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System Operator

Wind Generation and Grid Operations: Experience & Perspective

Yuri Makarov and David Hawkins

California Independent System Operator Corporation
Folsom, California, USA

Participating Intermittent Resources Workshop
March 23, 2005

TOPICS

- Fundamentals of Area Control: ACE, Load Following, Regulation
- Wind Generation Impact on CAISO Balancing Functions
- Summary of Observations
- We Need To Work Together For Optimal Solutions
- Conclusions

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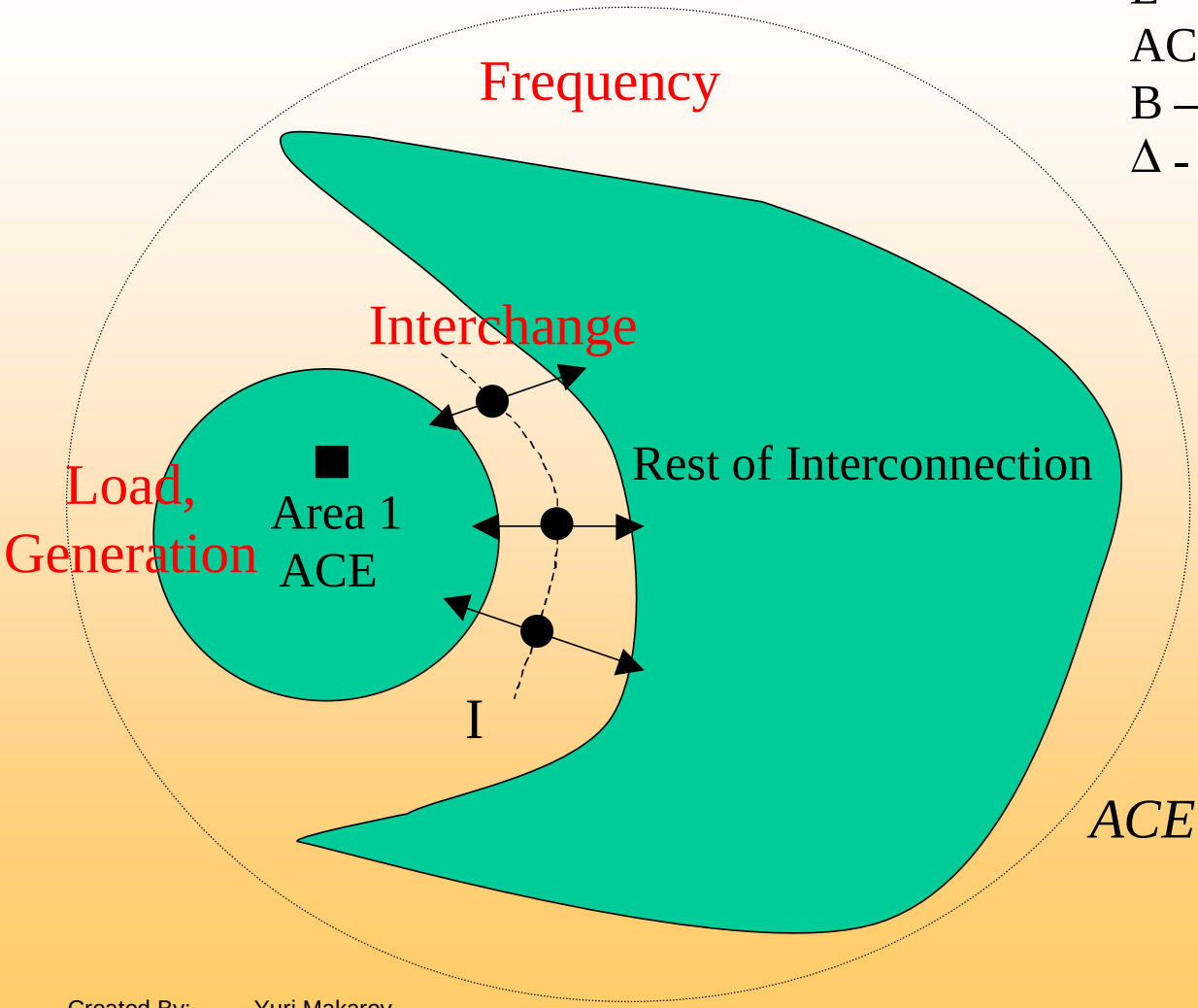
I. Fundamentals of Area Control: ACE, Load Following, Regulation

Created By: Yuri Makarov

LST UPDT: 3/22/2005

Area Control Error ACE

F – frequency, Hz
I – net interchange, MW
G – generation, MW
L – load, MW
ACE – area control error, MW
B – bias setting, MW/0.1Hz
Δ - deviation from schedule

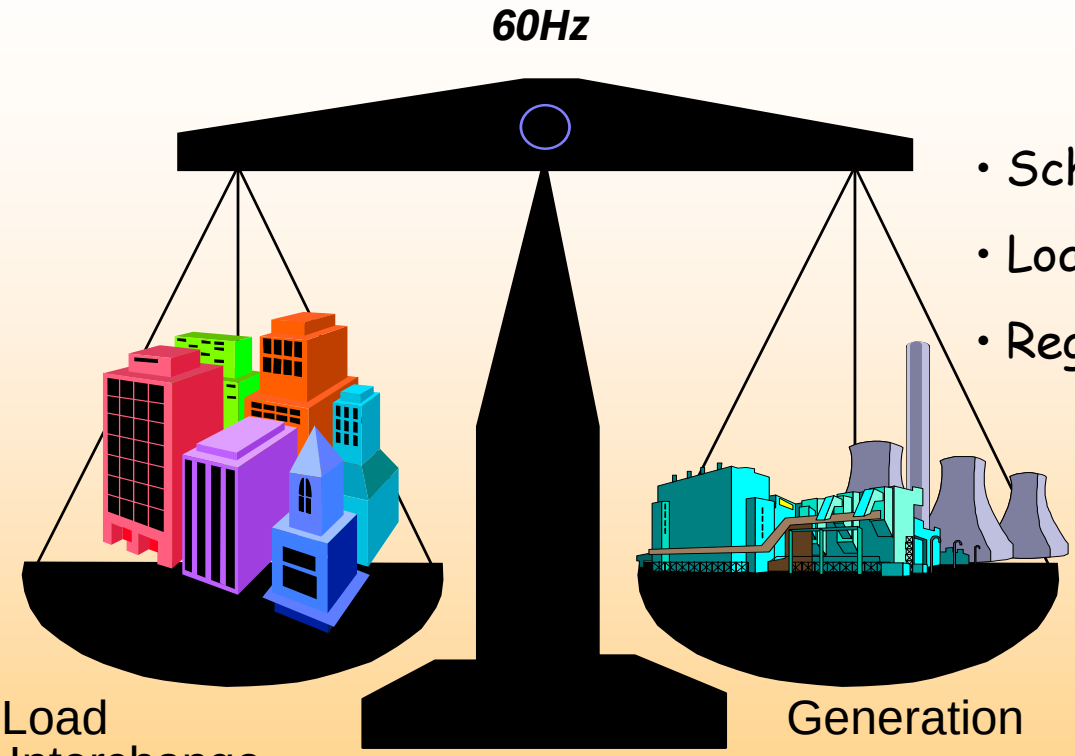


● Tie-line meter

■ Frequency meter

$$ACE = \Delta I - 10B \cdot \Delta F$$
$$= \Delta G - \Delta L - 10B \cdot \Delta F$$

Understanding of Area Control Objectives



- Scheduling (Day & Hour Ahead)
- Load Following (Real Time Dispatch)
- Regulation (AGC)

- **Balance Generation Against Load**
- **Maintain Scheduled Interchanges**
- **Support Interconnection Frequency**

Source: Craig Taylor and Don De Berry, California ISO

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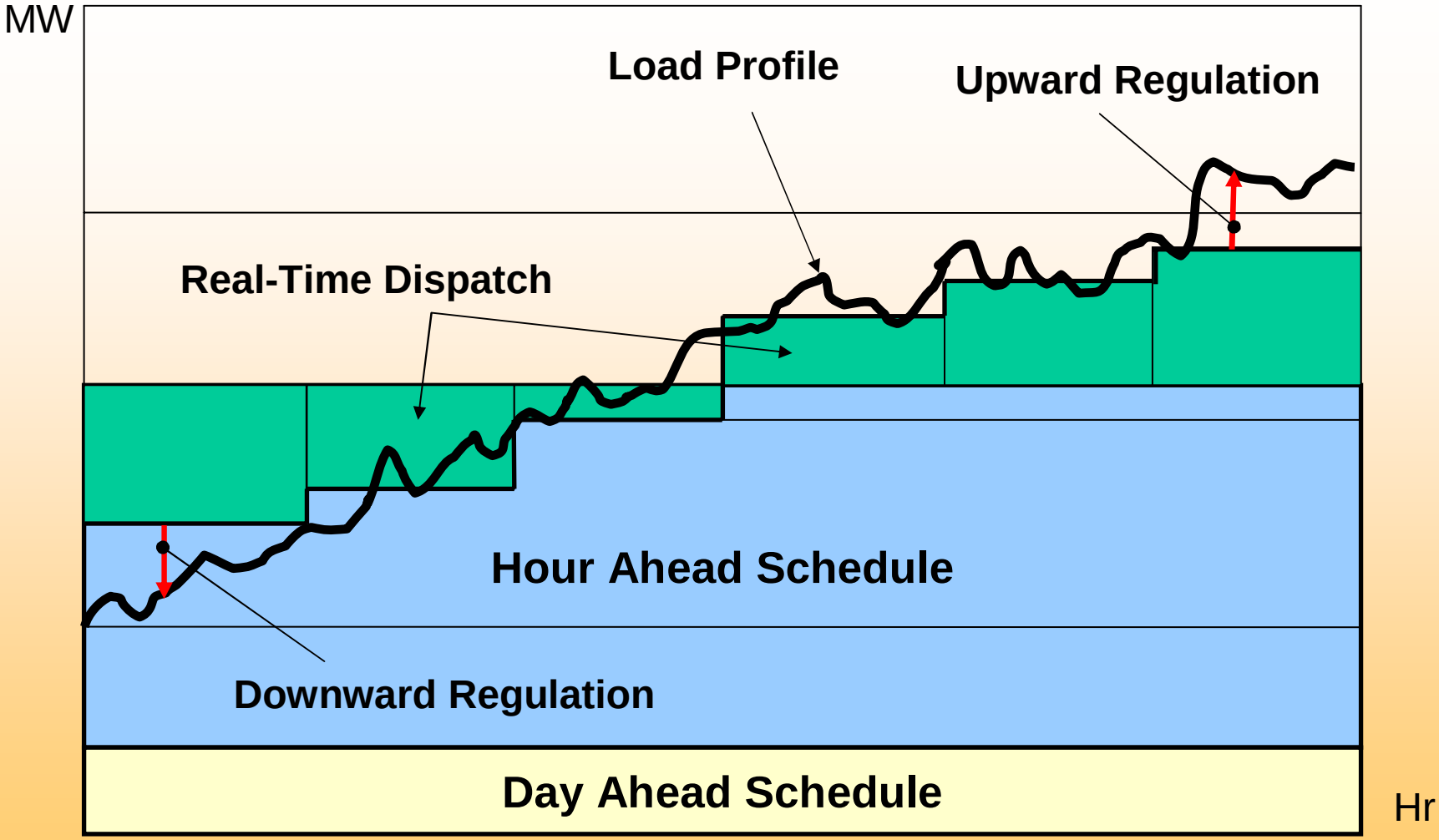
Area Control



Source: Craig Taylor and Don De Berry, California ISO

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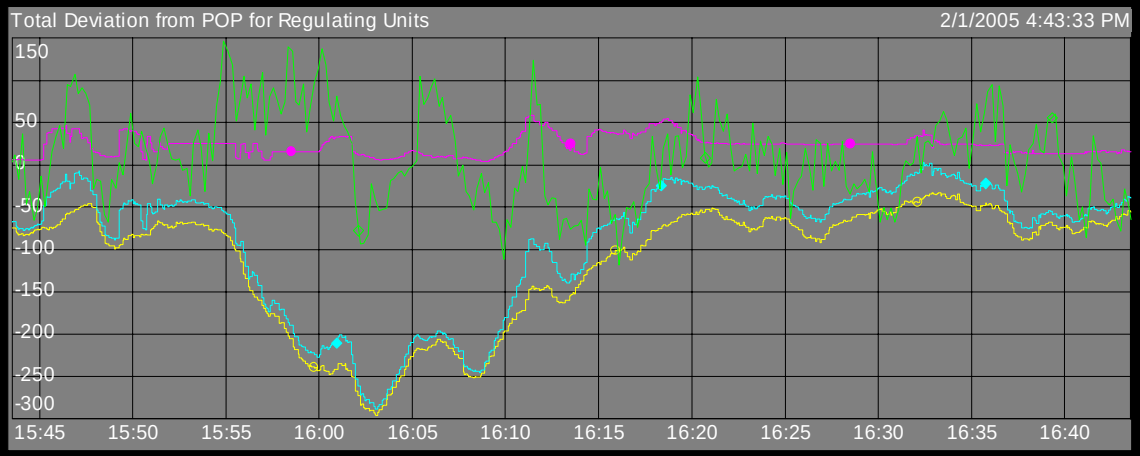
Actual Regulation Process

Regulation Overview

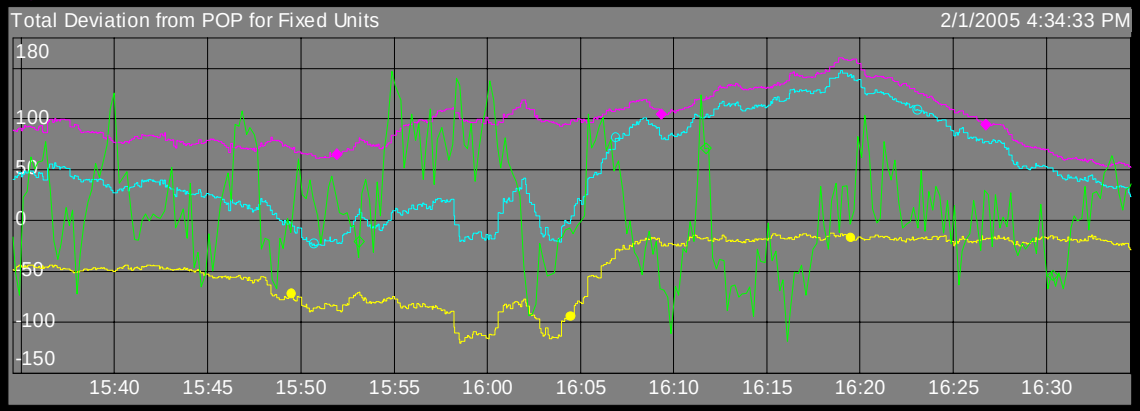
Total Deviation from POP for Regulating Units

Upward 37.68 Downward -57.80 Total -20.11 CAISO ACE 30



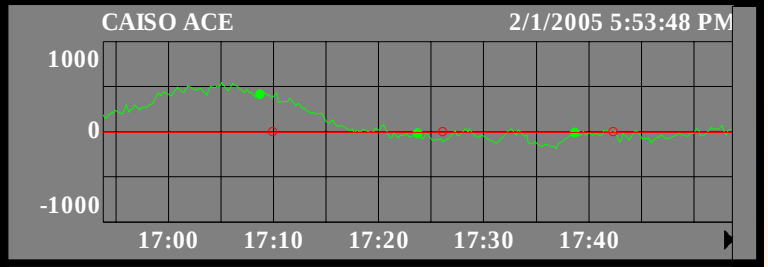
Total Deviation from POP for Fixed Units

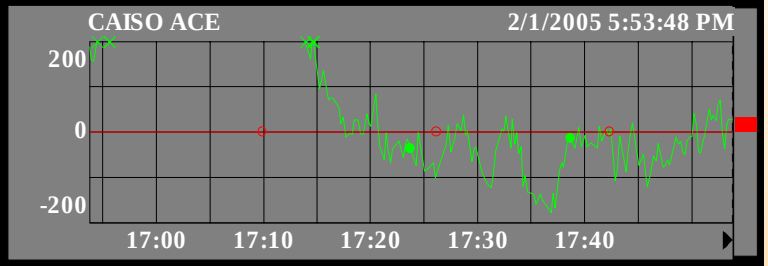
Upward 108.59 Downward -175.69 Total -67.10 CAISO ACE 30



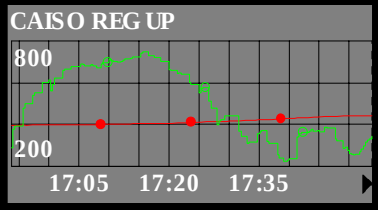
Units on Regulation

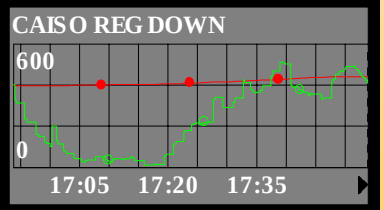
CAISO ACE 30





UPPER REGULATION		LOWER REGULATION	
REQUIRED	ACTUAL	REQUIRED	ACTUAL
443	345	443	413





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II. Wind Generation Impact on CAISO Balancing Functions

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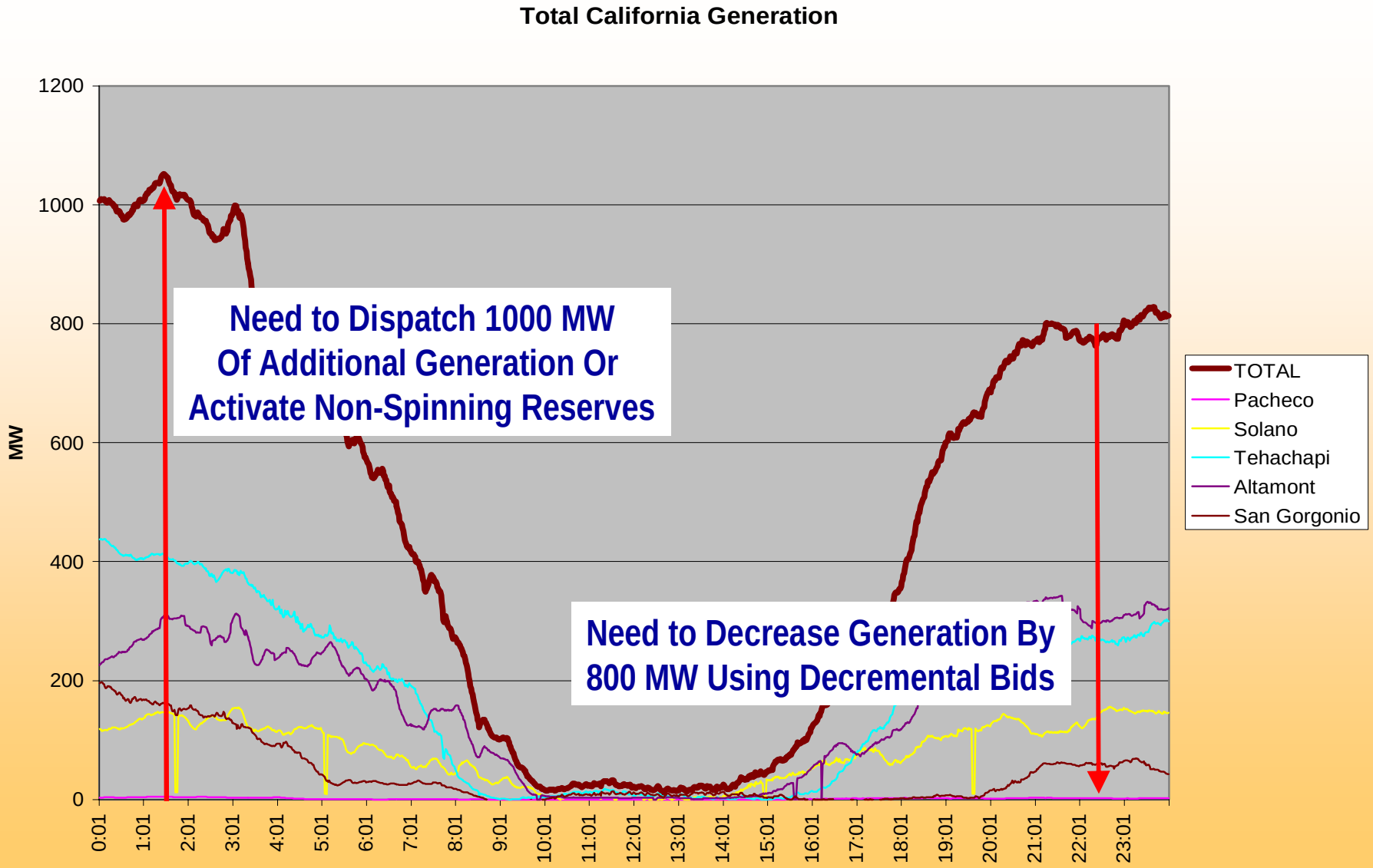
(Unscheduled) Impact on Generation Dispatches & Reserves



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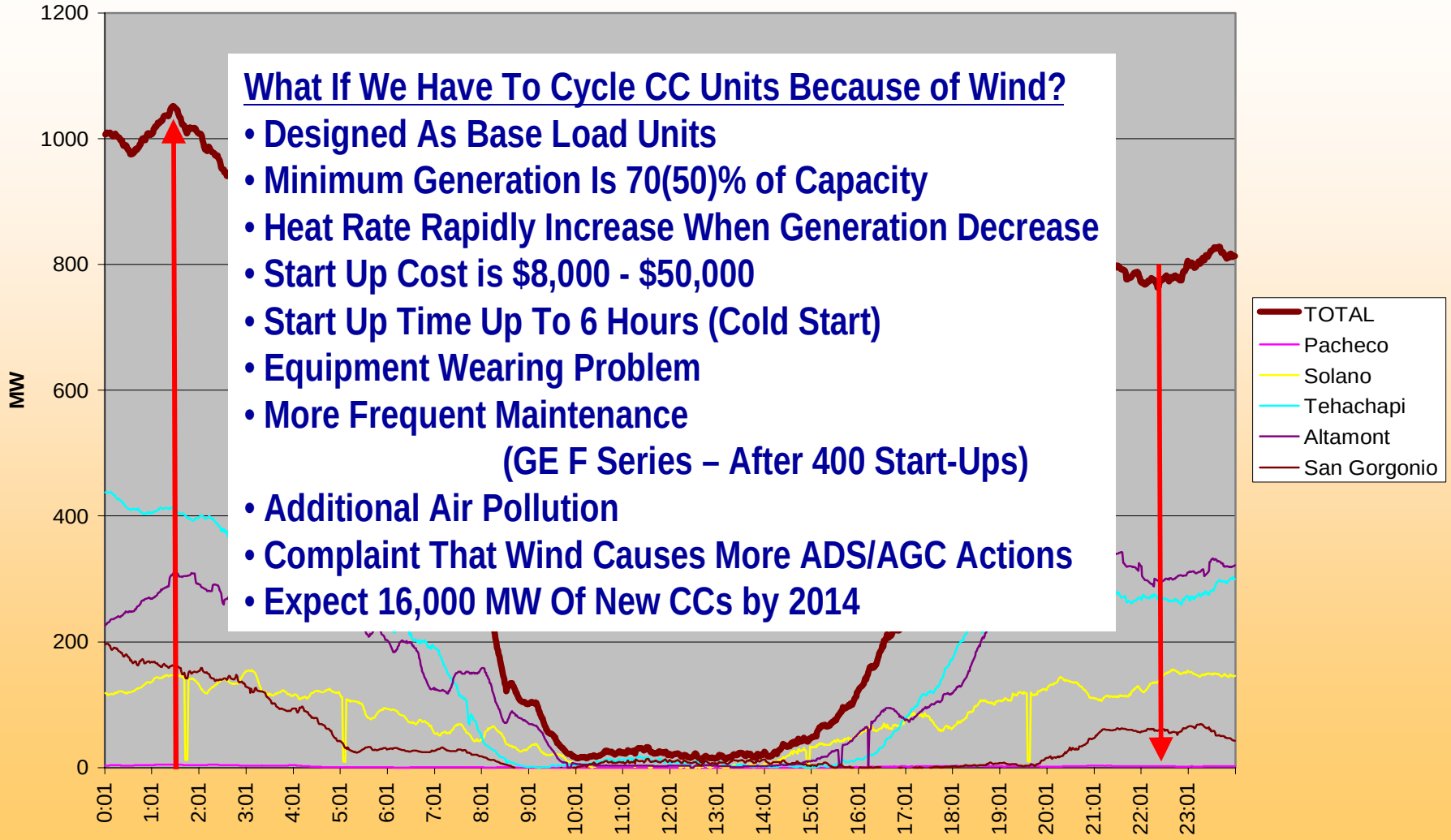
Potential Impact on Other Generators' Performance

Total California Generation



What If We Have To Cycle CC Units Because of Wind?

- Designed As Base Load Units
- Minimum Generation Is 70(50)% of Capacity
- Heat Rate Rapidly Increase When Generation Decrease
- Start Up Cost is $8,000 - $50,000
- Start Up Time Up To 6 Hours (Cold Start)
- Equipment Wearing Problem
- More Frequent Maintenance
  (GE F Series – After 400 Start-Ups)
- Additional Air Pollution
- Complaint That Wind Causes More ADS/AGC Actions
- Expect 16,000 MW Of New CCs by 2014

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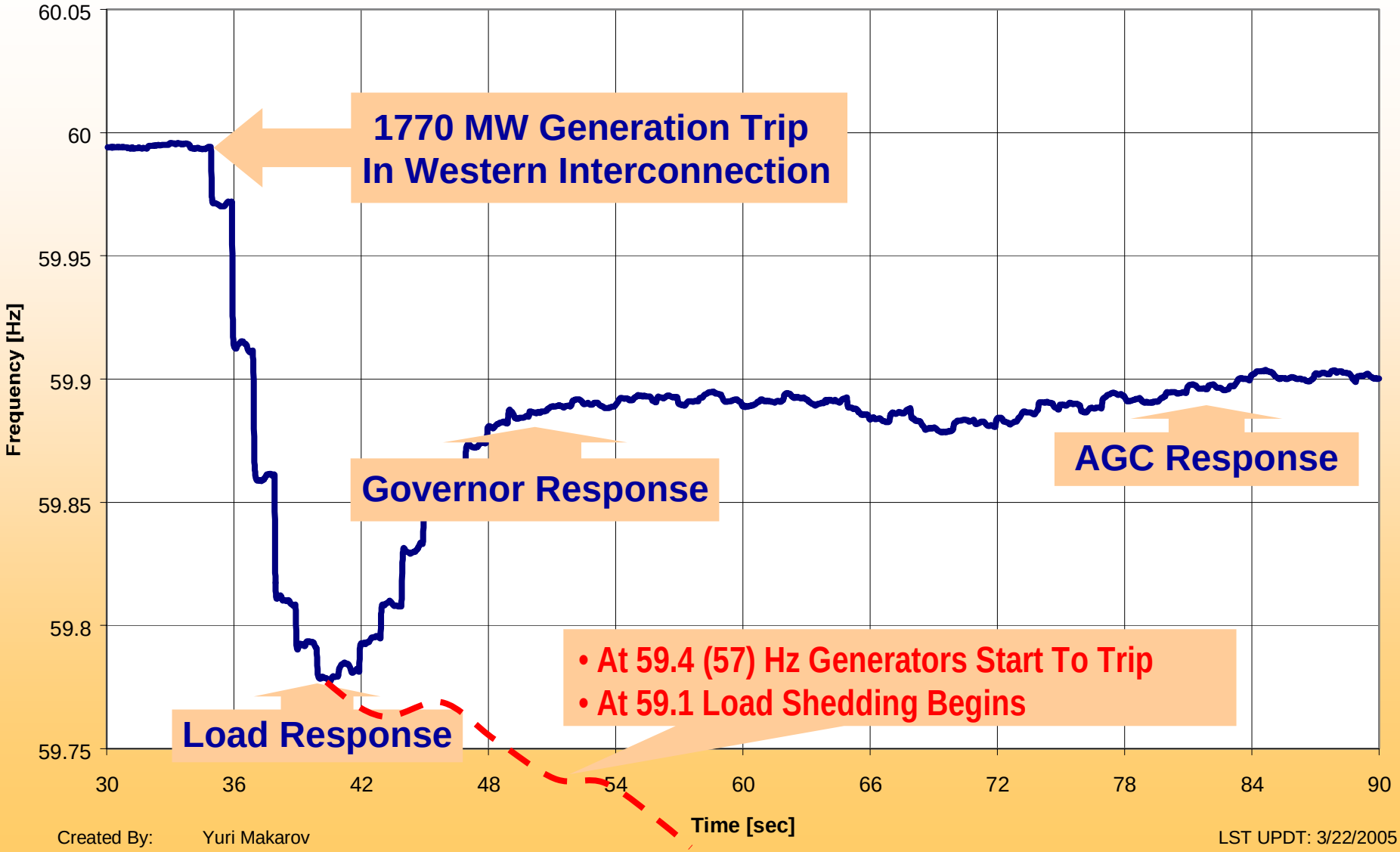
Frequency Response



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Frequency Response

- **NERC Policy 1: - Governors should be fully responsive to frequency deviations exceeding ±0.036 Hz**

  - Generators 10 MW or greater should have governors

- **Frequency Response is Deteriorating**

- **Noticed Impacts of Reduced Frequency Response:**

  - California-Oregon Operating Transfer Capability May Be Reduced by 100 – 300 MW

  - Slower Frequency Recovery After Disturbances

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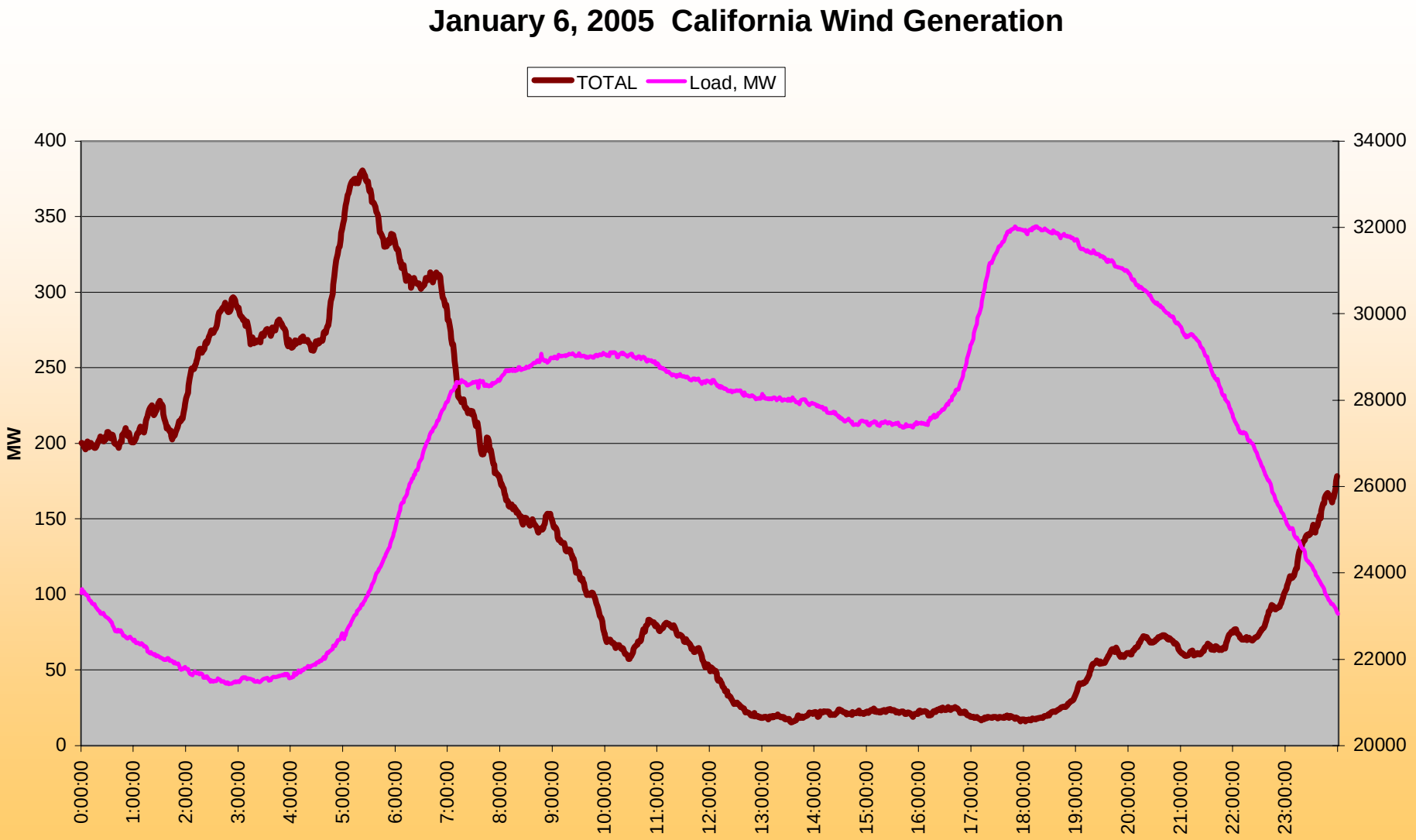
Wind Generation And System Load Have Different Daily Patterns



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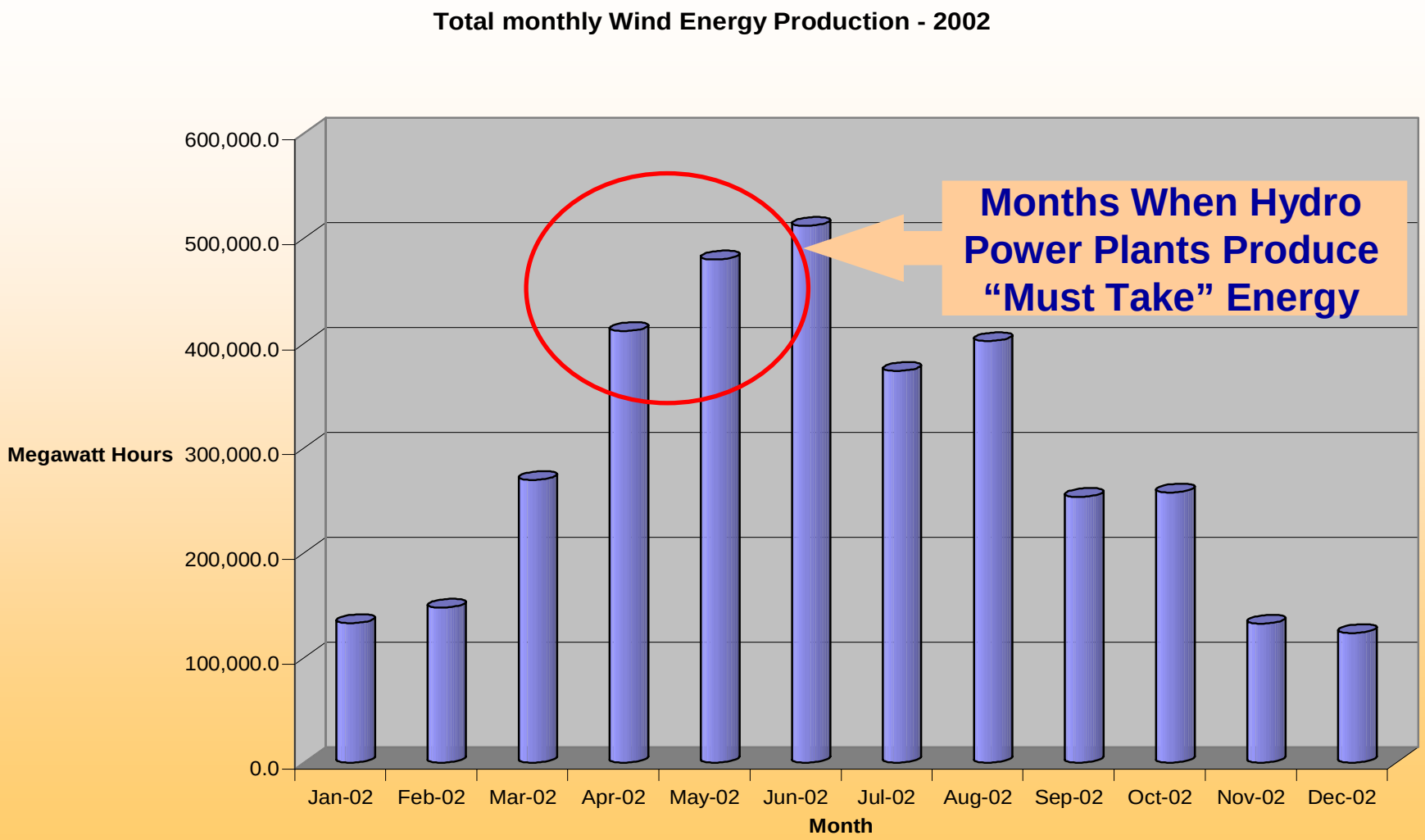
Overgeneration Problem



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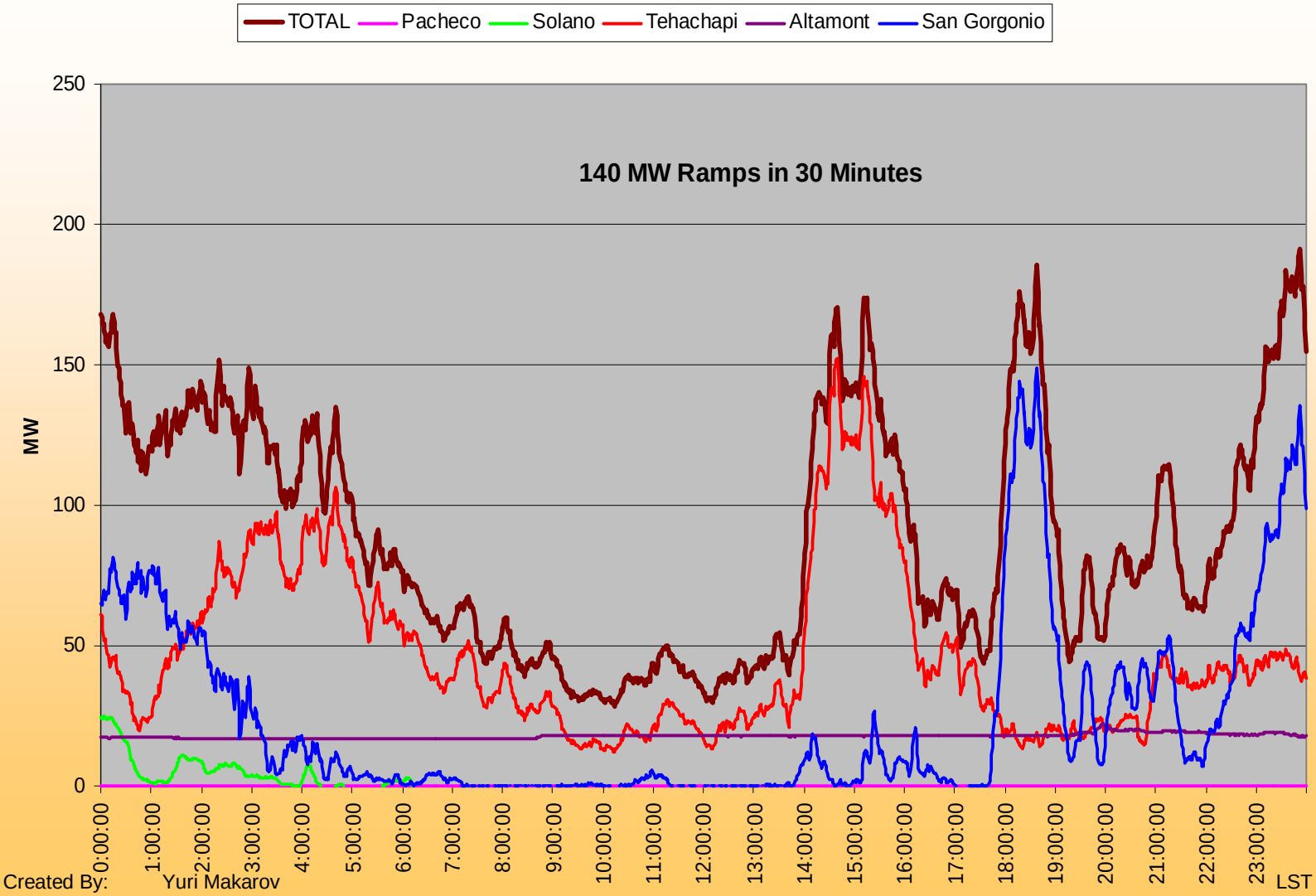
Ramp Rates

January 9, 2005 California Wind Generation



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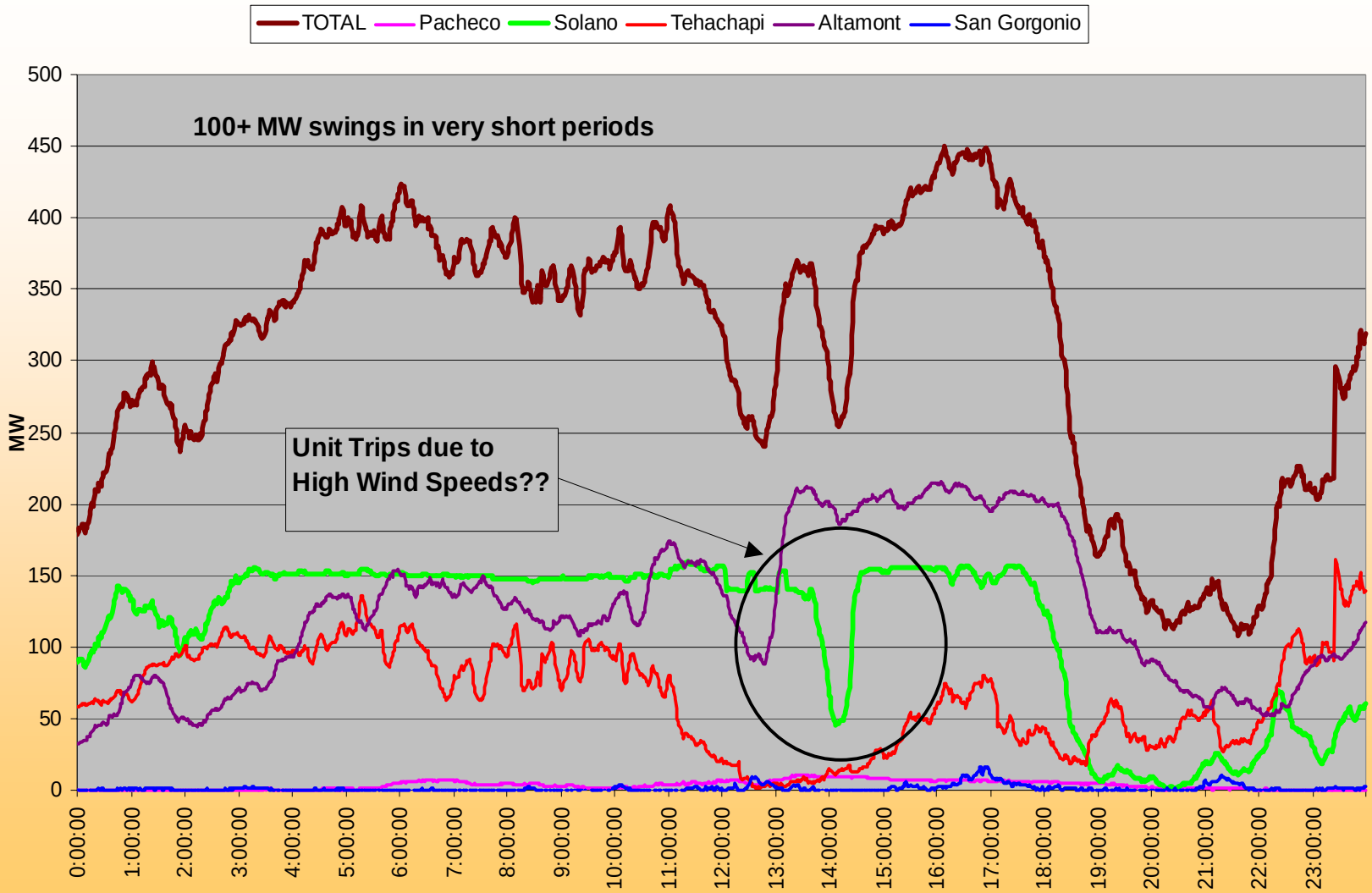
Intermittency at High Wind Speeds

January 7, 2005 California Wind Generation



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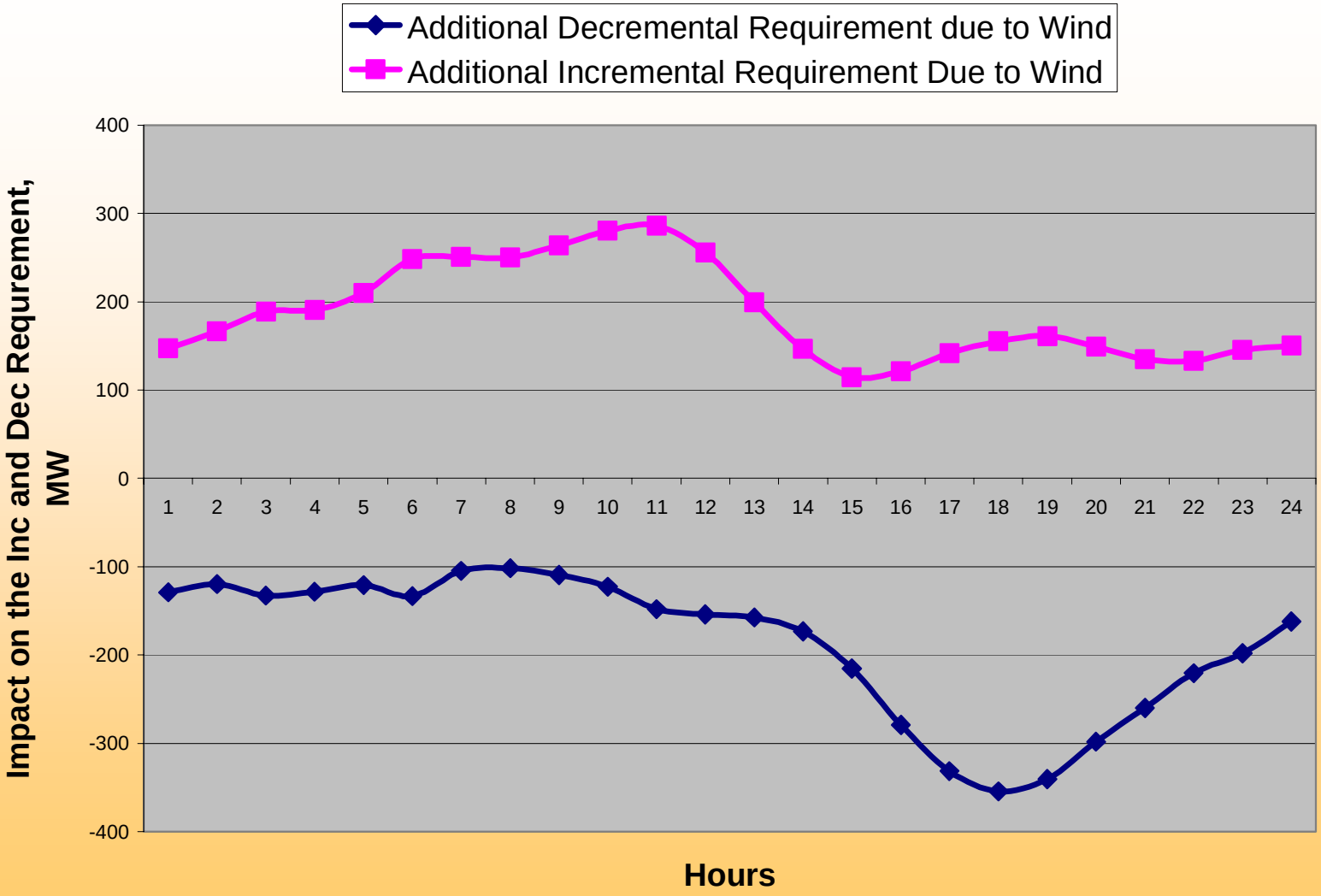
Impacts on Load Following Requirements (2002)



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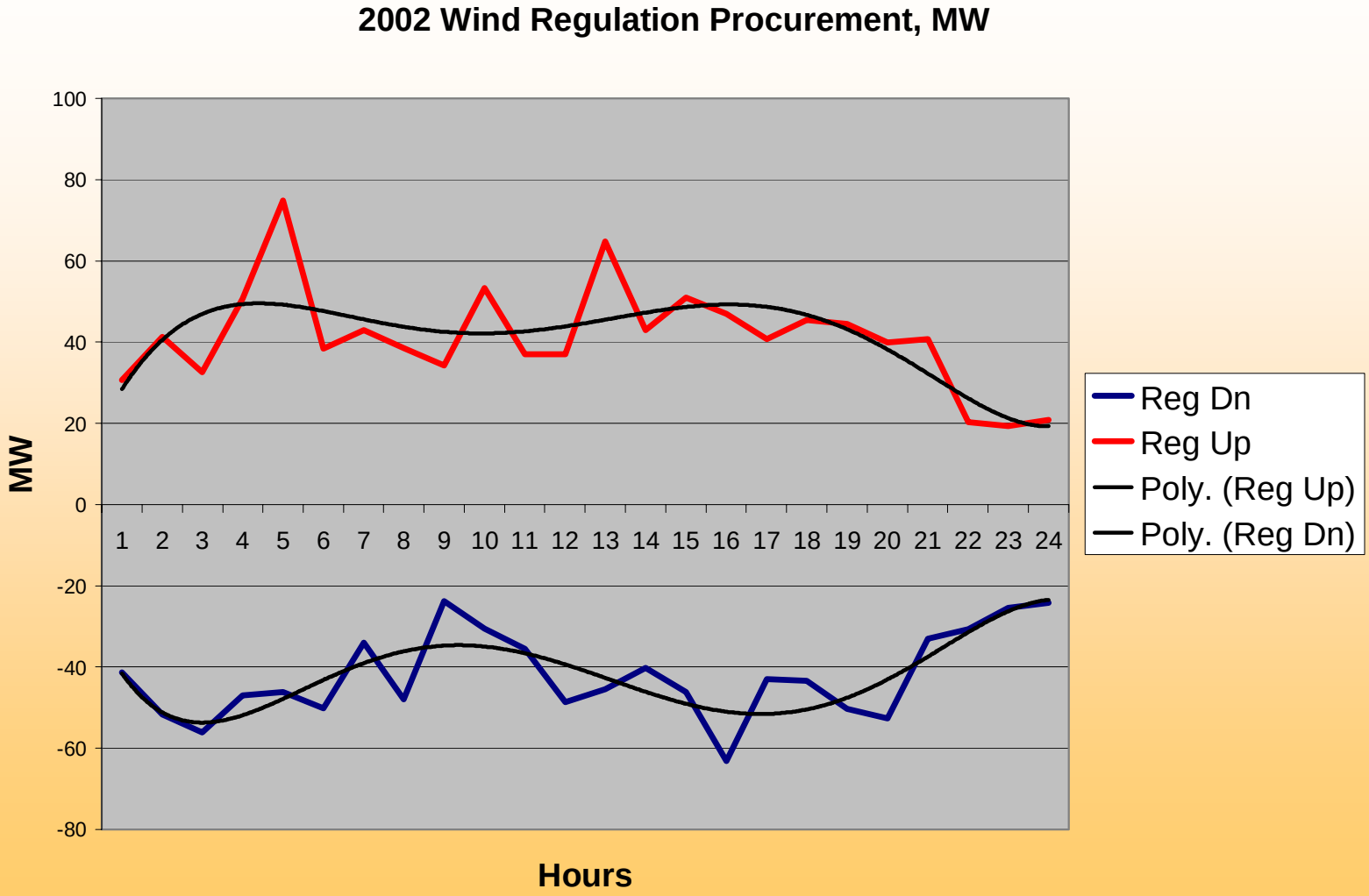
Impacts on Regulation Requirements (2002)



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III. Summary of Observations

SUMMARY OF OBSERVATIONS

- Certain operational issues with just ~2000 MW of wind
- (Unscheduled) Impact on Generation Dispatches & Reserves
- Potential Impact on Other Generators' Performance
- Frequency Response
- Wind Generation And System Load Have Different Daily Patterns
- Overgeneration Problem in April-May
- Ramp Rates
- Intermittency at High Wind Speeds
- Impacts on Regulation and Load Following Requirements
- Need to be prepared to accommodate more wind energy in our system

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IV. We Need To Work Together For Optimal Solutions

POSSIBLE SOLUTIONS TO THINK ABOUT – OPEN LIST

Better Forecasting and Scheduling

- WG Resources Should Be Equipped With Day- and Hour-Ahead Forecasting Service For Better Scheduling
- WG Resources Should Be Equipped With Meteorological Towers And Provide Real-Time Telemetry To CAISO For Near-Real Time Forecasting
- Report Capacity Derate Information To CAISO
- Quality Of Real-Time Information Including MW Production Should Be A Priority
- CAISO To Develop Wind Generation Displays, Alert Systems, And Near-Real Time Regional Forecast System Integrated With ADS

POSSIBLE SOLUTIONS TO THINK ABOUT – OPEN LIST

Limited Dispatchability

WGs should comply with the CAISO dispatch instructions to reduce their output at system conditions endangering grid reliability:

- **Congestion Mitigation**
- **Emergency, e.g. significant positive frequency excursions**
- **Excessively fast ramping of intermittent resources**
- **Overgeneration**

POSSIBLE SOLUTIONS TO THINK ABOUT – OPEN LIST

Intermittent Resources Work Group II – Grid Operations

- **Using the successful experience of the Intermittent Resources Work Group created to develop principles of market integration of intermittent resources in California (PIRP), create a similar Work Group for operational issues.**

- **Based on the idea that ensuring the operational grid reliability is in the best interest of all participating parties, and that developing related principles of grid integration of intermittent resources will actually pave the road for more green power in California, by joint effort develop rules for this integration acceptable to the California ISO and Wind Power Producers.**

POSSIBLE SOLUTIONS TO THINK ABOUT – OPEN LIST

New Technologies and World Experience

- Improved Unit Designs
- Energy Storage Devices, e.g. CEC/CAISO Project with Beacon Power
- Use European Experience (Germany, Spain, Denmark)
- Any Other Technologies???

Should We Think About Harmonization Of California Generation Portfolio The Longer-Term Future?

V. CONCLUSIONS

CONCLUSIONS

- **We are committed to achieve the goals of the California Renewable Portfolio Standard, SB 1078**

- **At the existing penetration of wind generation, we noticed certain operational issues related to this resource**

- **These issues will become problems with significant additions of WG and we need to address them before they appear**

- **We need to work together to pave the road for much more green power in California while maintaining reliability and controllability of the grid**