Integrated Distribution System & Grid Modernization Planning

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Newport Consulting

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Distribution planning across the U.S. addresses unique areas of focus regarding planning considerations often within these three areas to meet customer needs:

- Reliability & Resilience
- DER Integration & Utilization
- Safety & Operational Efficiency

Customer Needs
Distribution Planning for a Modern Grid

- **Resilience Threat Assessments**
- **Sourcing DER Provided Services**

- **Granular Locational Forecasts & Scenarios**
- **Longer Term Distribution Planning**
  - Systemic Resilience Needs
  - Service Quality Improvements
  - Capacity Upgrades/NWA for Load & DER

- **Near-term Distribution Planning**
  - Reliability & Service Quality Improvements
  - Near-term Enhancements for Load & DER

- **Near-term Distribution Asset Management**
  - Resilience hardening
  - Programmatic aging infrastructure replacement
  - Preventative maintenance programs

**Planning Objectives & Criteria**

- **Grid Modernization Strategy**
- **Grid Mod Implementation Plans**
Architecture Manages Complexity

The engineering issues associated with the scale and scope of customer choice, and envisioned in policy objectives for grid modernization, requires a holistic architectural approach.

So, pick-up a pencil

Before trying to hang windows

Resist temptation to start with technology choices
Grid Mod Strategy & Planning Process

What, Why, How, When & How Much

**Strategy**

1. Identify Grid Mod Objectives, Scope & Timing
2. Identify Grid Capabilities & Functionality Needed
3. Identify Grid Architecture & Develop Strategic Roadmap

**Implementation Plan**

4. Develop Functional Use Cases to Identify Detailed Business & Technical Requirements
5. Develop Detailed Architecture & Design
6. Technology Assessment & Selection
7. Develop Deployment Plan & Cost Effectiveness Assessment
Grid Modernization

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

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Objectives</th>
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<tbody>
<tr>
<td></td>
<td>Safety &amp; Operational Efficiency</td>
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<td>Market Operations</td>
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<td>Grid Operations</td>
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<td>Planning</td>
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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.
Customer needs, public policy & trends shape grid mod objectives that align to organizational mission & grid mod principles
Mission Examples

Ohio
“The PUCO was created to assure Ohioans adequate, safe and reliable public utility services at a fair price. More recently, the PUCO gained responsibility for facilitating competitive utility choices for Ohio consumers.”

Missouri
“We will:
- ensure that Missourians receive safe and reliable utility services at just, reasonable and affordable rates;
- support economic development through either traditional rate of return regulation or competition, as required by law;
- establish standards so that competition will maintain or improve the quality of services provided to Missourians;
- provide the public the information they need to make educated utility choices;
- provide an efficient regulatory process that is responsive to all parties, and perform our duties ethically and professionally.”
Grid Mod Principles Example

Hawaii (Adopted by HECO & PUC)

• Enable greater customer engagement, empowerment, and options for utilizing and providing energy services.

• Maintain and enhance the safety, security, reliability, and resiliency of the electric grid, at fair and reasonable costs, consistent with the state’s energy policy goals.

• Facilitate comprehensive, coordinated, transparent, and integrated grid planning across distribution, transmission, and resource planning.

• Move toward the creation of efficient, cost-effective, accessible grid platforms for new products, new services, and opportunities for adoption of new distributed technologies.

• Ensure optimized utilization of resources and electricity grid assets to minimize total system costs for the benefit of all customers.

• Determine fair cost allocation and fair compensation for electric grid services and benefits provided to and by customers and other non-utility service providers.
## DSPx Taxonomy & Objectives

Taxonomy Provides a Structured Method to Trace Objectives to Functionality

<table>
<thead>
<tr>
<th>Level 0</th>
<th>Level 1</th>
<th>Level 2</th>
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<tbody>
<tr>
<td>Principles</td>
<td>Objectives</td>
<td>Capabilities</td>
<td>Functionalities</td>
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<thead>
<tr>
<th>Objective</th>
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<td>Affordability</td>
<td>Operational Excellence</td>
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<td>Enable DER Integration</td>
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<td>Customer Enablement</td>
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<td>System Efficiency</td>
<td>Enable Technology Innovation</td>
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<td>Cyber-physical Security</td>
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<td>Reduce Carbon Emissions</td>
<td>Enable Electrification</td>
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## Sample Relationship Maps

Objectives to Capabilities to Functionality Maps Enable Traceability

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<thead>
<tr>
<th>CAPABILITIES</th>
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<tbody>
<tr>
<td>2.1.1 Scalability</td>
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<td>2.2.4 Management of DER and</td>
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<td>Load Stochasticity</td>
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- ( ) indicates a relationship or mapping.
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FUNCTIONALITIES

- Short and Long-term Demand Forecasting
- Short-term Distribution Planning
- Long-term Distribution Planning
- Interconnection Process
- Reliability and Resiliency Criteria
- Locational Value Analysis
- Integrated Resource, Transmission, and Distribution Planning
- Distribution System Information Sharing
- Planning Analytics
- Hosting Capacity Analysis
- EV Readiness
# Taxonomy Example

<table>
<thead>
<tr>
<th>Objective</th>
<th>Capability</th>
<th>Function</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer Choice</strong></td>
<td>Provide online customer access to relevant &amp; timely information</td>
<td>Remote meter data collection &amp; verification</td>
<td>Customer Portal</td>
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<td>Customer Analytic Tools</td>
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<td>Greenbutton</td>
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<td>Smart Meter</td>
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<td>Telecommunications</td>
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<td>Meter Data Management System</td>
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<td>Customer Info System</td>
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<td>Data Warehouse</td>
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<td>Reliability 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 1st Quartile CAIDI Performance by 2020</td>
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<td>Fault Location</td>
<td>Outage Notification from Meters</td>
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<td>Fault Isolation</td>
<td>Outage Management System</td>
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<td>Service restoration</td>
<td>Geospatial Information System</td>
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<td>Distribution Management System and/or SCADA</td>
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<td>Automated Switches</td>
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<td>Work Management System</td>
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Architectural Strategy

1. Outline key system considerations from an understanding of grid technology, emerging trends and systemic issues

2. Define architectural strategies from an understanding of grid structure concepts

3. Apply strategies to key considerations in the design of new and modified grid systems
Distribution Grid as a Platform

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.
Technology Implementation Decision Criteria

General framework for technology assessment within a stage gate sequence where the evaluation begins with conceptual screening on a set of these criteria and increasingly becomes more detailed and definitive in terms of the quantitative and qualitative assessment.
Deciding when to adopt grid technologies involves several factors: technology maturity, time to deploy, implementation complexity & functional criticality.

Technology Adoption Strategy

Technology Maturity Curve

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
Grid Investment Cost-Effectiveness Framework

Cost-effectiveness Methods for Typical Distribution Grid Projects

- **Least-cost, best-fit** for core grid platform and grid expenditures required to maintain safe, reliable, resilient operations as well as integrate distributed resources connected behind and in front of the customer meter that may be socialized across all customers.

- **Benefit-Cost Analysis** for grid expenditures proposed to enable public policy and/or incremental system and societal benefits to be paid by all customers. Grid expenditures are the cost to implement the rate, program or NWA. Various methods for BCA may be used.

- **Customer Self-supporting** costs for projects that only benefit a single or self-selected number of customers and do not require regulatory benefit-cost justification. For example, DER interconnection costs not socialized to all customers. Also, undergrounding wires at customers’ request.
Thank You

Contact:
Joe Paladino, joseph.paladino@hq.doe.gov

References & Examples:

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