

Planning for Renewable Energy

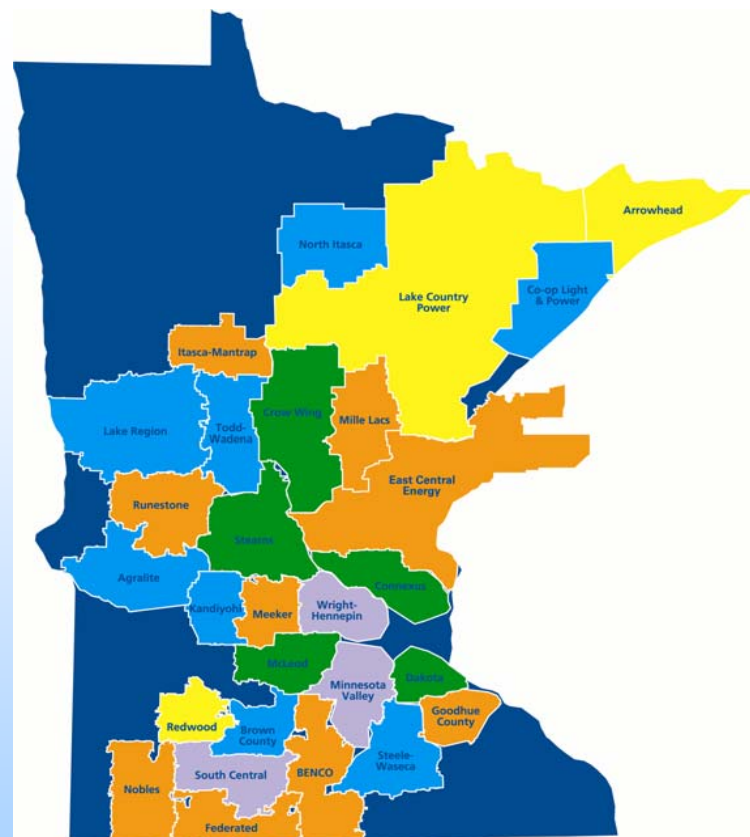
Glen Skarbakka
Great River Energy

Workshop on Renewable Energy for Minnesota
October 12, 2006



Great River Energy Overview

- A Generation & Transmission Cooperative
- 28 Member Distribution Cooperatives
- 600,000 Distribution Customers
- Long term growth rate $\sim 3\%$
- Summer peaking (~ 2600 MW)

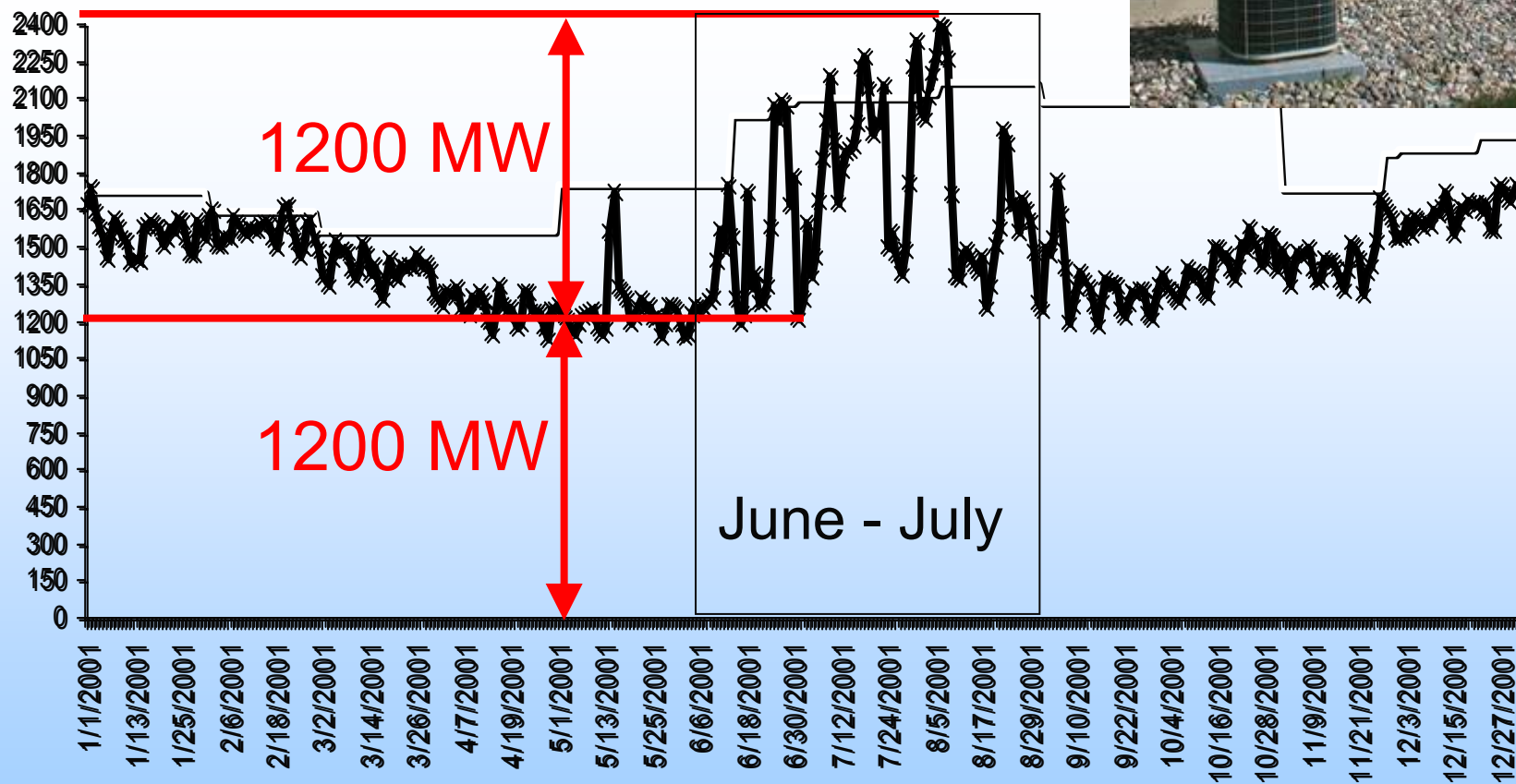


2005 Energy Growth





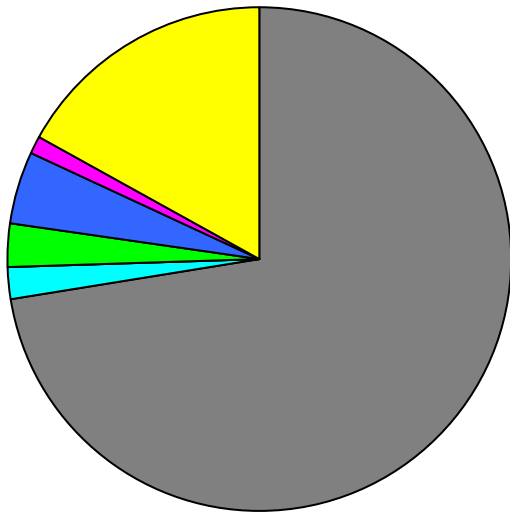
GRE is very summer peaking



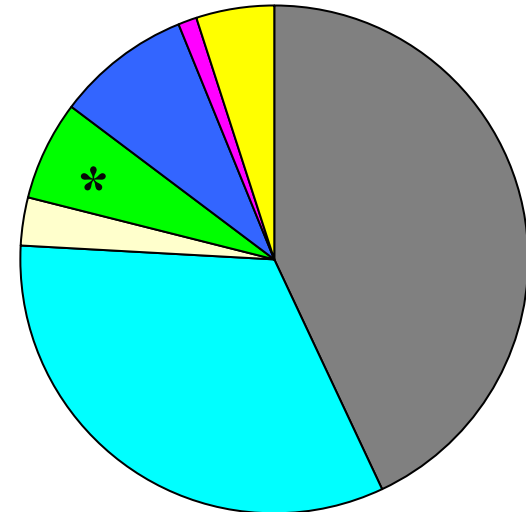


GRE's Supply Portfolio

Energy



Capacity



- Coal
- Gas
- Oil
- Wind
- Hydro
- RDF
- Purch

*nameplate rating



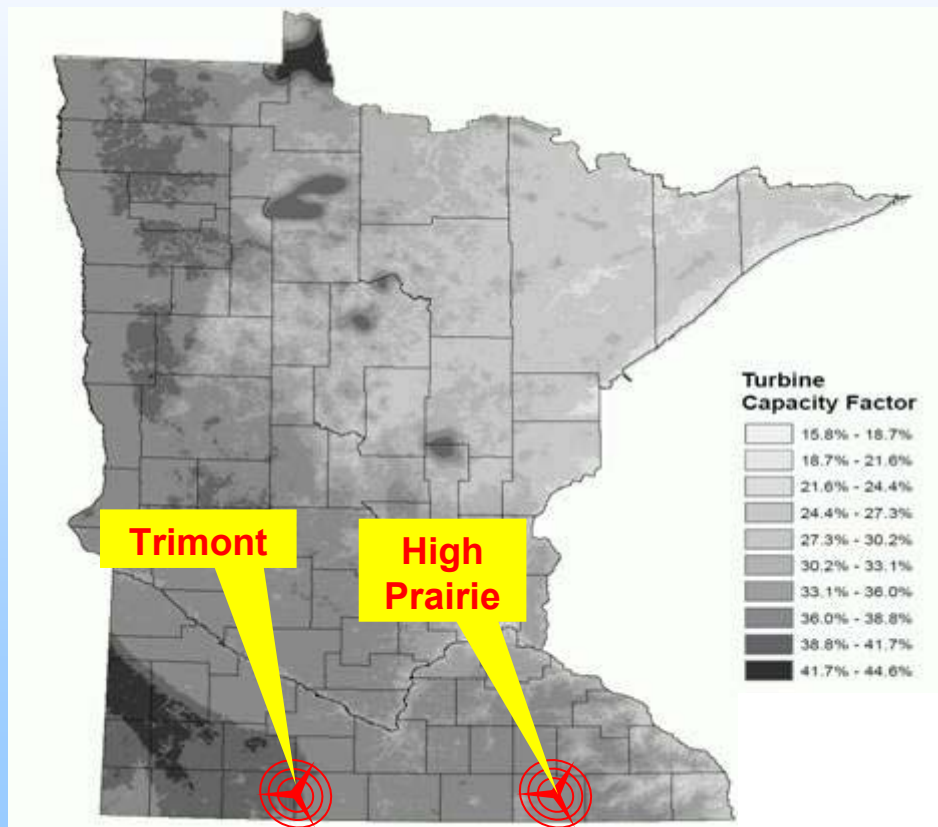
GRE Generating Facilities





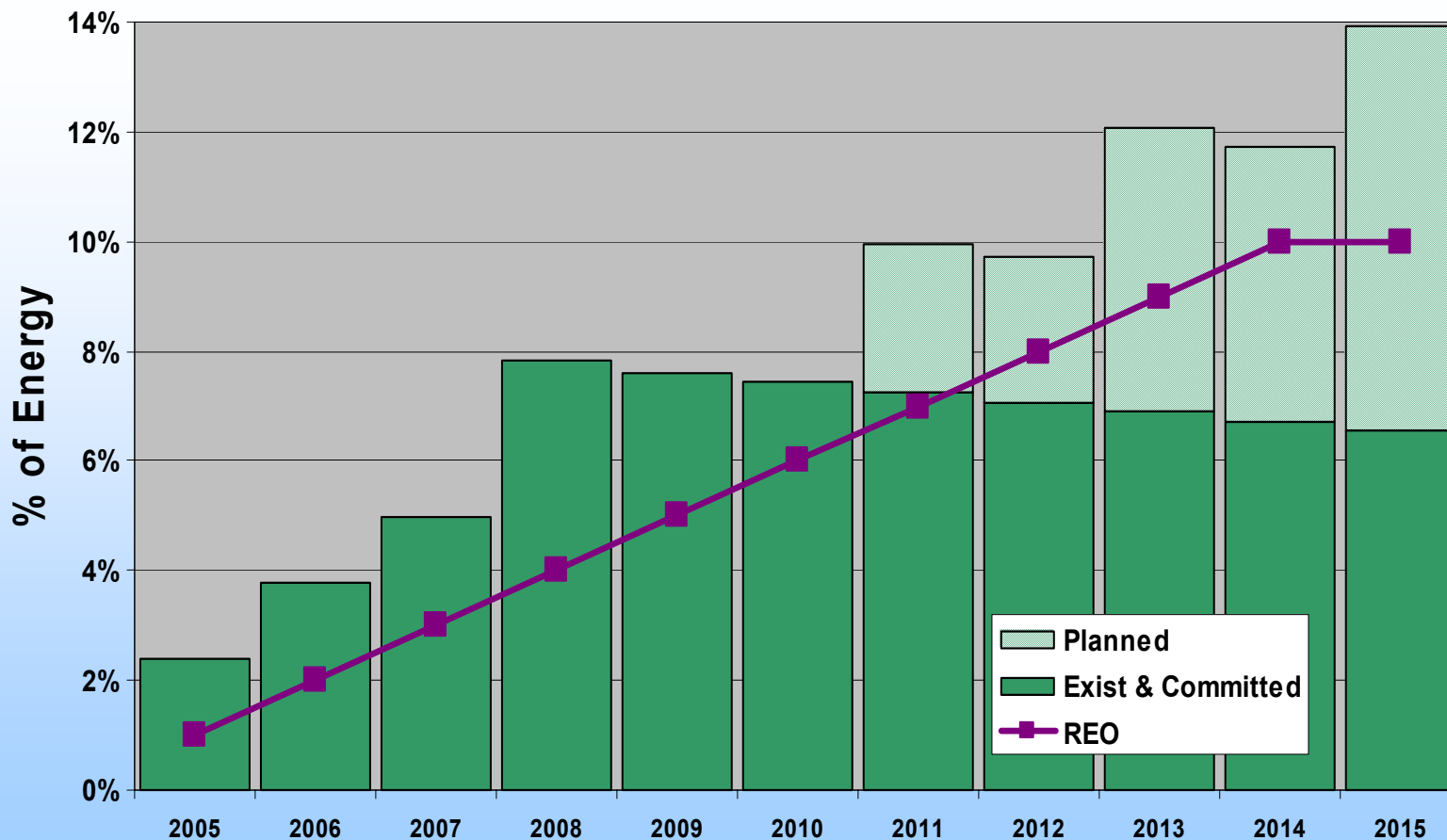
Wind Power Purchases

- <2005: 3 x 6 MW projects = 18 MW
- 2005: Trimont = 100 MW
- 2007: High Prairie = 100 MW



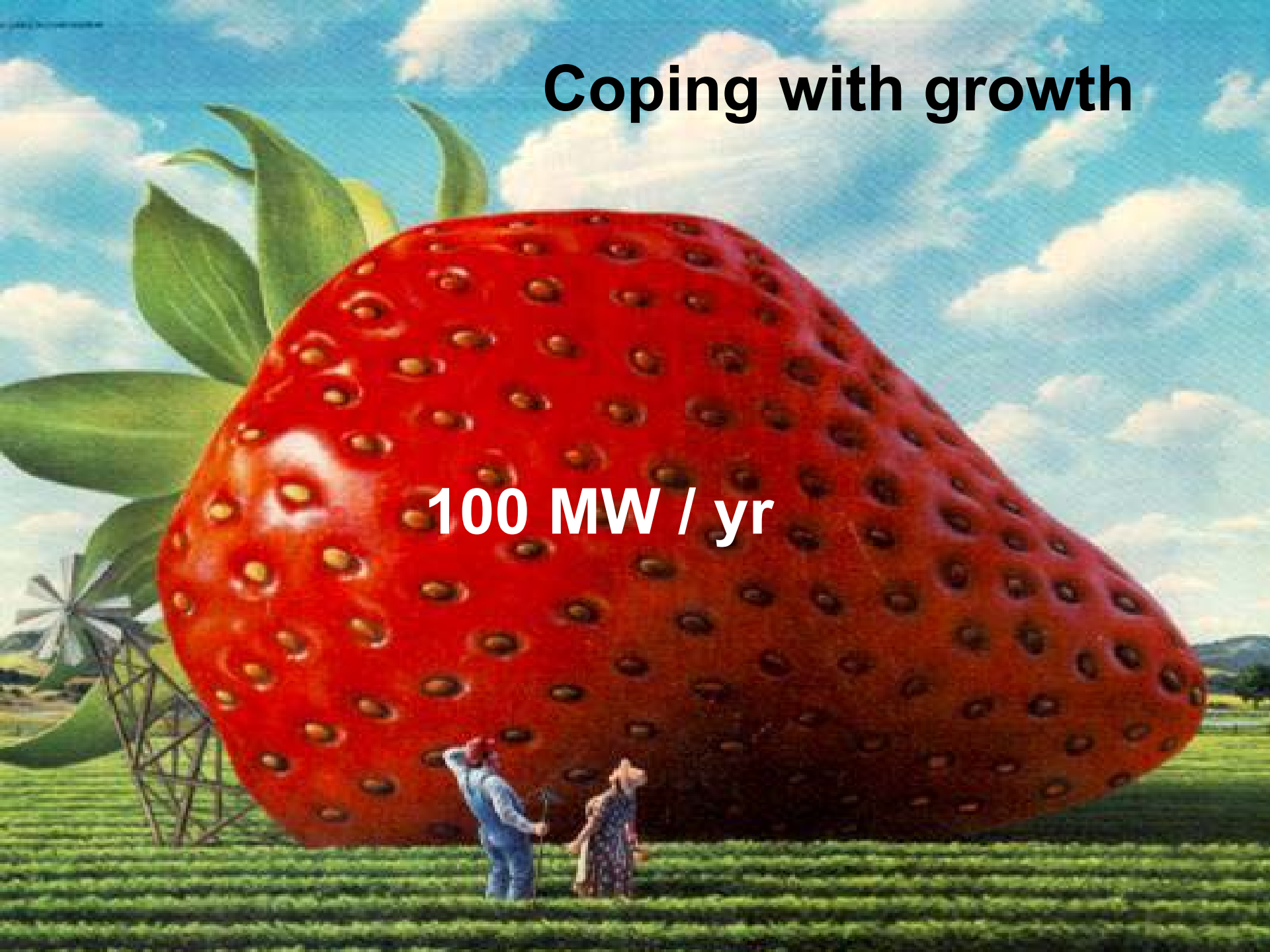


GRE is meeting MN's Renewable Energy Objective



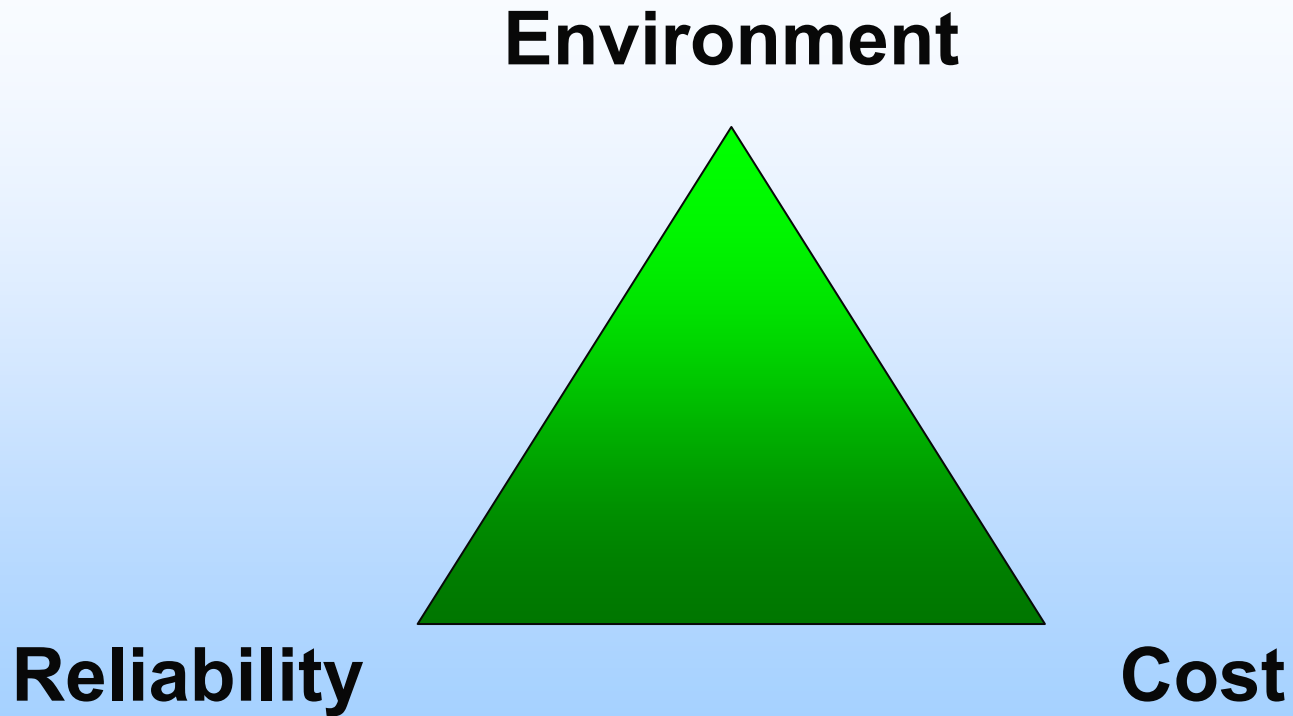
Coping with growth

100 MW / yr





Planning Objectives





Environmental Targets

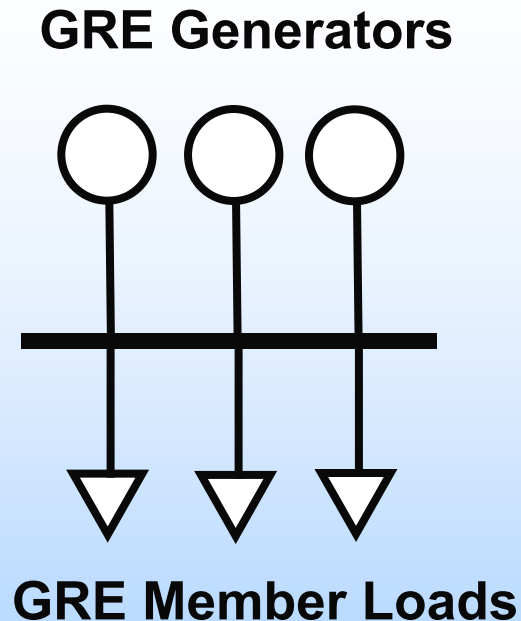
By 2020:

- Supply 20% of energy with renewables
- Reduce CO₂ emissions to 2000 levels





The olden days: a physical world

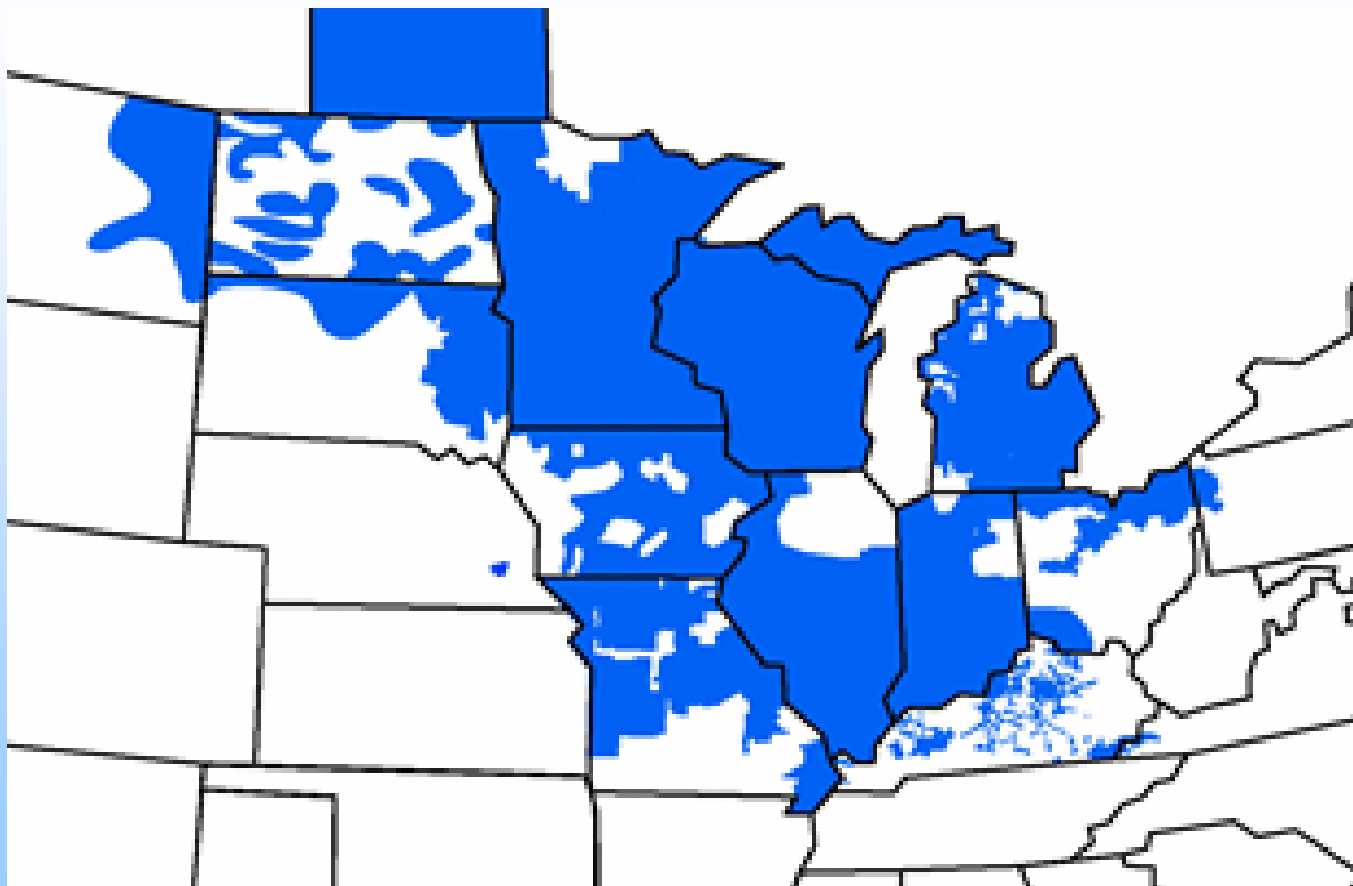


$$\text{GRE Gen} = \text{GRE Load}$$



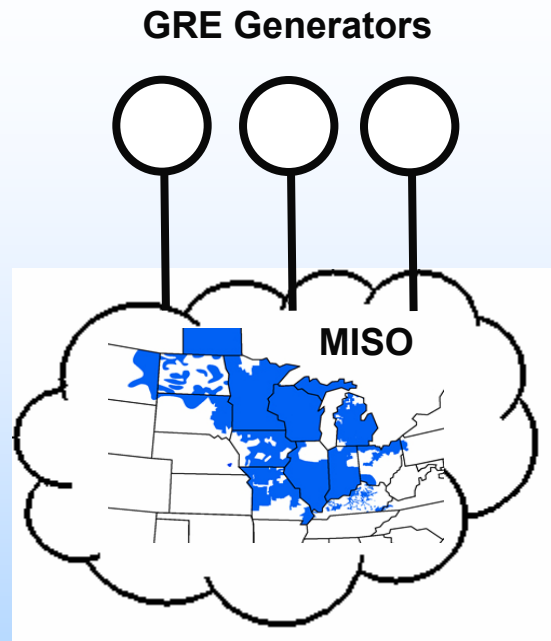
Midwest ISO

Operates transmission and energy markets.

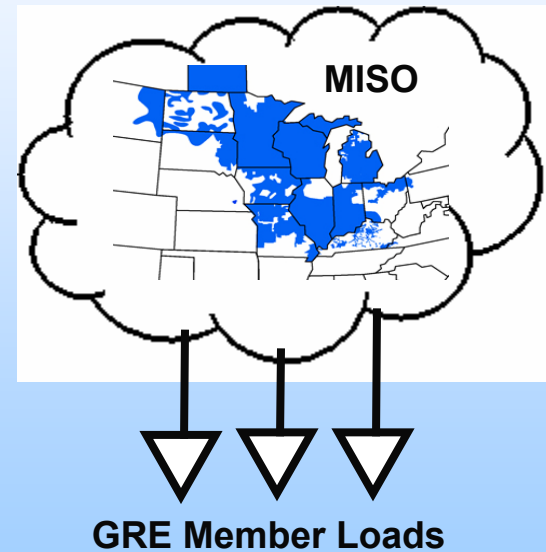




Today: a financial world

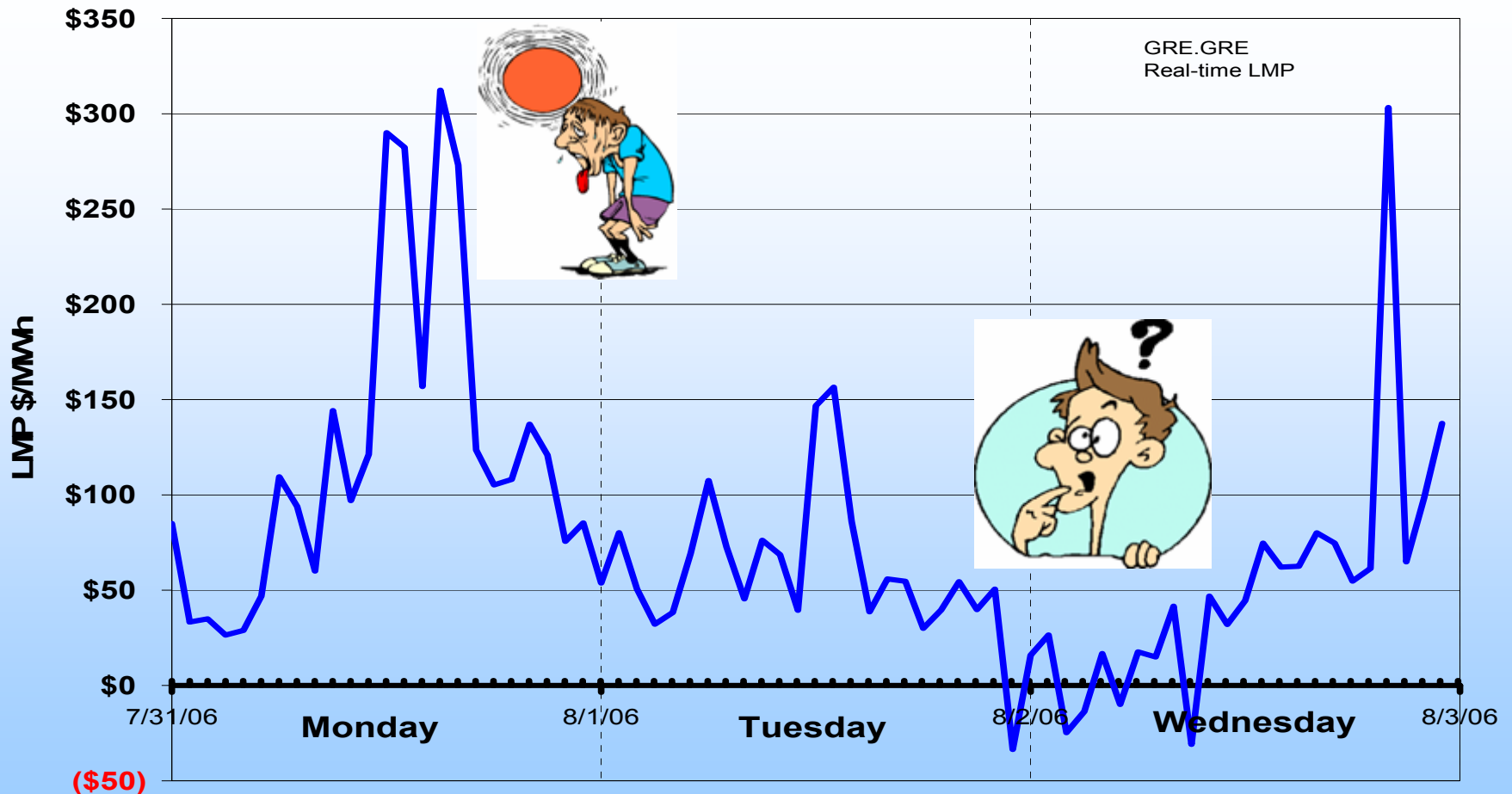


Midwest
Independent
System
Operator



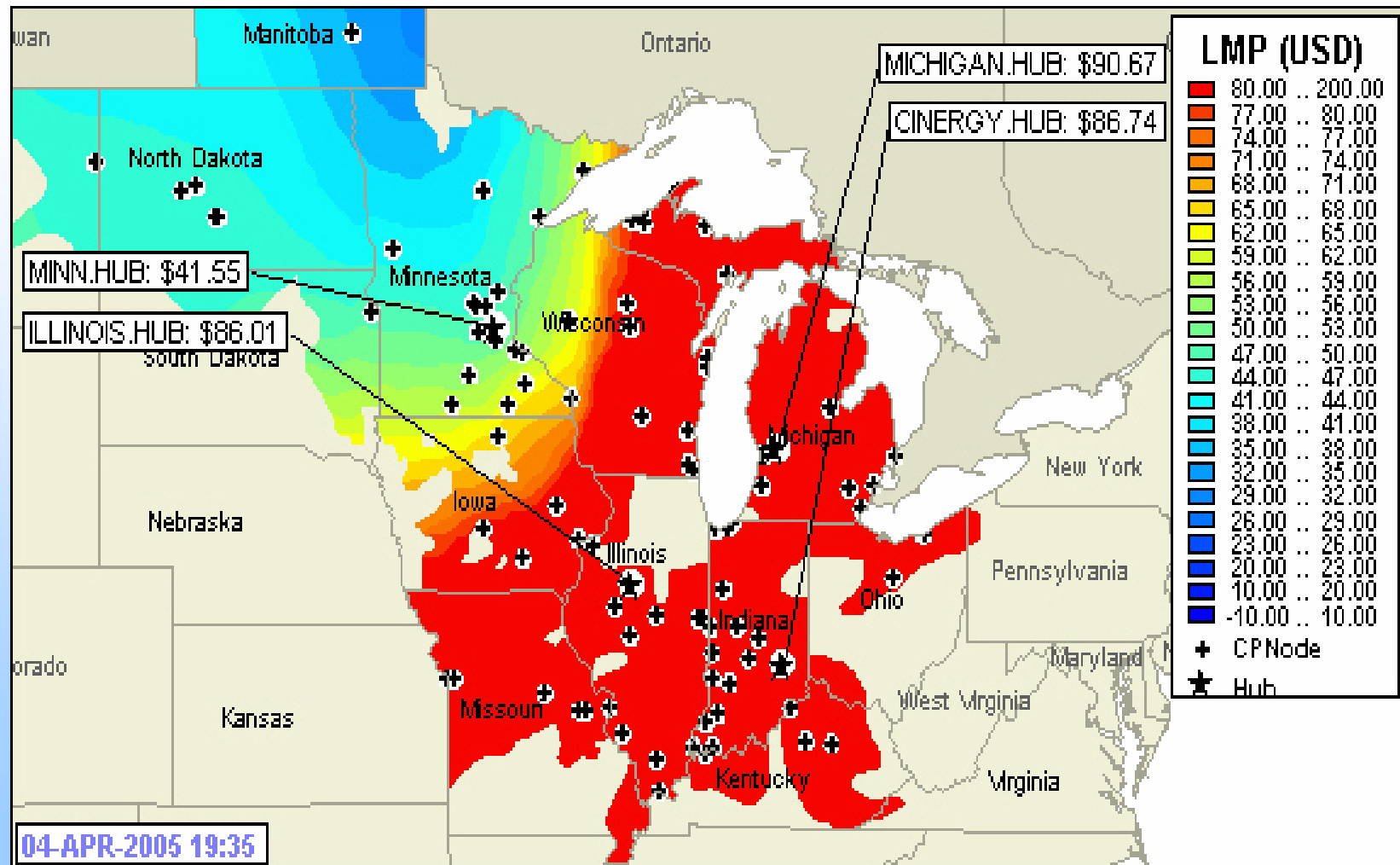


Market Prices: temporal volatility





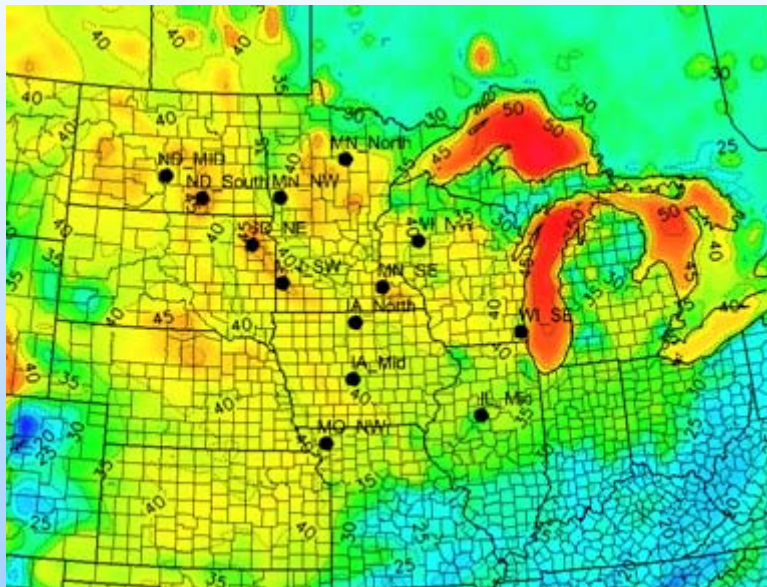
Market Prices: spatial volatility



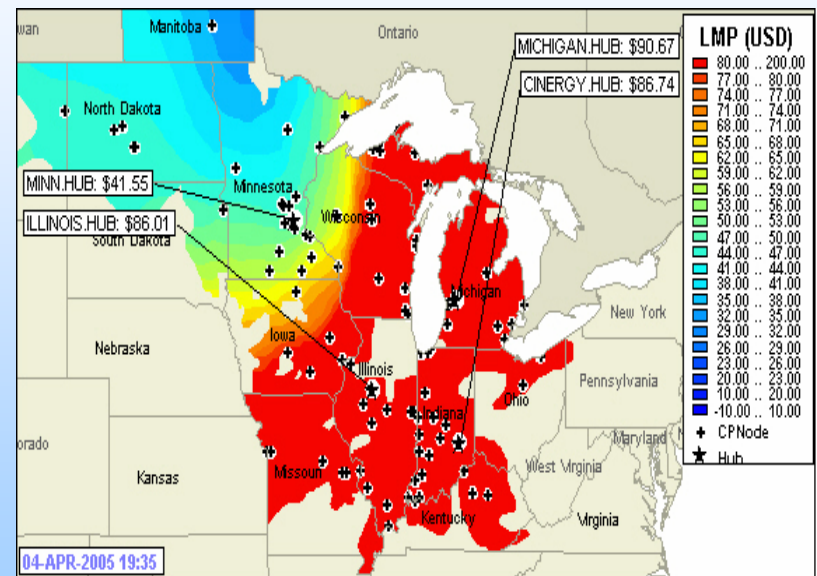


Wind Site Value: Cost v. Revenue

Wind Resource
→ **Cost of Wind**



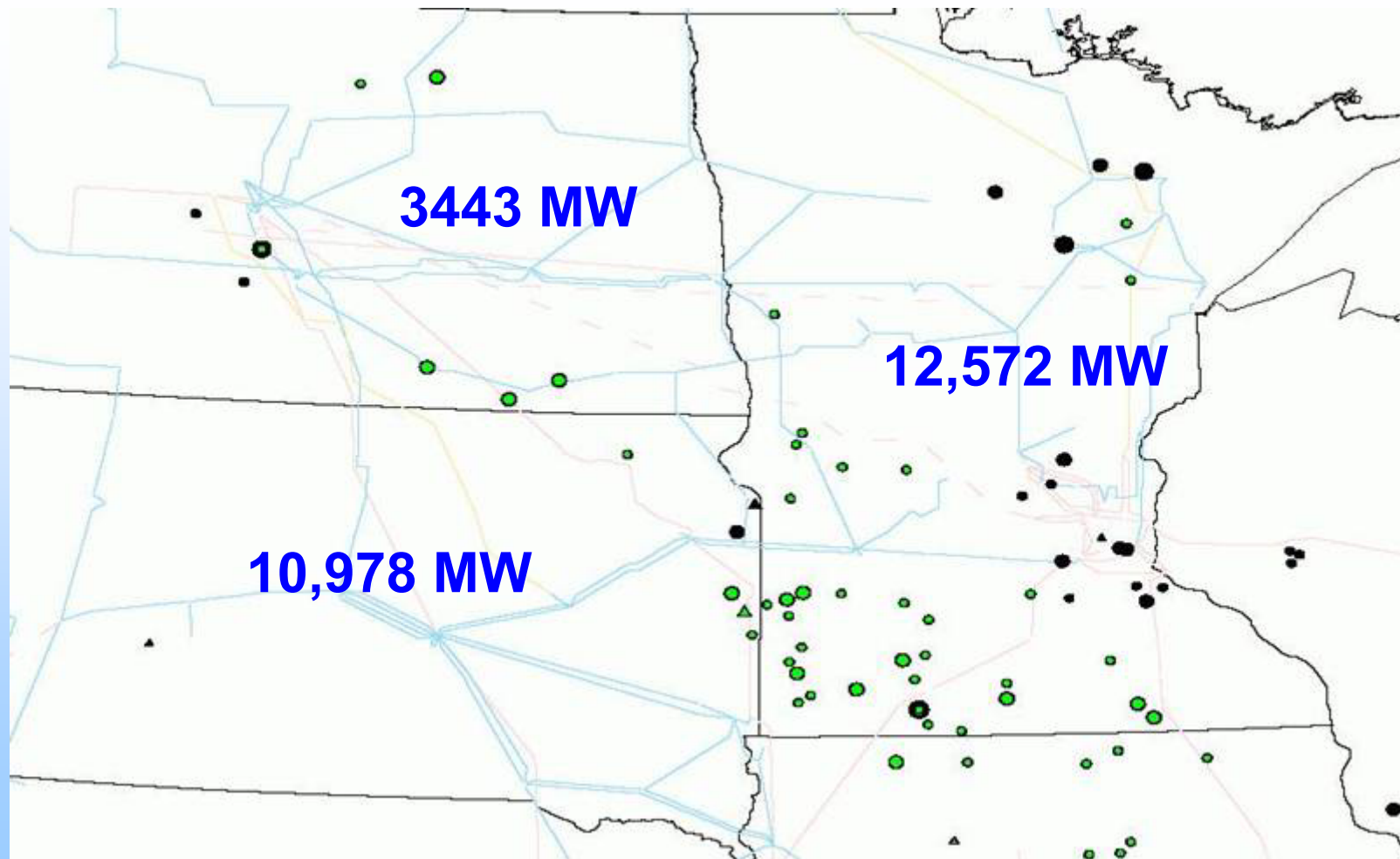
Market Price (LMP)
→ **Revenue from Wind**





Queued Generating Projects

MISO Generator Interconnection Queue 9/26/06





Wind Development Issues

- **Siting**
 - Energy Value
 - Geographic diversity
 - Transmission availability
- **Timing**
 - Transmission interconnection arrangements
 - Federal Production Tax Credit deadlines
- **Cost**
 - Equipment & installation
- **Technical**
 - Equipment reliability (long term)
 - Wind integration / ancillary services
- **Project Size**
 - Economies of scale v. small developer preference





Other renewables

■ Biomass

■ Waste streams

- Municipal waste
- Waste wood
- Ag waste
- Landfill gas

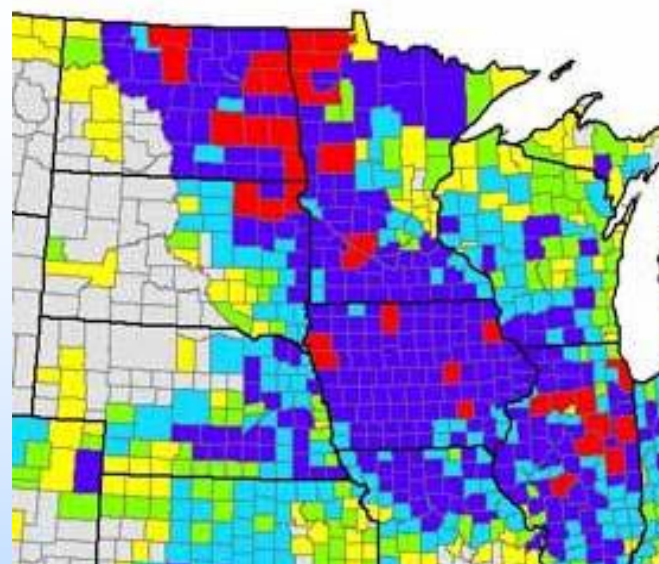
■ Energy crops

- Switchgrass, trees, etc.

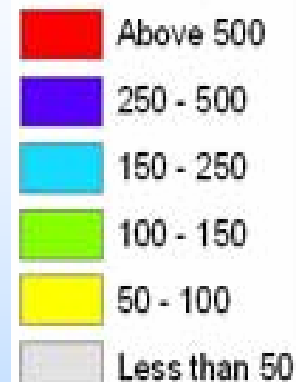
■ Co-firing

■ Hydro

■ Solar

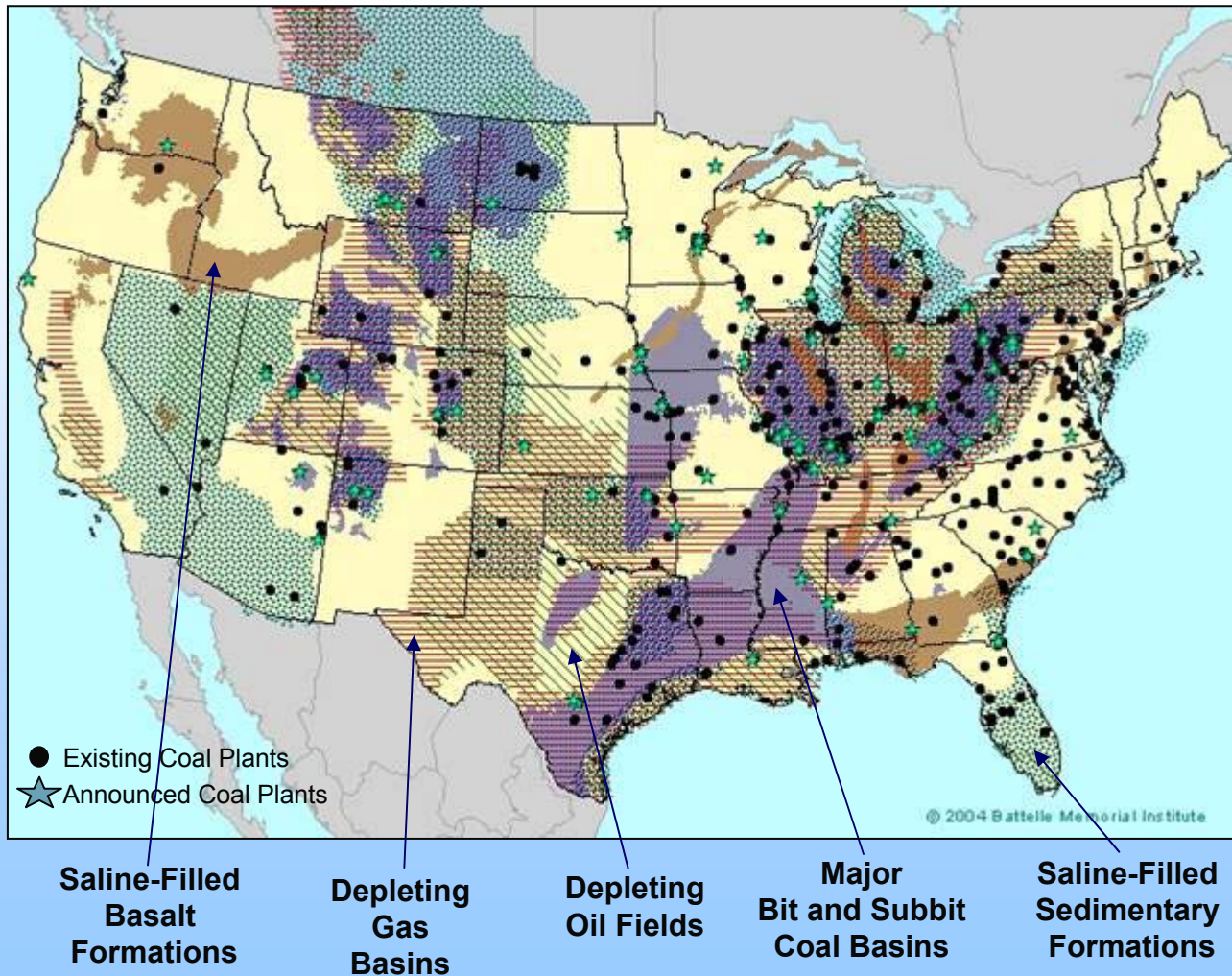


Thousand
Tonnes/Year



Other ways to reduce CO₂

■ CO₂ capture & sequestration





Other ways to reduce CO₂

- CO₂ capture & sequestration
- Improved power plant efficiencies
- "Energy Factories"
 - Combined heat and power
 - power production <--> industrial process
 - Coal to liquids or syngas
- Distributed Gasification Combined Cycle
- Nuclear
- Point of use generation
- Conservation!



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