SAND2008-5302P

Energy Storage Enabling Technologies

EPRI Workshop:

Opportunities and Challenges for Energy Storage Systems to Reduce Greenhouse Gas Impacts in the Electric Power Sector

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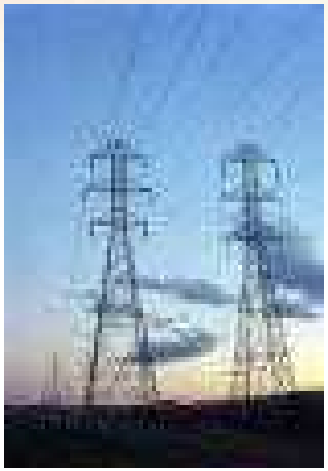
Why Energy Storage?



Energy Storage Mediates Between Variable Sources and Variable Loads

Without storage, energy generation must equal energy consumption

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Storage Enables

- Use more renewables –reduce need for fossil plants
  - for regulation and spinning reserve
  - minimize transmission congestion

- Operate Fossil fuel generators at optimum set point
  - reduce emissions

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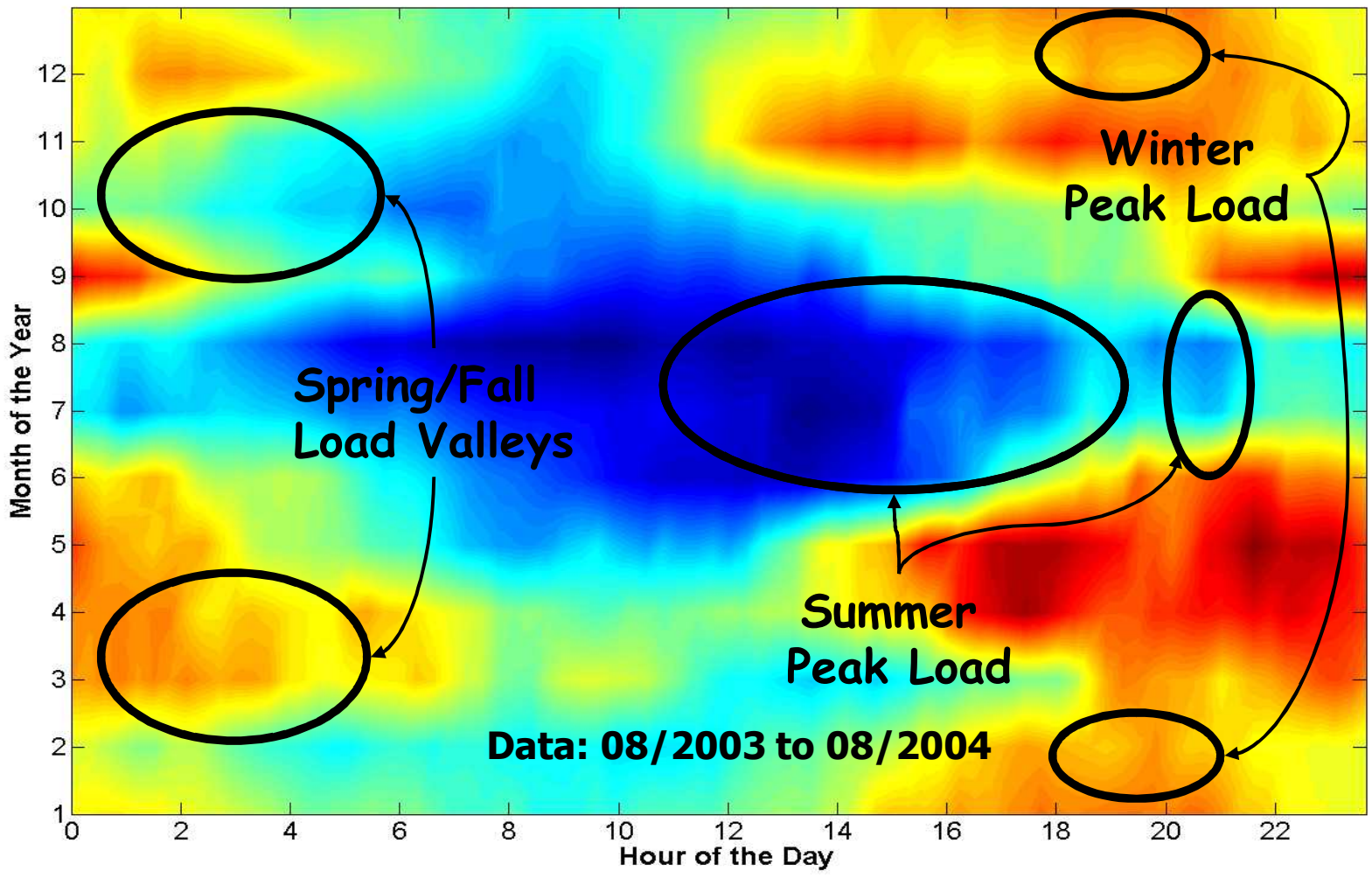
Wind Output Profile vs. Min/Max Load



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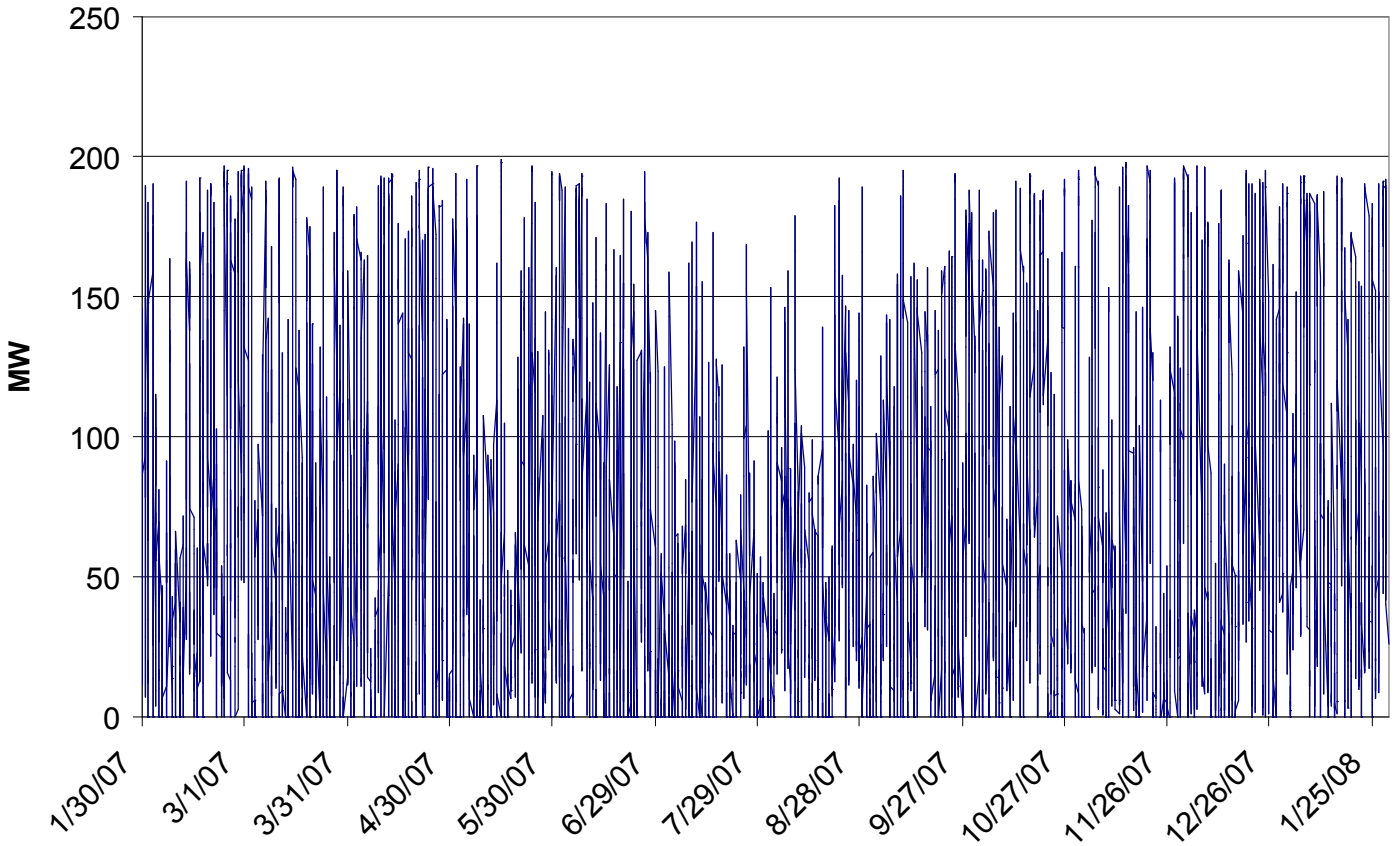
New Mexico Wind Energy Center
(200 MW)



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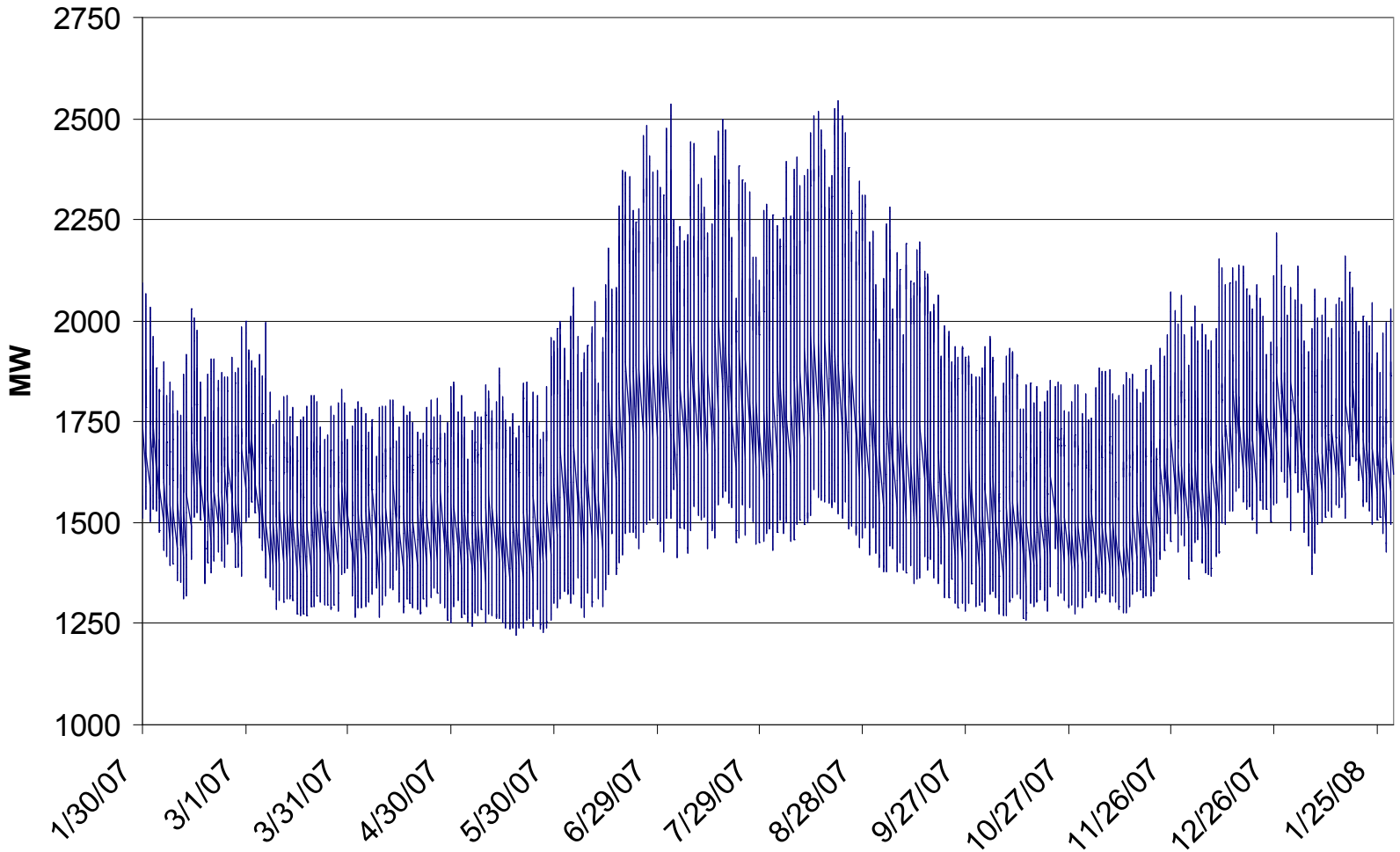
PNM Balancing Area Load

(Max = 2500MW, Min = 1250MW)



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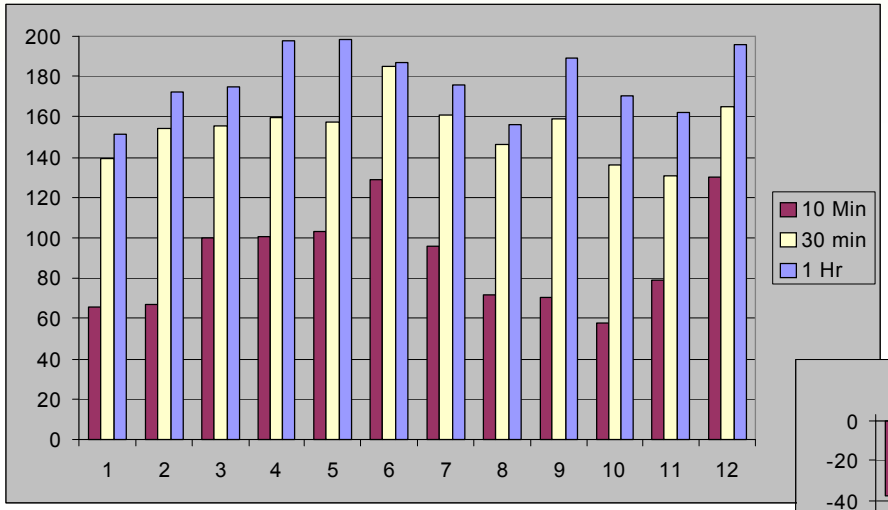
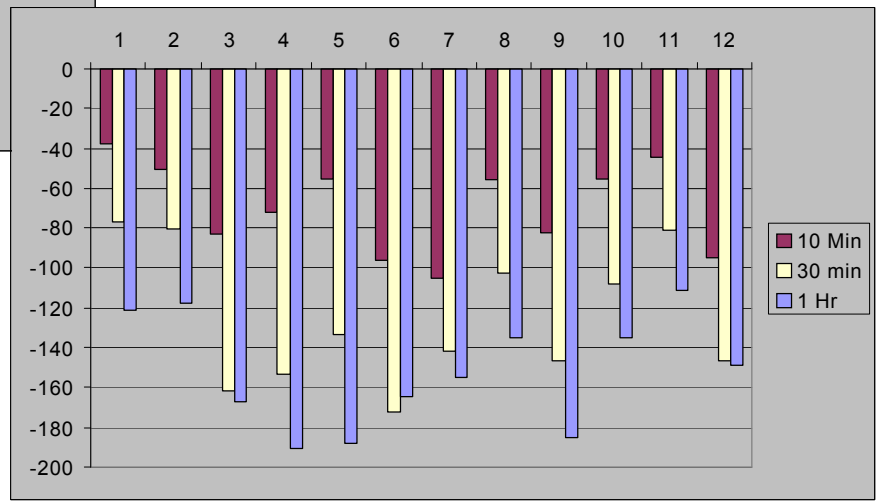
Maximum Up Ramps and Down Ramps

New Mexico Wind Energy Center
(by month)



MW Up Ramps



MW Down Ramps

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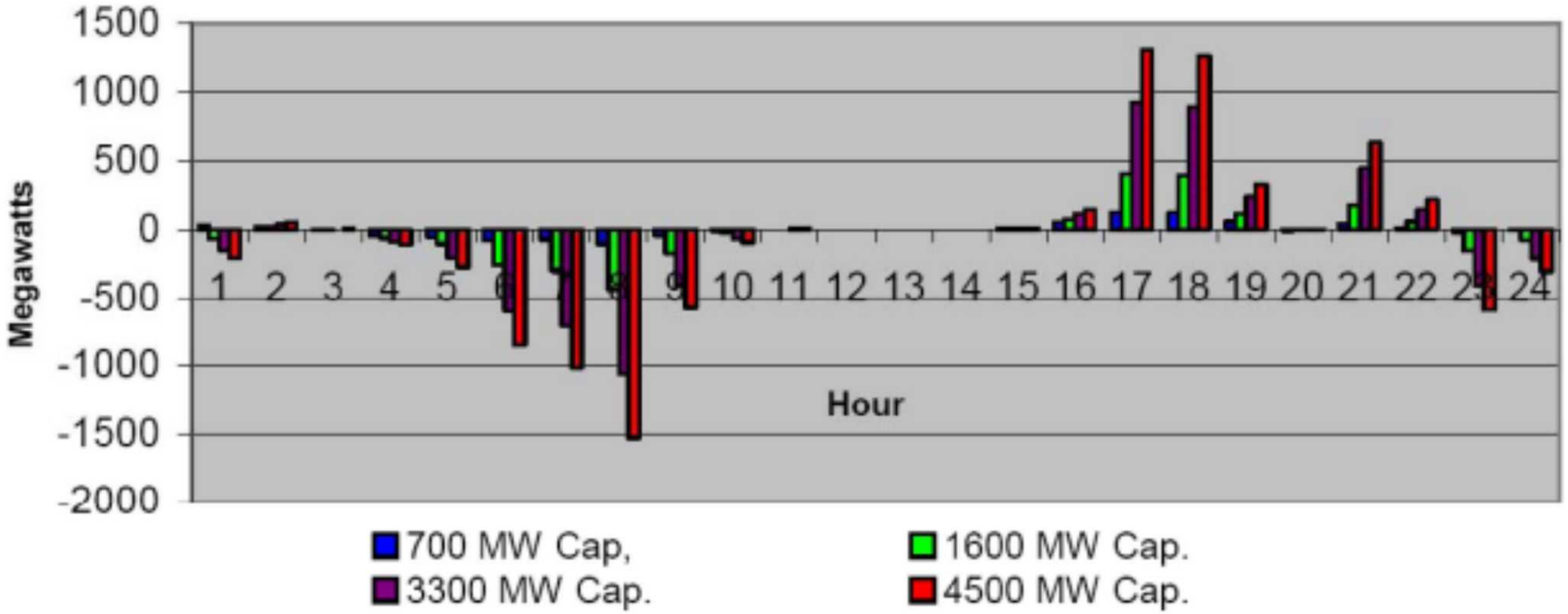
Predicted Energy Ramps-Additional Tehachapi Generation



California ISO
Your Link to Power

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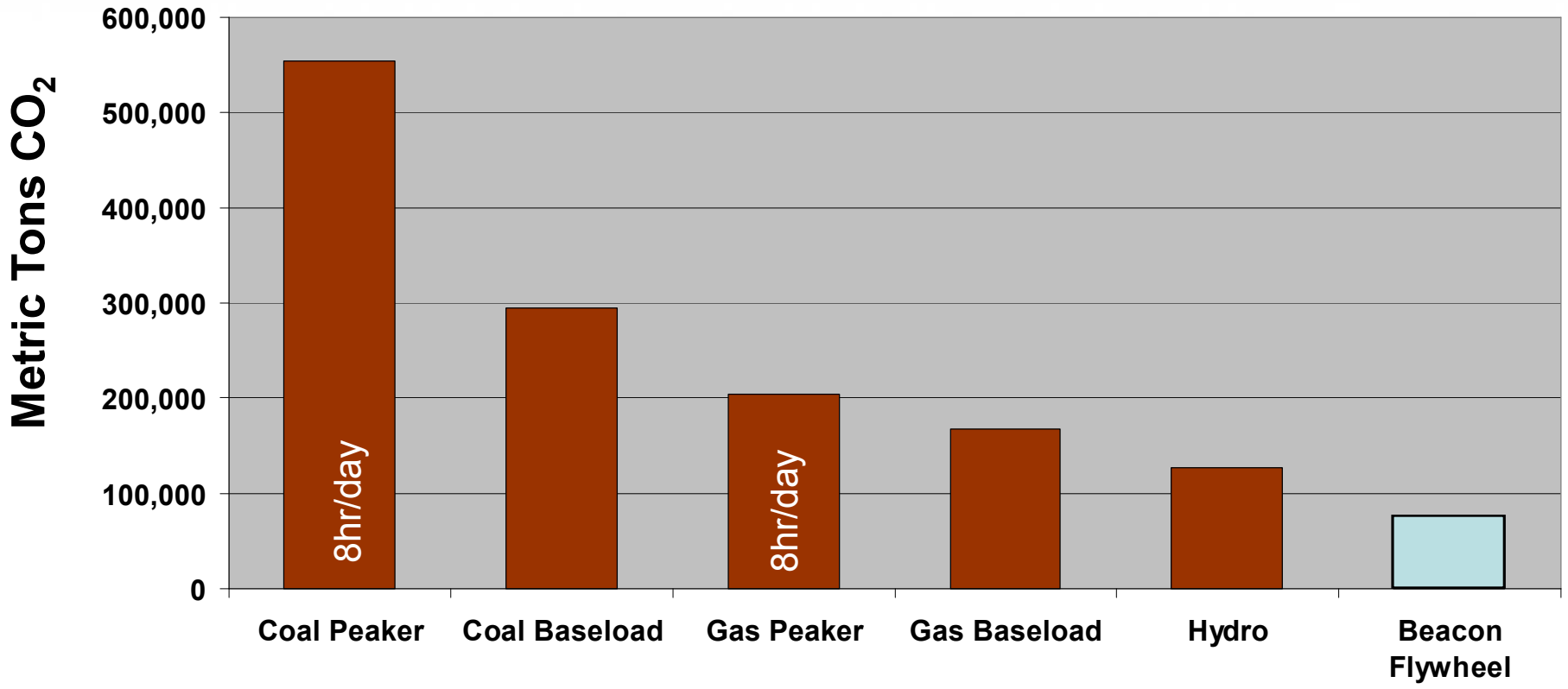
Technology Comparison - Emissions

CO_2 Reduction

From KEMA study: 20 MW of Regulation over 20-year operating life



Dramatic reduction in CO_2 emissions vs. present methods

Beacon POWER

KEMA

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Emissions Comparison Approach

- Premise:
  - Traditional coal and gas power plants operate *less efficiently* in ramping output in frequency regulation mode **- Increased Emissions**.
  - Flywheels and other energy storage devices use grid power at *average* emission profiles – **Decreased Emissions.**
- Approach:
  - Examine Regulation Cycle
  - Calculate All flywheel losses and associated emissions from operation

Beacon POWER

KEMA

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Results of Emission Analyses

Flywheel Regulation Compared:

- Coal Power Plants
  - Large reductions in the CO_2, SO_x, and NO_x
  - Generators use more fuel in ramping regulation mode
- Natural Gas Fired Power Plants
  - Mainly CO_2 emission reduction

Beacon POWER

KEMA

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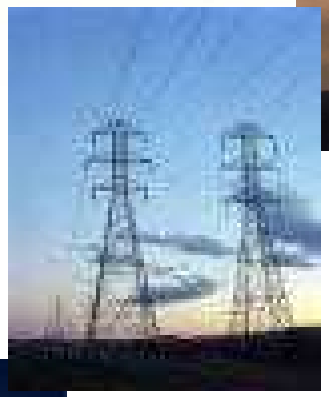

Energy Storage Enables

- Better system-wide asset utilization
- Enhanced reliability / power quality
- Increases value of Renewables

To Reduce Greenhouse Gas Impacts

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Coast Guard Example

- 1 year simulation - consumed ~25% less fuel
- Diesel generator run time reduced by ~38%
- Demonstration at operational site
  - Duke Island (near Ketchikan, AK)

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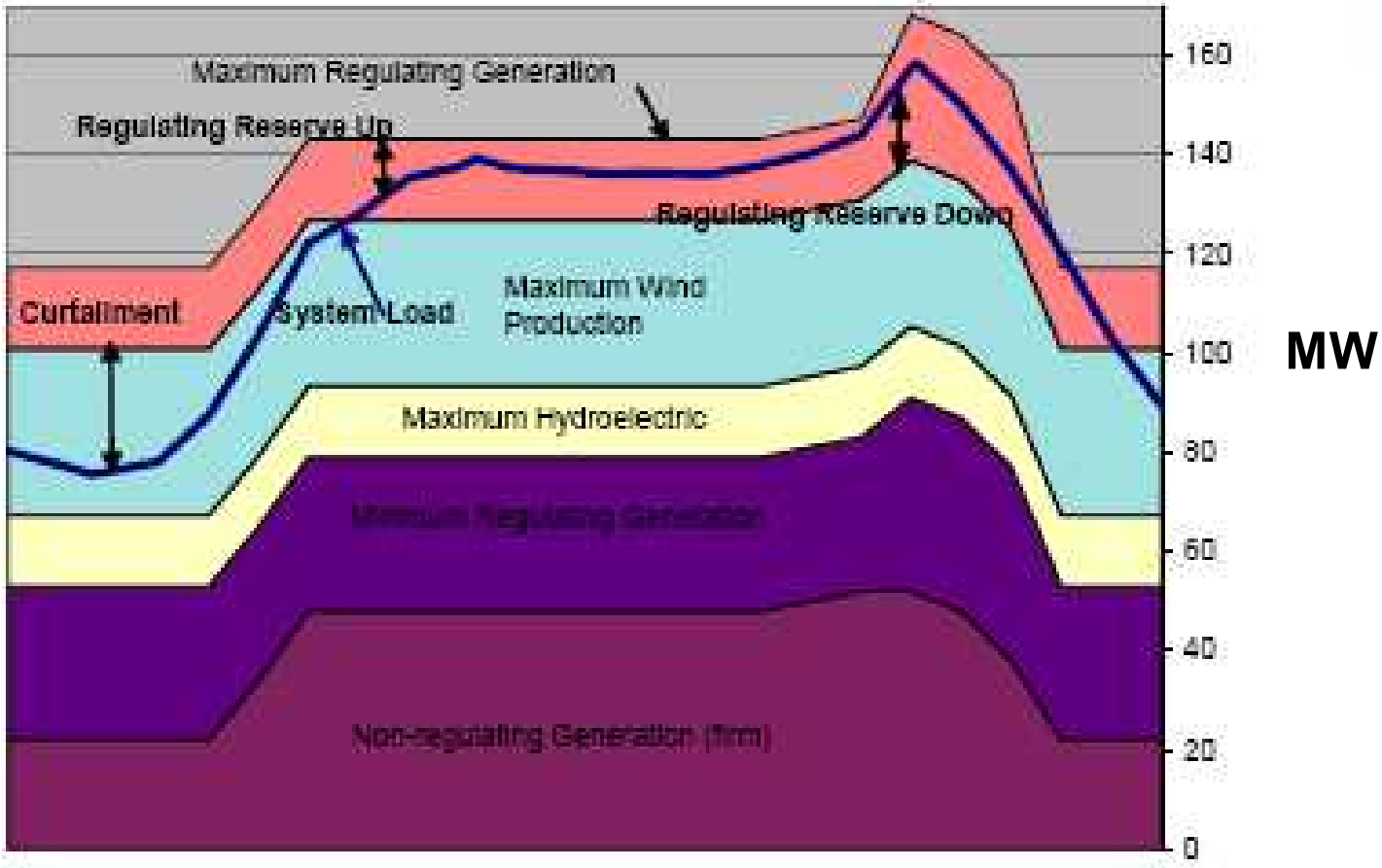
HELCO Load Curve/ Generation Characteristics for Future Wind



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Storage as Part of a Transmission System