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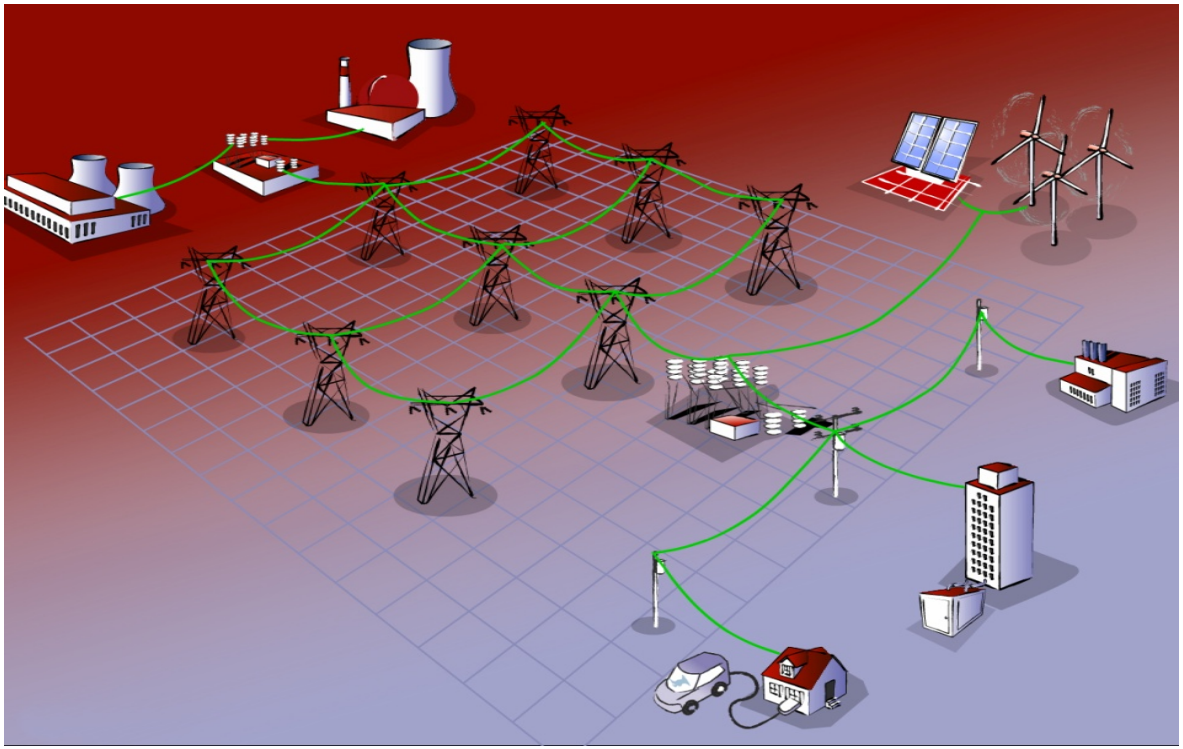

Smart Grid Overview

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Topics

- Case for Grid Modernization
- Smart Grid Vision, Technologies, & Metrics
- US Smart Grid Activities
- Some Challenges and Risks
- Global Smart Grid
- Questions

Case for Grid Modernization

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 transaction jumped 300% from 2000 to 2005. *Insight Magazine, Oct 2005*
  - Increase in variable renewables and distributed generation

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

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

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**

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

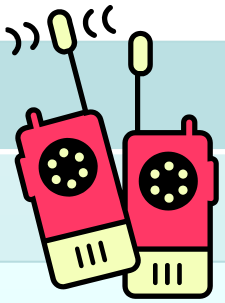
$165 B Cost

$638 - $802 B Benefits

EPRI Report: http://www.smartgridinformation.info/pdf/3272_doc_1.pdf

Smart Grid Vision

What's Different with a Modern Grid



Current Grid	Modern Grid
Little consumer engagement	Consumer involvement
Radial system	Networked and integrated system
One-way power flow	Two-way power flow
One-way communications	Two-way communications
Central generation	Mix of central and distributed generation
Passive control	Active control
Fixed rates	Dynamic rates
Separate transmission & distribution	Interaction between T&D
Little ties with other infrastructures	Potential to transform transportation sector

Context of Smart Grid & Modern Grid

Smart Grid Technologies	Enhanced Technologies
Two-way communications Sensors Controls Decision support tools Components • Transformers • Power electronics • Conductors	Renewable energy resources Electric vehicles Energy storage Distributed generation Connected appliances/devices Load control/demand response
Attributes	**Enhanced Functionality**
Sensing, control, automation, power transformation, protection and communications	Generation, storage, and load

----------Modern Grid----------

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 Key Success Factors

The Smart Grid is MORE:

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

Who are the Beneficiaries?

Utilities (What's in it for my shareholders?)

- Outage restoration
- Billing
- Operations and maintenance
- Asset utilization

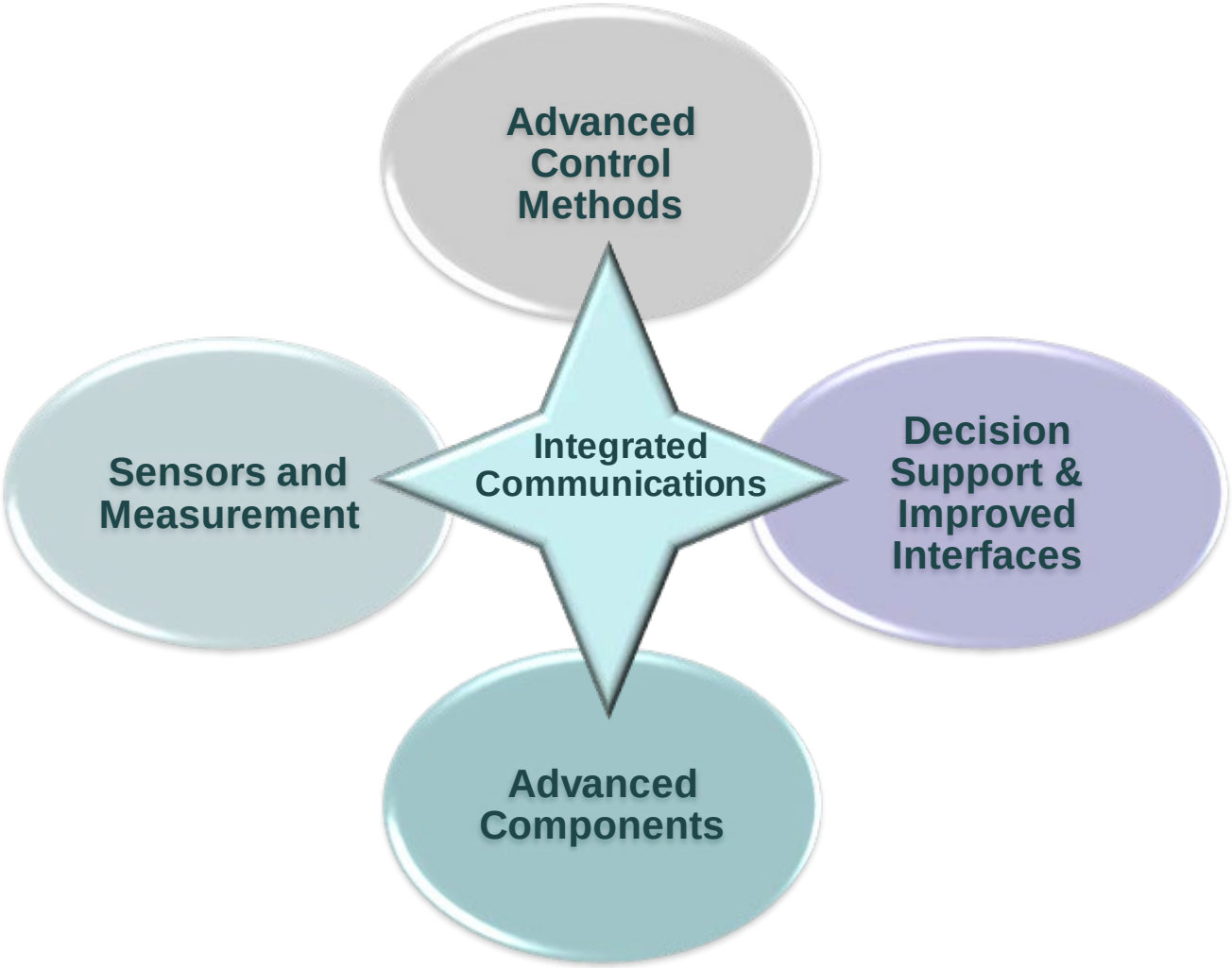
Consumers (What's in it for me?)

- Improved reliability
- Manage electric power usage
- Energy bill savings (power & transportation)

Society (What's in it for us?)

- Reduce emissions
- Energy independence

Smart Grid Technologies



Smart Grid Activities

Smart Grid ARRA Activities

American Recovery and Reinvestment Act ($4.3B)

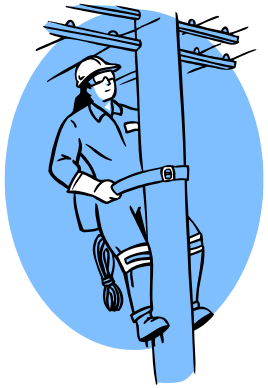
- **Smart Grid Investment Grants (99 projects)**
  - $3.4 billion Federal; $4.7 billion private sector
  - >800 PMUs covering almost 100% of transmission
  - 6500 distribution automation circuits
  - >15 million smart meters

- **Smart Grid Demonstration Projects (32 projects)**
  - $620 million Federal; $1 billion private sector
  - 16 storage projects
  - 16 regional demonstrations

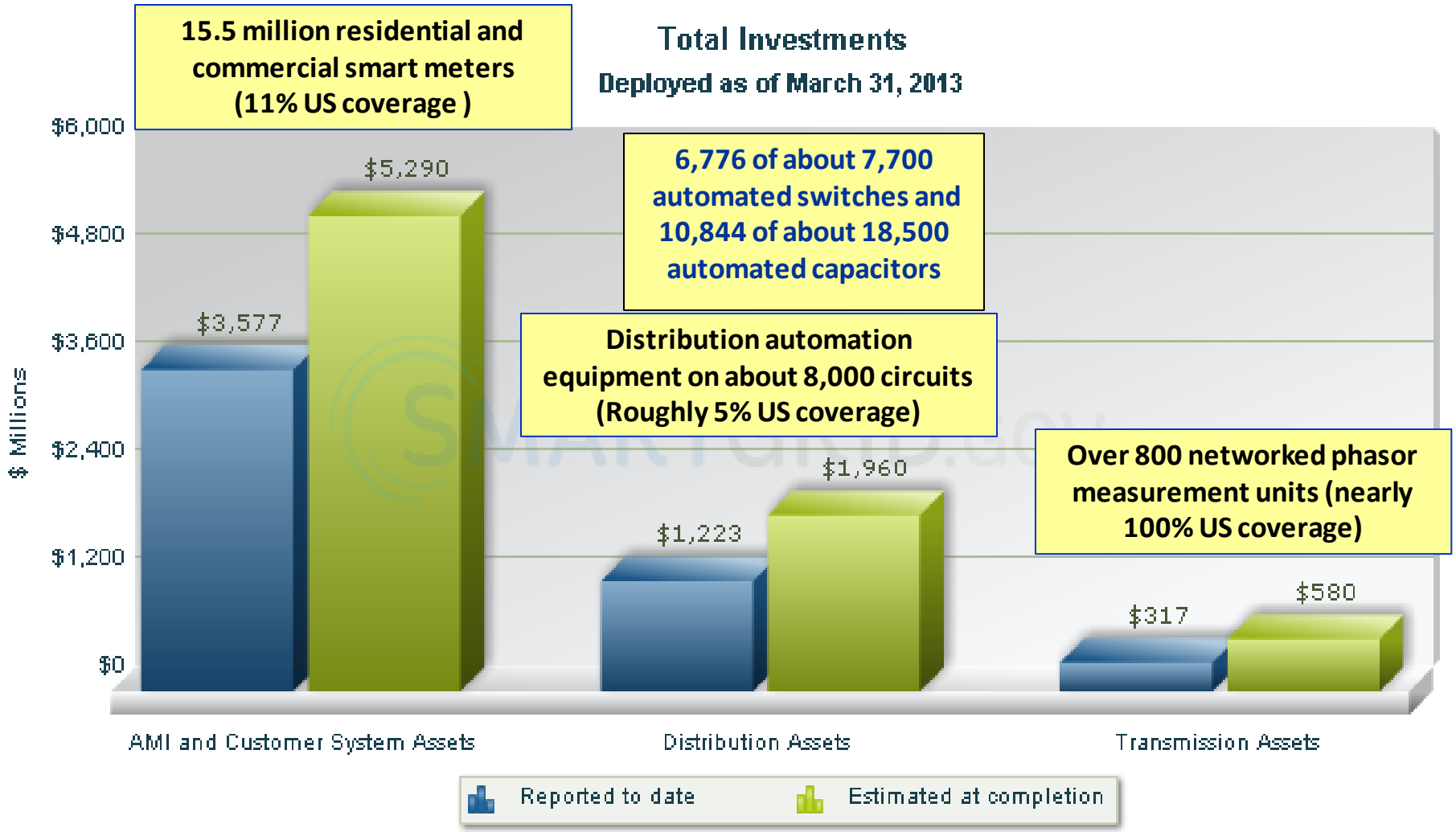
Smart Grid ARRA Activities (continued)

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)



SGIG Deployment Status

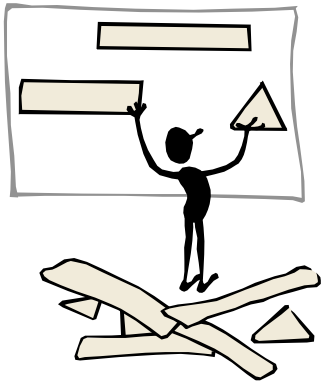


Some Challenges and Risks

Challenges for Smart Grid Deployment

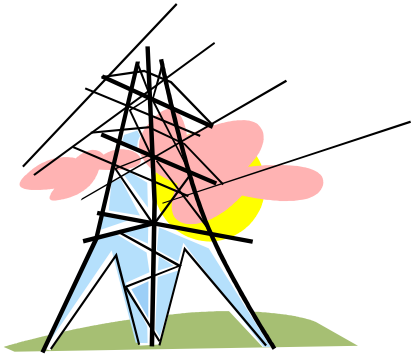
Change Management

- Common vision
- Consumer education and motivation
- Metrics needed for accountability



Technical

- Interoperability and cyber security
- Communications
- Data management
- Central and distributed control
- Two-way protection



Regulatory

- Time-based rates
- Cost recovery
- Consumer privacy concerns
- Societal benefits in business case

Global Smart Grid

Top Ten Countries Account for 80% of Global Smart Grid Investment by 2030*

- China
- United States
- India
- Brazil
- France
- Germany
- Spain
- United Kingdom
- Japan
- South Korea

Others

- Italy
- Norway
- Sweden
- Australia
- Russia

* Innovation Observatory

International Smart Grid Action Network

IEA Implementing Agreement established in April, 2011

- Policy, standards, and regulation
- Finance and business models
- Technology and systems
- User and consumer engagement
- Workforce skills and knowledge

22 countries signed agreement; 5 more prepared to sign

Current initiatives

- Inventory of global smart grid activities
- Case studies
- Benefit-cost analyses and toolkits
- Synthesis of insights for decision makers
- Smart Grid international research facility network
- Power T&D systems

Contact Information

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Federal Smart Grid Website

www.smartgrid.gov

Smart Grid Clearinghouse

www.sgiclearinghouse.org/

Smart Grid Implementation Strategy

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

Questions ?