

The Smart Grid – Benefits and Challenges

EEI Annual Convention - Toronto

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Office of Electricity Delivery and Energy Reliability



Conducted by the National Energy
Technology Laboratory

With 200 million electric vehicles that:

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

And are powered by:

- **Clean nuclear and coal with carbon capture**
- **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)



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Resulting in

- **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**

A Smart Grid is needed to enable such “worlds”



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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

DOE SmartGrid Implementation Workshop – June 2008 – Vision and Metrics



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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 Smart Grid is MORE:

- **Reliable**
- **Secure**
- **Economic**
- **Efficient**
- **Environmentally friendly**
- **Safe**

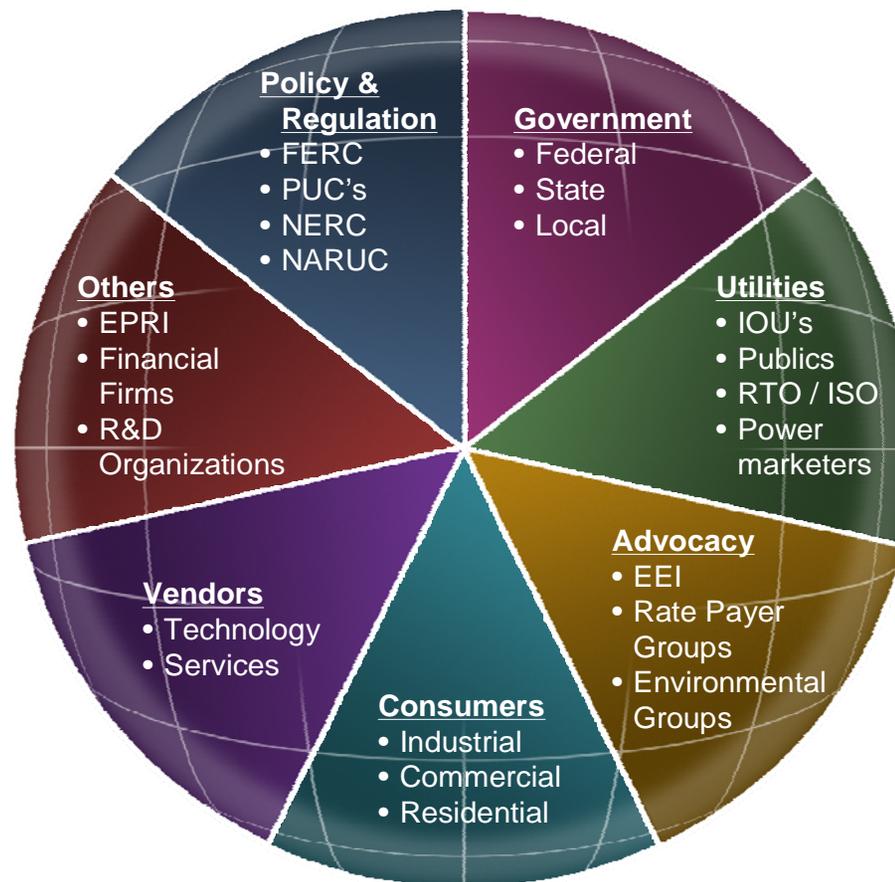
These values define the goals for grid modernization and suggest where metrics are needed to monitor progress.



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What are the challenges?

- Change management
- Regulatory Policy
- Technical
- Other?



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A significant change management effort is needed:

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



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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



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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 – new technologies



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- **David Cagigal – Alliant**
- **Bob Gilligan – GE**
- **Lew Hay – FPL**
- **Dick Kelly – Xcel**
- **Rick Stevens – Hydro One**



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Backup Slides



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What is the role of the MGS?

- Define a vision for the Modern Grid
- Reach out to stakeholders to gain consensus
- Assist in the identification and resolution of barriers & issues
- Act as “independent broker” consistent with the vision
- Promote testing of integrated suites of technologies
- Communicate success stories to stimulate deployment

Our role is Strategic rather than Tactical!



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NETL's Modern Grid Strategy

- Began concept development in early 2005
- Conducted regional summits (7) to get input
- Numerous other presentations
- Incorporated feedback

Smart Grid Workshop

- Further unification of concepts with others
- Workshop planned for June 2008 with focus on metric development



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It will “Enable active participation by consumers”

- **Customers see what they use, when they use it, and what it costs**
- **Consumers have access to new information, control and options**
 - Manage energy costs
 - Invest in new devices
 - Sell resources for revenue or environmental stewardship
- **Grid operators have new resource options**
 - Energy and capacity
 - Ancillary services

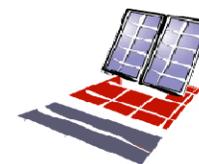
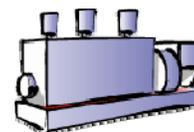
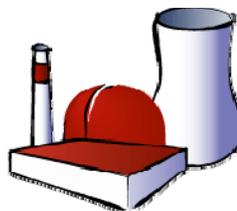
Involving the consumer is win – win!



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It will “Accommodate all generation and storage options”

- Seamlessly integrates all types and sizes of electrical generation and storage systems
- Simplified interconnection process analogous to “plug-and-play”
- Large central power plants including environmentally-friendly sources such as wind and solar farms and advanced nuclear plants will continue to play a major role
- Number of smaller, decentralized sources will increase



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It will “Enable new products, services and markets”

- Links buyers and sellers down to the consumer level
- Supports the creation of “secondary” electricity markets
 - Brokers, integrators, aggregators, etc.
 - New commercial goods and services
- Provides for consistent market operation across regions
- Supports growth of competitive retail markets
- Stimulates deployment of energy resources closer to the consumer

Markets motivate behavior and get results!



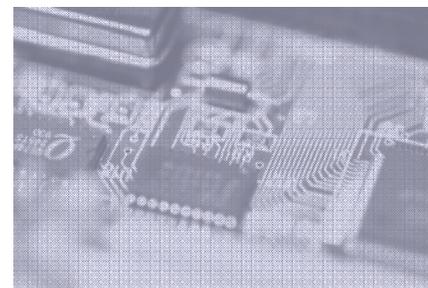
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It will “Provide power quality for the digital economy”

- Monitors, diagnoses and responds to PQ issues
- Varying grades of power quality at different pricing levels
- Power quality standards will balance load sensitivity with delivered power quality at a reasonable price
- Solutions at both system and consumer level

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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It will “Optimize asset utilization and operate efficiently”

- Improved load factors and lower system losses
- More power through existing systems
- The knowledge to build only what we need
- Tools for efficient, optimized designs
- Intelligent monitoring and diagnostics
- Computer-aided asset management, workflow management, outage management
- Condition Based Maintenance

Convergence of operating information with asset management processes will dramatically improve grid efficiency



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It will “Anticipate & respond to system disturbances (self-heal)”

- 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
- Acts as the grid’s “immune system”
- Supports grid reliability, security, and power quality

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



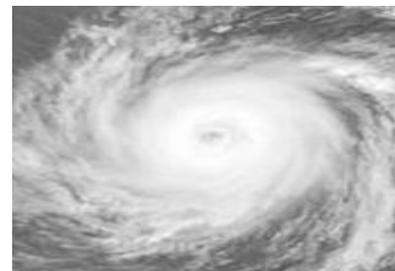
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It will “Operate resiliently against attack and natural disaster”

- Physical and cyber security built in from the ground up
- Reduces threat, vulnerability, consequences
- Deters, detects, mitigates, responds, and restores
- Less vulnerable to natural disasters
- Energy security has become national security

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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The Smart Grid Gap

<i>Characteristic</i>	<i>Today</i>	<i>Tomorrow</i>
Enables Consumer Participation	Little price visibility, time-of-use pricing rare, few choices	Full price info, choose from many plans, prices and options, buy and sell
Accommodates Generation/Storage	Dominated by central generation. Little DG, DR, storage or renewables.	Many “plug and play” distributed energy resources complement central generation
Enables New Markets	Limited wholesale markets, not well integrated	Mature, well-integrated wholesale markets, growth of new electricity markets
Meets PQ Needs	Focus on outages not power quality	PQ a priority with a variety of quality/price options according to needs



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The Smart Grid Gap

<i>Characteristic</i>	<i>Today</i>	<i>Tomorrow</i>
Optimizes Assets & Operates Efficiently	Little integration with asset management	Deep integration of grid intelligence with asset management software
Self Heals	Protects assets following disruption (e.g. trip relay)	Prevents disruptions, minimizes impact, restores rapidly
Resists Attack	Vulnerable to terrorists and natural disasters	Deters, detects, mitigates, and restores rapidly and efficiently



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Why Modernize the Grid?

- Today's grid is aging and outmoded
- Unreliability is costing consumers billions
- 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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- **Major reduction in outage duration and frequency**
 - Reduces losses to consumers (>\$100B/year)
 - Improves customer satisfaction
- **Far fewer Power Quality disturbances**
 - Reduces manufacturing losses
 - Improves safety
- **Virtual Elimination of Regional Blackouts**
 - Reduces huge societal costs by minimizing occurrences (>\$10B per event)



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- **Significantly reduced vulnerability to terrorist attack and natural disasters**
 - Intelligent networking and deployment of Distributed Energy Resources improves the resiliency of the grid
 - Decentralization of DER
 - Diversity of fuels and size
- **Improved Public and Worker Safety**
 - Improved monitoring and decision system support systems will quickly identify problems and hazards
 - Reduced number and duration of outages reduces public safety and crime issues proportionately



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- **Reduction or mitigation of electricity prices**
 - Consumer response to market prices will reduce peak demand leading to a reduction in peak prices
 - Deferral of capital investments will mitigate upward pressure on rates
 - Increased grid robustness and efficiency will also mitigate rate increases
- **New options for market participants**
 - Home energy management systems
 - Investment in resources
 - Sale of energy, capacity, ancillary services
- **Supports a growing national economy**



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- **Reduced O&M costs from more efficient operation and improved asset management**
 - Optimal loading of assets to prevent overloads and extending life
 - Improved planning process leading to “just in time” capacity additions
 - Improved understanding of asset health leading to more efficient maintenance practices

- **Reduction of electrical losses**
 - Reduces generation requirements
 - Extends life of assets



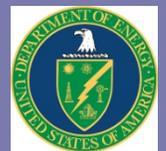
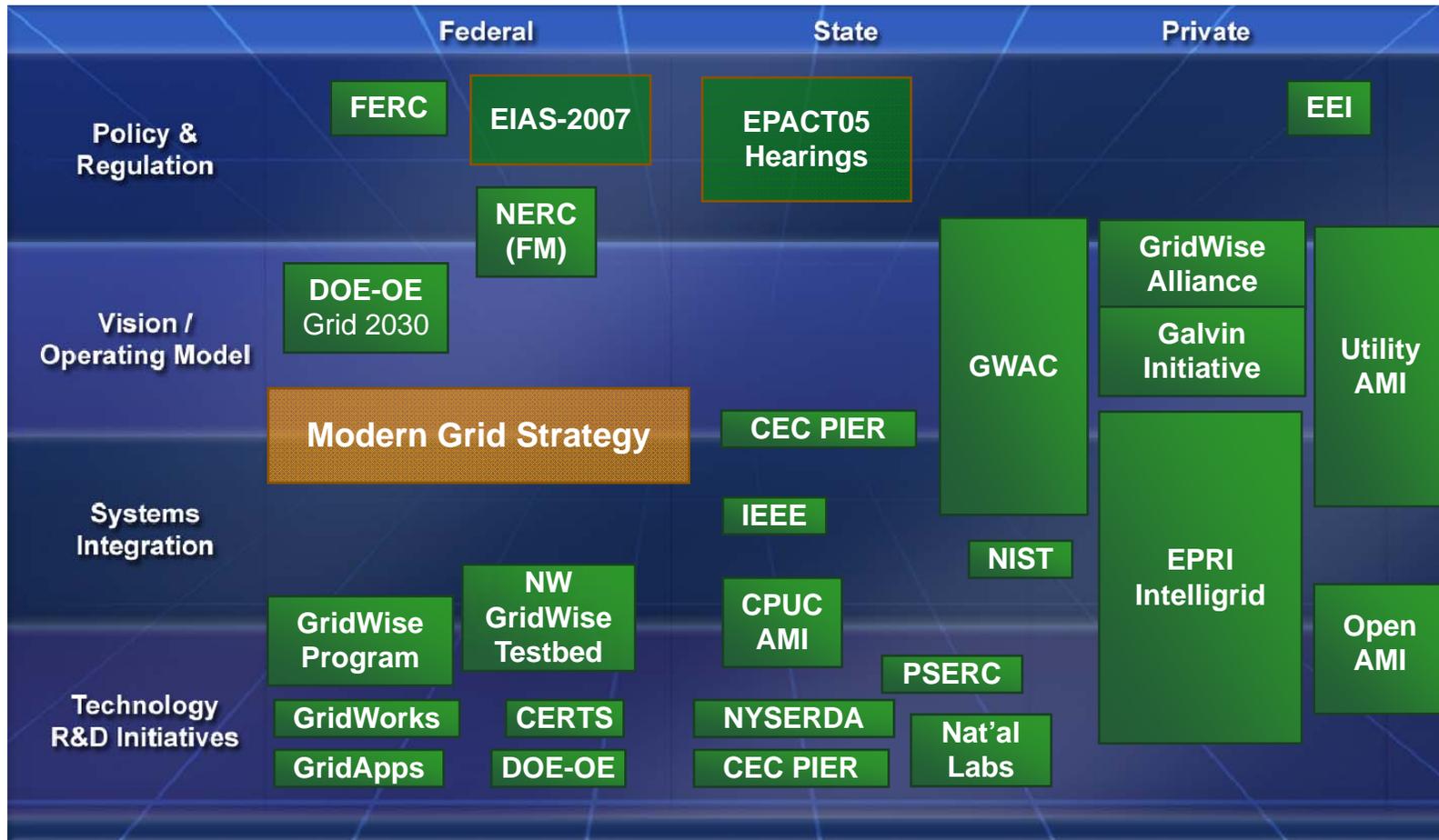
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- **Much wider deployment of environmentally friendly resources**
 - “Plug and Play” simplifies interconnection of DER including renewables
 - Distributed renewable generation reduces the need for less environmentally friendly central generation
- **Electrical losses reduced leading to a corresponding reduction in system generation**
 - Less generation means less emissions



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And many working to make it real



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For More Information

- [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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