MODERN GRID
STRATEGY

The Smart Grid – An Emerging Option

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IRPS Conference

December 10, 2008

Funded by the U.S. Department of Energy,
Office of Electricity Delivery and Energy Reliability

Conducted by the National Energy
Technology Laboratory

Agenda

- **What is it?**
- **Where's the value?**
- **What does it mean for consumers?**
- **Some current activities**

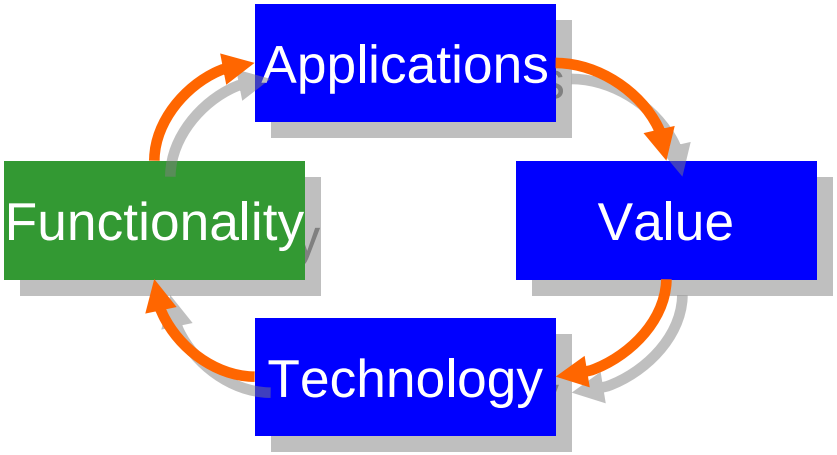
What is the role of the MGS?

- **Define a vision for the Modern Grid**
- **Reach out to stakeholders for input**
- **Assist in the identification of benefits and barriers**
- **Facilitate resolution of issues**
- **Promote testing of integrated suites of technologies**
- **Communicate and educate stakeholders**

MGS is an "Independent Broker" for the Smart Grid

What is the Smart Grid?

- ✓ **Empowering consumers**
- ✓ **Accommodating all generation and storage options**
- ✓ **Enabling new markets**
- ✓ **Providing power quality for the digital economy**
- ✓ **Optimizing assets and operating efficiently**
- ✓ **Self-healing**
- ✓ **Operating resiliently against attack**



It will "Enable active participation by consumers"

- **Consumers have access to new information, control and options to engage in electricity markets**
  - See what they use, when they use it, and what it costs
  - Manage energy costs
  - Investment in new devices
  - Sell resources for revenue or environmental stewardship
- **Grid operators have new resource options**
  - Reduce peak load and prices
  - Improve grid reliability

Today	*Tomorrow*
Little price visibility, time-of-use pricing rare, few choices	Full price info, multiple options, buy and sell, "E-Bay" level of activity

It will "Accommodate all generation and storage options"

- **Seamlessly integrates all types and sizes of electrical generation and storage systems**
- **"Plug-and-play" convenience**
  - Simplified interconnection processes
  - Universal interoperability standards
- **Number of smaller, distributed sources will increase – shift to a more decentralized model**
- **Large central power plants will continue to play a major role.**

Today	*Tomorrow*
Dominated by central generation. Little DG, DR, storage or renewables	Many "plug and play" devices complement central generation

It will "Enable new products, services and markets"

- **Links buyers and sellers – consumer to RTO**
- **Supports the creation of new electricity markets**
  - PHEV and vehicle to grid
  - Brokers, integrators, aggregators, etc.
  - New commercial goods and services
- **Provides for consistent market operation across regions**

Today	*Tomorrow*
Limited wholesale markets, not well integrated	Mature, well-integrated wholesale markets, growth of new electricity markets

It will "Provide power quality for the digital economy"

- **Monitors, diagnoses and responds to PQ issues**
- **Supplies various grades of power quality at different pricing levels**
- **Greatly reduces consumer losses due to PQ (~$25B/year)**
- **Quality Control for the grid**

Today	*Tomorrow*
Focus on outages not power quality	PQ a priority with variety of price/quality options based on needs

It will "Optimize asset utilization and operate efficiently"

- **Operational improvements**
  - Improved load factors and lower system losses
  - Integrated outage management
  - Risk assessment
- **Asset Management improvements**
  - The knowledge to build only what we need
  - Improved maintenance processes
  - Improved resource management processes
  - More power through existing assets
- **Reduction in utility costs (O&M and Capital)**

Today	*Tomorrow*
Limited grid information & minimal integration with asset management	Deep integration of grid intelligence with asset management applications

It will "Anticipate & respond to system disturbances"

- **Performs continuous self-assessments**
- **Detects, analyzes, responds to, and restores grid components or network sections**
- **Handles problems too large or too fast-moving for human intervention**
- **Self heals - acts as the grid's "immune system"**
- **Supports grid reliability, security, and power quality**

Today	*Tomorrow*
Protects assets following disruption (e.g. trip relay)	Prevents disruptions, minimizes impact, restores rapidly

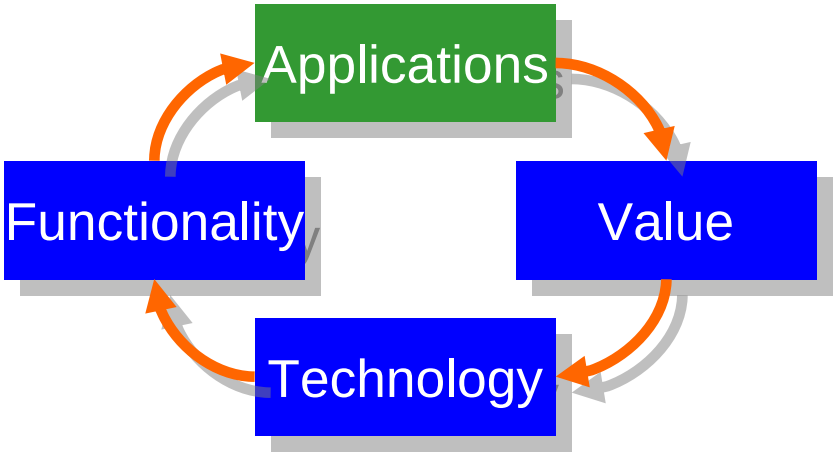
It will "Operate resiliently against attack and natural disaster"

- **Reduces threat, vulnerability, consequences**
- **Deters, detects, mitigates, responds, and restores**
- **"Fort Knox" image**
- **Decentralization and self-healing enabled**
- **Absolute cyber security**

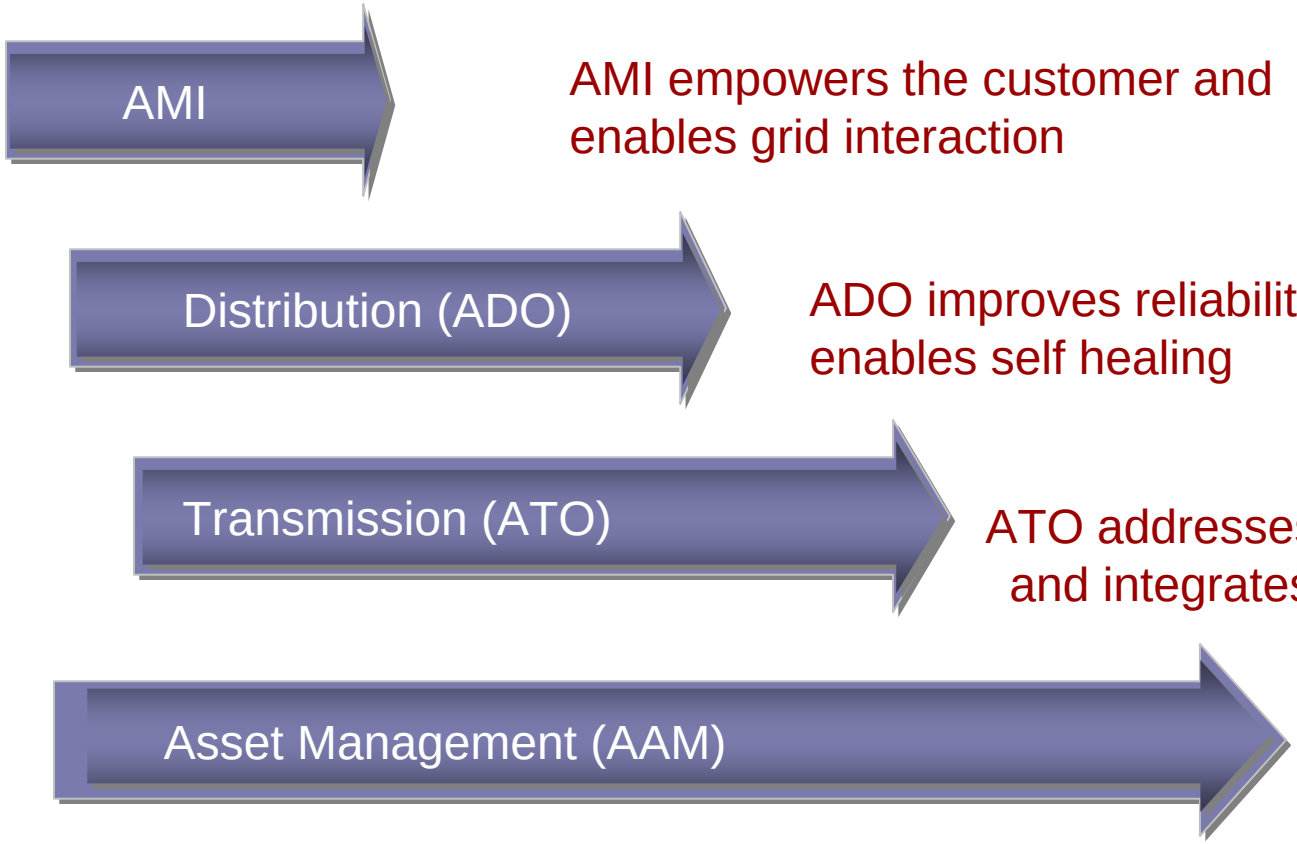
Today	*Tomorrow*
Vulnerable to terrorists and natural disasters	Deters, detects, mitigates, and restores rapidly and efficiently

What is the Smart Grid?

- ✓ **AMI**
- ✓ **Demand Response**
- ✓ **Distribution Management Systems**
- ✓ **Advanced OMS**
- ✓ **Distribution Automation**
- ✓ **Micro-grids**
- ✓ **Interface with RTO's**
- ✓ **Dynamic Ratings**
- ✓ **Wide area measurement**



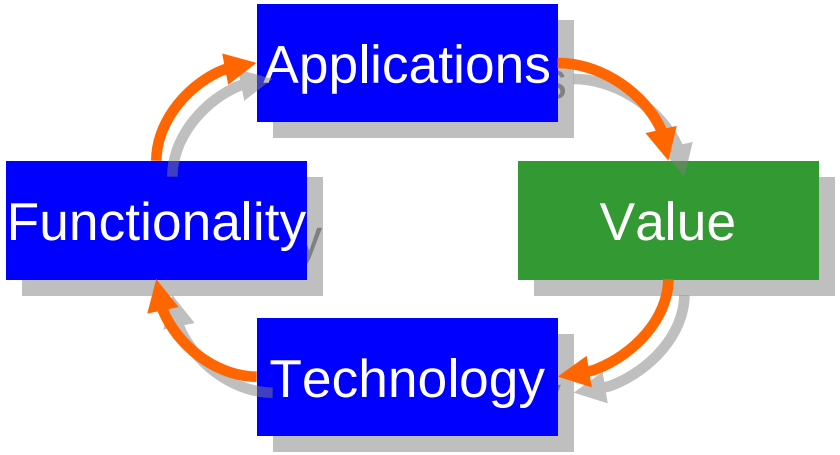
Steps to the Smart Grid



What is the Smart Grid?

It's MORE:

- ✓ **Reliable**
- ✓ **Secure**
- ✓ **Economic**
- ✓ **Efficient**
- ✓ **Environmentally Friendly**
- ✓ **Safe**



Where's the value?

Cost to Modernize

- **$165B over 20 years**
  - $127B for Distribution
  - $38B for Transmission
- **~$8.3B per year (incremental to business-as-usual)**
- **Current annual investment - $18B**

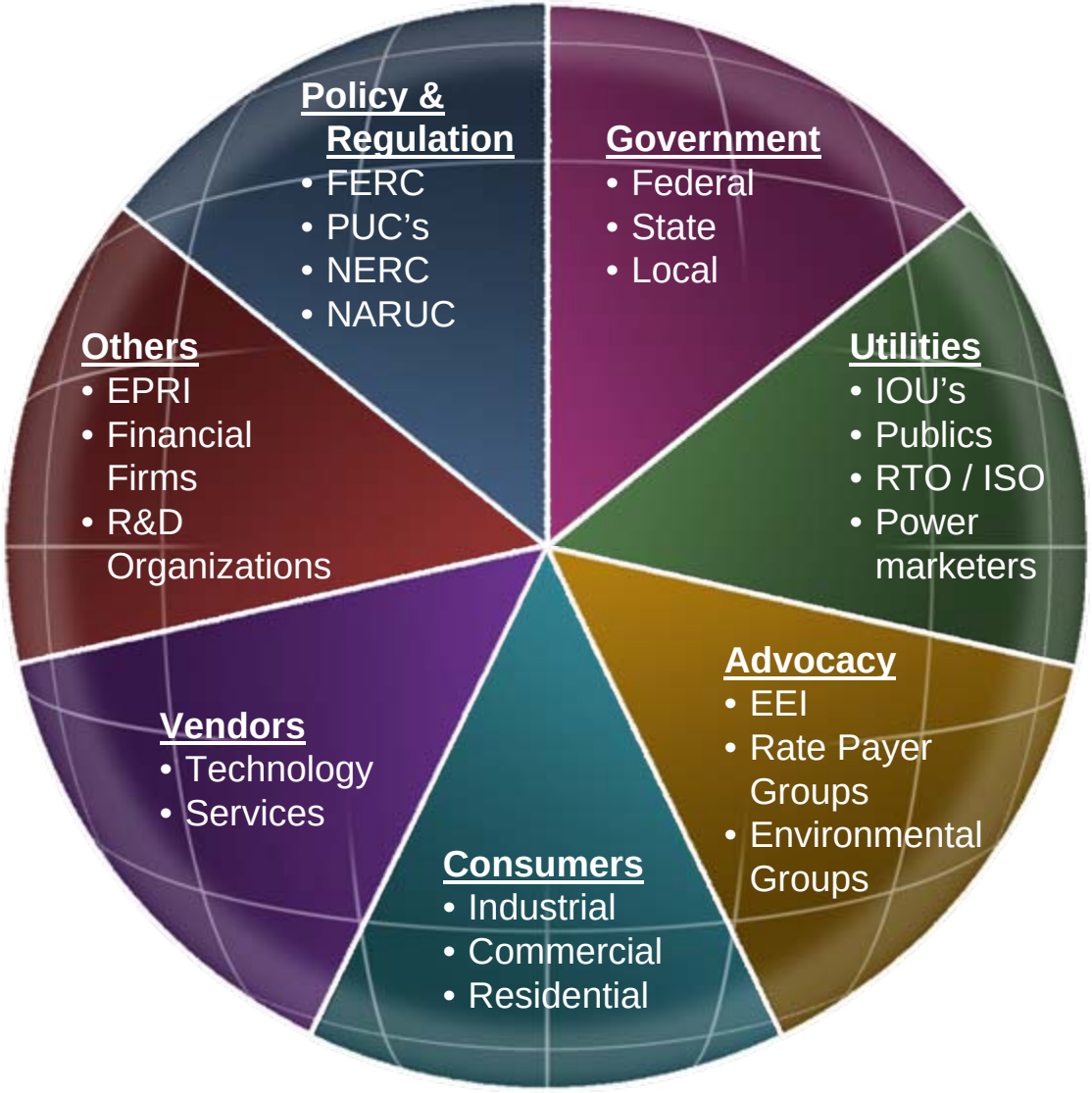
Benefit of Modernization

- **$638B - $802B over 20 years**
- **Overall benefit to cost ratio is 4:1 to 5:1**

(Source: EPRI, 2004)

Thus, based on the underlying assumptions, this comparison shows that the benefits of the envisioned Future Power Delivery System significantly outweigh the costs. *(EPRI, 2004)*

Who are the Smart Grid "benefactors"?



Utility Benefits

Operational improvements

- ***Metering and billing***
- ***Outage management***
- ***Process improvement***
- ***Work force management***
- ***Reduced losses (energy)***
- ***Asset utilization***

Asset Management improvements

- ***System planning***
- ***Maintenance practices***
- ***Engineering***

These benefits are expected to improve customer satisfaction and reduce O&M and capital costs

Consumer Benefits

- **Improved reliability and power quality**
- **Access to information**
- **Ability to manage energy consumption**
- **Option to participate in demand response**
- **Convenient interconnection of distributed generation**
- **Potential to dramatically reduce transportation costs (PHEV)**
- **Option to bid (sell) into electricity markets**

Consumers have access to information, control and options

Societal Benefits

- **Downward pressure on electricity prices** *through improved operating and market efficiencies, consumer involvement*
- **Improved reliability** *leading to reduction in consumer losses (~$135B)*
- **Increased grid robustness** *improving grid security*
- **Reduced losses and emissions** *through integration of renewables and a more efficient delivery system*
- **New jobs and growth in GDP**
- **Opportunity to revolutionize the transportation sector** *through integration of electric vehicles as generation and storage devices*

Societal benefits add significant value

Impact on the transportation sector

- **Dramatic reduction in tailpipe emissions**
- **Reduction in petroleum imports of >50%**
- **Reduction in peak loads – lowering prices for consumers**
- **Improved grid reliability – decreasing today's consumer losses of ~$150 Billion annually**
- **Increased grid security – the "Fort Knox" model**

What other opportunities exist?

Reliability

- **Far broader implications …not just waiting for lights to come on**
  - plant production stopped
  - perishable food spoiling
  - traffic lights dark
  - credit card transactions rendered inoperable
- **Annual Outages and PQ events costs are huge**
  - In 2000, one-hour outage that hit Chicago Board of Trade resulted in $20 trillion in trades delayed
  - Sun Microsystems estimates that a blackout costs company $1 million every minute
  - Up to $150B per year

Total Electric Industry Revenues are $326B per year

The Smart Grid and Reliability

- **Rapid detection of degraded conditions**
- **Distributed generation and micro-grids**
- **Automatic isolation and reconfiguration**
- **Rapid damage assessment and diagnosis**
- **Rapid dispatch of repair crews**
- **Overall self-healing capability**

Smart Grid and the Environment

- **Smart Grid is a key enabler to help reduce CO2 and other emissions through**
  - Reduced consumption from demand response
  - Reduce losses and increased grid efficiency
  - Integration of renewables and CHP DG
  - Enabling energy system diagnostics
  - Enabling PHEV adoption

- **Will provide a "window" for concerned consumers to assess and react to their personal environmental desires (Prius effect)**

Smart Grid could reduce global power system emissions of CO2 14% by 2020

Climate Group, 2008

Activity is increasing

- AMI is the busiest area
- Others are working the distribution system first
- Demonstrations planned on the distribution system (including micro-grids)
- RTO's are interested and studying
- Many evaluating how to implement a Smart Grid
- "Chief Smart Grid" Positions being established

Energy Independence and Security Act of 2007

- **US policy is to support grid modernization**
- **Smart Grid System Report**
  - Status and prospects of development
  - Regulatory or government barriers
  - Technology Penetration
  - Communications network capabilities, costs, obstacles
  - Recommendations for state and federal policies
- **Smart Grid Advisory Committee (thru 2020)**
- **Smart Grid Task Force (thru 2020)**
- **Smart Grid Interoperability Framework (NIST)**

Energy Independence and Security Act of 2007

- **Smart Grid Technology RD&D**
- **Smart Grid Regional Demonstration Initiative**
  - 50% Cost Share
  - $100M per year – 2008-2012
- **Federal Matching Funds**
  - 20% reimbursement for qualifying Smart Grid investments
- **States shall consider:**
  - Requiring utilities to consider Smart Grid solutions including societal benefits
  - Allowing utilities to recover capital, O&M and other costs
  - Allowing recovery of book value of technologically obsolete assets

Authorized but not yet appropriated!

Contact Information

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Questions?

Additional information on the Smart Grid is available:

http://www.netl.doe.gov/moderngrid/

Office of Electricity
Delivery and Energy
Reliability

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Back up Slides

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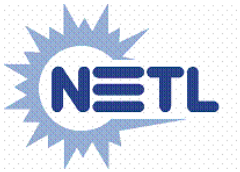
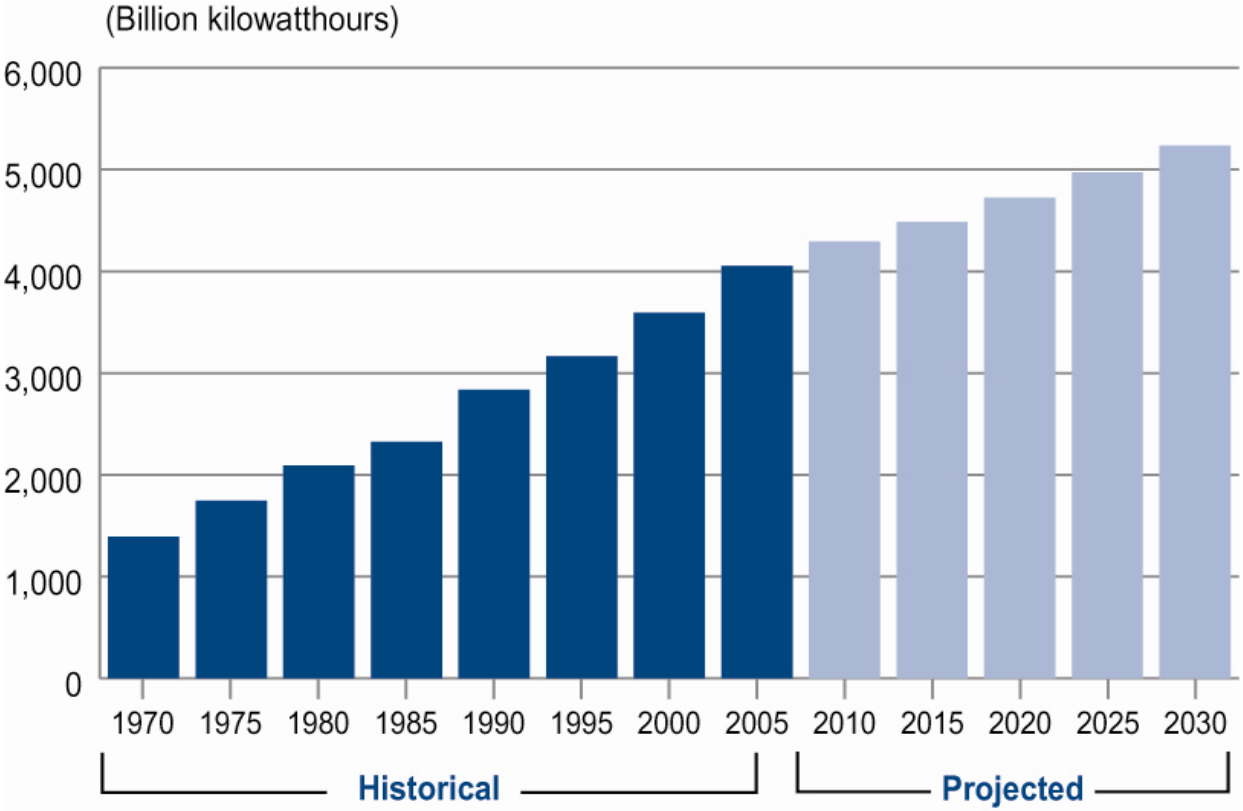
A Case for Action



Demand for Electricity Is Projected to Increase 30% by 2030



*Electricity demand projections based on expected growth between 2006 and 2030.

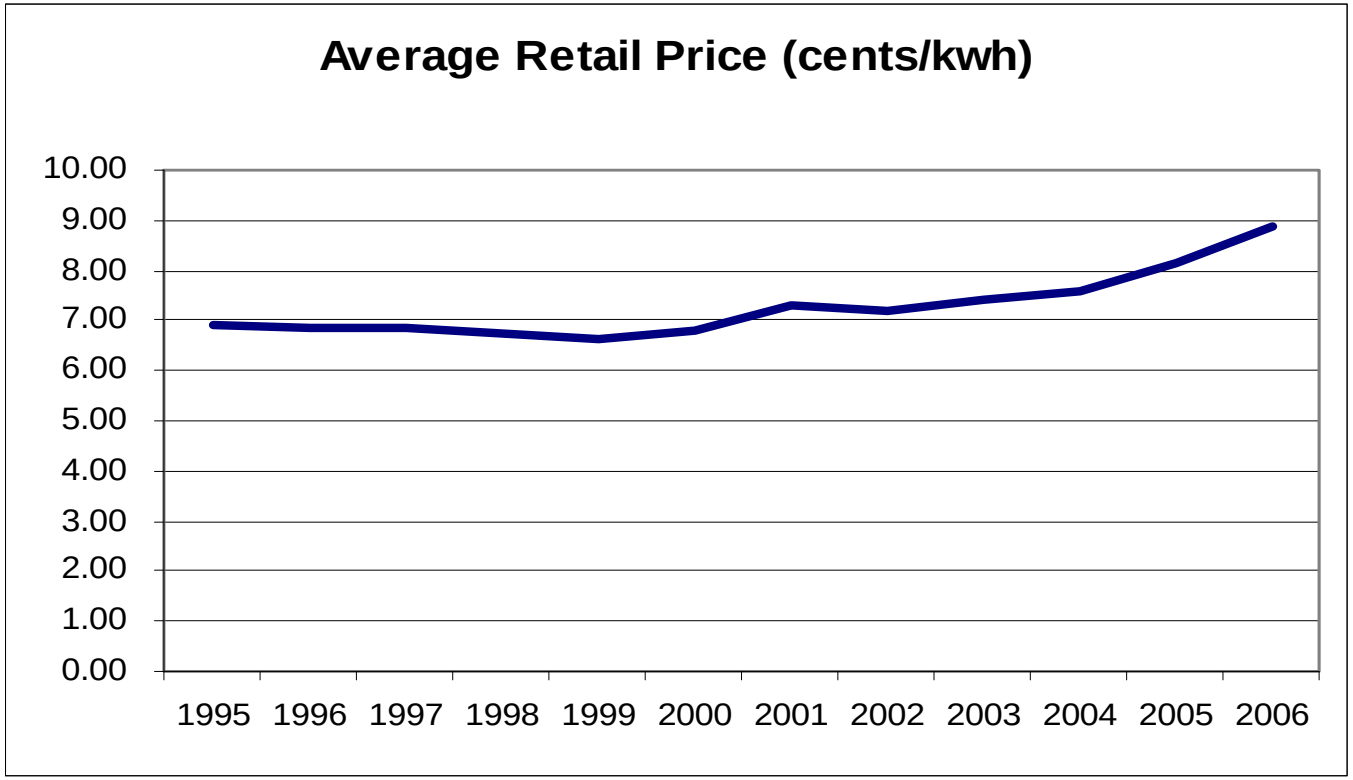
Source: U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 2006* and *Annual Energy Outlook 2008* (early release).

Cost of new generation is increasing

Generation Type	2003-04 ($/KW)	2008 ($/KW)
Nuclear	$1300 - $2300	$4500 - $7500
Conventional Coal	$1000 - $1600	$1800 - $4000
IGCC Coal	$1400 - $1800	$1800 - $2000
Combined Cycle	$600 - $700	$900 - $1600
Combustion Turbine	$300 - $700	$600 - $1000
Wind	$1000 - $1400	$1400 - $2700
Geothermal	$1500 - $2500	$2600 - $3600
Concentrated Solar	$3100 - $5100	$3000 - $5000

IGCC costs from NETL May 2007 Cost and Performance Baseline for Fossil Energy Plants report. Remaining data compiled and reported June 2008 by FERC staff. Costs exclude carbon capture and sequestration costs.

Retail prices are increasing

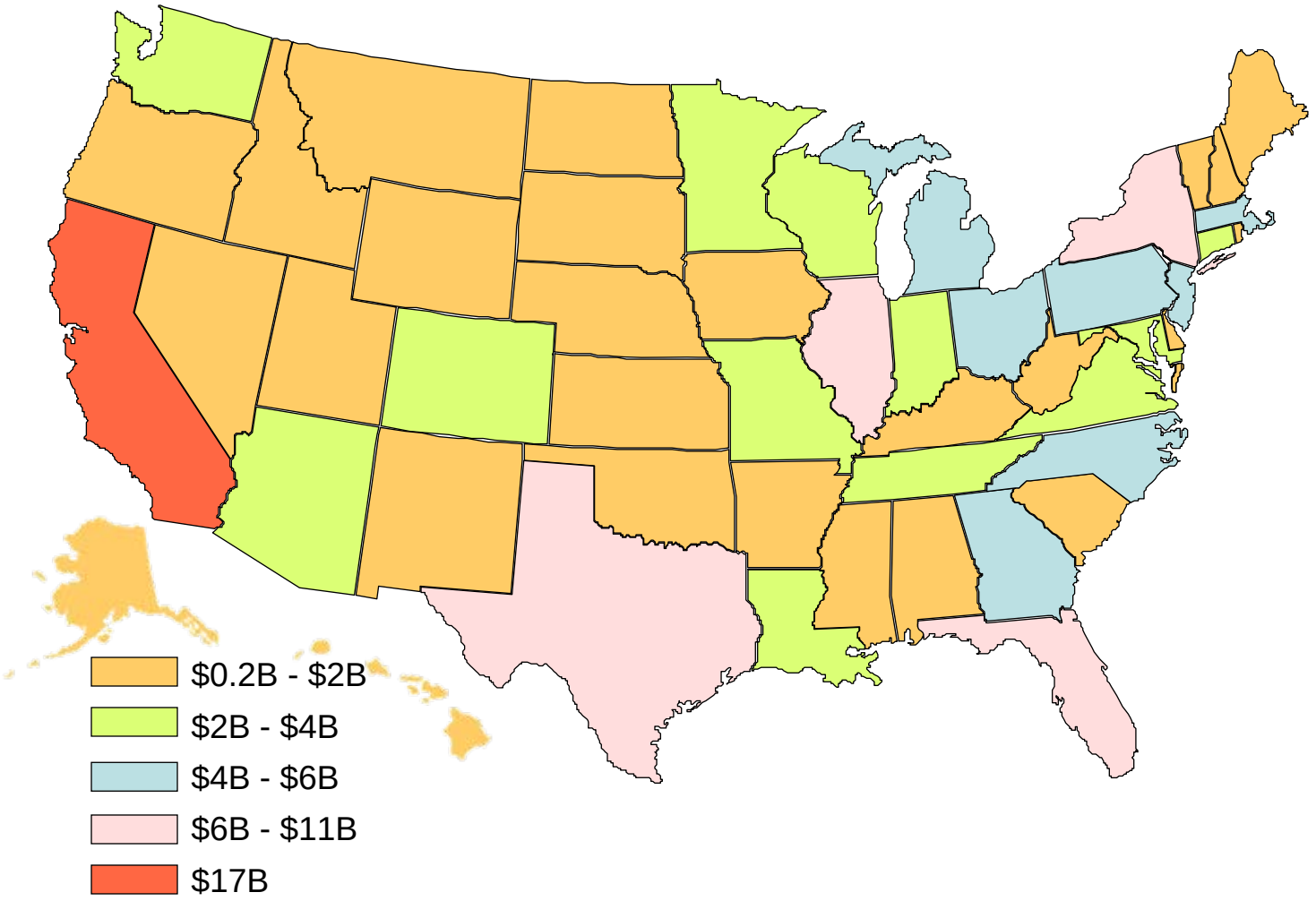


30% increase over last decade

DOE EIA Energy Outlook 2007

Businesses losing billions from interruptions

Primen Study: Up to $135B annually for power interruptions



Today's grid

- **Aging**
  - 70% of transmission lines are 25 years or older
  - 70% of transformers are 25 years or older
  - 60% of circuit breakers are 30 years or older
- **Outmoded**
  - Designed in the 50s and installed in the 60s and 70s, before the era of the microprocessor.
- **Stressed**
  - Never designed for bulk power shipments
  - Wholesale power transactions jumped 300% from 2000 to 2005. *Insight Magazine, Oct. 2005*

Much of the equipment that makes up the North American grid is reaching the end of its design life.

EnergyBiz Magazine, Sept. 2005

Other considerations

- **50 coal plants canceled or delayed since January 2007**
- **Jobs and the economic downturn**
- **US dependence on foreign energy sources**
- **Rising oil and gasoline prices**
- **Climate change**
- **National security**
- **Impact of electric vehicles**

What is the Smart Grid?

The Smart Grid will:

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- Accommodate all generation and storage options
- Enable new products, services and markets
- Provide power quality for the digital economy
- Optimize asset utilization and operate efficiently
- Anticipate & respond to system disturbances (self-heal)
- Operate resiliently against attack and natural disaster