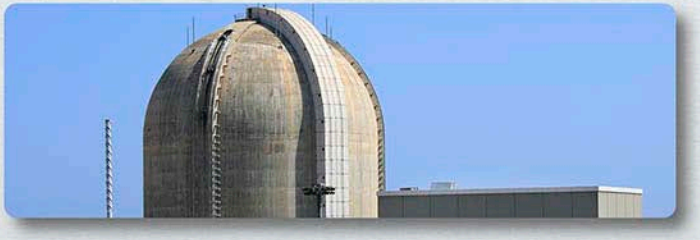


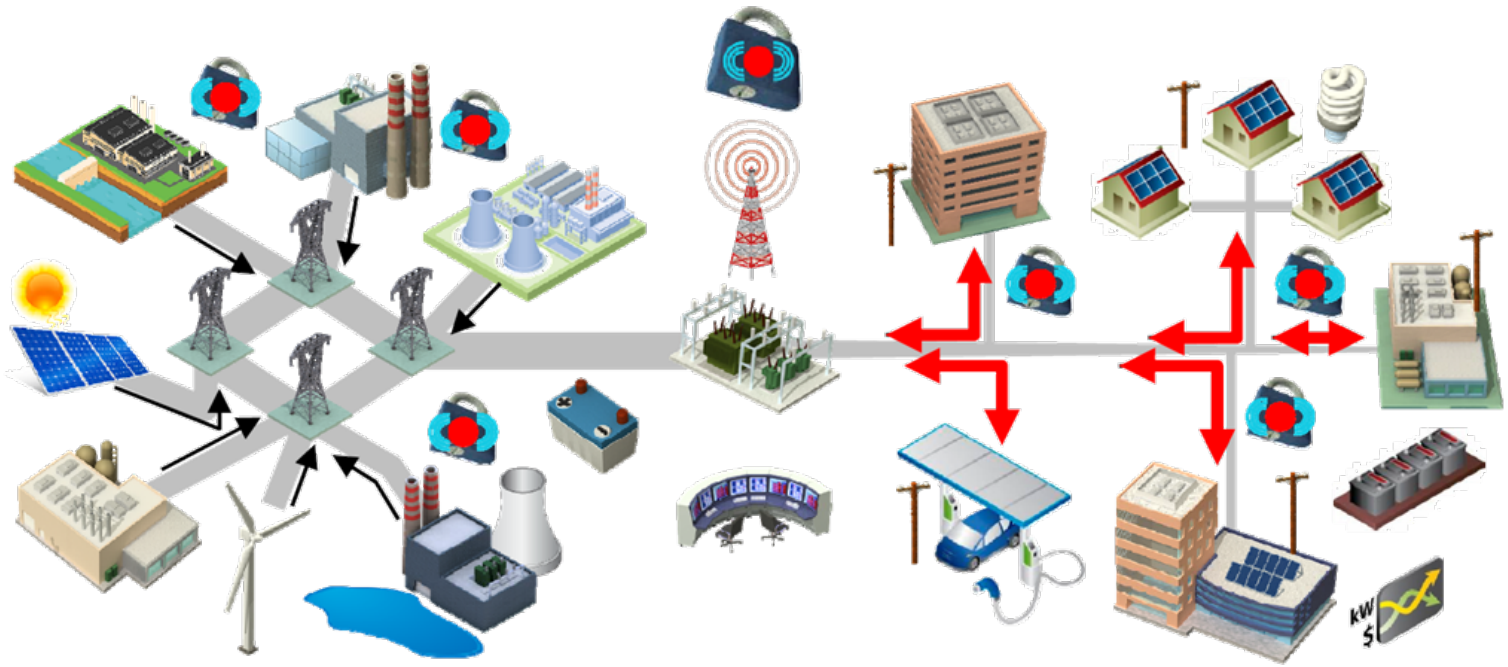
ELECTRIC POWER RESEARCH INSTITUTE

U.S. Government Support for Smart Grid

Harvard Electricity Policy Group
December 1, 2011

Jeffrey D. Roark
Sr Project Manager
Smart Grid Demonstrations
Electric Power Research Institute

The Smart Grid



"Smart Grid" refers to *"the integrated array of technologies, devices and systems that provide and utilize digital information, communications and controls to optimize the efficient, reliable, save and secure delivery of electricity."*

Methodology for Estimating the Benefits and Costs for Smart Grid Demonstration Projects – EPRI, Jan 2010

ELECTRIC POWER RESEARCH INSTITUTE

Legislative Support for Smart Grid (SG)

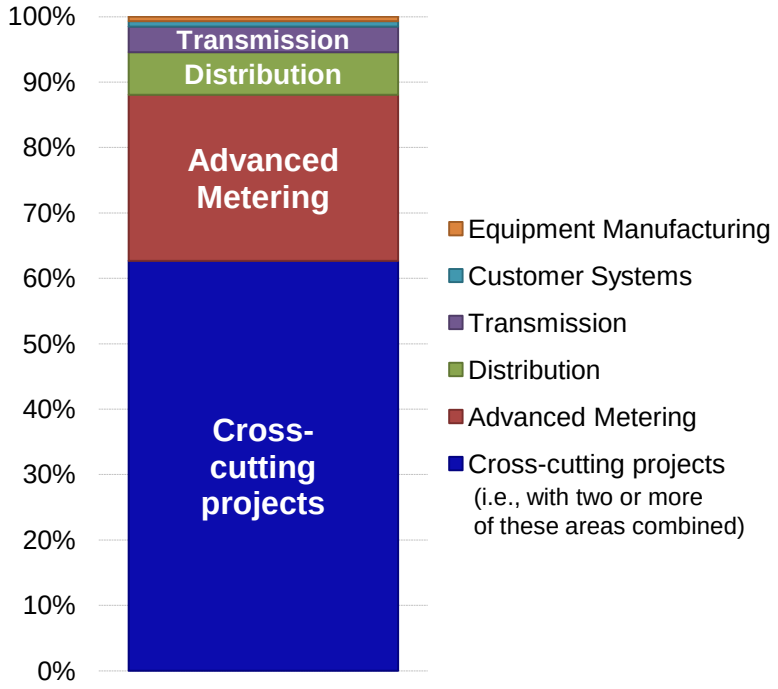
- Energy Independence and Security Act of 2007 (EISA)
  - Created an R&D and demonstration program for Smart Grid technologies at DOE
  - Provided federal matching funds for portions of SG Investments
- American Recovery and Reinvestment Act of 2009
  - Provided ~$4 billion for Smart Grid investments:
    - Smart Grid Investment Grant Program (SGIG)
      Focused on existing technologies, tools, and techniques
    - Smart Grid Demonstration Program (SGDP)
      Focused on demonstrating advanced concepts and innovative applications in smart grid and energy storage

Goals of Federal Smart Grid Support
(from smartgrid.gov)

- To provide fact-based information from actual projects, assessing impacts, costs, and benefits of the full spectrum of SG applications:
  - transmission
  - distribution
  - metering
  - customer systems
- To assist public and private decision makers to identify the most cost-effective SG technologies, tools, and techniques.

Smart Grid Reporting Requirements

- Competitive solicitation to select/award projects
- Cost Sharing requirement leveraged the projects to a total investment of $8B.
- Selected projects file Metrics & Benefits Reporting Plans
- SGIG Projects (99)
  - "Build" metrics filed quarterly
  - "Impact" metrics filed semi-annually
- SGDP Projects (32)
  - "Build" metrics filed quarterly
  - "Impact" metrics to be contained in Technical Performance Report



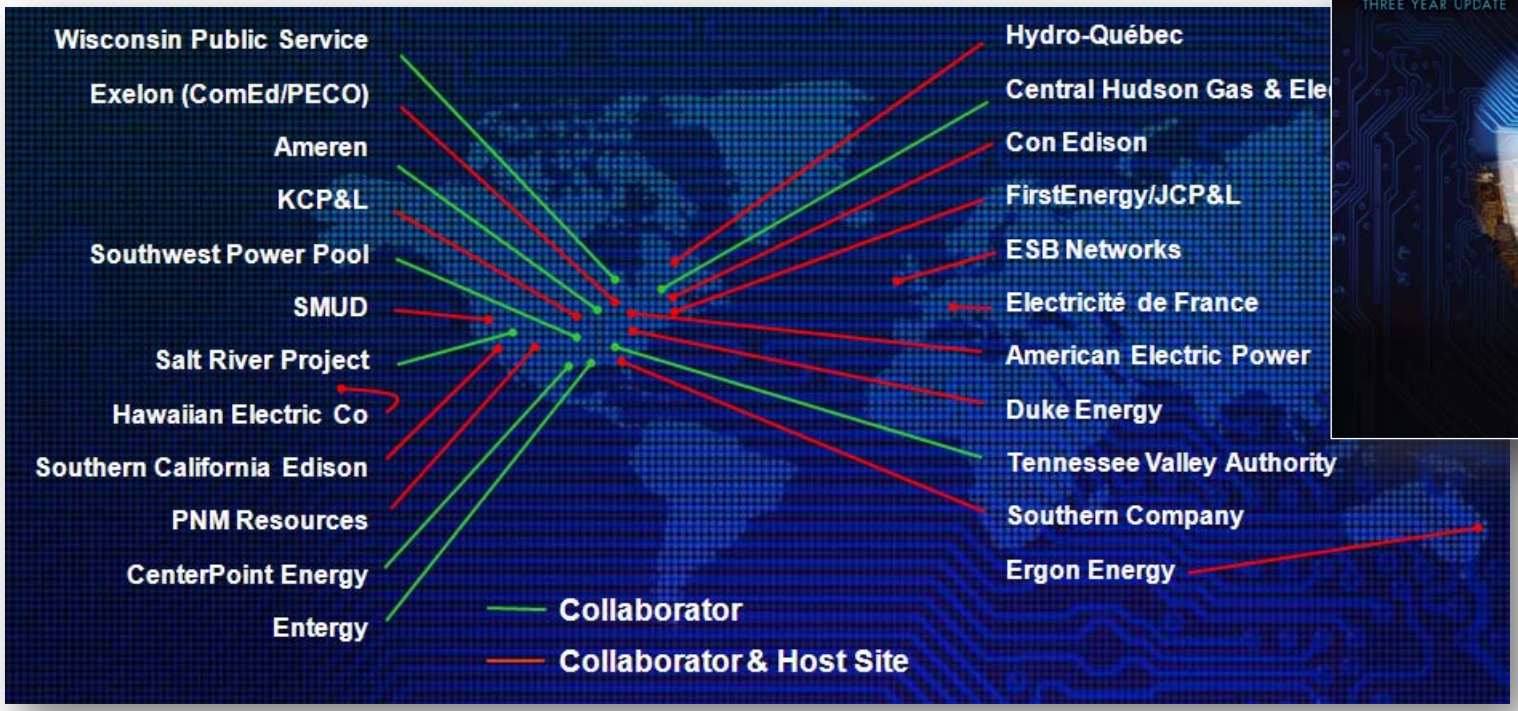
Approximate Distribution of SG Support by Type, based on *total* investment of nearly $8B.

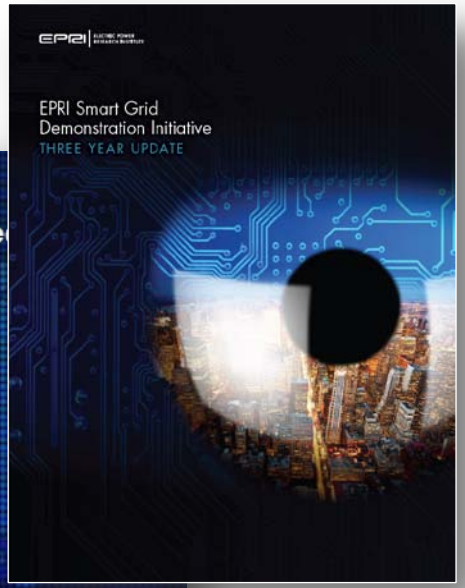
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Some of the Technologies Being Deployed

- Automated Metering
- Distribution Automation
  - Coordinated, controlled reclosers for fault isolation and automated service restoration
- Volt/Var Control
  - Enhances power-factor correction and regulator control
  - Allows lower average feeder voltage
- Intelligent Universal Transformers
- Integration of Electric Vehicles
- Direct Load Control
- In-Home Displays, Time-Differentiated Rate Designs
- Distributed Generation

EPRI Smart Grid Demonstration Initiative

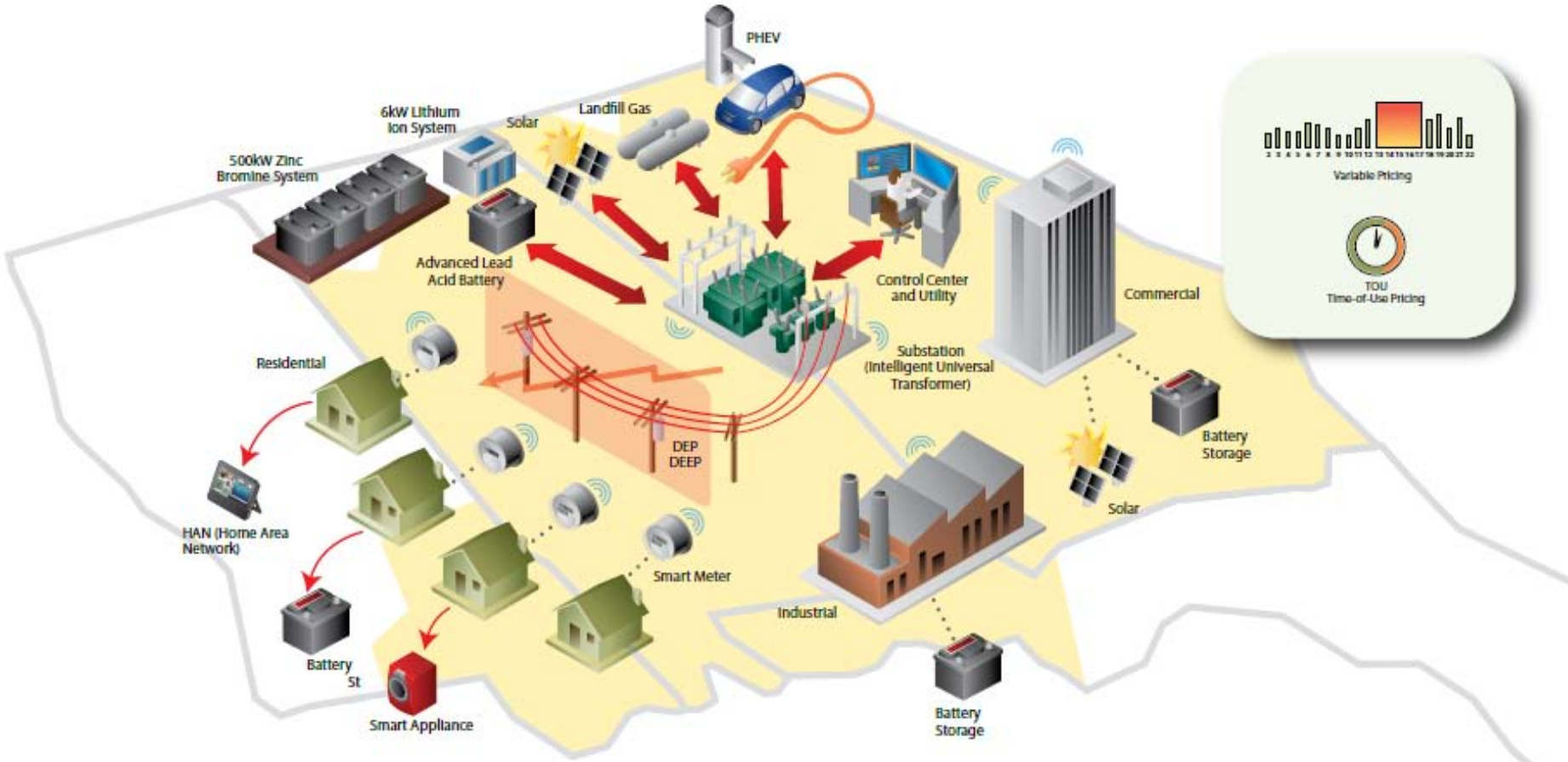




"Three-Year Update"
Publicly Available:
Product ID 1023411

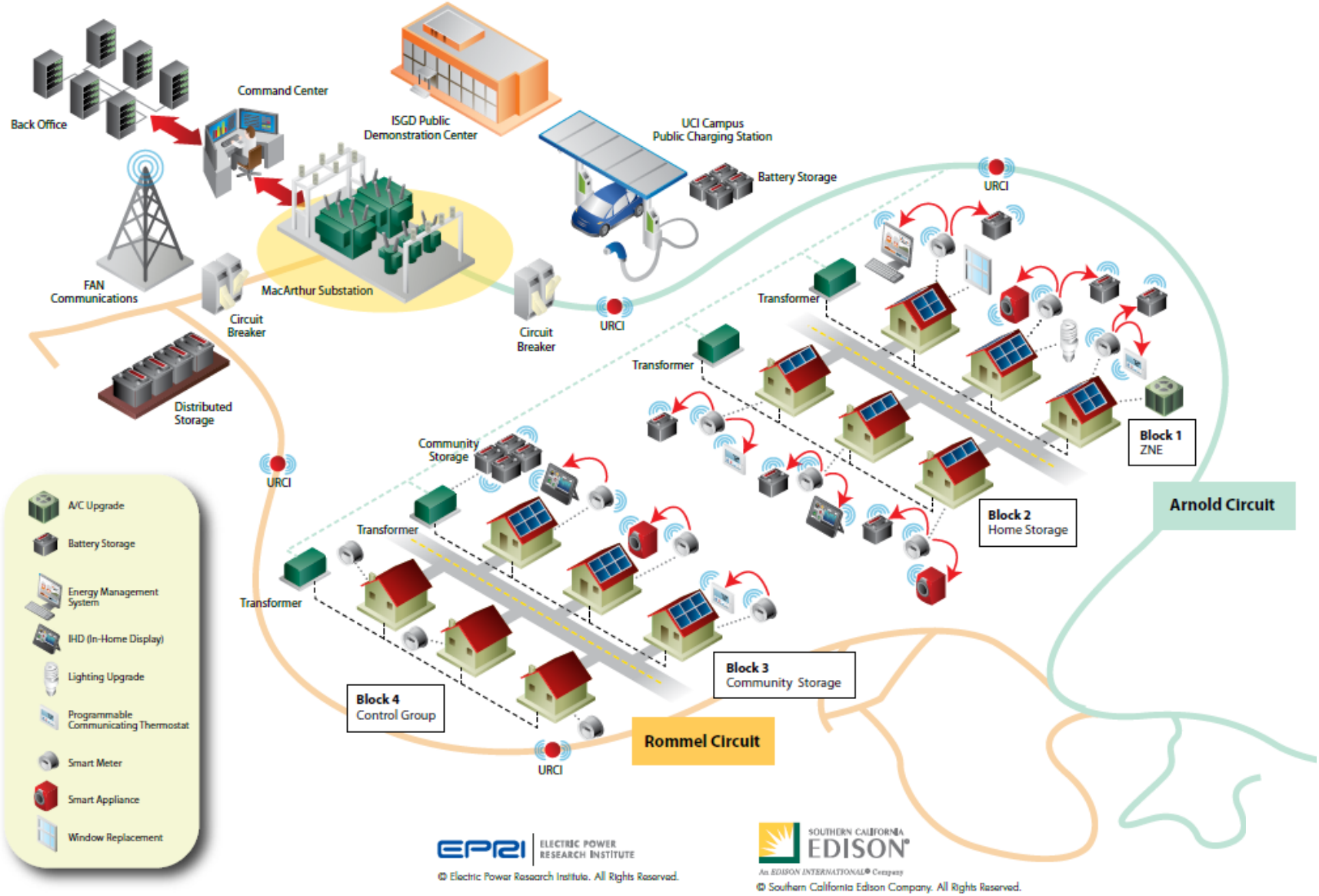
ELECTRIC POWER RESEARCH INSTITUTE

Example Demo Project: Southern Company



ELECTRIC POWER RESEARCH INSTITUTE

Example Demo Project: Southern California Edison

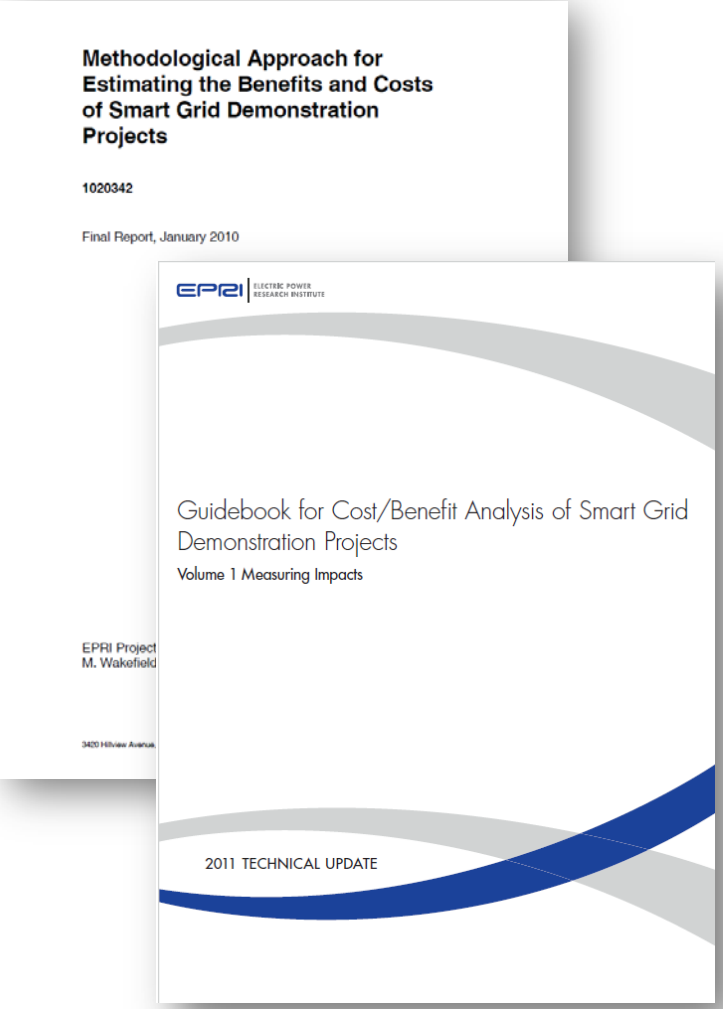


What will be accomplished?

- The projects will provide data, but will also establish experience utilities need to “prove” technology values.
- DOE, with collaborative support from EPRI, is working to extract value for the public from its Smart Grid projects.
  - to provide performance data across a wide variety of smart grid devices and systems
  - to promote comparability and transferability of results
  - to provide methodologies for cost/benefit analysis
  - to provide a cost/benefit analysis computational tool for SG projects

EPRI/DOE Cost-Benefit Analysis Methodology

- **"Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects"** Jan 2010
  - Jointly funded by DOE and EPRI
  - Provides framework for estimating benefits & costs
  - Provides definitions, concepts and data sources
  - Publicly available: Product ID 1020342
- **"Guidebook for Cost/Benefit Analysis, Volume 1: Measuring Impacts"** May, 2011
  - Provides a manual for practical application with step by step instruction
  - Provides guidance for documenting the project in detail and approach to perform a CBA,
  - Includes templates for working through the process.
  - Publicly available: Product ID 1021423



EPRI ELECTRIC POWER RESEARCH INSTITUTE

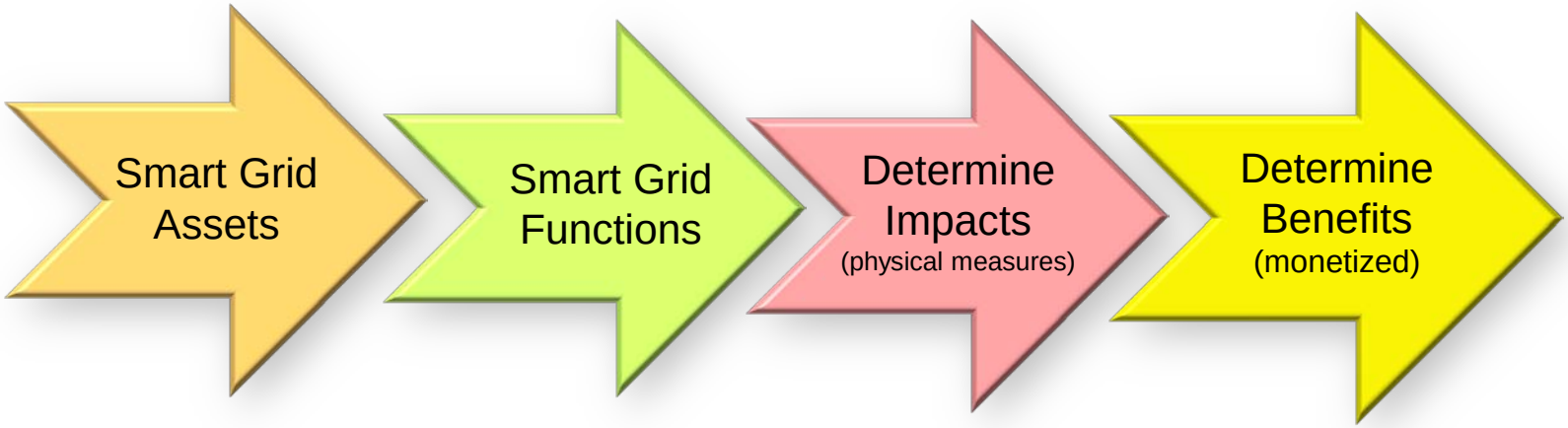
Goal of the CBA Process: Maximizing Learning

- **Maximize *learning* from Smart Grid projects by**
  - Advancing understanding of where, how, and why Smart Grid technologies perform as they do
  - Promoting transferability of results
- **For *learning* to be maximized:**
  - Methodologies must be credible
  - Results must be verifiable by others

We address these goals by applying the Scientific Method:

Formulating, testing, and modifying hypotheses through experimentation, observation, and measurement.

Overview of Smart Grid Evaluation Process



- List Technologies, Devices, & Systems

Examples:

- AMI/Smart meters
- Distribution Automation
- 2-way communication
- Smart Appliances
- Intelligent Electronic Devices (IEDs)

- Describe Systems' Intended Functions

Examples:

- Volt/VAR control
- Dynamic Capability Rating
- Flow control
- Intelligent line switching
- Real-time load management

- Compare project performance to baseline case

Example measures:

- kWh reduction
- Peak kW reduction
- Loss reductions
- Outage reductions
- Improved asset utilization

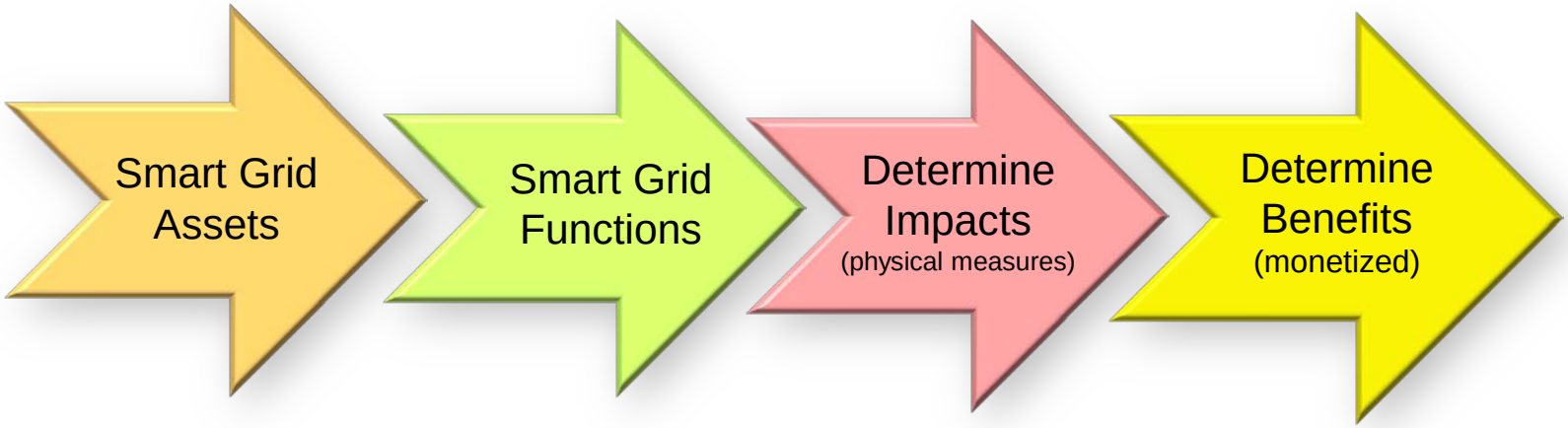
- Monetize physical measures

Example metrics:

- Fuel savings
- Capacity savings
- Reduced outage costs
- Customer bill reductions
- Reductions in CO_2, Hg, etc.

ELECTRIC POWER RESEARCH INSTITUTE

Overview of Smart Grid Evaluation Process



Functions

SG Assets

	Transmission		Distribution						Substation			Customer	
	Flow Control	Wide Area Monitoring and Visualization	Adaptive Protection	Automated Feeder Switching	Automated Switching and Reconfiguration	Automated Voltage and Var Control	Enhanced Fault Protection	Fault Current Limiting	Improved Loading Signals & Notification	Dynamic Capacity Rating	Fault Current Limiting	Customer Electricity Use Optimization	Residential Demand Response
Advanced Interrupting Switch							●						
AMI/Smart Meters						●						●	●
Controllable/regulating Inverter					●	●							
Customer EMS/Display Portal												●	
Distribution Automation			●	●	●	●		●					
Distribution Management System			●	●	●	●		●		●			●
Enhanced Fault Detection Technology							●						
Equipment Health Sensor									●	●			
FACTS Device	●												
Fault Current Limiter											●		
Loading Monitor								●	●	●			
Microgrid Controller					●								
Phase Angle Regulating Transformer	●												
Phasor Measurement Technology		●											
Smart Appliances and Equipment (Customer)												●	
Software – Advanced Analysis/Visualization		●								●			
Two-way Communications (high bandwidth)		●	●	●	●	●		●					●
Vehicle to Grid 2-way power converter													
VLI (HTS) cables	●												

Functions

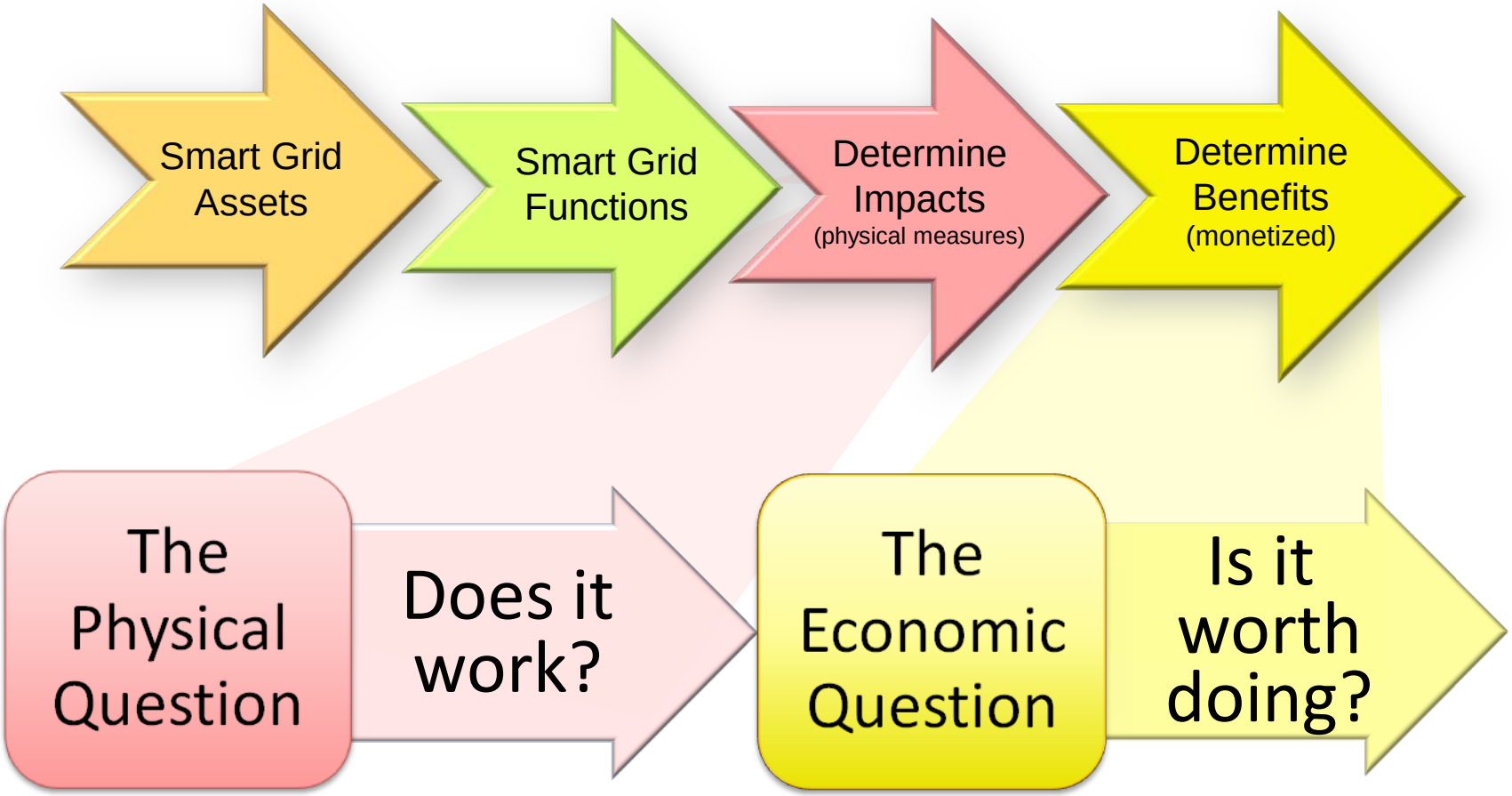
Benefits

			Transmission		Distribution							Substation			Customer		Energy Resources	
			Flow Control	Wide Area Monitoring and Visualization	Adaptive Protection	Automated Feeder Switching	Automated Switching and Reconfiguration	Automated Voltage and Var Control	Enhanced Fault Protection	Fault Current Limiting	Improved Loading Signals & Notification	Dynamic Capacity Rating	Fault Current Limiting	Customer Electricity Use Optimization	Customer Electricity Use Measurement	Distributed Generation	Stationary Electricity Storage	Plug-In Vehicles
Economic	Improved Asset Utilization	Optimized Generator Operation		●													●	●
		Deferred Generation Capacity Investments													●		●	●	●
		Reduced Ancillary Service Cost		●					●							●	●	●	●
		Reduced Congestion Cost	●	●								●					●	●	●
	T&D Capital Savings	Deferred Transmission Capacity Investments	●	●								●	●	●			●	●	●
		Deferred Distribution Capacity Investments									●		●		●	●	●	●	●
		Reduced Equipment Failures							●			●	●	●					
	T&D O&M Savings	Reduced Distribution Equipment Maintenance Cost										●							
		Reduced Distribution Operations Cost				●		●											
		Reduced Meter Reading Cost													●				
	Theft Reduction	Reduced Electricity Theft													●				
	Energy Efficiency	Reduced Electricity Losses						●			●				●	●		●	
	Electricity Cost Savings	Reduced Electricity Cost													●			●	
Reliability	Power Interruptions	Reduced Sustained Outages			●	●	●		●			●				●	●	●	●
		Reduced Major Outages		●			●									●			
		Reduced Restoration Cost			●	●			●			●							
	Power Quality	Reduced Momentary Outages						●		●								●	
		Reduced Sags and Swells							●									●	
Environmental	Air Emissions	Reduced CO_2 Emissions	●			●		●							●	●	●	●	●
		Reduced SOx, NOx and PM-10 Emissions	●			●		●							●	●	●	●	●
Security	Energy Security	Reduced Oil Usage (not monetized)				●						●				●			●
		Reduced Wide scale Blackouts		●					●				●						●

Tables 4-4 and 4-8 in "Methodological Approach"
and Tables 5-1 and 5-2 in "CBA Guidebook"

ELECTRIC POWER RESEARCH INSTITUTE

Cost/Benefit Analysis Guidebook for SG Demos
Overview of Smart Grid Evaluation Process



<u>Demonstrate</u> *physical impacts* of technologies in *specific applications*.

<u>Estimate</u> *economic viability* of the *demonstrated applications*.

ELECTRIC POWER RESEARCH INSTITUTE

Government Support for Smart Grid Demos

Matching government funds have been made available for a wide spectrum of Smart Grid projects.

- The funds were limited in amount, by legislation.
- The recipients decide what they want to demonstrate, subject to approval and selection.
- Experimentation is encouraged.
- Demonstrations will provide information to the public.
  - SMARTGRID.gov
  - Smart Grid Information Clearinghouse (sgiclearinghouse.org)
- DOE and EPRI are working to make the information widely applicable and scientifically based.

Clarifying Questions?

Jeffrey D. Roark
Sr. Project Manager – Smart Grid Economics
Electric Power Research Institute
3379 Lakewind Way
Alpharetta, GA 30005
678-325-8971
jroark@epri.com

ELECTRIC POWER RESEARCH INSTITUTE