Grid Modernization Planning and Investment Economics

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Grid Modernization Planning

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Grid Architecture Approach

- Grid modernization planning starts with objectives & capabilities needed
- Scale and scope of needs require a holistic architectural approach.
- Resist temptation to start with technology choices
While encouraged, it is not essential to start with a grid mod strategy. But, a clear set of objectives is necessary to develop and assess implementation plans.
Objectives Drive Grid Mod Planning

PUC Ohio example:

- **A Strong Grid**: A distribution grid that is reliable and resilient, optimized and efficient and planned in a manner that recognizes the necessity of a changing architectural paradigm.

- **The Grid as a Platform**: A modern grid that serves as a secure open access platform—firm in concept and as uniform across our utilities as possible—that allows for varied and constantly evolving applications to seamlessly interface with the platform.

- **A Robust Marketplace**: A marketplace that allows for innovative products and services to arise organically and be delivered seamlessly to customers by the entities of their choosing.

- **The Customer’s Way**: An enhanced experience of the customer’s choosing on the application side, whether for reasons arising from financial, convenience, control, environmental, or any other chosen consideration.

Note: The ‘safe, reliable, and affordable’ components were included in the mission statement, which was incorporated into the principles of the PowerForward Roadmap.
# Grid Modernization Capabilities

Customer Needs & Policy drive grid capabilities and corresponding enabling business functionality and technology

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Safety &amp; Operational Efficiency</td>
</tr>
<tr>
<td>Market Operations</td>
<td><img src="#" alt="New" /></td>
</tr>
<tr>
<td>Grid Operations</td>
<td><img src="#" alt="Existing" /></td>
</tr>
<tr>
<td>Planning</td>
<td><img src="#" alt="Existing" /></td>
</tr>
</tbody>
</table>

This analysis helps to identify the core platform functions and related technologies as well as the applications linked to specific policies/customer needs/locational value realization.
## Taxonomy Example

<table>
<thead>
<tr>
<th>Objective</th>
<th>Capability</th>
<th>Function</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reliability</strong> improvement by reducing customer unplanned outage durations</td>
<td>Improve outage identification and customer service restoration</td>
<td>Fault Identification</td>
<td>Fault Current Indicators</td>
</tr>
<tr>
<td>Achieve 2nd Quartile CAIDI Performance by 2025</td>
<td></td>
<td>Fault Location</td>
<td>Outage Notification from Meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fault Isolation</td>
<td>Outage Management System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service restoration</td>
<td>Geospatial Information System</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Distribution Management System and/or SCADA</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Automated Switches</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Work Management System</td>
</tr>
</tbody>
</table>
The Grid as a Platform: A modern grid that serves as a secure open access platform—firm in concept and as uniform across our utilities as possible—that allows for varied and constantly evolving applications to seamlessly interface with the platform.

— Public Utility Commission of Ohio

Source: P. De Martini
Logical layering of core components that enable specific applications

- **Green** - Core Cyber-physical layer
- **Blue** - Core Planning & Operational systems
- **Purple** - Applications for Planning, Grid & Market Operations
- **Gold** - Applications for Customer Engagement with Grid Technologies
- **Orange** - DER Provider Application

Identify Starting Point for Grid Investment

This graphic is a summary illustration of a more complete assessment documented in narrative and tables to enable a gap analysis against objectives and identified capabilities & functionalities.

Source: Hawaiian Electric 2017
Grid Modernization technologies layer on top of & integrate with foundational physical grid infrastructure.
Sequencing of Investments

Long-term strategic plan of distribution grid investments

From Xcel Energy’s 2019 Integrated Distribution Plan
Thank You

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References:

Modern Distribution Grid Report
https://gridarchitecture.pnnl.gov/modern-grid-distribution-project.aspx

PUCO Grid Mod Roadmap
https://puco.maps.arcgis.com/apps/Cascade/index.html?appid=59a9cd1f405547c89e1066e9f195b0b1

Grid Modernization Strategy Using DSPx
https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPopup&documentId={E098D466-0000-C319-8EF6-08D478880999}&documentTitle=201811-147534-01

Grid Modernization Strategy Using DSPx
www.hawaiianelectric.com/gridmod

Grid Architecture
http://gridarchitecture.pnnl.gov
Grid Modernization Investment Economics

Fredrich (Fritz) Kahrli, 3rdRail Inc.
Grid modernization investment economics

- Consensus on the vision of a future information-rich, flexible, automated, secure, resilient distribution grid
- Less consensus on the focus and timing of investment to get there
- Economic evaluation of potential investments is a key hurdle
Why is economic evaluation of grid modernization investments complex and challenging?

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole vs. Parts</td>
<td>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</td>
</tr>
<tr>
<td>Resources vs. Grid</td>
<td>Grid modernization investments may support distribution-level resources, but resource and grid investments often have different evaluation methods</td>
</tr>
<tr>
<td>Joint &amp; Interdependent Benefits</td>
<td>Grid modernization investments often have benefits that are hard to isolate and depend on other investments</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Grid modernization technologies are subject to significant uncertainty over costs, timing of need, technology maturity, deployment challenges, etc.</td>
</tr>
</tbody>
</table>
Economic evaluation framework

Framework has three basic stages:

Planning
- Develop/prioritize objectives, set spending limits
- Coordinate processes (needs identification, evaluation)
- Identify investment needs, priorities, timelines
- Link needs to objectives, develop performance metrics
- Categorize investments by evaluation methods (drivers)

Deployment
- Make investments

Evaluation
- Evaluate investments, adapt investment strategies
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
Targeting economic evaluation: Example of more detailed categorization
Economic evaluation of grid modernization investments is complex and challenging.

Clear objectives, robust and coordinated planning, and targeted evaluation of investments can help to address challenges.

Targeted evaluation can be organized around different evaluation methods:

- Least-cost best-fit — joint and interdependent benefits (core investments) and compliance with standards and policy mandates
- Benefit-cost analysis — net customer benefits
- Self-supporting — customer choice

Planning, spending limits, pilots, and ex post performance assessment are all tools for incorporating risk into investment decision-making.

Performance metrics are critical.
Questions states can ask

► Have clear modernization objectives been established in policy or regulation or proposed by the utility?
► Which objectives are supported by different grid mod investments?
► How should planning processes affected by grid mod be coordinated?
► What are the drivers of investments and how should they be evaluated?
► What is the pace and scope of change expected over the planning period and does the grid mod plan address the needs?
► 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?
► Has a clear starting point for modernization been identified?
► Do grid mod plans incorporate flexibility needed for the uncertainty in needs and emergent grid technologies?
Resources for more information

► DOE’s Modern Distribution Grid project

► Utility plans
  ■ HECO’s Modernizing Hawai‘i’s Grid For Our Customers
  ■ Xcel Energy’s Integrated Distribution Plan

► 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
Thank you

Questions?
Insights?

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