

# Integrating Wind Power Generation at Empire District Electric

June 26, 2008



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*Brad Beecher, P.E.*

# My Favorite Picture





# Integrating Wind Energy into Utility Systems

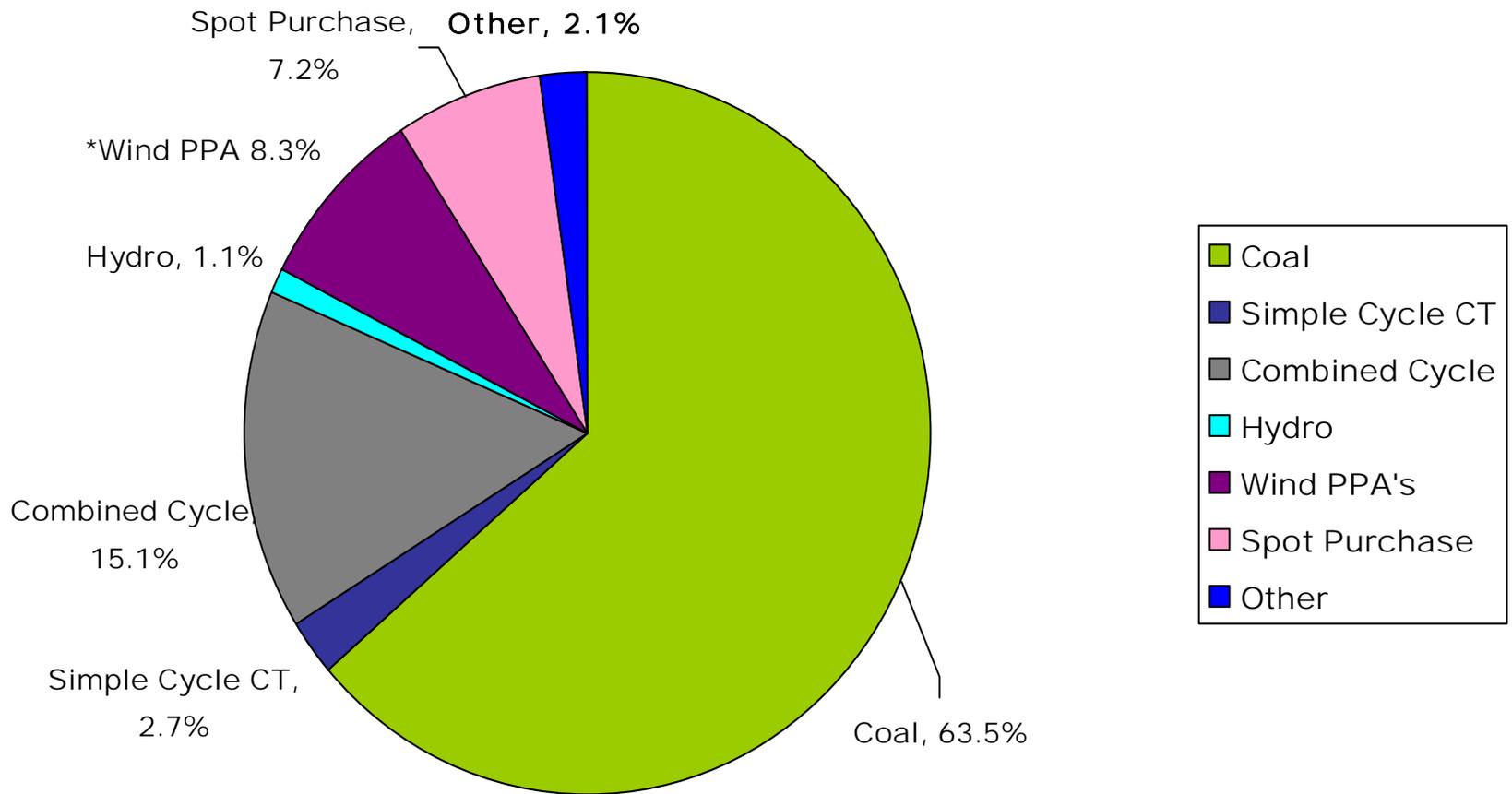


- Operational Impacts of Integrating Wind on a utility system
- Least Cost / Risk Planning Steps of Integrating Wind into an existing generation portfolio

# Wind PPA Agreements

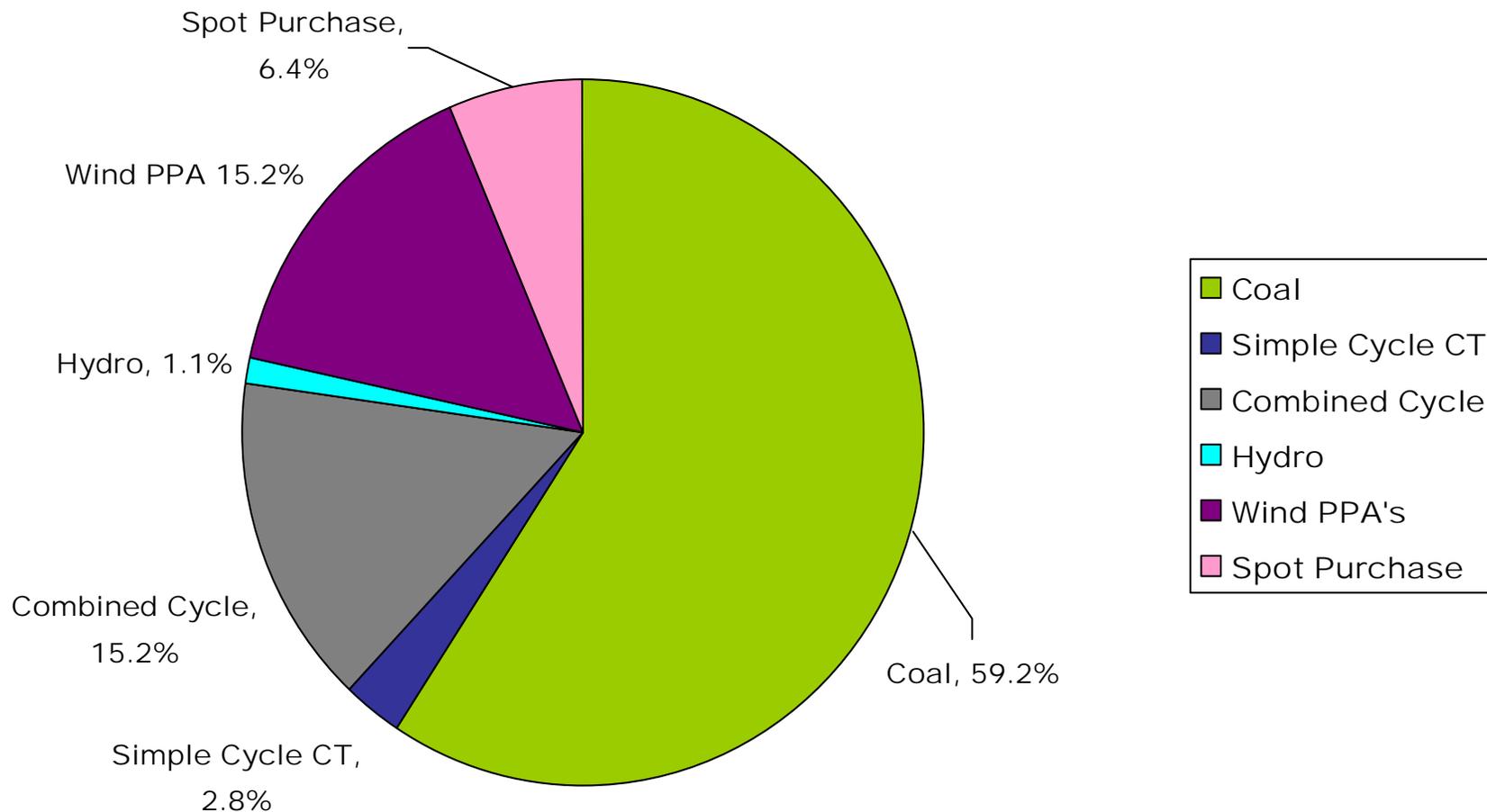
- 150 MW PPA for Elk River Wind Farm in Butler County Kansas
  - Approximately 550,000 MWh's per year
  - On-line December 2005
- 105 MW PPA for Meridian Way Wind Farm in Cloud County Kansas
  - Approximately 350,000 MWh's per year
  - On-line December 2008

# TME August 2007 Generation by Fuel Type



\*All Renewable Attributes have been sold via RECs

# Expected 2009 Generation Mix with Meridian Way



# Electric Utility Operations 101

- Generation = Customer Load
  - In = Out
  - Ying = Yang
  - Debit = Credit
- Instantaneously at all times

In order to provide:  
60 cycle electricity  
120 Volts at your household sockets  
.....All of the time

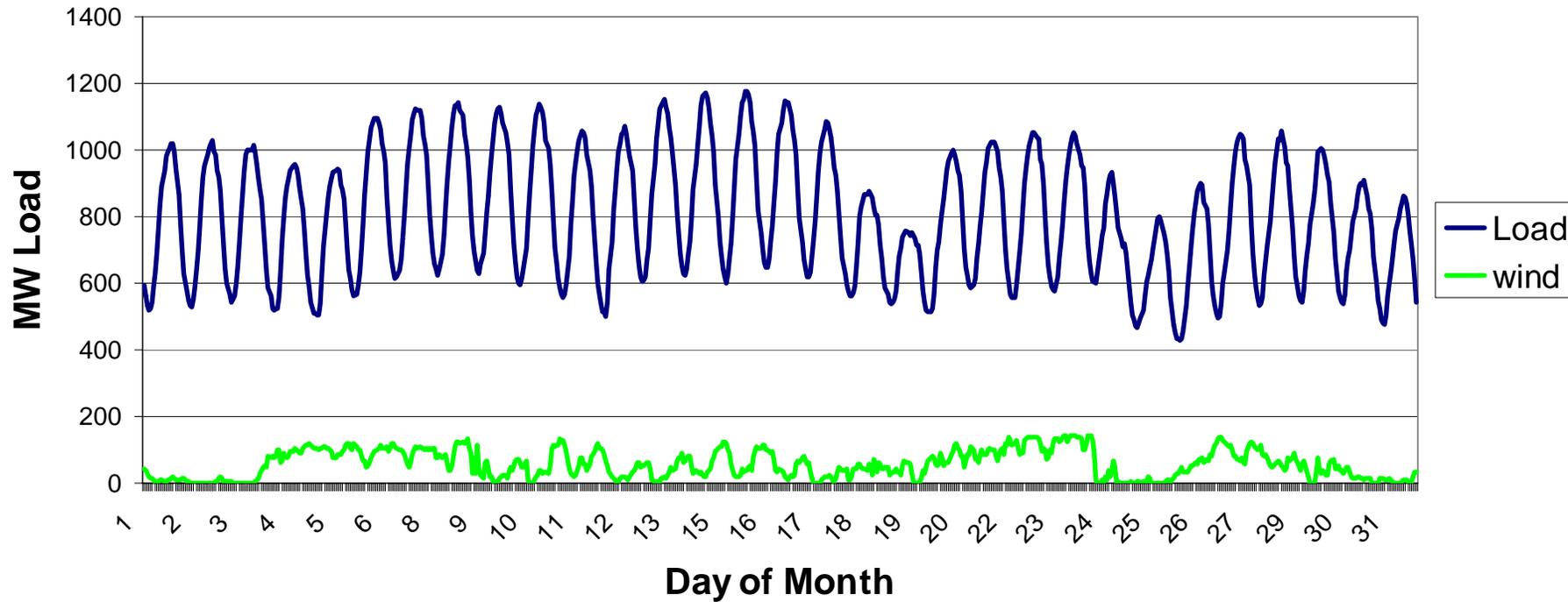


# Engineering a Reliable System

- Electric system stability is provided through appropriate
  - Generation Capacity Reserves
  - Transmission Capacity Reserves
  - Inertia of Generation
  - Protective Equipment
- Reliability is regulated by FERC and enforced by NERC

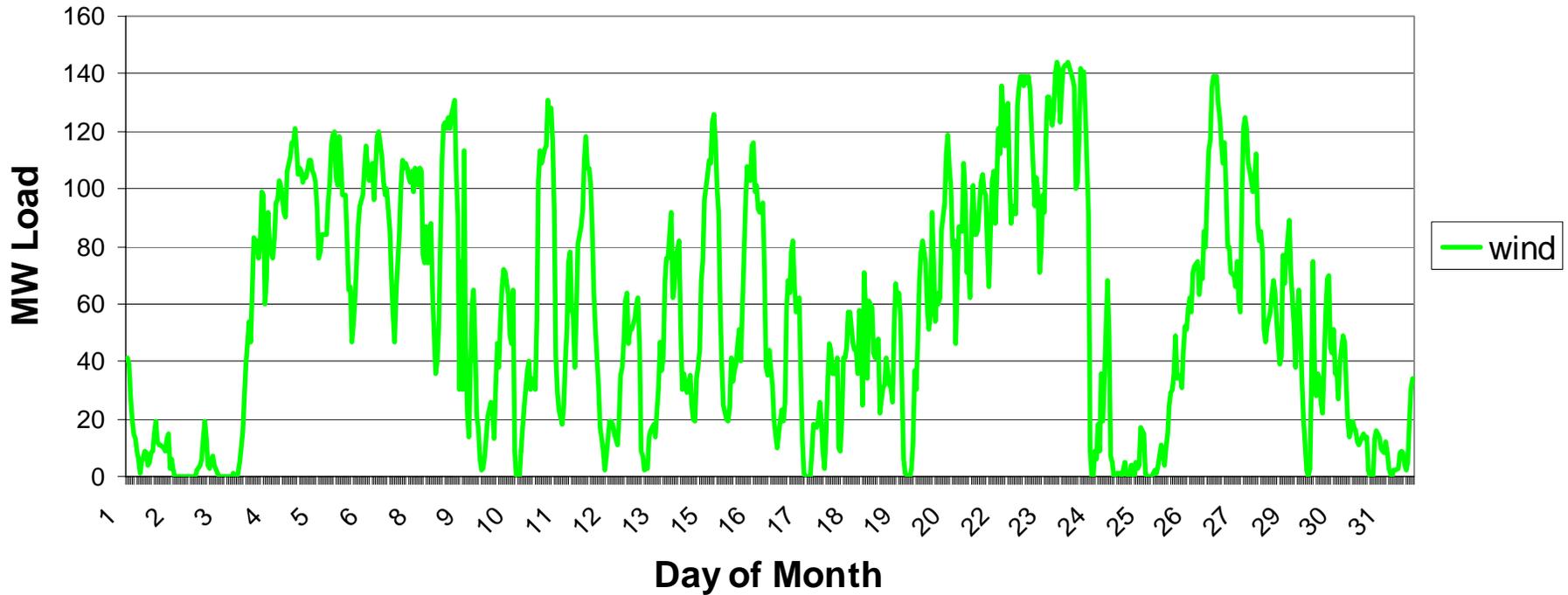
# Reliability

Customer Load and Wind  
Output August 2007

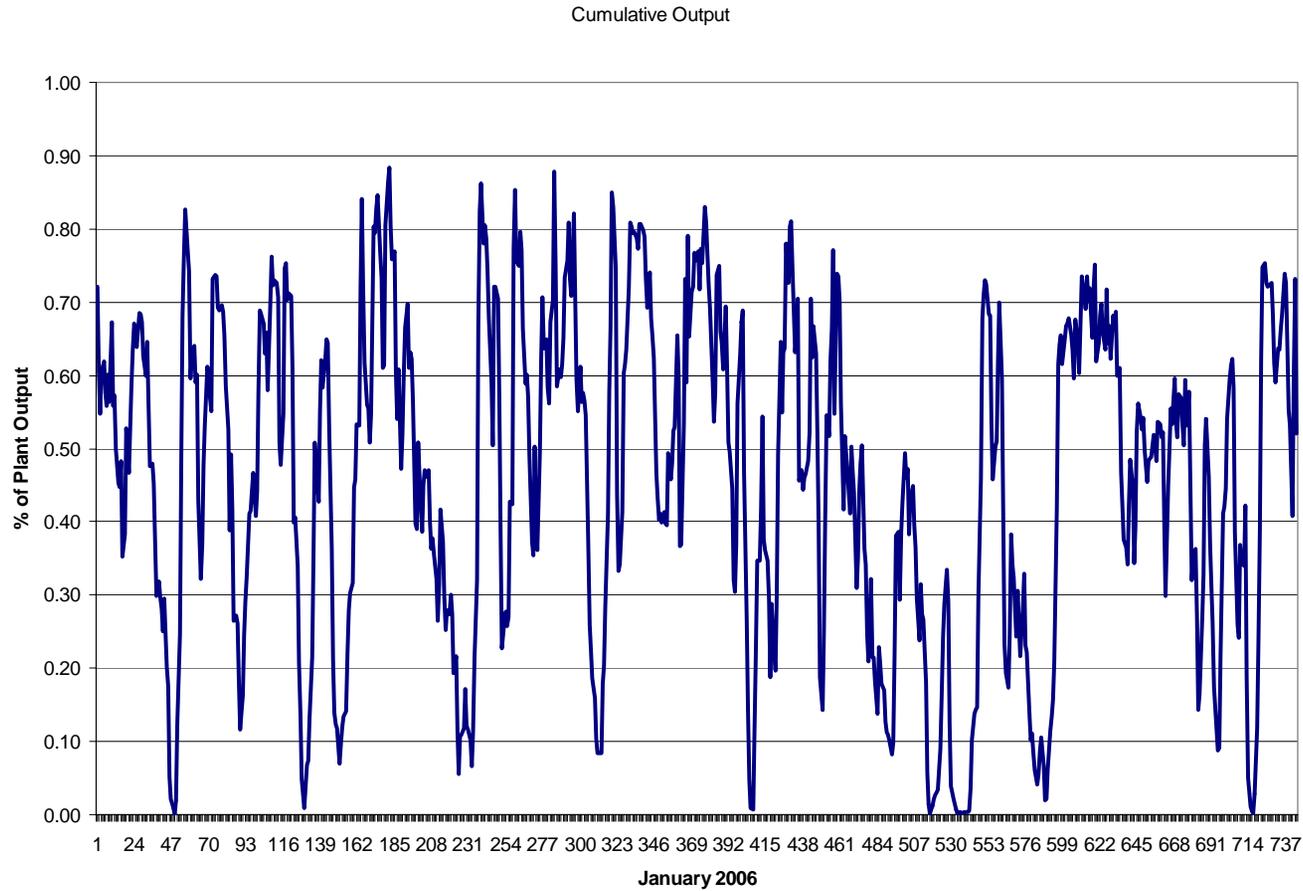


# Wind Output August 2007

and you thought a roller coaster went up and down a lot



# Does Geographical Diversity Help Elk River and Meridian Way



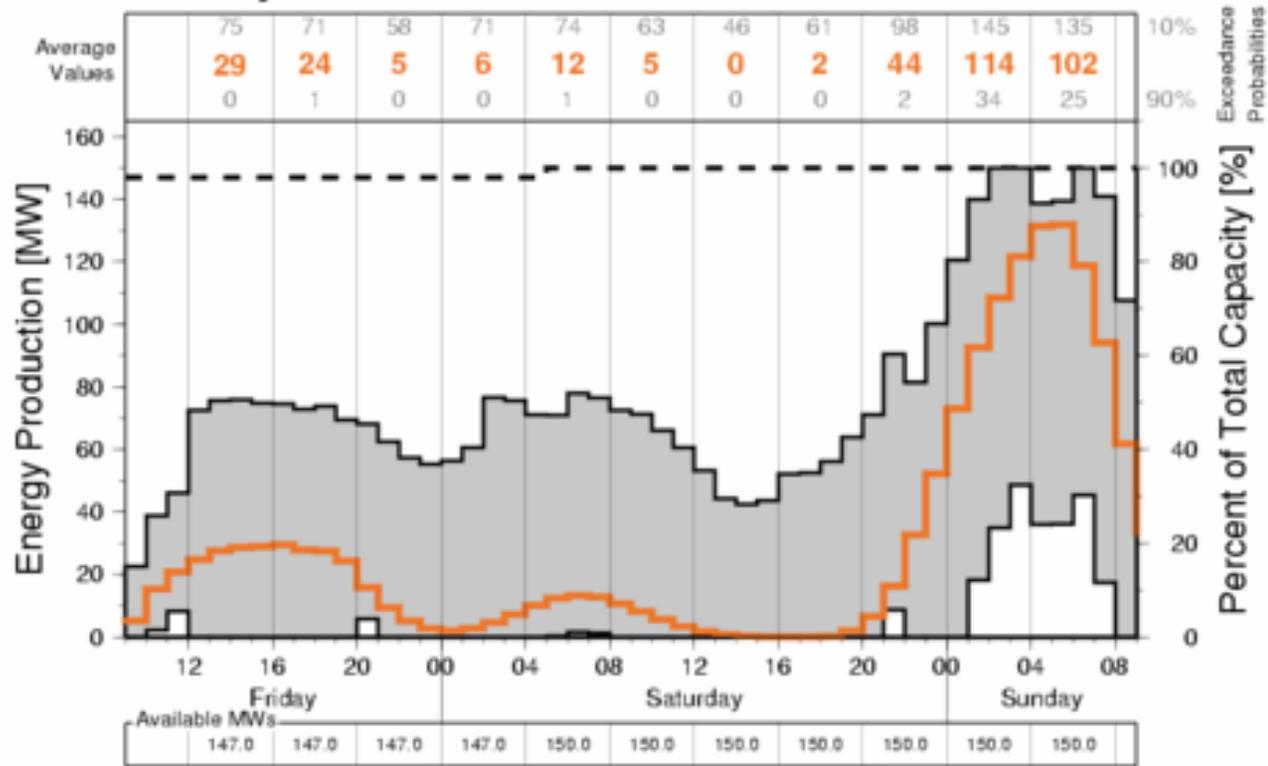
# Resources to Balance Wind

- Existing Generation Ramp or Start / Stop
- Storage of Energy in Compressed Air or Pumped Storage
- Develop Smart Customer Load
- Sell / Purchase Energy and Transmission
- Curtail Wind

# Forecasting Wind Needs Improved

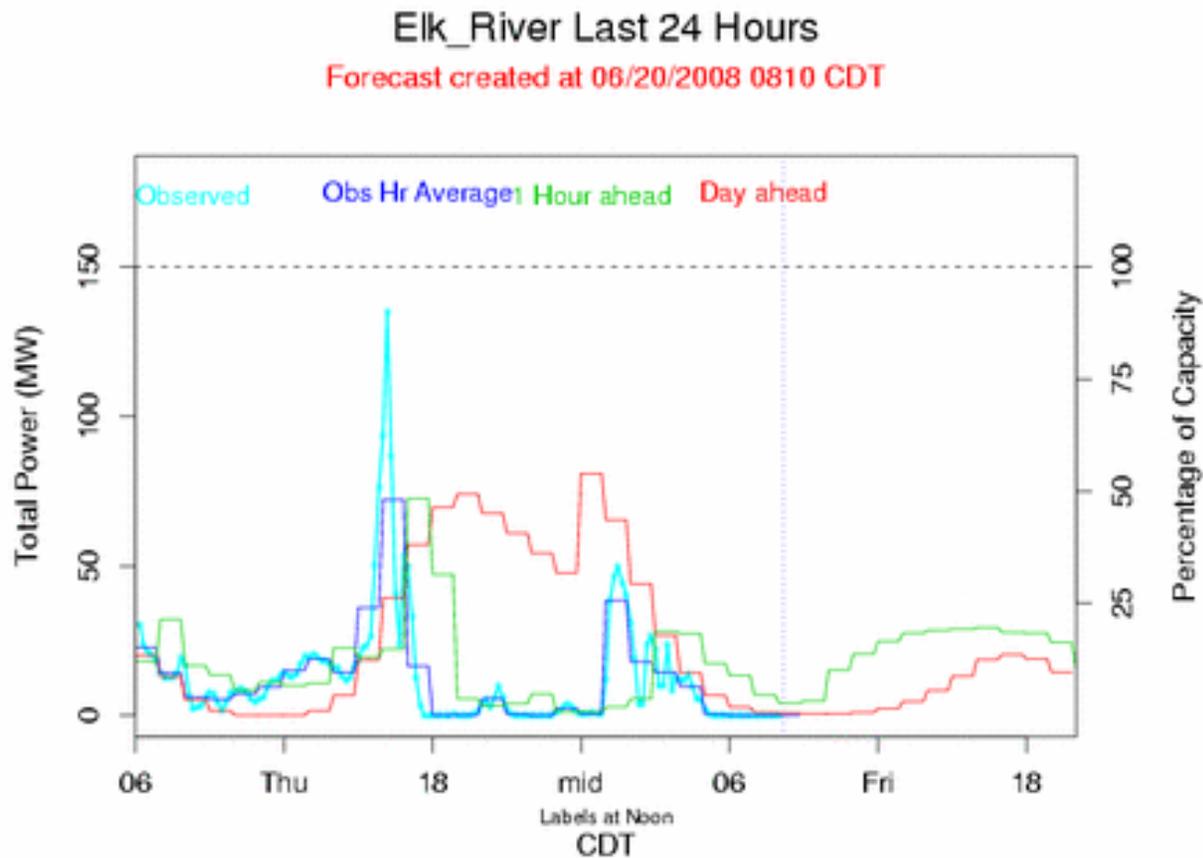
Elk River Day Ahead Forecast

TIME: 06/20/2008 @ 08:12:38 CDT



Observed Data Trace    Suspected Cutout Event    Max. Available Capacity    Prediction Interval    Forecast Data Trace

# Forecasting Needs Improved





# Keys to Operationally Integrate Wind into its Bulk Electric System?

- Dispersed Geographic Location of Wind Farms
- Flexibility of Existing Generation to Ramp Up and Ramp Down
  - Quick Start Units
  - Fast Ramping
  - Increased Operating Range
- Dance Partner
  - Compressed Air Energy Storage
  - Fly Wheels
  - Battery Systems
  - Smart Customer load
- Technology to more accurately predict wind

# Long Term Integration

- IOU's in Missouri must file long term Resource Plans that provide for the lowest cost / risk alternative
- Electric Utility Plant decisions are some of the largest dollar infrastructure decisions in the US today
- Utilities typical recover Capital Cost from for Utility Plant from customers over periods exceeding 30 Years

# Closing Thoughts

- Utilities Can Integrate Wind into their system, but we need “dance partners” for the wind and there is a cost to go to the “dance”
- Utility infrastructure is high capital cost, long lead time, long capital recovery period.
- We are able to integrate wind today because of the decisions to build fossil fired units in the past
- Wind, coal, natural gas, hydro, energy efficiency measures are all an Integral Part of Balanced Mix



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