Temporal Wind Variability and Uncertainty

Nicholas A. Brown

Iowa State University, Department of Electrical and Computer Engineering

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An Experiment at Home

One Cup of Coffee

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- Need water, roasted beans, a filter
- Have some basic steps you follow, and it should be "okay" to drink.
- "Okay" is - a very imprecise standard

Here is a more precise standard...

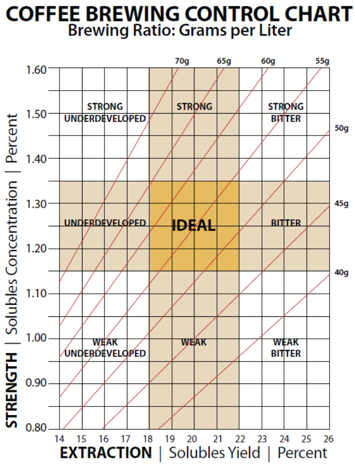

Figure: A Standard in Two Dimensions

Source: http://paradiseroasters.com/content/Brewing Control Chart.pdf

Aggregated, Wind Looks "Okay"

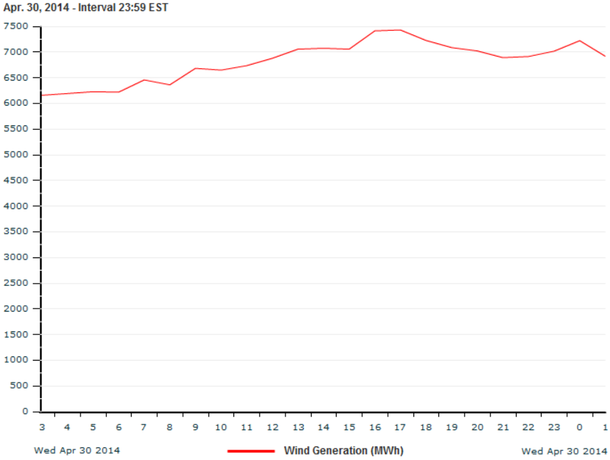

Figure: 24 Hours of Wind in MISO

Source: MISO Real-Time Market Data

Predicting Resource Needs

Serving Net Load Across Spatial and Temporal Scales

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- In addition to predicting overall trend, need to anticipate timing of large, sustained changes
- If timing of forecast is off (known as phase error), need to be able to readjust dispatch of resources quickly

Load and Renewables

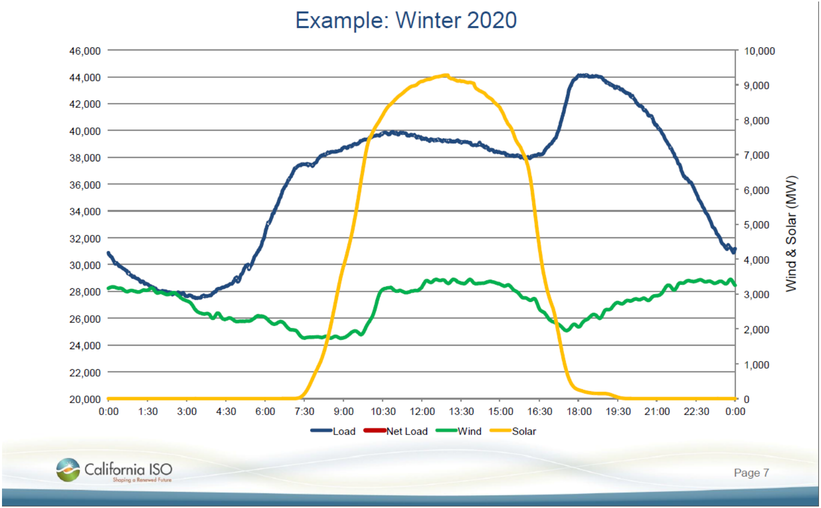
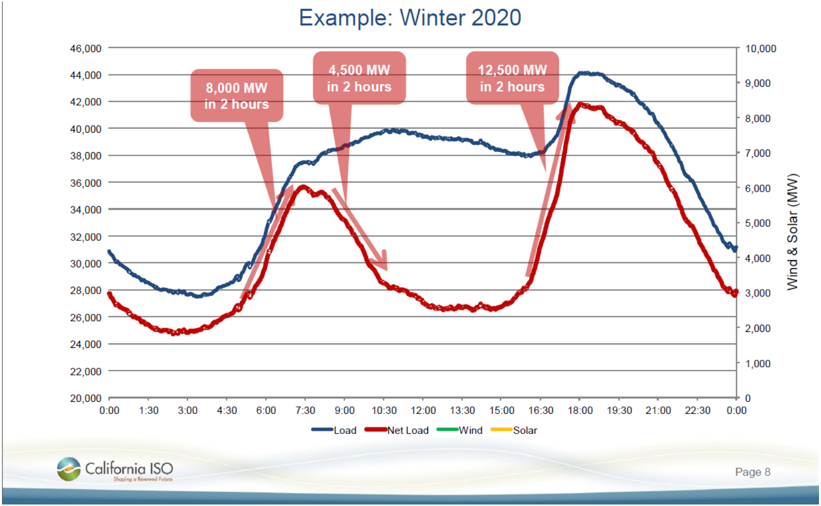


Figure: Winter Day in CAISO, 2020

Source: Blatchford, J. (2013) *View of the ISO*, 2013 UVIG Forecasting Workshop

Projected Load and Net Load



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- Support simulation with representative windows of time for many wind farms, with realistic uncertainty

Altoona

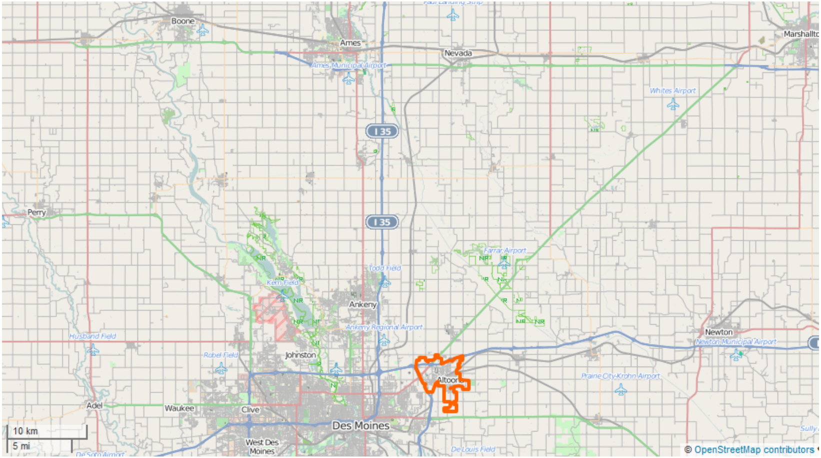


Figure: Altoona, IA

Altoona

Figure: Altoona Monthly Wind Speed

Altoona

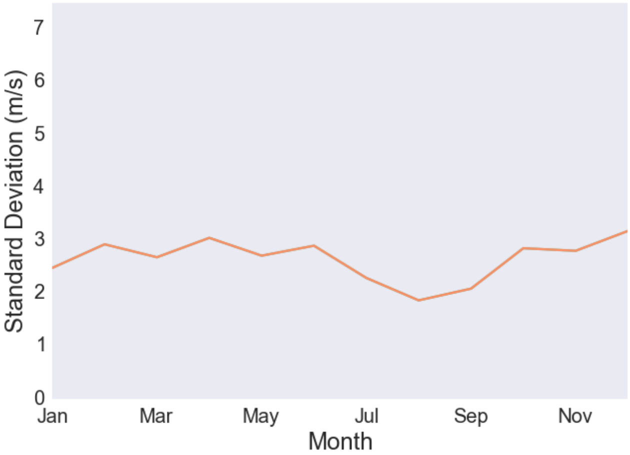


Figure: Altoona - Monthly Standard Deviation at 50m

Characterizing Altoona Wind Speed for Full Year

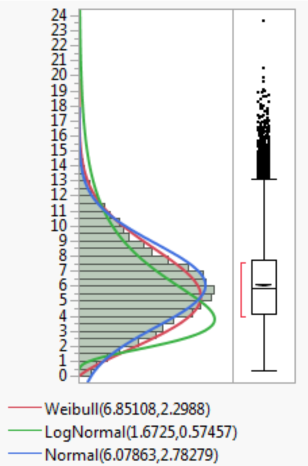
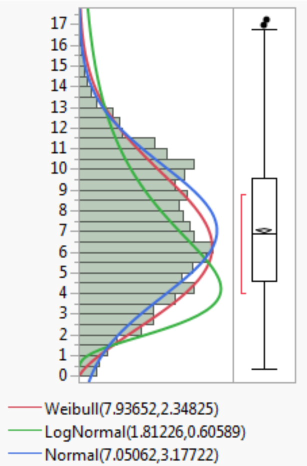


Figure: Altoona Distribution Fits - Weibull, Lognormal, Normal

Characterizing Altoona Wind Speed - December



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- For longer-term simulation, Weibull could tell whether the 5- or 10-minute wind speeds used are realistic
- Good to have long-term distributions for reference, but net load and operations have weekly, daily, hourly and sub-hourly cycles
- Would we want to use the Weibull itself to synthesize a range of daily wind speed simulations?

Altoona - June 1

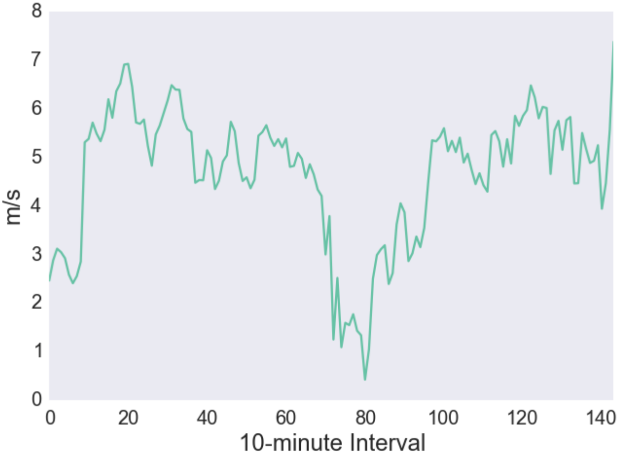
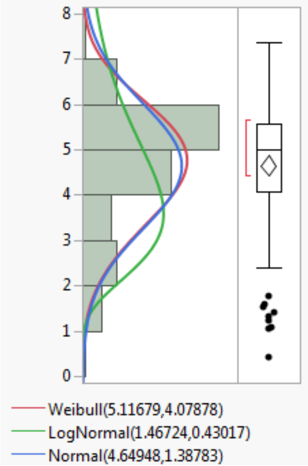


Figure: Altoona Average Wind Speed at 50m - June 1, 2008

Attempt to Fit Single Day



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Trend

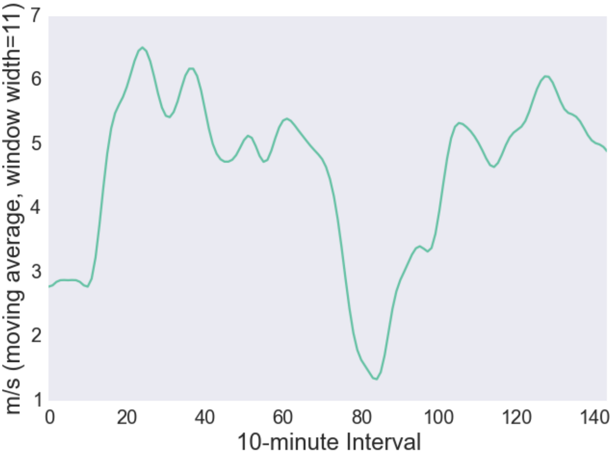

Figure: Moving Average of Wind Speed at 50m - June 1, 2008

Histogram Leads to...

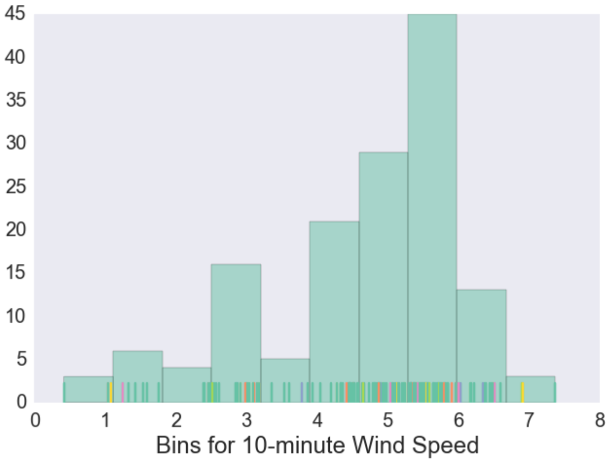

Figure: Altoona - June 1, 2008

Kernel Density Estimate

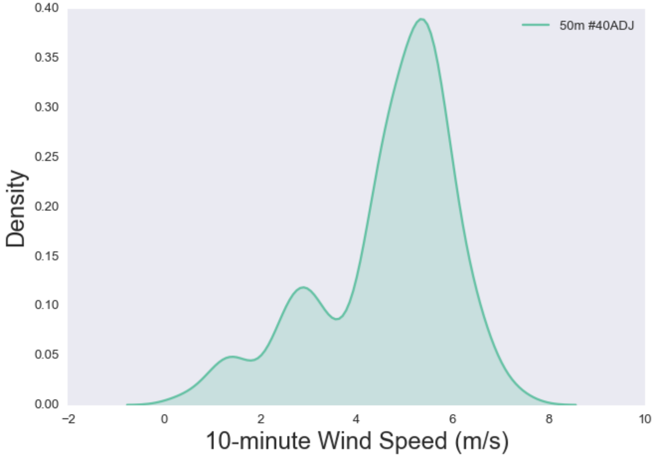

Figure: KDE - June 1, 2008

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- Distributions based on kernel density may provide way to generate variability and uncertainty across time scales

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- Main objective is to represent, but not reproduce in full detail, realistic situations that reflect both typical and extreme net load situations on grid
- Next steps are to consider other study sites and correlation with Altoona over 24-hour periods, and wind power at level of wind farms, based on wind speed