



Cisco Smart Grid

The Challenge of Renewables

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Renewable Energy Resources



Renewable Challenges:

- Variability
- Dispatch and Balancing
- Power Quality

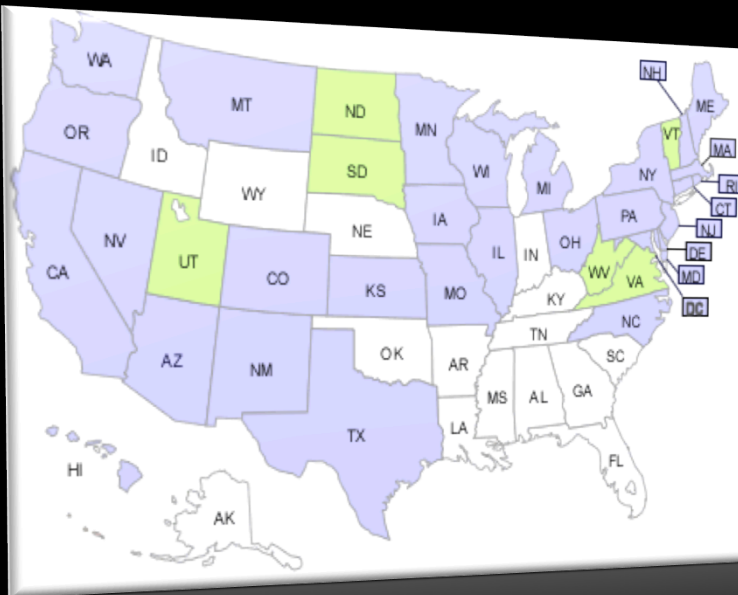
Managing Environmental Impacts

- Monitoring emissions
- Tracking renewable energy production
- Compliance with renewable portfolio standards
- Participate in CO2 Cap & Trade Markets



Environmental Policy Drivers

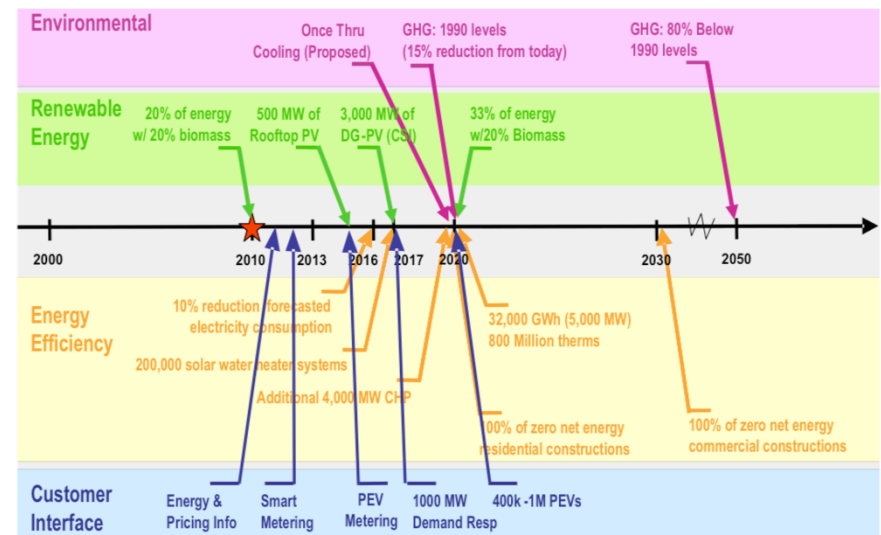
States are Moving Forward Irrespective of National Policy



35 States have either Renewable Portfolio Standard (RPS) or Renewable Portfolio Goal (RPG)

27 States have Energy Efficiency Resource Standards.

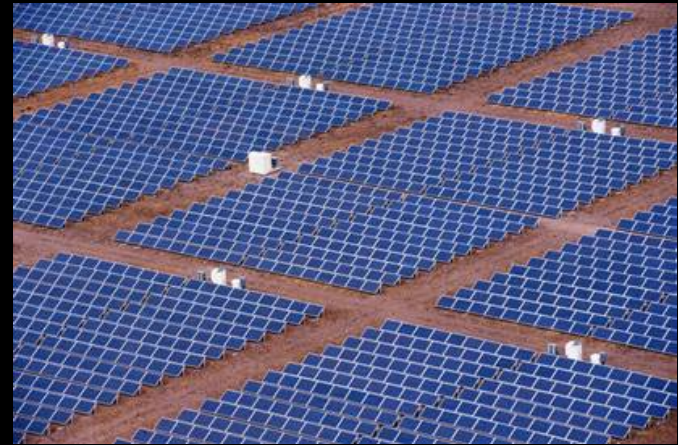
California policies are the most aggressive but many states incl Ohio have pursued similar broad policies



Source: SCE

Renewables Interconnect

- Transmission
 - Megawatts
 - SCADA control
 - Large scale storage
- Distribution
 - Fractional megawatts
 - Standby generation or Co-gen
- At the Premise
 - Kilowatts
 - No visibility, no control
 - Premise scale storage



Solar Parking Lot



Residential Energy Resources



Distributed Energy Examples:
Electric vehicles
Solar and Wind

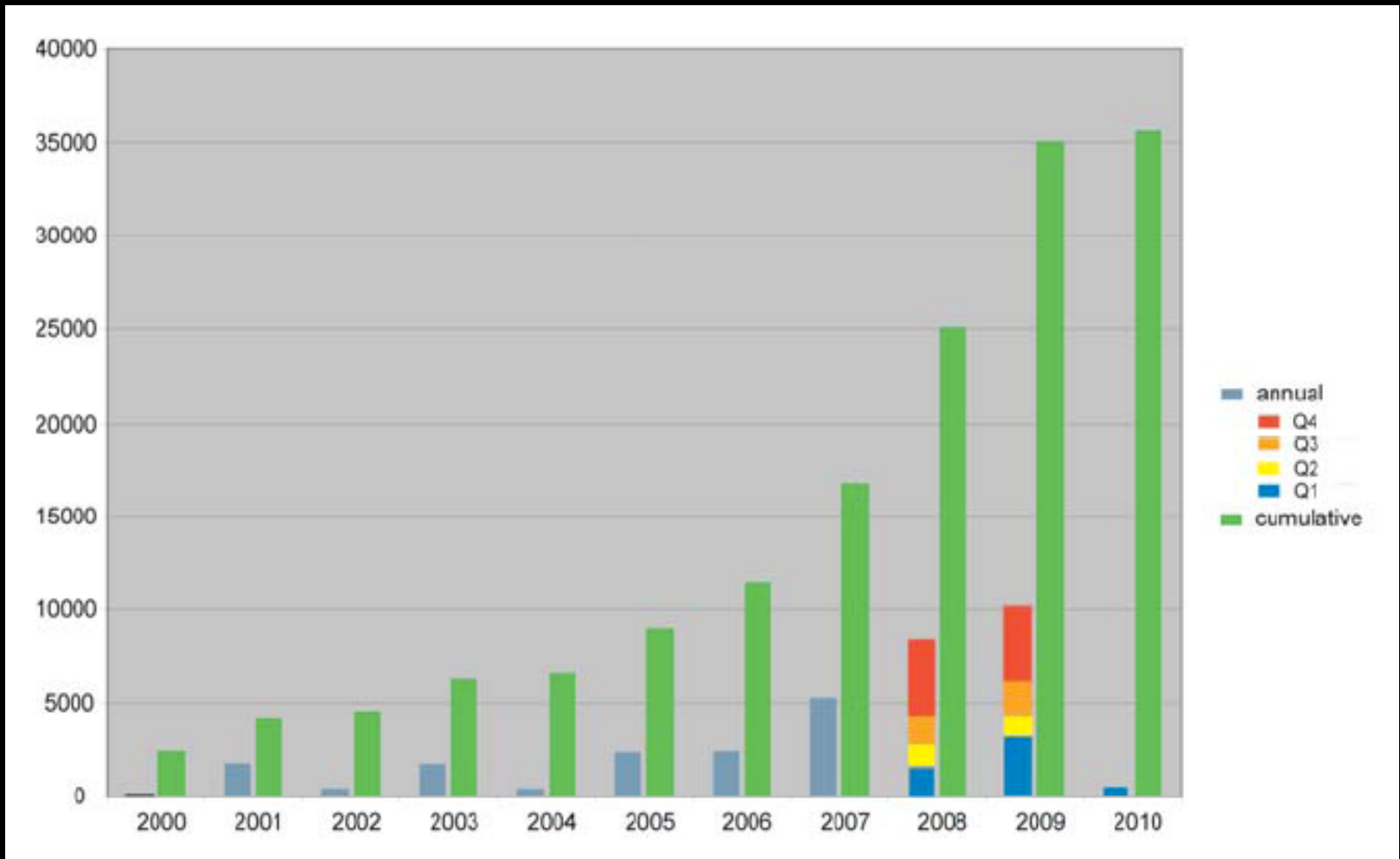
Distributed Energy Challenges:
How do we cope with
Electric vehicles for peak
residential loads?



What If ?

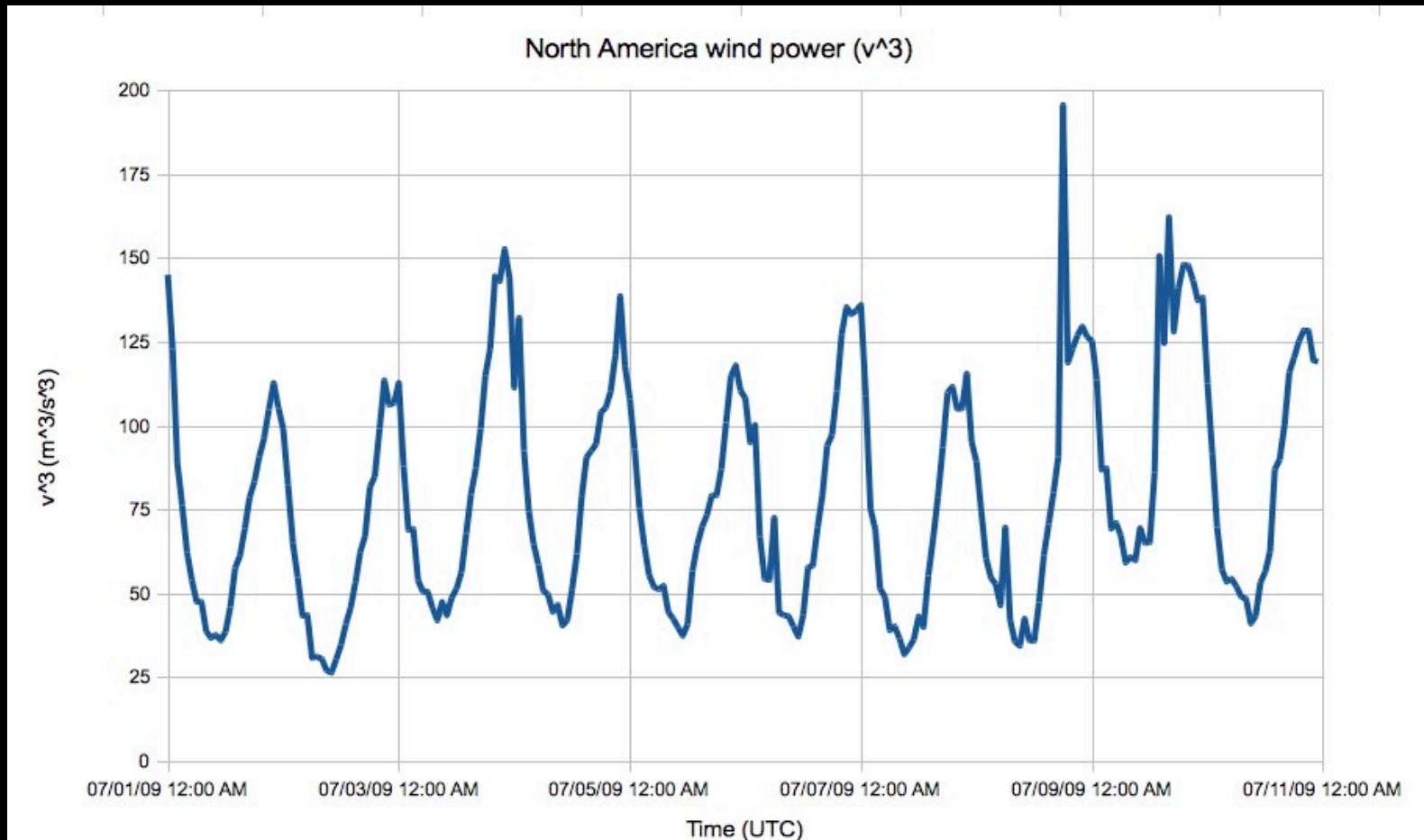


US Cumulative Wind Power



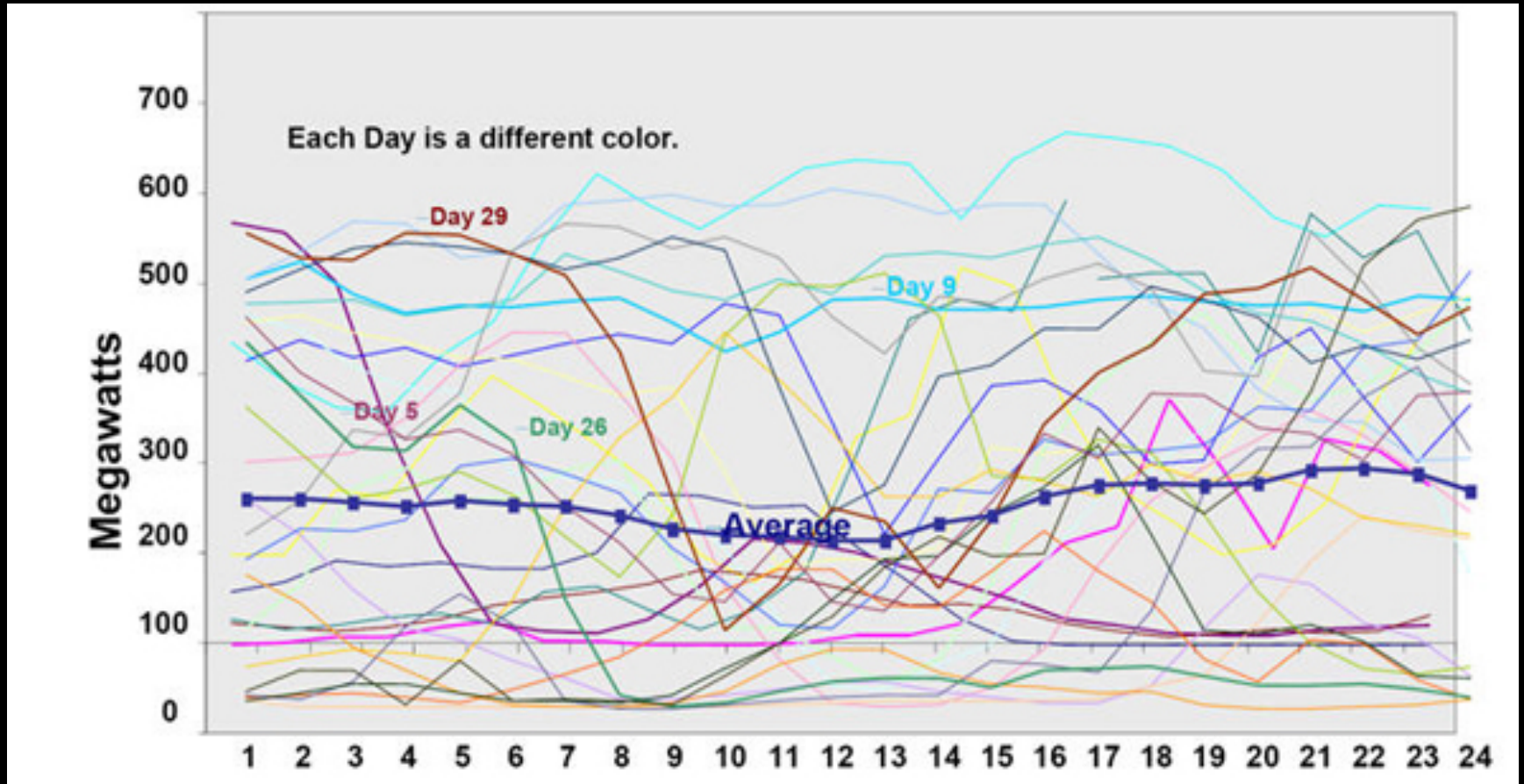
Source: American Wind Energy Association

Wind – Hourly Variation



Source: NOAA METAR

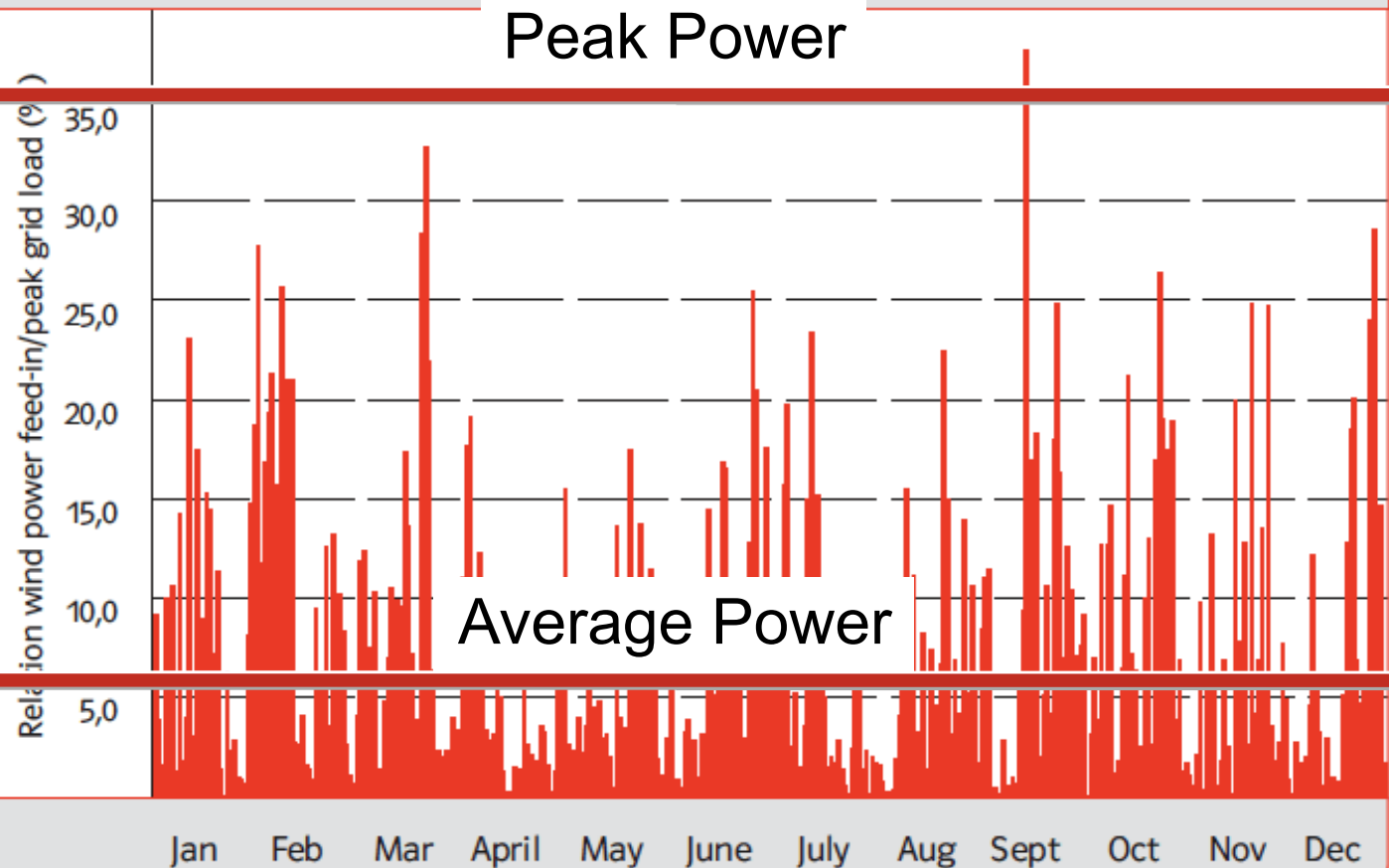
Tehachapi Wind



Wind – Daily Variation

3. Wind power feed-in in the E.ON control area

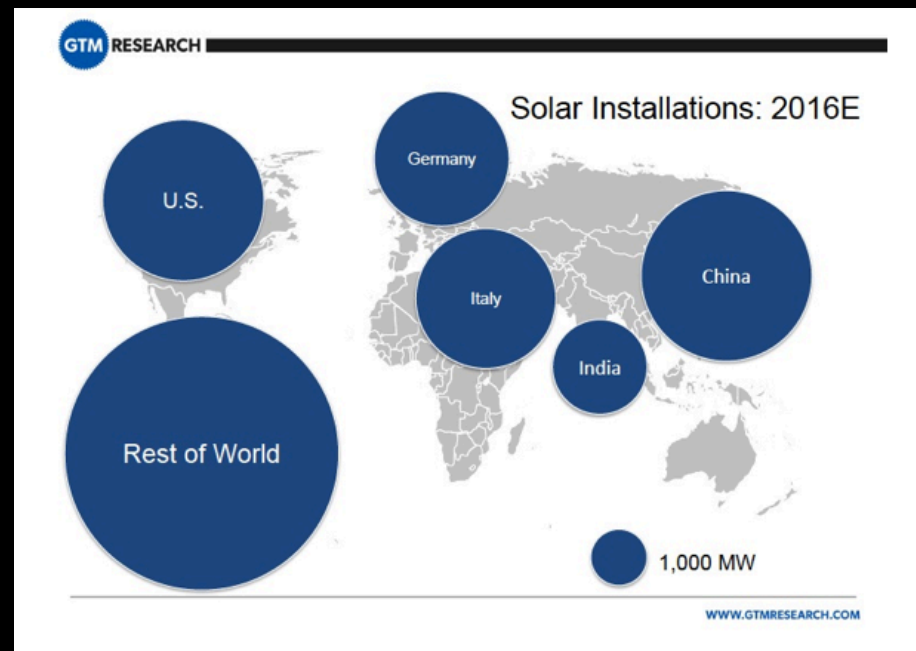
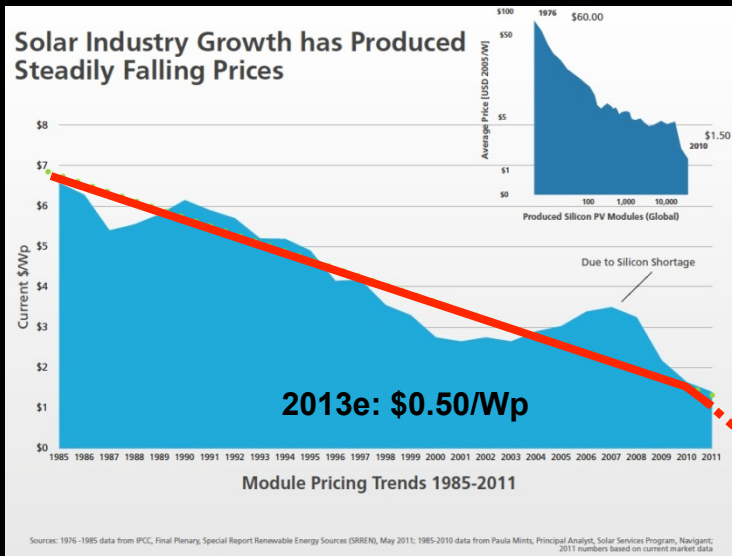
2004 between 0.2 and 38% of daily peak grid load



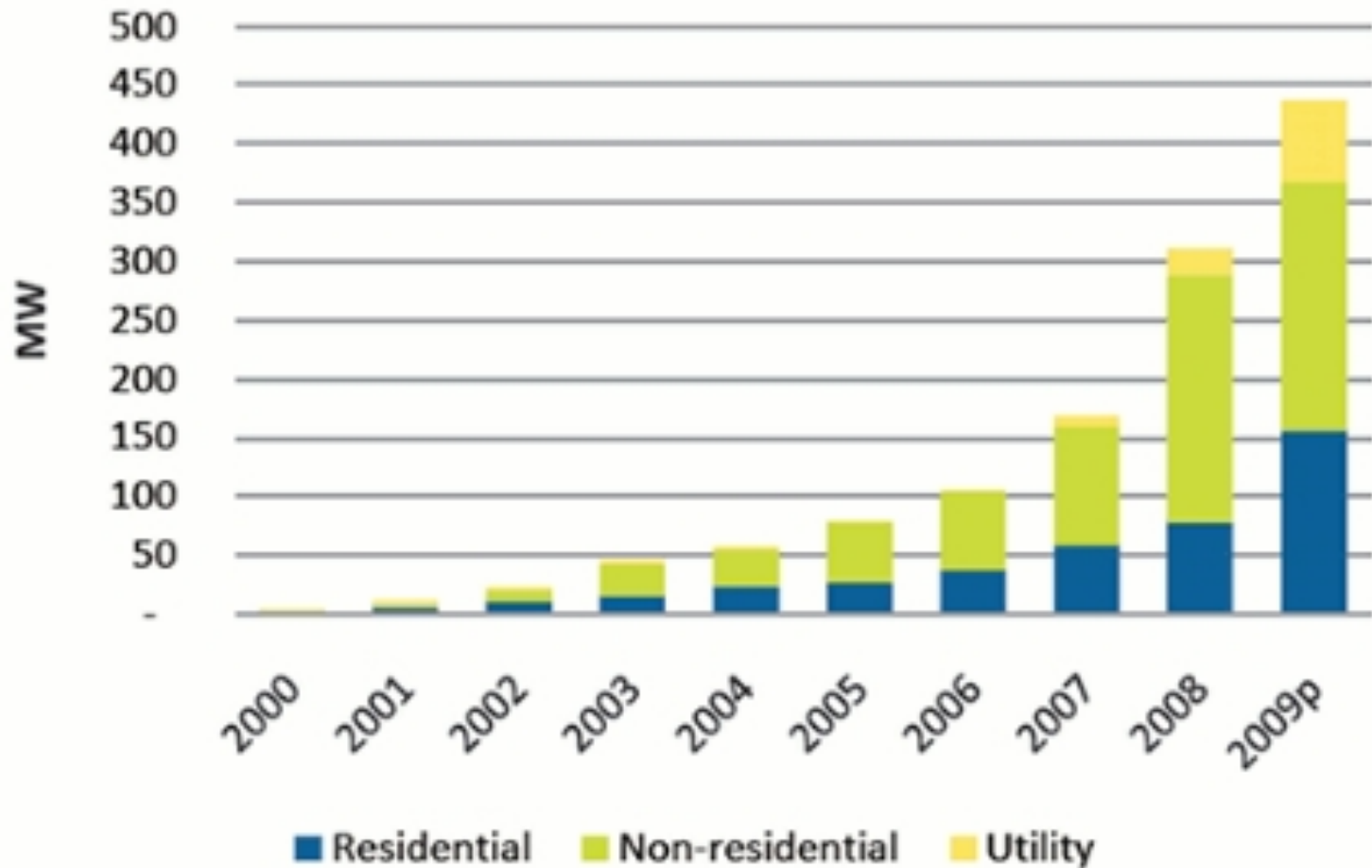
Solar PV is Reaching Retail Parity

"In the last two years, the delivered cost of energy from PV was cut in half. NRG expects the cost to fall in half again in the next two years, which would make solar power less expensive than retail electricity in roughly 20 states"

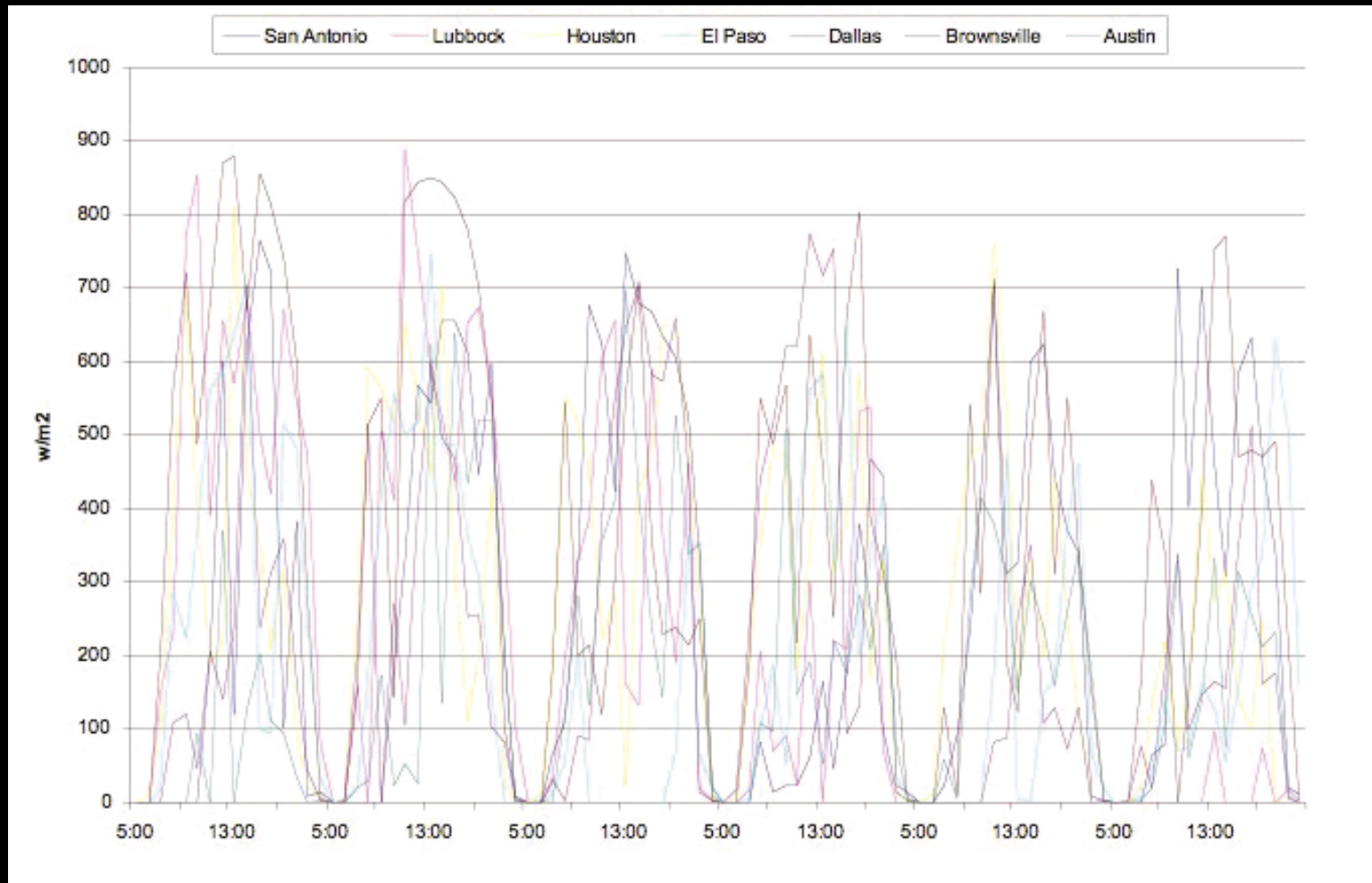
David Crane, CEO NRG Energy Nov. 2011



Annual Grid-Tied PV Capacity Additions

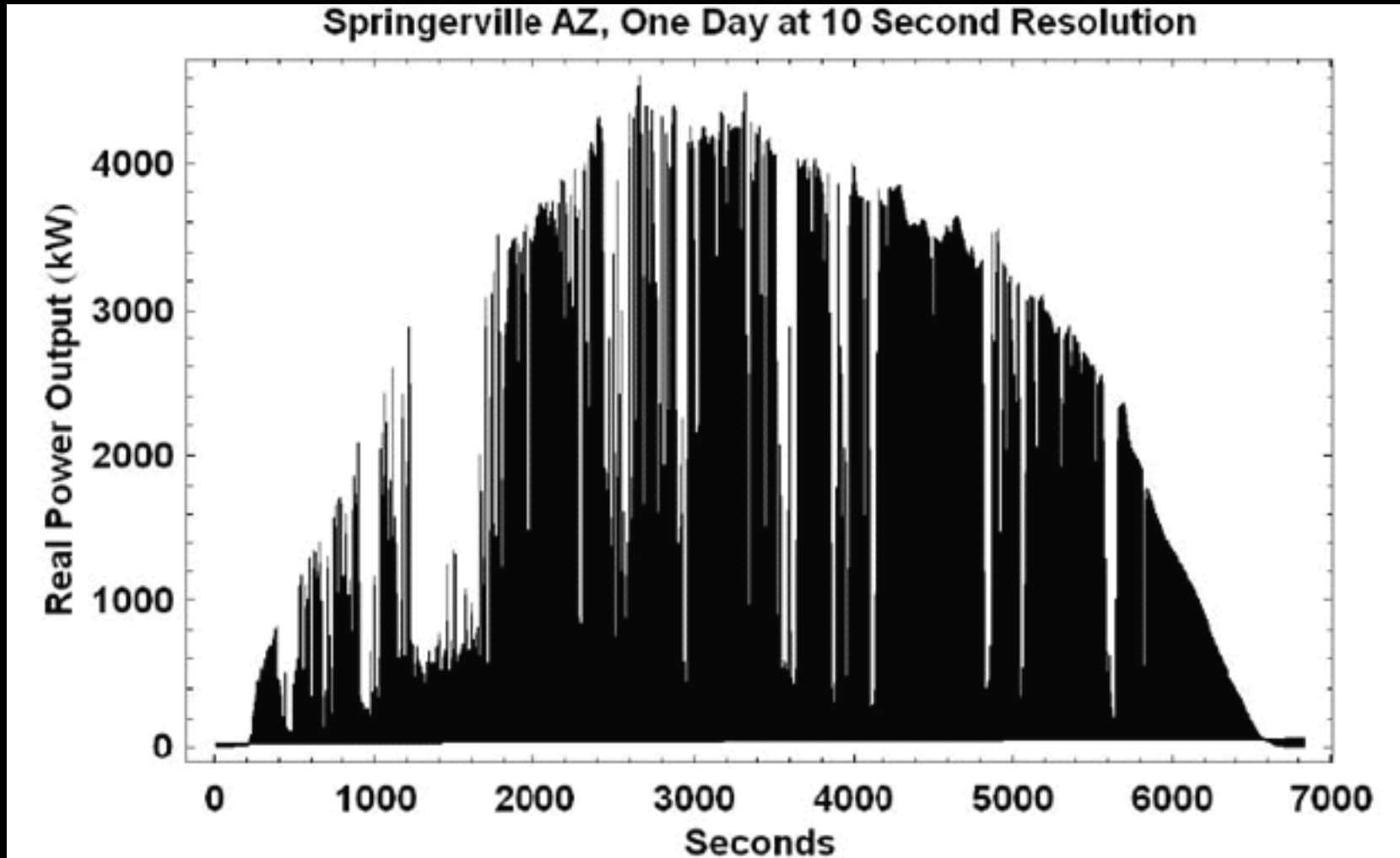


Solar – Hourly Variation



Source: Texas State Energy Conservation Office

Solar Short Term Variability





DISPATCH AND BALANCING

“Open Loop” Electric Power Supply

- 131 Balancing Authorities (ref: NERC)
- 24 Hour advance forecast – minute by minute
 - Estimated by on history and weather forecast
- Dispatch Plan
 - Buy/Sell base load
 - Buy/Sell & Schedule margin, peaking generation
 - Buy/Sell spinning reserve

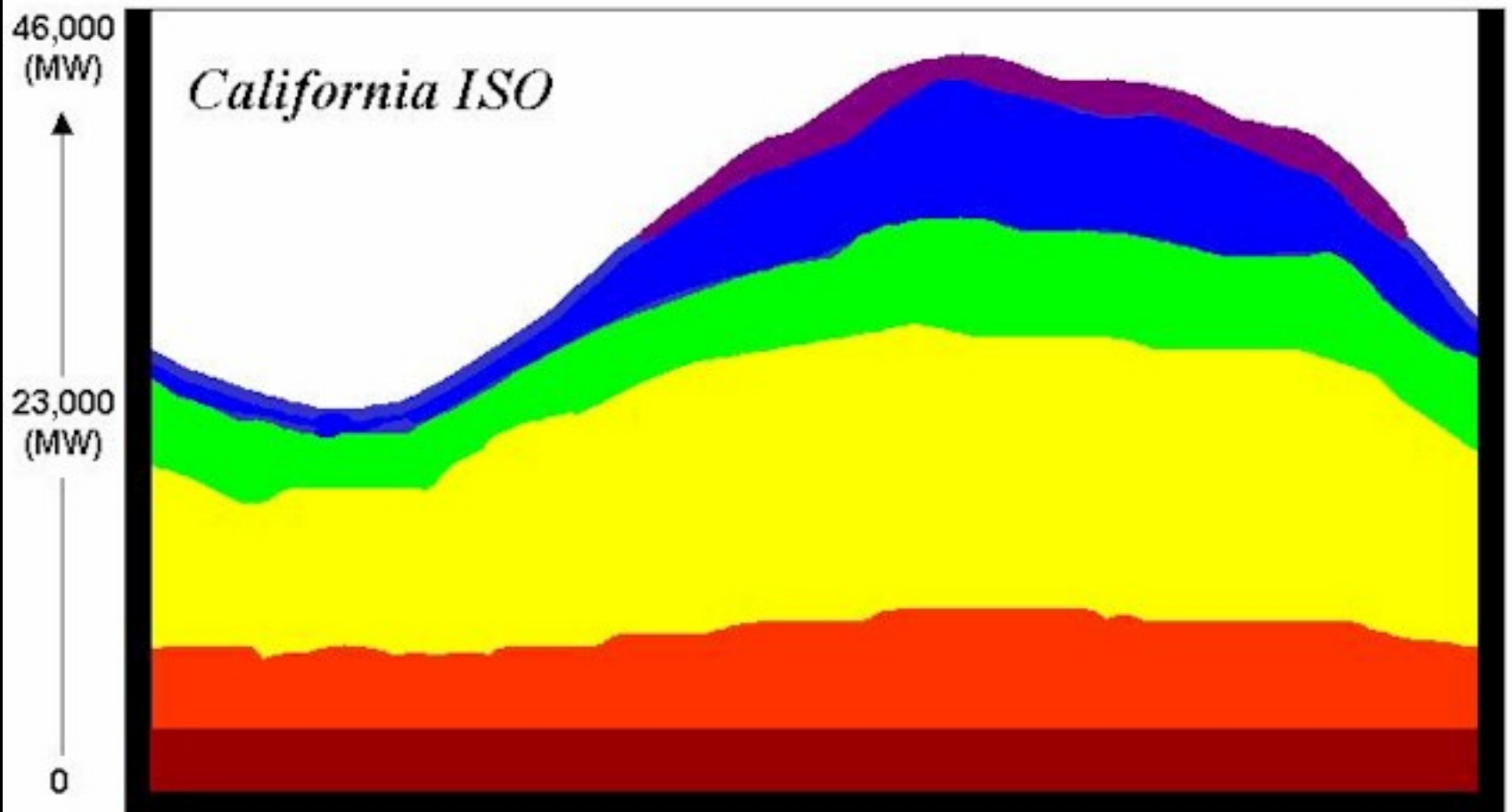


Generation Dispatch Load Balancing

- Historic Usage
- Weather Forecast
- Wind Forecast
- Maintenance Schedules
- Day Ahead Pricing
- 24 Hour Forecast, minute by minute, buy/sell
 - Base Load, Variable Load, Peaking Generation, Spinning Reserve
- Hour Ahead – presented 75 Minutes prior
- 5 minutes ahead

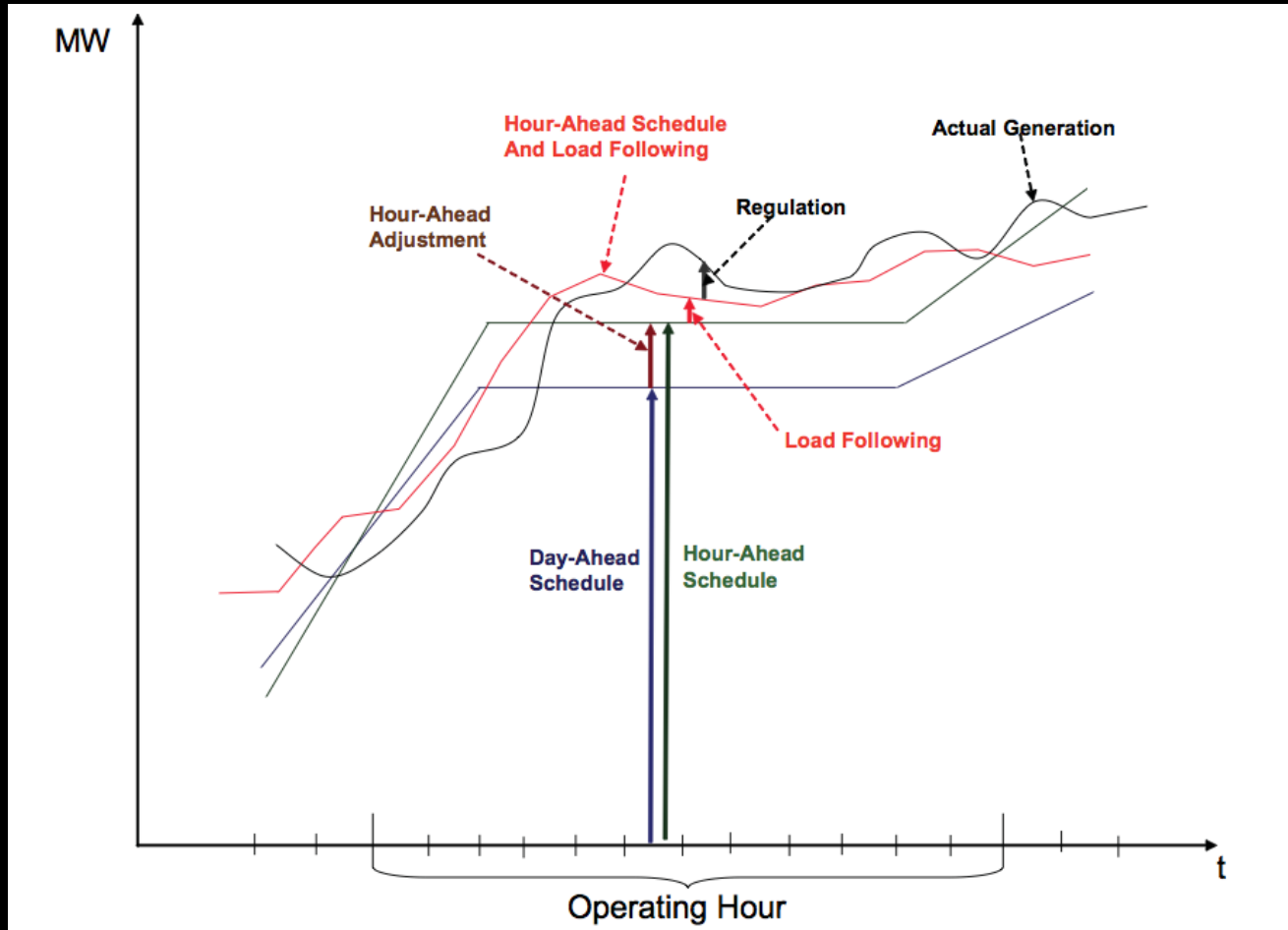
2000 PEAK DAY RESOURCE SUMMARY

(Wednesday, August 18, 2000)



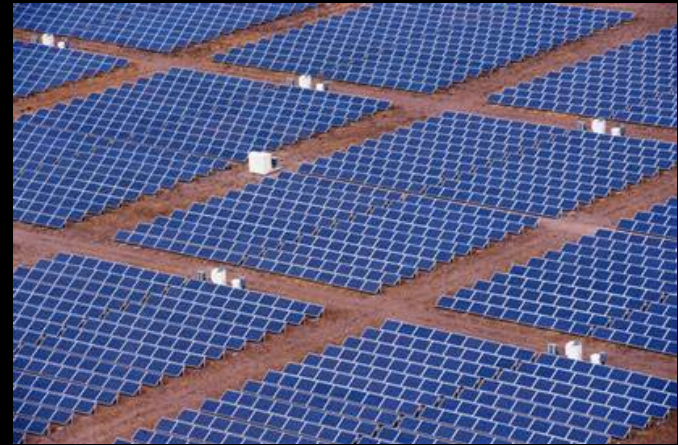
■ Nuclear ■ QF ■ Thermal ■ Imports ■ Hydro ■ Peaking

Cal ISO Hour Ahead Generation Scheduling



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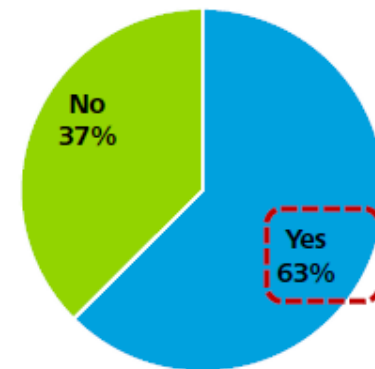


Plug-in Electric Vehicles

Forecasts range from 2% to 20% of new vehicle sales by 2020

- Research by EPRI and several utilities indicates the need to upgrade 4kv to higher distribution voltage and replace 25kVA transformers to 50kVA
- Early adoption areas tend to be in affluent neighborhoods that have high degree of existing hybrid vehicle ownership
- EV residential charging and separate metering infrastructure installation processes can average 45 days

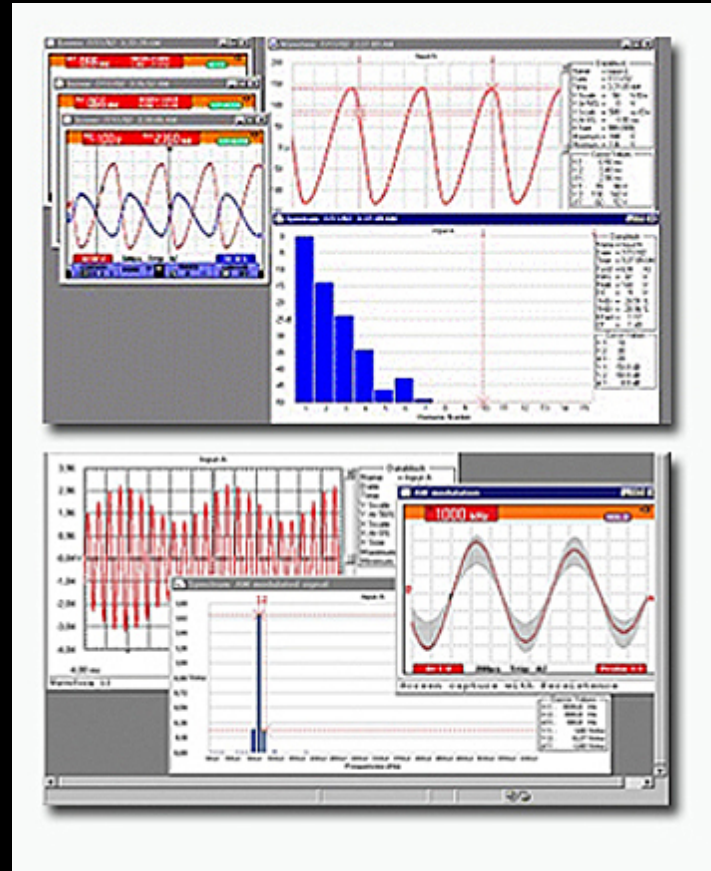
Question: Are you concerned about the capacity and reliability of your local utility to support electric vehicle charging?



Source: Deloitte



For the first time a load will (should?) ask if capacity is available.



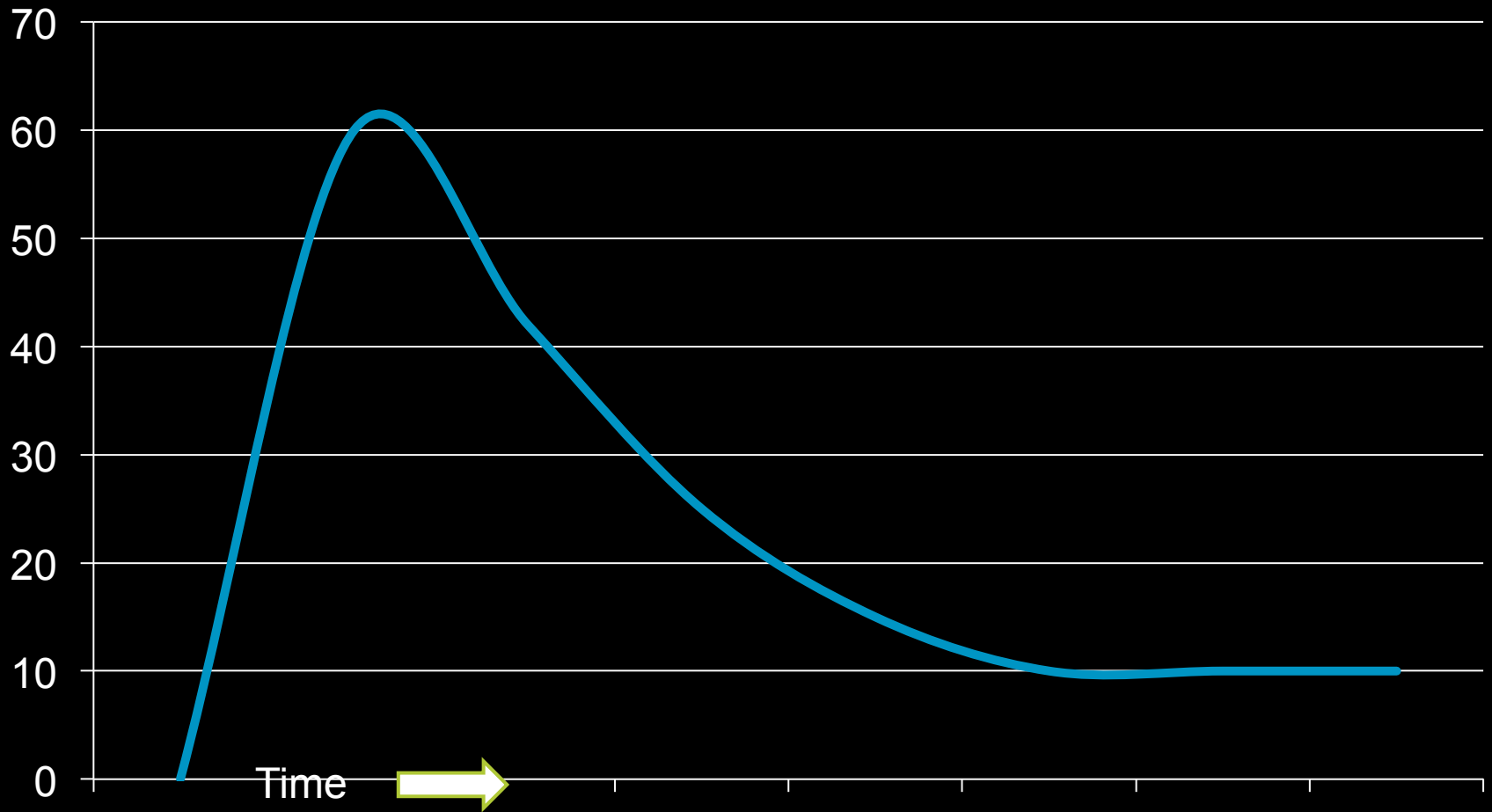
POWER QUALITY

Power Quality

- Volt/VAR control
- Capacitor Bank Switching
- Static Compensators
- Frequency Control
- Harmonics
- Damping Factor



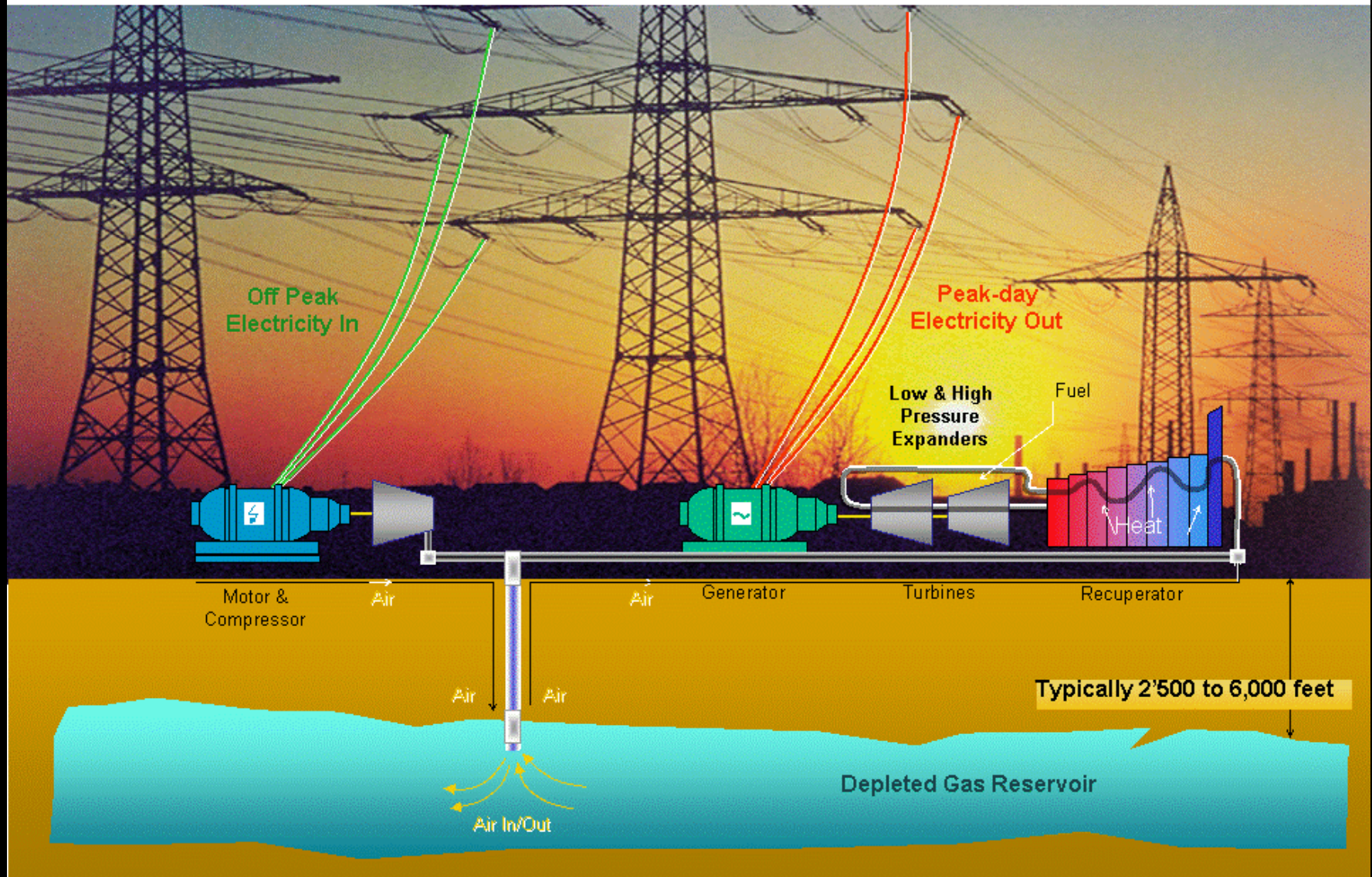
Motor Startup Current Approx 6X Running Current



Pumped Water Storage



Compressed Air Energy Storage



Electric Power Storage

- Generation Scale Storage

Pumped Water, Compressed Air, Sodium-Sulfur Batteries

Research: Fuel Cells, Flywheel, Battery, Ice, Molten salt, ultra capacitors, Flow Batteries, Electrolysis Hydrogen, etc.

- Business/Residential

Batteries

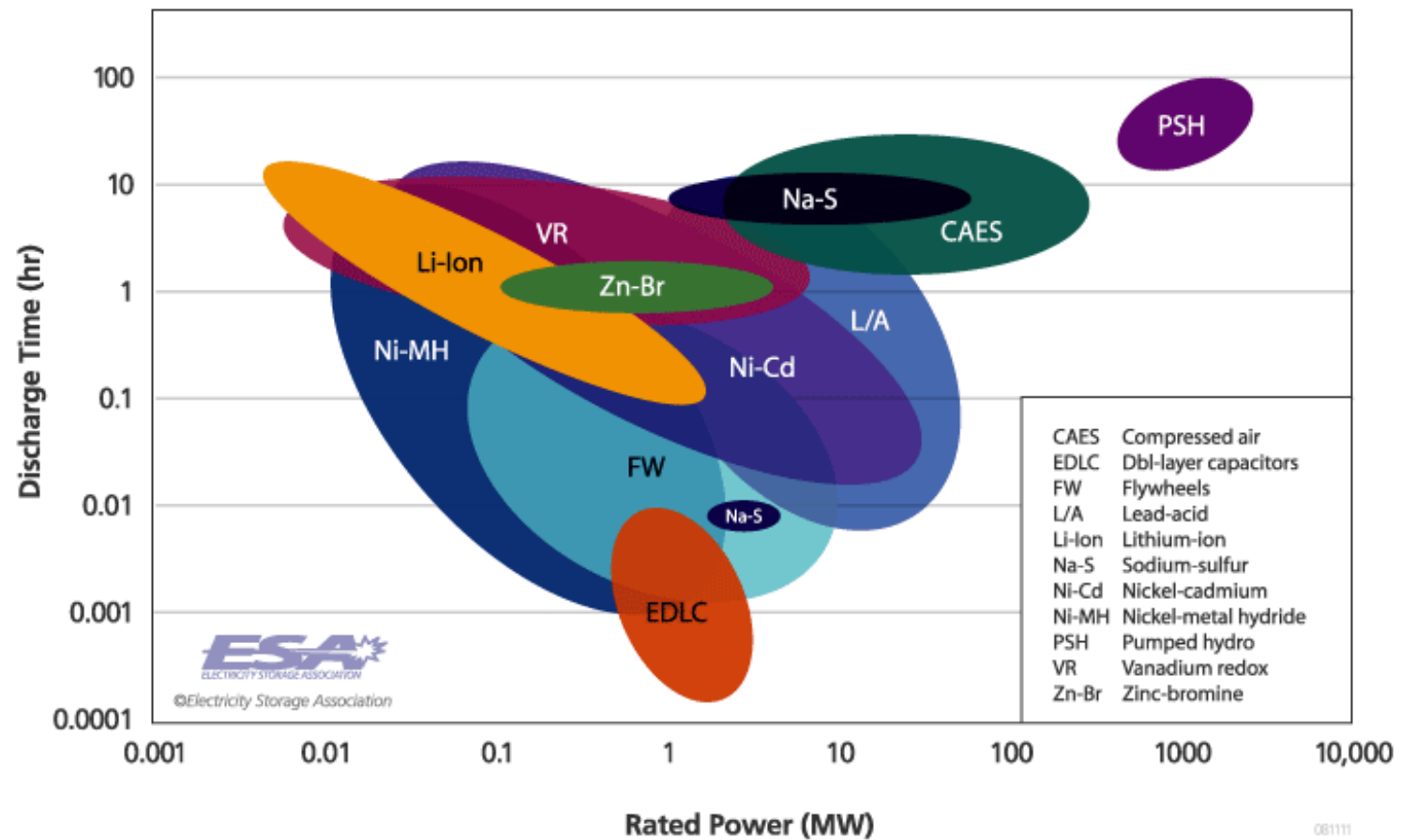
What About
Electric Vehicles ?



Electric Power Storage

System Ratings

Installed systems as of November 2008



Resources

- “Integration of Renewable Resources”, Cal ISO, 2007
- Dept of Energy, Energy Information Administration
- IEEE Power & Energy Society
- American Wind Energy Association
- Solar Energy Industries Association
- Carnegie Mellon Electricity Industry Center



CISCO