Briefing on the California Independent System Operator Renewable Integration Study

Clyde Loutan
Sr. Regional Transmission Engineer

California ISO
Your Link to Power

Board of Governors Meeting
General Session
October 17, 2007

California enacted a RPS requiring each LSE to procure 20% of its energy from renewables.

- State Law requires LSEs to meet the 20% RPS
- The focus of the CAISO study is on wind
- Existing and expected wind resources

	Tehachapi (MW)	*System wide (MW)*
Existing	722	2,648
Addition	3,540	4,040
Total	***4,262***	***6,688***

- Goal – Identify Transmission and Operational challenges
- Scope – Engineering Analysis
- 20% RPS target can be met, without adverse Transmission or Operational impacts

The study builds on the CEC's intermittency analysis for the 2007 Integrated Energy Policy Report

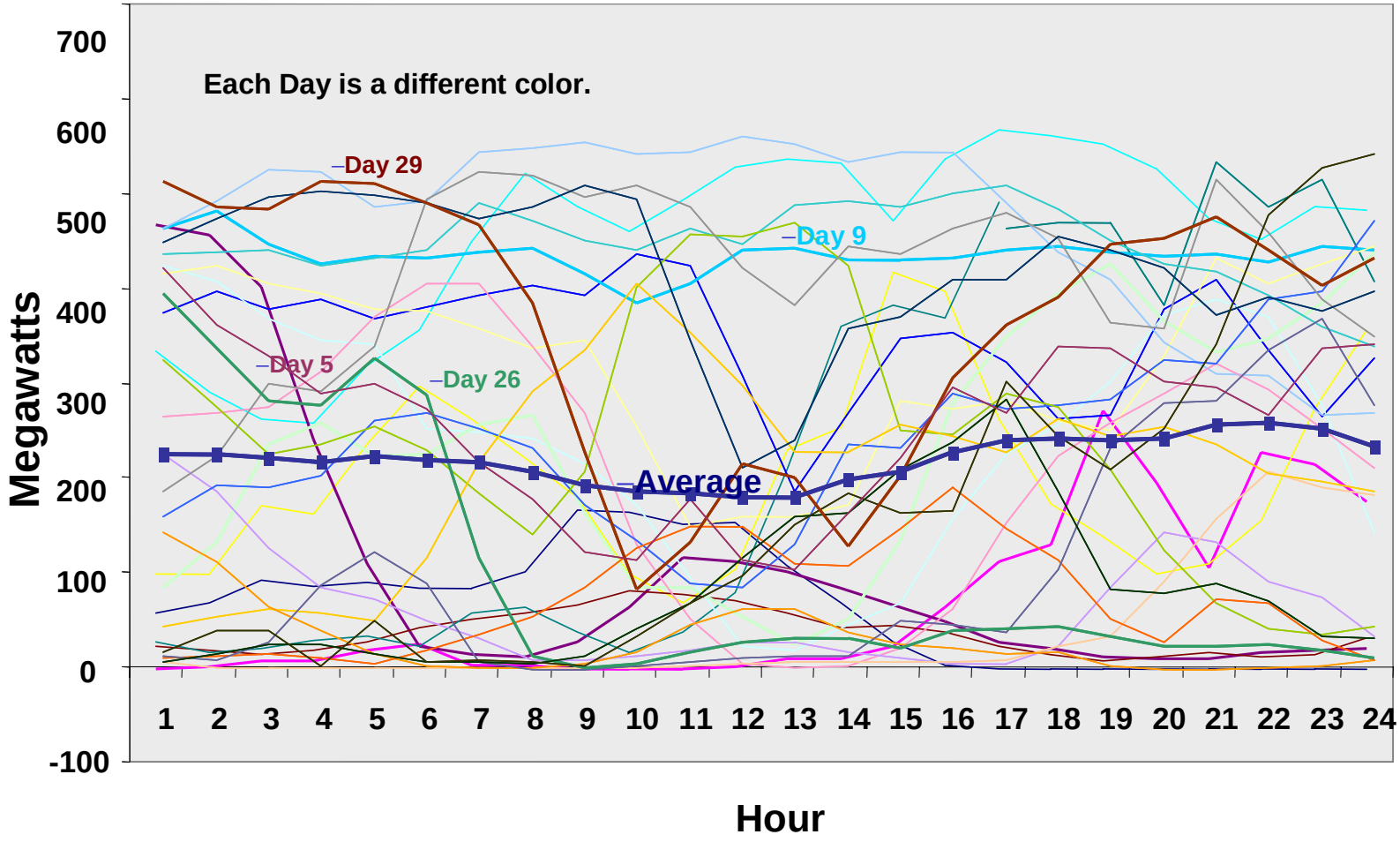
- **Infrastructure Analysis**
  - Grid stability and voltage performance
  - Characteristics of Wind Turbine Generator models
  - Required voltage support
- **Operational Analysis**
  - Modeled operating practice and timelines
  - Multi-hour ramps
  - Load Following/Regulation Capacity Requirements
  - Over-generation Issues and Potential Solutions

Transmission studies focused on a high concentration of wind resources in the Tehachapi Area.

- **Focused on stability performance following contingencies**
  - WECC requirements for new wind plants
  - FERC Order 661
- **Study Methodology**
- **Conclusions**
  - Tehachapi Transmission Project must be built to accommodate the new wind resources
  - 4,200 MW of wind generation can be integrated in the Tehachapi area
  - Both transient stability and system damping are satisfactory
  - Dynamic reactive capability at wind plants is required
  - New wind Plants should be of Type 3 or Type 4 design
  - Adequate reactive margins exist following critical contingencies

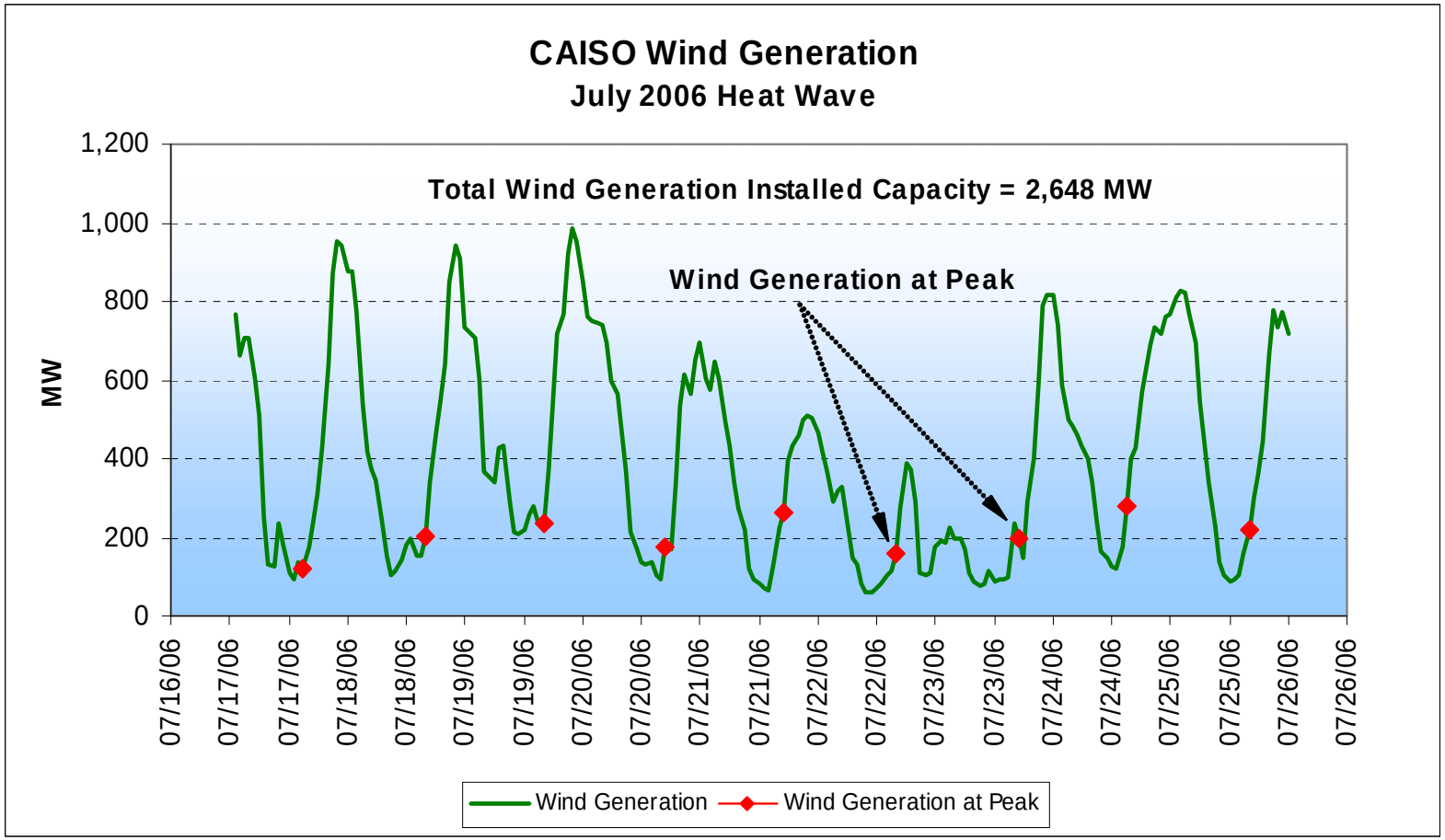
Wind energy production is very difficult to predict in the Day Ahead or a few hours ahead.

Tehachapi – April 2005



California ISO
Your Link to Power

Wind production levels are typically low on hot days.



California ISO
Your Link to Power

Wind generation tends to be inversely correlated to daily load curve, creating ramping impacts.

Multi – Hour Ramps

HE8 to HE10

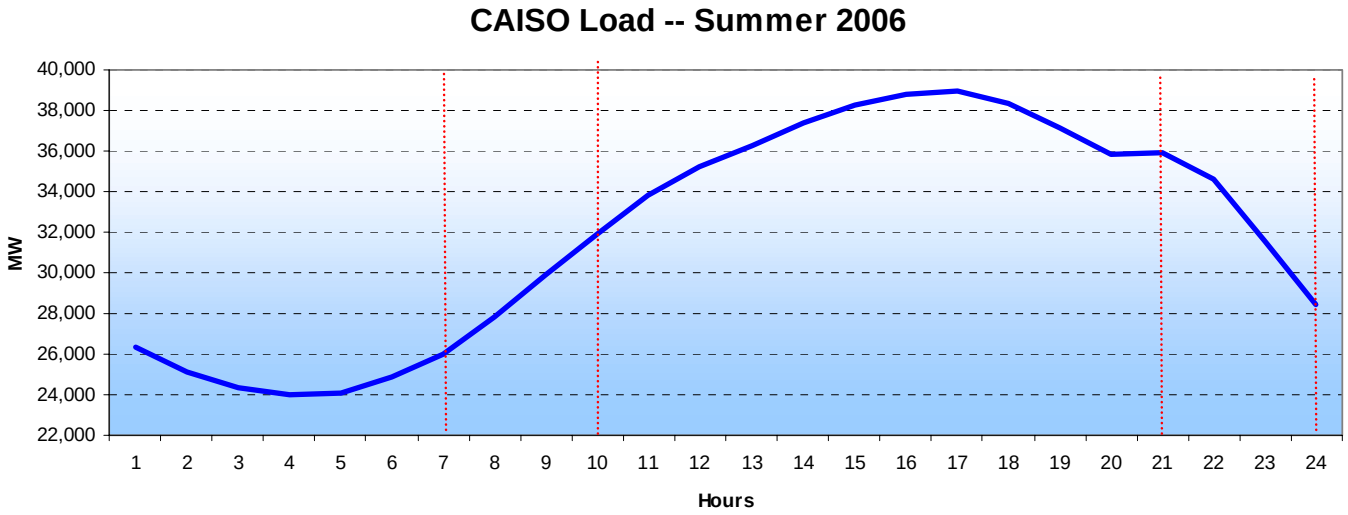
2006 ~ 10,000 MW
Change in Wind ~ 580 MW

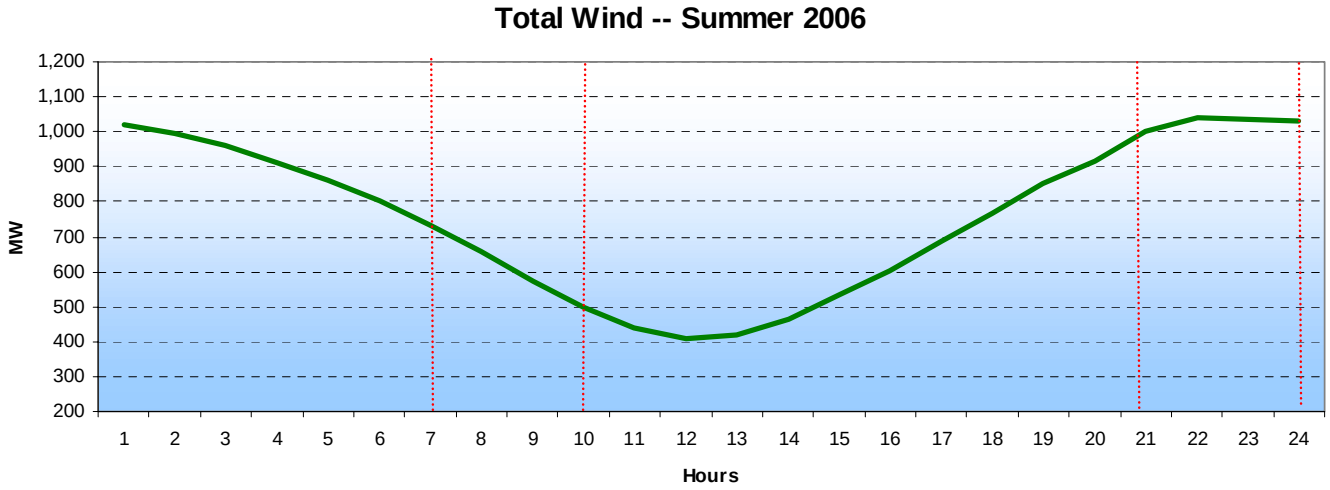
20% RPS ~ 12,600 MW
Change in Wind ~ 2,100 MW

HE22 to HE24

2006 ~ 10,500 MW
Change in Wind ~ 400 MW

20% RPS ~ 12,000 MW
Change in Wind ~ 800 MW

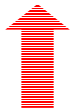




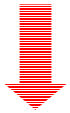
California ISO
Your Link to Power

Load Following is necessary to maintain stable operations.

- **MRTU will help with wind integration**
  - The Real Time Market balances Load and Generation on a forward looking basis
  - Short Term Unit Commitment looks ahead 5 hours
  - Real Time Unit Commitment looks out up to 105 minute
  - Real Time Economic Dispatch software runs every 5-minutes
  - Generation is dispatched based on economics/ramping capability
- **Conclusions**
  - Load following Capacity requirements will increase



700 - 800 MW



500 - 900 MW

Existing generation fleet can meet the increased requirements

Regulating resources are dispatched through Automatic Generation Control every four-seconds to meet real time fluctuations in the system.

- **Regulation is required to maintain frequency and maintain interchange schedules**
- **Regulation is not dispatched based on economics**
- **Today, the CAISO procures ± 350 MW of regulation on an hourly basis**
- **Conclusions**
  - Regulation capacity requirements may double certain hours

    ↑ 170 - 250 MW ↓ 100 - 500 MW
  - Additional regulation requirements are significant but manageable

Recommendations

- **Advanced Information Needs**
  - 4-second wind generation data
  - Graphical displays for real-time operators
  - Ramp forecasting tool
  - State-of-the-art (DA, HA, RT) wind forecasting service
  - solar power variability
- **Software Enhancements**
  - Incorporate wind forecasts into scheduling processes
  - Integrate wind forecast into MRTU dispatching applications

Recommendations (cont.)

- **Generation Fleet Improvements**
  - Additional generation with faster ramping capabilities
  - Additional quick start units
  - Resources with lower minimum operating levels
  - Conventional generation impacts due to additional cycling, wear-and-tear and environmental constraints
  - Evaluate wider-area ACE sharing with BPA
- **Policy Enhancements**
  - Encourage the development of new energy storage technology
  - Develop a procedure to allow pro-rata cuts in wind energy production
  - Develop a policy for Imports/Exports of Renewables
  - Critical to align with other policy considerations – GHG, once-through cooling, increased RPS