

Smart Grid Overview

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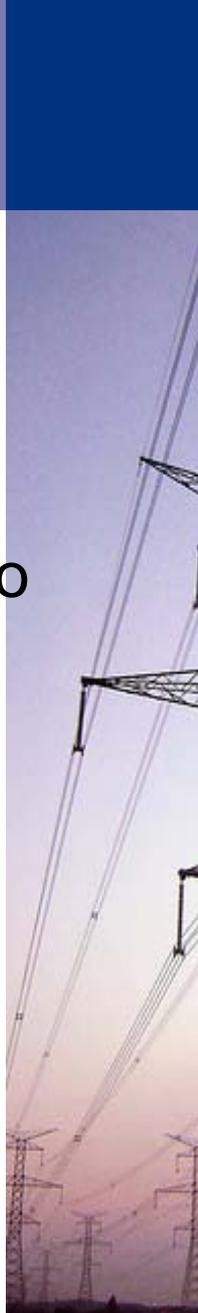
Agenda

- Case for Grid Modernization
- Smart Grid Vision, Technologies, & Metrics
- What's the Value Proposition?
- Change Management – “Performance Feedback”
- Smart Grid Activities
- Questions



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
- Adverse trends associated with the grid
 - Costs, reliability, peak loads, asset underutilization, TLRs, grid divorce
- The benefits of a modernized grid are substantial



Today's grid – Status quo is not an option

- **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*



What's different with the Smart Grid?

- De-centralized supply and control
- Two-way power flow
- Two-way information flow
- Consumer engagement with resources to solve power issues locally
- Imperative to transform from passive to active control in Distribution

...for all Stakeholders

Creating the intelligence and capability to optimize:

- *Reliability*
- *Security*
- *Economics*
- *Efficiency*
- *Environment*
- *Safety*

Smart Grid is a Vision and a System



The Big Picture



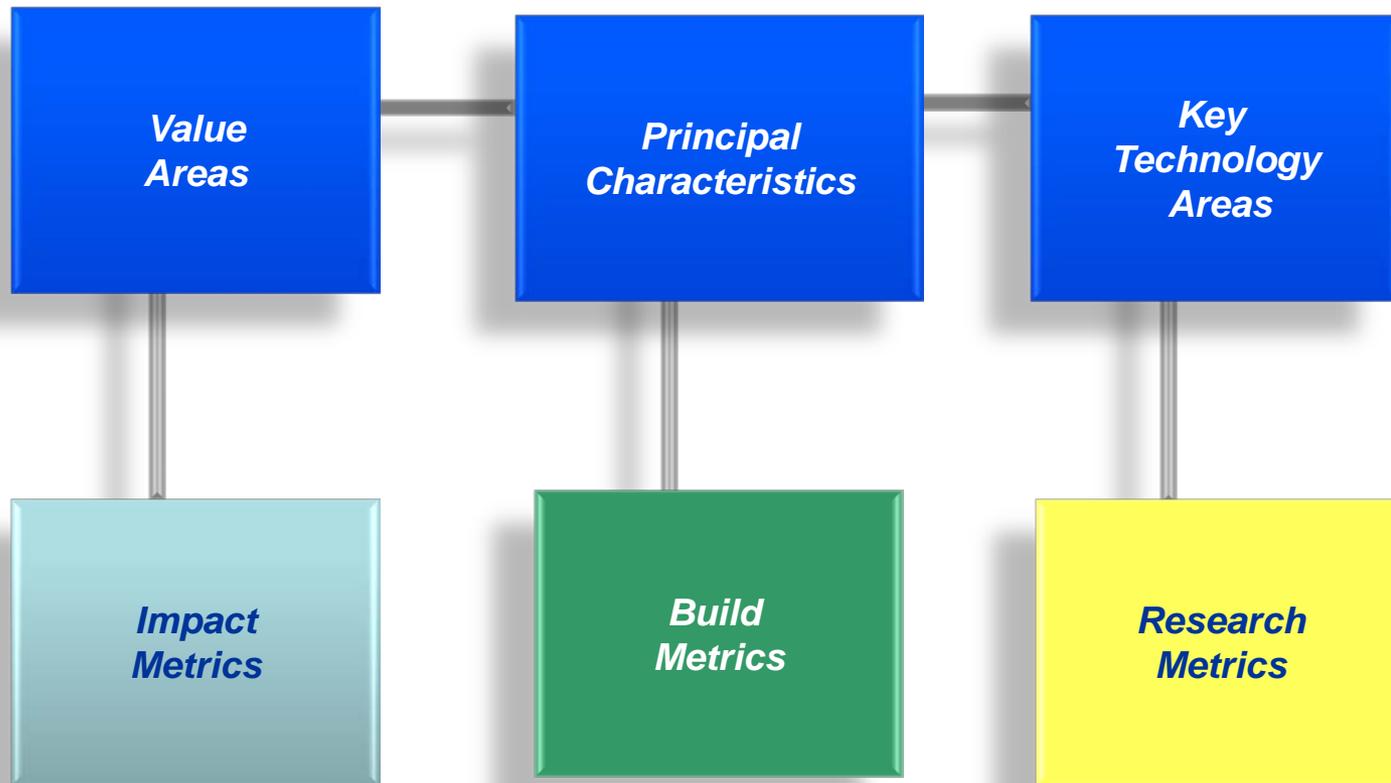
Smart Grid Principal Characteristics

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



Smart Grid Metric Map



Smart Grid Metrics

Reliability

- Outage duration and frequency, momentary disruption, power quality

Security

- Ratio of distributed generation to total generation

Economics

- Electricity prices, transmission congestion costs, cost of outages

Efficient

- T&D electrical losses, peak-to-average load ratio

Environmentally Friendly

- Ratio of renewable generation to total generation, emissions per kwh

Safety

- Injuries and deaths to workers and public



Value Proposition

Cost to Modernize

- \$338-\$476B over 20 years
 - \$ 82-90 B for transmission
 - \$232-\$339 B for distribution
 - \$24-46 B for consumer
- \$17-24 B per year
EPRI, 2011

Previous Studies

Benefit to Cost Ratio for West Virginia of 5:1

Benefit to Cost Ratio for San Diego of 6:1

Benefit to Cost Ratio for EPRI (2004) 4:1-5:1

\$165 B Cost

\$638 - \$802 B Benefits

Benefit of Modernization

- \$1294 – 2028 Billion
- Overall benefit-to-cost ratio of 2.8 to 6.0

Attribute	Net Present Worth (2010) \$B	
	Low	High
Productivity	1	1
Safety	13	13
Environment	102	390
Capacity	299	393
Cost	330	475
Quality	42	86
Quality of Life	74	74
Security	152	152
Reliability	281	444
Total	1294	2028

Who are the Beneficiaries?

- Utilities (What's in it for my shareholders?)
- Consumers (What's in it for me?)
- Society (What's in it for us?)

We get what we reward!



Progress won't be “smooth and easy”

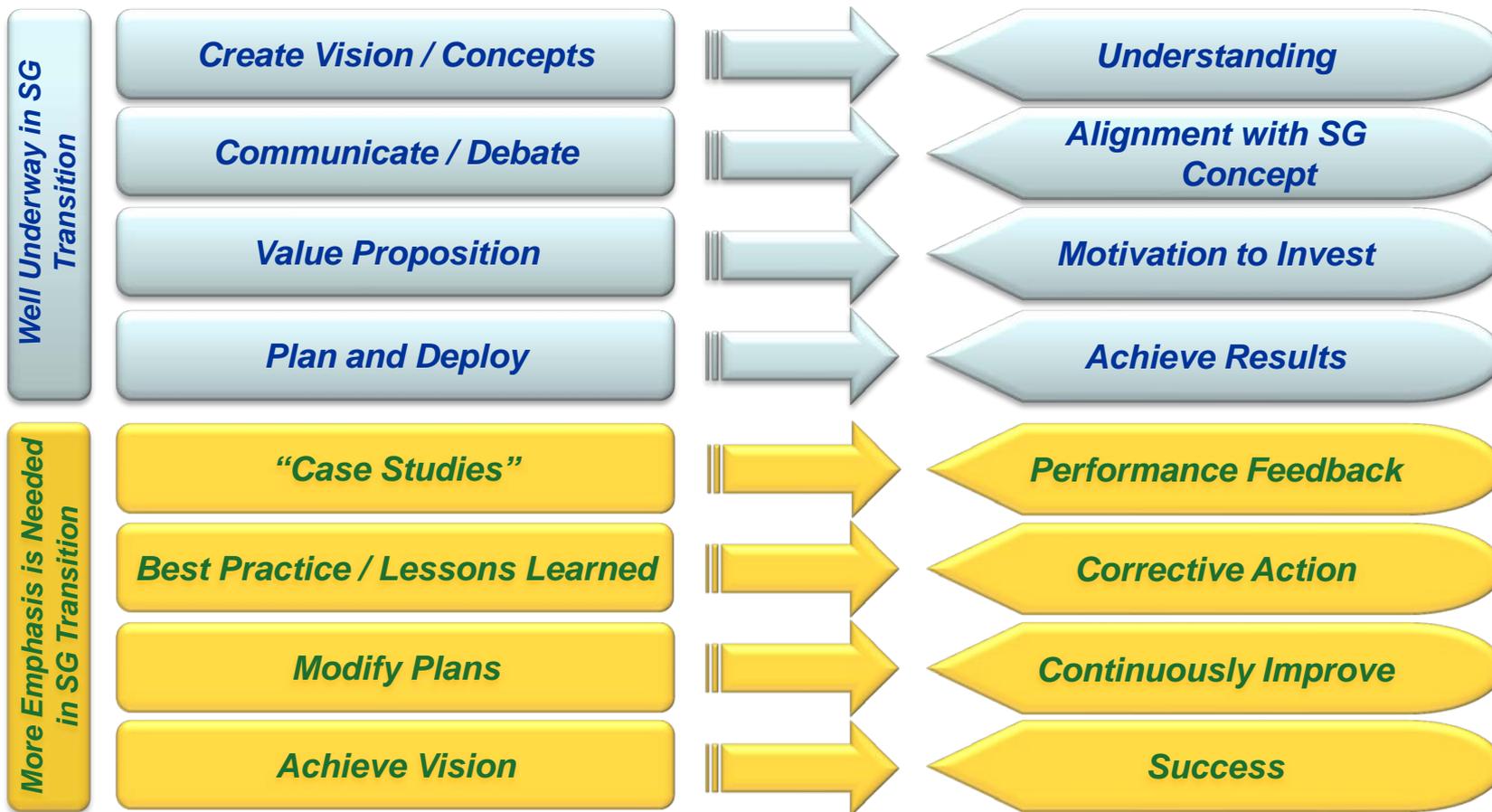
We can expect:

- Not all technologies will work as planned
- Software issues will arise
- “Myths and legends” will emerge that impede progress
- Unexpected events will occur
- Workforce training weaknesses will become apparent
- Progress may not be achieved at the expected rate
- Some benefits will not be realized as expected
- + Good ideas and practices will be identified

Experience sharing can greatly improve the change process



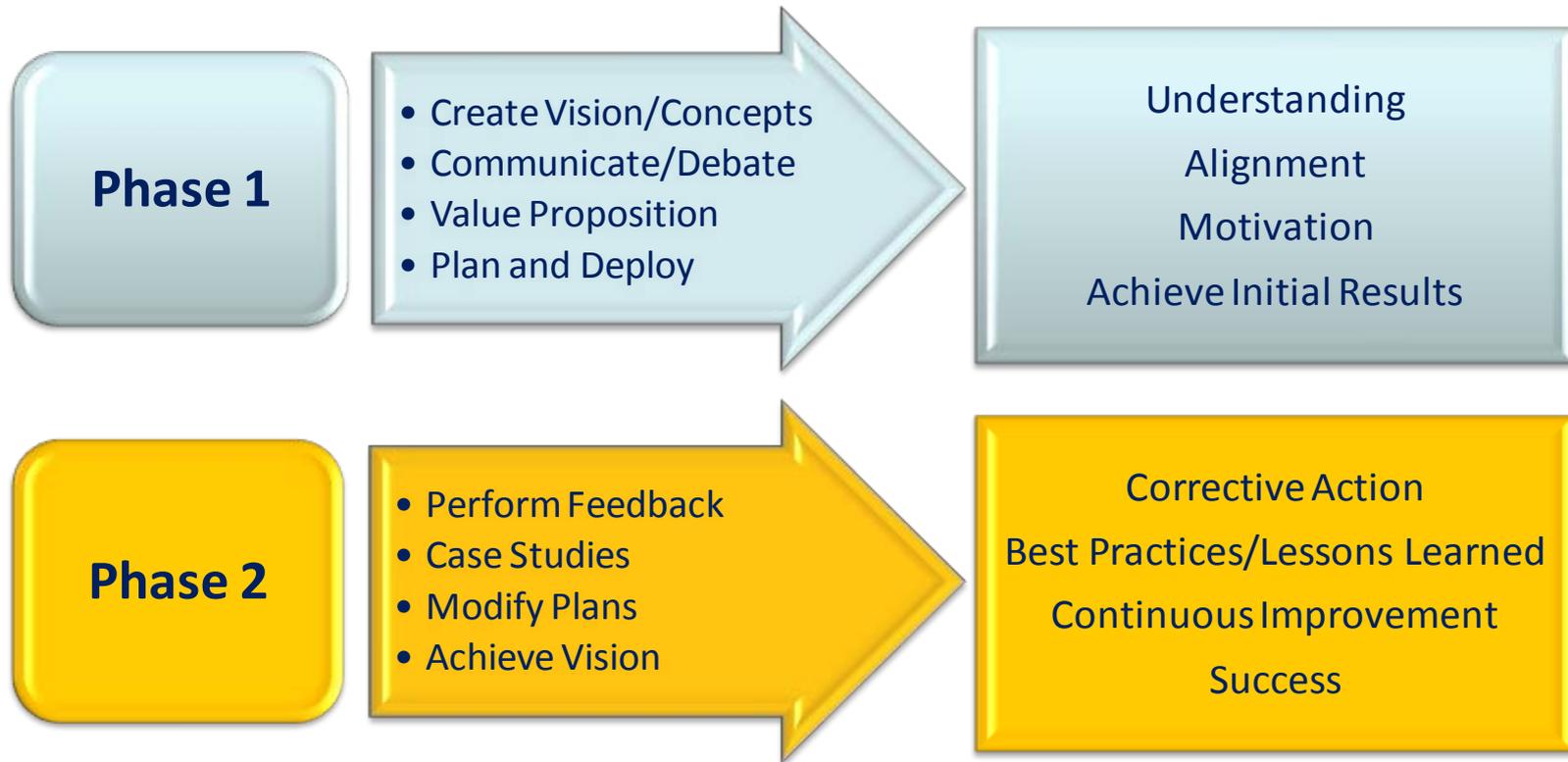
Managing the Change to the Smart Grid



Results are being achieved!



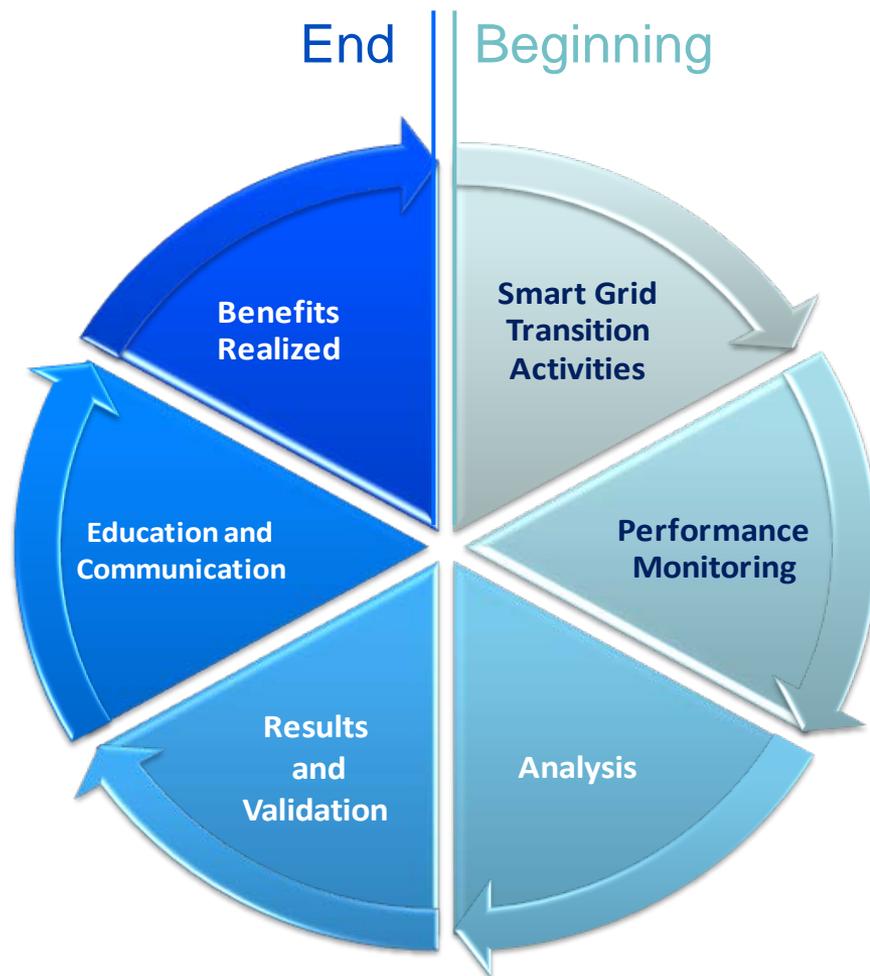
Achieving the Smart Grid Vision



Phase 1 is “getting started” — Phase 2 is “getting done”

PFP Closes the Feedback Loop

Performance Feedback Loop



Current Smart Grid Activities

American Recovery and Reinvestment Act

- **Smart Grid Investment Grants (100 projects)**
 - \$3.4 billion Federal; \$4.7 billion private sector
 - 877 PMUs covering almost 100% of transmission
 - 200,000 smart transformers
 - 700 automated substations
 - 40 million smart meters
 - 1 million in-home displays
- **Smart Grid Demonstration Projects (32 projects)**
 - \$620 million Federal; \$1 billion private sector
 - 16 storage projects
 - 16 regional demonstrations



Current Smart Grid Activities (continued)

- **Additional ARRA Smart Grid Activities**
 - Interoperability Framework by NIST (\$10M)
 - Transmission Analysis and Planning (\$80M)
 - State Electricity Regulator Assistance (\$50M)
 - State Planning for Smart Grid Resiliency (\$55M)
 - Workforce Development (\$100M)
- **DOE Renewable & Distributed Systems Integration**
- **EPRI Smart Grid Demonstrations (12 projects)**
- **Smart Grid System Report to Congress**
 - <http://www.smartgrid.gov/resources>



References

Smart Grid Implementation Strategy

www.netl.doe.gov/smartgrid/index.html

Federal Smart Grid Website

www.smartgrid.gov

Smart Grid Clearinghouse

www.sgiclearinghouse.org/

