

# North America, Transmission Bottlenecks or Golden Opportunities



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April 27, 2001  
Energy Storage Association Meeting  
Chattanooga, TN

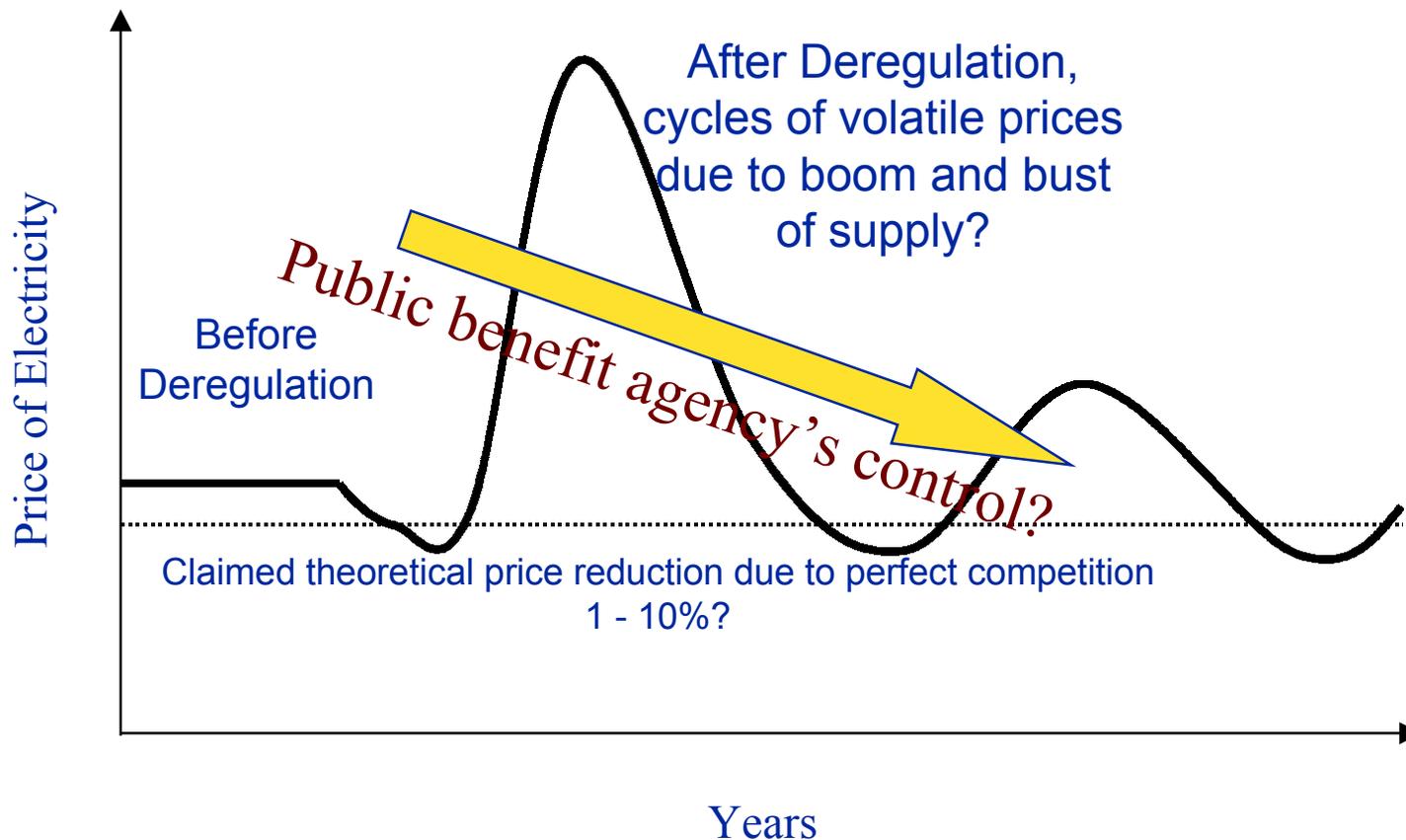
# *The Little Prince*

by Antoine de Saint-Exupery

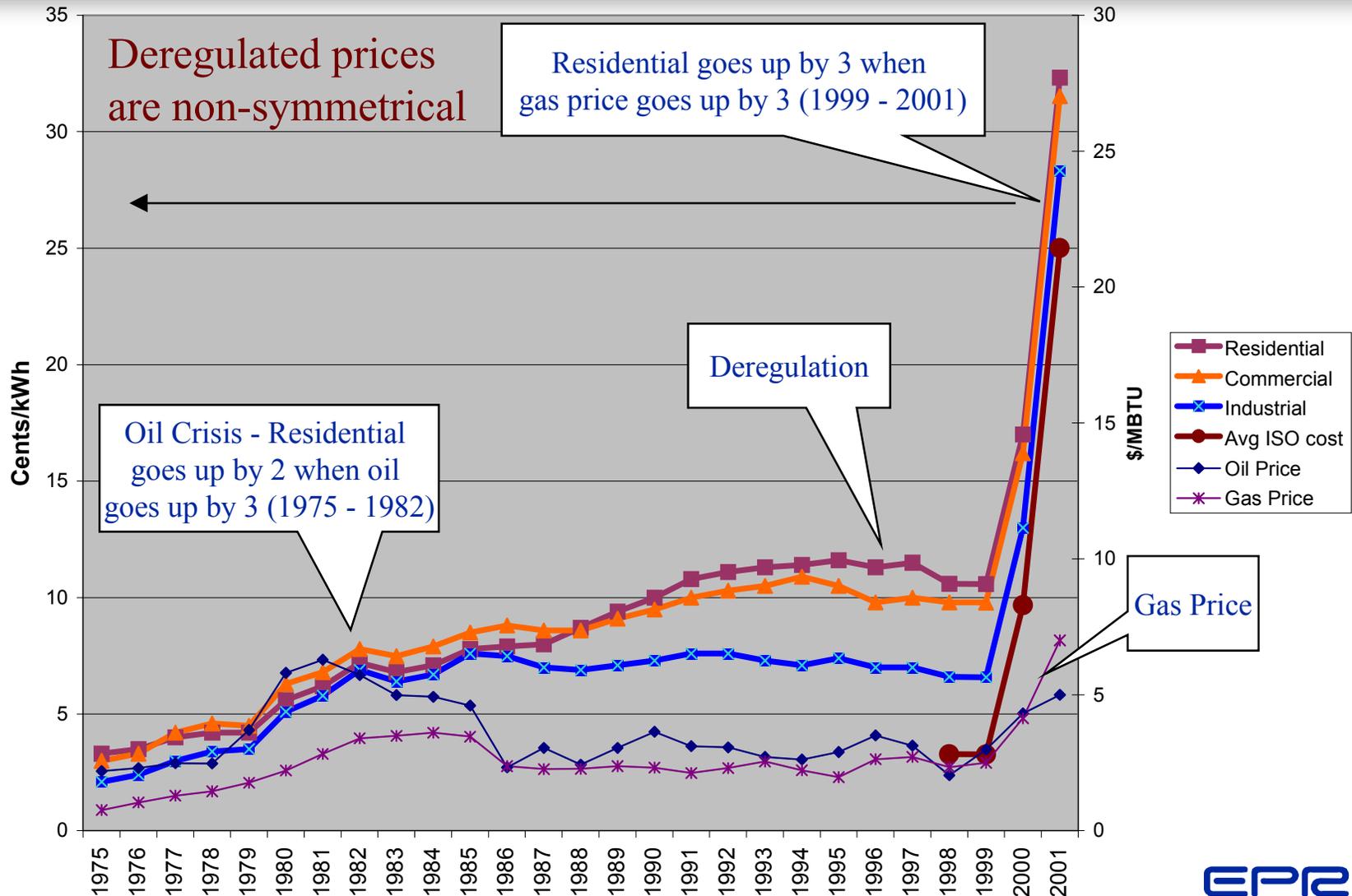
- The author crashed his plane all alone in the Sahara desert. At sunrise, he was awakened by an odd little voice. It said, “If you please---draw me a sheep”
- “What!” “Draw me a sheep!” “But---what are you doing here?”
- In answer, he repeated, very slowly, as if he were speaking of a matter of great consequence:
- “If you please---draw me a sheep ...”
- **When a mystery is too overpowering, one dare not disobey.**

# Road to Perfect Competition?

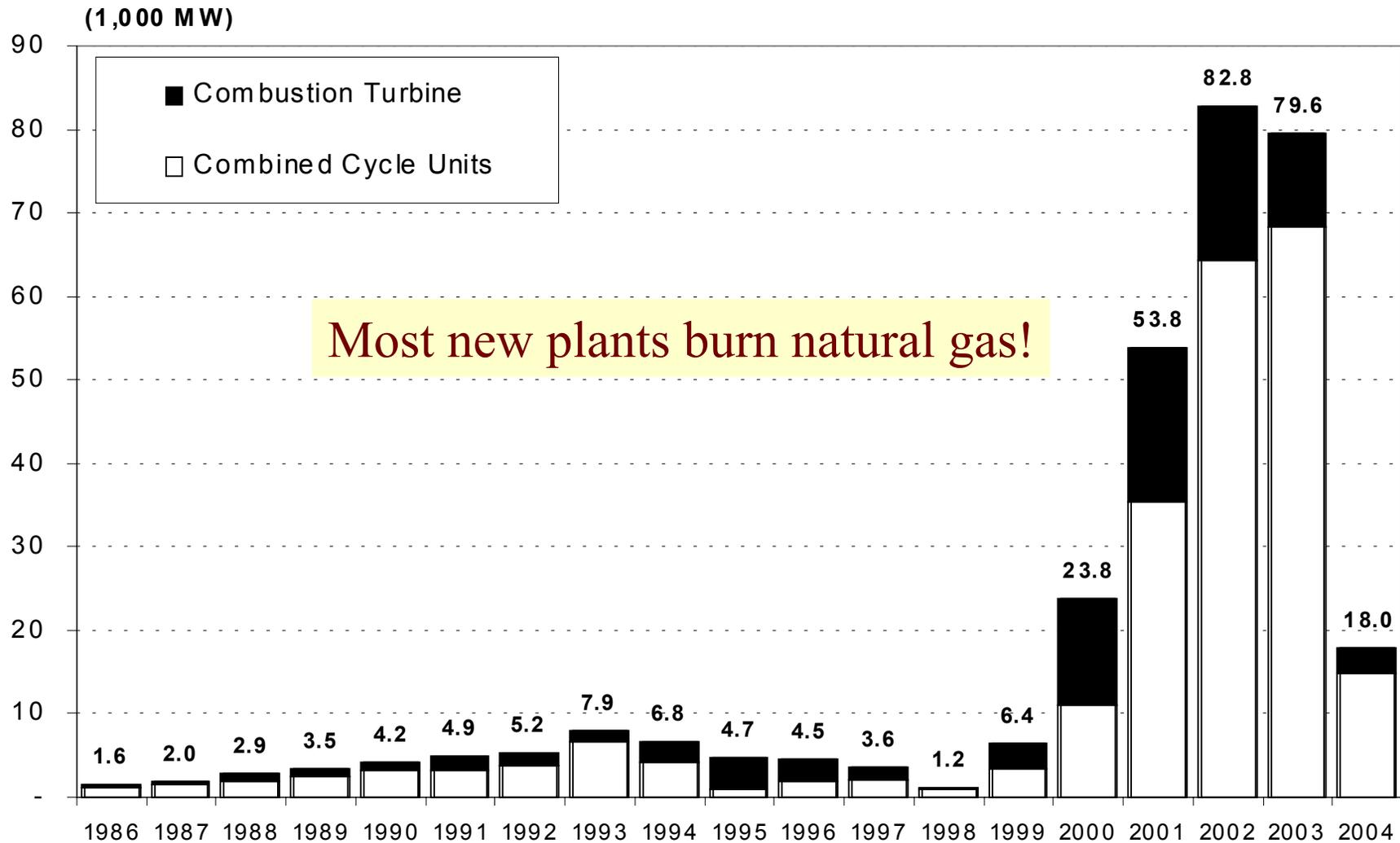
If transition cost is included, is competition better than regulation?



# Volatile Prices in California After Deregulation



# Historical and Projected Combustion Turbine and Combined Cycle Capacity Additions



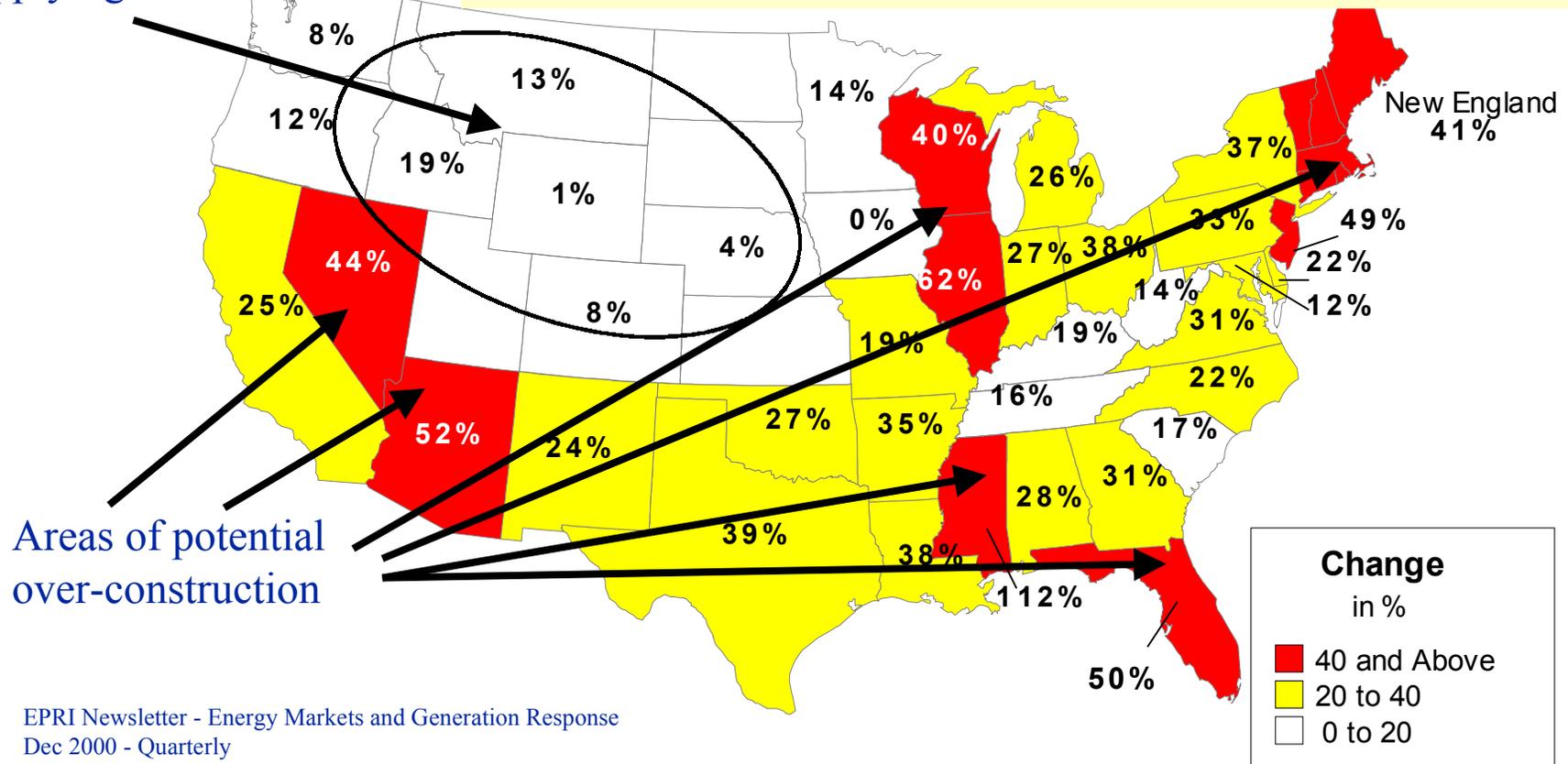
Note: Projected additions only include categories 1 through 4.  
Source: EIA, EEI, and EVA.

EPRI Newsletter - Energy Markets and Generation Response  
Dec 2000 - Quarterly

# New Power Plants 2000-2005, as a Percent of Existing Capacity

Areas of potential supply tightness

Regional imbalances & potential boom & bust



EPRI Newsletter - Energy Markets and Generation Response  
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# Basic Lessons on Deregulation

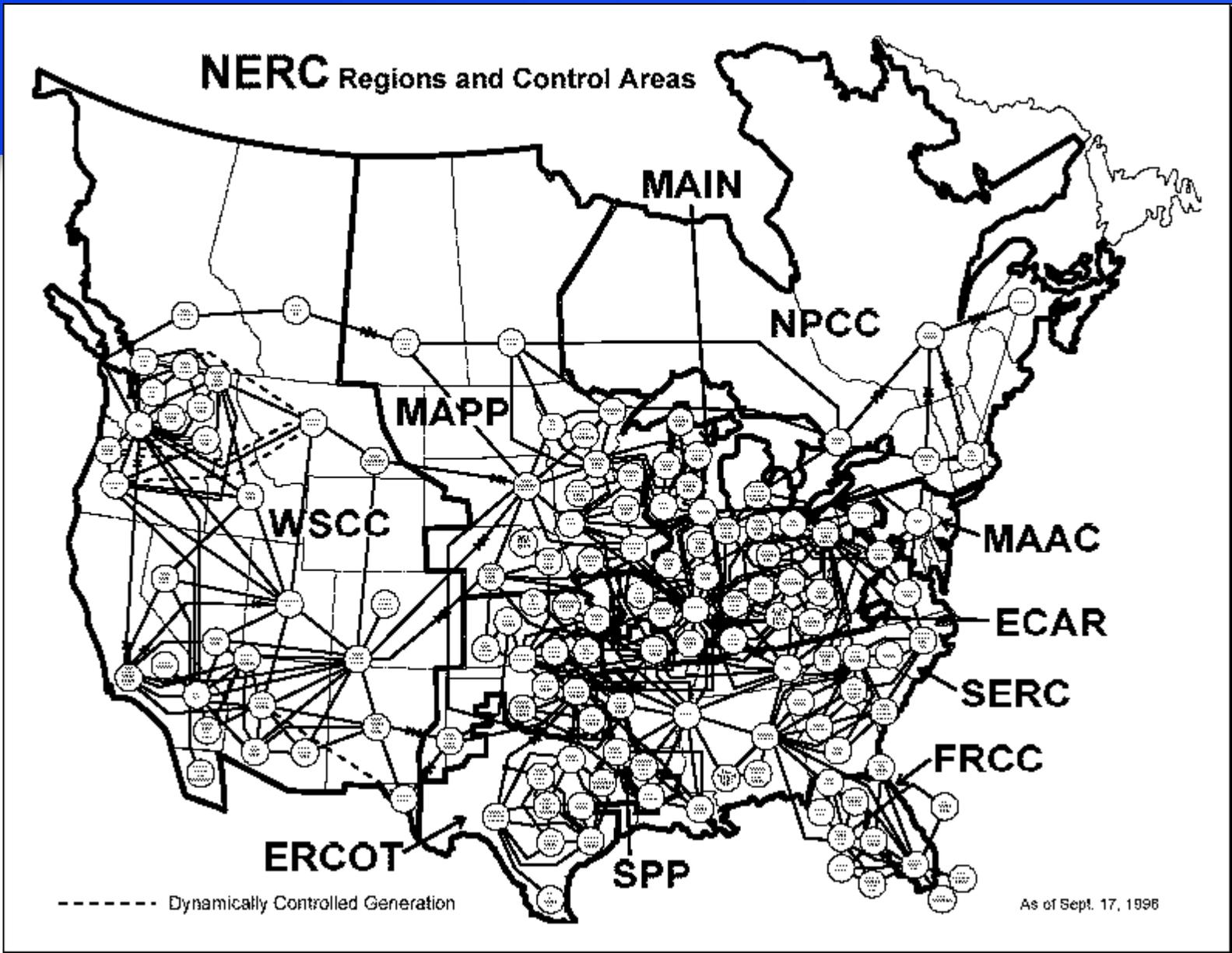
- Is electricity suitable for a competitive market?
  - Electricity is necessity-- for light, heat, business and public safety
  - Cannot be substituted, e.g., train for airplane
  - Long lead time to build power plants & lines
  - High entry cost & risk for new competitors
  - Market imbalance takes time to change
- What are objectives for a competitive market?
  - Lower electricity cost
  - Encourage innovation in technology by profit incentives
  - Encourage capital investment with potential higher profits
  - Create greater stock value for the industry

# Basic Lessons on Deregulation

- Can competition make the cost of electricity lower?
  - Regulated utility already tries to minimize cost & uses new technologies, so how much better with competition? 1%?
  - Can the promise of higher profit come without raising the cost to electricity users? Only if investors subsidize, like dot-com.
- Does competition add new risks to the industry?
  - Electricity price is now more volatile
  - Blackouts are more frequent
  - Social unrest
  - Power companies may go bankrupt (boom and bust cycle)
  - Government, taxpayers have to bail them out
  - Economic recession

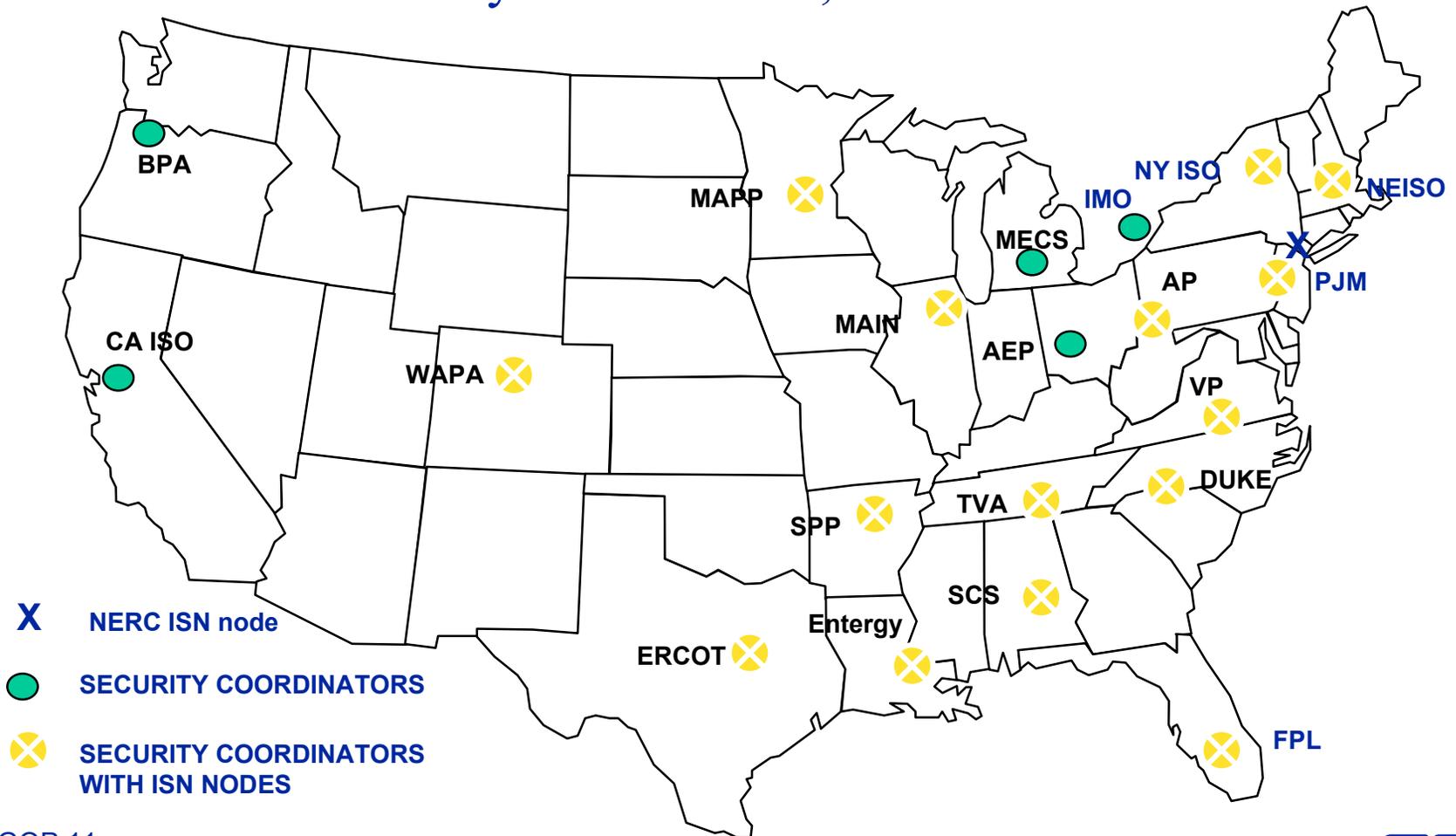
# What Are Other Lessons Learned?

- Study restructuring and market liberalization very carefully before making any irreversible changes
- Include transition costs into analysis
- Do not dismiss a mixed system of government intervention with competitive market (like the Feds with interest rate control on the free economy) -- California may yet be another pioneer (or guinea pig?)



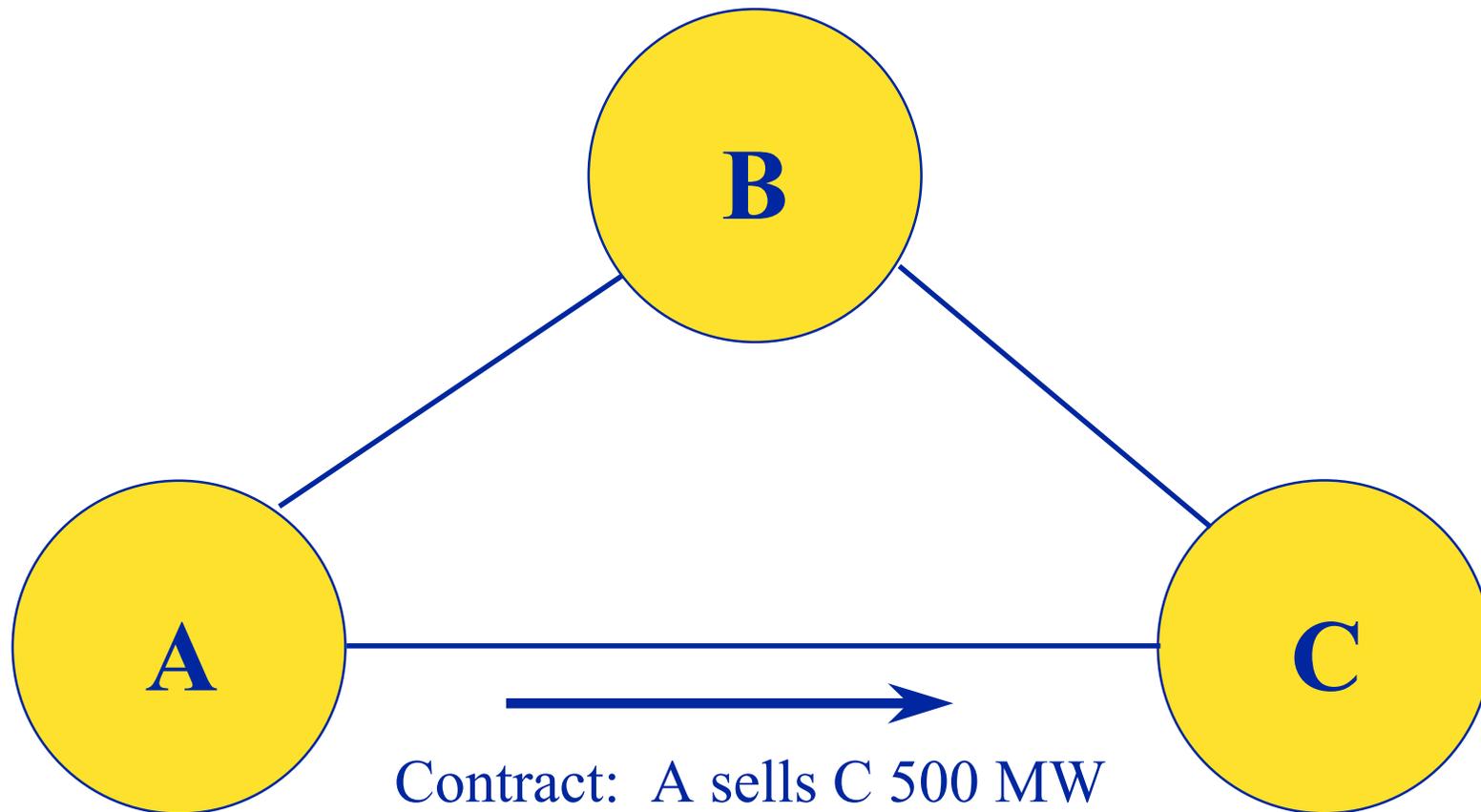
# Security Coordinators and ISN (Inter-regional Security Network)

20 Security Coordinators; 16 ISN Nodes



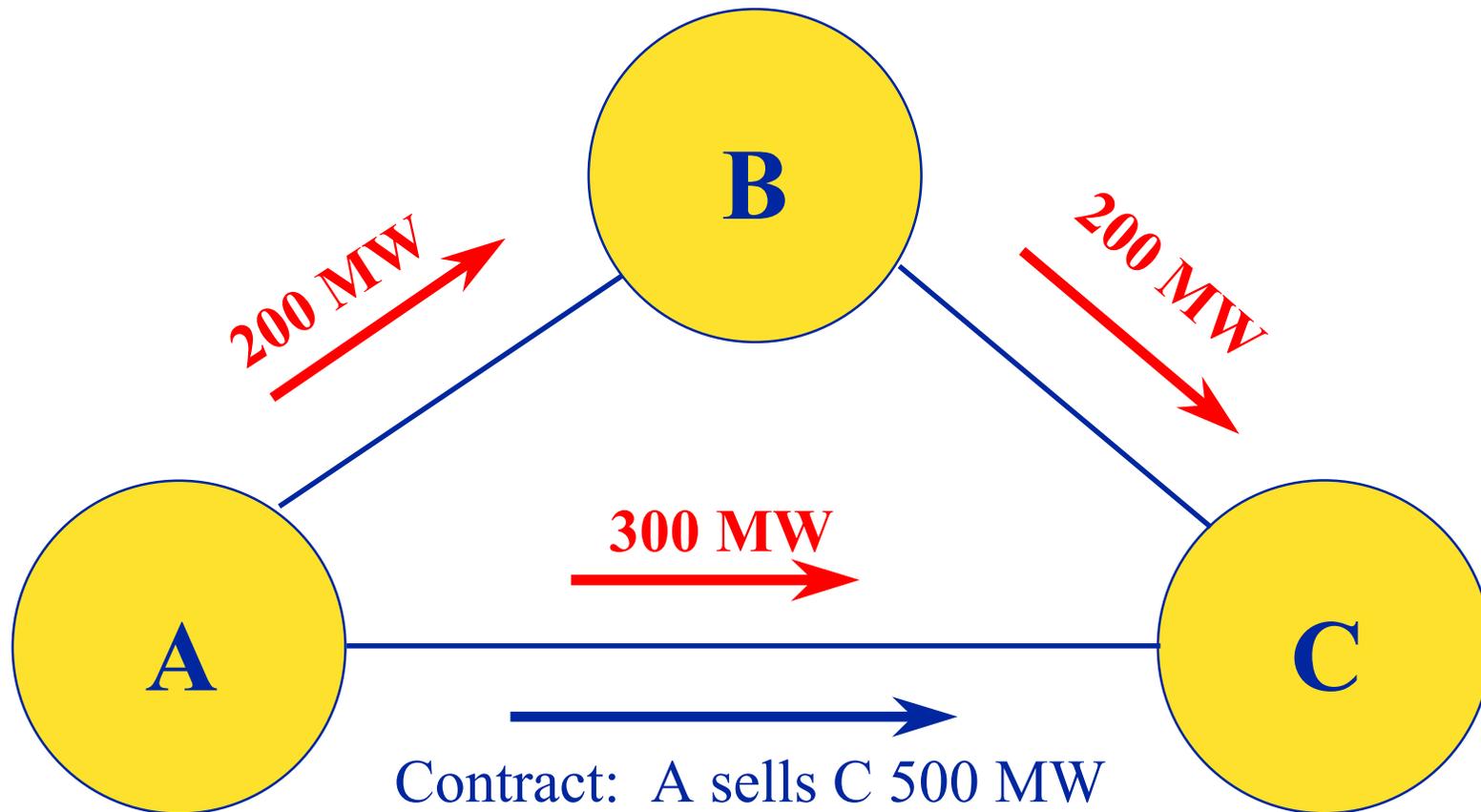
# Loop Flows

## The Contract Path



# Loop Flows

## How Power Actually Flows



# U.S. Transmission 10-Yr Plans



# NERC Congestion Management

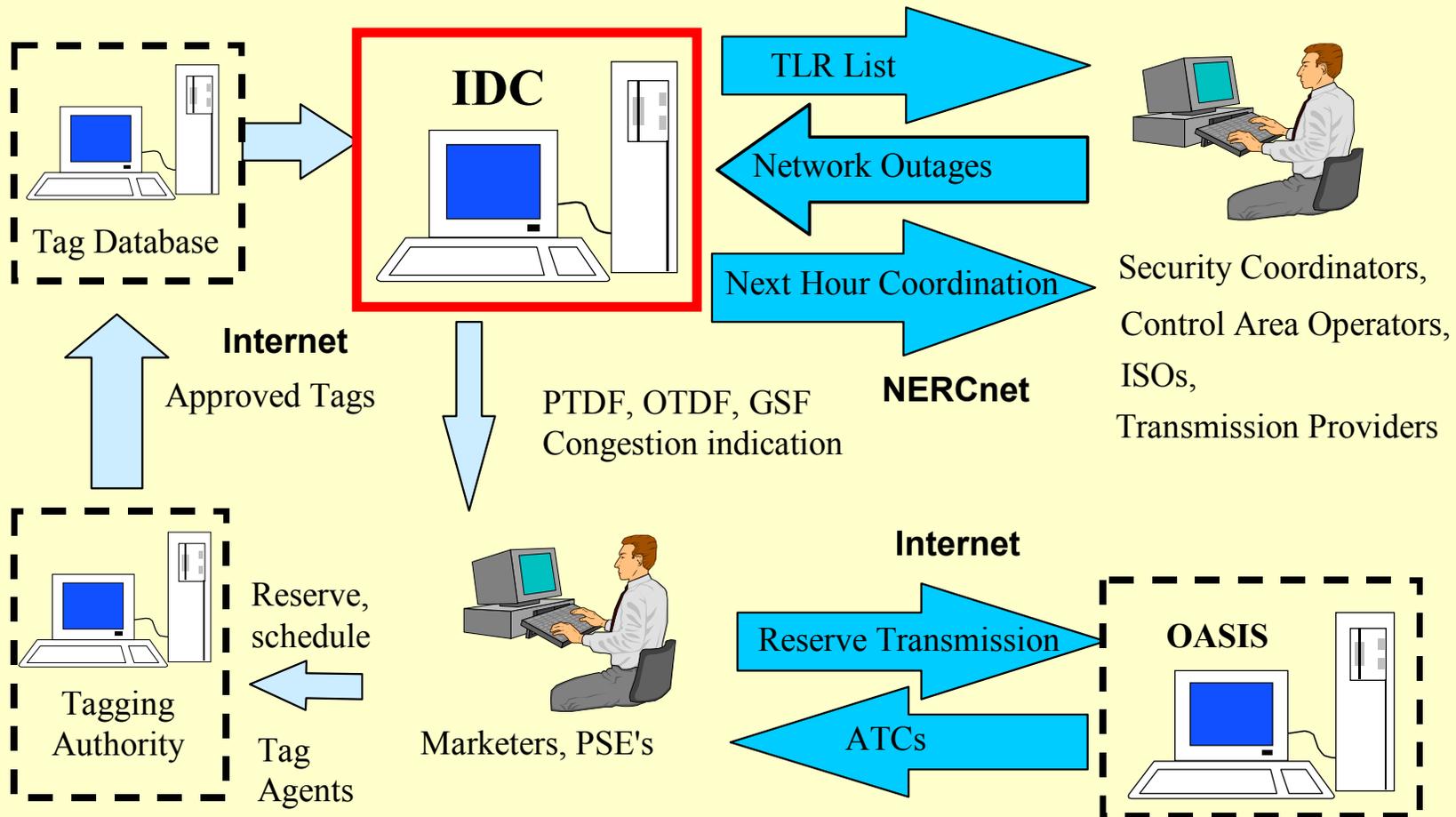
- Interchange Distribution Calculator (IDC) was developed in 1998-1999 and put on line in October 1999, along with Electronic Tags for tracking transactions
- The mathematical principle to estimate flow impact of a contract (source-sink schedule) is linear distribution factors that can also include simplified effect of post-contingency flows

# Functions of IDC

- IDC assists Security Coordinators and Control Areas in security coordination
  - Congestion Management involving interchange transactions
  - Coordination of curtailment, halting and re-allocation
- IDC supplements but does Not replace EMS security functions
  - IDC is Not a Contingency Analysis tool
  - It does check for other flowgate limitations under curtailment, halting and reloading

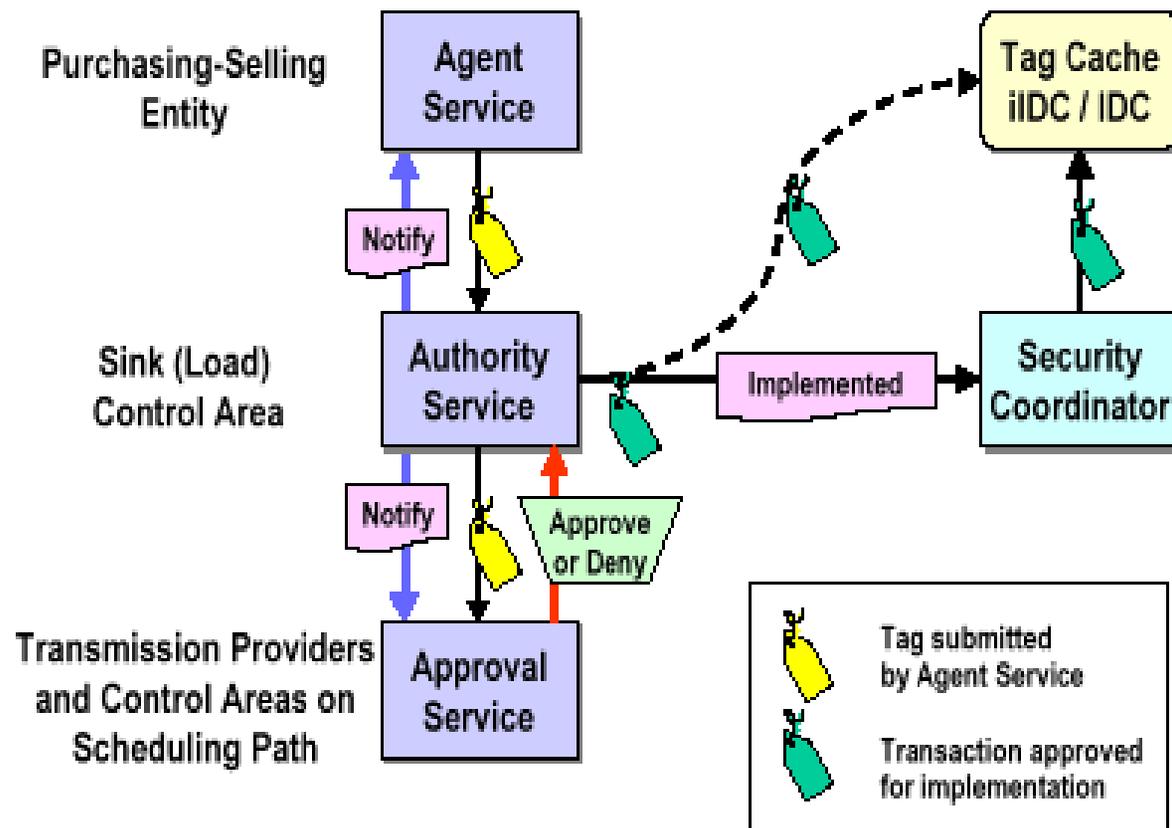
## Overview of IDC Functions, Interfaces and Users

- An integrated information system to support TLR Procedure and security coordination
- Interfaced with NERCnet, TIS (ETAG) and OASIS



# Business Process

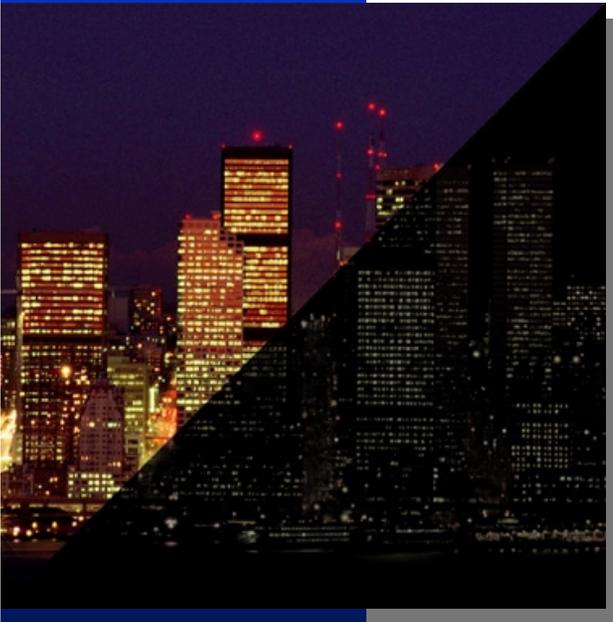
## Electronic Tagging and Approval Process



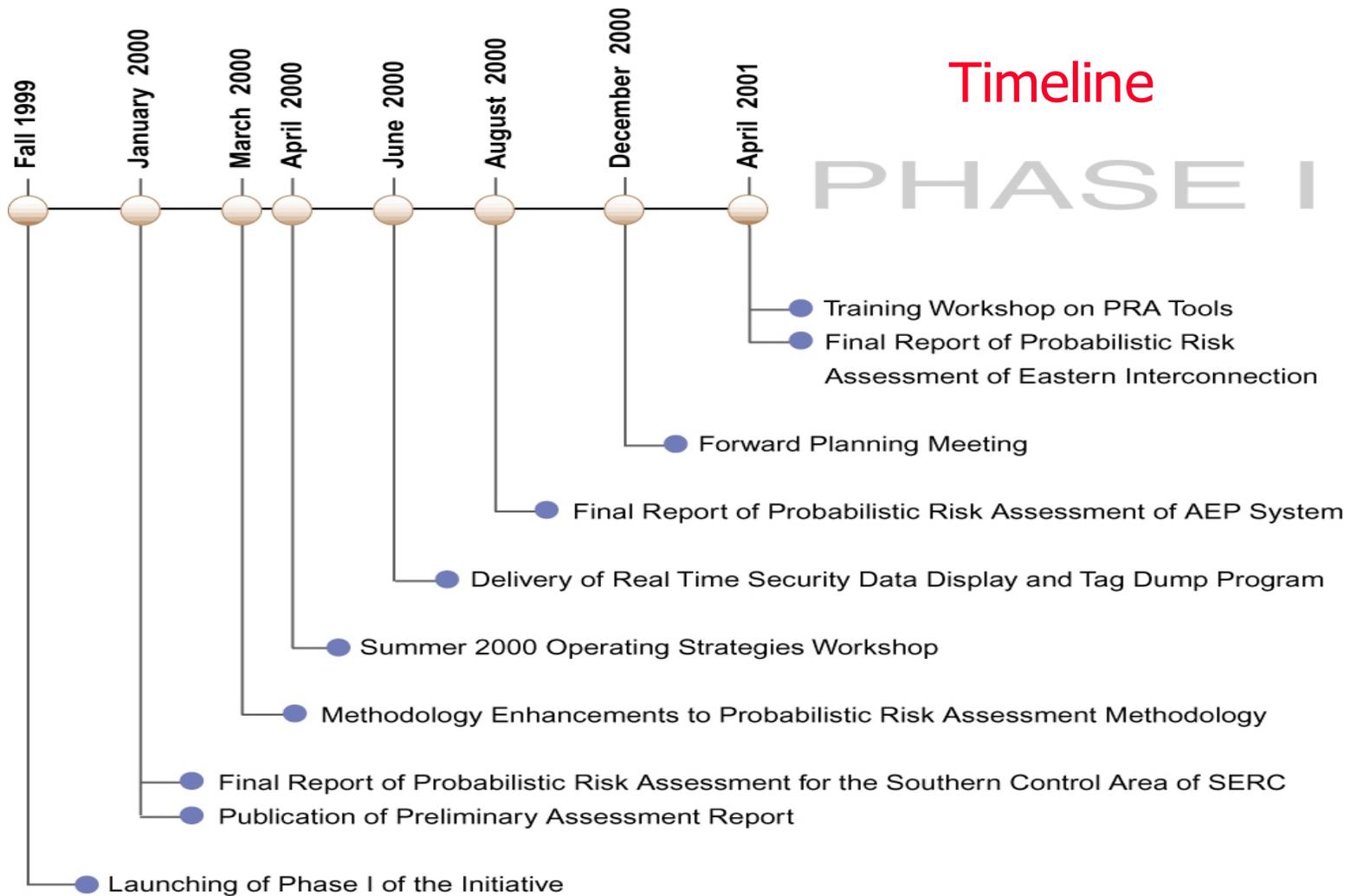
# EPRI Power Delivery Reliability Initiative Phase I

## Transmission Program

Stephen Lee  
Project Manager



# Transmission Program: Phase I Timeline



# Major Accomplishments

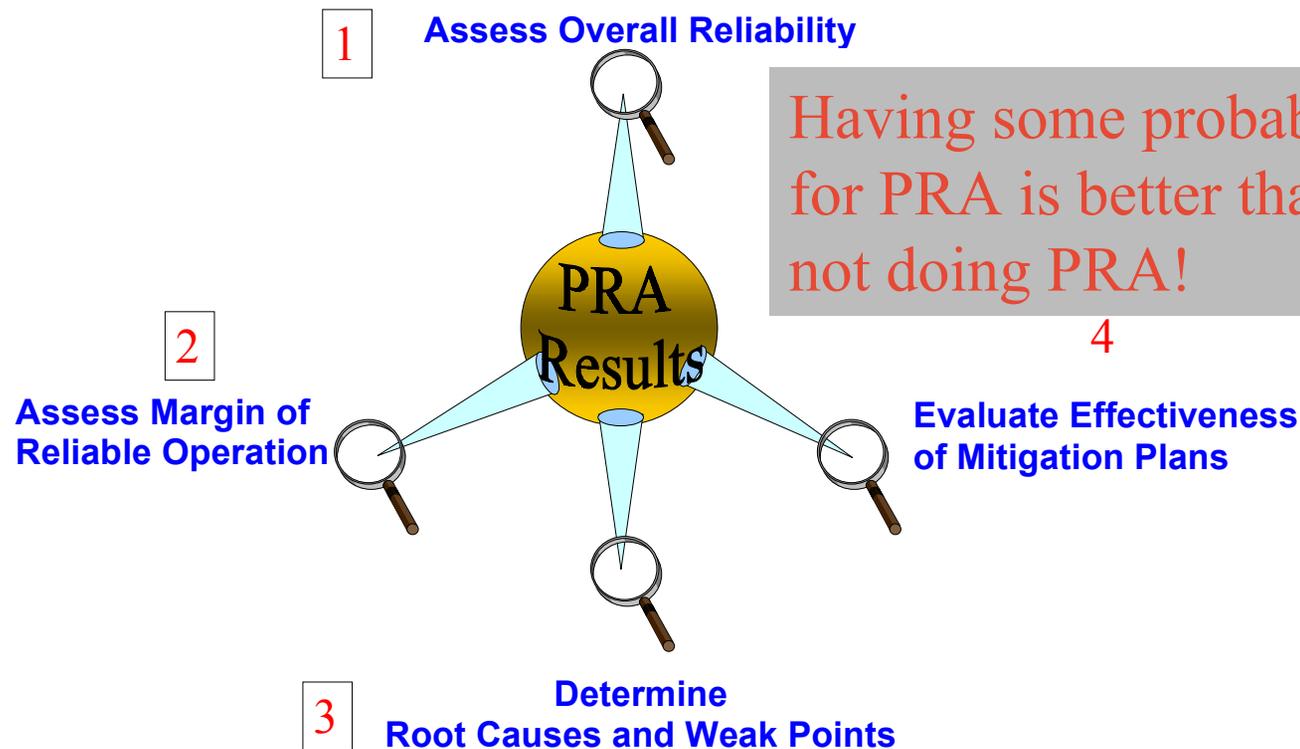
- Advancement of Probabilistic Reliability Assessment (PRA) to wide-area grid reliability problems including Software Tools
- Development of near-term wide-area tools for security coordinators

# Probabilistic Reliability Assessment (PRA)

- Compared to conventional deterministic methods for assessing transmission system reliability, PRA offers greater insight into potential failure modes and sets the stage for development of real-time risk monitoring
- Proof-of-Concept PRA studies have been completed for the Southern and American Electric Power transmission systems and have provided a basis for wide-area interregional reliability studies

# Application of PRA - Probabilistic Reliability Assessment

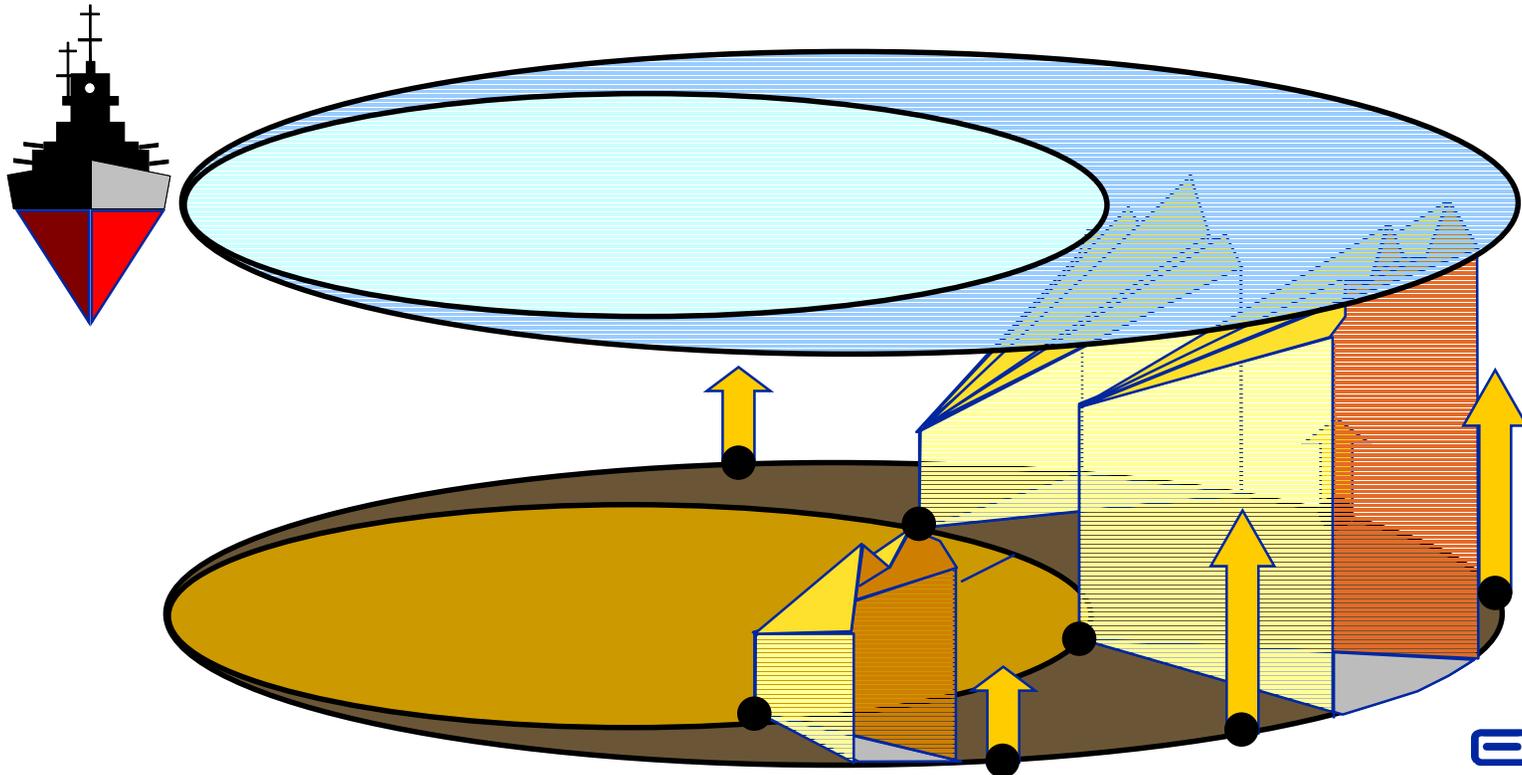
- PRA is a methodology for **quantitatively** assessing the **reliability** of a power system



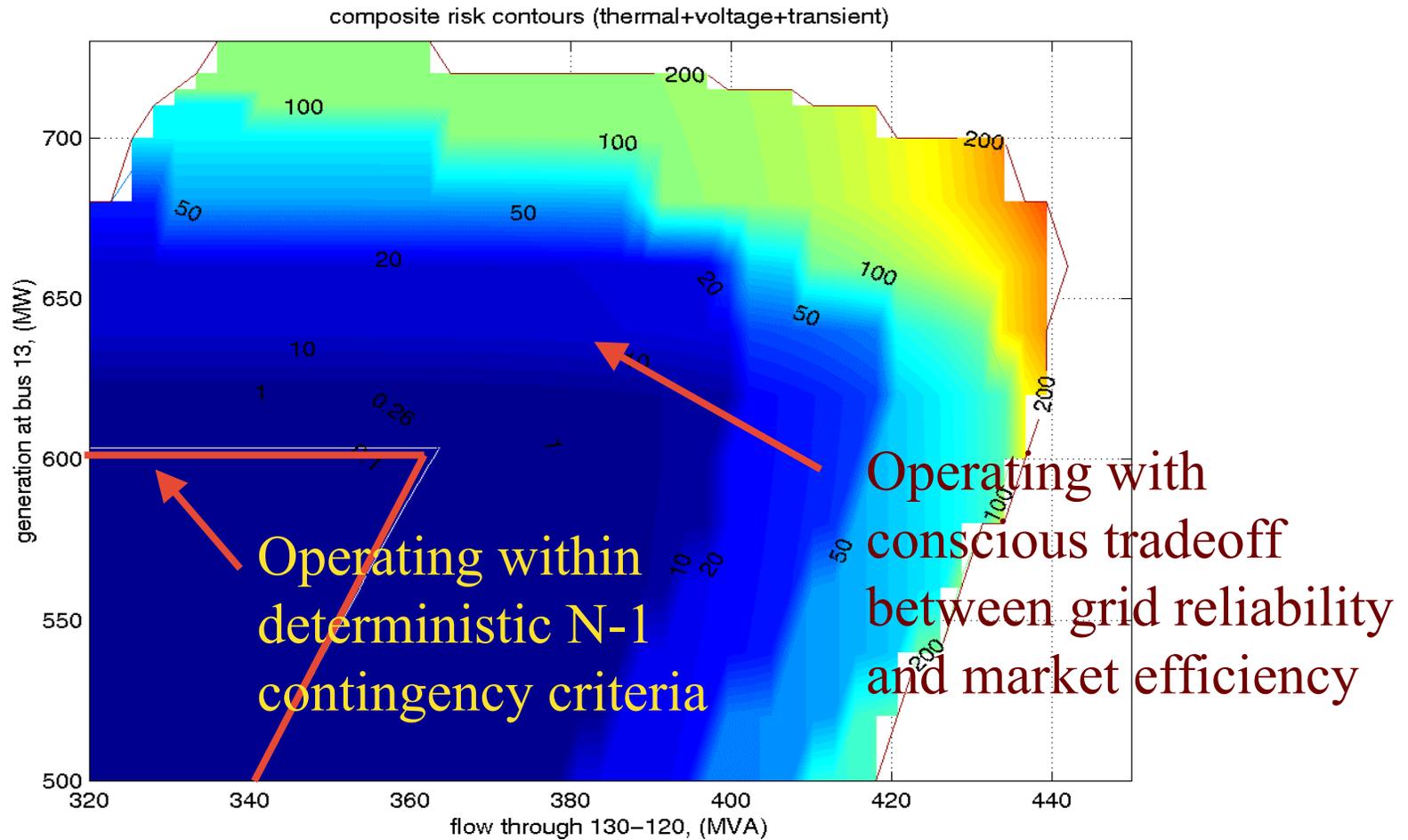
# PRA - Analogy with Radar Scanning of Submerged Rocks

The “Ideal” Probabilistic Reliability or Risk Index

- provides a consistent Reliability Assessment
- provides warning of potential danger and its proximity



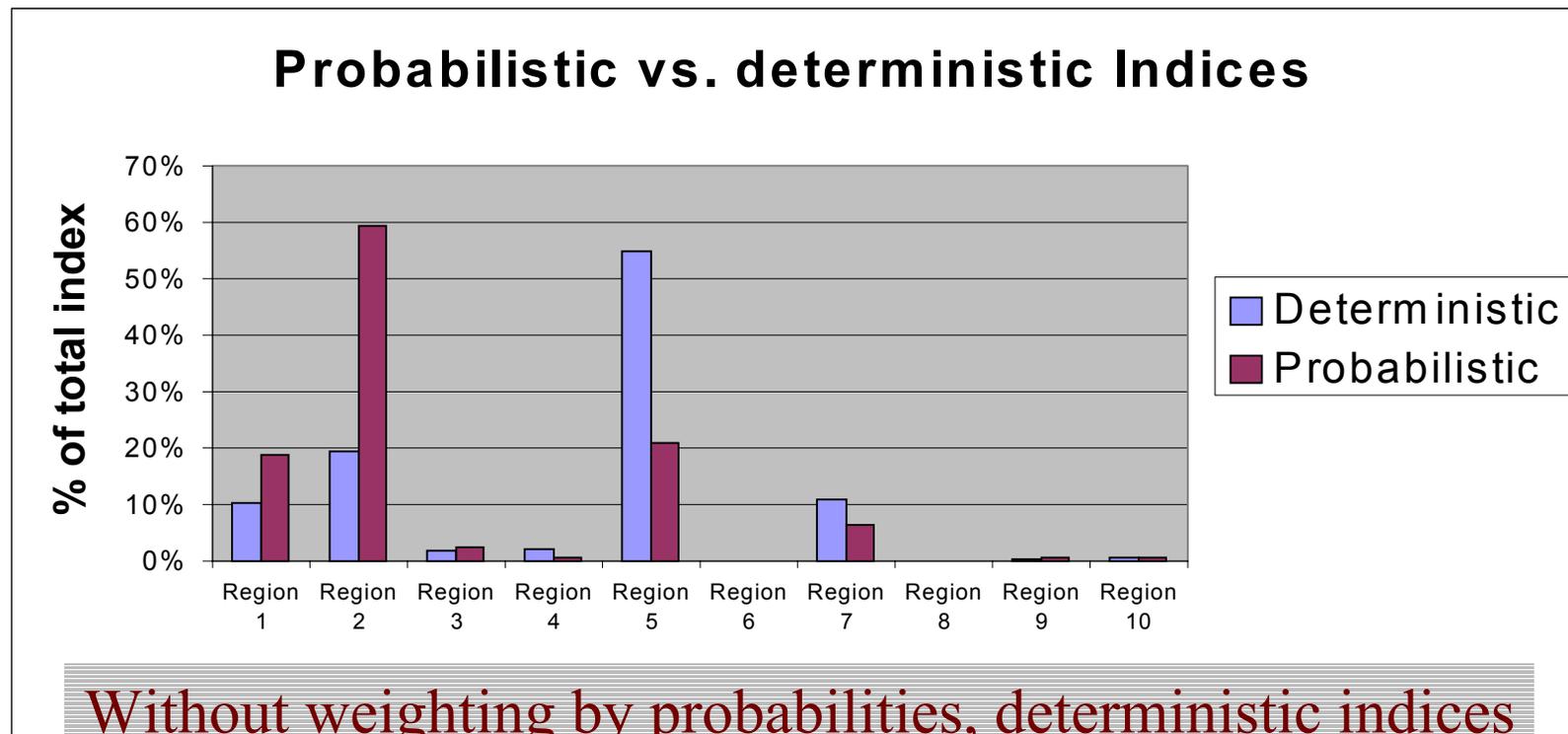
# PRA Risk Contours



# Why Perform Probabilistic Analysis?

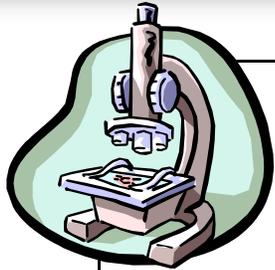
Synthesize in the reliability index information of Impact, frequency and duration of critical situations.

➔ Index provides an objective ranking of situations

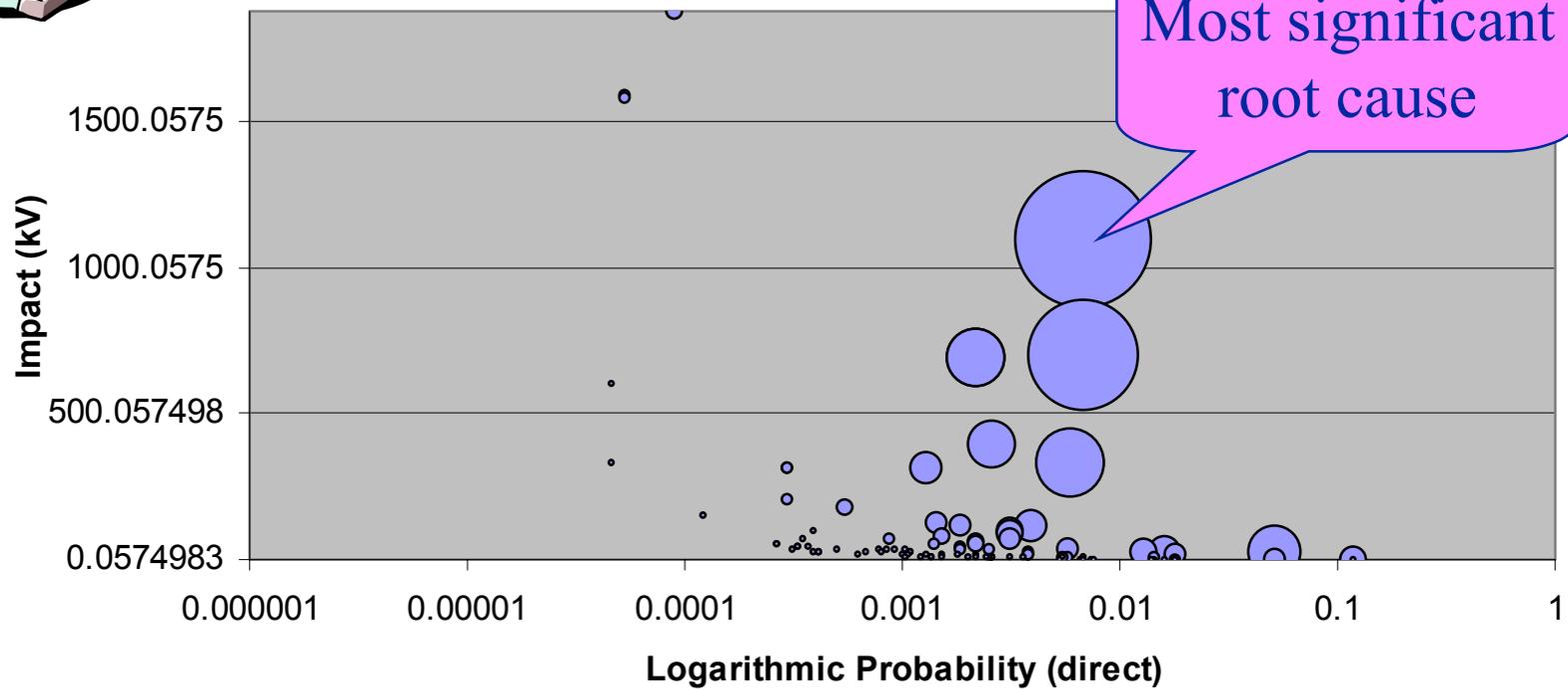


Without weighting by probabilities, deterministic indices can give wrong ranking of reliability among regions.

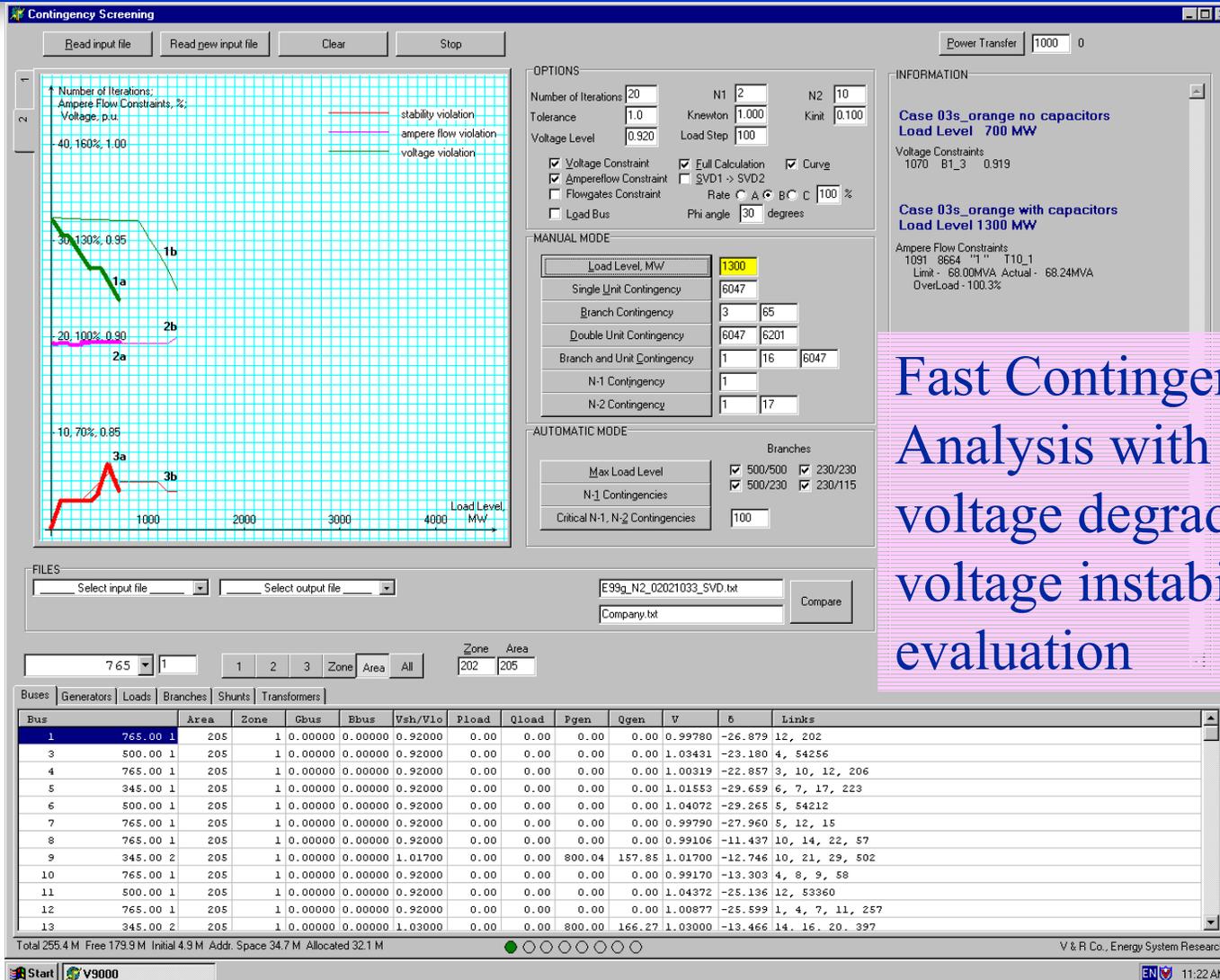
# Example of In Depth Analysis: Critical Contingency Situations



Critical Root Causes in the Proba/Voltage Impact State space (Region Cause: all, Affected Region: all)

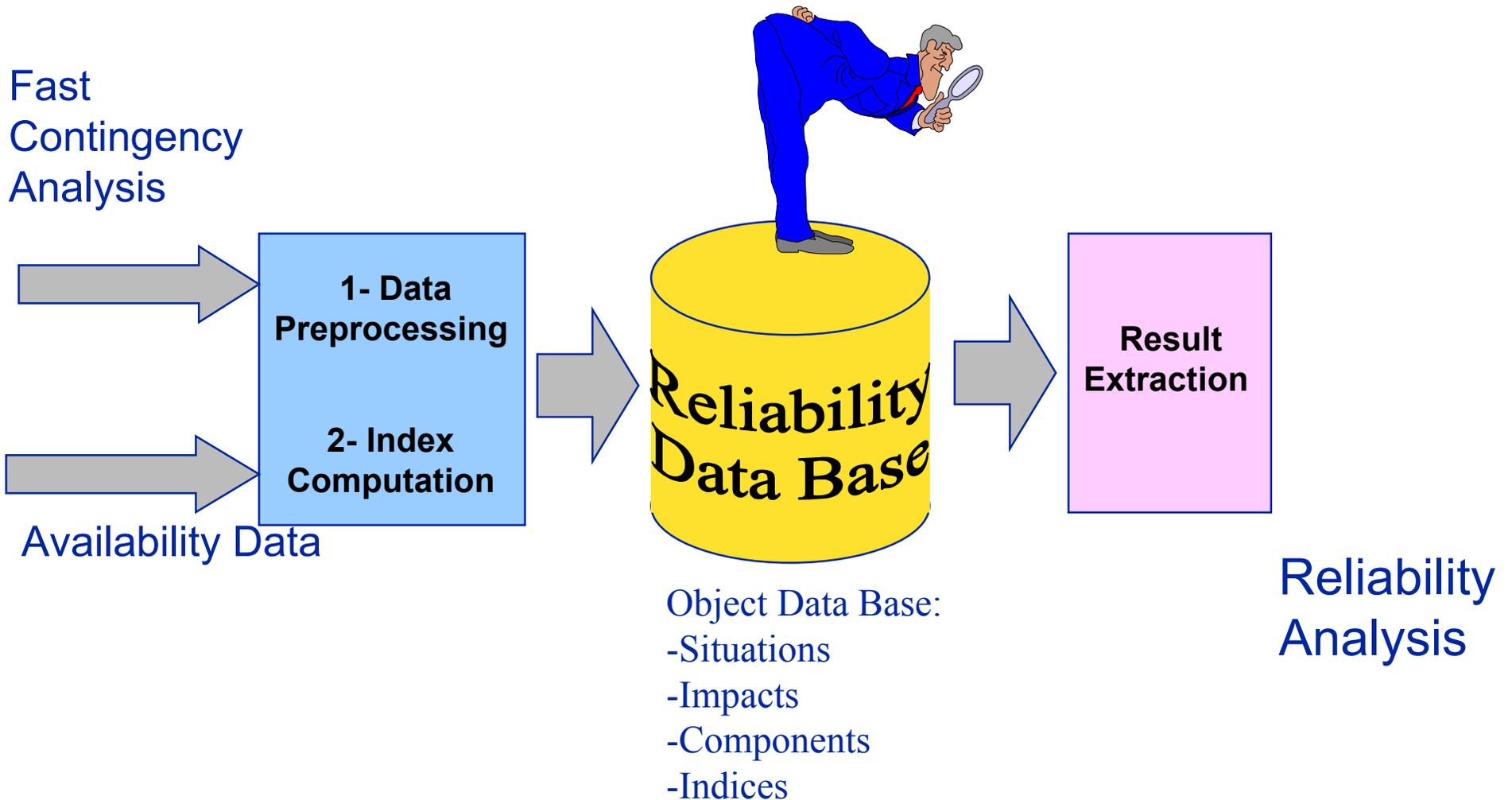


# POM (Physical Operational Margin)



Fast Contingency Analysis with overload, voltage degradation and voltage instability impact evaluation

# Probabilistic Reliability Index Program



# Near-Term Operating Tools: Real-time Security Data display (RSDD)

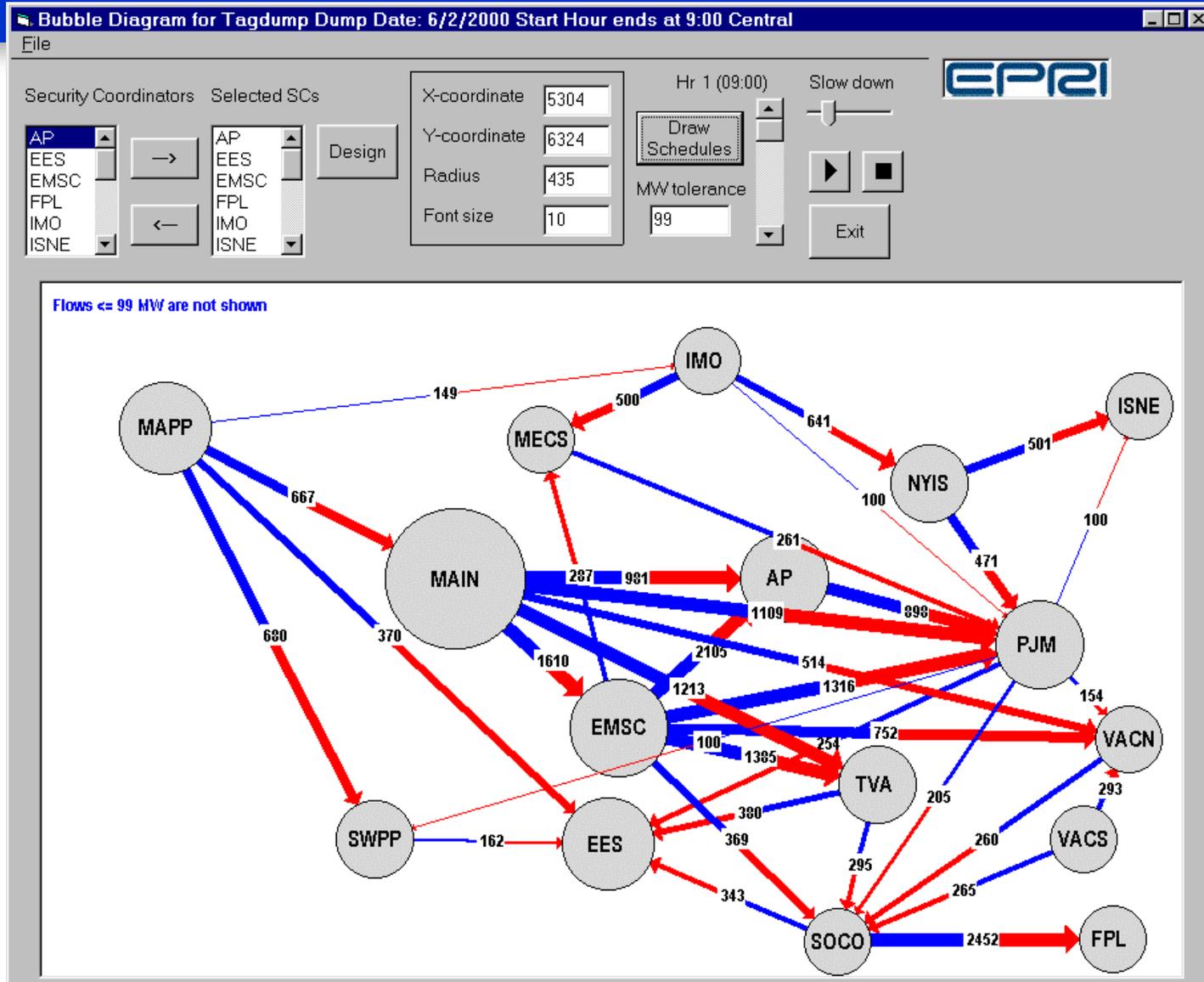
- RSDD provides transmission operators with a graphical, bird's-eye view of reliability over a wide region – up to the entire North American grid
- RSDD displays voltage values and limits for about 300 critical buses, together with the direction and amount of power flow for about 50 “flowgates,” representing critical lines or set of lines that need close monitoring



# Near-Term Operating Tools: TAG-Dump

- TAG-Dump software provides operators with aggregated schedules of wholesale power transactions between control areas, enabling regional security coordinators to determine more accurately whether particular flowgates are likely to become overloaded because of handling too many transactions

# Tag Dump - Bubble Diagram



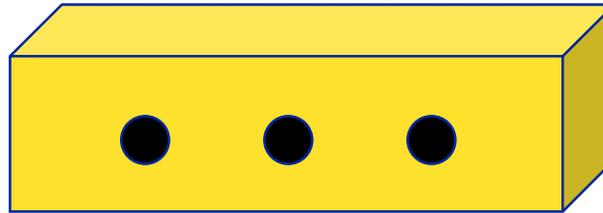


# What do all these have to do with Electric Storage?

- Large storage plants (without sufficient storage hours) cannot compete in a power market obsessed with energy and not paying enough for ancillary services
- Small, distributed energy storage with high efficiency will find a market directly with customers, for power quality, & as a hedge against price spikes and real-time pricing, which will emerge.
- Large storage plants may find a role in a public benefit power agency charged with ensuring a healthy competitive power market

# *The Little Prince*

- The author drew several sheep, but Little Prince rejected them one after another, as sickly, or old.
- Exhausted, the author drew a box with three holes, and said, “This is his box. The sheep you asked for is inside.”



- The Prince said, “This is exactly the way I wanted it ... Look! He has gone to sleep ...”
- We should be more imaginative and draw a picture of electric storage in the most creative way!