit of Gross State Product decreased by more than 30% 1990-2001.

Source: Inventory of California Greenhouse Gas Emissions and Sinks: 1990 To 2002 Update, Publication CEC-600-2005-025, California Energy Commission.



Energy Policy

- Low carbon intensity is due primarily to state policies (beginning in the 1970s) that have encouraged the use of natural gas, renewable resources and energy efficiency.
- Energy Action Plan developed by
 - California Energy Commission
 - California Public Utilities Commission
- It prescribes a “loading order” of cost-effective resources:
 1. Customer Energy Efficiency
 2. Demand Response/Dynamic Pricing
 3. Renewables
 4. Distributed Generation
 5. Clean gas-fired plants
 6. Transmission as needed for efficiency and to connect new plants

Aggressive Energy Goals

- Energy Efficiency
 - Nearly 5,000 MW statewide through 2013
- Demand Response
 - Target of 5% of load by 2007
- Renewables
 - State law requires addition of 1% renewables per year
 - 20% of total energy target by 2017, changing to 2010
 - Discussions about expanding goal to 33% by 2020
- Distributed Generation
 - Rebates on microturbines, fuel cells, etc.
 - Focus on photovoltaics through the “California Solar Initiative”
 - More than 9,800 solar systems connected to PG&E’s grid

California Solar Initiative (CSI)

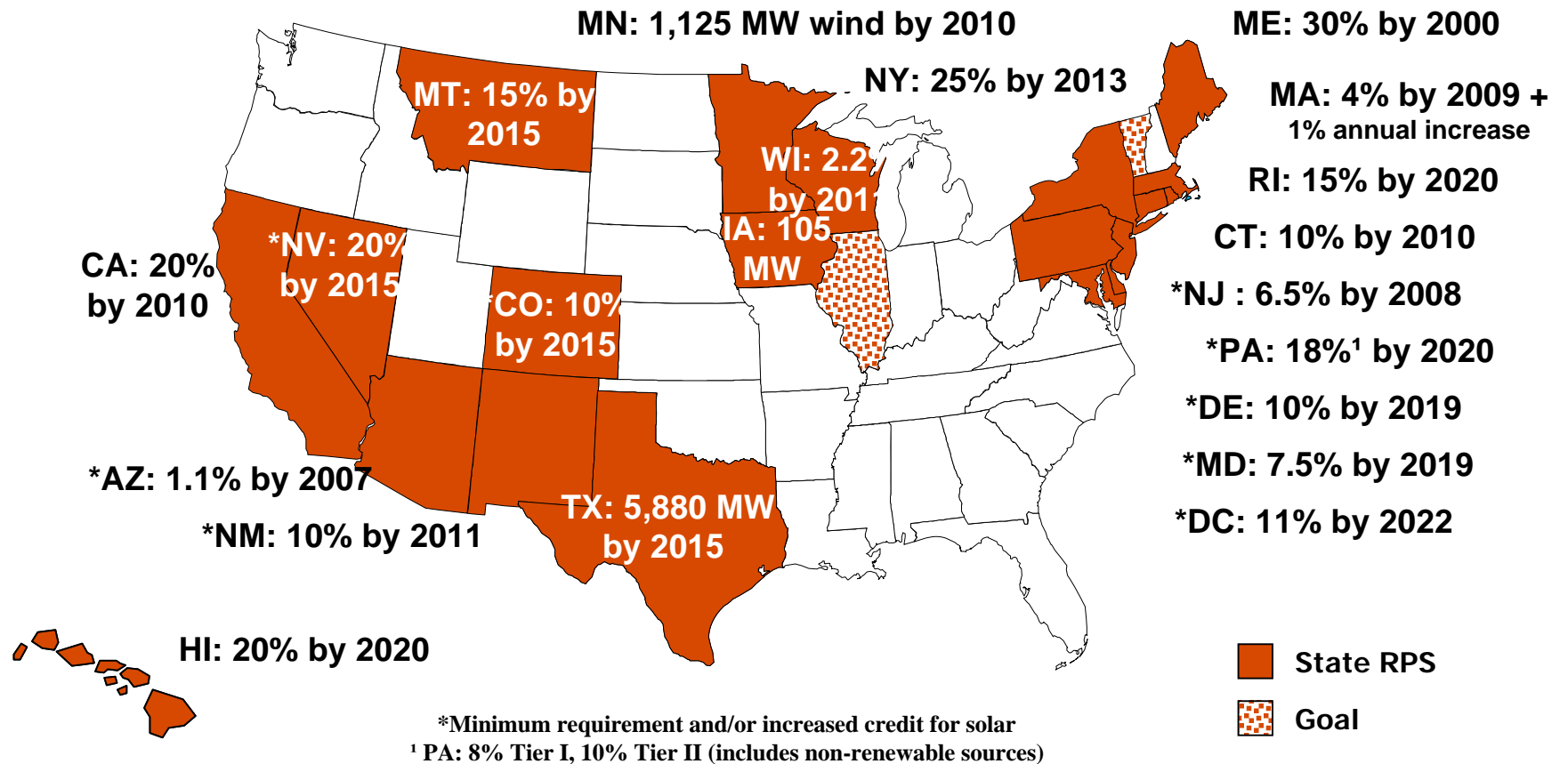
- \$2.8 billion in statewide incentives over 11 years.
- Long-term, but finite commitment to send a signal to manufacturers with the intent of transforming the market to make solar products cost-effective without incentives.
- No specific capacity goals adopted, but expectations are approximately 3,000 MW over 11 years.
- Initial CSI incentive levels set at \$2.80 per watt in 2006. Incentive levels will automatically reduce by 10% or more annually.
- Performance-based incentives will be considered as full or partial replacement of upfront capacity payments.
- Incentives initially to solar PV with solar thermal, solar water heating and solar heating and air conditioning technologies to be added.
- Up to 5% of each year's budget to go to RD&D.

Renewable Portfolio Standards (RPS) by State

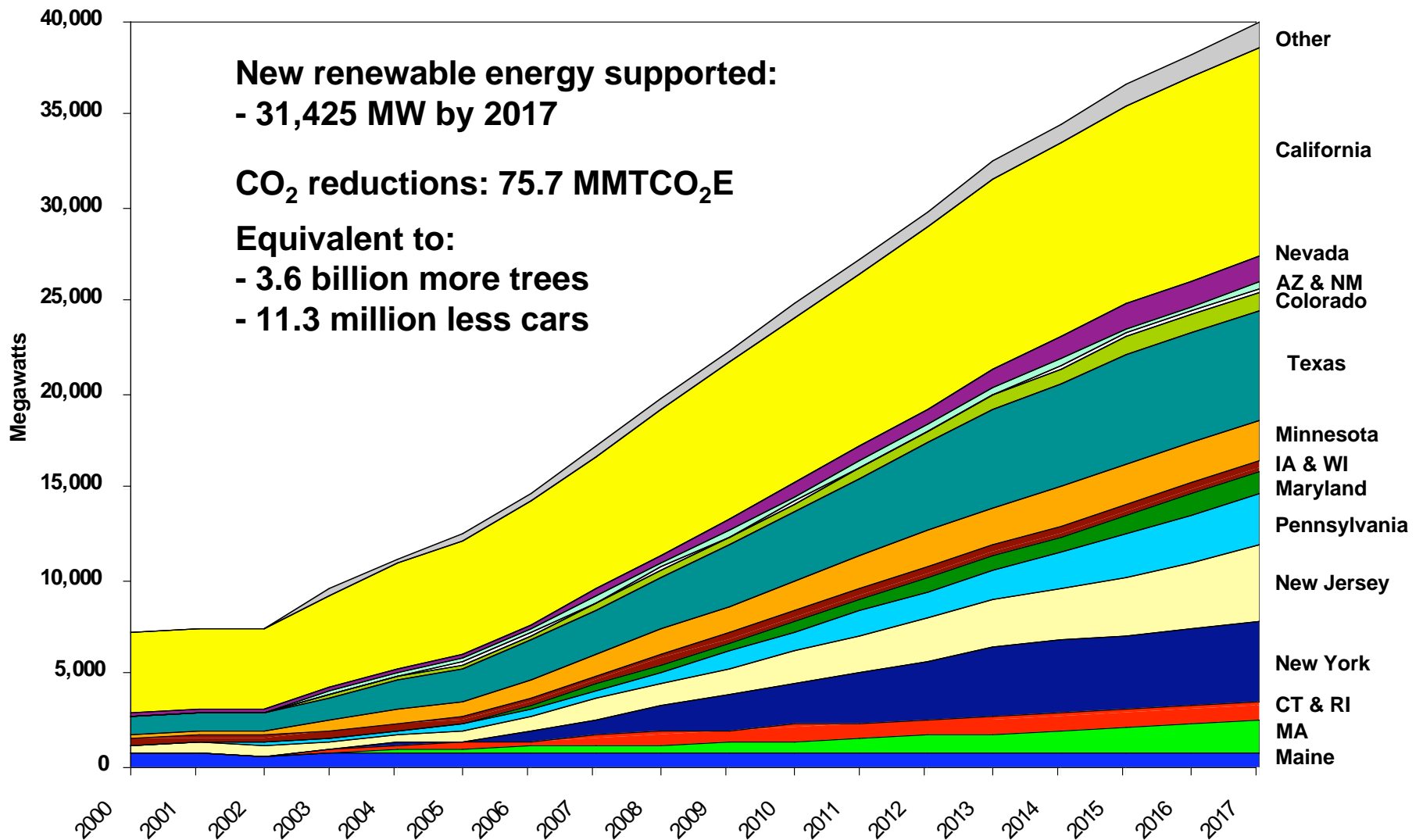
DSIRE: www.dsireusa.org

21 States

January 2006



Renewable Energy Expected From State Standards and Funds



Pacific Gas and Electric Company™

Source: Union of Concerned Scientists

RPS Eligible Renewable Resources

- Eligible renewable resources:
 1. Wind
 2. Solar (concentrating thermal and photovoltaic)
 3. Small hydro (less than 30 MW w/o new diversion)
 4. Geothermal
 5. Biomass, biogas (landfill gas, digester)
 6. Fuel cell using renewable fuel
 7. Municipal solid waste conversion using a non-combustion thermal process as defined by Senate Bill 1038;
 8. Ocean wave, ocean thermal, tidal current
- Does not include fossil-fueled cogeneration, gasified coal, large hydro, or municipal waste combustion
- In-state delivery requirement

RPS Solicitation and Evaluation Process

- Utility submits RPS Procurement Plan and initiates an RPS solicitation.
- Utility uses “least-cost, best-fit” evaluation criteria to develop ranking and “short-list” of bidders
 - “Least-cost” not just lowest price, but lowest cost relative to market value of energy and cost of transmission
 - “Best-fit” with particular utility resource needs (e.g., curtailability, dispatchability, and local reliability are quantified in evaluation)
 - Utilities Commission prescribes some evaluation elements (e.g., integration cost adders for regulation and load-following)
- Utility engages in extensive bilateral negotiation with short-list bidders to develop final contracts for pre-approval
- Utility consults with a “Procurement Review Group” made up of non-market participants that represent the public interest

PG&E's RPS Procurement Activities

To meet the RPS requirement, PG&E has conducted two power solicitations and several bilateral negotiations since the law's enactment.

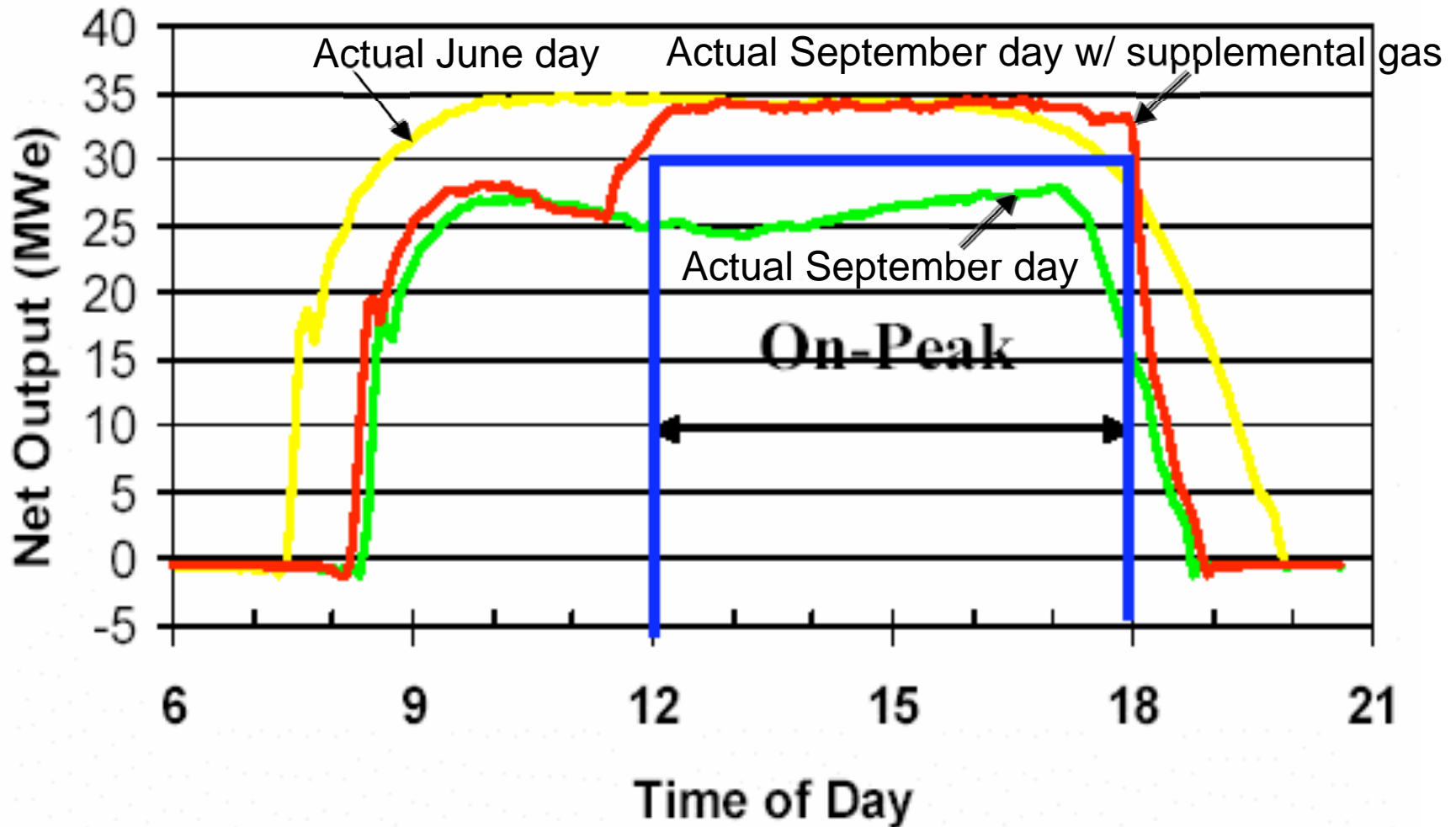
Technology	Number of Contracts	MW	GWh
Wind	5	251	793
Geothermal	2	110	722
Biomass / Landfill Gas	5	53	360
Hydro	1	29	160
Total	13	443	2,035

Technology May Mitigate Wind Operating Concerns

- Wind is the cheapest source of renewable energy today.
- 85% of all the renewable energy added in the U.S. over the last 6 years has been from wind.
- California development trends are similar.
- Operating with increasing levels of wind would be easier with technologies that address wind's characteristics:
 - Volatility: minute-to-minute and intraday changes
 - Variability: day-to-day changes
 - Diurnal pattern: production is lowest during peak demand periods and greatest when demand is lowest
 - Seasonality: Wind Resource Area with greatest potential has peak production in the 2nd quarter, when it competes with excess hydro
 - Intermittency – very low capacity value

Central Solar Fits Needs

Solar thermal can add storage or gas or biofuel cofiring to become firm

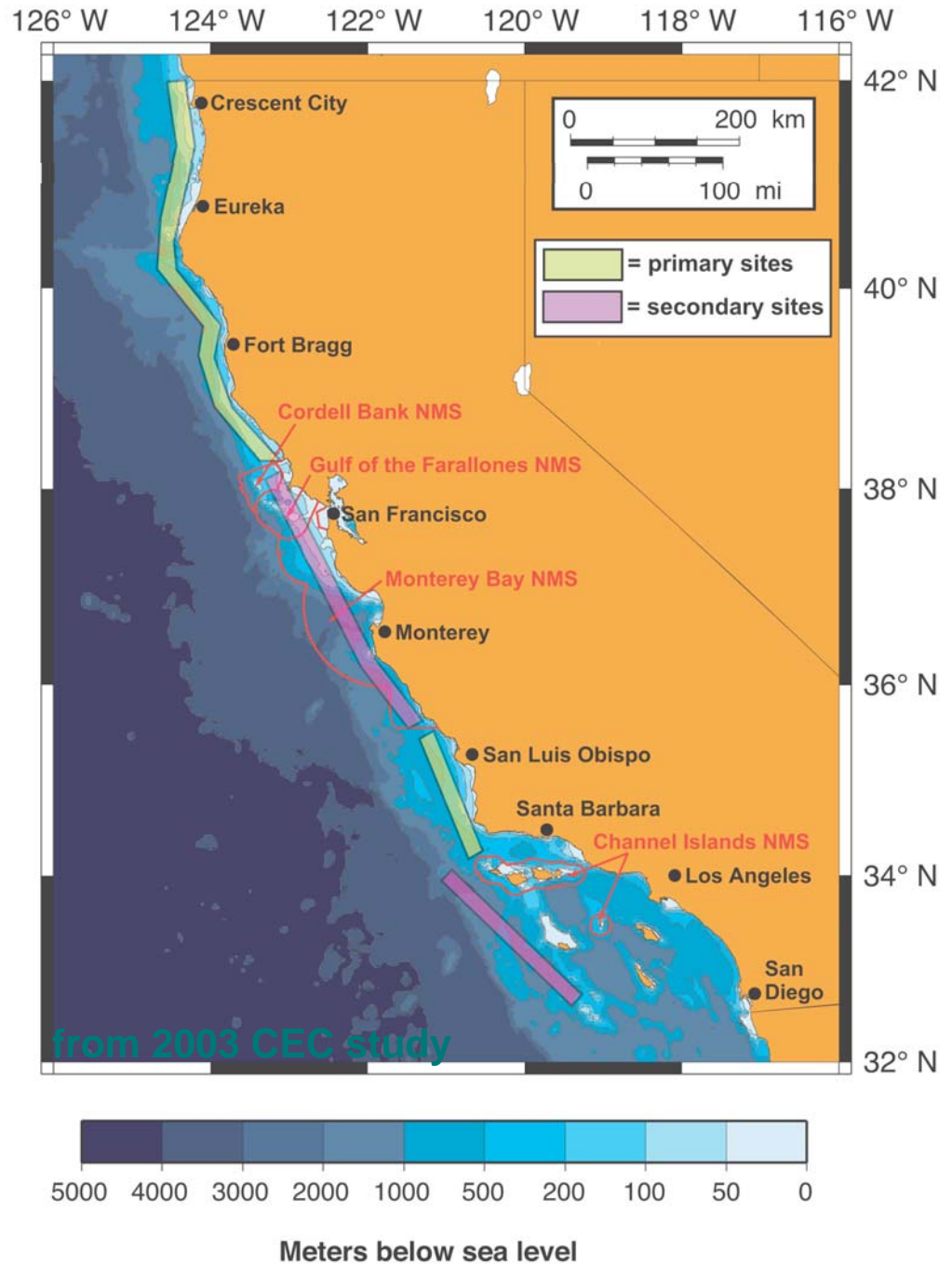


Pacific Gas and Electric Company

Parabolic Trough Solar Technology for Utility Power Markets in the Southwestern United States, Henry Price, National Renewable Energy Laboratory, August 2004

California Wave Energy Potential

- 1992 PG&E study identified 4,000 MW of wave energy “potential”
- 2003 CEC study identified primary and secondary sites (see map)



Clean Air Through Electrification

- U.S. average CO₂ emission by electric utilities is 1.3 lbs of CO₂/kWh. PG&E's portfolio emits approximately 0.5 lbs of CO₂/kWh, which means converting higher emitting uses to electricity can help achieve environmental goals.
- 5,700+ stationary diesel-powered pumps used for irrigation in the central valleys are significant contributors to ozone, NO_x, and reactive organic gases. Converting to electric pumps will both reduce local pollutants and decrease CO₂ as much as 318,000 tons/year.
- Vehicle electrification using off-peak electricity
 - Plug in hybrid electric vehicles
 - Truck stop electrification

Conclusion:

Emerging Technology Needs

- Developing renewable technologies
 - Photovoltaic cost breakthroughs
 - Renewable peaking and dispatchable resources
 - Small, cheap, and efficient biomass gasifiers
 - Municipal Solid Waste energy conversion technologies
 - Concentrating Solar Power: trough, Stirling, tower, HCPV
 - Ocean energy
- Competitive wind turbines
- Inverters and control systems
- Utility-scale energy storage applications
- New energy-dense rechargeable battery technology
- Rechargeable battery recycling or disposal
- Biofuels
- Dry cooling
- CO₂ sequestration

Useful Links

- <http://www.pge.com/selfgen/>
- <http://www.pge.com/renewablesrfo>
- <http://www.energy.ca.gov/renewables/index.html>
- <http://www.cpuc.ca.gov/proceedings/R0404026.htm>
- <http://biomass.ucdavis.edu/index.html>
- <http://www.calwea.org/>
- <http://www.calseia.org/>