

## Wind and Power Forecasting

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## Wind Forecasting: Definitions

*Hours Negative* – The count of hours for which the forecast is low (i.e., more generation will be needed than predicted)

*Hours Positive* - The count of hours for which the forecast is high (i.e., less generation will be needed than predicted)

*Negative Energy Error* – The total energy requirement (in MWh) under-predicted (the area under zero and above the forecast error curve in the figure shown later)

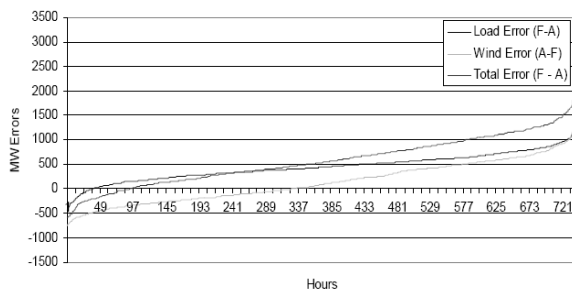


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## Wind Forecasting: Definitions



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## Wind Forecasting: Definitions

*Positive Energy Error* – The total energy requirement (in MWh) over-predicted (the area above zero and below the forecast error curve in the figure)

*Net Energy Error* – The total error in energy requirement predicted (the integral of the forecast error)

*Worst Negative Error* – The extreme or worst hour under prediction (the leftmost point in the duration curve)



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## Wind Forecasting: Definitions

*Worst Positive Error* – The extreme or worst hour over prediction (the rightmost point in the duration curve)

*Peak* – The maximum actual load or wind generation for the month

*Min* – The minimum actual load or wind generation for the month.

*Energy* – The total actual load or wind generation for the month



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## Wind Forecasting: Definitions

*Negative Energy Error* – The total energy requirement under predicted expressed as a percentage of the total load energy served

*Positive Energy Error* – The total energy requirement over predicted expressed as a percentage of the total load energy served



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## Wind Forecasting: Definitions

*MAE* – Mean absolute error of the forecasts, expressed in MW

$$AE = \frac{|y(t+T) - y(t+T)|}{NRP} \times 100\% \quad MAE = \frac{\sum_{i=1}^N AE(i)}{N}$$

*STD* – The standard deviation (sigma,  $\sigma$ ) of the forecast errors, in MW

$$Std = \sqrt{\frac{\sum_{i=1}^N (AE(i) - MAE)^2}{N-1}}$$

*MAE %* – Mean absolute error of the forecasts, expressed in percent of the installed MW of wind generation



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## Wind Forecasting: Definitions

*Forecast DA Wind* – The wind power that would have been forecast a day-ahead at that time for the study wind generation scenario

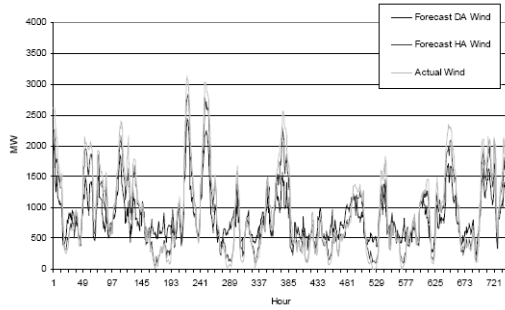
*Forecast HA Wind* – The wind power that would have been forecast an hour-ahead at that time for the study wind generation scenario

*Actual Wind* – The wind power that would have been produced at that time for the study wind generation scenario



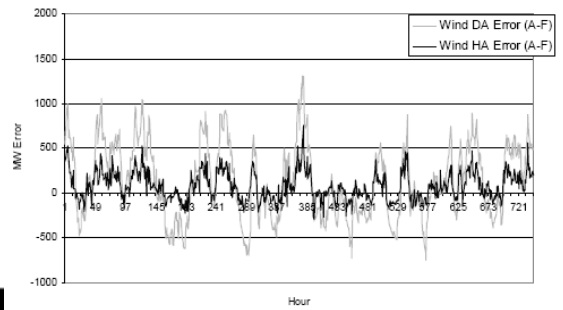
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### Day-ahead and Hour-ahead Forecast and Actual Wind



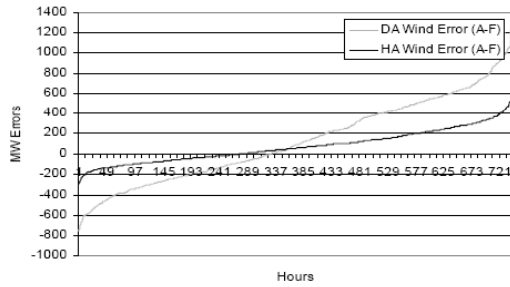
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### Day-ahead and Hour-ahead Forecast Error



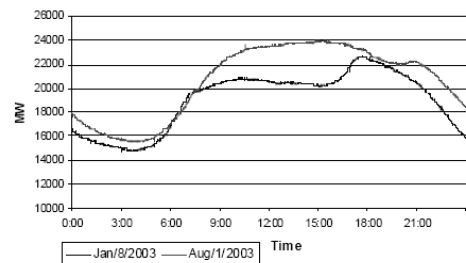
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### Day-ahead and Hour-ahead Forecast Error Duration

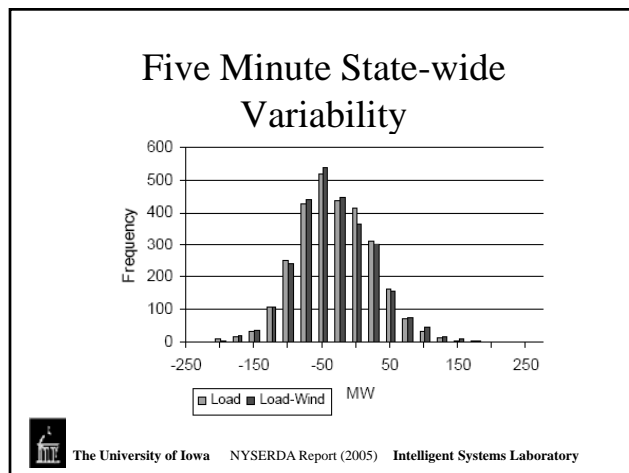
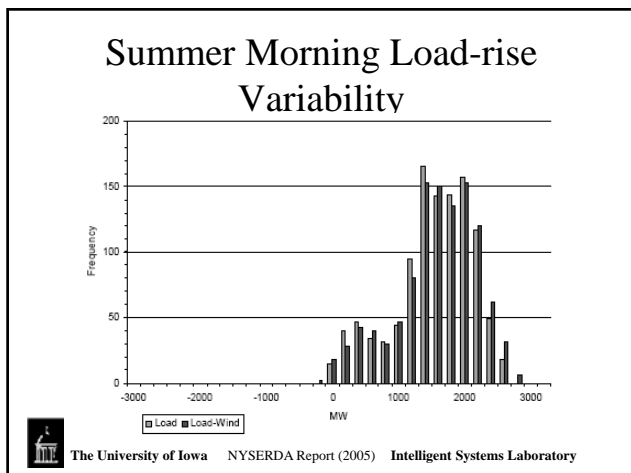
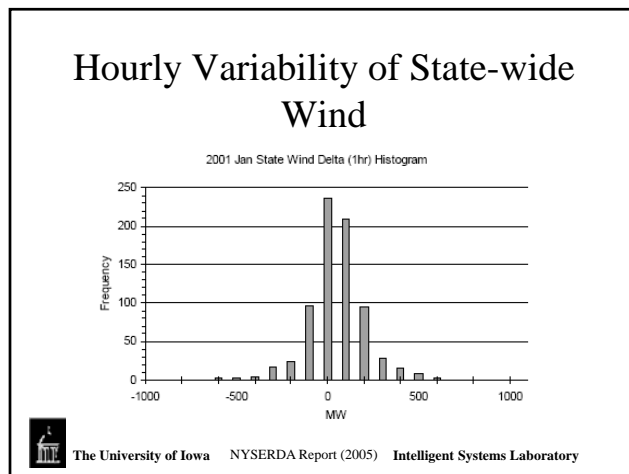
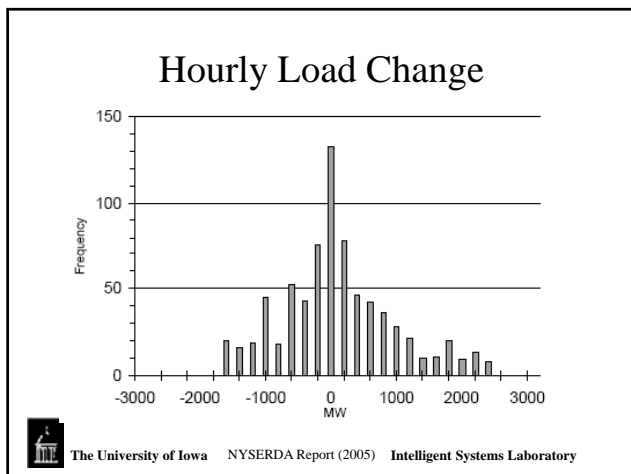


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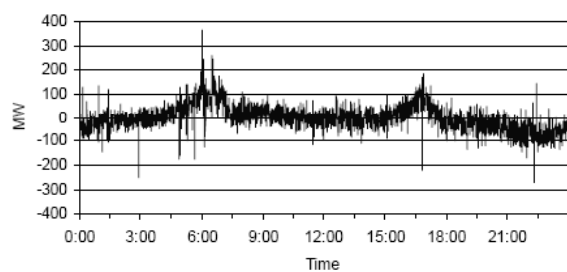
### State-wide Daily Load Profile



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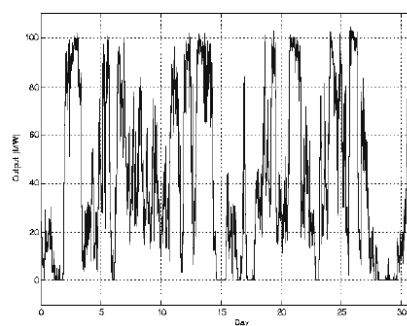


### State-wide Load Variability Around Five Min Running Average



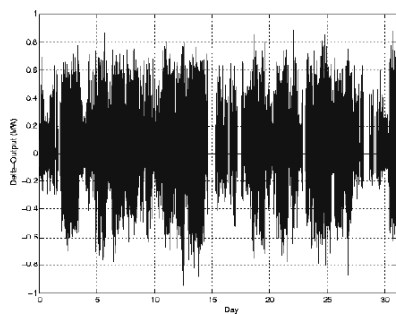
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### A Month a Second Resolution Data From an Operating Farm



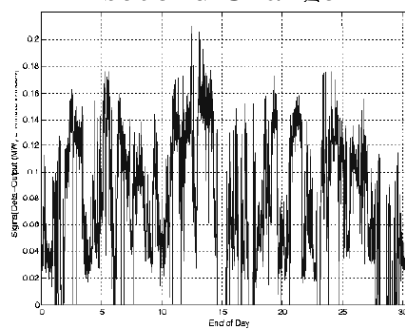
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### Second-to-Second Change of a Month



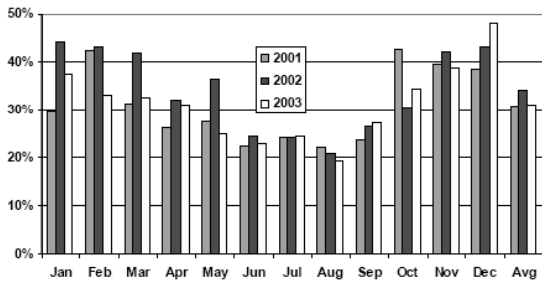
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### Moving Average SD of One-second Change



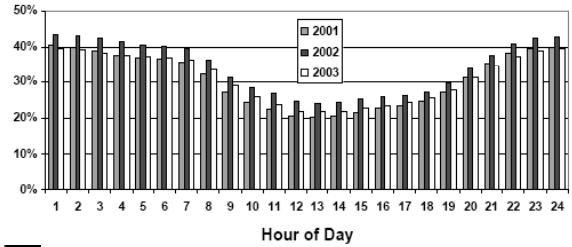
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### Monthly Wind-Capacity Factors



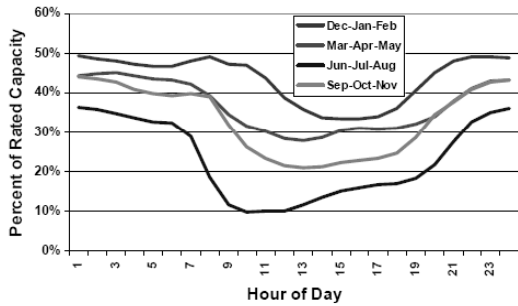
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### Hourly Wind-Capacity Factors



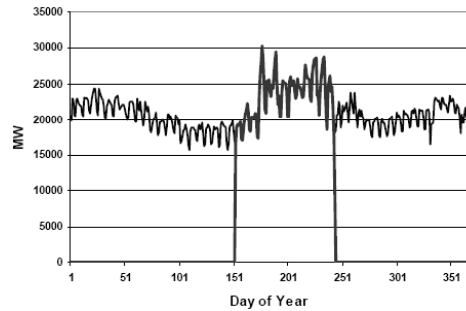
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### Average Seasonal Wind Shape



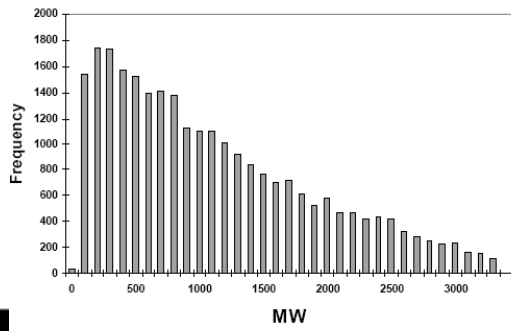
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### Daily Peak Load Profile



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### Hourly Output Over Three Years



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