

The Smart Grid

FERC – NARUC Smart Grid Collaborative Meeting

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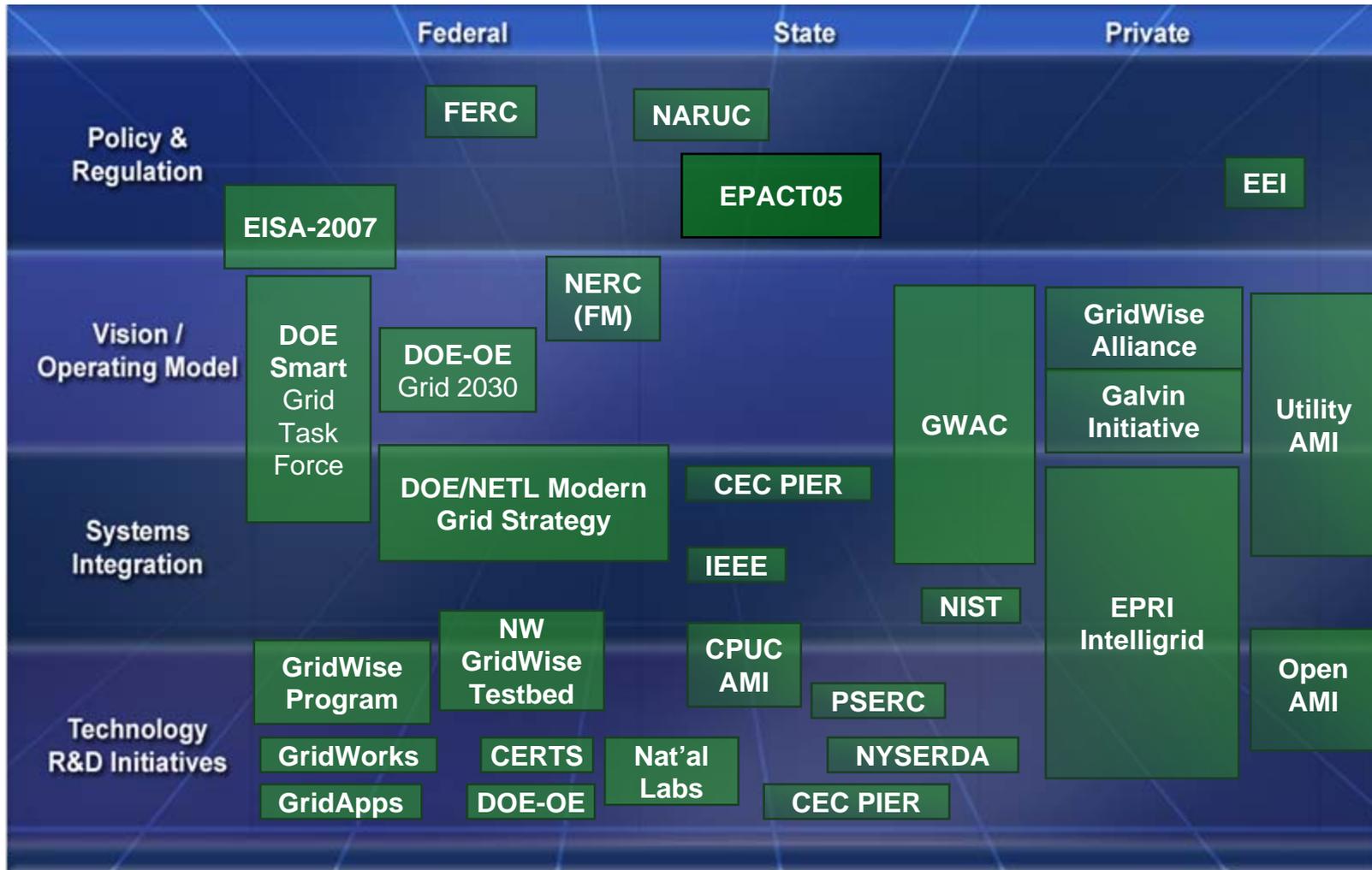
- **Smart Grid Background**
- **What is the Smart Grid?**
- **Some closing thoughts**
- **Questions**



Smart Grid Background



Many are working on the Smart Grid



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- **Developed vision and concept**
- **Vetted with stakeholders at 7 regional summits**
- **White papers published on website**
- **Regulatory support - Ohio and MO**
- **DOE SG Implementation Workshop**
- **Communication of concepts in many forums**

MGS is an “independent broker”



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What is the Smart Grid?



Forward Market Prices Continue to Climb

Midwest ISO (Cinergy)
\$112.12/MWh +62%

Massachusetts Hub
\$ 141.25/MWh +94 %

Northwest (Mid C)
\$ 105.66/MWh +70 %

New York City
\$ 208.51/MWh +123 %

**Southern California
(SP-15)**
\$ 139.41/MWh +88 %

PJM Western Hub
\$ 144.38/MWh +79 %

Palo Verde
\$ 132.95/MWh +76 %

Henry Hub (Gas)
\$ 12.99/MMBtu +108 %

Sources: Summer electric forwards data is July-August 2008 data from ICE as of 6/16/08. Actual on-peak data for 2007 are from Platts Megawatt Daily. The Henry Hub data is July-August Clearport data from Bloomberg as of 6/16/08.



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Imagine a World with 200 million electric vehicles that:

- **Connect anywhere**
- **Provide transportation and act as storage and generators for the grid**

And are powered by:

- **Clean central station generation**
- **Renewables and other distributed generation**

A shift from gasoline to PHEVs could reduce U.S. petroleum imports by 52% (PNNL – Impact assessment of PHEV's)



- Equivalent of ~\$1.00 / gallon for gasoline
- Opportunity to buy when KWh prices are low
- Opportunity to sell when KWh prices are high
- Home back-up power and mobile resource

Consumer involvement - a compelling value proposition is needed



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And substantial societal benefits

- **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 >\$125 Billion annually**
- **Increased grid security – the “Fort Knox” model**

The Smart Grid can make this “world” real!



The Smart Grid will:

- Enable active participation by consumers
- 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



It will “Enable active participation by consumers”

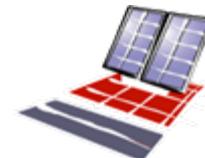
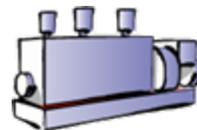
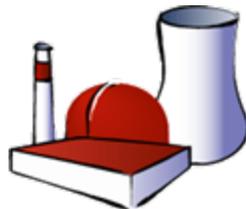
- **Consumers have access to new information, control and options to engage in electricity markets**
 - Energy management
 - Investment in DER and PHEV
 - Offer resources to market
 - ATM model
 - E-bay level of activity
- **Grid operators have new resource options**
 - Reduce peak load and prices
 - Improve grid reliability

Involving the consumer is win – win!



It will “Accommodate all generation and storage options”

- **Seamlessly integrates all types and sizes of electrical generation and storage systems**
- **Convenient for the consumer - “Plug-and-play”**
 - 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.**



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
- **Increases the value proposition for consumers**
- **Provides for consistent market operation across regions**

Markets motivate behavior and get results!



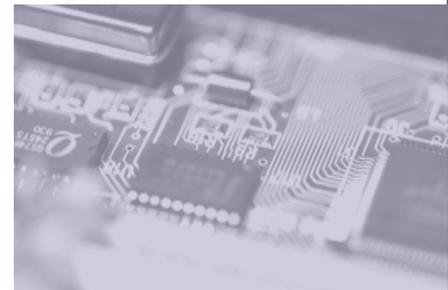
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It will “Provide power quality for the digital economy”

- **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**

Voltage dips that last less than 100 milliseconds can have the same effect on an industrial process as an outage that lasts several minutes or more

Primen, 2002



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- **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

Reducing O&M and Capital costs and system losses puts downward pressure on prices to consumers



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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”**
- **Reduces the cost of losses suffered by consumers (> \$100B annually)**

The blackout of August 2003 took hours to build up. Once it breached the original service territory, it took 9 seconds to blackout 50M people.

PNNL, June 2006



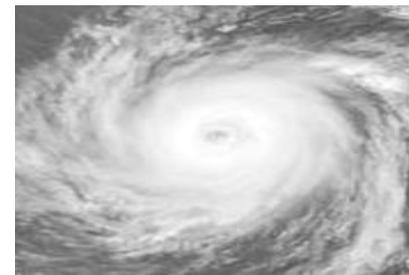
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It will "Operate resiliently against attack and natural disaster"

- **System-wide solution to physical and cyber security**
- **Reduces threat, vulnerability, consequences**
- **Deters, detects, mitigates, responds, and restores**
- **"Fort Knox" image**
- **Provides energy security for consumers**

The lack of a concerted, deliberate technical approach risks serious consequences from security threats to the power delivery system infrastructure.

Erich Gunther, Power & Energy Continuity, 2002



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Steps to the Smart Grid

AMI and DR

AMI empowers the customer and establishes communications to the loads

Distribution (ADO)

ADO enables self healing

Transmission (ATO)

ATO addresses congestion

Asset Management (AAM)

AAM greatly improves the performance of today's asset management programs



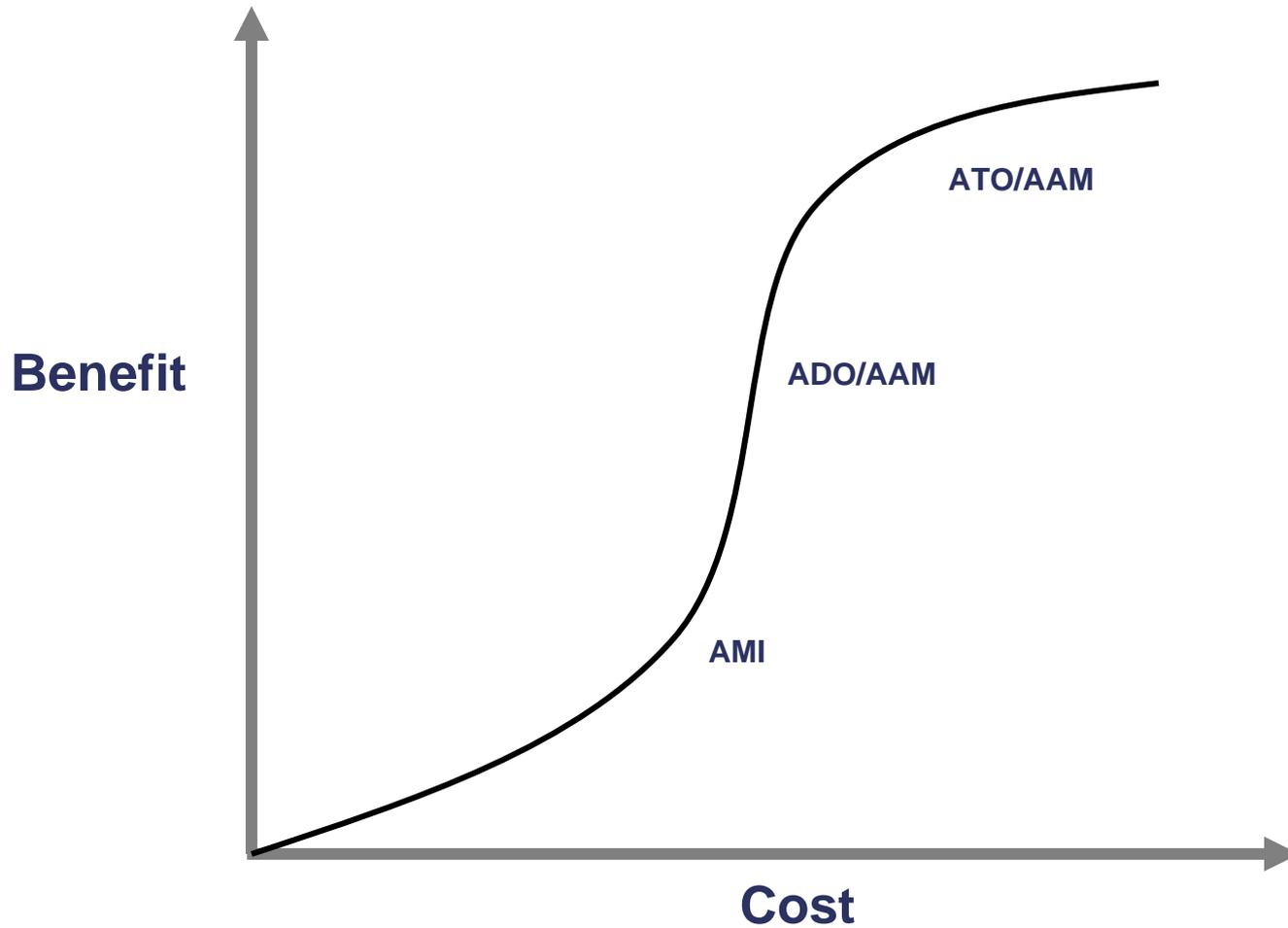
Keeping the “End in Mind”

<i>Characteristic</i>	<i>AMI</i>	<i>ADO</i>	<i>ATO</i>	<i>AAM</i>
Enables Active Consumer Participation	✓	✓		
Accommodates All Generation & Storage Options	✓	✓	✓	
Enables New Products, Services and Markets	✓	✓	✓	
Provides PQ for Digital Economy	✓	✓	✓	✓
Optimizes Assets & Operates Efficiently	✓	✓	✓	✓
Anticipates and Responds to System Disturbances	✓	✓	✓	✓
Operates Resiliently Against Attack and Natural Disaster	✓	✓	✓	



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Generally speaking...



Some Closing Thoughts



- **Communication of Smart Grid concepts and benefits should continue**
- **Consumer input, alignment, and support is essential**
- **Value of Smart Grid depends on consumer participation**
- **Value increases as progress is made towards the vision**
- **Sharing successes and “lessons learned” can leverage progress**
- **Supportive regulatory policies is an enabler**
- **Metrics will bring visibility to progress and results**



Questions?



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Back-up Slides



Operational efficiencies

- *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.



- **Access to information**
- **Ability to manage energy consumption**
- **Option to participate in demand response**
- **Convenient interconnection of distributed generation**
- **Option to buy and sell into electricity markets**
- **Reduction in outages (number and duration)**
 - Fewer losses
 - Fewer inconveniences
- **Improved overall level of service**

Consumers receive information, control and options



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- Improved efficiencies leading to downward pressure on electricity prices
- Improved reliability leading to reduction in consumer losses (~\$135B)
- Increased grid robustness improving grid security
- Reduced emissions due to more renewables and reduced system losses
- Growth in jobs and GDP
- Opportunity to revolutionize the transportation sector

Achieving the Smart Grid Vision depends on consumer involvement – and the benefits are significant!



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- **US policy is to support grid modernization**
- **Smart Grid Advisory Committee (thru 2020)**
- **Smart Grid Task Force (thru 2020)**
- **Smart Grid Interoperability Framework (NIST)**
- **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 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



Why Modernize the Grid?

- Today's grid is aging and outmoded
- Unreliability is costing consumers billions of dollars
- Today's grid is vulnerable to attack and natural disaster
- An extended loss of today's grid could be catastrophic to our security, economy and quality of life
- Today's grid does not address the 21st century power supply challenges
- The benefits of a modernized grid are substantial

Running today's digital society through yesterday's grid is like running the Internet through an old telephone switchboard.

Reid Detchon, Energy Future Coalition



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How Do We Get There?



Smart Grid Milestones

- **Advanced Metering Infrastructure (AMI)**
- **Advanced Distribution Operations (ADO)**
- **Advanced Transmission Operations (ATO)**
- **Advanced Asset Management (AAM)**

Each Milestone requires the deployment and integration of various technologies and applications



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- **Smart Meters**
- **Two-way Communications**
- **Consumer Portal**
- **Home Area Network**
- **Meter Data Management**
- **Demand Response**
- **Customer Service Applications**
- **Operational Gateway Applications**

AMI empowers the customer and supports grid operations



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- Distribution Management System with advanced sensors
- Advanced Outage Management (“real-time”)
- DER Operations
- Distribution Automation
- Distribution Geographic Information System
- Micro-grid operations (AC and DC)
- Advanced protection and control
- Advanced grid components for distribution

The functionality of ADO enables “Self Healing”



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- Substation Automation
- Geographical Information System for Transmission
- Wide Area Measurement System (WAMS)
- Hi-speed information processing
- Advanced protection and control
- Modeling, simulation and visualization tools
- Advanced grid components for transmission
- Advanced regional operational applications

Deeply integrated with AMI, ADO and AAM – ATO optimizes transmission operations



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- **Advanced sensors**
 - System Parameters
 - Asset “health”

- **Integration of real time information with other processes:**
 - Operations to optimize asset utilization
 - T&D planning
 - Condition based maintenance
 - Engineering, design and construction
 - Work and resource management

Integration of AMI, ADO, and ATO with asset management processes will dramatically improve grid operations and efficiency

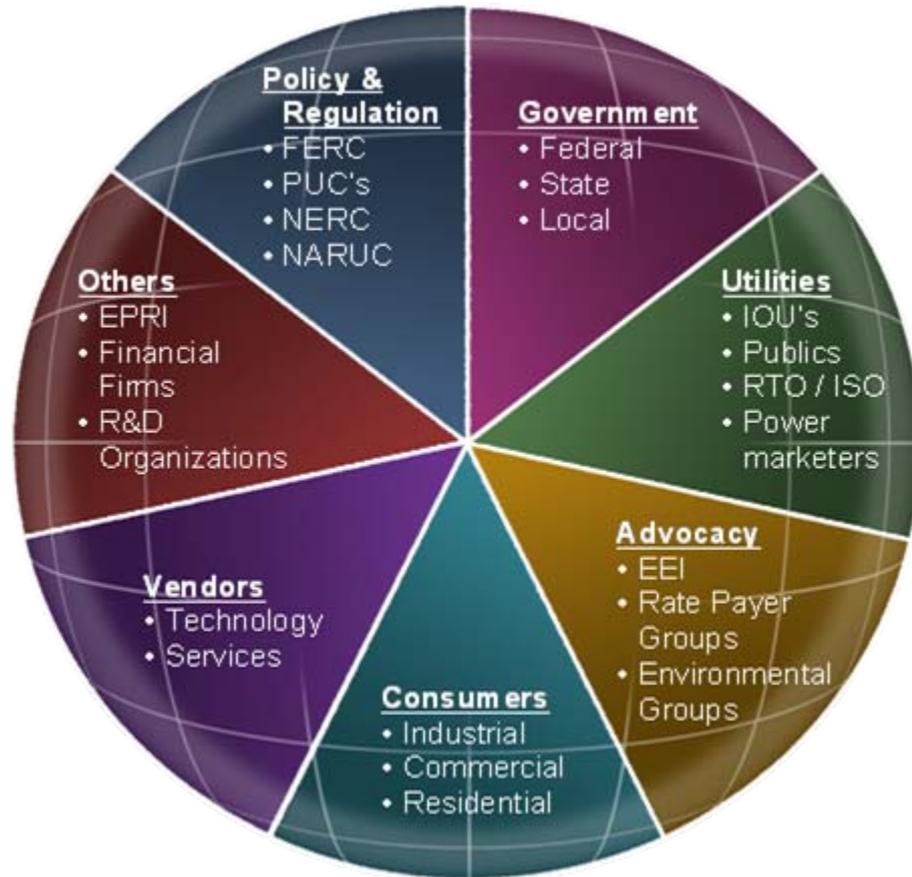


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What are some of the barriers?



- Change Management
- Regulatory Policy
- Technical
- Other?



A significant change management effort is needed:

- Communicate a vision
- Strengthen consumer education
- Communicate the compelling value proposition
- Align stakeholders around the vision
- Develop metrics to monitor progress
- Active leadership by regulators
- Keep the “end in mind”



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 to ensure informed decisions are made by the regulator



Some technical issues:

- Sharing successes and “lessons learned”
- Standards (interconnection and interoperability)
- Integration vs. “widgets”
- Distributed system behavior not well understood
- Loss of skilled human resources
- Minimal funding of R&D – new technologies



Is the SG Value Proposition Compelling?

- **Would you wash your clothes at 9pm to save 10 cents?**
- **Would you drive an extra quarter mile for 10% cheaper gas (that's 40 cents less)?**
- **Would you rather fill your vehicle with less carbon, while you sleep, work, shop for 75% less per gallon?**
- **Would you like it if your car had the intelligence to sell that power back during a peak and pay for your driving all week long?**
- **What value do you place on societal benefits?**



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

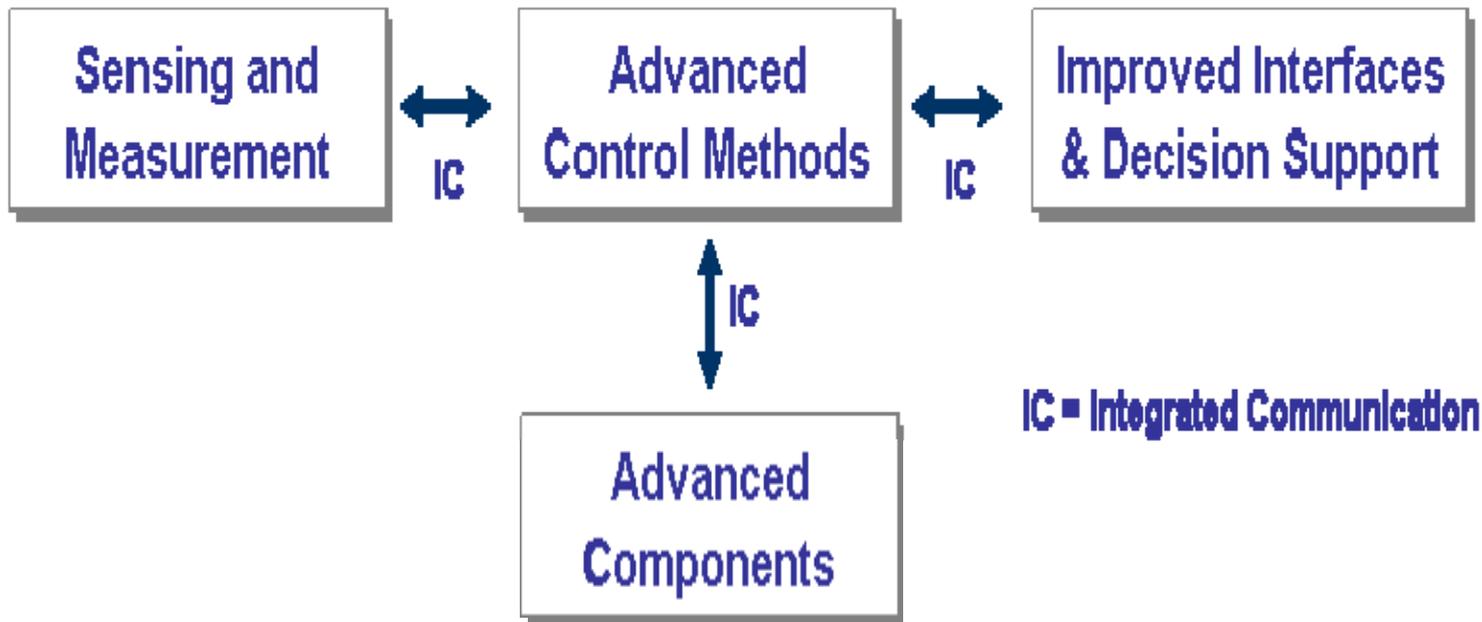
- **\$638B - \$802B over 20 years**
- **Overall benefit to cost ratio is 4:1 to 5:1**

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)



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- [The Modern Grid Strategy](#)
- [Smart Grid Newsletter](#)
- [EPRI Intelligrid](#)
- [Galvin Electricity Initiative](#)
- [GridWise Alliance](#)
- [GridWise Architecture Council](#)
- [European SmartGrid Technology Platform](#)

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