



CALIFORNIA ISO

California Independent
System Operator

Wind Energy in the California Market

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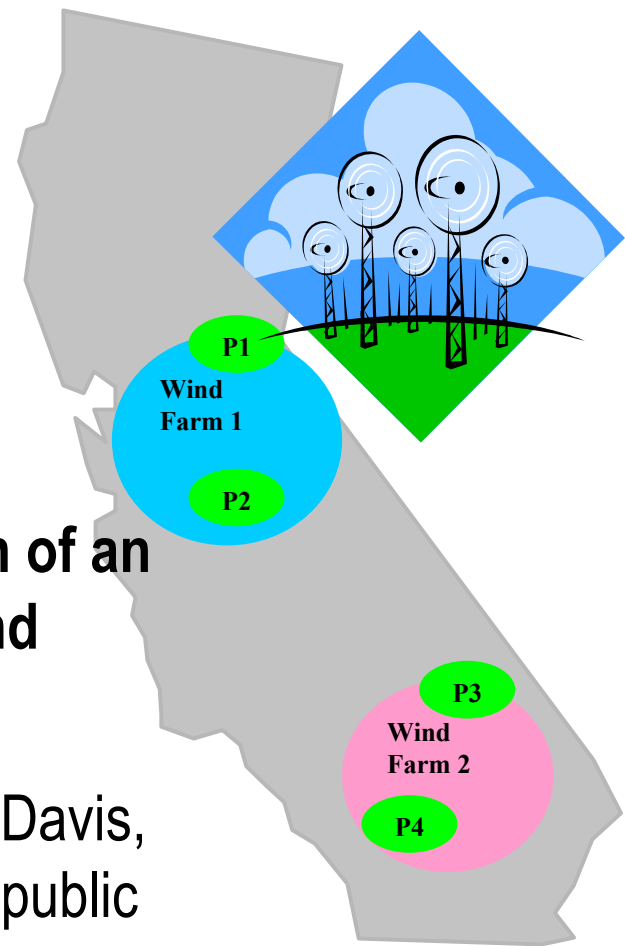


Wind Generation in California

California currently has approximately 1800 MW of installed Wind Generation, of which CAISO sees a maximum of 1200 Mw that can “show up” in real-time.

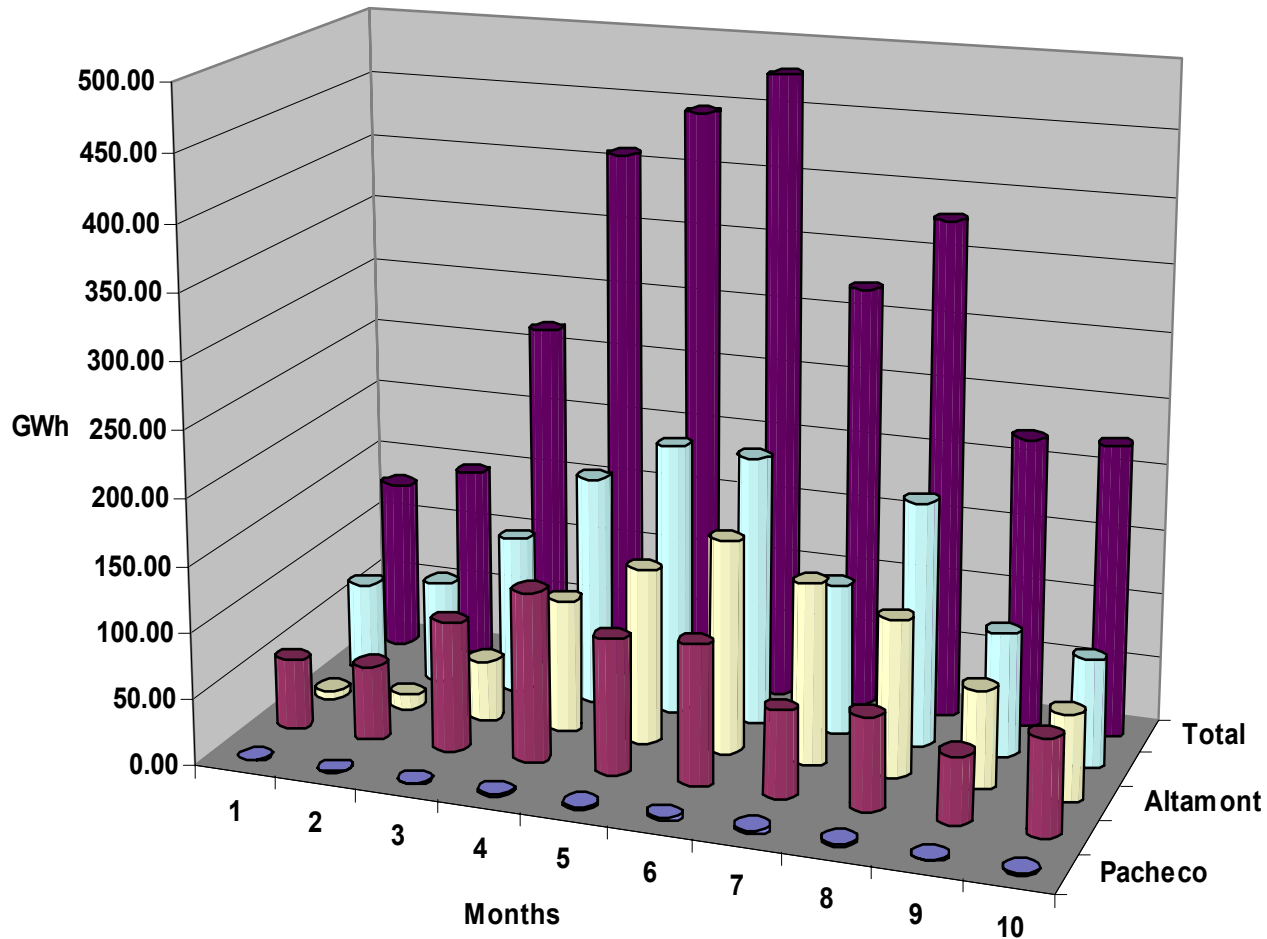
The state would like to encourage the installation of an additional 2000 to 3000 MW of additional wind generation!

Senate Bill 1078, recently signed by Governor Gray Davis, mandates that 20% of the State’s electricity sold by public utilities come from renewable energy resources by the year 2017.



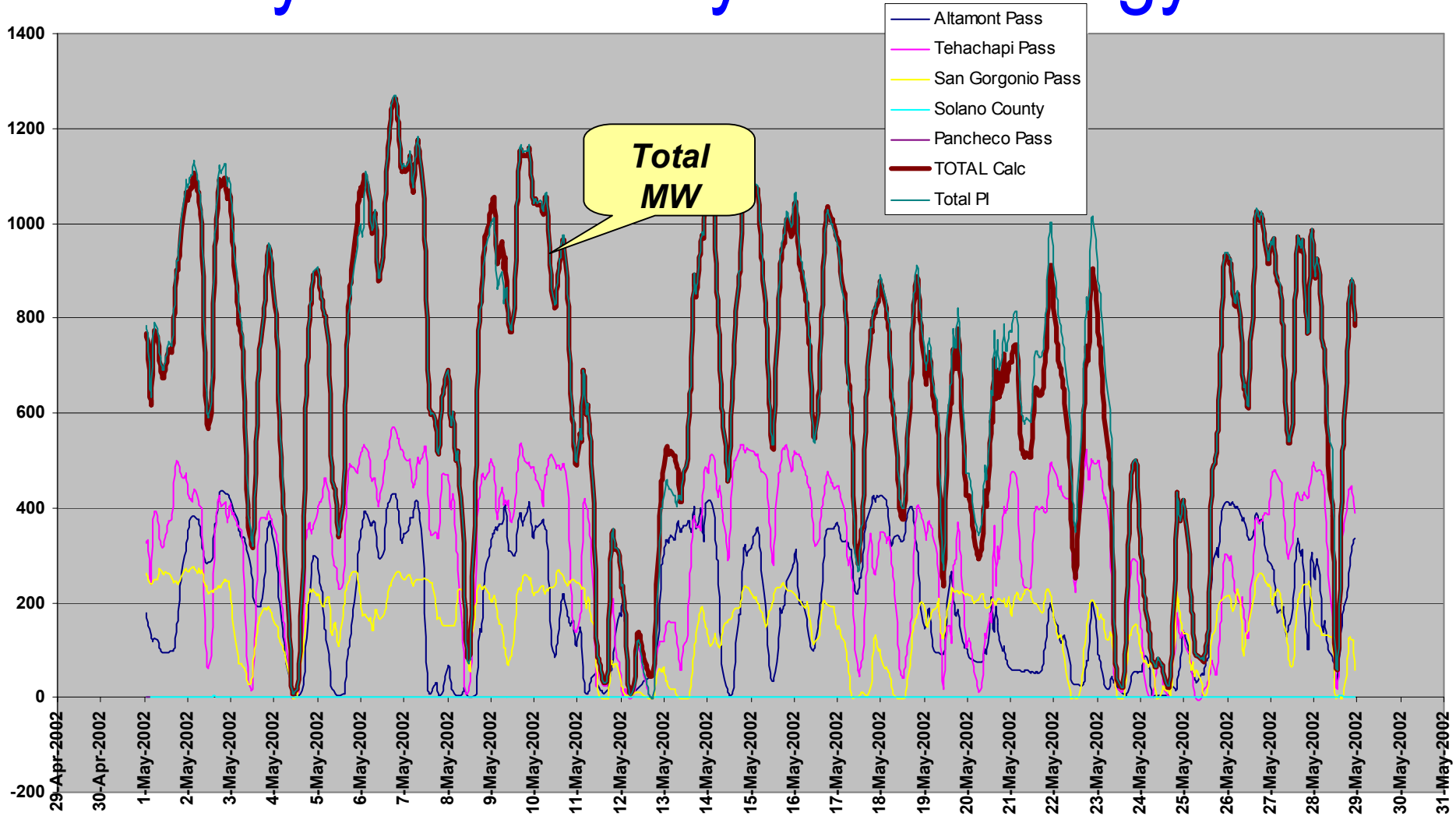


2002 Monthly Wind Energy Production



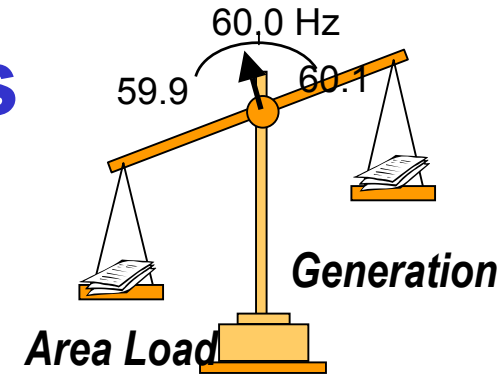


May 2002 – Daily Wind Energy





CAISO Real time Operations



- Balance total area Load and Generation on a continuous basis
- Maintain frequency at 60 Hertz
- Monitor transmission lines for overloads and correct overloads
- Forecast energy needs in the next 10 minutes, 20 minutes, etc. and send dispatch notices to generators



Operational Challenges

- **Intermittent Resources (Wind Generation)**
 - Energy Production is unpredictable day ahead, hour ahead, and from minute to minute
 - Increases the amount of Regulation Services CAISO procures from other Generators which increases costs
 - Production is often maximum between 10 PM and 2 AM when energy is not needed
(Adds to Over-generation problems)
 - Can cause additional transmission line overloads during some periods of heavy power flows
 - Generation is “Must Take” and is non-dispatchable
 - Can cause voltage collapse at wind farm areas which results in units automatically shutting down and restarting



CAISO Wind Gen. Project Objectives

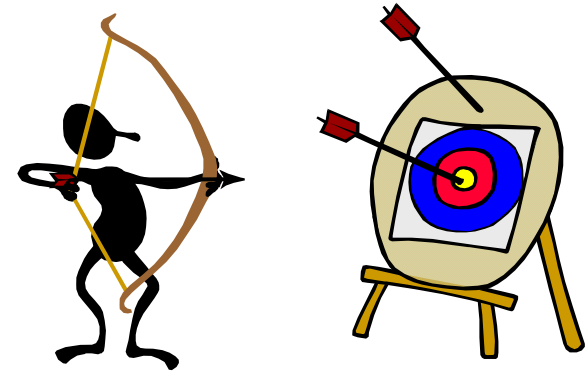
- Support the State's goal of increasing the amount of new Wind Generation installed in California
- Forecast wind energy production far enough in advance so we do not need to start other fossil units
- No Surprises - Predict the amount of Wind Generation that is going to show-up in Real Time to help the Generation Dispatchers keep system balanced
- Find a successful way to handle imbalance energy costs for deviation from schedule without shifting costs to others
- Lower financial risks for operators and wind generators



Markets for Wind Energy

Major Challenge is how to handle Imbalance Energy Costs?

- Energy Production must be scheduled in forward markets to get price certainty
- Actual Energy Production will always deviate from schedule
- Net Deviation (Scheduled – Actual) can be a high cost for the Scheduling Coordinator and a major penalty for Wind Resources





The Process

- Intermittent Resource Working Group formed in Summer 2001
 - Representatives from the Governor's Office, CAISO, California Wind Energy Association, the CEC, IEP, CERS and wind energy marketers
- Consensus Proposal developed and submitted to CAISO Board for approval in October 2001
- Proof of concept forecasting tool developed at the ISO
- Tariff Language developed & included in Amendment 42, filed at FERC at the end of January, 2002



Integration of Markets for Wind Energy into Real-Time Grid Operations

- Contract with a Forecasting Service to develop high-quality forecasts for DA and HA scheduling and a real-time forecast for ISO operations
 - Forecasts must be “un-biased” for each hourly interval
- Develop a monthly settlement process to net deviations across all intervals and to be settled at the weighted-average price for the month
- Create a Forecasting Work Group to monitor performance of the forecasting service, the intermittent resources and the impact on ISO system and costs

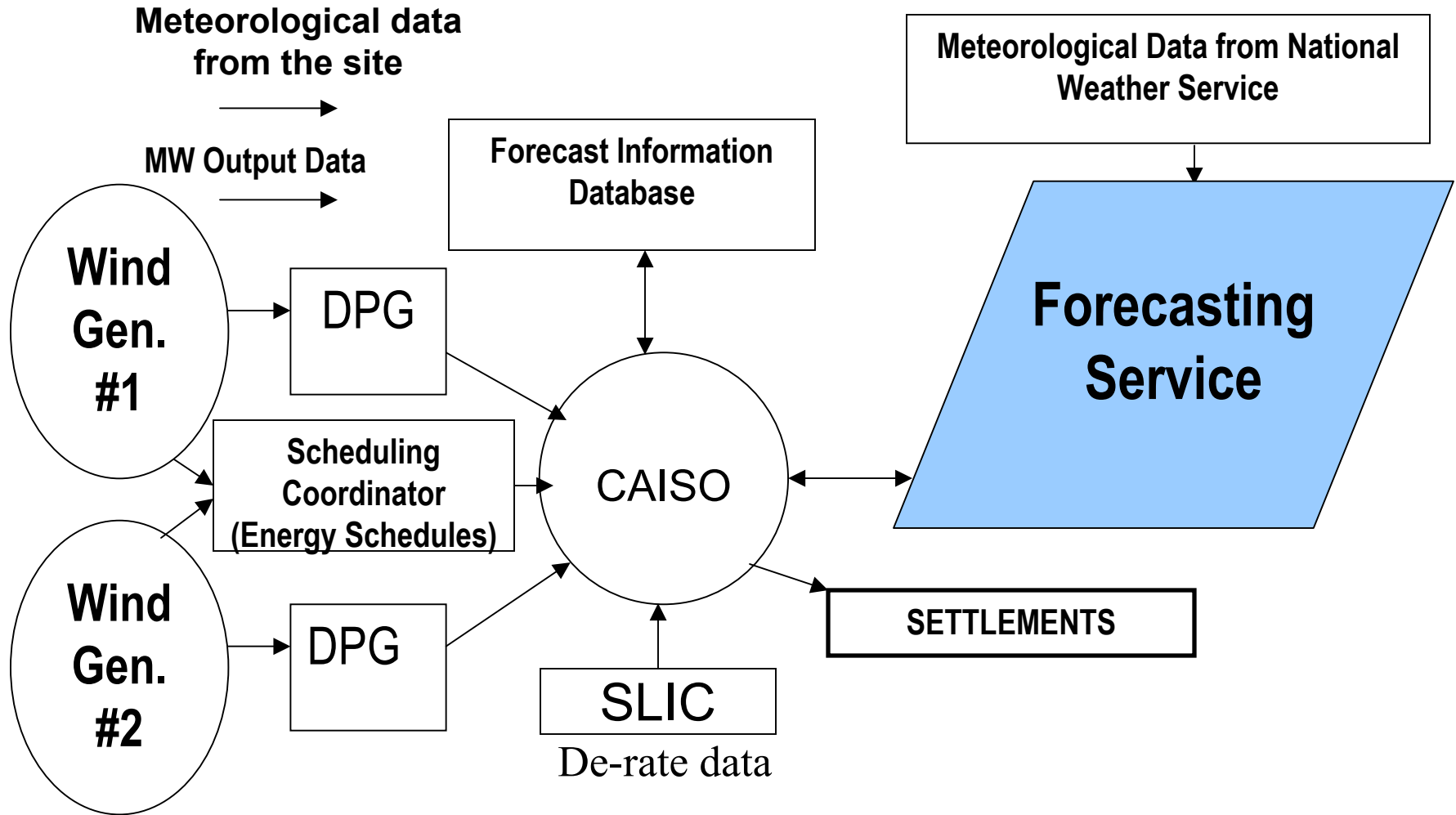


Integration of Markets for Wind Energy into Real-Time Grid Operations

- Eligible Intermittent Resources will sign all ISO agreements, install ISO meters, pay a forecasting fee and schedule consistent with a state-of-the-art forecast
- Intermittent Resources will not be charged for Deviation Replacement Reserve
- Deviation Replacement Reserve and Imbalance Energy costs will be assigned to Imbalanced Load
- Congestion charges may still apply to Intermittent Resources
- Each new wind generation area will provide meteorological and energy production data in real-time for use in the creation of the forecasting model for that facility

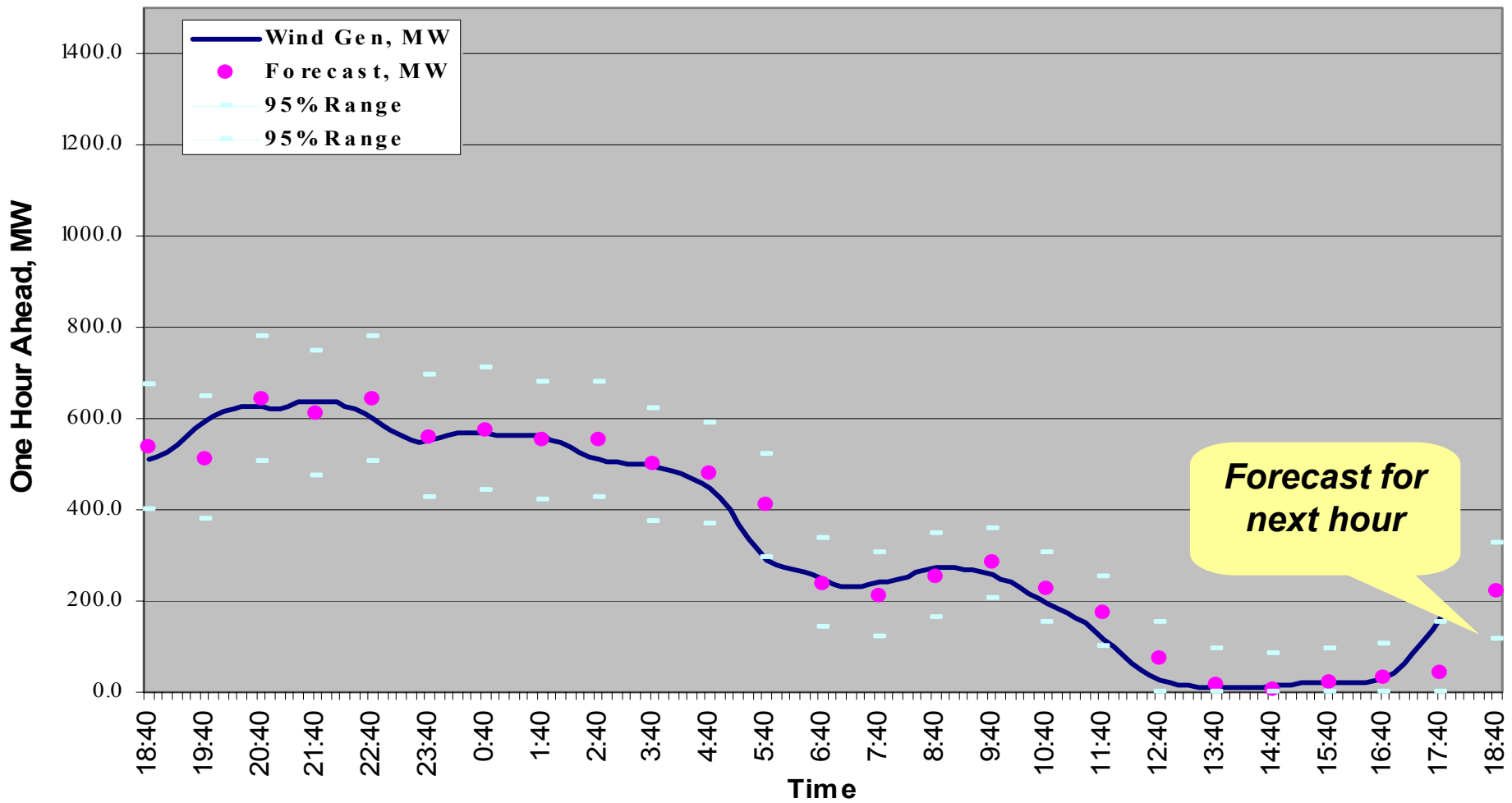


Data Flow for Wind Generation Scheduling Process





CAISO Hour Ahead Forecast Tool





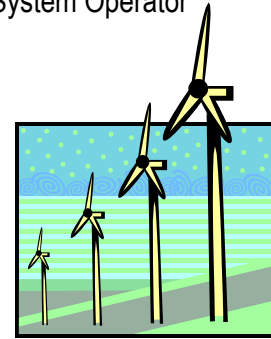
Impact on Grid Operations Reliability

- Goal is to forecast the amount of Wind Energy production for each 10 minute segment for the next 90 minutes
- Changes in “net-short” calculation for Supplemental Energy Dispatch will include changes in Wind Energy – **no surprises!**
- Impact on transmission loading can be assessed and mitigated as needed by dispatch instructions to other generators
- If over-generation emergency exists, Wind Generators will turn their blades and reduce production





How we are moving forward



- We have approximately 340 MW of new Wind Generation that is interested in participating in the program – this could grow to 2000 MW or more if SCE elects to participate in the program and additional new generation is built as forecasted.
- The CAISO is ready to contract with a professional Wind Generation Forecasting Service
- In January, we will start the internal software changes & development required to implement the program
- **Program ready for implementation in Summer 2003**