

NEMA GRID MOD R1-2018

Standard for Reviewing
the Business Case and
Cost Recovery for Grid
Modernization
Investments





NEMA GRID MOD R1-2018

***Reviewing the Business Case and Cost Recovery for
Grid Modernization Investments***

Published by

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Roanoke, Virginia 22209

www.nema.org

© 2018 National Electrical Manufacturers Association. All rights including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American Copyright Conventions.

NOTICE

This report was prepared for National Electrical Manufacturers Association (NEMA) by The Brattle Group. It was prepared in accordance with The Brattle Group's engagement terms, and is intended to be read and used as a whole and not in parts. The report reflects the analyses and opinions of the authors and does not necessarily reflect those of The Brattle Group's clients or other consultants. There are no third party beneficiaries with respect to this report, and The Brattle Group does not accept any liability to any third party in respect of the contents of this report or any actions taken or decisions made as a consequence of the information set forth herein.

PREPARED BY:
Sanem Sergici, Ph.D.
Michelle Li
Rebecca Carroll

CONTENTS

Executive Summary 5

I. Purpose 9

II. Definition of Grid Modernization Investments 9

III. Common Cost-Effectiveness Assessment Mechanisms 11

IV. Common Cost Recovery Mechanisms 12

V. Overview of Recent U.S. Grid Modernization Investments 13

VI. Summary Discussion of Case Studies 16

VII. Key Takeaways 23

Appendix A. Case Study: Ameren Illinois's Advanced Metering Infrastructure (AMI) Plan 24

 A. Background 24

 B. AMI Plan 24

 C. Regulatory History 26

 D. Cost Benefit Analysis 27

 E. Cost Recovery 31

 F. Current Status 31

Appendix B. Case Study: Austin Energy's Austin SHINES 32

 A. Background 32

 B. Austin SHINES Project 32

 C. Regulatory History 34

 D. Cost Benefit Analysis 34

 E. Cost Recovery 35

 F. Current Status 35

Appendix C. Case Study: Central Maine Power's Advanced Metering Infrastructure Project 37

 A. Background 37

 B. AMI Project 37

 C. Regulatory History 38

 D. Cost Benefit Analysis 39

 E. Cost Recovery 41

 F. Current Status 41

Appendix D. Case Study: Commonwealth Edison's Smart Grid Advanced Metering Infrastructure Deployment Plan 43

 A. Background 43

 B. AMI Plan 43

 C. Regulatory History 45

 D. Cost Benefit Analysis 46

 E. Cost Recovery 49

 F. Current Status 49

Appendix E. Case Study: Duke Energy Indiana's IVVC Project 50

 A. Background 50

 B. IVVC Project 50

 C. Regulatory History 51

D.	Cost Benefit Analysis.....	51
E.	Cost Recovery	53
F.	Current Status.....	53
Appendix F.	Case Study: Entergy Arkansas' Advanced Metering Infrastructure (AMI) Plan	54
A.	Background.....	54
B.	AMI.....	54
C.	Regulatory History	56
D.	Cost Benefit Analysis.....	56
E.	Cost Recovery	57
F.	Current Status.....	58
Appendix G.	Case Study: Hawaiian Electric Company's Grid Modernization Strategy	59
A.	Background.....	59
B.	Grid Modernization Strategy	59
C.	Regulatory History	61
D.	Cost Benefit Analysis.....	61
E.	Cost Recovery	63
F.	Current Status.....	64
Appendix H.	Case Study: Potomac Electric Power Company's DC PLUG Initiative	65
A.	Background.....	65
B.	DC PLUG.....	65
C.	Regulatory History	66
D.	Cost Benefit Analysis.....	67
E.	Cost Recovery	69
F.	Current Status.....	69
Appendix I.	Case Study: Public Service Company of Colorado's Advanced Grid Intelligence and Security (AGIS) Initiative	70
A.	Background.....	70
B.	Advanced Grid Intelligence and Security (AGIS) Initiative	70
C.	Regulatory History	71
D.	Cost Benefit Analysis.....	72
E.	Cost Recovery	74
F.	Current Status.....	75
Appendix J.	Case Study: Public Service Electric and Gas Company's Energy Strong Program	76
A.	Background.....	76
B.	Energy Strong Program	76
C.	Regulatory History	77
D.	Cost Benefit Analysis.....	78
E.	Cost Recovery	80
F.	Current Status.....	81
Bibliography		82

Executive Summary

Study Highlights

- There is now significant experience from grid modernization investments that can be used to develop best practices.
- We reviewed 21 grid modernization initiatives, of which 10 have achieved regulatory approvals based on quantified benefits and costs. This review showed:
 - While most grid modernization efforts were initiated in response to local or state policy requirements, some were based on utility initiatives.
 - In most cases regulatory approvals were based on standardized benefit-cost tests, such as the Total Resource Cost (TRC) test; some notable examples received approvals based on less standard approaches such as break-even analysis; proof of cost prudence and foundational nature of investments for other utility initiatives to move forward.
 - Obtaining regulatory approvals took 13 months on average. Significant delays were associated with presentations of incomplete benefit-cost analysis and strong stakeholder oppositions.
 - The majority of cost recovery utilizes general rate case filings, but a number of cost recovery mechanisms rely on formula rates and rate riders to address regulatory lag. Some jurisdictions also introduced performance-based rates and performance incentive mechanisms in combination with the cost recovery of grid modernization investments.

Over the past decade, several utilities and commissions across the U.S. have made investments into new grid technologies, tools, and techniques to modernize the electric grid. As some of these investments are reaching full implementation, it provides opportunities for other utilities and their regulators who are contemplating similar investments to learn from the experience of the “early adopters.” While such grid modernization efforts promise large benefits for utilities, customers, and society as a whole in the long-term, they come with a big price tag that can, at least in the short-term, increase rates.

National Electrical Manufacturers Association (NEMA) recognized the importance of sharing the grid modernization experience gained by early-adopter utilities and jurisdictions and retained The Brattle Group (Brattle) to: (1) review the experience with Grid Modernization investments to date; (2) summarize how these technologies have benefitted customers and utilities; and (3) document cost recovery mechanisms and business cases related to these investments. For the purposes of this report, grid modernization is broadly defined to encompass investments involving technologies, tools, and techniques that are used to upgrade the existing grid as well as the experience of the users of the grid.

Studies Reviewed

We screened grid modernization projects from 21 utilities, representing a wide range of relevant utility characteristics, regulatory environment, and grid modernization activities. We selected 10 of these projects, representing a cross-section of the 21 projects, to be studied in more detail. These projects span grid modernization efforts in five areas:

- a. Distribution Infrastructure Hardening and Resiliency: investments that physically improve asset durability to prevent outages/damage or investments that minimize the impact of events and improve the ability to recover.
- b. Transmission Infrastructure Hardening and Modernization: investments that support transmission line upgrades, flood mitigation, storm resistance, and enhanced physical and cyber security.
- c. Smart Grid and Distribution System Modernization: investments in advanced grid technologies, which allow two-way communication, self-healing, and autonomous restoration.
- d. Advanced Metering Infrastructure: investments in metering and communication infrastructure.
- e. Distributed-Energy Resources: investments that support deployment or integration of distributed energy resources such as distributed solar and storage.

The selection of case studies was based on the availability of cost-benefit analyses and obtaining approvals by the regulatory commission at the time of this report.

ES 1: List of Case Studies

Utility	Project Reviewed	Case Name
1. Ameren Illinois	AMI	Ameren AMI
2. Austin Energy	Storage & DER Optimization	Austin SHINES
3. Central Maine Power	AMI	CMP AMI
4. Commonwealth Edison Company	AMI	ComEd AMI
5. Duke Energy Indiana	Integrated Volt-Var Optimization	DEI IVVO
6. Entergy Arkansas	AMI	EAI AMI
7. Hawaiian Electric Companies	Smart Grid, Distribution Modernization, and DER Integration	HECO GMS
8. Potomac Electric Power Company	Distribution Infrastructure Hardening/Resiliency	Peppo DC PLUG
9. Public Service Company of Colorado	Integrated Volt-Var Optimization and AMI	PSCO AGIS
10. Public Service Electric & Gas Company	Distribution and Transmission Infrastructure Hardening/Resiliency	PSE&G Energy Strong

Cost-Effectiveness Tests Used

A cost-effectiveness or cost/benefit analysis (C/B analysis) typically is carried out to assess whether the benefits of a project outweigh its costs. Each C/B analysis of the case studies reviewed used the same approach, comparing the net present value of benefits and costs over the life of the investment. These tests differ, however, across jurisdictions in how they assess costs and benefits—ranging from a broad societal view to more narrowly defined views of benefits and costs.

The total resource cost (TRC) test was the most widely used approach to C/B Analyses in the case studies reviewed. Several utilities relied on methods beyond conventional C/B tests to demonstrate that the benefits of the investments outweigh the costs, such as break-even analyses.

Most projects that received approval demonstrated that quantified benefits exceeded costs. In a few cases (e.g., PSCo's AGIS), grid modernization plans received approval even though quantified benefits fell short because the investments were necessary to support other initiatives and/or they improved service reliability and safety in addition to the quantified benefits.¹ In a few cases, regulatory approval was based only on a showing of prudence (e.g., Pepco's DC PLUG) or by presenting a case that the likely recurrence of extreme events justify the investments (e.g., PSEG's Energy Strong).

Cost Recovery Mechanisms

The traditional approach to recovering costs of large capital investments involves "rate-basing" of the assets through the filing of general rate cases. Under this approach, uncertainty around the feasible timing of rate cases can create regulatory lag and make cost recovery unpredictable. To address these uncertainties and reduce regulatory lag (and its impact on the utility earnings), two other mechanisms are widely used for the recovery of large grid investment costs: "formula rates" and "cost trackers" (or riders).

Of the 10 grid modernization cases reviewed, relying on traditional rate cases is the most commonly used approach, followed by riders and formula rates. Some utilities are recovering the costs of investments from a combination of recovery mechanisms (i.e., rate basing plus riders).

More recently, several states have initiated regulatory or legislative orders that call for the review and consideration of alternative regulatory models such as performance-based regulation.² These models are typically more enabling for grid modernization efforts compared to traditional cost of service (COS) regulation, especially when paired with performance incentive metrics that track achievements in grid modernization and DER integration.

Key Takeaways

The grid modernization efforts reviewed range from distribution and transmission hardening to those involving a smart grid, advanced metering infrastructure (AMI), distribution automation, and DER optimization. Utilities typically combine grid-hardening investments to improve reliability and resiliency of their systems along with investments that involve the modernization of infrastructure or service delivery. Many utilities have defined (or are at the cusp of defining) their renewed "customer engagement strategies" and these new strategies almost always rely on the technologies and capabilities enabled by the grid modernization efforts.

While some of the grid modernization efforts were utility-initiated, most of the efforts reviewed were initiated in response to local or state-level policy or legislative drivers. Contrary to popular belief, grid modernization efforts are not limited to more visible states such as California, Illinois, and New York, but

¹ Colorado PUC, Proceeding No. 16A-0588E, Decision No. C17-0556, June 21, 2017.

² See respectively, Ohio's Power Forward Plan and Pennsylvania's legislative bill on alternative rate making:

Ohio Public Utilities Commission, Power Forward: A Roadmap to Ohio's Electricity Future, August 29, 2018 at <https://www.puco.ohio.gov/industry-information/industry-topics/powerforward/powerforward-a-roadmap-to-ohios-electricity-future/>

PPL Electric Utilities, Legislation allowing new utility rate structures becomes law: House Bill 1782 supports strong, flexible, resilient power delivery networks, CISION PR Newswire, June 28, 2018 at <https://www.prnewswire.com/news-releases/legislation-allowing-new-utility-rate-structures-becomes-law-300674475.html>

are taking place in many states across the country, each starting with their own priorities, such as improved resilience or AMI infrastructure.

Based on our review, grid modernization projects driven by state initiatives did not face fewer hurdles in the regulatory process. Of the 10 projects we have reviewed, the average project-approval time was 13 months. The projects that faced lengthier approval timelines were generally subject to substantial criticism from stakeholders or an initial rejection by the regulatory body. Failure to adequately demonstrate cost-effectiveness has been the main reason for delayed regulatory approval. Even though a few grid modernization projects have been approved without a complete cost-benefit analysis or quantified benefits less than costs, most regulatory agencies rely on established cost-benefit analysis frameworks and benefit-cost-ratios above 1.0 to approve these investments.

Most utilities are enthusiastic about undertaking grid modernization projects, provided they offer timely cost recovery. However, because the traditional general-rate-case approach can result in significant regulatory lag and associated uncertainties, formula rates and trackers/riders have been deployed to address these cost recovery challenges. The need for cost recovery of grid modernization investments has prompted some jurisdictions to revisit their existing regulatory models and consider alternative regulatory models, such as “performance based regulation” that reward meeting certain performance targets, such as DER utilization, beneficial electrification, and increased system utilization.³ We expect this trend to continue and more jurisdictions to move toward performance-based regulation as the urgency of grid modernization investments increase.

³ William Zarakas, Sanem Sergici, and Pearl Donohoo-Vallett, “Washington D.C. Performance Based Regulation Workshop”, prepared for PHI, September 2018.
http://files.brattle.com/files/14919_final_pbr_stakeholder_session_washington_dc_20180918.pdf

I. Purpose

Over the past decade or so, several utilities and commissions across the U.S. have made investments into new grid technologies, tools, and techniques to modernize the electric grid. As some of these investments are reaching full implementation, it is important for the other utility leaders, who are contemplating similar investments, to learn from the experience of “early adopters” in terms of the planning, implementation, and regulatory processes involved. Similarly, it is instrumental for regulators in jurisdictions facing similar decisions of approving grid modernization investments to understand the potential impacts of these activities. This is especially true because while grid modernization efforts promise large benefits to the utilities, customers, and society as a whole, they come with a big price tag that will, at least in the short-term, increase rates.

The National Electrical Manufacturers Association (NEMA) recognized the importance of sharing the experience gained by these leading utilities and jurisdictions more widely. It retained The Brattle Group (Brattle) to review the recent Grid Modernization investments and clearly summarize how these technologies have benefitted customers and utilities, and the cost recovery and business cases related to these investments. In doing so, NEMA is aiming to present evidence to key decision makers of the value that these new grid capabilities can provide for utilities, customers, and the society as a whole and with the information compiled in this report, they can make more informed decisions about pursuing Grid Modernization investments.

This effort is particularly timely as the penetration of distributed energy resources is increasing and introducing many challenges, as well as opportunities, for the grid and its customers. In order to be able to tap into opportunities raised by DERs, such as peer-to-peer transactions and to avoid challenges such as cost-recovery issues due to uneconomic bypass of the grid, we need a smarter and more flexible grid that would facilitate innovations in the industry by acting as a platform. If the state of the grid is not at par with these innovations, then the customers who are served by that system will have limited access to these innovations.

In an acknowledgment of this reality, many jurisdictions across the U.S. have initiated grid modernization dockets with varying degrees of ambition. In this report, we present a broad review of 21 grid modernization efforts undertaken in the U.S. We then provide a detailed review for 10 projects that cover a wide range of investments, geographies, and regulatory status. For each of these 10 projects, we review business cases, cost-effectiveness tests, and cost recovery mechanisms among other important elements discussed later in our report.

II. Definition of Grid Modernization Investments

Grid modernization is discussed regularly across the U.S. electrical industry. However, the term does not have a universally accepted definition. In some contexts “grid” refers to the electric system as a whole, while in others it refers only to transmission or distribution infrastructure. Additionally, “modernization” can be narrowly focused on updating existing infrastructure, adding specific types of new hardware devices, or more broadly include various types of hardware, software, and consumer participation. For the purposes of this report, “grid modernization” will encompass the entire electric system and a broad range of “Technologies, Tools, and Techniques.” These “Three T’s” of grid modernization are discussed in detail below.

First, utilities and consumers are employing newly developed “technologies” to increase data transparency, increase consumer control and independence, and increase grid resiliency to extreme weather. Sensors and control devices have been deployed across different levels of the electric grid to allow remote control of at-risk electric infrastructure, report performance of devices, and collect