

The Stella Group, Ltd.

RENEWABLE ENERGY - TRENDS

by Scott Sklar

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Growth of Global Investment in Renewables

Article: “Renewables could quadruple by 2050 with policy incentives, says IEA” and “Global renewables to increase to 19% from 8% by 2030”, (6\06)

The Cleantech Venture Network forecasts that cleantech venture capital investment opportunities for major institutional investors globally through 2009 are estimated at \$17 billion, with \$10 billion in North America, \$5 billion in Europe and \$2 billion for the rest of the world. (12\06)

The world will invest an average of US\$69 billion a year in emerging renewables over the next two decades, according to the latest forecast from McIlvaine Company. <http://www.mcilvainecompany.com/worldindbrochure/worldindcharts/worldindbrochure.htm> (3\17\06)

By Tom McNichol and Michael V. Copeland, Business 2.0 Magazine, October 26 2006: 12:36 PM EDT ... firms driving a sizzling \$11 billion worldwide market in solar energy, part of a rapidly expanding alternative-energy economy that promises to shake up the way power is produced and consumed as profoundly as the region's computer and Internet companies upended global communications and commerce in the late 20th century.

UTILITY GROWTH - 1994 - 2005 (EIA)

In 2005, total net summer capacity increased 1.6 percent, a net increase of 15,078 megawatts, almost all in natural gas-fired combined cycle units. The capacity margin dropped to 15.4 percent in 2005 from 20.9 percent in 2004. Net generation of electricity increased 2.1 percent from 2004 to 2005, reaching 4,055 billion kilowatt hours. This rate of increase slightly exceeded the average for the 12-year period 1994 through 2005 of 2.0 percent per annum.

Nuclear generation has essentially maintained its approximately 20 percent share of total net generation from 1994 through 2005 although no new nuclear units have been constructed.

Renewable energy, other than hydroelectric, grew 5.0 percent and accounted for 2.3 percent of net generation. Biomass contributed the majority of non-hydroelectric renewable generation; however, wind generation showed strong growth, 25.9 percent over 2004, contributing a record 17.8 billion kilowatthours out of 94.9 billion kilowatthours for biomass, wind, geothermal, and solar combined. Generation from other gases (refinery gases, blast furnace gas, etc.) and other miscellaneous sources accounted for the remaining generation.

http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html#figes1

EIA -- Grid -Connected Renewable, 2005

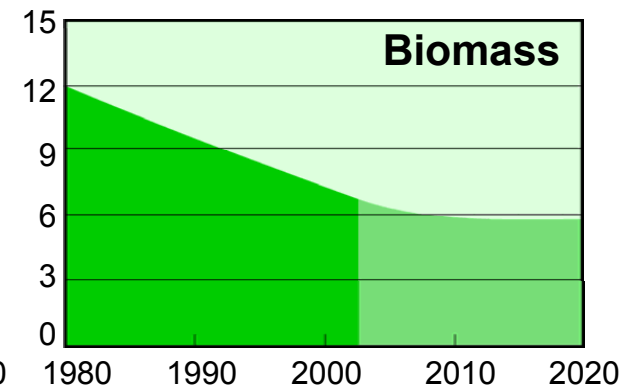
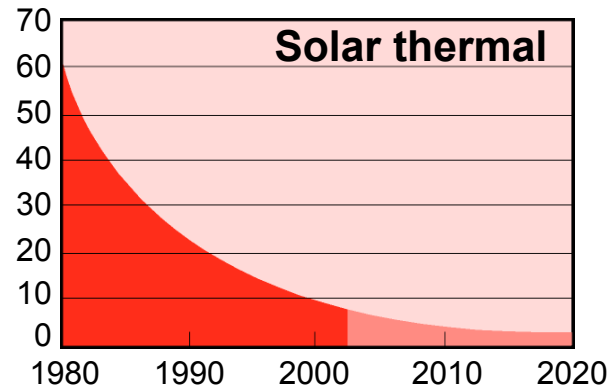
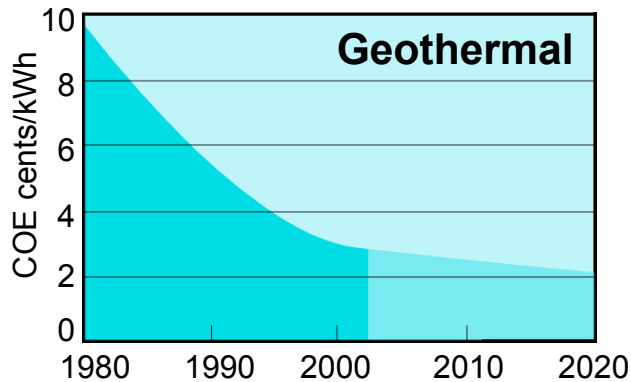
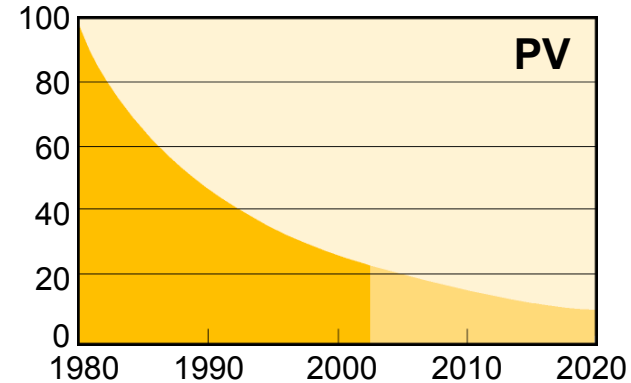
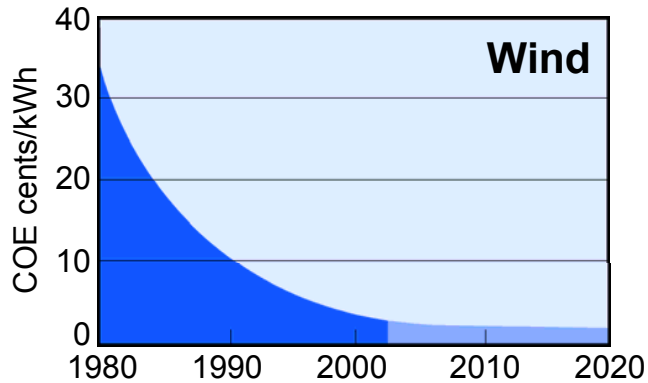
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Renewable Portfolio Standards and State Mandates by State, 2007 (EIA)

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Renewable Energy Cost Trends

Levelized cents/kWh in constant \$2000¹



Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2002.ppt)

¹These graphs are reflections of historical cost trends NOT precise annual historical data.

Updated: October 2002

BIOMASS POWER - ELECTRICITY and THERMAL

Power from biomass is a proven commercial electricity generation option in the United States. With about 9,733 megawatts (MW) in 2002 of installed capacity, biomass is the single largest source of non-hydro renewable electricity ([EIA Renewable Energy Annual 2002](#)), includes about 5,886 MW of forest product and agricultural residues, 3,308 MW of generating capacity from municipal solid waste, and 539 MW of other capacity such as landfill gas. The majority of electricity production from biomass is used as base load power in the existing electrical distribution system.

National Energy Modeling System to account for various types of biomass is discussed, and the underlying assumptions are explained. The Energy Information Administration's estimation of biomass resources shows that there are 590 million wet tons of biomass available in the United States on an annual basis; 20 million wet tons (enough to supply about 3 gigawatts of capacity) are available today at prices of \$1.25 per million Btu or less. The average price of coal to electric utilities in 2001 was \$1.23 per million Btu. Biomass, in terms of the overall U.S. energy picture, supplying 3.2 quadrillion Btu of energy out of a total of 98.5 quadrillion Btu in 2000.⁷ The vast majority of it is used in the pulp and paper industries, where residues from production processes are combusted to produce steam and electricity. The industrial cogeneration sector consumed almost 2.0 quadrillion Btu of biomass in 2000.

The electricity generation sector (excluding cogenerators) consumed about 0.7 quadrillion Btu of biomass in 2000. The remaining 0.5 quadrillion Btu of biomass was consumed in the residential and commercial sectors in the form of wood consumption for heating buildings. The electricity generation sector consumed 20.5 quadrillion Btu of coal and 6.5 quadrillion Btu of natural gas in 2000.

GEOTHERMAL - US

Washington, DC [RenewableEnergyAccess.com] 2006-11-14

When almost 60 new geothermal energy projects now under development in the U.S. are complete, up to 2,250 megawatts (MW) of electric power capacity will come online, generating approximately 18 billion kilowatt-hours (kWh) of electricity annually.

This would almost double installed U.S. geothermal power capacity to more than 5,000 MW, according to a survey by the Geothermal Energy Association (GEA).

These additions produce electric power roughly equivalent to all U.S. wind facilities operating in 2005. "This represents the U.S. geothermal industry's most dramatic wave of expansion since the 1980s." noted Karl Gawell, GEA's executive director.

WATER POWER

23,000 MW by 2025: Report on hydropower's potential

WASHINGTON DC (March 14, 2007) – A report by the Electric Power Research Institute (EPRI) reveals the short-term and long-term potentials of water energy to the U.S. renewable energy supply.

The EPRI's Doug Dixon, project manager of the report address focused on EPRI's estimate of water power's potential and what can be achieved by 2025. During the EPRI study, investigators reviewed conventional hydro-electric plants and the new technologies using energy from tides, ocean waves and currents. EPRI estimates that 23,000 MW of additional capacity can be brought online by 2025, Dixon said.

The EPRI report, "The Power of Moving Water." written by senior project manager Doug Dixon at EPRI and the program manger of EPRI's Hydropower Environmental Issues Research Program, as well as EPRI's Clean Water Act Fish Protection Program for Thermal Power Plants. Dixon has been with EPRI since 1997 and has more than 30 years of professional experience in environmental science and energy-related research

WIND ENERGY

SCE touts renewable sources by Kevin Smith Staff Writer

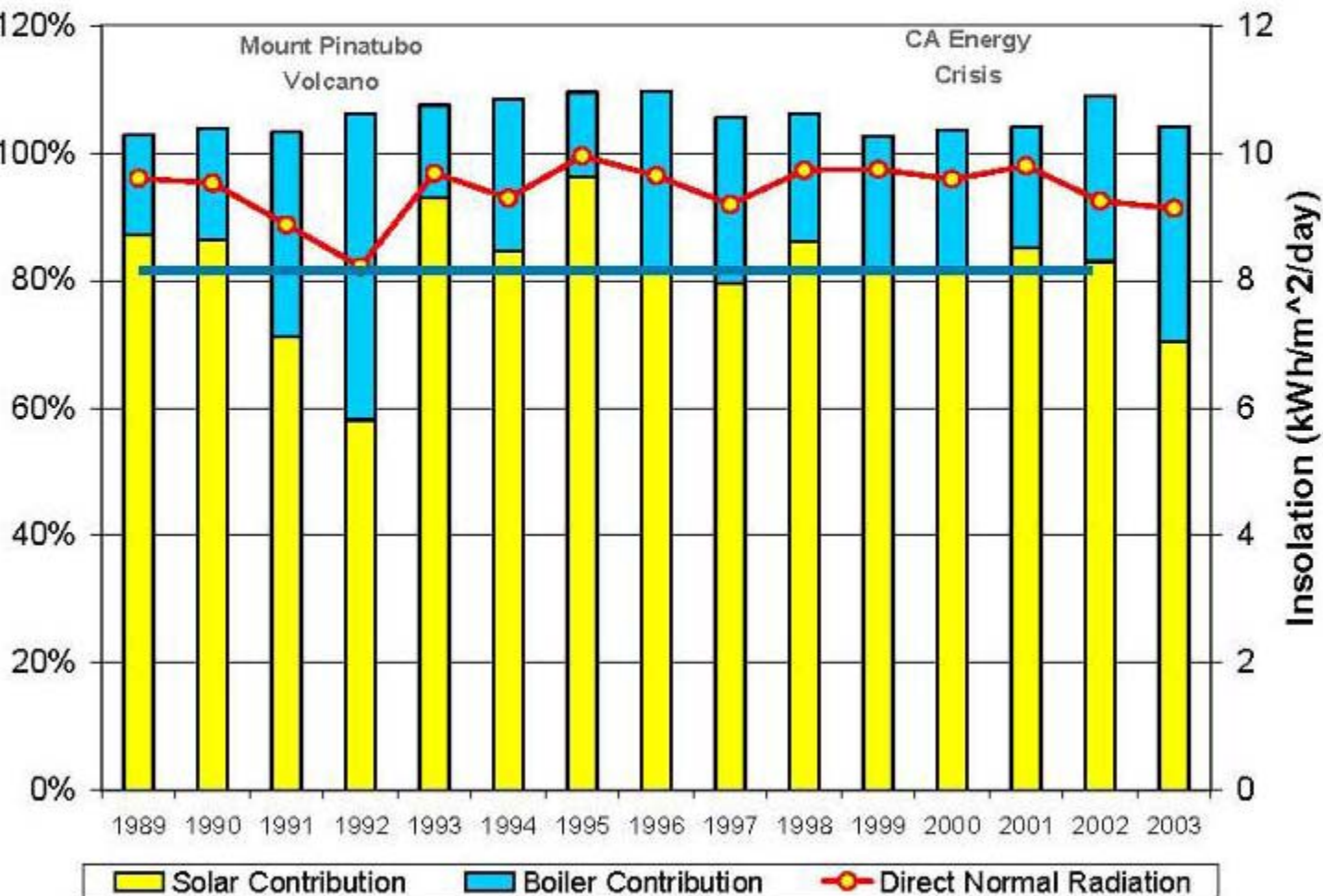
ROSEMEAD - (August 2006) U.S. wind energy facilities now exceed 10,000 megawatts in generating capacity, producing enough electricity to power more than 2.5 million homes a day, an industry report said.

Wind power already figures into Southern California Edison's portfolio of renewable energy sources. In fact, SCE is the nation's leader at meeting customer needs with renewable power.

Last year, 17 percent of SCE's overall energy was produced by renewable power. That number is expected to be between 16 percent and 17 percent this year.

"We have more than 1,000 megawatts of wind contracted," said Stuart Hemphill, SCE's director of renewable and alternative power. "We're doing all we can to get more"

CSP Has Been a Reliable Resource for California



- Averaged 80% on-peak capacity factor from solar
- Over 100% with fossil backup
- Could approach 100% from solar with the addition of thermal energy storage.

SCE Summer On-Peak
Weekdays: Jun - Sep
12 noon - 6 pm

Southwest Solar Resources with All Filters

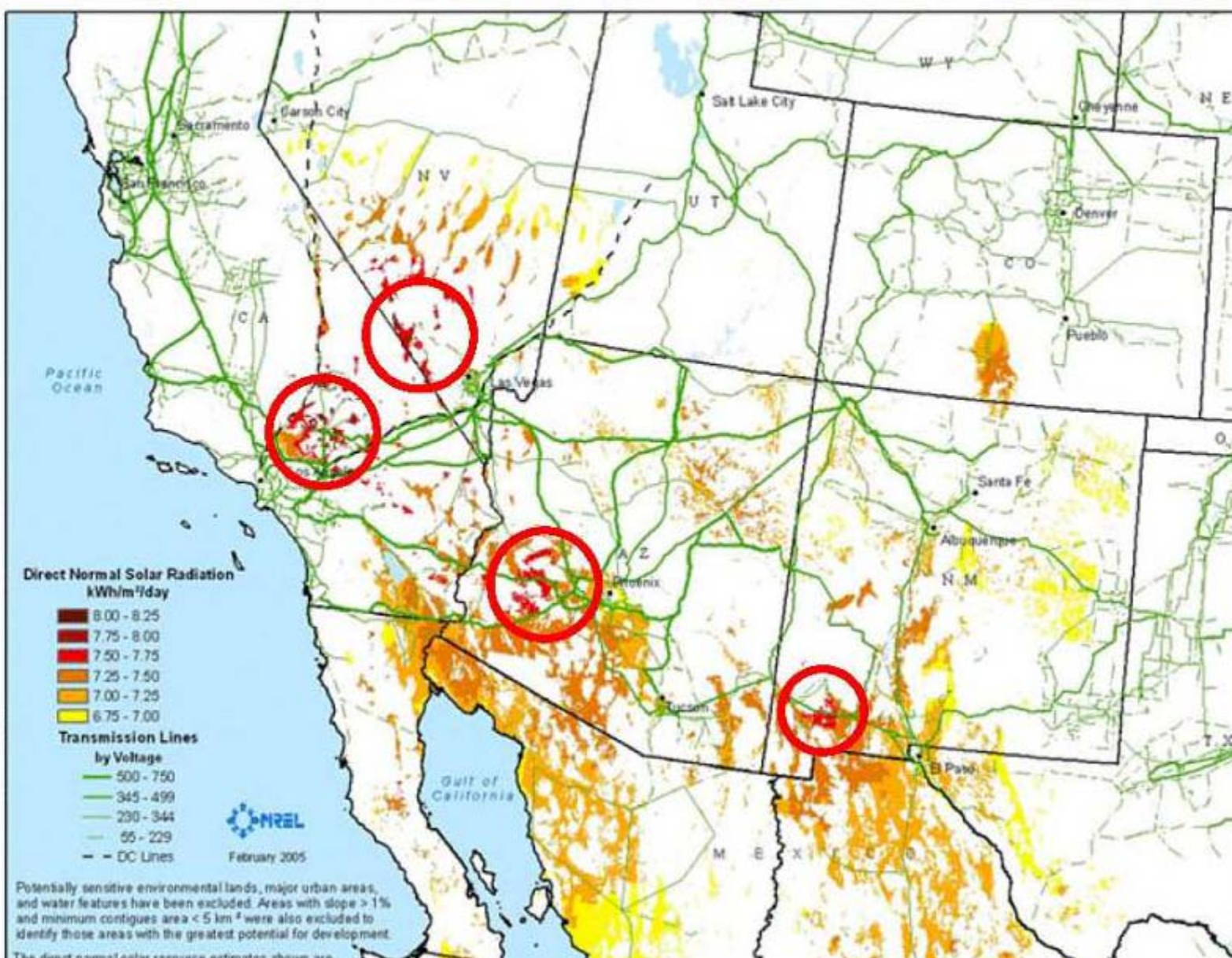
Filters

6.75 kWh/m²/day

Environmental
and Land Use
Exclusions

Slope < 1%

Western Governors
Association study
identified potential
200 GW, but set
conservative target
4-13 GW online
2015.



Early adopters of fuel cells are driven by the need for uninterrupted, high quality power.

Power Disruption Events per Month

Event	Median	Average	Worst
Interruptions	1.0	1.3	10.0
Sags / undervoltages	4.1	27.9	1,660
Swells / overvoltages	3.4	13.9	1,450
Transients	15.7	63.5	1,166

Source: Duke Power, Sandia National Laboratories

- Power disruptions may cause sensitive equipment to fail.
- As a result, organizations face potential for significant losses – lost data, lost materials, lost productivity, and lost income – as well as risks to public safety.
- A study by Sandia National Laboratories estimates losses from power disruptions at more than \$150 billion per year in the U.S.
- In response, more and more organizations are turning to on-site generation to boost power availability.



Energy Source	SO _x (gSO _x / kWh)	NO _x (gNO _x / kWh)	C in CO ₂ (gC/kWh)	C in CO ₂ from non-generating portion of fuel cycle* (gC/kWh)
Coal	3.400	1.8	322.8	50.0
Oil	1.700	0.88	258.5	50.0
Natural Gas	0.001	0.9	178.0	30.0
Nuclear	0.030	0.003	7.8	7.8
Photovoltaics	0.020	0.007	5.3	5.3

*Estimated emissions related only to the gathering and processing of fuel, and to the building and decommissioning of the generation plant. Based on calculations derived from: R. Dones and R. Frischknecht, "Life Cycle Assessment of Photovoltaic Systems: Results of Swiss Studies on Energy Chains," *Environmental Aspects of PV Power Systems: Report on the IEA PVPS Task 1*, Report No. 97072, December 1997. Emission factors for fossil fuel from The American Gas Association; emission factors for nuclear and renewable energy sources from the Council for Renewable Energy Education (as reported by SEIA, ref. 7).

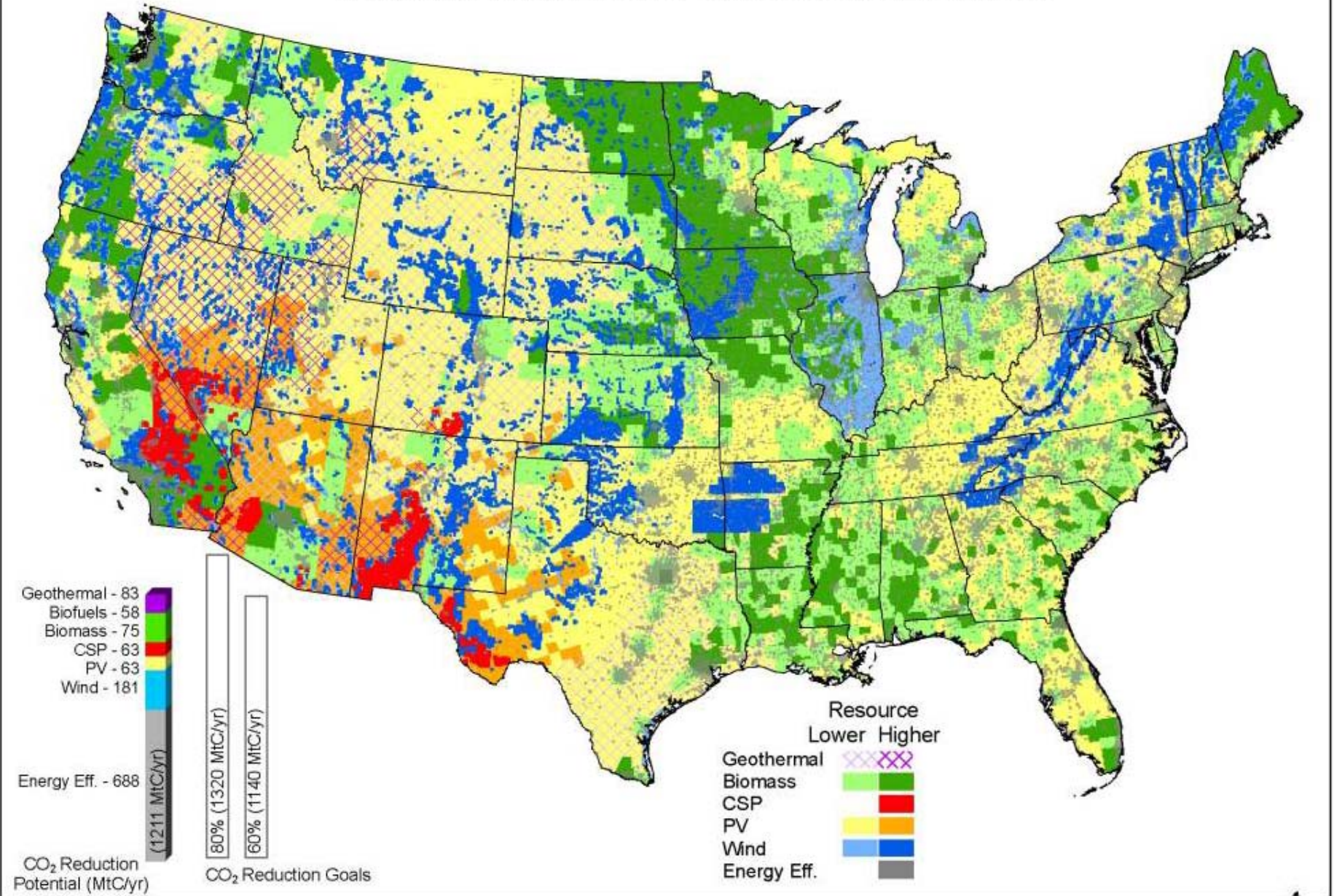
GHG - SOURCES

Figure 3: Sources of Anthropogenic GHG Emissions

Waste Disposal	02%
Residential & Commercial	12%
Transportation	14%
Agriculture	20%
Electric Power	20%
Industrial Processes	32%

Sources: Distribution to sectors for CO₂, CH₄, and N₂O is from EDGAR, 2000. All other GHGs are assumed to be from industrial processes.

Potential Reduction in U.S. Carbon Emissions



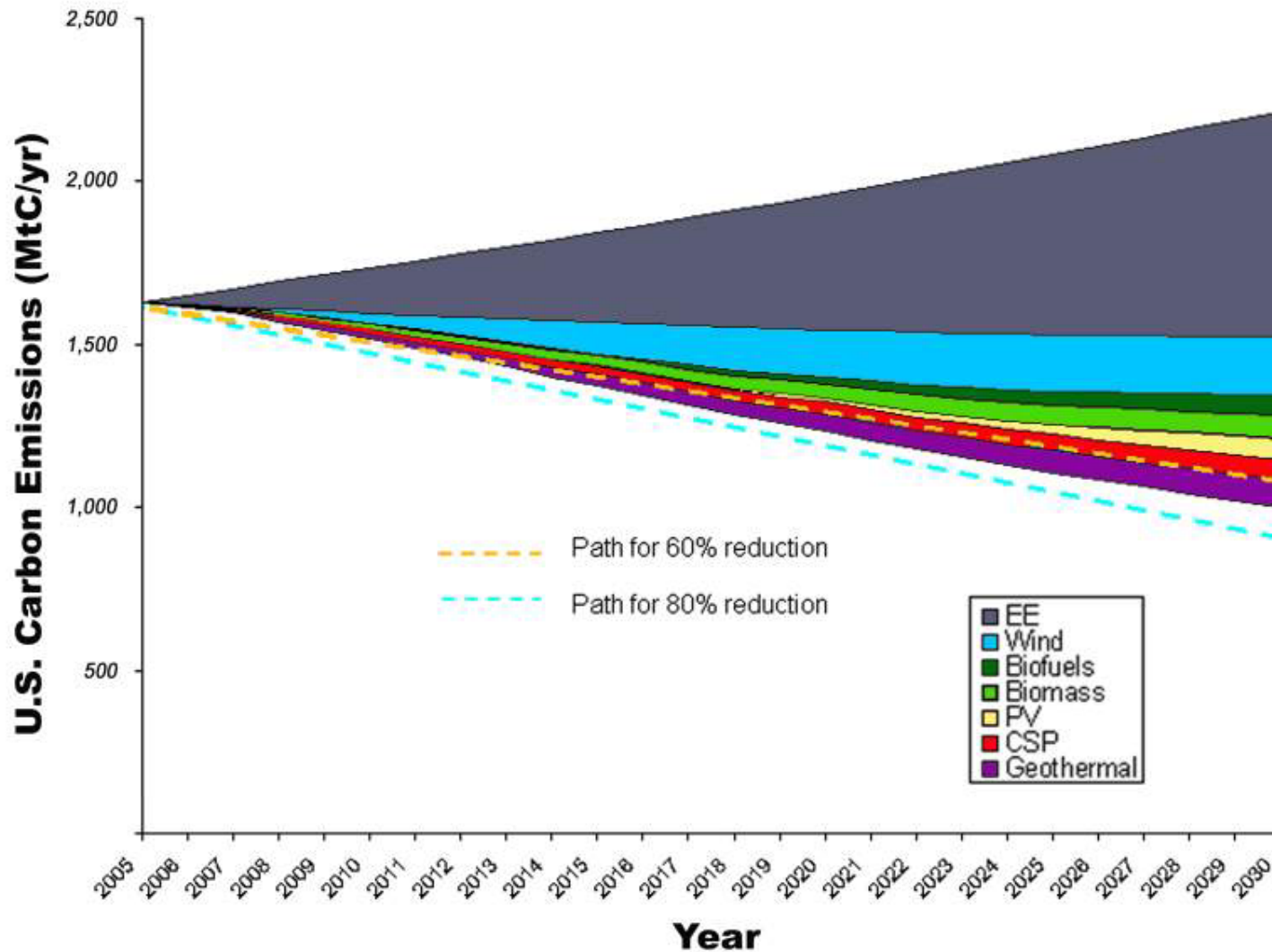
Tackling Climate Change in US

- NREL papers commissioned by ASES and the Sierra Club released in Feb 2007
- Ability to achieve emission cuts between 60 - 80% of current levels thru energy efficiency and renewable energy options
- Two scenarios thru 2030 and 2050

www.ases.org

- continued -

U.S. Carbon Emissions Displacement Potential from Energy Efficiency and Renewable Energy by 2030



57% Energy Efficiency, 43% Renewables

ASES Study (continued)

CARBON OFFSET CONTRIBUTIONS (in MtC/yr in 2030)

(based on middle range of carbon conversions)

- Energy efficiency 688
- Concentrating solar power 63
- Photovoltaics 63
- Wind 181
- Biofuels 58
- Biomass 75
- Geothermal 83

U.S. Renewable Electricity Generation in 2030

<u>Technology</u>	<u>Percent of Grid Energy in 2030</u>
Concentrating Solar Power*	7
Photovoltaics	7
Wind	20
Biomass*	8
Geothermal*	9
Total	51

ENERGY (r)evolution

- January 2007 - Greenpeace/EREC commissioned DLR (German NASA)
- Economically feasible to cut global CO2 by 50% within the next 43 years
- Massive utilization of energy efficiency
- Massive uptake in renewable energy in all areas - transp, bdgs, gen, indust, ag

www.greenpeace.org

Multiple Benefits: Local Picture

- Distributed generation - near the users
- Power quality - no surges, sags, transients
- Power reliability - back-up - augmentation
- Dedicated to uniquely high energy rates
expressed in demand charges, peak
power and ratchet rates
- Lower noise, emissions, waste streams

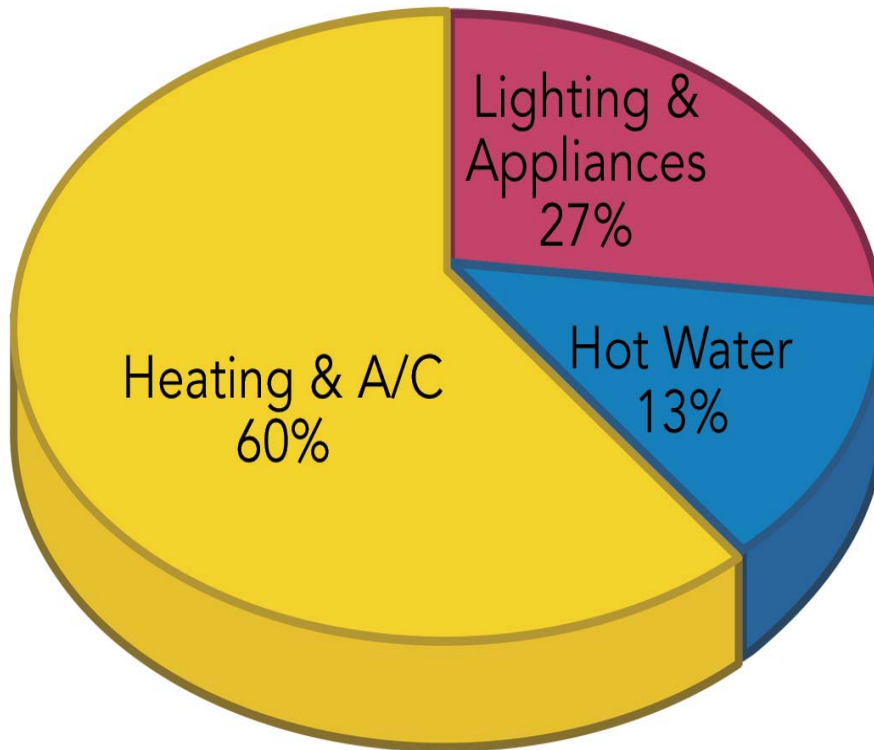
"All companies have a duty to provide shareholders with more analysis and disclosure on climate risks and their strategies for managing or mitigating those risks," said Dr. Julie Fox Gorte, vice president and chief social investment strategist at Calvert.

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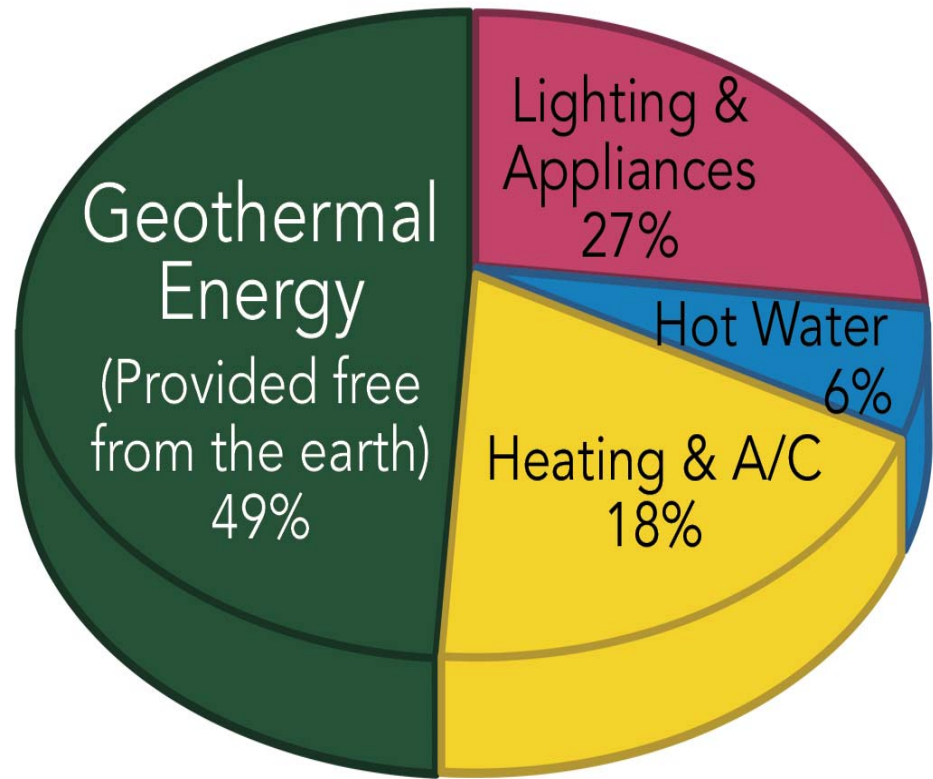
Residential Site Energy Conventional System



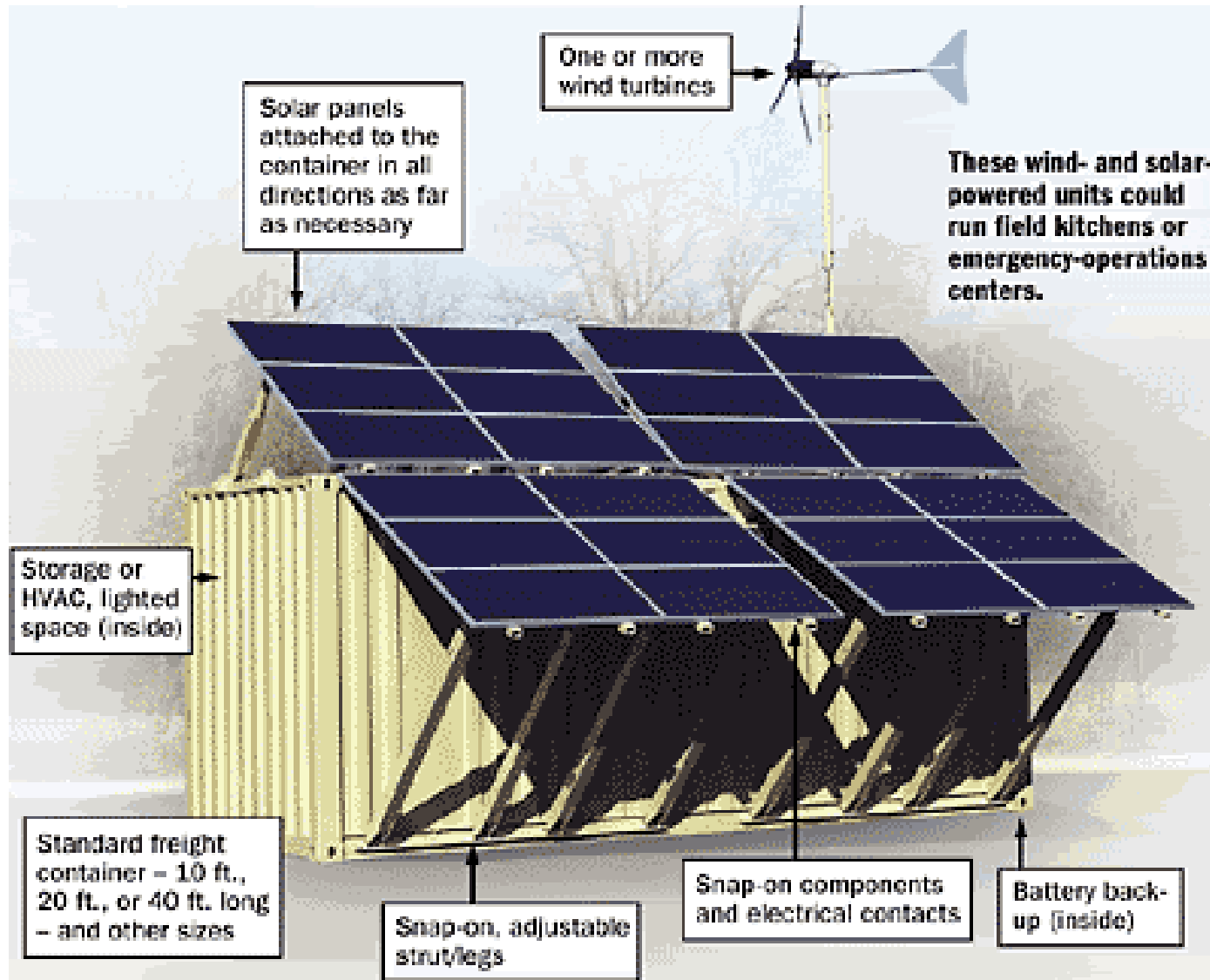
Over 70% of the energy consumed by a typical home is used for heating, cooling, and water heating

Residential Site Energy Geothermal Heat Pump System

**Total site energy
consumption is
reduced by 50%**



'Plop and drop' power center



On-Site Generation Utilization List

- **Battery Bank Augmentation or Displacement** — Adding length of back-up power to traditional battery banks
- **Battery Charging** small electronics
- lap tops, radios, computers, walkietalkies — Small power (under 250 watts)
- **Dedicated circuits** for critical functions in buildings



On-Site Generation Utilization List

- **Communications** —Solar and wind-driven WiFi, cellular, field radios, AM radio, and networks
- **Uninterruptible Power System (UPS)** — A portfolio of distributed generation devices which range from 1 kW to 250 kW, on skids, and standardized. Some systems can be leased.







PV Nanotechnology - Light Sensitive Dyes

Conclusions

- Energy efficiency can negate emissions growth
- Renewables can provide significant deep cuts in emissions
- The world is blessed with abundant renewable resources spread throughout the globe - with decentralized applications having the greatest near term impact and larger, centralized applications having longer term benefits
- Renewables can provide $\sim 1/2$ of global energy; remaining split about evenly among the renewable resources
- EE and RE can begin **today** to tackle global warming
- Continued R&D and policy support will help these technologies achieve their large future potential, tied to aggressive tax and tariff policies