SHOULD EM&V BE REQUIRED FOR GRID MODERNIZATION INVESTMENTS?

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TOPICS

- What is *Grid Modernization*?
  – How big is it? and
  – Do we need to measure it?
- Methodologies for EM&V
  – Traditional DSM Programs
  – Do we know how to measure Grid Mod?
- Grid Mod Evaluation case Studies
  – Some historical perspective
- Where from Here?

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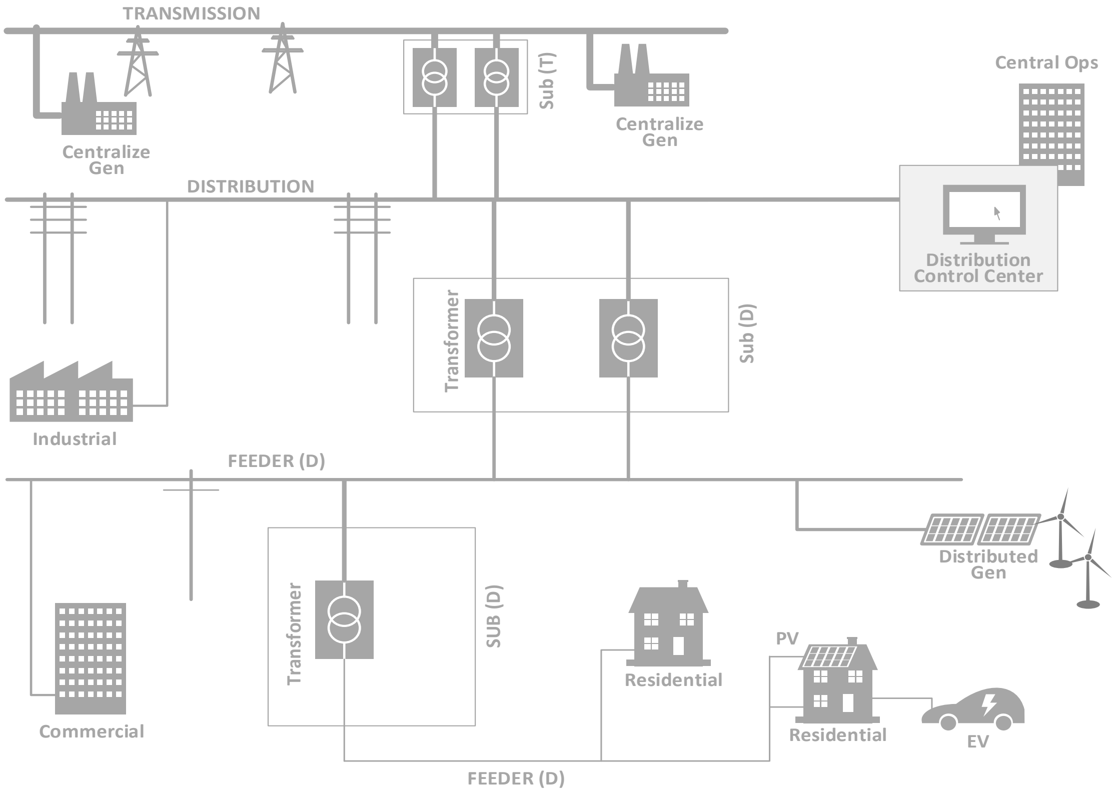
WHAT IS *GRID MODERNIZATION*?



Source: Navigant

Traditional Grid Infrastructure

- Central Generation
- Poles & Wires (high & low voltage)
- Substation infrastructure
- Meters

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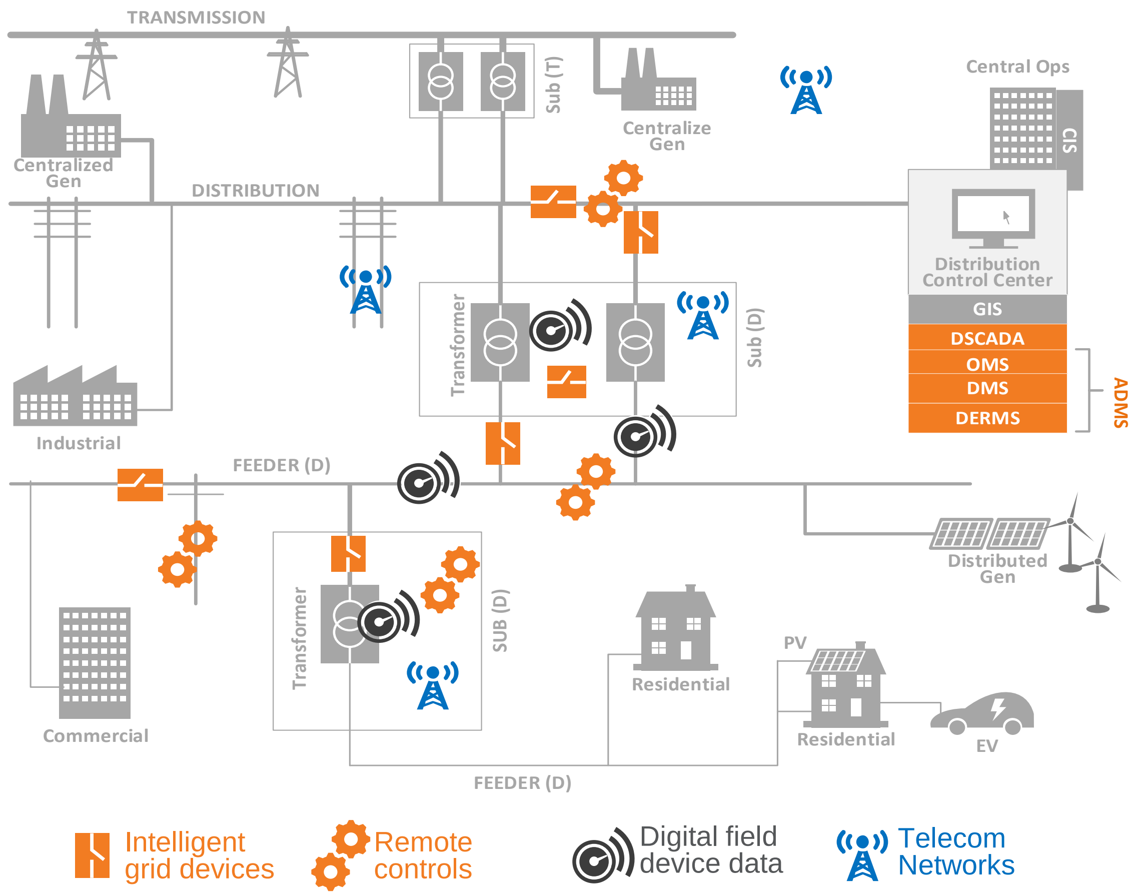
WHAT IS *GRID MODERNIZATION*? (CONT.)



Source: Navigant

Traditional Grid Infrastructure

- Central Generation
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Grid Modernization = "Smart Grid"

- Two way communications
- Intelligent devices and controls
- Software control and support
- Centralized remote control
- Distributed control and decision making
- Automated switching
- Automated Volt-VAR management

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WHAT IS *GRID MODERNIZATION*? (CONT.2)

Example Types of Grid Modernization Investments.

Grid Modernization Capabilities	Area
AMI, Automated Meter Reading & Billing	T&D Energy and Asset Optimization
Automated Volt/VAR Control (CVR & DVR)	
Dynamic Capacity Rating (e.g., for Transmission lines)	
Automated Power Flow Control for Transmission	
Automated Real Time Load Transfer for Distribution	
Real Time Monitoring for T&D	
Fault Current Limiting for T&D	
Distributed Energy Resource Monitoring & Control	
Wide Area Monitoring (e.g., for grid instability)	Grid Reliability
Automated Islanding & Reconnection (Microgrid)	
Enhanced Fault Prevention for T&D	
Fault Location, Isolation & Service Restoration (FLISR)	
T or D Sited Grid Storage Integration & Control	Grid Storage
Customer Sited Storage Integration & Control	
Electric Vehicle Battery Integration & Control	

Source: Bonneville Power Administration/Navigant 2015—updated from original content

How big is
Grid Modernization?

- Electric Power Research Institute (EPRI) has estimated that $338B to $476B will be required for a "fully functioning smart grid" over a 20 year period.

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DO WE KNOW HOW TO MEASURE GRID MODERNIZATION?

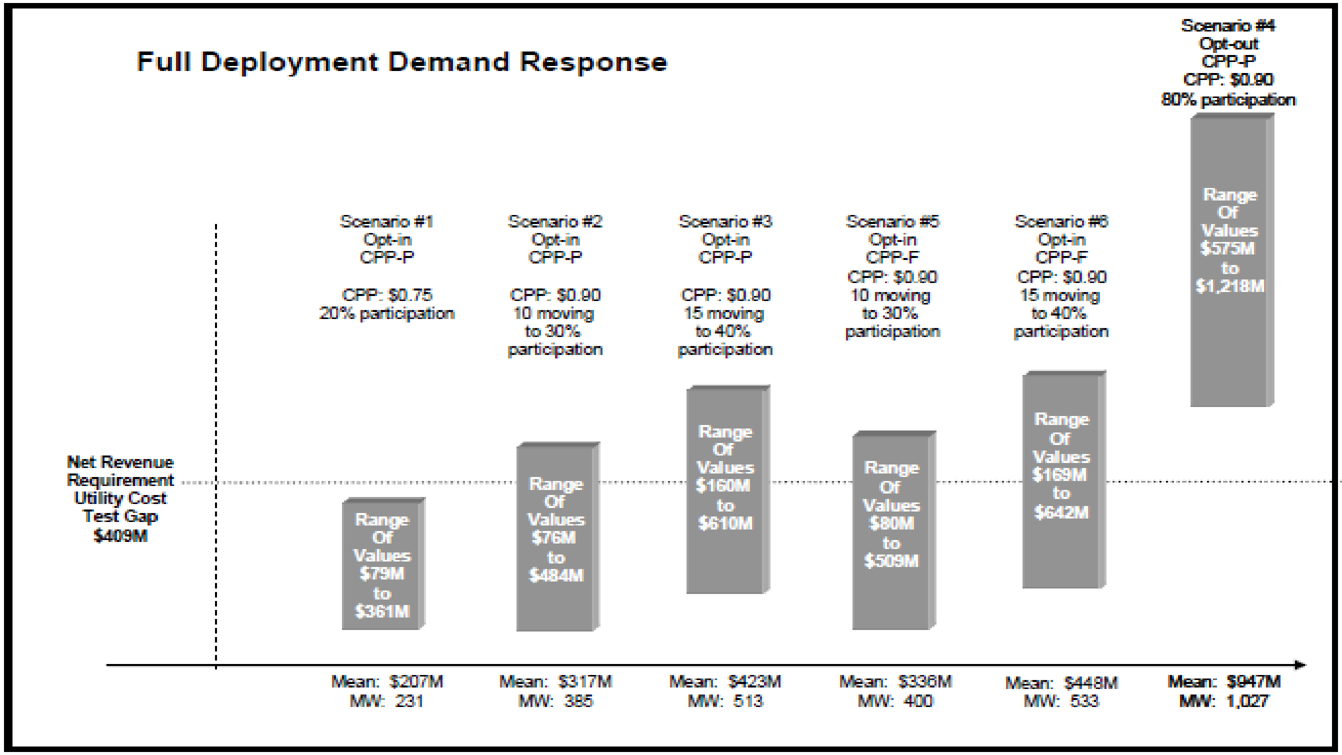
Evolution of Methodology for Impact Assessment and BCA Analysis

Jurisdiction	Year	Impact/Benefit Methodology Reference
California (and beyond)	2002	• "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects," CPUC, CA: 2002. *
United States	2010 - 2012	• "Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects," EPRI, Palo Alto, CA: 2010. Link * • "Metrics and Benefits Analysis and Challenges for Smart Grid Field Projects," US DOE: 2011. Link • "Guidebook for Cost/Benefit Analysis of Smart Grid Demonstration Projects: Revision 1, Measuring Impacts and Monetizing Benefits," EPRI, Palo Alto, CA: 2012. Link
Pacific Northwest	2015	• "Smart Grid Regional Business Case for the Pacific Northwest," BPA/Navigant: 2015. Initial work to quantify uncertainty within benefit-cost framework and analysis. Link *
New York	2016 - 2018	• "Benefit Cost Analysis (BCA Handbook) Version 1.1," Joint Utilities of New York, New York: 2016. * • "Con Edison BCA Handbook – v2.0," Con Edison, New York: 2018. Example of latest instance of NY Benefit Cost Analysis Handbook. Link

* Navigant provided key contributions to the methodological approaches developed in these works.

SOME HISTORICAL PERSPECTIVE

Case Study: AMI Investment in California (PG&E 2005). Business Case



Source: Updated AMI Business Case, PG&E, 2005

Resulting evaluation of benefits… ???

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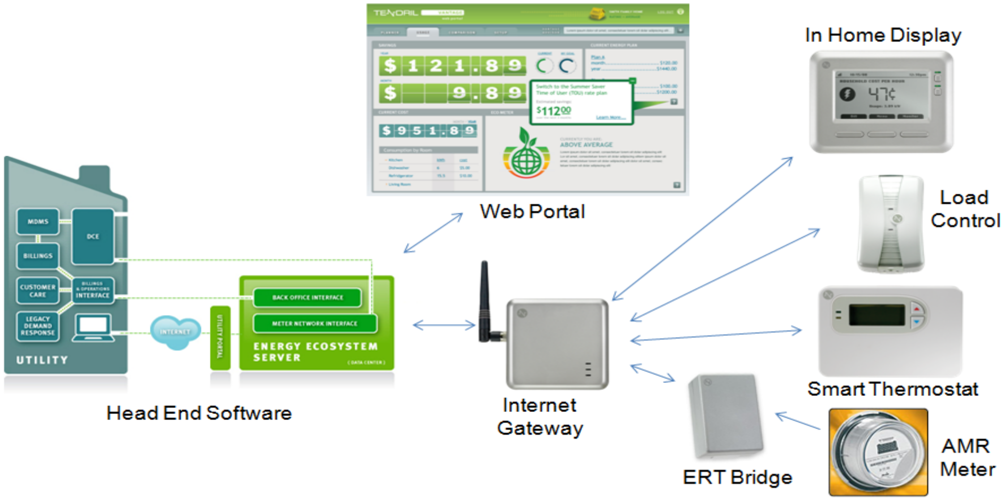
SOME (MORE) HISTORICAL PERSPECTIVE

Case Study: Smart Grid Demonstration Project—AMR - Dynamic Pricing Pilot (NSTAR 2010-2014). Components of the Smart Grid Technology Platform



Tendril System Overview

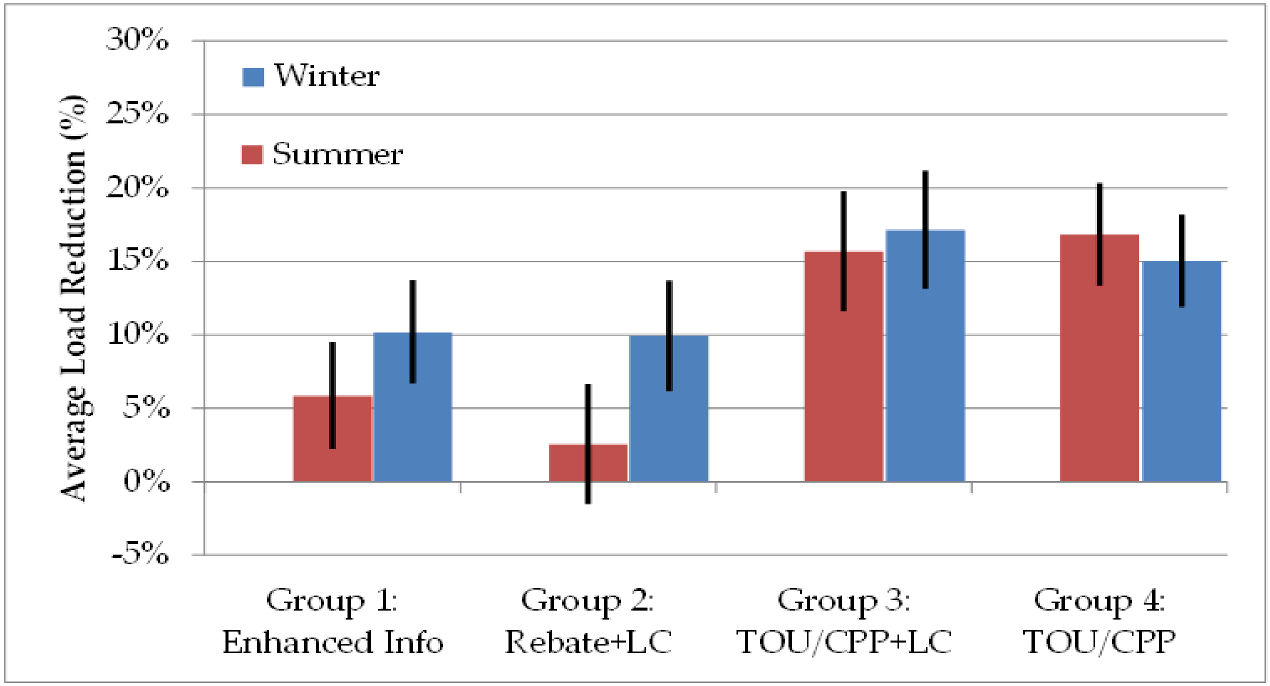
Source: AMR and Dynamic Pricing Pilot. Final Technical Report. NSTAR (Eversource)/Navigant, 2010-2014.

Information Type	Description	Reporting Interval
Build Metrics	Build metrics refer to the monetary investments, electricity infrastructure assets, policies and programs, marketplace innovation and jobs data that are part of smart grid projects.	Quarterly
Impact Metrics	Impact metrics refer to smart grid capabilities enabled by projects and the measurable impacts of smart grid projects that deliver value.	Annually

Source: US DOE ARRA Guidebook for Metrics and Benefits.

SOME (MORE2) HISTORICAL PERSPECTIVE

Case Study: Smart Grid Demonstration Project—AMR - Dynamic Pricing Pilot.
Demand Impact Evaluation Results for Average Load Reduction



Source: AMR and Dynamic Pricing Pilot. Final Technical Report. NSTAR (Eversource)/Navigant, 2010-2014.

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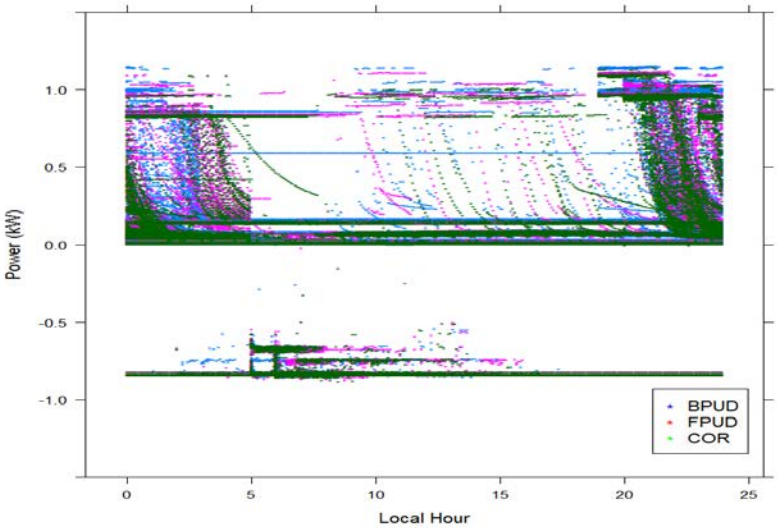
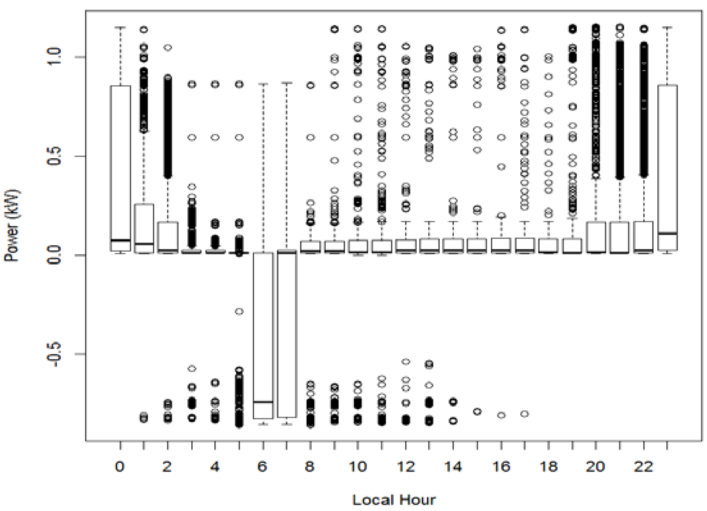
SOME (MORE3) HISTORICAL PERSPECTIVE

Case Study: Pacific Northwest Smart Grid Demonstration Project (Battelle 2010-2015).

- Attempted to collect a tremendous amount of granular data to evaluate smart grid demonstration results.
- In many cases utilities reported insufficient data to derive requisite conclusions concerning changes in reliability.
- Where sufficient data was available, smart grid infrastructure did not always yield desired results. (e.g., in some cases reliability indices became worse).





Source: PNW-SGDP. Final Technical Report. Battelle, 2010-2015.

SOME RECENT PERSPECTIVE

Benefits categories from the New York REV BCA Handbook, (2016). Prescribes methodology for benefits quantification for a set of categories (“value streams”).

Sect. #	Benefit/Cost	SCT	UCT	RIM
Benefit				
5.1.1	Avoided Generation Capacity Costs, or ICAP, including Reserve Margin	✓	✓	✓
5.1.2	Avoided LBMP	✓	✓	✓
5.1.3	Avoided Transmission Capacity Infrastructure	✓	✓	✓
5.1.4	Avoided Transmission Losses	✓	✓	✓
5.1.5	Avoided Ancillary Services	✓	✓	✓
5.1.6	Wholesale Market Price Impacts		✓	✓
5.2.1	Avoided Distribution Capacity Infrastructure	✓	✓	✓
5.2.2	Avoided O&M	✓	✓	✓
5.2.3	Avoided Distribution Losses	✓	✓	✓
5.3.1	Net Avoided Restoration Costs	✓	✓	✓
5.3.2	Net Avoided Outage Costs	✓		
5.4.1	Net Avoided CO_2	✓		
5.4.2	Net Avoided SO_2 and NO_x	✓		
5.4.3	Avoided Water Impacts	✓		
5.4.4	Avoided Land Impacts	✓		
5.4.5	Net Non-Energy Benefits	✓	✓	✓

Source: NY REV BCA Handbook. Joint Utilities of NY, 2016

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SOME *CURRENT* PERSPECTIVE

Case Study: MA Grid Modernization Evaluation (2018-2020).

Device Type	Not Included	Partial Automation	Full Automation	Included as a Sensor
Feeder Breakers (No SCADA)		X		
Feeder Breakers (SCADA)			X	X
Reclosers (including sectionalizers, single phase reclosers, intellirupters, ASU) (No SCADA)		X		
Reclosers (including sectionalizers, single phase reclosers, intellirupters, ASU) (SCADA)			X	X
Padmount Switchgear (No SCADA)		X		
Padmount Switchgear (SCADA)			X	X
Network Transformer/Protector with full SCADA			X	X
Network Transformer/Protector with monitoring, no control		X		X
Network Transformer/Protector with no SCADA		X		
Feeder Meter (e.g., ION, with comms)				X
Capacitor and Regulator with SCADA		X		X
Capacitor and Regulator no SCADA	X			
Line Sensor (with comms)				X
Fault Indicator (with comms)				X

Source: MA Grid Modernization Metrics filing. 2018

The Electric Distribution Companies (IOUs—or EDCs in MA) jointly developed definitions for grid modernization line equipment → "Automation"

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SOME MORE *CURRENT* PERSPECTIVE

- Case Study: MA Grid Modernization Evaluation (2018-2020). EDC proposed, and DPU agreed, Evaluation Metrics (e.g., specific Volt-VAR Investment focused.)

Metric Type	VVO Evaluation Metrics	Required
Investment Metric-4	Number of devices or other technologies deployed	✓
Investment Metric-5	Cost for deployment	✓
Investment Metric-6	Deviation between actual and planned deployment for the plan year	✓
Investment Metric-7	Projected deployment for the remainder of the three-year term	✓
Performance Metric-1	VVO Baseline	✓
Performance Metric-2	VVO Energy Savings	✓
Performance Metric-3	VVO Peak Load Impact	✓
Performance Metric-4	VVO Distribution Losses w/o AMF (Baseline)	✓
Performance Metric-5	VVO Power Factor	✓
Performance Metric-6	VVO – GHG Emissions	✓
Performance Metric-7	Voltage Complaints	TBD

Source: MA Grid Modernization Metrics filing. 2018

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WHERE FROM HERE?

- Magnitude of investments should motivate serious accounting of investment outcomes
- Clear industry trajectory towards more measurement and rigor
  – Industry stakeholders—consumer advocates, DER developers, environmental advocates, industry groups and chambers of commerce—are pushing for more transparency in distribution planning and evidence of outcomes
  – State Utility Commissions are increasingly moving to require these measurements
- Tremendous opportunity!
  – Development of more standardized, rigorous EM&V approaches for grid modernization
  – Key areas in near term:
    - Evolve and standardize current set of techniques for VVO/CVR evaluation
    - Develop techniques for reliability and resiliency measurement and evaluation
    - Develop metrics for power quality as DER density grows
  – Requires:
    - Knowledgeable evaluators and to educate regulators, staff and other stakeholders
    - Active engagement of, and participation by, the T&D organizations in utilities!

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