

Blending Data, Models & Human Expertise

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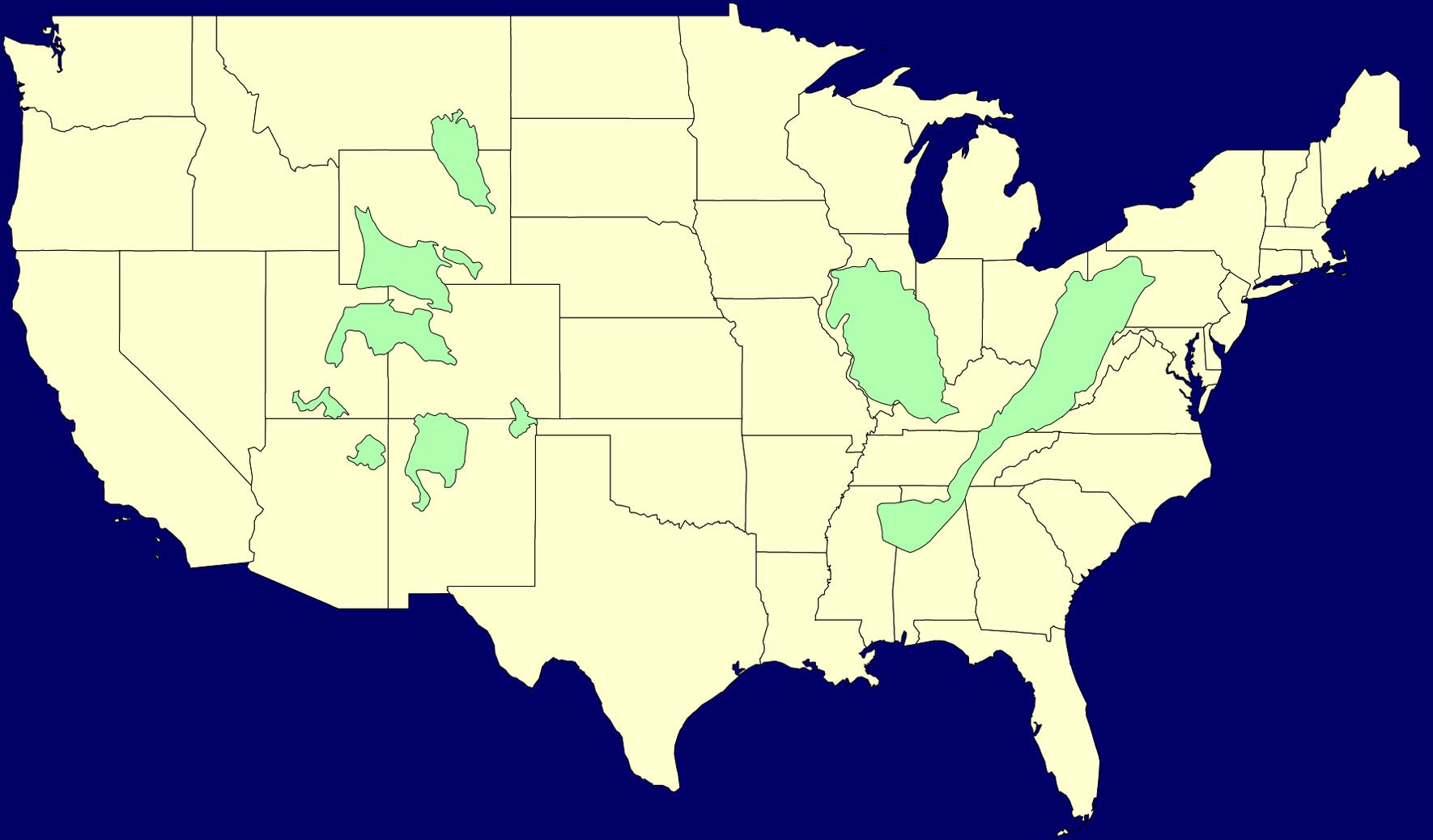
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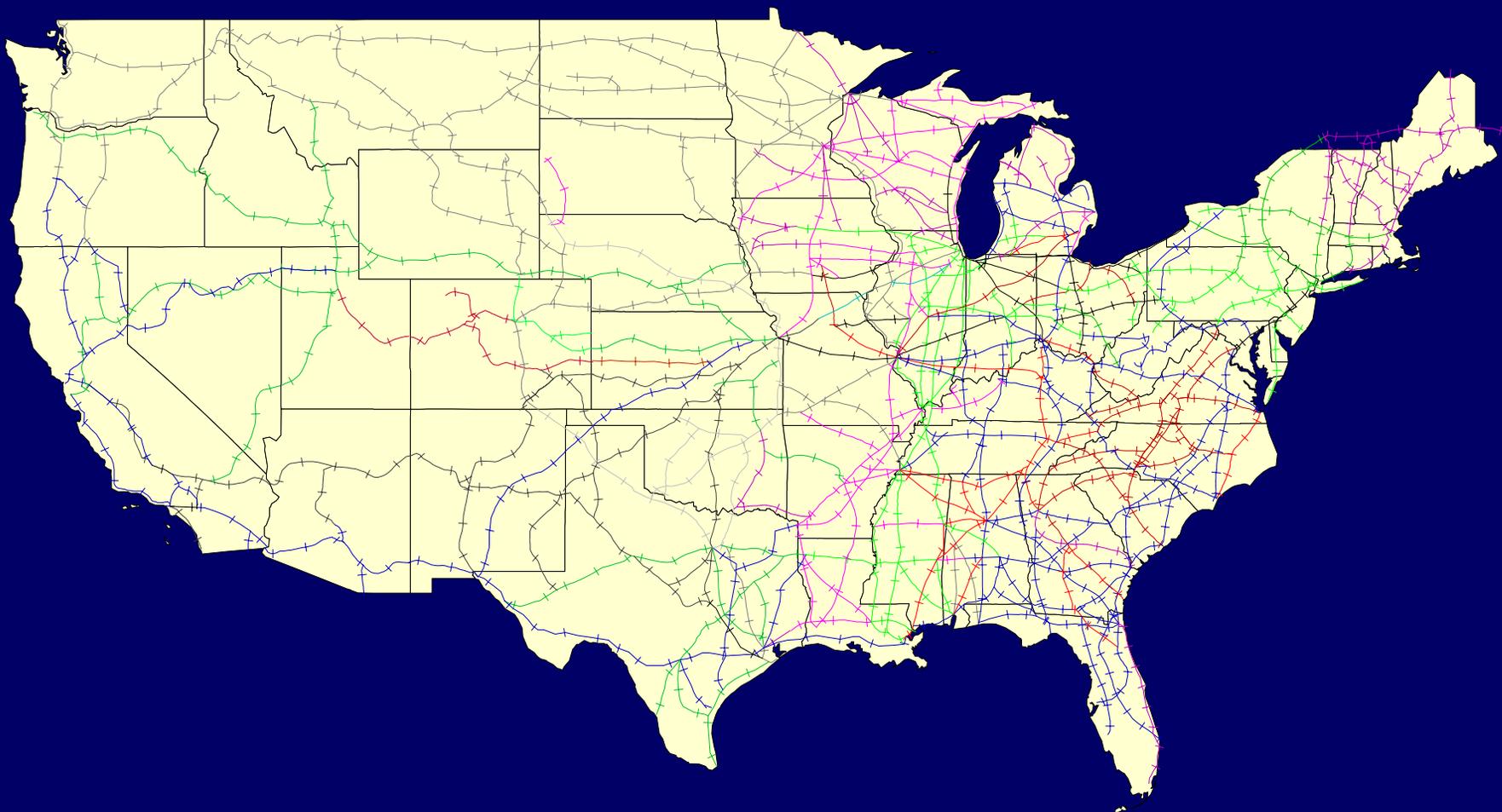
The Coal Industry

- Coal:
 - Highly Competitive Free Market Commodity for Decades
 - 1 Billion Annual Tons
 - 10% Met Coal, 90% Steam Coal
 - Steam Coal Mostly used for Electricity Generation
 - Almost Always Oversupply

U.S. Coal Basins



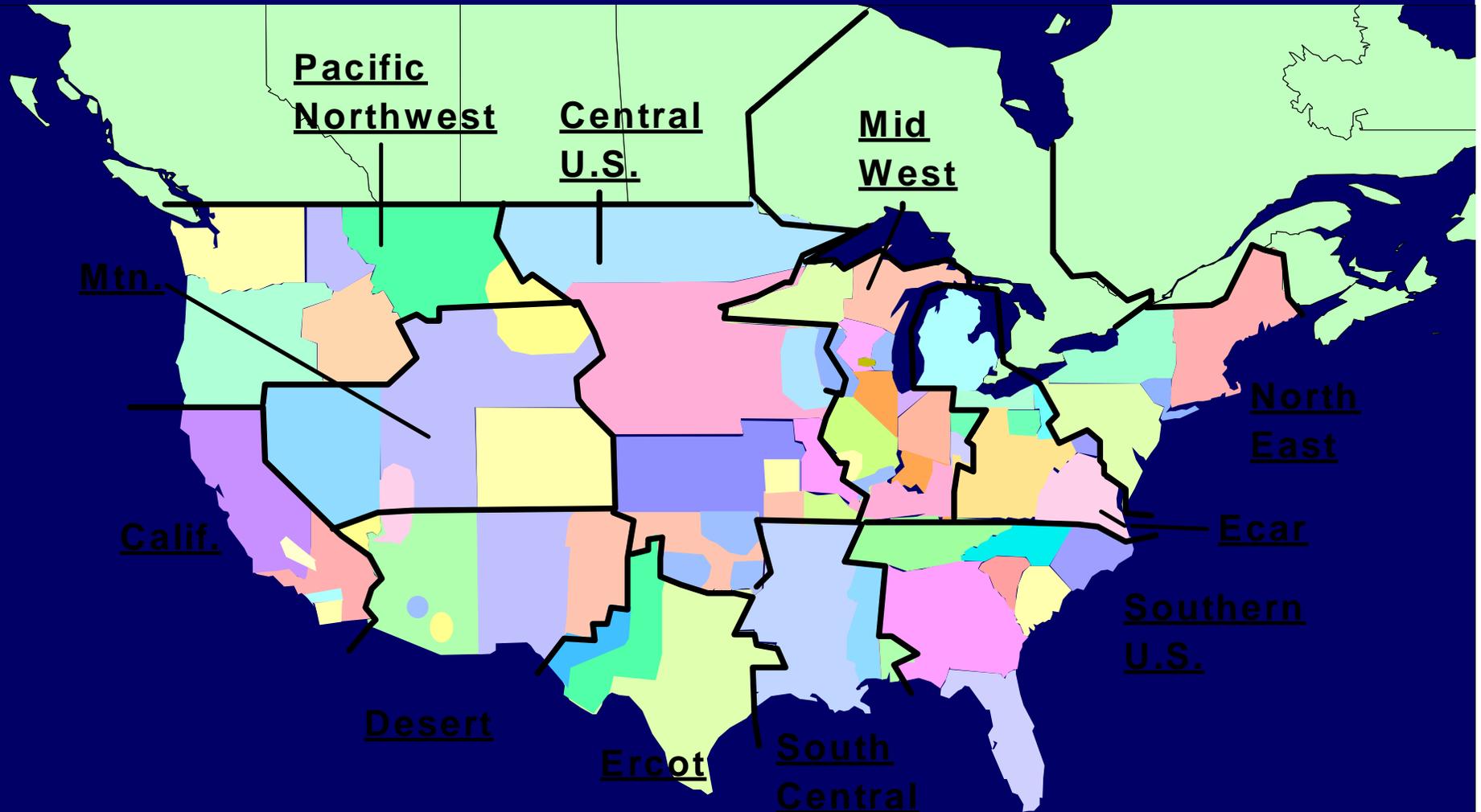
U.S. Rails



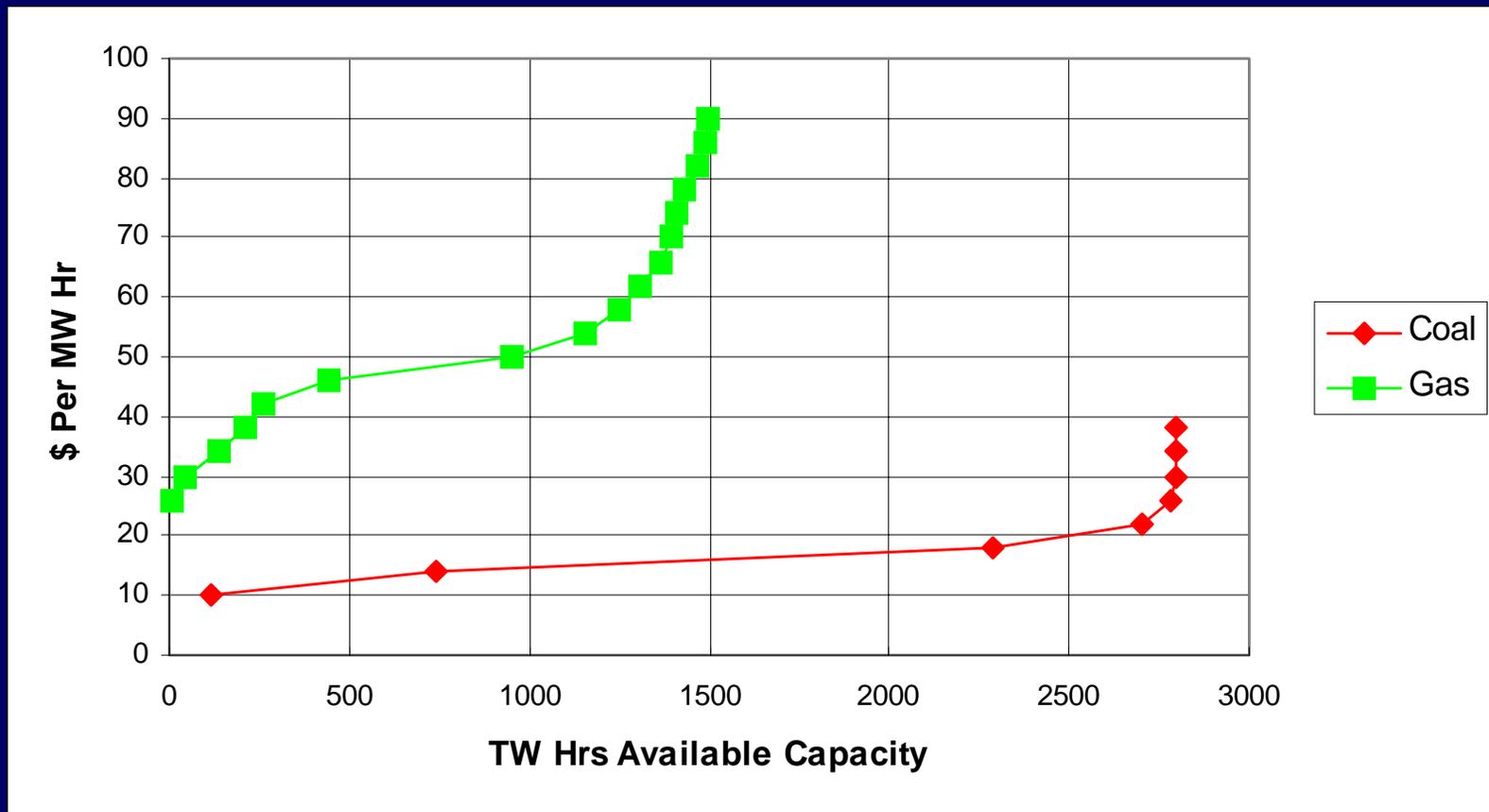
Electric Utility Industry

- In Transition to De-Regulated Markets
- "*Wholesale*" (Utility to Utility or Industry) Already There
- ISO's, RTO's Dispatch Bidding
- Proposed Environmental Rules May Shift Fuel Choices

11 Regional Trade Organizations



Dispatch Costs - Gas and Coal Units

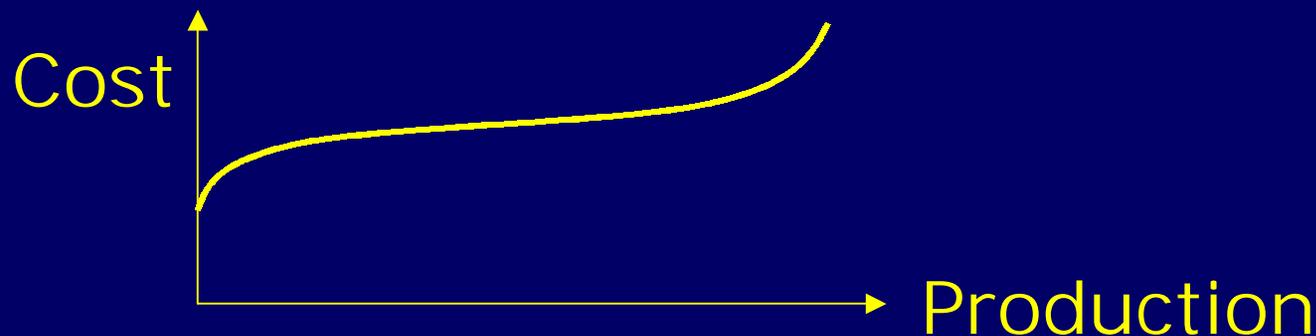


The Ingredients of the Hill Model

- Coal Mines
 - Specs: BTU, Sulfur, Grind Index, ...
 - Cost Curve
 - Mining Operation: Capacity, Lifespan, ...
- Power Plants
 - Dispatch, Production of Electricity
 - Emissions, Cleanup Technology
- Control Areas
 - Demand
 - Power Wheeling Network between Control Areas

Chronology Of Model Development

- The *original* Coal Choice Model (UFEM)
 - Fuel Choice for Coal Fired Plants, Price of Pollutant Allowances
 - Separate Lotus Spreadsheets by Utility
 - LP based Optimization at Fixed Coal Prices
 - By-Hand Price Adjustments from Cost Curves



Chronology Of Model Development

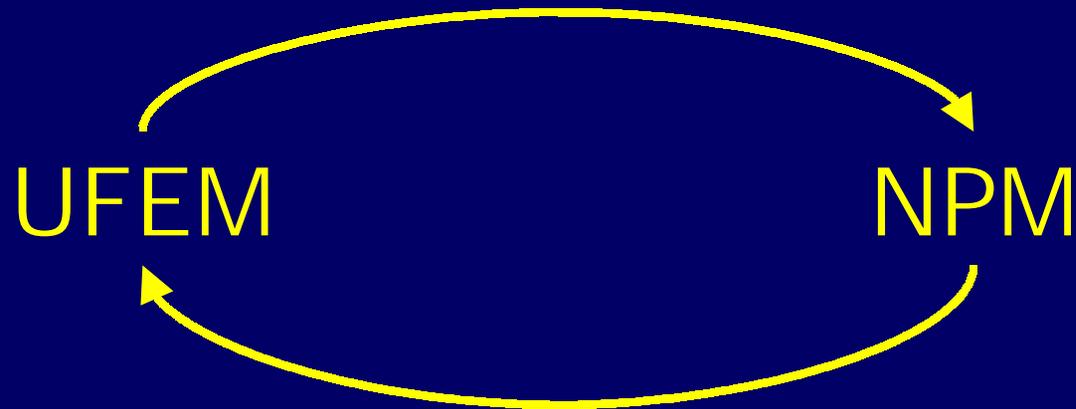
- National Power Model
 - Dispatch, Power Wheeling, Pollution
 - *Originally* LP based Optimization
 - *Turn-down rates* required binary variables
 - GAMS Implementation
- NPM Coupled with UFEM via DBASE Programs

Chronology Of Model Development

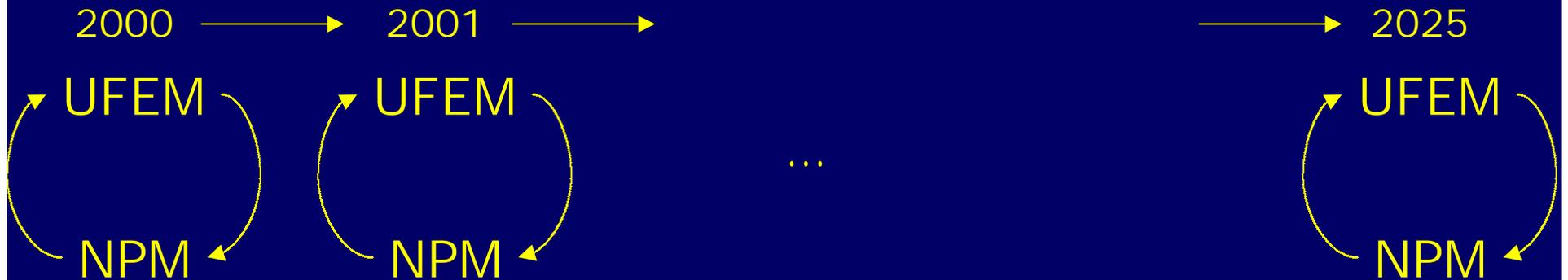
- Revised UFEM Model
 - All Utilities simultaneously
 - Cost Curves part of the model
 - LP based Optimization
 - Coal and Allowance Prices: *Shadow Prices*
 - GAMS Implementation
- "*True*" Solution (reproduceable)

UFEM-NPM Looping

Dispatch Cost, Emission Rate



Dispatch Level



Why Looping

- Model Size:

- UFEM:

- 60,000 Equations
 - 120,000 Variables
 - 400,000 Non Zeros
 - Solves in 15 Minutes

- NPM:

- 100,000 Equations
 - 230,000 Variables
 - 3000 Binary Variables
 - 1,000,000 Non Zeros
 - Solves in 30 Minutes

- Combining UFEM/NPM seems technically infeasible

Why Looping

- Human Intervention
- Basis of some Decisions impossible to model properly
 - Investment Decisions
- Data Errors
- "*Giggle*" Test

Packaging the Hill Models

