

Brilliant ***The Smart Network***

More Competitive
More Environmentally Acceptable
More Responsive
More Efficient!

Environmental Pressures

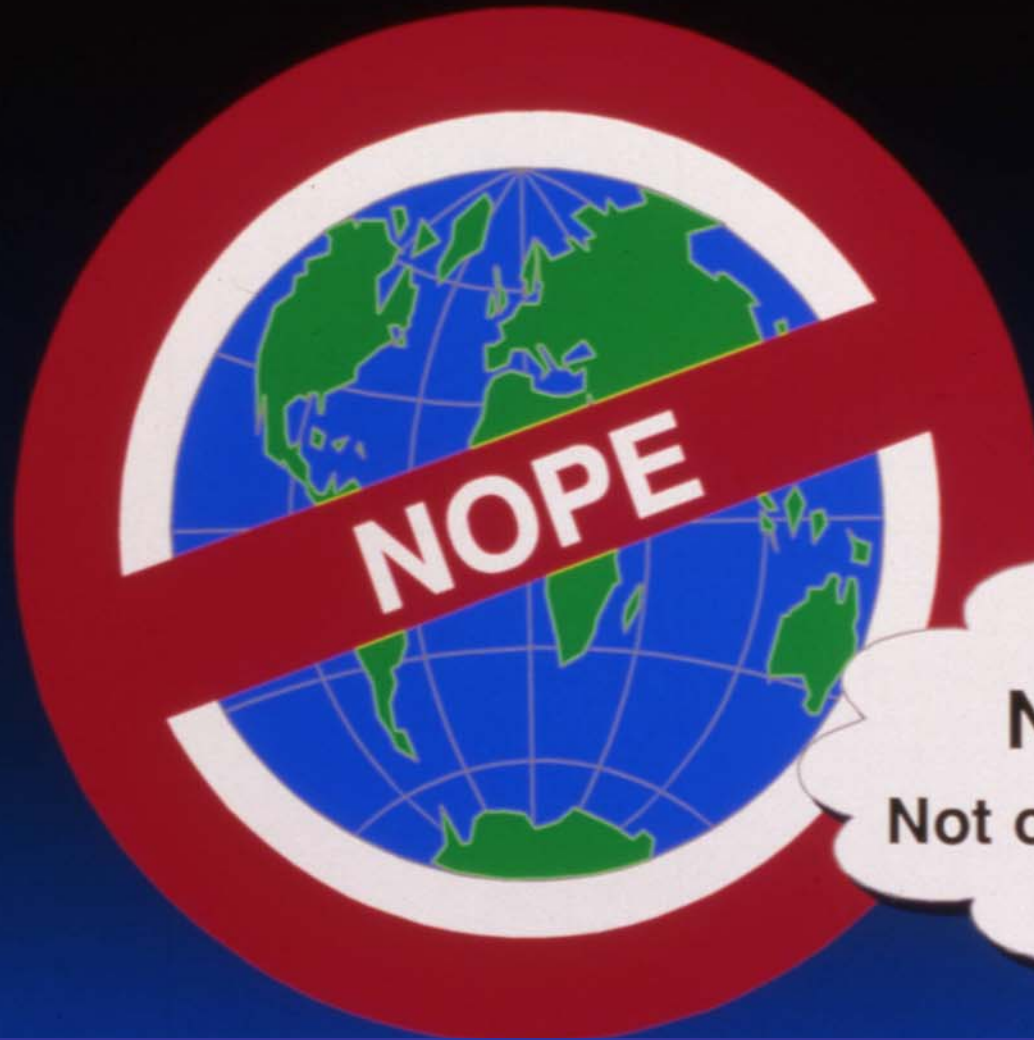


NIMBY = Not In My Backyard

LULU = Locally Undesirable Land Use

BANANA = Build Absolutely Nothing
Anywhere Near Anything

The Challenge



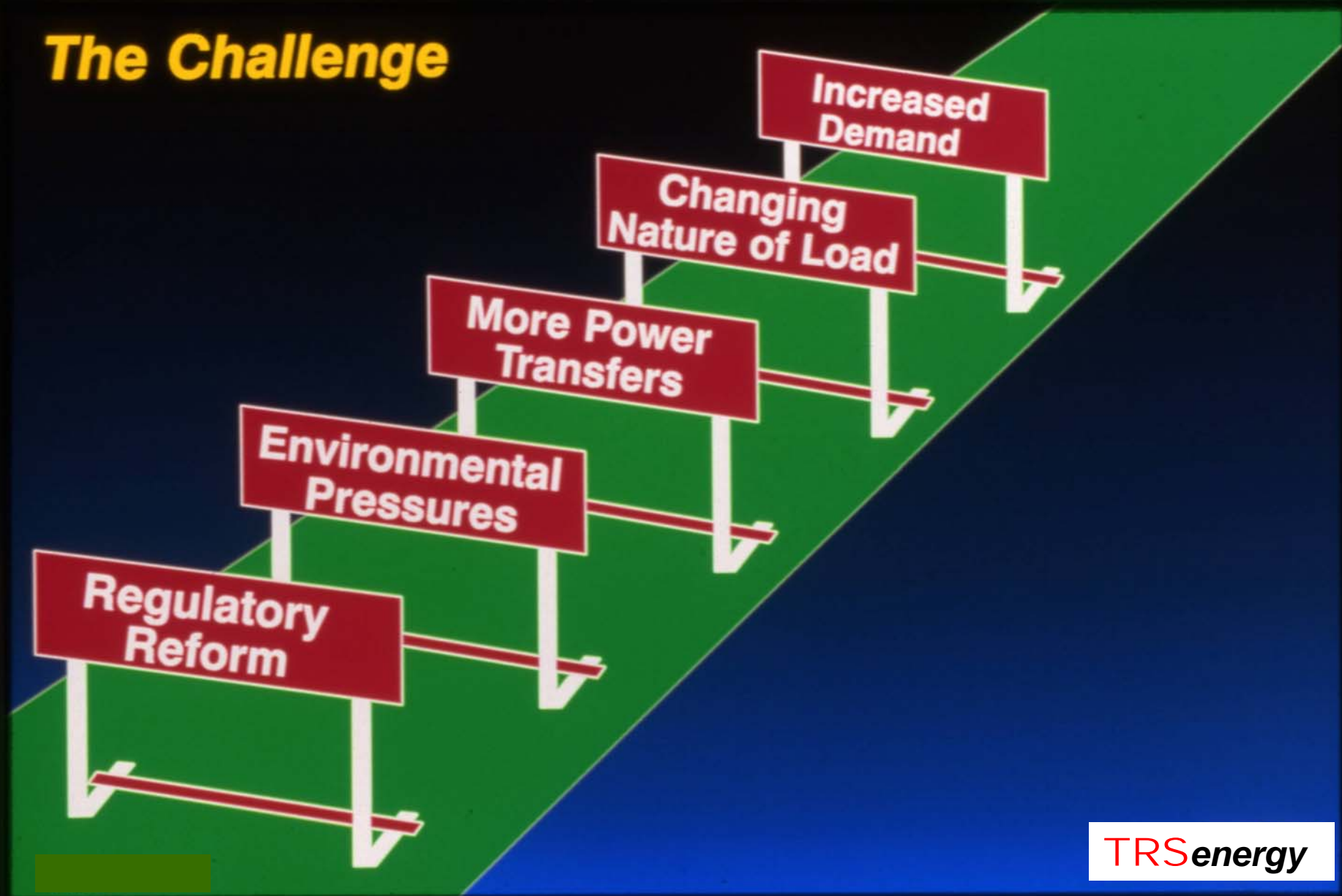
NOPE =
Not on Planet Earth

**“We are a major superpower with a
third-world electrical grid.”**

New Mexico Gov. Bill Richardson

August 2005

The Challenge



Change Is Inevitable

New Challenges

Changes in society are limiting the availability of transmission expansion as the simplest way to meet power system delivery needs

Power System Reliability

- Key to quality of life and economic competitiveness

- Largely ensured through robust transmission system

- Under threat as stresses to system mount

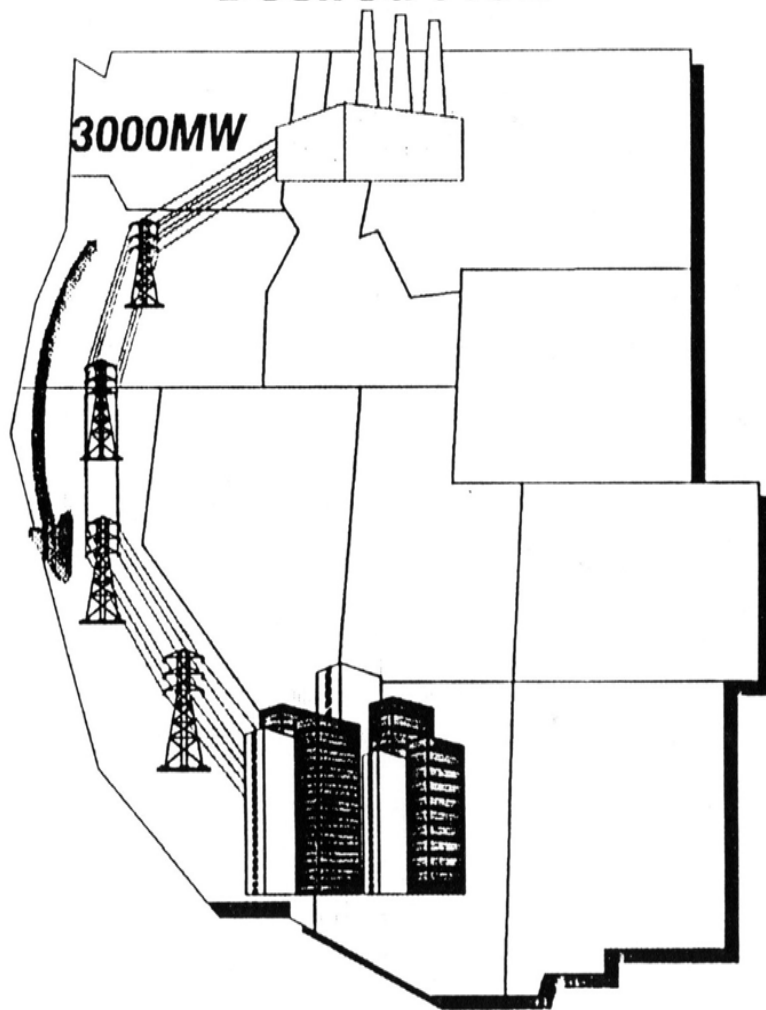
Public “Goods” Attributes

- Voltage
- Frequency
- Reliability
- Power Quality
- Losses (Real & Reactive)

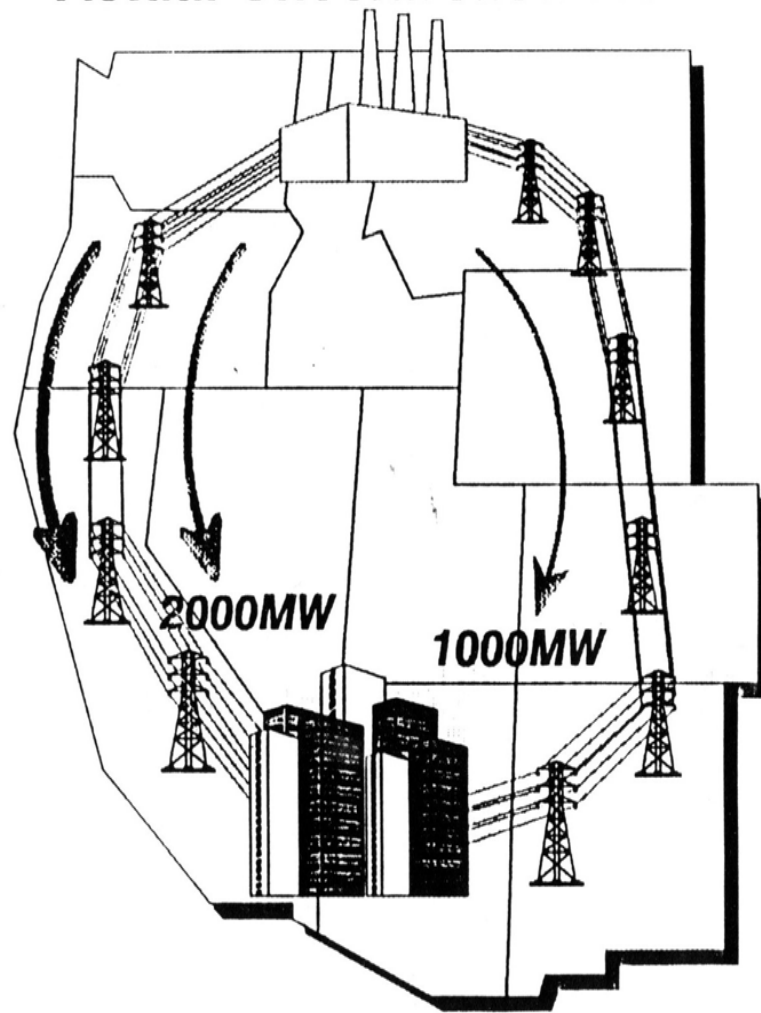
***Markets Do Not Efficiently Provide
Public Goods***

Can't Legislate Where Electrons Go

Desired Flow

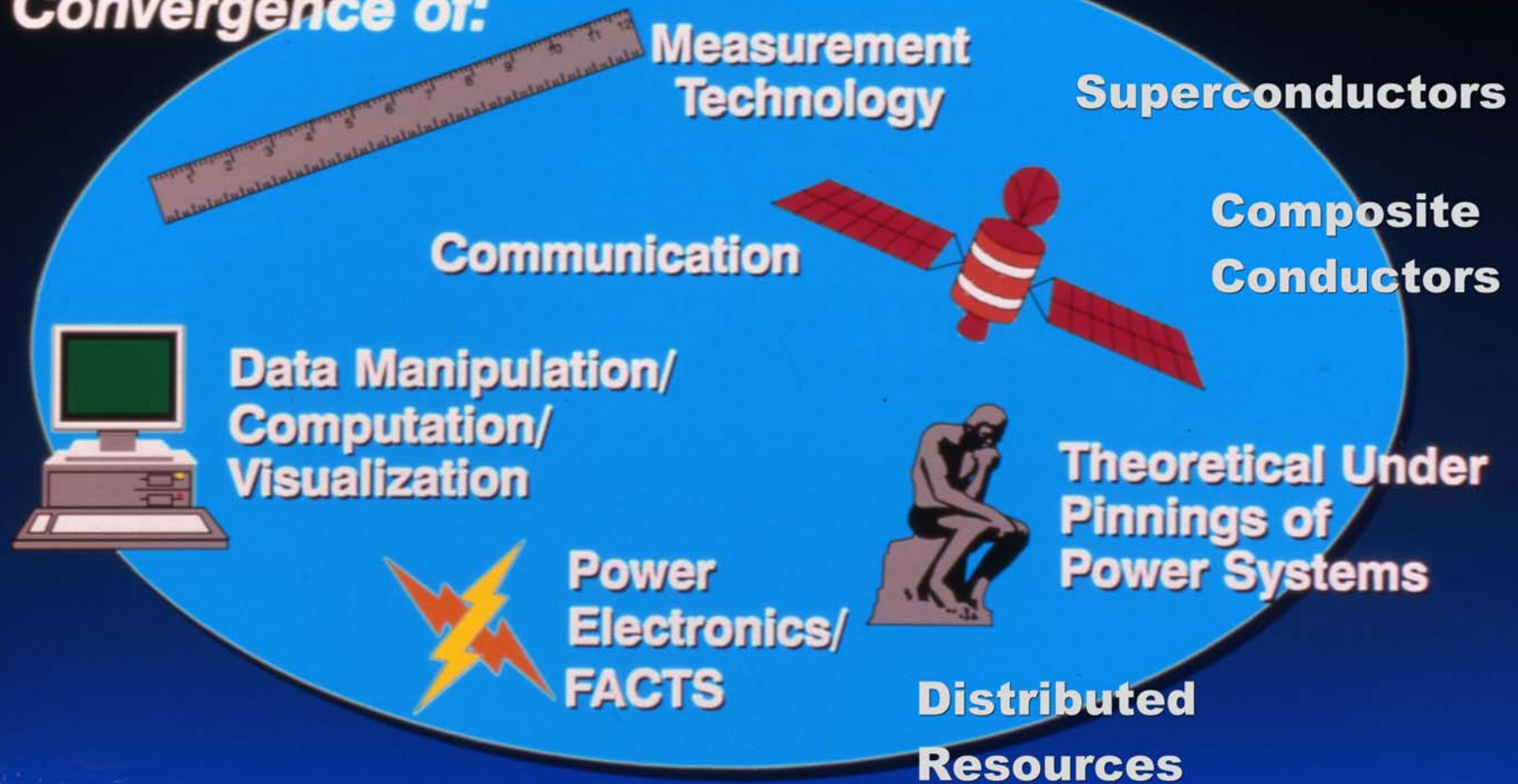


Actual Uncontrolled Flow




The Opportunity

Convergence of:







Measurement Technology



 **Capture, measure, and analyze power system operating data**

 **Sample technologies**

-  Data acquisition tools
-  Distributed processing capabilities
-  Fiber-optic sensors
-  Laser instrumentation

Communication Technology








Rapid, reliable, accurate acquisition and transmission of critical data to remote controllers



Sample technologies


- Integrated utility communications
- Fiber optics
- Satellite communications


Silicon Science - FACTS







- 
-  **Control flow and voltage while maintaining stability**
 -  **More power transfers**
 -  **More robust system**
- 

Advanced Computer Capabilities



 ***Better management, display, and manipulation of data for quick action***

 ***Sample technologies***

-  Super computers
-  Super workstations
-  Mega chips
-  Distributed processing
-  Data visualization
-  Reinvention of analog machines

Innovations

- Composite Aluminum Conductors for High Voltage Transmission
- Superconductors for Underground Transmission and Distribution Cables
- Superconducting Magnetic Storage (SMES) and D-SMES
- Superconducting Motors, Generators and Rotating Condensers
- Superconducting Transformers

Distributed Resources

- Advanced Diesels
- Wind Turbines
- Microturbines
- Fuel Cells
- Batteries
- Super capacitors
- Photovoltaics

The Opportunity

New Theoretical Understanding



***Could lead to new approaches for
predicting, diagnosing, and controlling
system disturbances and system
operations***

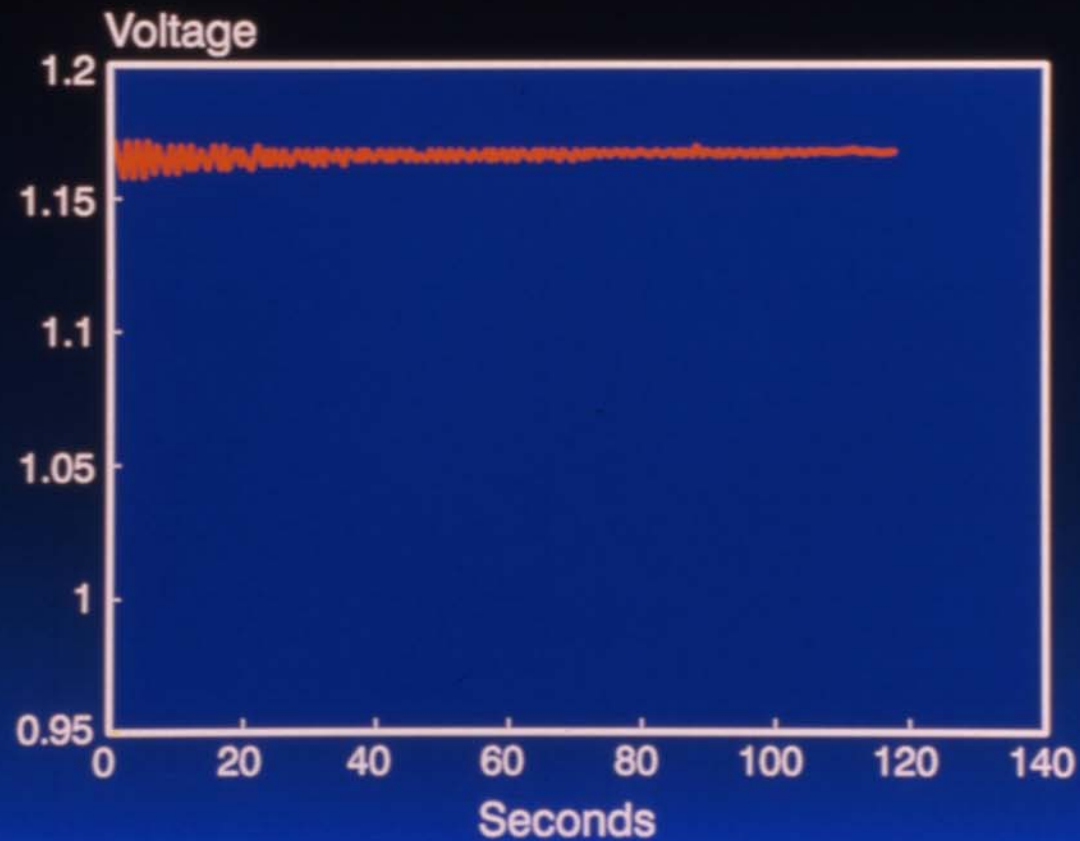
Chaos Theory & Electric Power!

AC Power System Fundamentally Chaotic

This is Important for

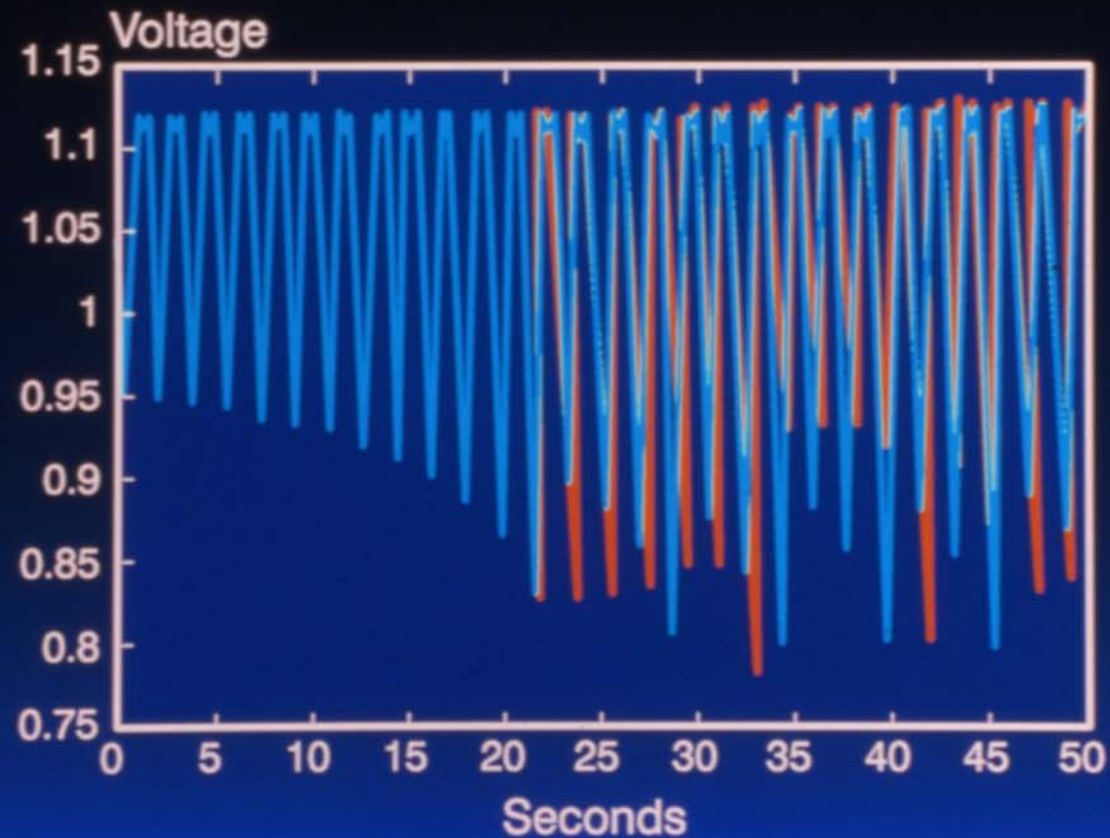
- System Stability
- Ability to Predict and Anticipate Outages
- Risk and Probability of Large-Scale Outages
- **Need to Monitor Global Properties of System**
 - Distance to Collapse
 - Criticality

A Stable System. . . Returns to Equilibrium

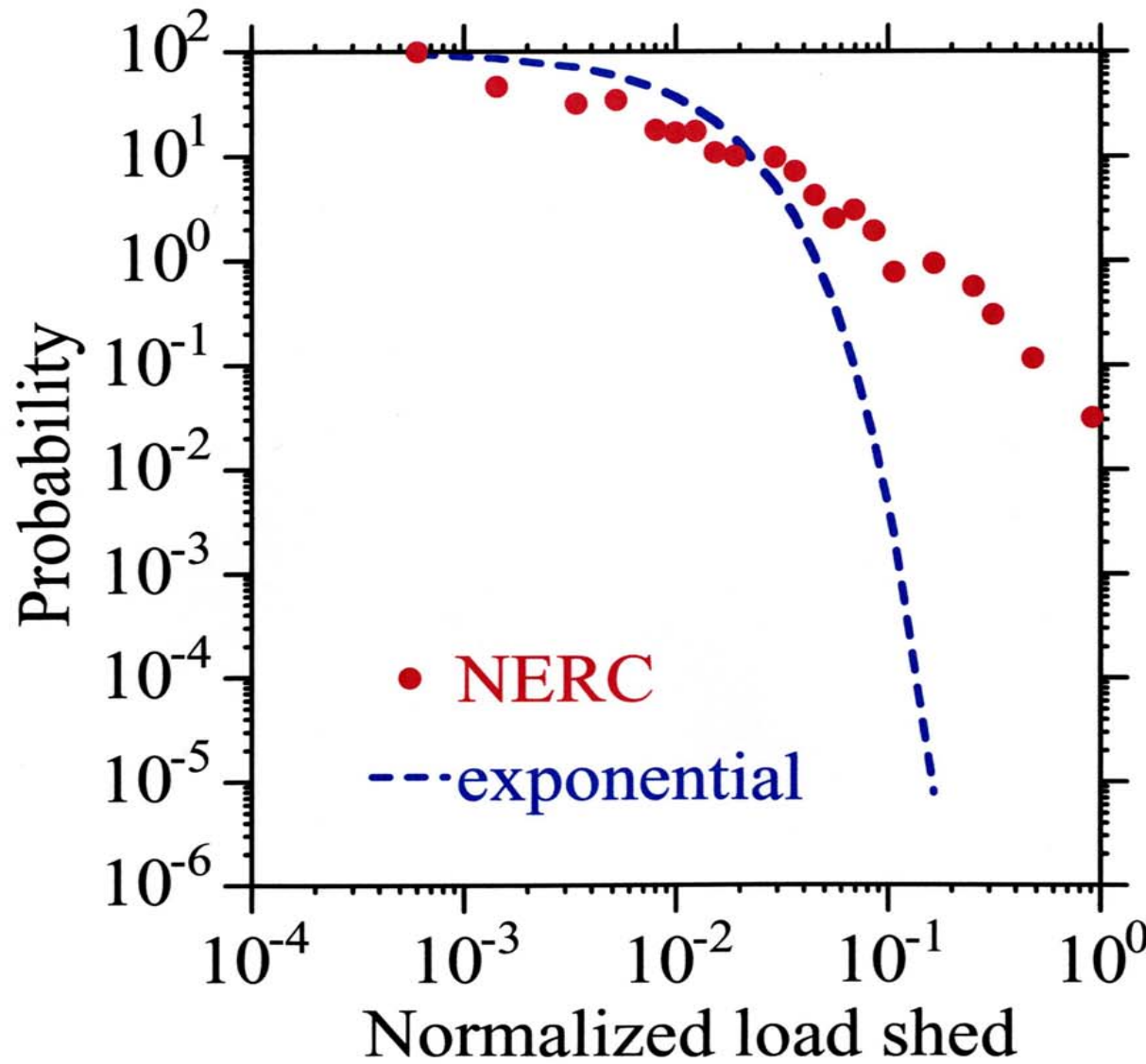


TRSenergy

In Chaotic Region. . . Small Initial Change Leads to Random Behavior



Blackout Risk Needs New Thinking



NERC
distribution of
blackout size
and an
exponential
distribution
on a
log-log plot

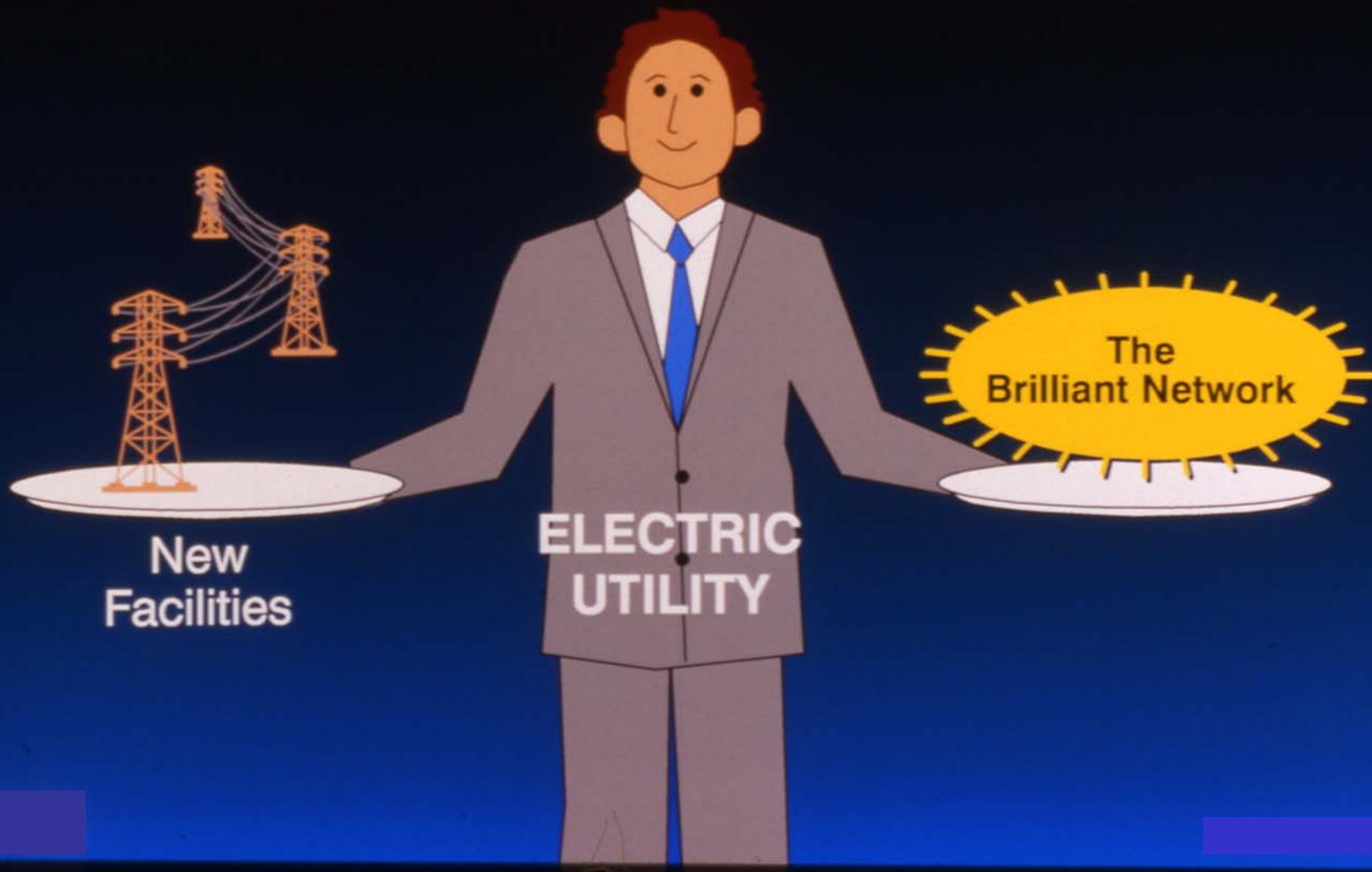
The Future Power System

New Technology Advances

Will Enable

- Cleaner, healthier, customized offices
- More comfortable, efficient homes
- More economic and efficient industry

Balancing the Need for New Facilities



The Benefits

Increased. . .

- . . .stability without new capacity*
- . . .chances of survival under excess conditions*

More. . .

- . . .economic use of individual stations and entire system*
- . . .power transfers*
- . . .competitive exploitation of system*
- . . .integration of nontraditional resources*

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