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Cost and Benefit Analysis Framework: Update
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Smart Grid Demonstrations
Cost and Benefit Analysis Methodology

- **Objectives:**
  - Develop and apply common cost and benefits methodology across all Smart Grid demonstrations
  - Publish methodology including underlying rules and assumptions
  - Enable fair and consistent comparison of different approaches to Smart Grid implementation
  - Ensure that methodology can easily accommodate changes and expansion

Types of Benefits
(Benefits are outcomes that have value)
Defined consistently for all projects

- **Broad categories of benefits**
  - Economic
  - Reliability and power quality
  - Environmental
  - Energy independency
  - Safety and security noted but not quantified
- **Benefits above are viewed differently by different stakeholders**
  - Utilities (reduced costs to utilities)
  - Consumers (reduced electricity bills and damages to consumers from outages and power-quality events
  - Society at large (i.e., externalities such as emissions)

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Methodological Approach Has Ten Steps to Calculate Project Benefits and Costs

Characterize the Project

1. Identify the assets/elements that are deployed, i.e., the Smart Grid systems
2. Assess the Smart Grid principal characteristics, each having one or more metrics, that are reflected in the project
3. Identify, from a standardized set, the smart grid functions which each project element/asset could provide and what will be demonstrated

Estimate Benefits

4. Map each function onto a standardized set of benefit categories
5. Baseline – Define the project baseline and how it is to be estimated
6. Data – Identify and obtain, from the project, the baseline and project data needed to calculate each type of benefit
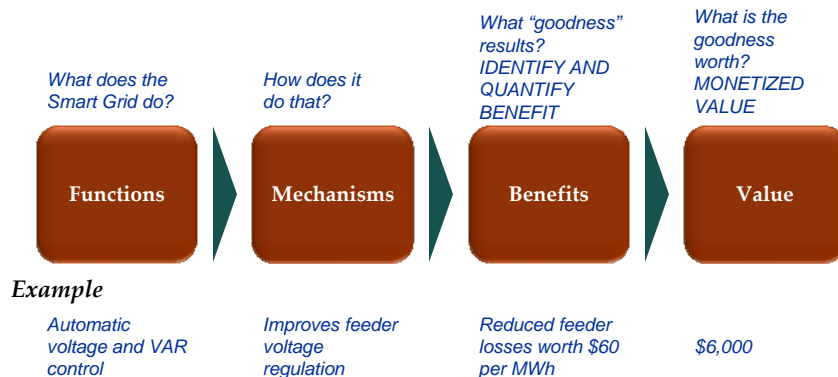7. Quantify the benefits
8. Monetize the benefits

Compare Costs to Benefits

9. Estimate the relevant, annualized costs
10. Compare costs to benefits

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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**

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Key "Mappings" Used in the Analysis

What does the Smart Grid do?	How does it do that?	What "goodness" results? IDENTIFY AND QUANTIFY BENEFIT	What is the goodness worth? MONETIZED VALUE
Functions	**Mechanisms**	**Benefits**	**Value**

Example

| Automatic voltage and VAR control | Improves feeder voltage regulation | Reduced feeder losses worth $60 per MWh | $6,000 |

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Smart Grid Functions and Enabled Energy Resources

Smart Grid Functions
• *Fault current limiting*
• *Wide area monitoring, visualization, and control*
• *Dynamic capability rating*
• *Impedance control*
• *Adaptive protection*
• *Automated feeder switching*
• *Automated islanding and reconnection*
• *Automated voltage and VAR control*
• *Diagnostics and notification of equipment condition*
• *Enhanced fault protection*
• *Real-time load measurement and management*
• *Real-time load measurement & management*
• *Real-time load transfer*
• *Customer electricity use optimization*

Enabled Energy Resources
• *Demand response*
• *Distributed generation*
• *Stationary electricity storage*
• *Plug-in electric vehicles*

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Smart Grid Benefits are the Result of Smart Grid Functionality and Enabled Energy Resources

Smart Grid Functions And Enabled Energy Resources →

Key Benefits to Quantify
• *Reduced generation operation costs*
• *Deferred generation capital investments*
• *Reduced ancillary service cost*
• *Deferred transmission capital investments*
• *Deferred distribution capital investments*
• *Reduced equipment failures*
• *Reduced distribution maintenance costs*
• *Reduced distribution operations costs*
• *Reduced electricity theft*
• *Reduced electricity losses*
• *Reduced electricity cost to consumers*
• *Reduced sustained outages*
• *Reduced major outages*
• *Reduced restoration costs*
• *Reduced momentary outages*
• *Reduced sags and swells*
• *Reduced CO_2, SO_2, NOx and PM-2.5 emissions*
• *Reduced oil usage*

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Examples of Information which a Project is to Report – Will Depend on Nature of the Project

Example of Information to be Reported for the Baseline and for the With-Project Period		
Reliability	*Distribution O&M*	*Load and Generation*
• *SAIFI* • *SAIDI* • *MAIFI* • *% of SAIFI caused by feeder faults* • *% of SAIFI caused by equipment failure*	• *OH line expense* • *UG line expense* • *S/S maintenance expense* • *Inspection expense* • *OH maintenance expense* • *UG maintenance expense* • *Time required per switching event* • *Time required per restoration job* • *Vehicle miles driven*	• *Hourly S/S loads (P/Q)* • *Hourly feeder loads (P/Q)* • *Hourly DG output (P/Q)* • *Hourly customer loads* • *Hourly feeder and customer voltage* • *Log of ISO and utility demand response requests (frequency and size)* • *Log of microgrid demand response actions* • *Log of microgrid frequency during islanded condition*

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Delineating Information Obtained from Projects

Project provides information and data:
- **Information about project elements (devices, systems, etc.)**
- **"Build metrics" (principal characteristics metrics)**
- **Data to establish baseline conditions, which serve as a basis for estimating changes due to the project, and on project performance (e.g., SAIFI, SAIDI)**
- **Data on quantified benefits (refer to list of benefits) and costs**

Defines metrics and calculates benefits using project data:
- **Uniform set of definitions for different types of benefits**
- **Guidance on identifying the benefits for the particular project**
- **Guidance on how each type of benefit may be quantified**
- **Default parameter values and equations to monetize benefits**
- **Calculation and comparison of the monetized benefits and costs**

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Issues and Current Thinking in Revised Report

Availability of data from the projects:	Negotiated between DOE and the project
Adequacy of duration and size of demonstration to determine benefits:	Duration period – at least 3 years ideal
Estimation of national benefits versus limited demonstration benefits:	Remains as a challenge.
Defining benefits in a uniform way so that estimates are both comprehensive and mutually exclusive:	Definitions consistent, taking care not to double count. Providing flexibility to projects to quantify certain benefits means that estimates relevant to their specific situation (e.g., accounting practices}; but is source of across-project variability
Determination of baseline:	Rely on statistical controls (e.g., for smart meter control group) or on performance data over a sufficiently long period of time prior to deployment
Monetization of benefits:	Default values being developed for value of lost load, emissions damages, oil security
What costs to include:	Track costs in different categories to match definitions of benefits;

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Status

- **Draft report that details the methodological framework has been reviewed by NETL and EPRI – report being revised focusing on key issues raised**

- **Version 1.0 of a computational tool, based largely on that framework, to be completed soon**

- **Methodology likely to be used for the nine DOE RDSI projects and possibly for the EPRI demonstration projects, as well as for other applications**

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