MODERN GRID
STRATEGY

Barriers to Smart Grid Implementation – Is There Light at the End of the Tunnel?

Utility Field Service Conference

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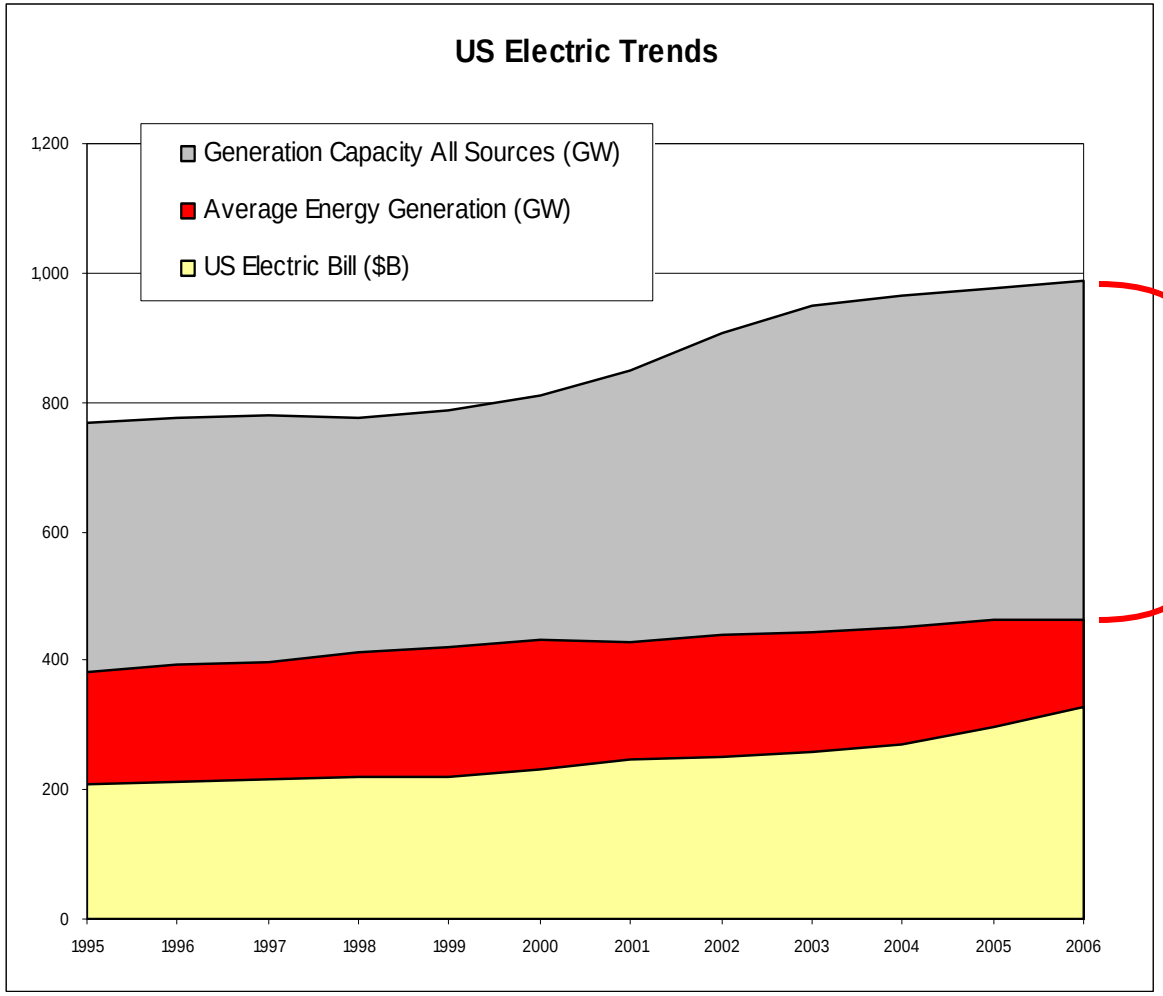
Call for Change – Drivers and Trends to Watch

- **The national average in reliability metrics over the last 5 years shows a 3% per year increase in outage duration and 4% per year increase in outage frequency.**
- **The businesses in the average state lose more than $1B annually in revenue from outages and power quality events.**
- **Modern infrastructure and technology-rich regions draw business to themselves, an important driver for municipal economic development.**
- **The business as usual approach to electricity supply in the average State will lead to a 50% increase in electric bills over the next 7 to 10 years.**
- **The States have little chance of developing a renewables portfolio without the foundation provided by a Smart Grid.**

Capacity and Energy Production



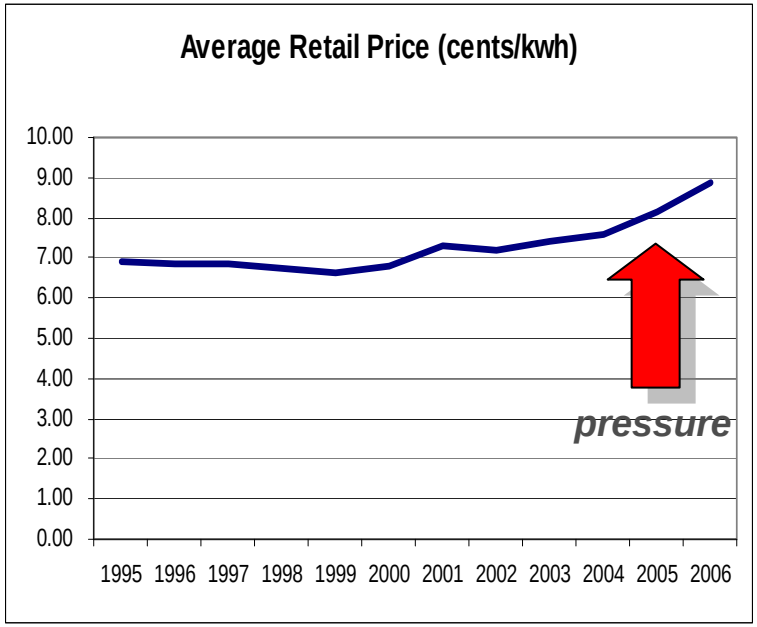
Ever-widening gap drives asset utilization down and cost up.

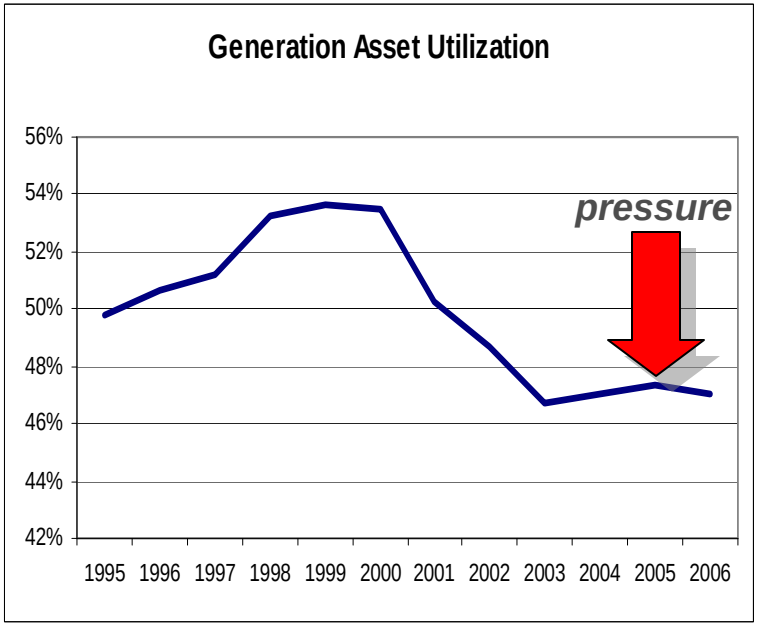
Average energy increased 16% over last decade; peak capacity increased 27%.

Source data: DOE EIA

Office of Electricity Delivery and Energy Reliability

Cost and Asset Utilization





30% increase over last decade

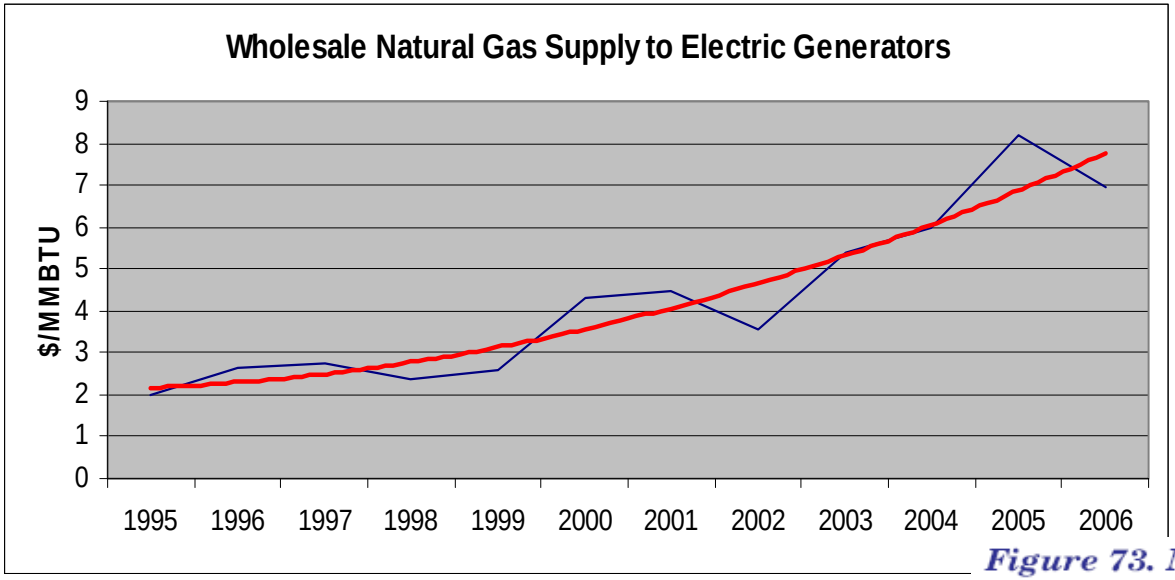
- Natural gas prices
- Capital build and O&M costs
- Equipment scarcity (China, India, ME)

8% drop over last decade

- Large peaking units builds
- Cancelled baseload coal plants

Source data: DOE EIA

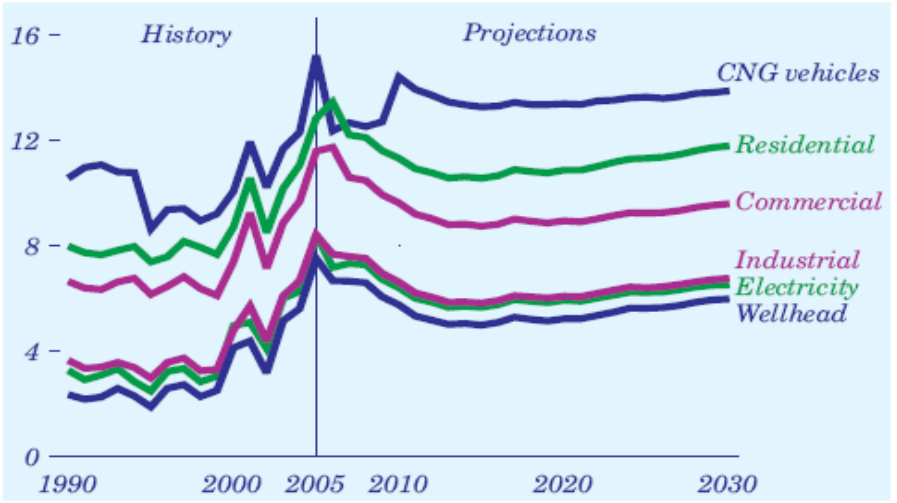
Natural Gas Price Trend



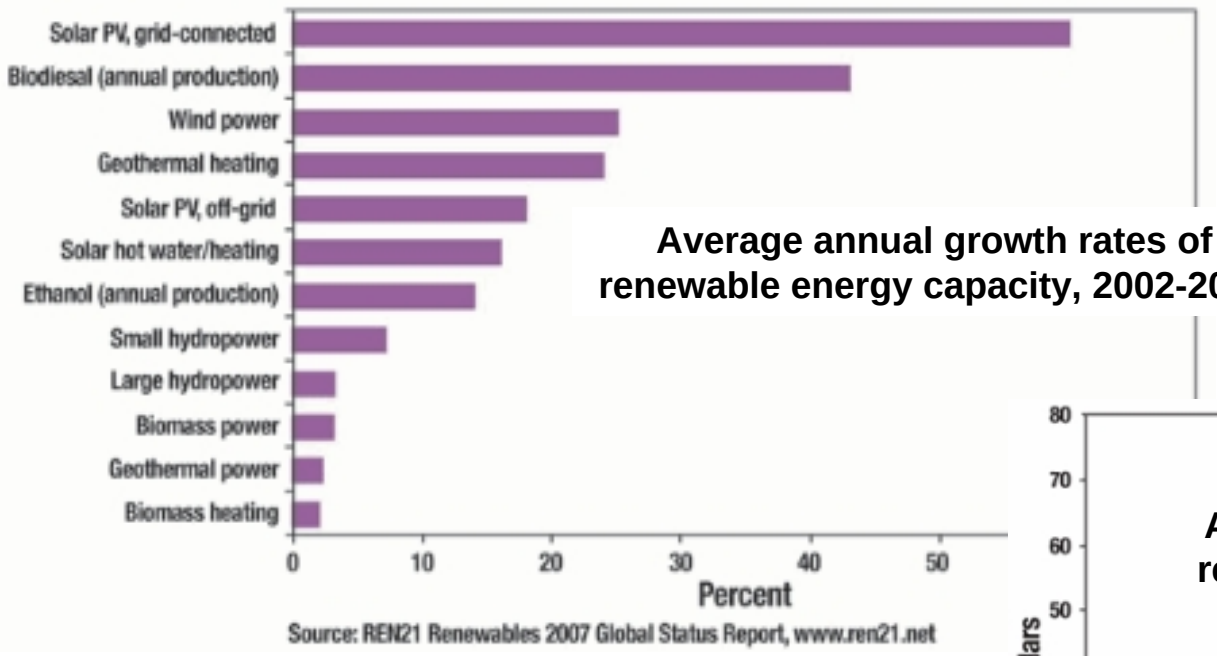
251% increase in the last decade.

What will the future price be? Any Bets?

Figure 73. Natural gas prices by end-use sector, 1990-2030 (2005 dollars per thousand cubic feet)

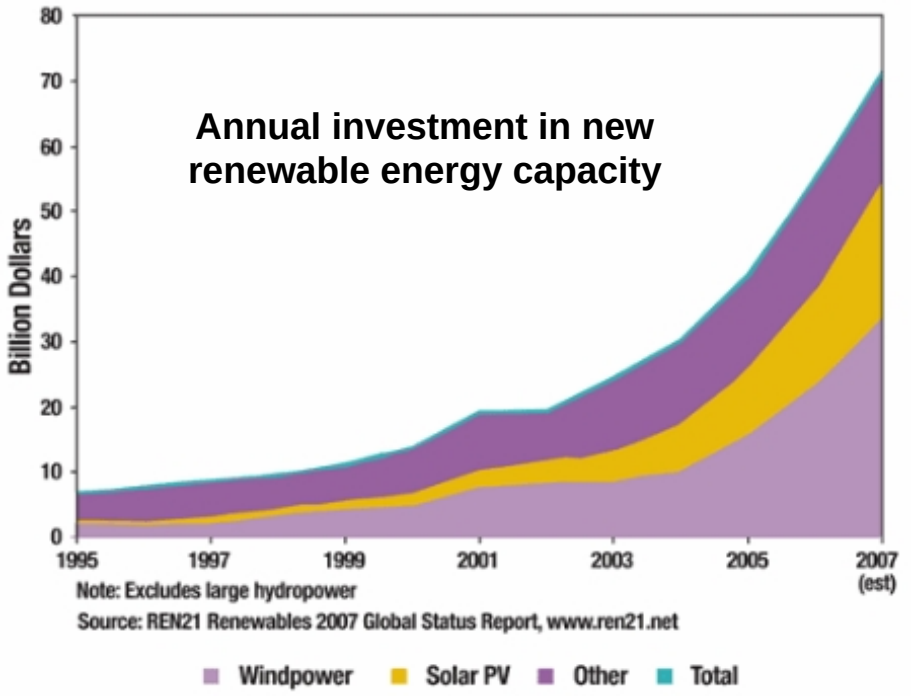


Renewables Growth



Average annual growth rates of renewable energy capacity, 2002-2006

Annual investment in new renewable energy capacity



Today vs. Tomorrow

Today's Grid	Principal Characteristic	Modern Grid
Consumers are uninformed and non-participative with the power system.	**Enables active consumer participation**	**Informed, involved and active consumers. Broad penetration of Demand Response**
Relatively small number of large generating plants. Numerous obstacles exist for interconnecting DER	**Accommodates all generation and storage options**	**Very large numbers of diverse distributed generation and storage devices deployed to complement the large generating plants. "Plug-and-play" convenience. Significantly more focus on and access to renewables.**
Limited wholesale markets still working to find the best operating models. Not well integrated with each other. Transmission congestion separates buyers and sellers. Limited opportunities for consumers	**Enables markets**	**Mature wholesale market operations in place, well integrated nationwide and integrated with reliability coordinators. Retail markets flourishing where appropriate. Minimal transmission congestion. New commercial goods and services available to consumers**

Today vs. Tomorrow (cont.)

Today's Grid	Principal Characteristic	Modern Grid
Focused on outages rather than power quality problems. Slow response in resolving PQ issues	**Provides power quality for 21st century needs**	**Quality of power meets industry standards and consumer needs. PQ issues identified and resolved prior to manifestation. Various levels of PQ at various prices.**
Minimal integration of limited operational data with Asset Management processes and technologies. Siloed business processes. Time based maintenance.	**Optimizes assets and operates efficiently**	**Greatly expanded sensing and measurement of grid conditions. Grid technologies deeply integrated with asset management processes to most effectively manage assets and costs. Condition based maintenance.**
Responds to prevent further damage. Focus is on protection of assets following system faults.	**Self-heals**	**Automatically detects and responds to actual and emerging transmission and distribution problems. Focus is on prevention. Minimizes consumer impact.**
Vulnerable to malicious acts of terror and natural disasters	**Resists attack**	**Resilient to attack and natural disasters with rapid restoration capabilities**

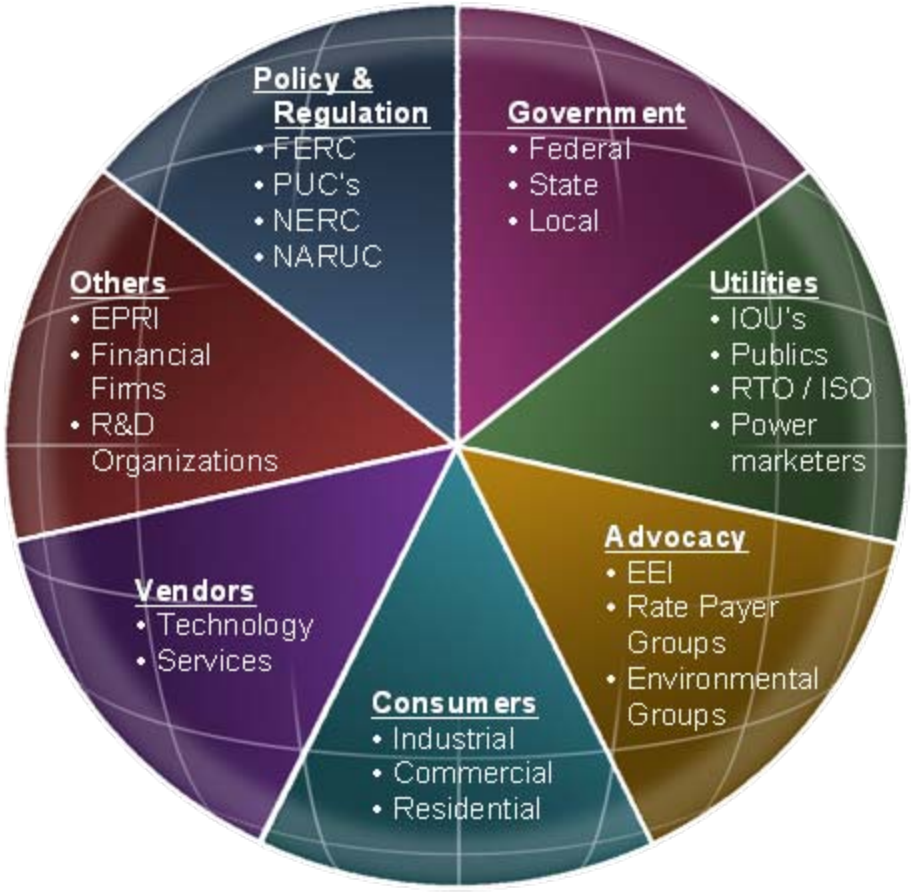
What's taking so long to get there?

So many variables to align:

- **Lot of players**
- **Regulatory Policies**
- **Legislation**
- **Communication and Culture**
- **Technical**

Lot of players!

- All Play a Part
- Need a clear vision
- Alignment critical
- Keep the “End in mind”
- Must be “win-win”



Regulatory Policy

Regulatory policy could incentivize investment in the Smart Grid:

- ***Time based rates -*** incentives for consumers to become actively involved
- ***More favorable depreciation rules –*** recovery of book value for assets that are retired early for "smart grid" reasons
- ***Policy changes that provide incentives and remove disincentives to utilities –*** investment in a Smart Grid should make business sense
- ***Clear cost recovery policies -*** uncertain cost recovery increases investment risk
- ***Societal benefits –*** business cases should include societal benefits for completeness and correctness to ensure informed decisions are made by the regulator

Common Regulatory Goals

- **Improved system operations**
  - More efficient use of the network
  - Improved customer service, reduced costs
- **Improved economic efficiency**
  - Greater information on usage and costs
  - Increased reliance on dynamic pricing
- **Increased deployment of customer-sited resources**
  - End-use efficiency
  - Distributed generation, combined heat-and-power

• Source: Regulatory Assistance Project

Legislation Since 2005 – Grid

- **EPACT 2005**
  - Studies: congestion, energy efficiency, demand response, trends in the workforce, etc
  - National interest corridors and transmission siting
  - RD&D and commercial application programs related to distributed energy and advanced grid reliability
- **EISA – 2007**
  - RD&D Program for SmartGrid technologies
  - Regional Demonstration Initiative with cost sharing
  - 20% Cost Reimbursement
  - Regulators “shall consider”

Communication and Culture

A significant change management effort is needed:

- Communicate a vision
- Strengthen consumer education and sense of urgency
- Align stakeholders around the vision
- Provide the motivation (win-win)
- Develop metrics to monitor progress
- Keep the “end in mind”
- Active leadership by regulators

Technical

Some technical issues:

- Standards (interconnection and interoperability)
- Integration vs. “widgets”
- Distributed system behavior not well understood
- Decades behind in “computing and communications”
- Loss of skilled human resources
- Minimal funding of R&D
- Transformation of transportation infrastructure

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How do we achieve a Smart Grid?

Where does the industry start?

- **Plan**
  - Create the vision
  - Identify the milestones
  - Determine the sequence
  - Define needed technologies and applications
- **Deploy**
  - Address the barriers
  - Apply resources
- **Measure**
  - Establish metrics
  - Monitor progress

The payoff to modernizing the electric infrastructure from the resulting economic progress could easily exceed $1T per year in additional GDP within a decade.

Galvin Electricity Initiative, 2005

To Stay Involved

- **The Modern Grid Strategy**
  - Collaborative, public/private effort open to all
  - Independent "broker"
- **www.netl.doe.gov/moderngrid/**
  - Downloadable documents
  - Forums
  - Meeting announcements
- **www.smartgridnews.com**
  - Grid modernization columns, articles and case studies
  - Modern Grid BLOG (future)
- **moderngrid@netl.doe.gov**
  - (304) 599-4273 x101


Office of Electricity Delivery and Energy Reliability

Developed for the U.S. Department of Energy Office of Electricity Delivery and Energy Reliability by the National Energy Technology Laboratory

A Vision for the Modern Grid

Powering our 21st-Century Economy

A Vision for the Modern Grid

What will the Modern Grid Look Like?

Background

Before we can begin to modernize today's electric grid, we first need a clear vision of the power system required for the future. Given that vision, we can create the alignment necessary to inspire passion, investment, and progress toward an advanced US grid for the 21st century.

Goals

The grid must be more reliable.
A reliable grid will provide power dependably, when and where its users need it and of the quality they value.

The grid must be more secure.
A secure grid will withstand physical and cyber attacks without suffering massive blackouts or exorbitant recovery costs. It will also be less vulnerable to natural disasters and will recover faster.

The grid must be more economic.
An economic grid will operate under the basic laws of supply and demand, resulting in fair prices and adequate supplies.

The grid must be more efficient.
An efficient grid will take advantage of investments that lead to cost control, reduced transmission and distribution electrical losses, more efficient power production and improved asset utilization.

The grid must be more environmentally friendly.
An environmentally friendly grid will reduce environmental impacts through initiatives in generation, transmission, distribution, storage and consumption.

The grid must be safer.
A safe grid will not cause any harm to the public or to grid workers and will be sensitive to users who depend on it as a medical necessity.

The Vision

First, it will heal itself.
The modernized grid will perform continuous self-assessments to detect, analyze, respond to, and as needed, restore grid components or network sections. It will handle problems too large or too fast-moving for human intervention. Acting as the grid's "immune system", self-healing will help maintain grid reliability, security, affordability, power quality and efficiency.

Second, it will motivate consumers to be active grid participants and will include them in grid operations.
Active participation of consumers in electricity markets brings tangible benefits to both the grid and the environment, while reducing the cost of delivered electricity. In the modernized grid, well-informed consumers will modify consumption based on the balancing of their demands and the electric system's capability to meet those demands.

Third, the Modern Grid will resist attack.
Security requires a system-wide solution that will reduce physical and cyber vulnerabilities and will recover rapidly from disruptions. The Modern Grid will demonstrate resilience to attack, even from those who are determined and well equipped. Both its design and its operation will discourage attacks, minimize their consequences and speed service restoration. It will also be less vulnerable to natural disasters.

Fourth, the Modern Grid will provide the level of power quality desired by 21st century users.
New power quality standards will balance load sensitivity with deliverable power quality at a reasonable price. The modernized grid will supply varying grades of power quality at different pricing levels.

Fifth, the Modern Grid will accommodate all generation and storage options.
It will seamlessly integrate all types and sizes of electrical generation and storage systems with a

http://www.TheModernGrid.org phone: 304 - 599 - 4273 email: info@TheModernGrid.org

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