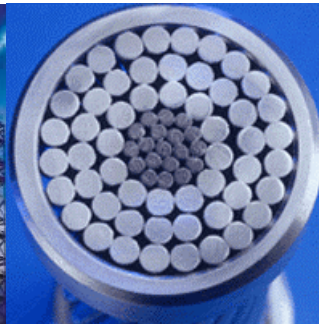


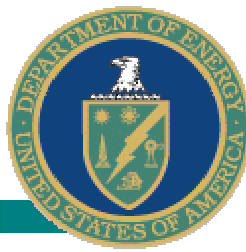
Transforming the Grid to Revolutionize Electric Power in North America

December 11, 2003

*Jimmy Glotfelty
Office of Electric Transmission and Distribution
U.S. Department of Energy*



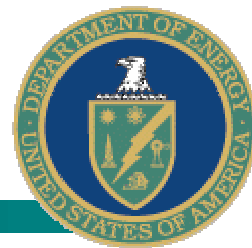
Electricity Modernization



“...it's clear that the power grid needs an overhaul. It needs to be modernized. As we go into an exciting new period of American history, we want the most modern electricity grid for our people... we need more investment; we need research and development...”



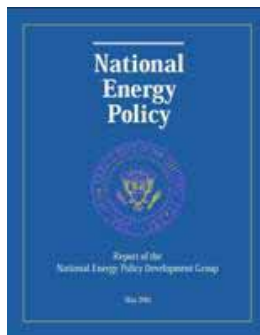
George W. Bush
September 15, 2003



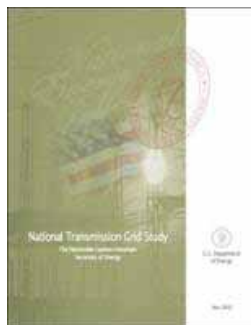
Leadership from all Levels

“...It is a plan to modernize our electricity delivery system. It is a plan which is needed now. It is needed for economic security. It is needed for national security...”

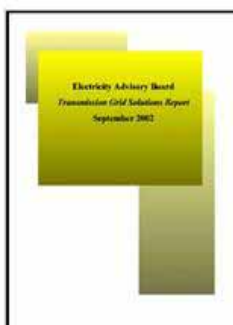
George W. Bush February 6, 2003



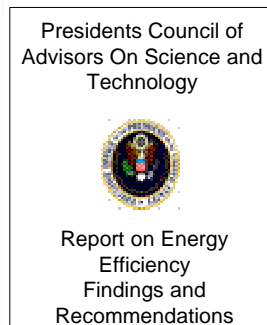
May 2001



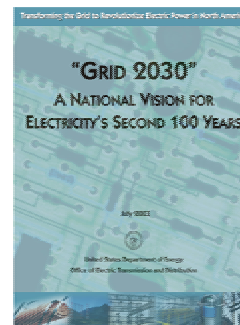
May 2002



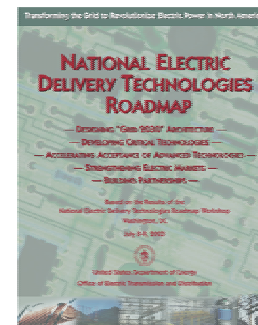
Sept 2002



April 2003



July 2003

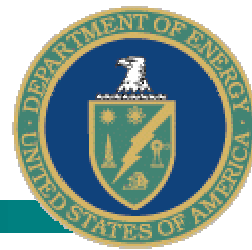


Draft
Sept 2003

“When the lights go out, modern life as we know it grinds to a sudden halt. Transportation is interrupted, communications fail, water systems shut down, factory work is disrupted, food spoils, businesses lose money, and people are inconvenienced and even endangered. ”

Spencer Abraham, September 3, 2003

Electricity and Economic Growth



"If the energy structure of this country is inadequate or in some way excessively costly, it will undermine economic growth, and is therefore a major issue that must be addressed."

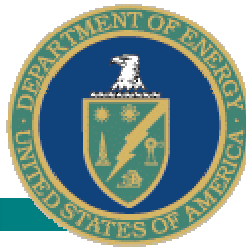


Alan Greenspan
Chairman, Federal Reserve
Board
January 25, 2001

August 14th Blackout *By-The-Numbers*

2 Canadian Provinces
3 deaths
8 U.S. states
12 airports closed
23 cases of looting in Ottawa
250+ power plants
9,266 square miles
61,800 MW of power lost
1.5 million Cleveland residents
without water
50 million people
\$6,012 billion in economic activity lost

National Reliability Challenges

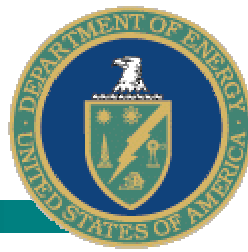


- **Prevention** – keep problems from occurring
- **Detection** – ready for immediate action
- **Response** – proper "tool kits" for any contingency
- **Modernization** – “next generation” of grid

technologies

Prevention

Stop reliability problems from occurring in the first place



Technologies for Today

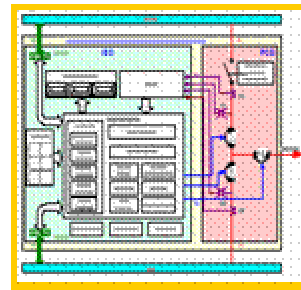
- **Advanced conductors and tower designs**
- **Modeling and system planning tools**
- **Communications**
- **Training**



Composite Core Conductors



Communications Systems



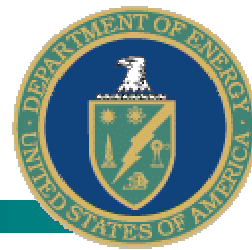
Modeling and Simulation Packages



Training Seminars

Detection

*Improve grid operator readiness
for taking action immediately*



■ Monitoring Systems

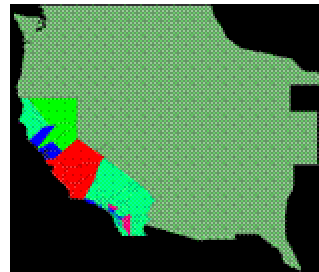
- Frequencies
- Voltages
- VARs
- Phasors
- Line Sag

■ Data Acquisition

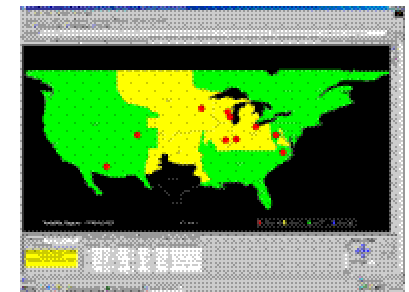
■ Visualization Tools

■ Communications

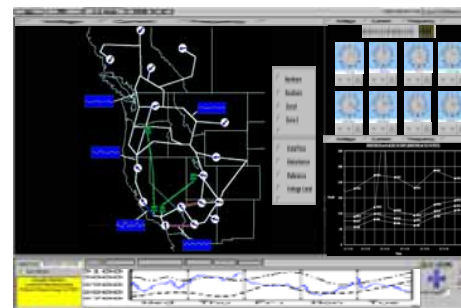
■ Training



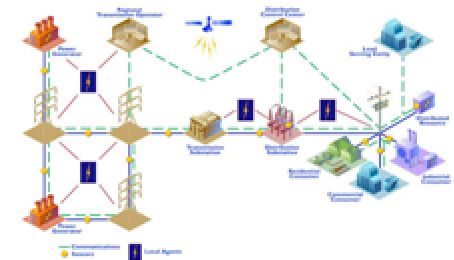
Voltage and VAR
Monitoring



ACE Frequency Monitoring



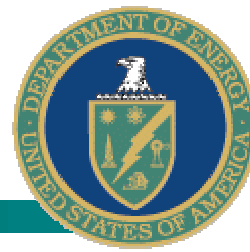
Synchronized Phasor
Applications



Distributed Sensing and Controls
Systems

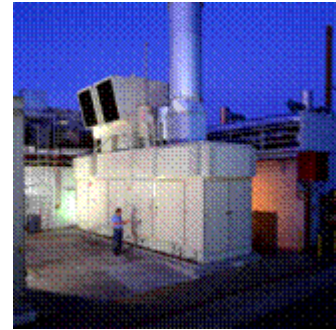
Response

Equip operators with a portfolio of resources comprising the best available tools and techniques



Technologies for Today

- **Distributed Generation**
- **Energy Storage Systems**
- **Demand Response**
- **Communications**



Industrial Gas Turbines



Aggregated Water Pumping Loads



Zinc-Bromine Battery System



Smart Thermostat



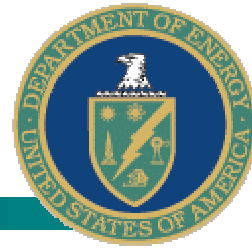
Reciprocating Engine Gen Sets



Microturbines

Modernization

“Next generation” technologies for meeting future needs



Technologies for Tomorrow

■ “GridWorks” Technologies

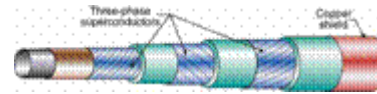
- High temperature superconducting devices
- Cables
- Transformers
- Motors
- Fault current limiters

■ “GridWise” Technologies

- Distributed intelligence
- Distributed energy
- Distributed communications and controls

■ Advanced Materials

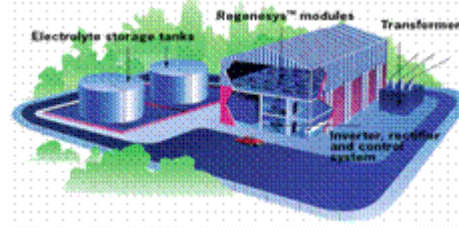
■ Power Electronics



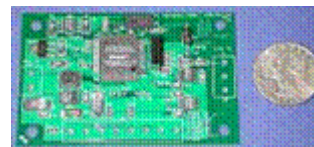
Superconducting Cable



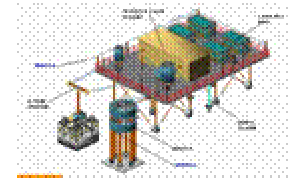
Superconducting Transformer



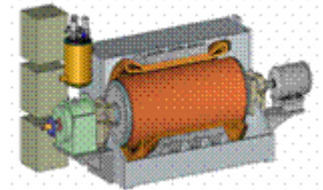
Advanced Energy Storage



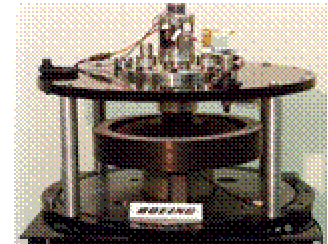
Grid-Friendly Appliance Controller



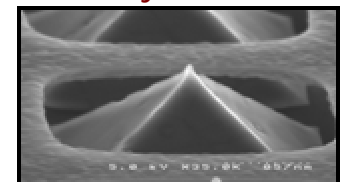
Fault current limiter



SuperVAR System

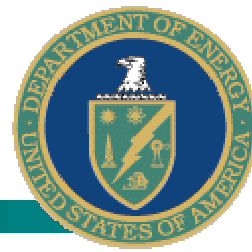


Superconducting Flywheel

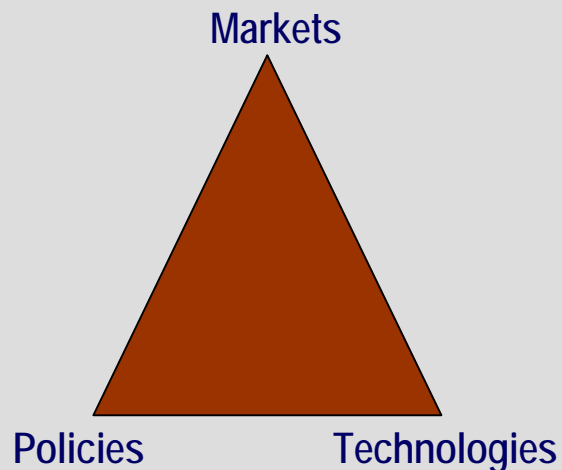


Diamond Devices

U.S. DOE's Strategic Response



An Integrated Approach



Electricity
RD&D



Analysis,
modeling, and
data

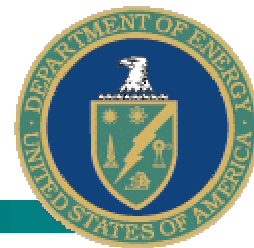


Federal,
Regional, and
State
Coordination

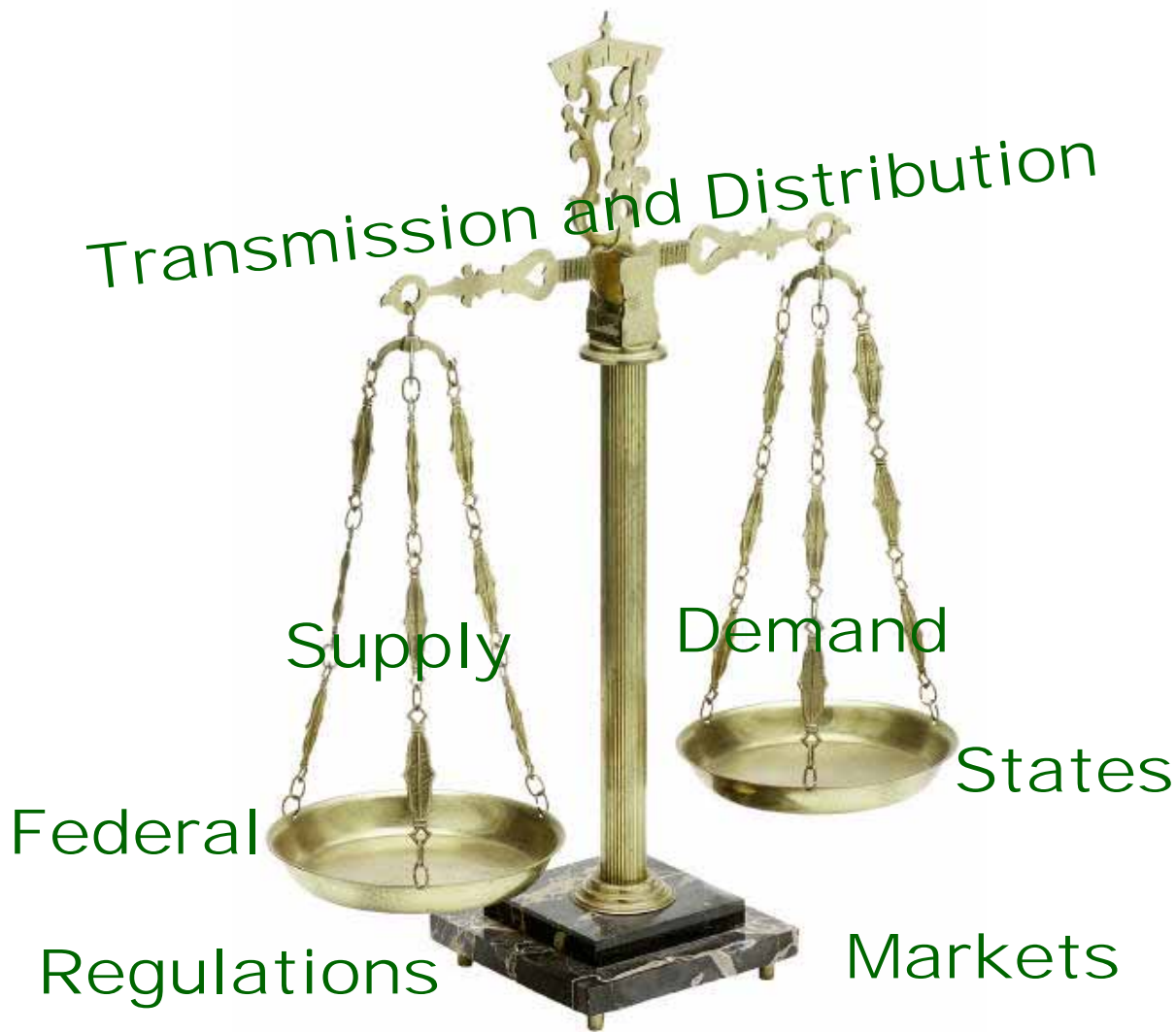


OETD Mission

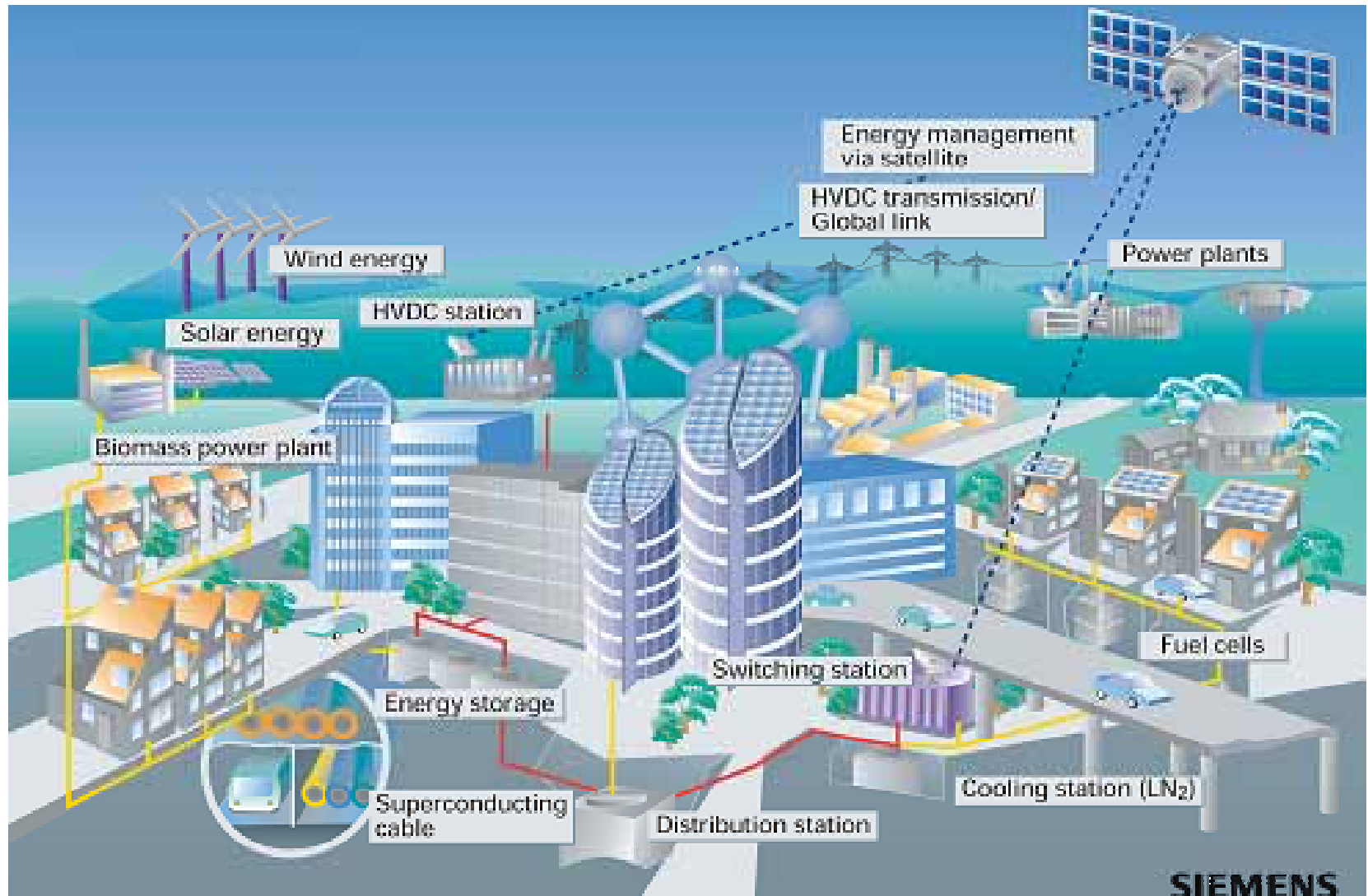
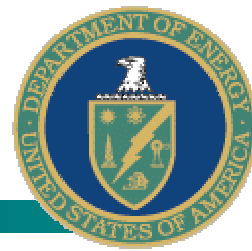
To lead a national effort to modernize and expand America's electric delivery system to ensure a more reliable and robust electricity supply, as well as economic and national security.



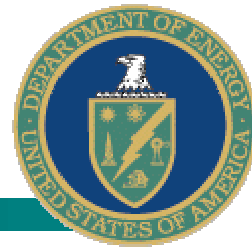
Balancing Act



The Vision ... "Grid 2030"



Electric Delivery Technologies Roadmap



An Action
Agenda
for
Turning
the Vision
into
Reality

Design “Grid 2030” Architecture

Conceptual framework that guides development of the electric system from transmission to end-use

Develop Critical Technologies

Advanced conductors, electric storage, high-temperature superconductors, distributed intelligence/smart controls, and power electronics that become building blocks for "Grid 2030"

Accelerate Technology Acceptance

Field testing and demonstrations that move the advanced technologies from the laboratory and into the "tool kit" of transmission and distribution system planners and operators

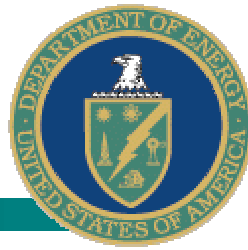
Strengthen Market Operations

Assessing markets, planning, and operations; improving siting and permitting; and addressing regulatory barriers bring greater certainty and lower financial risks to electric transactions and investment

Build Partnerships

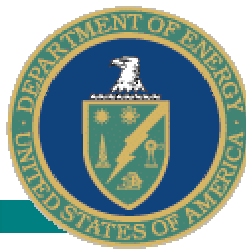
Leveraging stakeholder involvement through multi-year, public-private partnerships; working with States to address shared concerns

Public-Private Partnerships



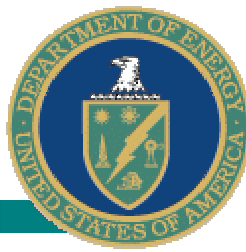
- **Electricity Consumers**
- **Electric and Gas Utilities**
- **Independent System Operators**
- **Independent Power Producers**
- **Equipment Manufacturers**
- **IT Companies**
- **State Agencies**
- **Other Federal Agencies**
- **Canada, Mexico, and other countries**
- **Trade Associations**
- **Environmental and Labor Groups**
- **Universities**
- **National Laboratories**

Energy Legislation



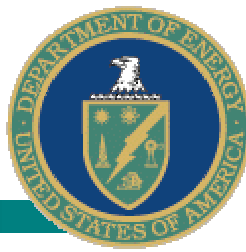
- **Mandatory Reliability**
- **RTO's**
- **Incentive Rates**
- **Standard Market Design**
- **Transmission Siting**
- **Transmission Tax Incentives**

Blackout Investigation



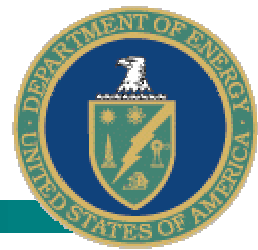
- **Working Groups**
 - Security Update
 - Nuclear Update
 - Electric System Update
- **Timing of Report**
- **Root-cause Analysis**

Conclusion

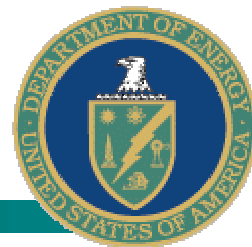


“We will work to unleash innovation and strengthen our markets to allow entrepreneurs to develop a more advanced and robust transmission system that meets growing energy demand in the years ahead.”

Secretary of Energy
Spencer Abraham

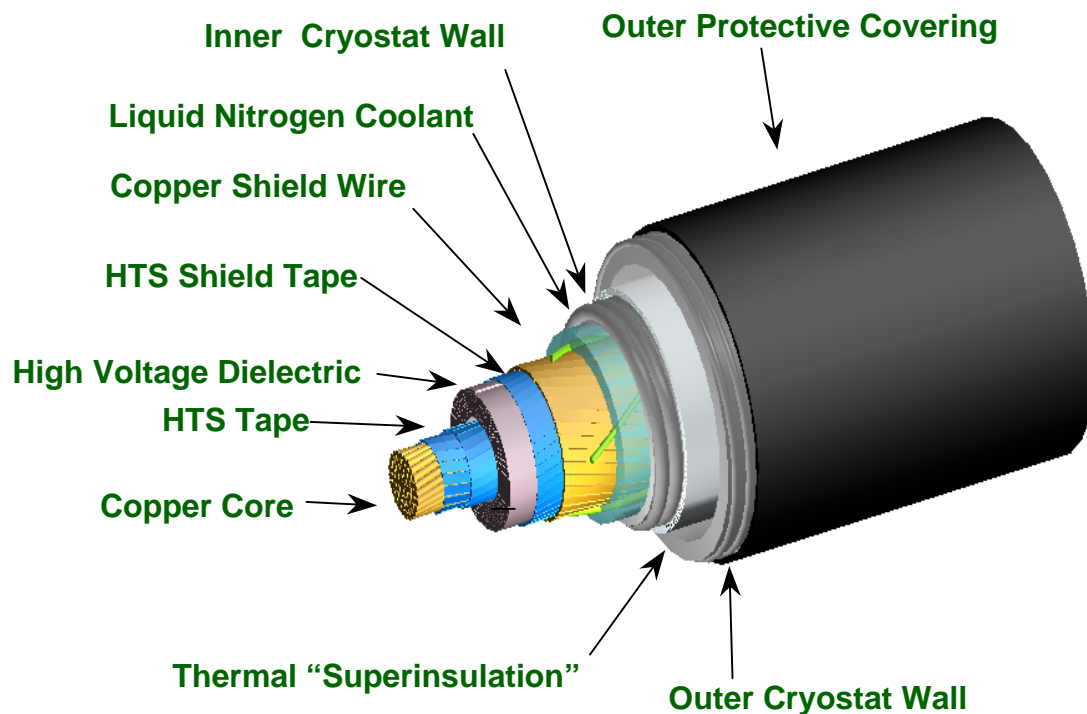


Back-ups



HTS Transmission Cable Project

- **Electrical Operating Characteristics**
 - Voltage/Power – 138kV/600MVA
 - Design Fault Current – 69,000A
- **Physical Characteristics**
 - Length – 610m
 - Three 610m long Phase Conductors
 - Six 161kV Outdoor Terminations
 - One 161kV Splice
 - One Refrigeration System



Project Team



Prime Contractor
Wire Supplier



Installation
Operation

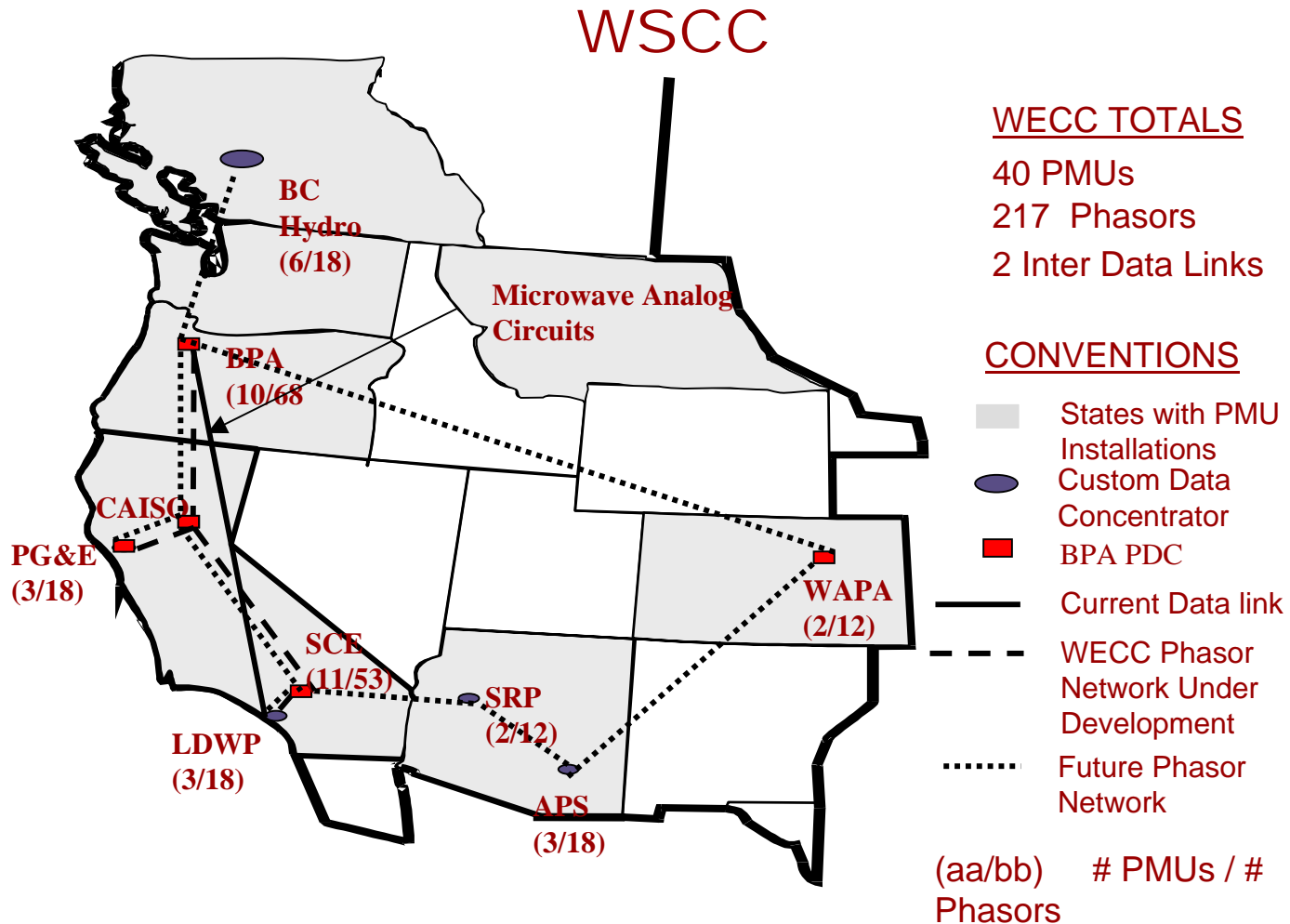
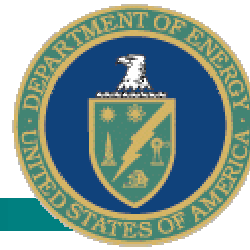


Power Cable
Assembly

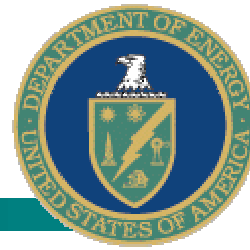


Refrigeration

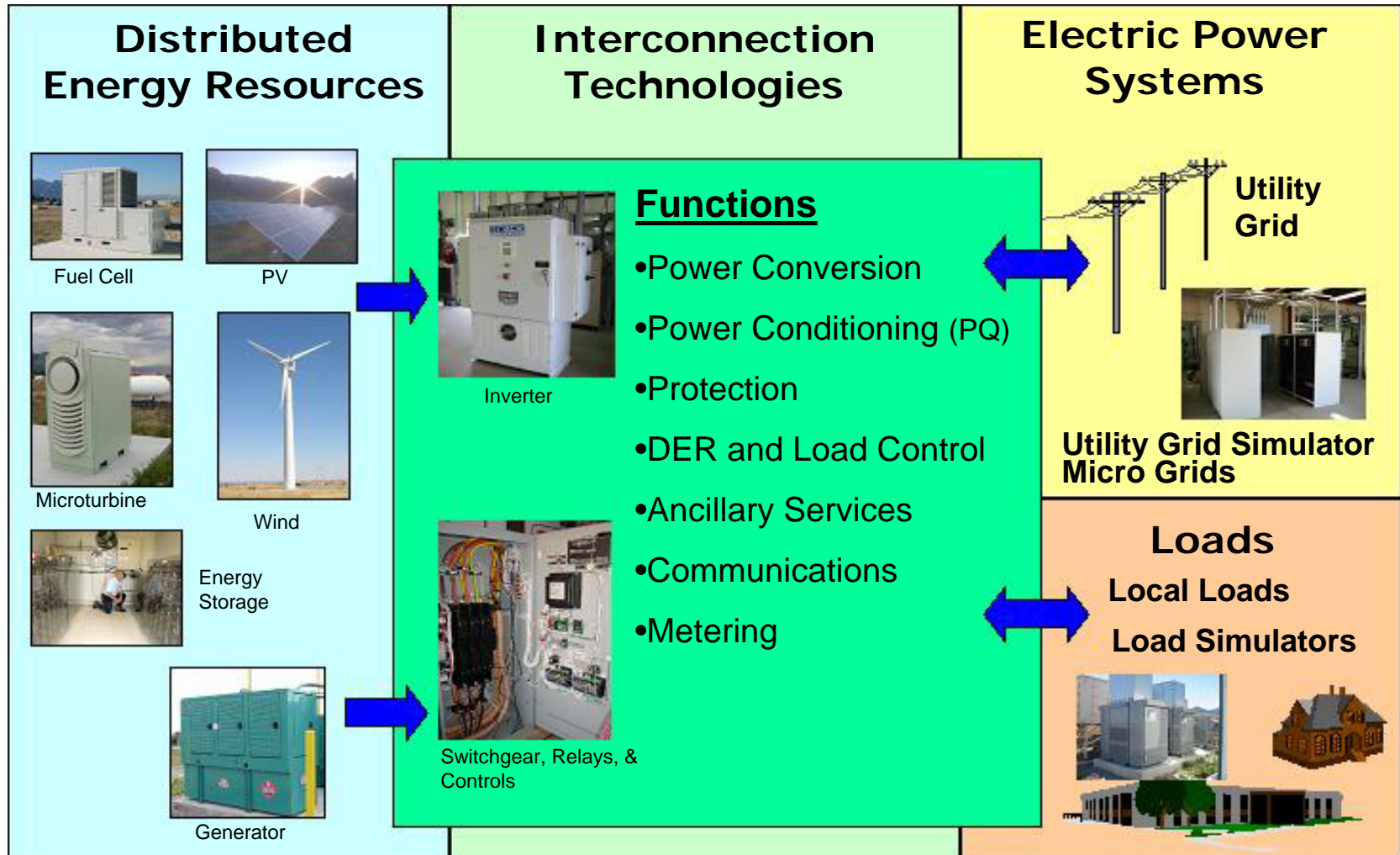
Synchronized Phasor Network



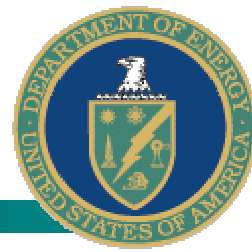
Interconnection Standards & Technologies



Interconnection Technology and System Integration

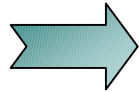


Distributed Sensing, Intelligence, & Control Technologies



Grid-Friendly™ Appliance (GFAs) Controller

Millions of GFAs



eliminate need for 100s of new power plants,



saving tens of billions of dollars over 20 years.

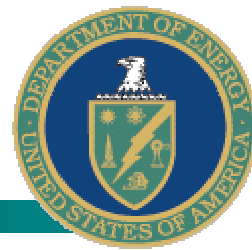


Grid-friendly appliances ...

- ... instantaneous, automatic response to grid crises
- ... displace need for spinning reserves
- ... allow grid to run “closer to the edge” safely
- ... 10 min. interruptions unnoticeable by consumer
- ... mass marketing/mass customization opportunity
- ... platform for active communication & control
 - pre-heat/pre-cool to coast through peaks
 - utilize & value thermal storage
- ... increase reliability & security

“...given enough ants, you can move a mountain!...”

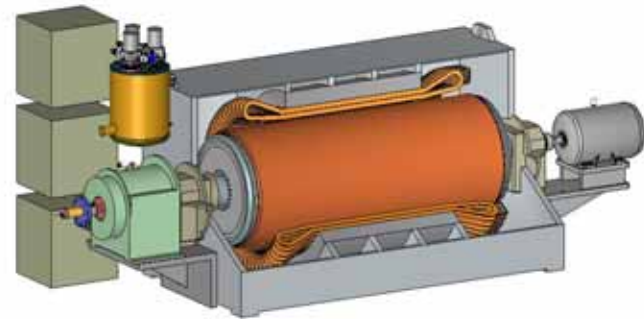
impromptu reaction from a utility power engineer



Other Reliability Technologies

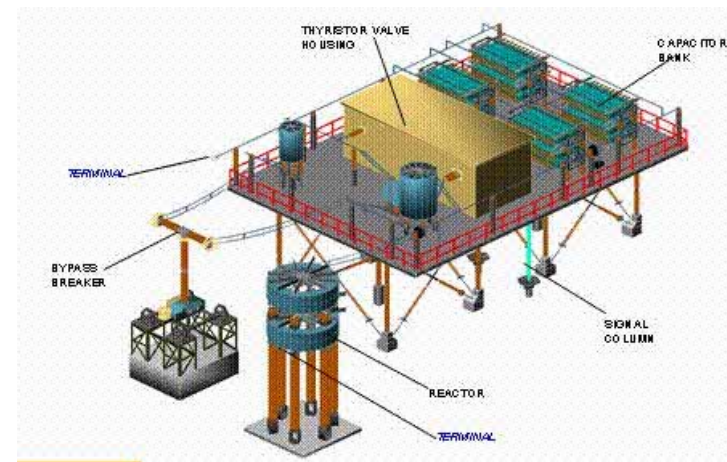
SuperVAR

- **New lower cost option to provide dynamic reactive power**
- **Prototype to be field-tested in TVA service area**



Fault Current Limiter

- **Tradeoff between fault control, bus capacity, and system stiffness has persisted for decades**
- **HTS design offer solution with no impedance**



New England Demand Response Initiative (NEDRI)



"Getting the Rules Right"

- **NEDRI Final Report: "Dimensions of Demand Response: Capturing Customer Based Resources in New England's Power Systems and Markets"**
- **38 consensus recommendations for incorporating demand response in retail and wholesale – first ever in U.S.!**
- **IMPACTS:**
 - ISO-NE creates new Demand Response department
 - NEPOOL files revised summer 2003 DR programs based on NEDRI recommendations -- FERC approves
 - NH investigates advanced pricing/metering options
 - ME legislative hearings; VT Senate bill drafting
 - NY ISO working groups considering several NEDRI recommendations
 - CT, MA, RI proposing to adopt NEDRI-recommended emissions rule for DG participating in DR programs

