MODERN GRID
STRATEGY

What is the Smart Grid?

Illinois Smart Grid Initiative

Joe Miller – Modern Grid Strategy Team

June 3, 2008

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

Conducted by the National Energy
Technology Laboratory

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!

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

Value Proposition

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)*

Smart Grid Values

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.

Our future will change

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 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)*

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**

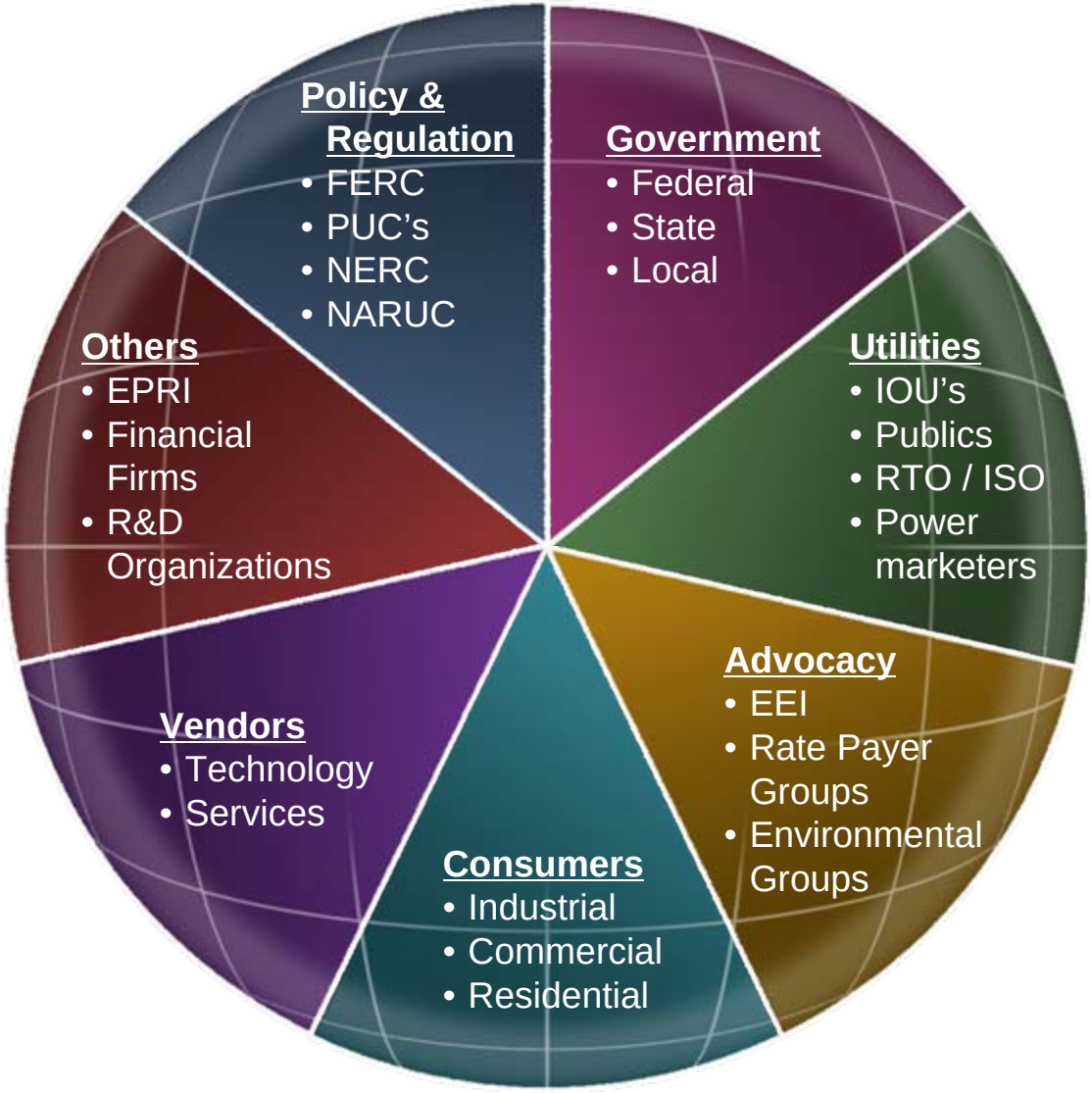
But we need a Smart Grid to enable such "worlds"

Smart Grid Characteristics

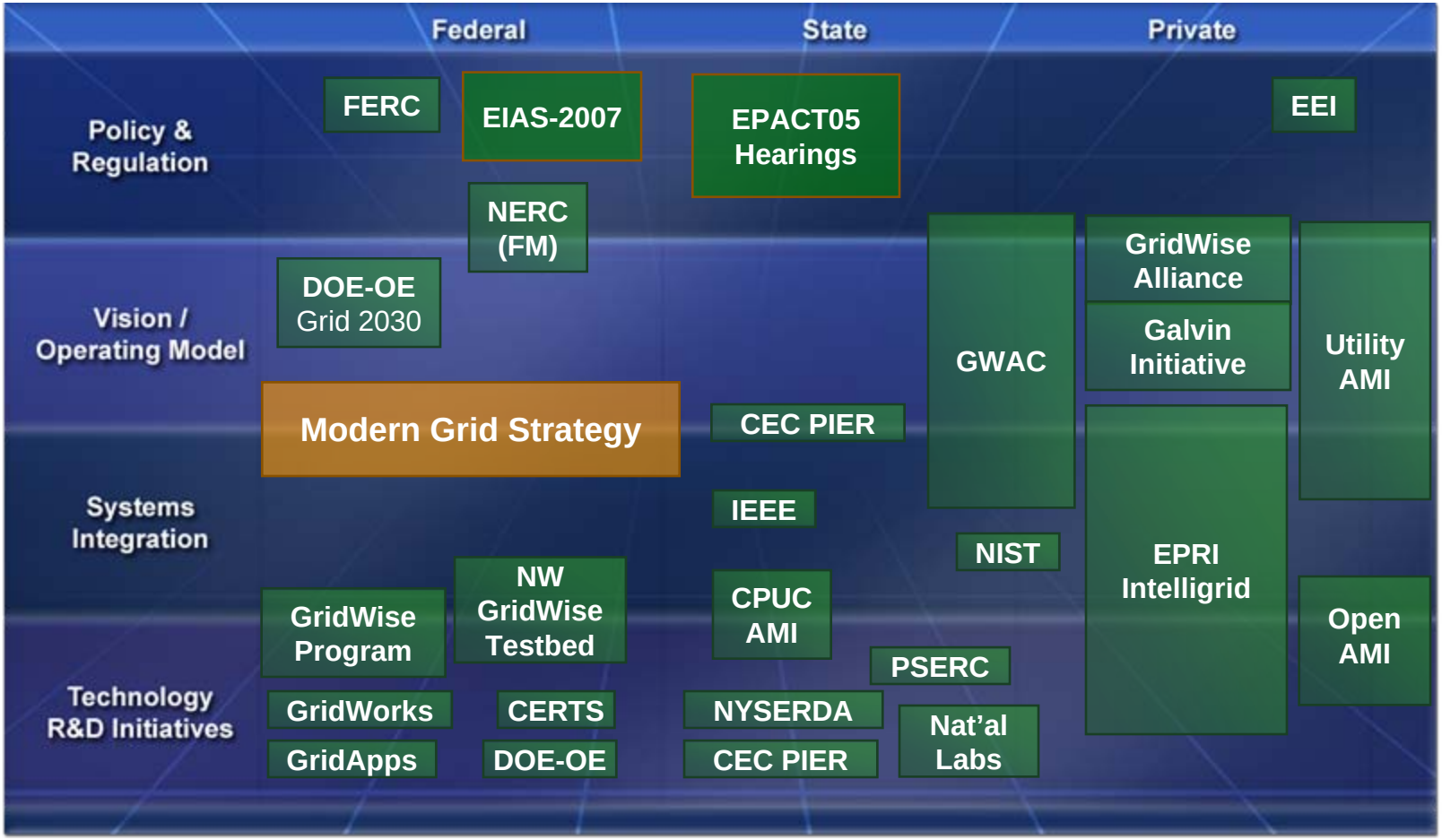
The Smart Grid will:

- 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

There are many stakeholders



And many working to make it real



Office of Electricity Delivery and Energy Reliability

For More Information

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

Backup Slides

Background

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

Smart Grid Characteristics

It will "Enable active participation by consumers"

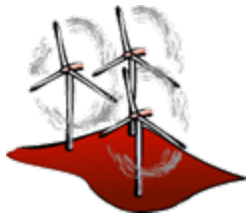
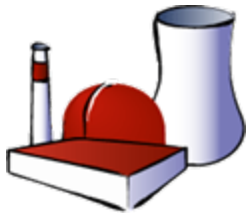
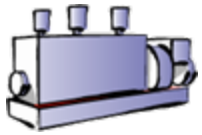
- **Customers see what they use, when they use it, and what it costs**
- **Consumers have access to new information, control and options**
  - Manage energy costs
  - Invest in new devices
  - Sell resources for revenue or environmental stewardship
- **Grid operators have new resource options**
  - Energy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

Involving the consumer is win – win!

Smart Grid Characteristics

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


Smart Grid Characteristics

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!

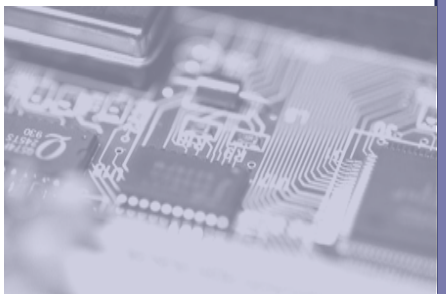
Smart Grid Characteristics

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



Smart Grid Characteristics

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

Smart Grid Characteristics

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

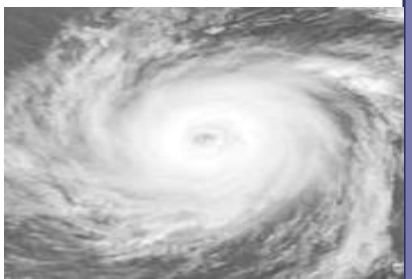
Smart Grid Characteristics

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



The Smart Grid Gap

Characteristic	*Today*	*Tomorrow*
Enables Consumer Participation	Consumers are uninformed and non-participative with the power system	Informed, involved and active consumers – DR and DER
Accommodates Generation/Storage	Dominated by central generation – many obstacles exist for DER interconnection	Many distributed energy resources with "plug and play" convenience – focus on renewables
Enables New Markets	Limited wholesale markets, not well integrated – limited opportunities for consumers	Mature, well-integrated wholesale markets, growth of new electricity markets
Meets PQ Needs for 21st Century	Focus on outages – slow response to PQ issues	PQ a priority with a variety of quality/price options – rapid resolution of issues

The Smart Grid Gap

Characteristic	*Today*	*Tomorrow*
Optimizes Assets & Operates Efficiently	Little integration of operational data with asset management – business process silos	Greatly expanded data acquisition of grid parameters – deeply integrated with asset management processes
Self Heals	Responds to prevent further damage – focus is on protecting assets following fault	Automatically detects and responds to problems – focus on prevention, minimizing impact to consumer
Resists Attack	Vulnerable to malicious acts of terror and natural disasters	Resilient to attack and natural disasters with rapid restoration capabilities