DSPx: Planning for Resilient Modern Grid

Paul De Martini, Newport Consulting
The Next Generation of Distribution System Platform (DSPx) project was initiated in 2016 to produce reference materials to facilitate development of grid modernization strategies and implementation plans and their evaluation in any US regulatory jurisdiction or utility.

The Modern Distribution Grid Reports, Volumes I-III, were released in 2017, and have been used in over 20 states/territories by commissions and/or utilities as well as EPRI and leading consulting firms.

The DSPx Phase 2 updated Volumes I & II to simplify the taxonomy and created a new volume (Volume IV) to update the decision process in Vol III and expand upon the planning and cost-effectiveness frameworks based on feedback from users.
Modern Grid Report Structure

**Summary & Users Guide**
- Overview of DSPx methodology
- Taxonomy Details & Maps

**Strategy & Planning Guidebook**
- Strategic & Implementation Planning framework
- IDP Planning summary
- Strategic Planning Steps
- Grid Architecture & Architectural Strategies
- Implementation Planning Steps
- Cost-effectiveness framework

**Volume 1: DSPx Taxonomy**
- Function-Technology Maps
- Technology Definitions & Maturity
- Technology Gap Identification

**Volume 2: Technologies**
- Strategic & Implementation Planning framework
- Grid Architecture & Architectural Strategies
- Implementation Considerations
- Cost-effectiveness Framework

**Volume 3: Strategic Planning**
- IDP Planning summary
- Strategic Planning Steps
- Implementation Planning Steps
- Cost-effectiveness framework

*Updated in Guidebook

In Development by RAP
Scope of Distribution Grid Modernization

“Grid Modernization” has different definitions & scope across the U.S. Most include various aspects of these three areas to meet customer needs:

- Safety & Operational Efficiency
- Reliability & Resilience
- DER Integration & Utilization
Typical investment objectives:

- Enable DER utilization and high adoption levels
- Enhance reliability & resilience as well as foundational investment for DER integration
- Improve customer reliability & resilience
- Basic safety, reliability and resilience hardening requirements
Distribution Planning

Multiple Planning Efforts Involved with Distribution Investment Planning
IDP – Grid Mod Planning Process

Adapted from P. De Martini, Integrated Distribution Planning, ICF
Planning for a Modern Distribution Grid

- **Resilience Threat Assessments**
  - Systemic Resilience Needs
  - Service Quality Improvements
  - Capacity Upgrades/NW/A for Load & DER

- **Sourcing DER Provided Services**

- **Granular Locational Forecasts & Scenarios**

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

- **Near-term Distribution Planning**
  - • Reliability hardening
  - • Programmatic aging infrastructure replacement
  - • Preventative maintenance programs

- **Grid Modernization Strategy**
  - **Grid Mod Implementation Plans**
Resilience – Reliability Event Continuum

The fundamental difference is the scale and scope of an event’s impact and subsequent outage duration

**Resilience Events**: Large geographic impact on distribution and/or bulk power system with long duration outage (typically greater than 24 hours & excluded from IEEE)

**Reliability Events**: Local impact with short duration outage (generally less than 24 hours measured by IEEE metrics)
Customer needs, public policy & trends shape grid mod objectives that align to organizational mission & grid mod principles.
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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<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.
Grid Mod Strategy & Planning Process

What, Why, How, When & How Much

Strategy

0. MISSION & PRINCIPLES
1. OBJECTIVES, SCOPE & TIMING
2. GRID CAPABILITIES & FUNCTIONALITY
3. ARCHITECTURE & STRATEGIC ROADMAP

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
Mission & 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.
Revised DSPx Taxonomy & Objectives

Taxonomy Provides a Structured Method to Trace Objectives to Functionality

- **L0**: Principles
  - Affordability
  - Operational Excellence
  - Reduce Carbon Emissions

- **L1**: Objectives
  - Safety
  - Enable DER Integration
  - Customer Enablement

- **L2**: Capabilities
  - System Efficiency
  - Reliability & Resilience
  - Enable Technology Innovation

- **L3**: Functionalities
  - Cyber-physical Security
  - DER Utilization

- **L4**: Technologies
  - Enable Electrification
Sample Relationship Maps

### CAPABILITIES

- **Safety**
- **Affordability**
- **Reliability**
- **Technology**
- **Innovation**
- **Customer Enablement**
- **System Efficiency**
- **Cyber-Physical Security**
- **Resilience**
- **Operational Excellence**
- **DER Integration**
- **DER Utilization**

#### OBJECTIVES

2.1.1 Scalability
2.1.2 Impact Resistance and Impact Resiliency
2.1.3 Open and Interoperable
2.1.4 Accommodate Tech Innovation
2.1.5 Convergence with other Critical Infrastructure
2.1.6 Accommodate New Business Models
2.1.7 Transparency
2.2.1 Operational Risk Management
2.2.2 Situational Awareness
2.2.3 Controlability and Dynamic Stability
2.2.4 Management of DER and Load Stochasticity

### FUNCTIONALITIES

#### 3.1 DISTRIBUTION SYSTEM PLANNING

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#### CAPABILITIES

- 2.1.1 Scalability
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- 2.2.3 Controlability and Dynamic Stability
- 2.2.4 Management of DER and Load Stochasticity
- 2.2.5 Contingency Management
- 2.2.6 Security
- 2.2.7 Public and Workforce Safety
### Taxonomy Example

<table>
<thead>
<tr>
<th>Objective</th>
<th>Capability</th>
<th>Function</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Choice through information access for small business &amp; residential customers to support decision making by 2020</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 data management</td>
<td>Customer Analytic Tools</td>
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<td>Energy management &amp; DER purchase analysis</td>
<td>Greenbutton</td>
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<td>Smart Meter</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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</table>
## Taxonomy Example

<table>
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<th>Objective</th>
<th>Capability</th>
<th>Function</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<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>
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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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Achieve 1st Quartile CAIDI Performance by 2020
Architectural Strategy

The engineering issues associated with the scale and scope of dynamic resources envisioned in policy objectives for grid modernization requires a holistic architectural approach

1. Outline key system considerations that come from an understanding of grid technology, emerging trends and systemic issues
2. Define architectural strategies that derive from an understanding of grid structure concepts
3. Apply the strategies to key considerations in the design of new and modified grid systems
Logical layering of core components

- **Customer Choice Decision Support Analytics**
- **Customer Energy Information & Analytics**
- **Outage Information**
- **Customer DER Programs**

**Core Components**

- **Power Quality Analysis**
- **Fault Analysis**
- **DER & Load Forecasting**
- **Power Flow Analysis**

**Operational Data Management**

- **Sensing & Measurement**
- **Operational Communications (WAN/FAN/NAN)**

**Physical Grid Infrastructure**

**Logical layering**

- **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

What is the 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
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.

- **Customer/Policy/Business Priority**
  - Policy Goals
  - Regulatory Compliance
  - Business Goals
  - Business Plan Alignment

- **Technology Fit & Risk**
  - Tech Maturity
  - Technology Fit
  - Project Complexity
  - Vendor Maturity

- **Organizational Capacity**
  - Business Process Impacts
  - Staff Bandwidth for Project
  - Organizational Change Management
  - Partners – Vendor Capability

- **Costs**
  - Product Costs
  - Integration Costs
  - O&M Costs
  - Commercial Terms

Source: P. De Martini
Technology Adoption Considerations

Deciding when to adopt grid technologies involves several factors: technology maturity, time to deploy, implementation complexity & functional criticality

Grid Modernization technologies layer on top of & integrate with foundational physical grid infrastructure
Sequencing of Investments

Long-term strategic plan of distribution grid investments

<table>
<thead>
<tr>
<th>Foundational Investments</th>
<th>Near-Term (2018 – 2022)</th>
<th>Medium-Term (2023-2027)</th>
<th>Long-Term (2028-2032)</th>
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<td>ADMIS</td>
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<td>TOU Rate Pilot</td>
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<td>AMI</td>
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<td>FLISR</td>
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<td>Underlying IT Infrastructure</td>
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<tr>
<th>Substation Upgrades and Additional Distribution Automation</th>
<th>Customer Platform</th>
<th>OMS Integration</th>
<th>OMS Enhancement</th>
<th>MDMIS Enhancement</th>
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<td>Other Planned or Potential Future Investments</td>
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<td>DRMIS</td>
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<td>Data Hardware</td>
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<td>Distribution Planning Tools / Interconnection</td>
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<td>Electric Vehicle Pilots</td>
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<td>Electric Vehicle Infrastructure</td>
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<td>Energy Storage</td>
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<td>DERMS Monitoring and Control</td>
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<td>Potential DERMS/DRMS Integration</td>
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<td>Edge Device FAN Integration</td>
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From the Xcel Energy 2018 Integrated Distribution Plan. Link: [https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPopup&documentId={E098D466-0000-C319-BEF6-08D47888D999}&documentTitle=201811-147534-01](https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPopup&documentId={E098D466-0000-C319-BEF6-08D47888D999}&documentTitle=201811-147534-01)
Grid Investment Cost-Effectiveness Framework

**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:

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=59a9cd11405547c89e1066e9f195b0b1

Grid Modernization Strategy Using DSPx
https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPopup&documentId={E098D466-0000-C319-8EF6-08D47888D999}&documentTitle=20181114-01

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

Grid Architecture
http://gridarchitecture.pnnl.gov