Grid Modernization Investment Economics

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Consensus on the vision of a modern electric grid: information-rich, automated, flexible, secure, reliable, resilient

Less consensus on the focus and timing of investments to achieve that vision

Managing costs and risks is an important obstacle to grid modernization
Regulated utility investments in the grid are shaped by federal and state regulation — most importantly for utility rates and cost recovery.

Regulators must balance consumer protections and utility risks and incentives:
- Cost-of-service regulation gives utilities a built-in incentive to over-invest
- Regulators conduct after-the-fact review to determine if utility investments were “used and useful” and costs prudently incurred
- To mitigate risk, utilities may ask regulators for pre-approval of investments, shifting risks onto ratepayers.

Getting incentives right is a central challenge in grid modernization.
Key regulatory issues for grid modernization

**Transmission system**: The high voltage (“bulk power”) transmission system is regulated by the Federal Energy Regulatory Commission (FERC). States regulate siting and inclusion of transmission costs in retail rates.

**Key regulatory issues**: Growing need for transmission to integrate renewables, impacts of declining loads and distributed energy resources (DERs) on transmission needs, siting and interstate coordination, wildfire risk

**Distribution system**: The lower voltage distribution system is regulated by state public utility commissions (PUCs).

**Key regulatory issues**: Encouraging demand flexibility, improving reliability, increasing resilience to extreme events, encouraging efficient DER investments, mitigating impact of high PV levels on system reliability and costs, beneficial electrification
Why is evaluating grid modernization costs and risks complex and challenging?

- **Whole vs. Parts**: Grid modernization will ideally be supported by a holistic vision and investment strategy, but component investments may support different objectives and have different evaluation methods.

- **Resources vs. Grid**: Grid modernization investments may support distribution-level resources, but resource and grid investments often have different evaluation methods.

- **Joint & Interdependent Benefits**: Grid modernization investments often have benefits that are hard to isolate and depend on other investments.

- **Uncertainty**: Grid modernization technologies are subject to significant uncertainty — e.g., over costs, timing of need, technology maturity, deployment challenges.
DOE’s Modern Distribution Grid guidebook

► Volume IV includes an economic evaluation framework for grid modernization investments
  o Aims to inform approaches to evaluating economics and managing costs and risks of grid modernization investments

► No textbook approach — multiple reasonable paths to achieving the same broad goals

U.S. Department of Energy. Modern Distribution Grid Volume IV: Guidebook (final draft)
Economic evaluation framework

- Framework has three basic stages:
  - Planning
  - Deployment
  - Evaluation

- Stakeholder input throughout the process can help regulators reduce information asymmetry, improve outcomes.

- Develop/prioritize objectives, set spending limits
- Coordinate regulatory processes
- Identify investment needs, priorities, timelines
- Link needs to objectives, develop performance metrics
- Evaluate investments using targeted approach
- Make investments
- Evaluate investments, adapt investment strategies

See “Example performance metrics” in extra slides.
Prioritizing objectives

- Different jurisdictions will identify and emphasize different objectives for modernizing distribution grids
- Priorities will shape economic evaluation frameworks

<table>
<thead>
<tr>
<th>Priority objective</th>
<th>Customer choice</th>
<th>Distributed energy resource integration</th>
<th>Reliability and resilience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment priority</strong></td>
<td>Advanced metering infrastructure that enables full retail competition</td>
<td>Monitoring, sensing, and control systems that enable higher DER penetration</td>
<td>Feeder upgrades, distribution automation, outage management systems that reduce outages and improve response time</td>
</tr>
<tr>
<td><strong>Example priority investments and functionality</strong></td>
<td>Communications network, data management, advanced meters</td>
<td>Communications network, ADMS, GIS, VVO</td>
<td>Communications network, ADMS, GIS, OMS, FLISR</td>
</tr>
</tbody>
</table>

ADMS - Advanced Distribution Management Systems; GIS - Geographic Information System; VVO - Volt-var optimization; OMS – Outage Management System; FLISR - Fault location, isolation, and service restoration
Targeting economic evaluation

► **Joint and interdependent benefits** — core platform investments that are needed to enable new capabilities and functions in the distribution grid

► **Standards compliance and policy mandates** — utility investments that are needed to comply with safety and reliability standards or to meet policy mandates for proactive investments to integrate DER

► **Net customer benefits** — utility investments from which some or all customers receive net benefits in the form of bill savings

► **Customer choice** — utility investments triggered by customer interconnection, opt-in utility programs, and customer-driven reliability improvements, paid for by individual customers
Using decision trees to aid categorization: Hawaii example

**Self-Supporting**
Will it be installed by customers on margin neutral rates?

**Standards and Safety Compliance**
Required based on reliability and safety criteria?

**Policy Compliance**
Expenditure needed to support and enable commission policies?

**Net Benefits**
Expenditure lowers costs for all ratepayers?

- **No**
  - **Yes**
    - Customer opt-in projects – no cost effectiveness test required
  - **Yes**
    - Evaluated with Hawaiian standard practice lowest reasonable cost assessment
  - **Yes**
    - Evaluated with Hawaiian standard practice lowest reasonable cost assessment
  - **Yes**
    - Evaluated based on total resource cost and an estimate of the potential cost shift between customers

Strategies for managing costs and risks: stakeholder initiatives and utility planning

► Developing objectives and priorities for grid modernization through stakeholder initiatives
  - Examples: Maryland (PC44), Michigan (MI Power Grid), New York (Reforming the Energy Vision), Ohio (PowerForward), Rhode Island (Power Sector Transformation)

► Providing greater transparency on needs, priorities, costs, and risks by requiring utilities to develop long-term grid modernization plans, with nearer-term action plans
  - Examples: California (Grid Modernization Plans), Hawaii (Grid Modernization Strategy), Massachusetts (Grid Modernization Plans), Minnesota (Integrated Distribution Plans)
Strategies for managing costs and risks: analysis, pilots, metrics, and incentives

► Requiring utilities to conduct alternatives analysis and risk scoring for investments
  o Example: Minnesota PUC required Xcel Energy to conduct alternatives analysis and risk-ranking of investments in its Integration Distribution Plans (Docket 18-251, [Order Accepting Report and Amending Requirements](#))

► Encouraging and approving well-designed grid modernization pilots
  o Examples: Austin Energy ([advanced distribution management system](#)), Xcel Minnesota ([advanced metering and time-of-use pricing](#)), Rocky Mountain Power Utah ([customer-sited solar + battery demand response](#)), Oregon ([storage](#)), New York State Electric & Gas ([flexible interconnection](#))

► Using budget caps to limit potential rate impacts
  o Example: Massachusetts DPU pre-authorized specific categories of grid-facing utility investments for three-year term, [subject to a budget cap](#)

► Designing performance metrics and linking these to utility incentives
  o Examples: Illinois ICC [created performance metrics for grid modernization](#) that are linked to utility earnings; Minnesota PUC ([Docket 17-401](#)) required Xcel Energy to develop performance metrics and a reporting schedule
Potential roles of legislators

State legislators can play several potential roles in managing the costs and risks of grid modernization — for example:

- Affirm or set grid modernization objectives and priorities
- Provide guidance or policy on desired levels of grid resilience
- Proactively address issues that may require legislative intervention (e.g., equity issues, data privacy and access, interoperability and cybersecurity standards, facilitate DER aggregation by third parties, encourage performance-based incentives for utilities)
- Provide state funding where there are broader public benefits of grid modernization (e.g., resilience, environment)
Questions state legislators and regulators can ask

► What types of grid modernization investments support the state's objectives and priorities for grid modernization?
► How do regulated utilities’ grid modernization plans support the state’s objectives and priorities?
  o For each planned investment, which objectives and priorities does it support?
► What are the drivers of different investments and how should they be evaluated?
► What are reasonable levels of spending and rate impacts for grid modernization investments?
► What performance metrics should be used to evaluate investments?
► How should risk management be incorporated into investment prioritization and decision-making?
► How should the different regulatory processes affected by grid modernization be coordinated — e.g., for utility planning, procurement, programs, cost recovery, rate design?
For more information

► Background reading:
  - DOE’s Modern Distribution Grid project
  - Berkeley Lab, Benefit-Cost Analysis for Utility-Facing Grid Modernization Investments: Trends, Challenges, and Considerations
  - IREC and GridLab, A Playbook for Modernizing the Distribution Grid
  - NCCETC, The 50 States of Grid Modernization

► Public Utility Commission documents
  - California PUC, Decision on Track 3 Policy Issues, Sub-Track 2 (Grid Modernization)
  - New Hampshire PUC, Staff Recommendation on Grid Modernization
  - Minnesota PUC, Staff Report on Grid Modernization

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Example performance metrics

- Performance metrics will vary across jurisdictions, according to differing objectives and priorities.

<table>
<thead>
<tr>
<th>Example category</th>
<th>Example performance metrics</th>
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<tbody>
<tr>
<td>Deployment</td>
<td>Extent of planned deployment or number of installations</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>Customer experience ratings, customer engagement metrics</td>
</tr>
<tr>
<td>Reliability</td>
<td>System-wide or targeted SAIDI, SAIFI, CAIDI, CAIFI</td>
</tr>
<tr>
<td>Resilience</td>
<td>Service interruptions and restoration time after extreme events</td>
</tr>
<tr>
<td>Safety</td>
<td>Emergency events and response times, accidents and injuries</td>
</tr>
<tr>
<td>Economic efficiency</td>
<td>Investment and operating cost savings</td>
</tr>
<tr>
<td>Network and data access</td>
<td>Interconnection times, data access times, developer satisfaction</td>
</tr>
<tr>
<td>Retail competition</td>
<td>Number of customers choosing a competitive retail option</td>
</tr>
<tr>
<td>Program or rate participation</td>
<td>Customers enrolled in EV and other time-of-use rates, utility programs</td>
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</tbody>
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