Integrating Wind and Solar Projects

2009 Southwest Renewable Energy Conference

Meeting of the AZ Wind Working Group

Flagstaff, AZ

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UWIG
Utility Wind Integration Group

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Integration Group

What is UWIG?

- Non-profit corporation established by 6 utilities in 1989 with support from EPRI and DOE/NREL
- Over 150 members, including utilities, developers, manufacturers, consultants, government organizations
- Focus on technical issues
- Mission: To accelerate the development and application of good engineering and operational practices supporting the appropriate integration of wind power into the electric system

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It's All About Dealing with Variability and Uncertainty

- Variability
  - Load varies by seconds, minutes, hours, by day type, and with weather
  - Supply resources may not be available or limited in capacity due to partial outages
  - Prices for power purchases or sales exhibit fluctuations
- Uncertainty
  - Operational plans are made on basis of best available forecasts of needs; some error is inherent
  - Supply side resource available with some probability (usually high)
- Key questions
  - How does wind generation affect existing variability and uncertainty
  - What are the costs associated with the changes
  - What does the future hold

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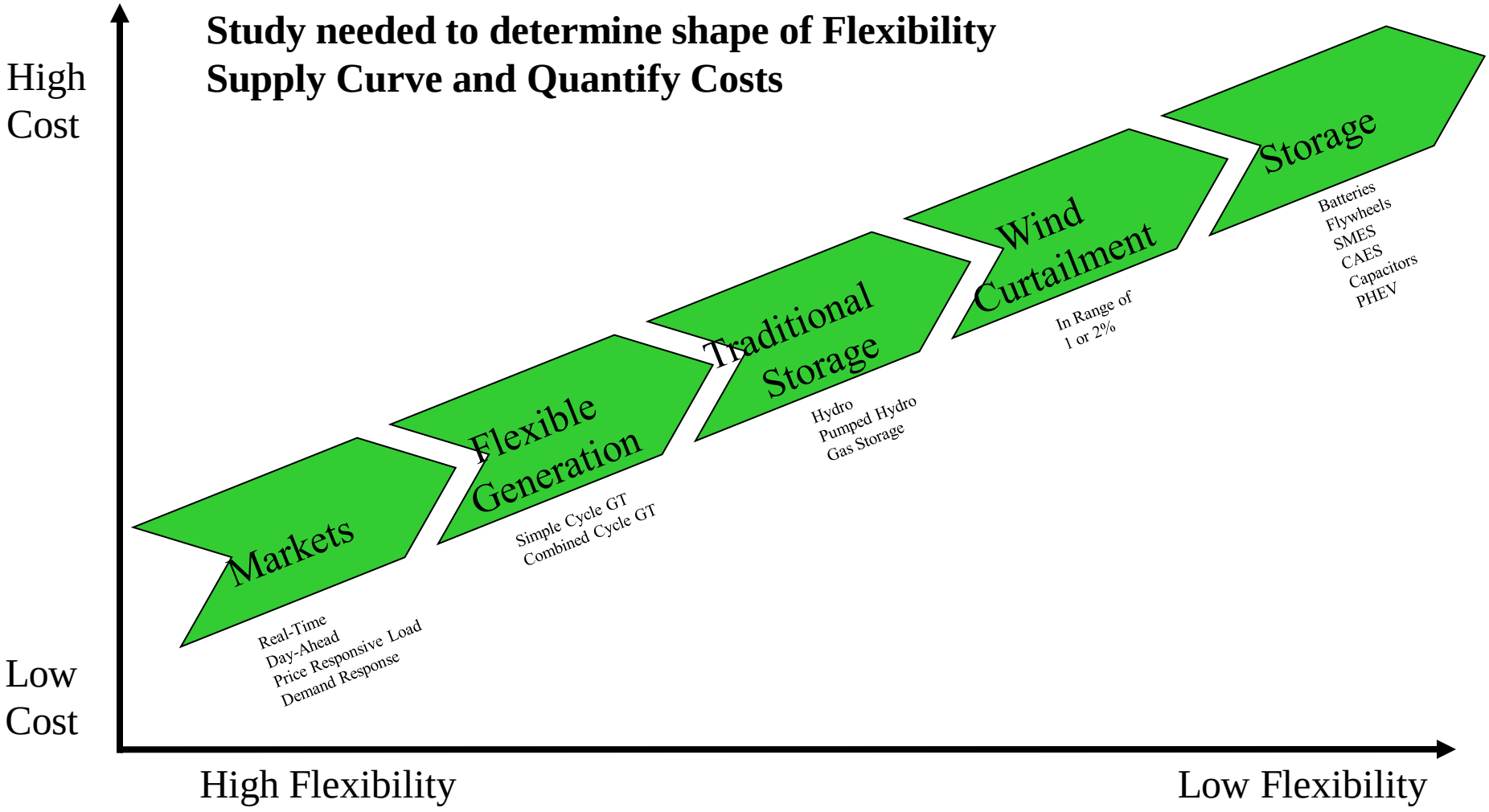
Flexibility Supply Curve

Study needed to determine shape of Flexibility Supply Curve and Quantify Costs



Interestingly – Generators Do Not Appear To Command A Premium For Sub-Hourly Response

ISO	Day-Ahead $/MWH	Hour-Ahead $/MWH	5-Minute $/MWH	Average Within-Hour 5-Minute Range $/MWH
NYISO	$67.70	$64.93	$63.31	**$91.18**
ISO-NE	$81.38	$80.76	$81.22	**$24.40**
CAISO		$69.78	$68.32	**$59.87**
ERCOT[1]			$71.69	**$40.00**
MISO	$49.99	$48.62	$48.71	**$67.75**

[1]ERCOT currently operate a 15 minute sub-hourly market rather than a 5 minute market.

- *Average* day-ahead, hour-ahead, and 5-minute prices are nearly equal
  - 5-minute price is often slightly lower
  - No premium for flexible generation
- *Within hour* 5-minute price *range* is very large
  - Marginal generators receive a strong signal to move within the hour

Source: Brendan Kirby, UWIG 2009 Spring Workshop

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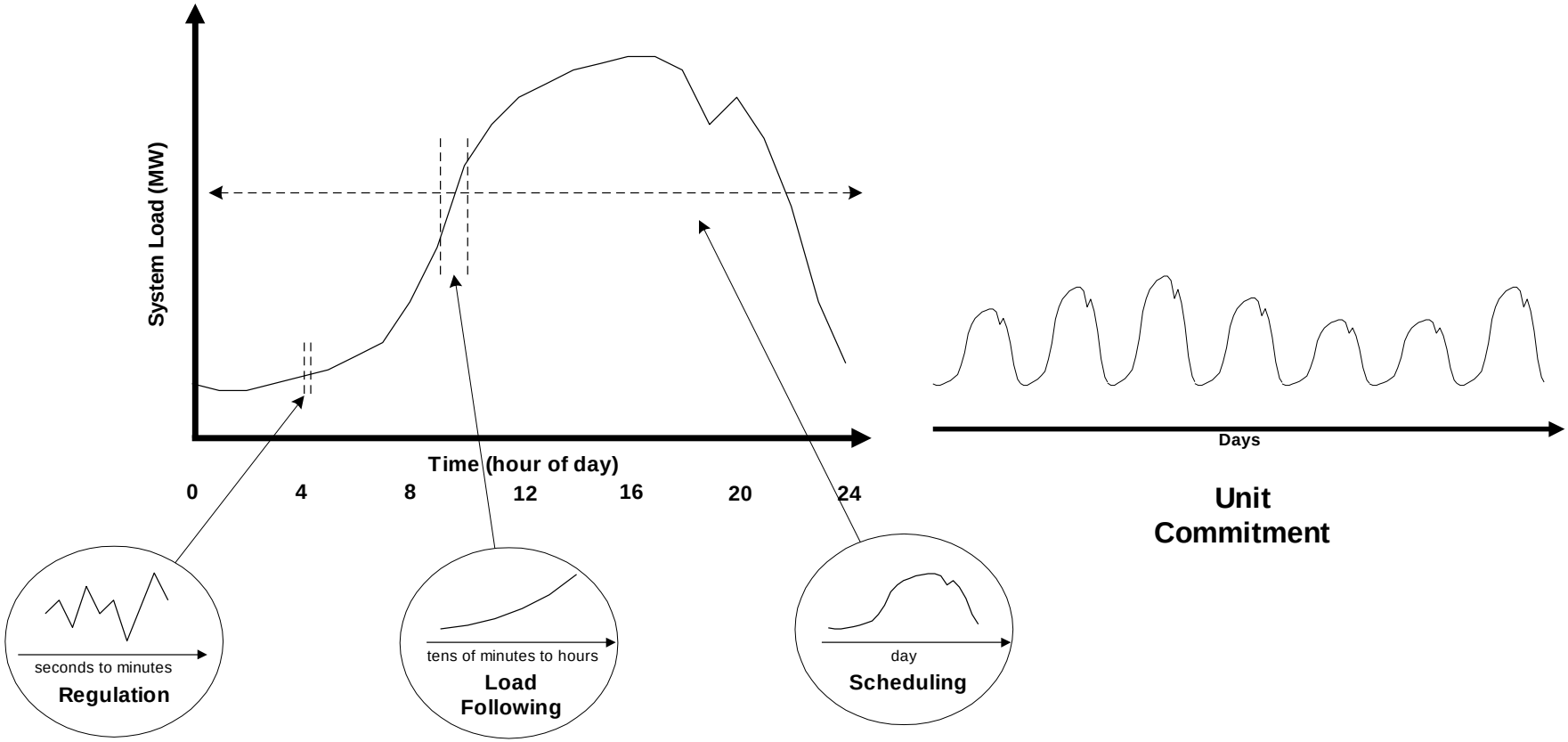
Time Scales of Interest



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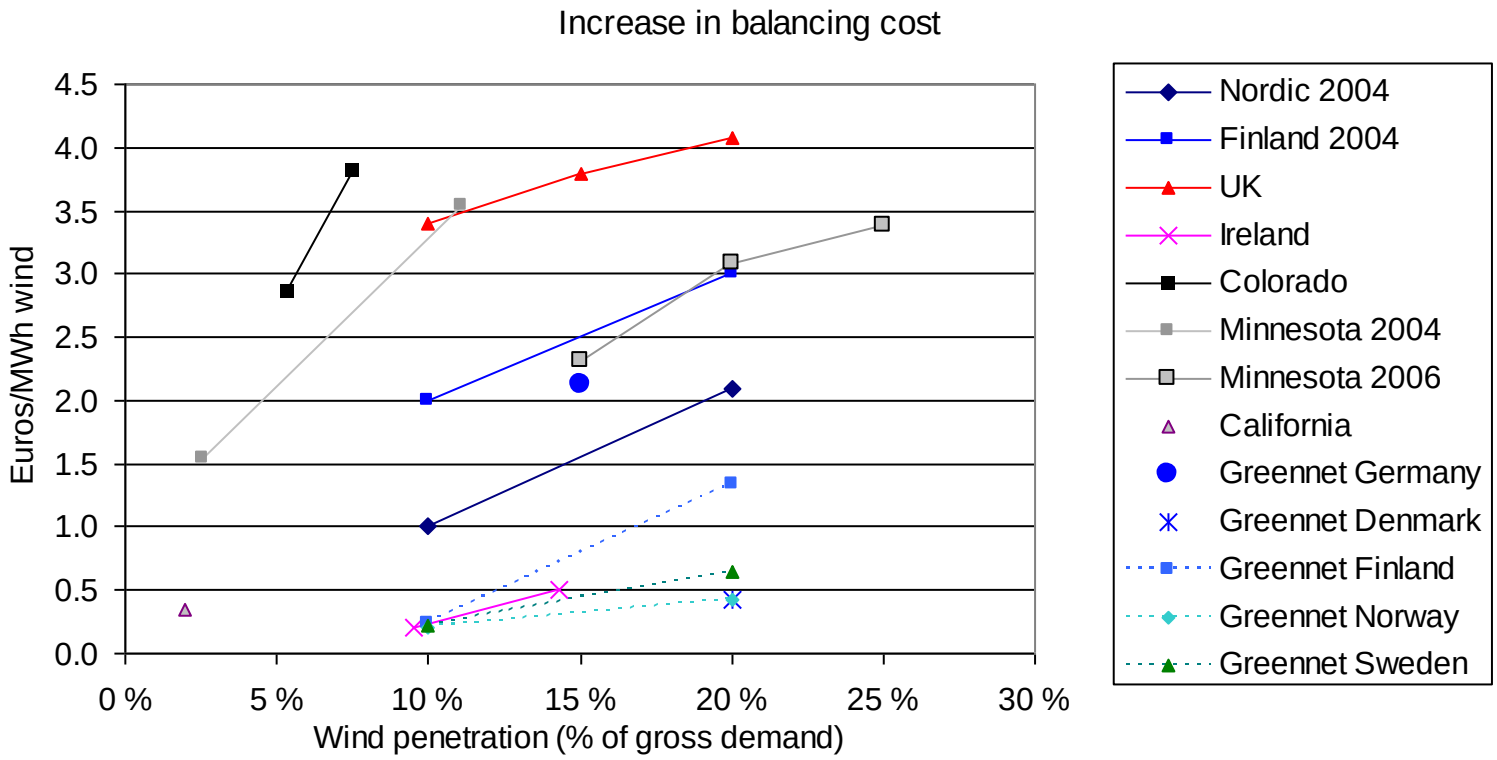
Increased Balancing Cost



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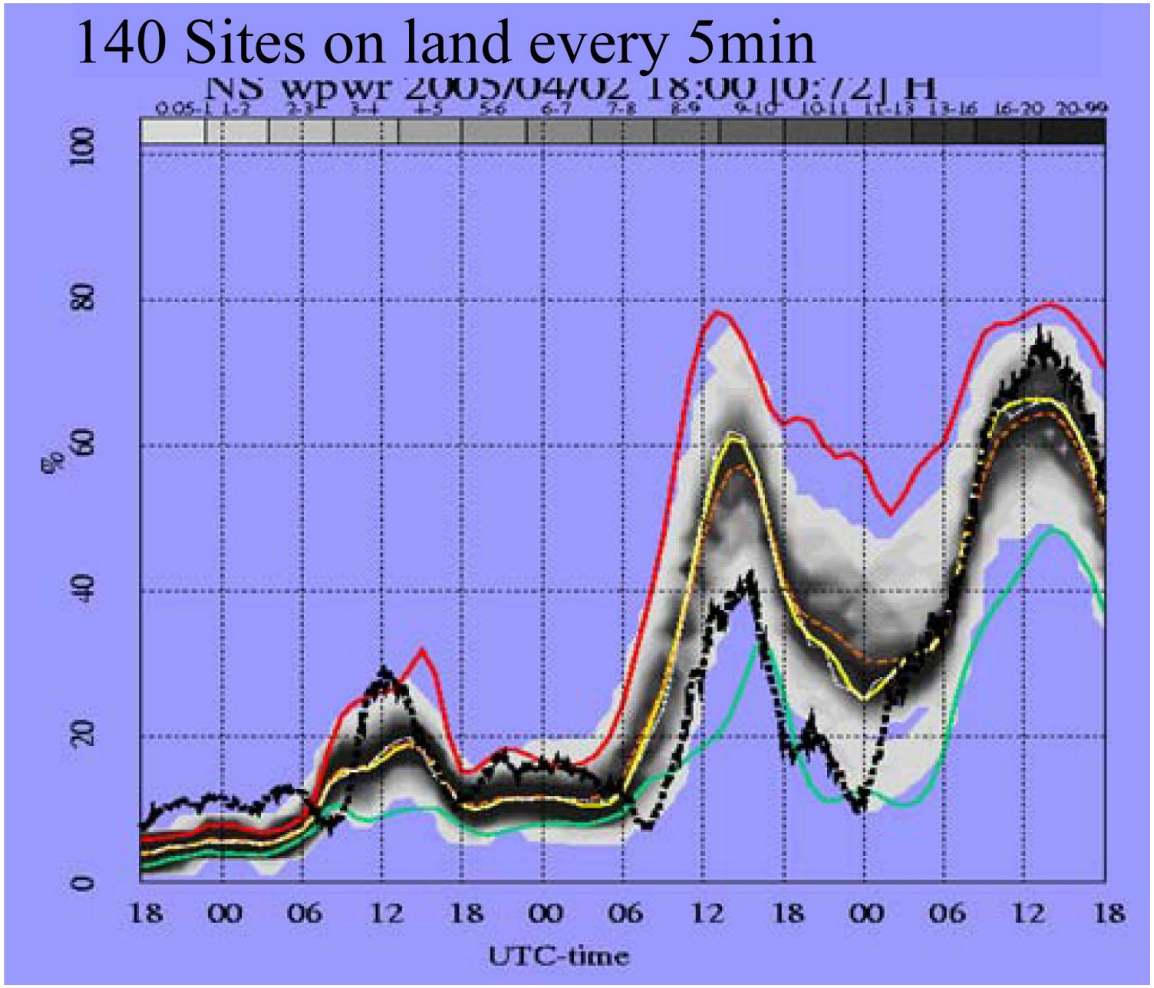
Forecasting and Balancing Markets Reduce Impacts



System Planning and Operation Recommendations

- Perform detailed wind integration studies
- Deploy more flexible generation and load technologies
- Improve wind plant output forecasting tools
- Improve grid codes and wind plant models
- Aggregate wind plant output over large regions
- Improve balancing area consolidation and ACE sharing
- Ongoing forums to share operating experience

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Transmission Planning Recommendations

- Develop adequate transmission capacity
- Comprehensive regional planning processes
- Federal leadership in developing transmission in support of national energy policy
- Reassessment of transmission financing approach
  - Customers in remote regions can't afford it
  - load pays in the end
- More certainty of transmission cost recovery
- More robust and flexible "smart" grid

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Market Operation and Transmission Policy Recommendations

- Develop well-functioning real-time, hour-ahead and day-ahead energy and price responsive load markets and expand access to those markets
- Adopt market rules and tariff provisions that are more appropriate to weather-driven resources
- Make better use of physically (in contrast with contractually) available transmission capacity
- Eliminate pancaked rates

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and the conclusion is…

- There are no fundamental technical barriers to the integration of 20% wind energy into the electrical system, but…

- There needs to be a continuing evolution of transmission planning and system operation policy and market development for this to be achieved.

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Additional Solar PV Challenges

- Lack of solar plant output data on all time scales
- Evidence of greater variability in solar plant output on all time scales
- Lack of understanding of aggregated solar plant output from multiple distributed sources
- Lack of experience in forecasting solar plant output
- Solar plant provides no system inertia
- Lower plant capacity factor, but higher capacity value than a wind plant
- Need Data, Data, Data!