DOE Electrolysis-Utility Integration Workshop September 22, 2004

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Xcel Energy

Xcel Energy and Wind

- Who we are?
- Amount of wind?
- Issues and Experiences

Xcel Energy Utilities

- Northern States Power
- Cheyenne Light
- PSC of Colorado
- Southwestern PSC

Wind on Xcel Energy Systems

System	Contracted Wind	2004 Capacity Penetration	2004 Energy Penetration
NSP	481	5.8%	3.1%
PSCo	222	3.6%	2.0%
SPS	165	3.5%	1.8%

Planned Wind on System

System	2010 Wind	2010 Capacity Penetration	2010 Energy Penetration
NSP	1125	12.3%	6.5%
PSCo	722	10.2%	5.8%
SPS	445	9.0%	4.3%

Wind's Value

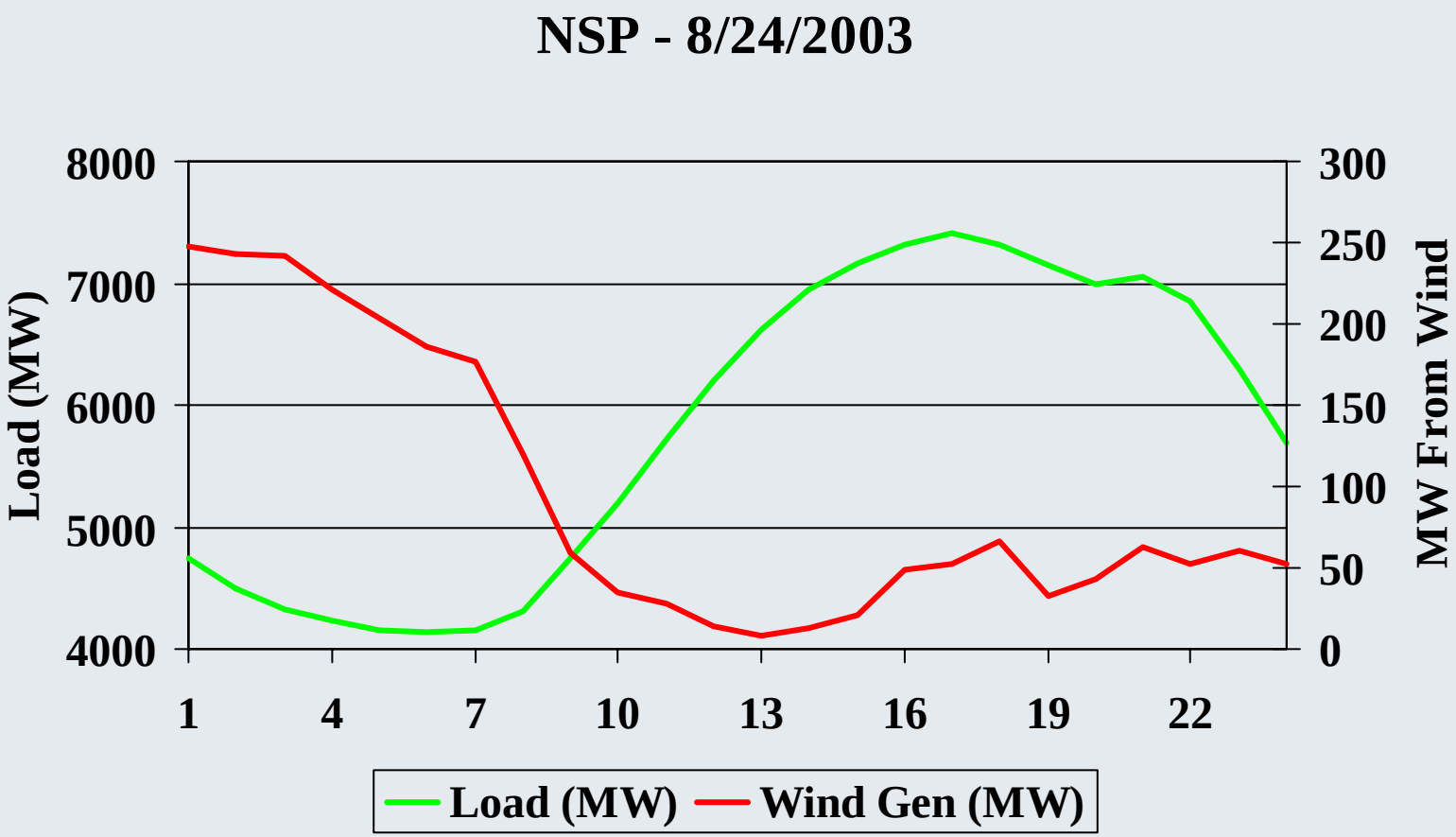
- Cheapest resource with federal production tax credit
  - SPS < $25/MWh
  - NSP < $30/MWh
  - PSCo < $35/MWh, but expect lower
- No emissions
- 1-2 year lead times
- Hedge against gas prices
- *Why isn't wind the perfect generation solution?*

Why Isn't Wind "the" Solution?

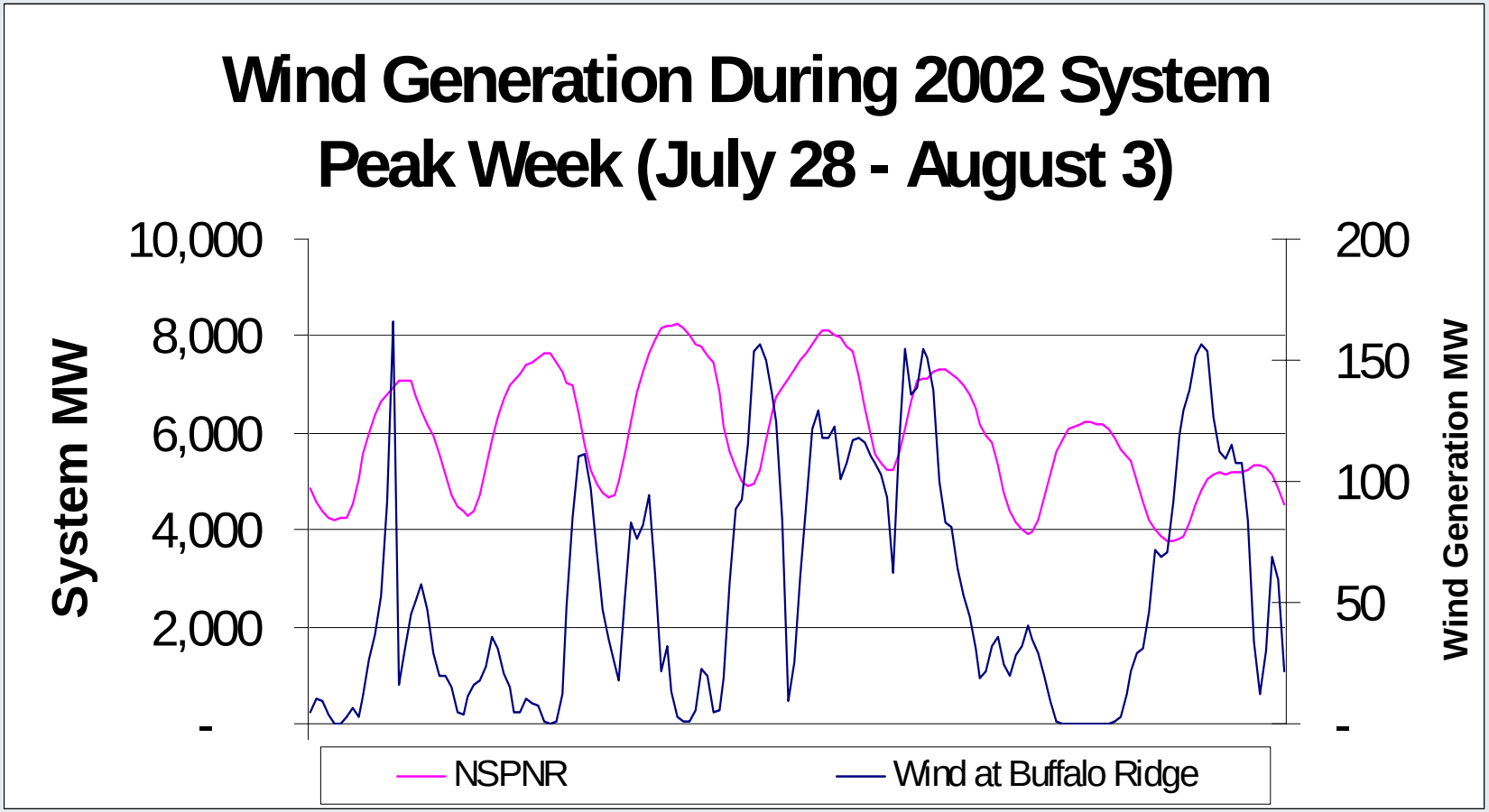
- Intermittent: does not blow all the time
- More unpredictable than other sources
- → Operational impacts
- Wind generation at Xcel Energy does not match hourly demands
- Transmission: distance from load centers

- ***…Wind is a part of the solution***

Intermittent Source



More Unpredictable



Power Operation Issues

- Intermittence causes scheduling challenges
  - 3-day horizon
  - Purchase and generation commitments, units either off or on
  - Cannot start or stop other plants on a “dime”
- System regulation and load following costs
  - Do not have a perfect forecast
  - Electricity can not be stored, generation must match use
  - Back down economic units or dispatch less economic units
  - More units capacity assigned to regulation or load following
  - More area control error → NERC reliability concern

Power Operation Impacts

- Impacts are system-specific
- **Impacts add costs for our customers**
- Higher penetration → higher extra costs

Wind Integration Studies - NSP

- 2001: 280 MW on 8,000 MW system
  - Total $1.85/MWh
  - Missed
    - Opportunity cost of using load following potential earlier than otherwise
    - Increased maintenance costs on plants

Wind Integration Studies - NSP

- 2004: 1500 MW on 10,000 MW system
  - Total $4.60/MWh
  - Missed
    - Opportunity cost of using load following potential earlier than otherwise
    - Increased maintenance costs on plants

Wind Integration Studies - SPS

- 2004 Hirst Study
  - Analyzed cost of different amounts of wind on system
  - 200 to 2000 MW on 4000 MW SPS system

Wind Integration Studies - SPS

Wind Amount (MWs)	Break Even Payments to Wind
0	$29/MWh
200	$26 /MWh
400	$23 /MWh
1000	$17 /MWh
2000	$8 /MWh

Power Operation Impacts

- Increased operations and maintenance costs
  - More starts and stops on plants
  - More thermal cycling on plants
  - Both shorten time between maintenance overhauls
- Cost impact has **not** been analyzed

Potential Power Impact Solutions

- Solutions
  - Live with it and bear cost increases
  - Storage
    - Compressed Air
    - Pumped Storage
    - Positive cost-benefit elusive
  - Load that matches output and can be tied to it
    - Not explored much
    - H2 production is possibility
    - Positive cost-benefit elusive

Xcel Energy
Renewable Development Fund

- 2001 Results
  - No requests for wind-electrolysis research

- 2004 Results
  - Wind-electrolysis requests: 2
  - Wind-electrolysis projects selected: 0

Transmission

- Wind farms are not near load centers
- Wind often cannot support transmission upgrade costs by themselves
  - 30 to 35% capacity factor
  - Generation at time of peak demand is low
- Lead time mismatch between wind generation and transmission construction
- RTOs/FERC protocols make resolution more difficult

Distributed Wind

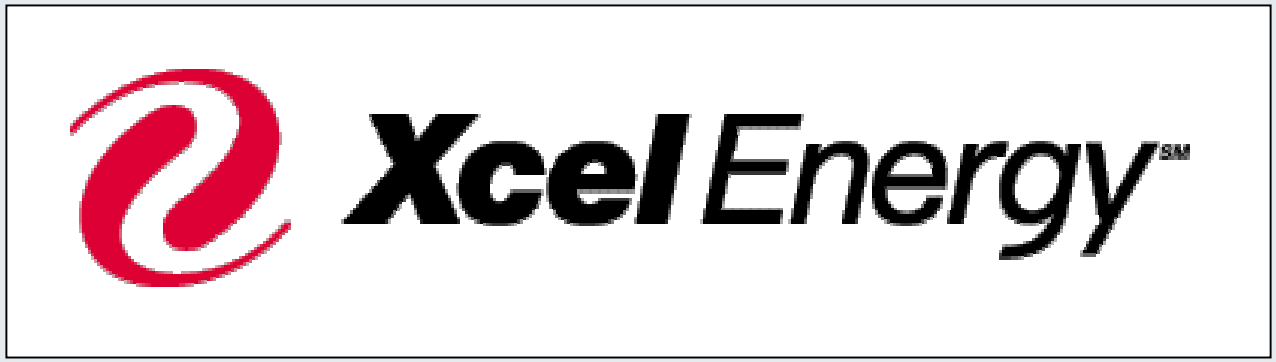
- Definition
  - Small wind
  - Distributed sites
  - Connect to distribution system
- Xcel Energy Experiences
  - Energy more costly than large wind farms (~30%)
  - Higher administrative costs
  - Less sophisticated owners → middle person
  - Not the least cost wind option

Wind Summary

- Good environmental characteristics
- Good pricing characteristics [f(PTC)]
- Poor operating characteristics
  - not dispatchable
  - intermittent
  - causes operating problems

Wind Summary

- Research solutions to operating cost issues
- Research storage issues → reduce costs
- Research demand side partnerships
  - Electrolysis
  - Resistance loads
  - Achieve positive cost-benefit conclusion
- **Regardless, part of future supply solution**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