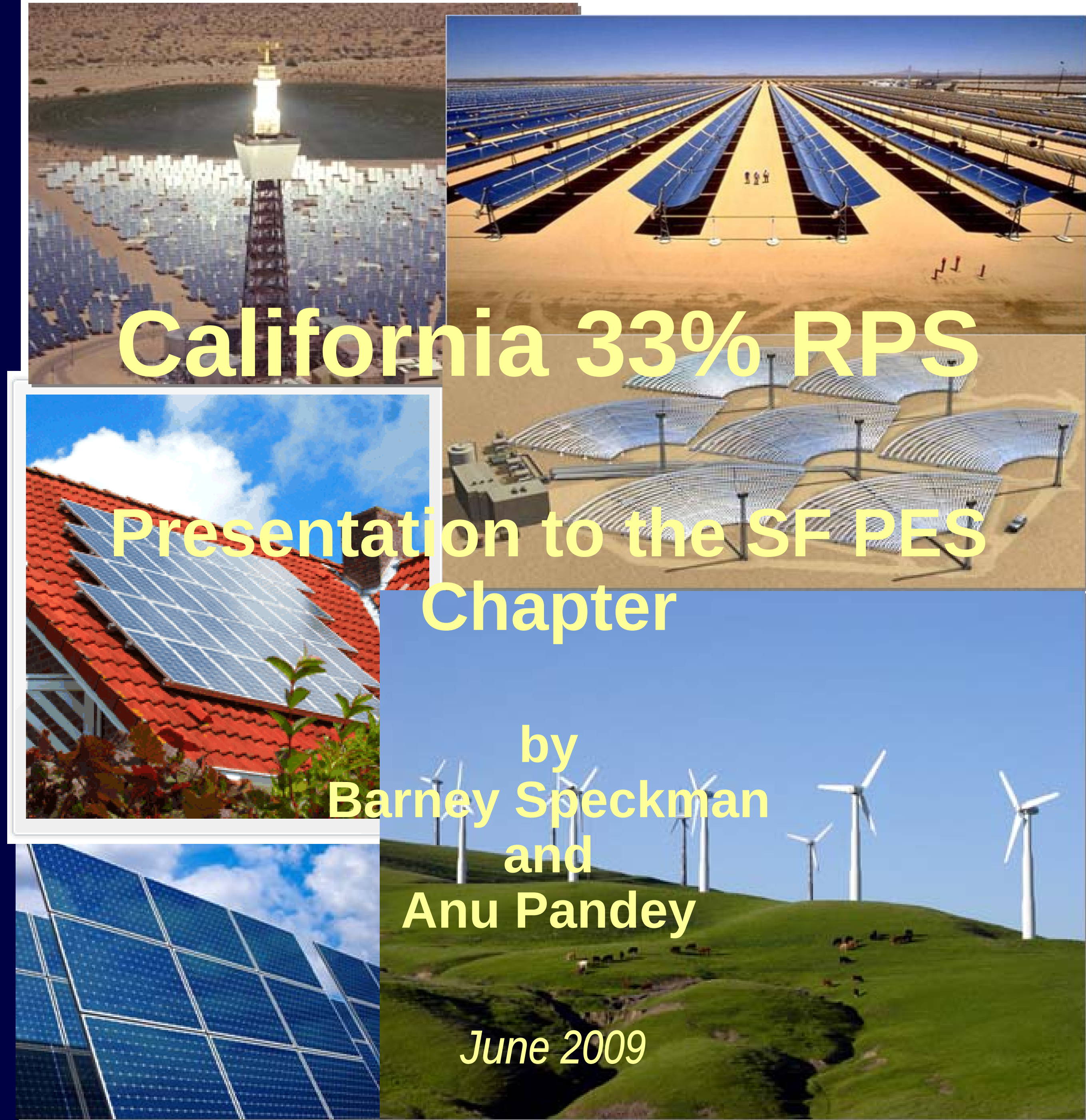
California 33% RPS

Presentation to the SF PES Chapter



by
Barney Speckman
and
Anu Pandey

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Nexant
Energy Solutions

Overview

- What is the 33% Renewable Portfolio Standard (RPS)
- How would it work
- How might the 33% RPS requirements be met
- What are some of the challenges
- What are the opportunities
- Q&A

What is the 33% RPS

- **AB 32 (2006) Requires California to reduce GHG emissions to 1990 levels by 2020**
- **California Air Resources Board (CARB) has been assigned task of developing a plan to implement AB 32**
- **CARB's proposed plan includes establishing a 33% Renewable Portfolio Standard for the California electric industry**
- **Currently a mandatory 20% RPS (by 2010) is in place for the states investor owned utilities (PG&E, SCE, SDG&E) with many Municipal Utilities voluntarily implementing RPS targets**

How would it work

- Would require 33% of the amount of energy sold to customers to be produced by eligible renewable resources
- Applies to all companies selling energy at retail in CA
- Sets 2020 as date to meet the 33% Standard
- Establishes penalties for non compliance
- Legislation being discussed in Sacramento

How might the 33% RPS be met

No none knows for certain!!!

- **Many degrees of freedom in the implementation thus many uncertainties will have to be dealt with**
- **What technologies will utilized?**
- **Where, when and what plants will be built?**
- **How will the power be delivered to customers?**
- **What other infrastructure will be needed?**

Several studies have/are being conducted

Possible 33% Renewable Futures

- **Recent CPUC study used to consider several possible futures as a way to bracket the future implementation of the 33% RPS**
- **Examines cost, difficulty, GHG reductions for several mixes of technology and infrastructure requirements**
- **Looks at:**
  - 33% Reference
  - High Wind
  - High Imports
  - High Distributed Generation

Possible 33% Futures (Cont'd)

- **Energy and Capacity Requirements based upon CPUC Forecast compared to 2007**

Renewable Portfolio Standard	Additional Energy Required	Additional Renewable Capacity Required (Approx)
20% RPS	35 TWh	10,000 MWs
33% RPS	75 TWh	22,000 MWs

2007 Renewable Energy was 27 TWh

TWh = 10^{12} Watt-hours

Lets Look at the Technologies in California

- **Major contributors (potentially) to new production**
  - Wind
  - Solar Thermal
  - Solar PV
  - Geothermal
- **Lesser contributors to new production**
  - Biomass
  - Biogas
  - Small Hydro
- **Majority of new renewables in California are in Southern part of the state**

New Renewable Additions Under CPUC Cases

	High Out Of State Delivered	High Wind	Distributed Generation
California			
Biogas	279	279	279
Biomass	575	634	403
Geothermal	1,655	1,655	1,415
Solar PV	969	1,162	**15,068**
Solar Thermal	2,101	3,163	1,095
Wind	5,756	**9,575**	4,484
Sub Total	11,357	16490	22,766
Out of State			
Biomass	87	87	87
Geothermal	938	58	58
Solar Thermal	534	534	534
Wind	6,910	**4,802**	3,302
Sub Total	**8,496**	5,496	3,996
Total	19,853	21,986	**26,762**

Nexant Study - Assumed Locations of Incremental Renewables in California - 33% RPS, 2020

Excluded areas with high population density, national parks, landmarks, sensitive areas, etc., to exclude areas not practical for renewable project development

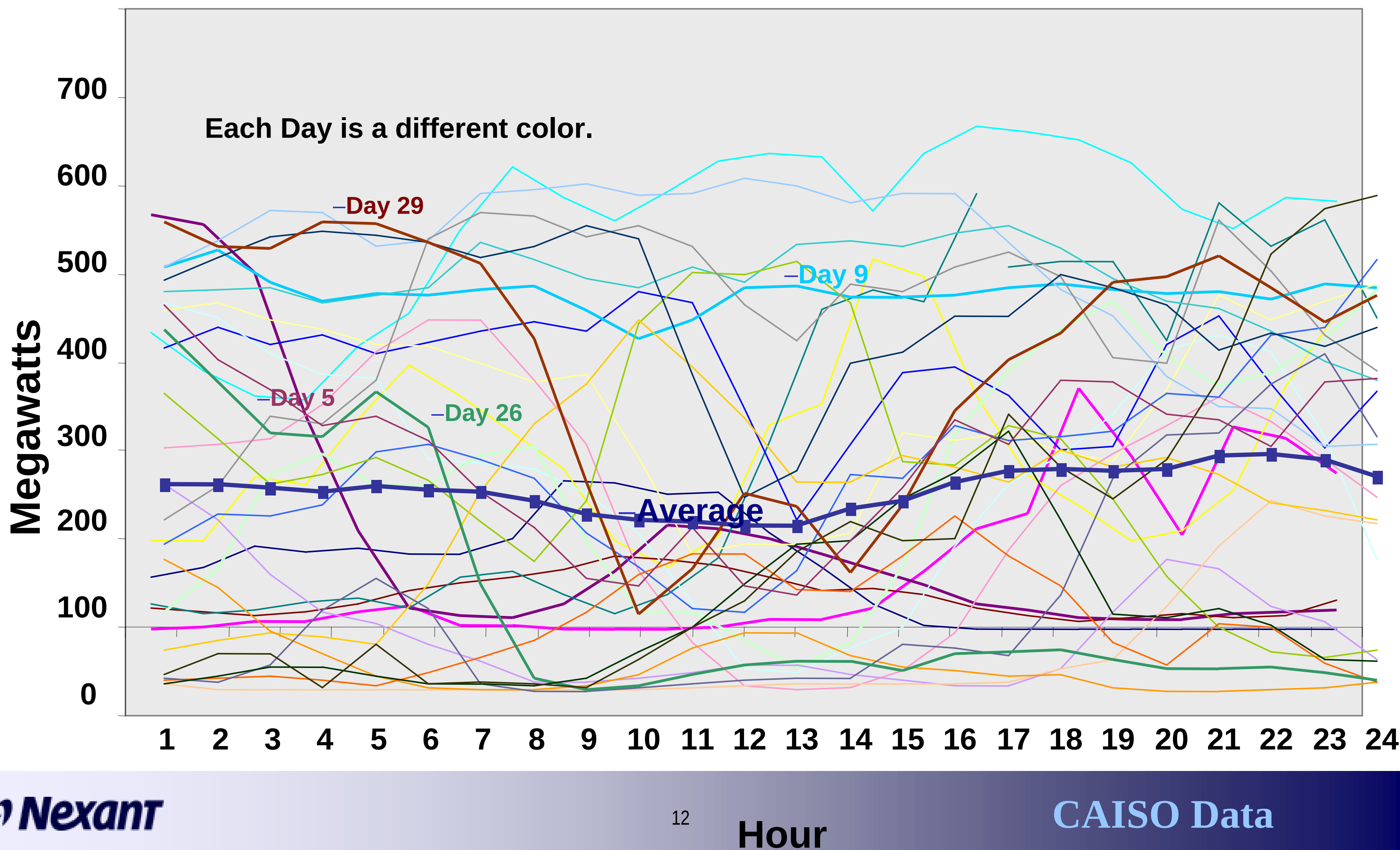
Lets Look at the Technologies in California Wind Generation

Wind Generation Characteristics

- **Low cost technology on an energy basis**
- **Production is**
  - Variable
  - Uncertain
  - Often Remotely Located
  - Not highly correlated in time with system load
- **Capacity credit 10-30% of nameplate for long range planning purposes**

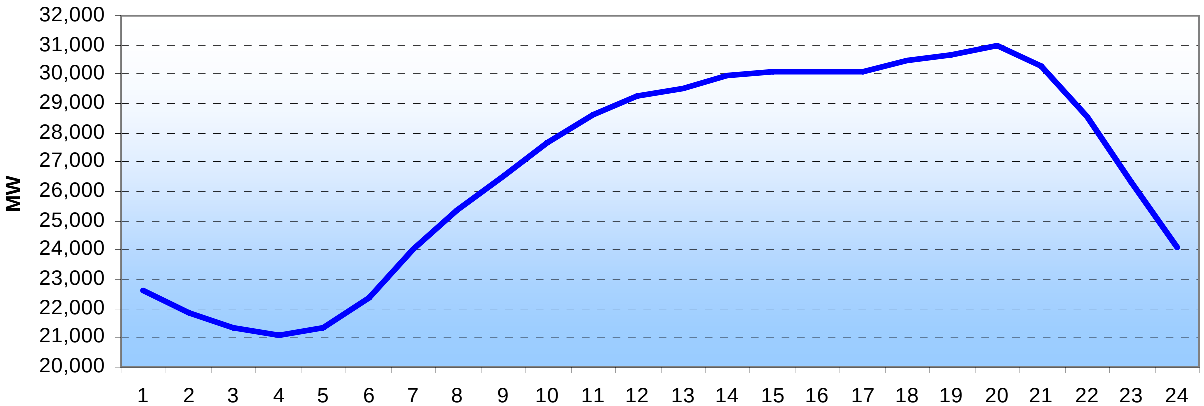
Tehachapi Wind Generation in April – 2005

Variable and Uncertain

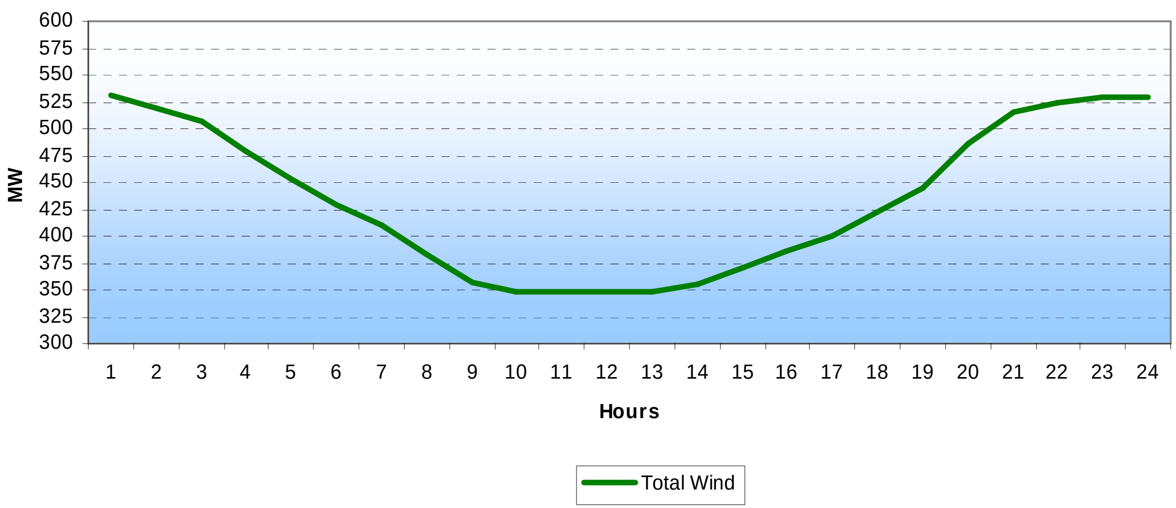


Wind generation tends to be inversely correlated to daily system load

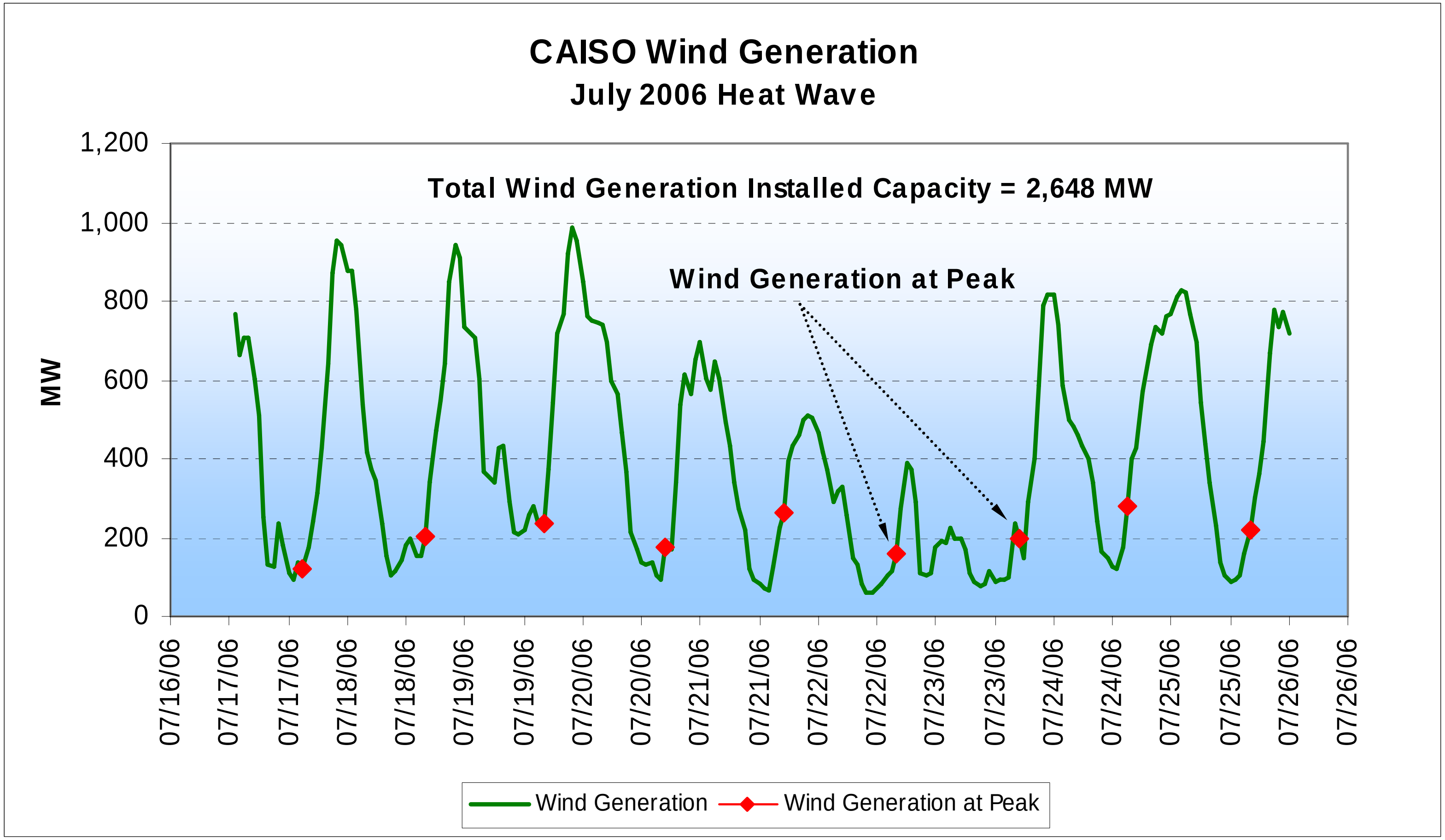
CAISO Load -- Fall 2006



Total Wind -- Fall 2006

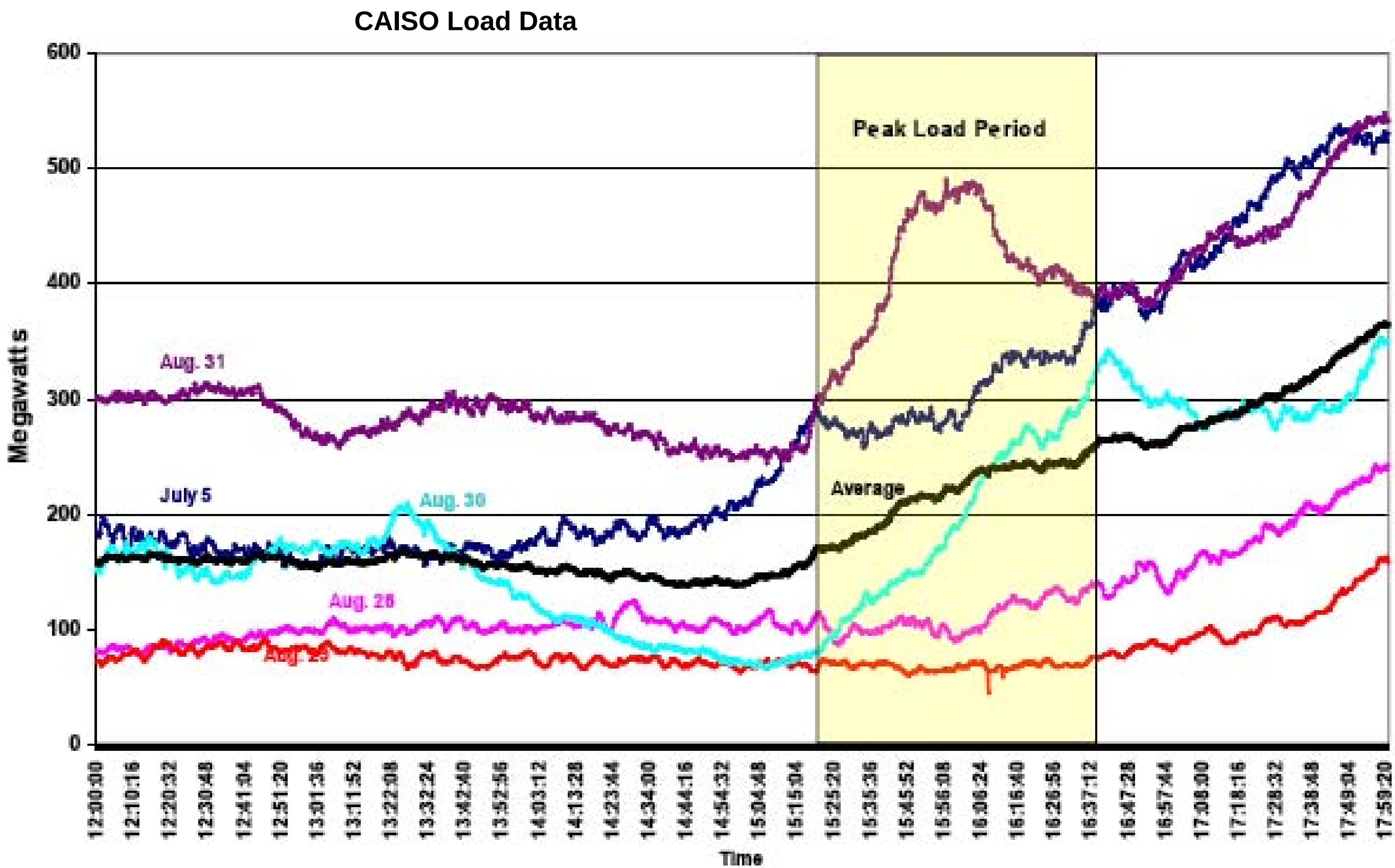


Wind vs. Actual Load on a Typical Hot Day in 2006



CAISO Data

Wind Generation Summer 2007 – 5 Hottest Days



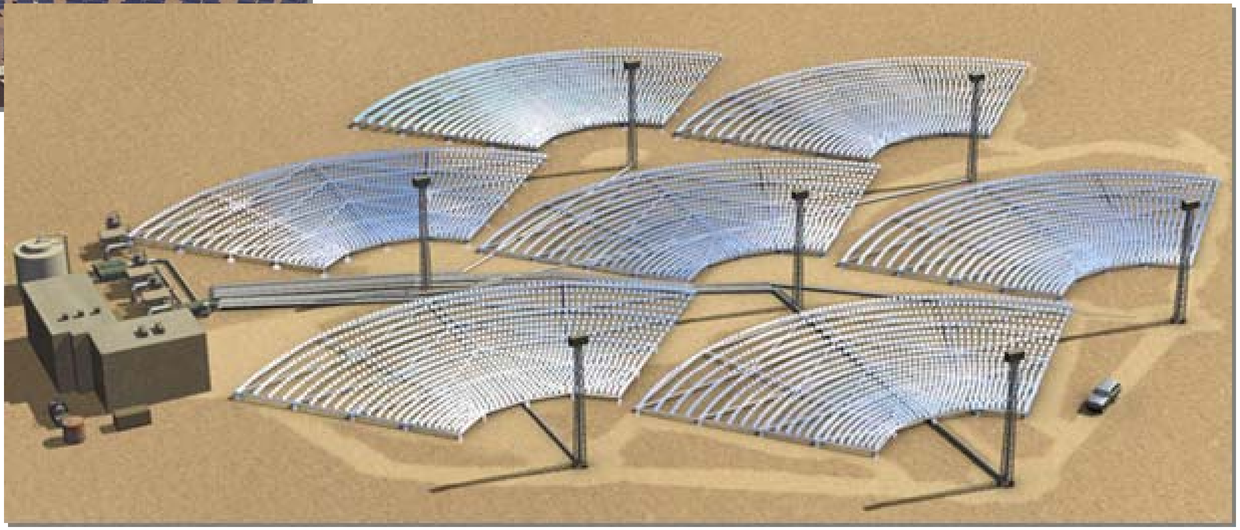
Lets Look at the Technologies in California Solar Characteristics

- **Higher cost on an energy basis**
- **Several technologies**
  - Thermal (central tower, trough, Sterling, etc)
  - Thermal with storage or supplemental gas firing
  - PV roof top
  - PV large scale (> 1MW)
- Insolation is variable but absent clouds relatively certain
- With clouds, production is less certain
- Solar production correlates with system load
- Technologies with larger thermal mass tend to filter out short term variability (e.g solar thermal)
- Solar Capacity Credit 60% – 95% (depending upon technology) for the purpose of long range planning

Lets Look at the Technologies in California Solar Thermal Generation

Trough Design

Solar II Solar Central Receiver



eSolar's Modular Solar Power Plant Concept

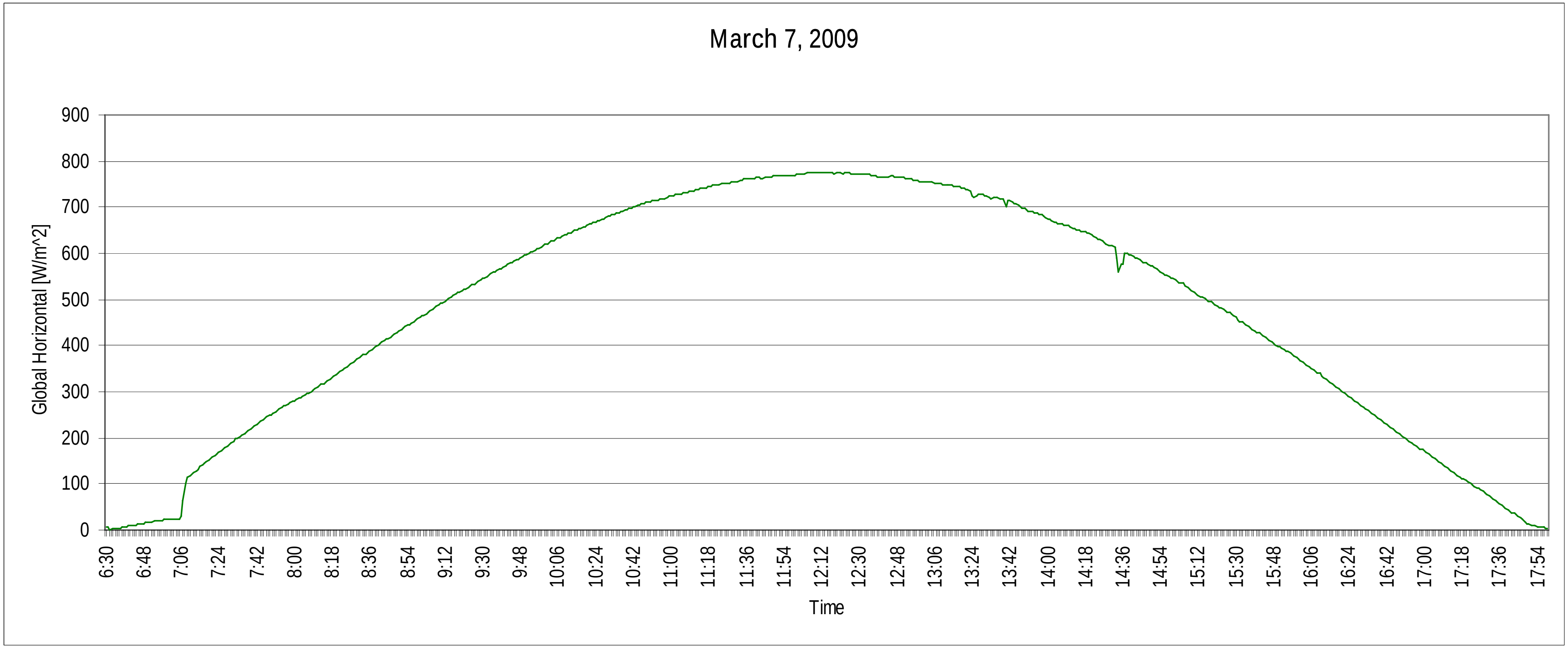
Lets Look at the Technologies in California Solar PV

Solar Insolation Examples – Sacramento Area

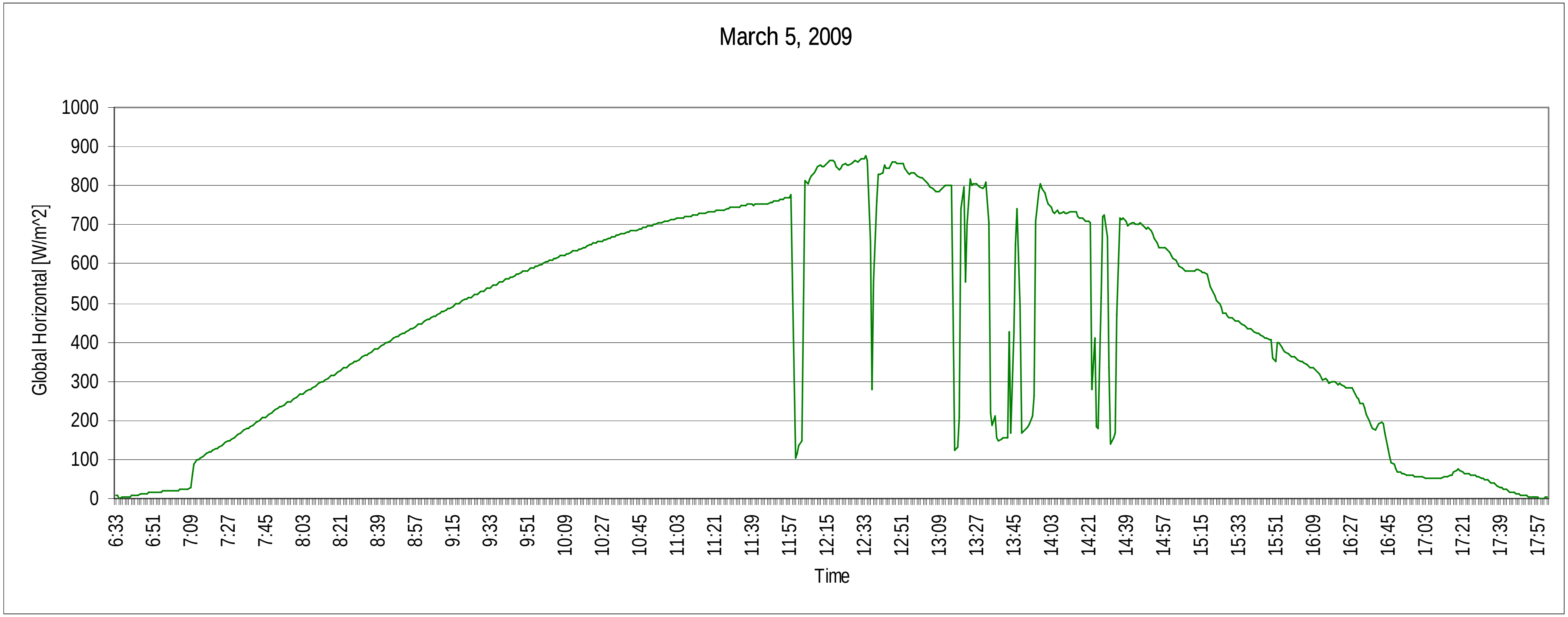
- **Spring 2009 data collected at SMUD PV site**
- **Data is collected at 1 minute intervals**
- **Several days shown in first week of March and May**
- **Indicative of Solar production, especially PV**

Source: http://www.nrel.gov/midc/

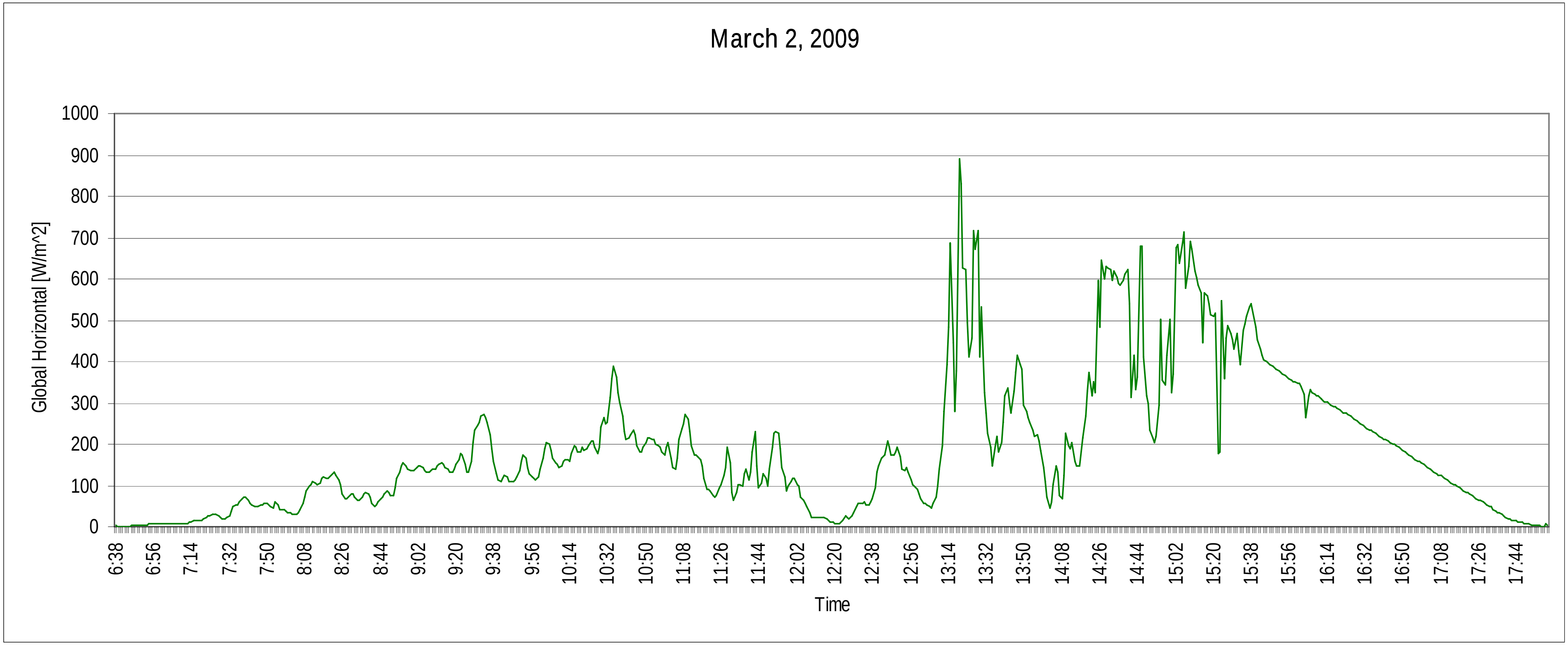
Solar Insolation Examples – Sacramento March 7



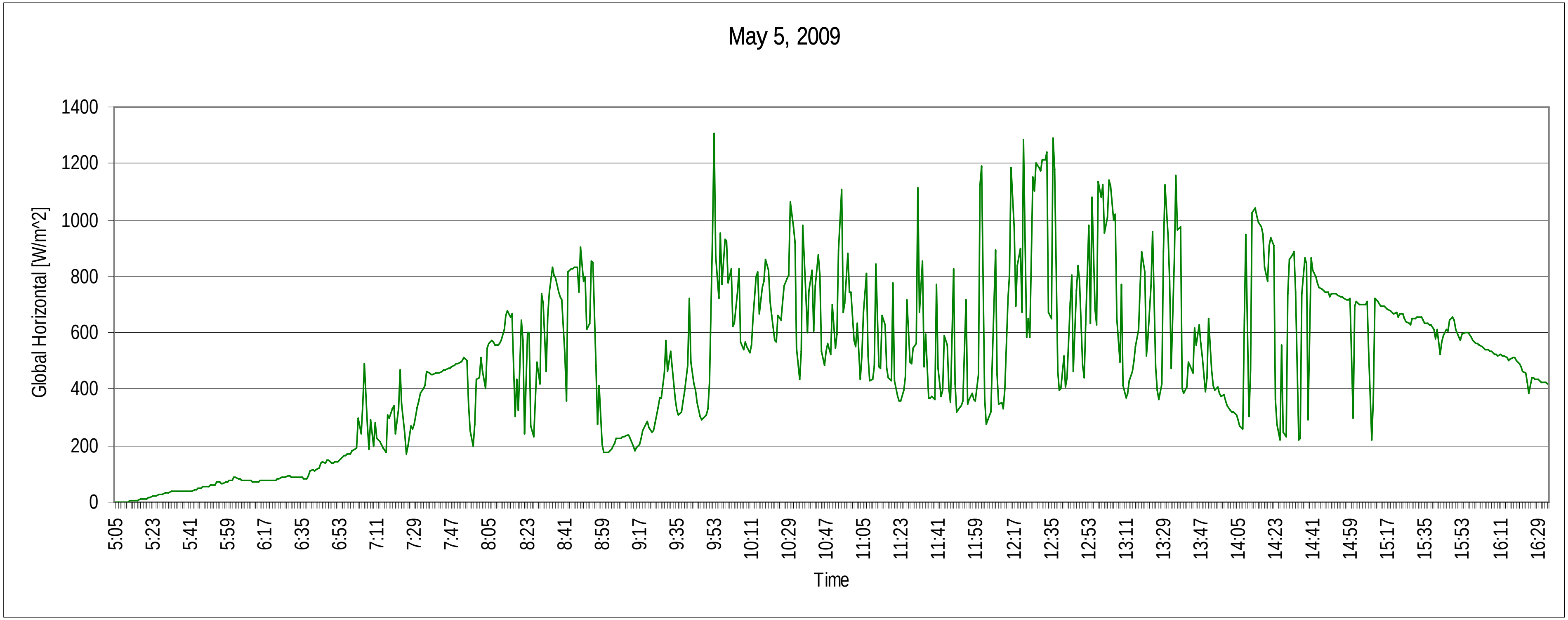
Solar Insolation Examples – Sacramento March 5



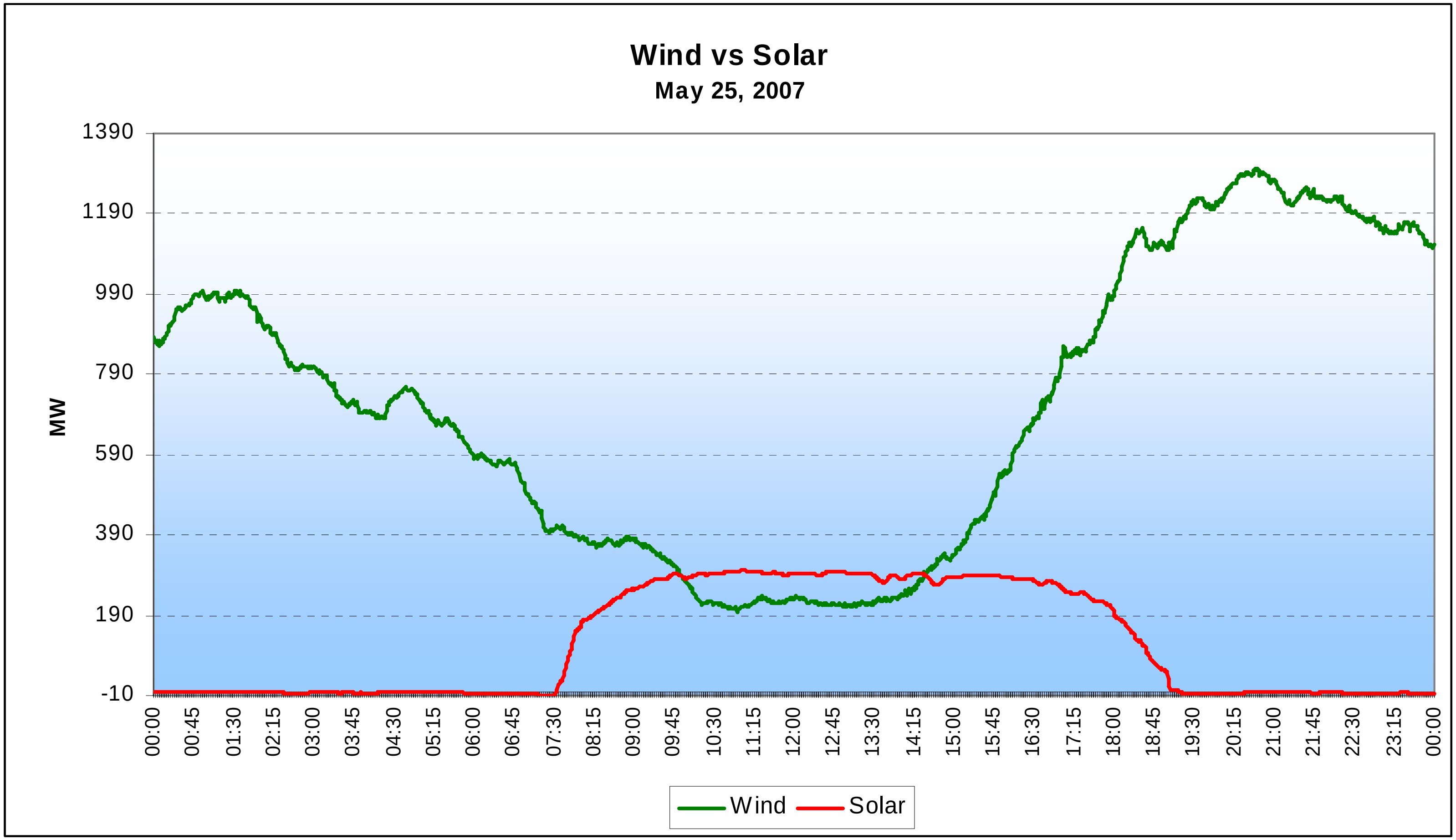
Solar Insolation Examples – Sacramento March 2



Solar Insolation Examples – Sacramento May 5



Typical Daily Wind vs. Solar Generation Pattern Shows Complimentary Nature



CAISO Data

System Operations – Renewable Integration

- Regulation (second to second Auto Generation Control) and Ramping (minute to minute) requirements affected by amount of renewables and the type
- Unit commitment to cover the peak plus reserves
- Variability and Uncertainty (forecast error) contribute to increased requirements
- Nexant study results

System Operations – Renewable Integration Requirements Regulation and Ramping Nexant Study

Morning Ramps				
	CAISO 2006	CAISO 20% 2013	Statewide 20% 2025	Statewide 33% 2025
Winter	6,979	8,631	10,243	12,184
Spring	6,860	8,494	10,967	13,272
Summer	10,090	12,664	17,823	18,727
Fall	7,229	8,995	11,016	11,950

Evening Ramps				
	CAISO 2006	CAISO 20% 2013	Statewide 20% 2025	Statewide 33% 2025
Winter	7,856	9,293	12,090	13,483
Spring	7,962	9,783	11,854	13,497
Summer	10,589	12,135	15,938	16,330
Fall	11,511	13,483	14,167	15,851

- **Includes effects of load and wind only (not solar); results understates needs**
- **Regulation for 33% RPS in 2020 = 541 MW Up, 559 MW Down, vs. +/- 350 MW today**

System Operations – Renewable Integration

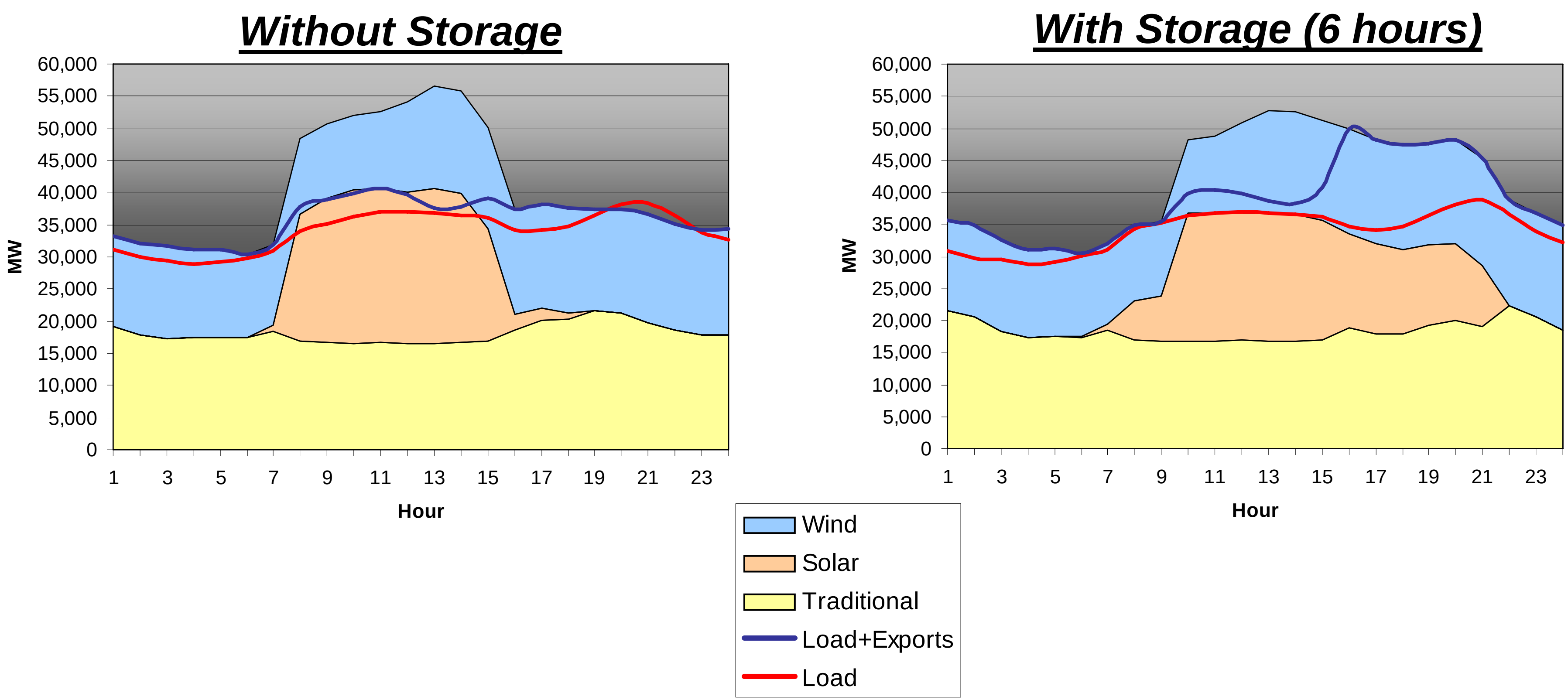
- Over-generation potential increases with renewables
- Overgen occurs when inflexible generation exceeds load plus planned exports
- “Energy Dump” occurs when over-gen can not be sold to willing buyers in neighboring areas
- Nexant studies indicate
  - **Technology dependent**
  - **With high solar penetration can occur during high load hours**

System Operations – Renewable Integration Overgen/Dump Energy – Nexant Results

- Most likely to happen in March-May period when hydro, wind and solar production can all be high and on weekends when load is low
- In simulations, more than 90% of dump occurs in SCE territory
- Simulation understates dump due to simplified transmission model used in production simulation and normal hydro conditions assumed
- May require changes in current and future contract structure to allow more frequent curtailment, as well as needing to reduce minimum generation levels

Results – Dump Energy for 50% RPS

- Storage Technologies reduce dump energy

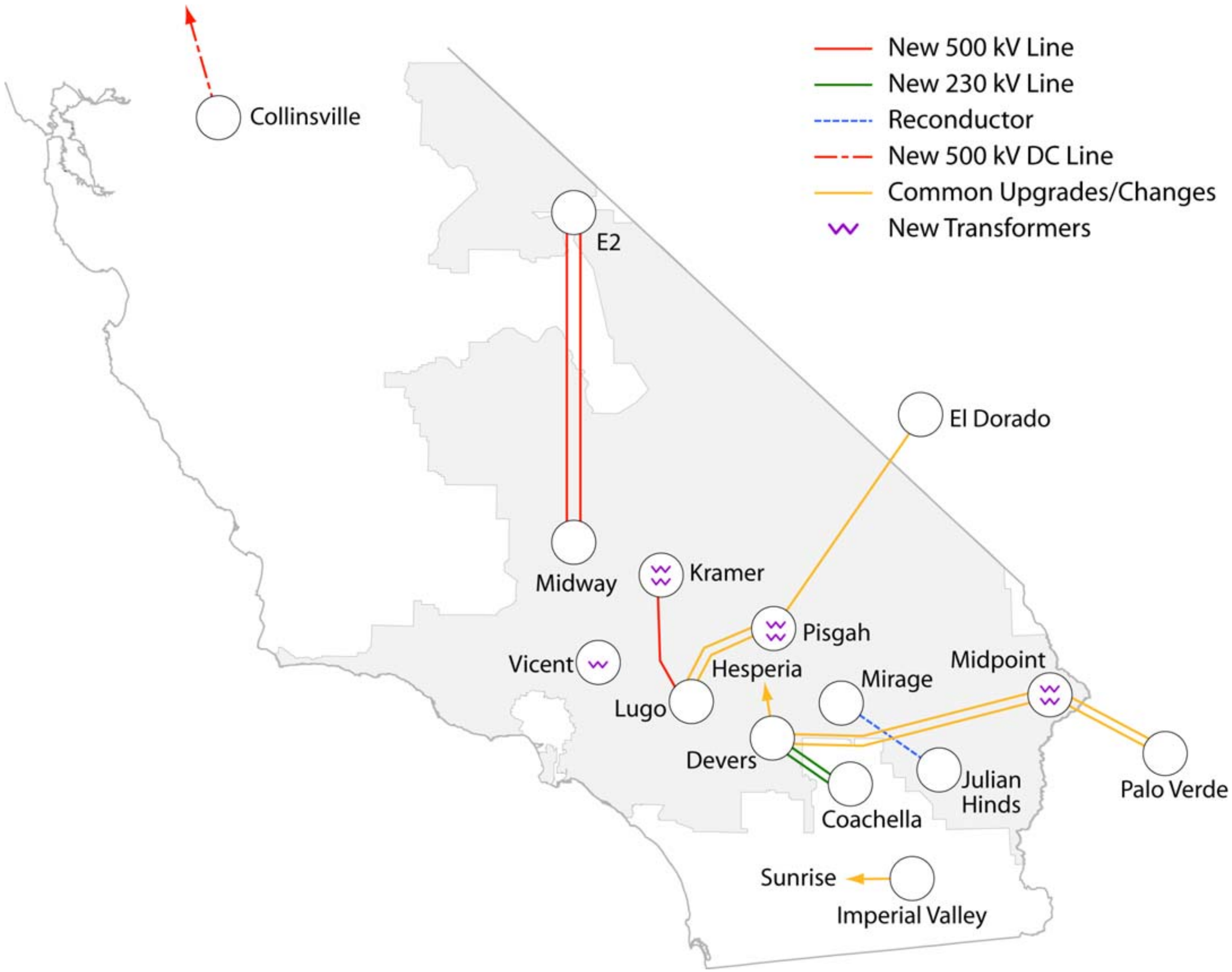


- Conditions on a day with solar and wind conditions both high… 50% RPS

33% Implementation Challenges - Transmission

- Long lead time to build transmission
- Uncertain which generation projects will develop
- Uncertain where transmission upgrades will be needed
- CPUC study shows need for up to 7 new major high voltage transmission projects
- Indicative Nexant results

Nexant Results – Transmission Expansion
Bulk Transmission Upgrades For 33% RPS – 2020



33% Implementation Challenges - Transmission

Potential Source of Multi-Year Delay for HV Transmission

- **Typical lead-time 6-11 years**
- **Typical process involves:**
  - Project study and approval by CAISO (1-2 years)
  - CPUC approval (2-3 years)
    - Can add significant delays, e.g., delay in approval of Sunrise Project
    - Other litigation post CPUC approval can also delay the project
  - Engineering/Procurement (1-3 years)
  - Construction/Environmental Mitigation (2-3) years
    - Delays could be based on the route and degree of environmental mitigation

33% Implementation Challenges - Resources

- **Need for non-renewables dependent upon renewable mix**
- **For example a high wind case would require more “capacity” to meet Planning Margin than a high solar**
  - 3000 MW needed for Wind (10,000 MW) and Solar (2,000 MW)
  - 300 MW needed for Wind (4000 MW) and Solar (8000 MW)
  - Assuming wind at 15% and solar at 60% capacity credit
- **Regulation and ramping needs are dependent upon renewable mix**
  - Not well understood at this time for full mix of renewables
  - CAISO 33% RPS Integration studies underway to clarify requirements

What are the opportunities to address these challenges

- Focused geographical development to streamline transmission siting to reduce the time to build transmission
- Improved longer term analytical tools to help narrow the uncertainty as 2020 approaches - more probabilistic
- PRM may have to be expanded to include integration requirements
- Potential increased use of distributed generation to reduce the transmission delays associated with larger scale remote wind and solar

What are the opportunities to address these challenges

- Improved control over new wind and solar to deal with severe ramps and over-gen events
- Potential increased role for storage and demand side responses to address regulation, ramps and over-gen
- Improved wind forecasting to reduce daily uncertainty and thus reduce regulation and load following requirements
- Improved solar generation forecasting through better cloud cover forecasting to reduce daily uncertainty

Questions

- Questions?