DSPx: Planning for a Modern Grid

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Distribution Systems and Planning Training for Mid-Atlantic Region and NARUC-NASEO Task Force on Comprehensive Electricity Planning

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Planning a Modern Grid

► The scope of planning has expanded from past practices focused primarily on deterministic load growth, reliability, safety and asset management to…

• Improving Reliability, Resilience, Safety and Operational Efficiency (incl. microgrids)
• Enabling DER Integration (incl. electrification)
• Utilizing DER services for grid operations (e.g., non-wires alternatives)
Planning for a modern grid is done through two primary processes based on customer needs & public policy:

- Grid modernization strategic planning
- Integrated distribution planning (IDP)
Grid Mod Strategy & Planning Process

Strategic planning process identifies “What”, “How” & “Value”

Strategy

1. Identify Grid Mod Objectives, Scope & Timing based on Organizational Principles/Mission
2. Identify Grid Capabilities & Functionality Needed
3. Identify Grid Architecture Considerations & Develop Strategies (e.g., communications, sensing & measurement, protection & controls, field automation, information management, cybersecurity)

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 Roadmap & Cost Effectiveness Assessment
Policy Drivers w/Dist. System Implications

**Environmental**
- **RES: 2% Tier 3**
- **RES: 55% Tier 1**
- **RES: 12% Tier 3**
- **GHG: -50% of 1990 levels**
- **GHG: -75% of 1990 levels**

**Renewable Energy**
- **Standard Offer: 127.5 MW**
- **Total energy: 25%**
- **Total energy: 90%**

**Energy Efficiency**
- **60,000 houses weatherized**
- **8% buildings fossil fuels reduction**
- **35,000 CCHPs**
- **10% buildings fossil fuels reduction**
- **35% wood heat in buildings**
- **All new buildings net zero**
- **Reduce per capita energy consumption by 1/3**

**Transportation**
- **20% reduction in 2015 energy use**
- **10% renewable energy**
- **10% of fleet PEVs (~55K vehicles)**
- **80% renewable**

**Italics indicate statutory requirements/goals**
Objectives Drive Grid Modernization 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.
# Modern Grid Capabilities & Functions

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

<table>
<thead>
<tr>
<th>Functions</th>
<th>Grid Capabilities</th>
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<tbody>
<tr>
<td></td>
<td>Reliability, Resilience &amp; Operational Efficiency</td>
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<tr>
<td>Market Operations</td>
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<td>Grid Operations</td>
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Identify the core platform functions and related technologies as well as the applications linked to specific customer needs/policies/value realization

Source: DOE Modern Distribution Grid Report
Objectives, Capabilities & Functions

Objectives
- Affordability
- Safety
- Customer Enablement
- System Efficiency
- Cyber-physical Security
- Reduce Carbon Emissions
- Operational Excellence
- Enable DER Integration
- Reliability & Resilience
- Enable Technology Innovation
- DER Utilization
- Enable Electrification

Capabilities
- Distribution System Planning
  - Impact Resistance and Impact Resiliency
  - Open and Interoperate
  - Accommodate Tech Innovation
  - Convergence with other Critical Infrastructure
  - Accommodate New Business Models
  - Transparency
  - Scalability

- Distribution Grid Operations
  - Operational Risk Management
  - Controllability and Dynamic Stability
  - Contingency Management
  - Public and Workforce Safety
  - Workforce Management
  - Attack Resistance / Fault Tolerance / Self-Healing
  - Integrated Grid Coordination
  - Flexibility
  - Security

- Distribution Market Operations
  - Distribution Investment Optimization
  - Distribution Asset Optimization
  - Market Animation
  - System Performance
  - Environmental Management
  - Local Grid Optimization

Functions

Distribution System Planning
- Short and Long-Term Demand and DER Forecasting
- Short-Term Distribution Planning
- Long-Term Distribution Planning
- Power Flow Analysis
- Estimation of Distribution Capital Upgrades
- Locational Value Analysis
- Integrated Resources Transmission and Distribution Planning
- Interconnection Process
- Reliability and Resilience Criteria
- Interconnection Studies
- DER Integration (incl. Distributed Grid-Code)
- Distribution System Information Sharing
- Hosting Capacity Analysis
- Customer Information Access
- Analytics
- Customer Information Access (Portal)
- EV Readiness

Distribution Grid Operations
- Microgrid Management
- DER Operational Control
- Distribution to Transmission Operations Coordination
- Distribution to Customer/Aggregator Coordination
- Operational Telecommunications
- Simulation
- Asset Optimization
- Outage Management
- Customer Information

Distribution Market Operations
- Market Participation Rules
- Solution Sourcing
- Solution Evaluation
- Market Settlement
- DER Aggregation to Distribution and/or Wholesale Market
- Advanced Pricing
- Programs
- Market Information Sharing
- Market Oversight
- Measurement & Verification
- Confirmation and Clearing
- Billing
- Solutions Portfolio Optimization
- Advanced Pricing
- Programs
- Market Security and Cybersecurity
Core components are foundational; applications layer on this foundation as additional functionality is needed.

Source: DOE, Modern Distribution Grid, Volume 3
Determine Starting Point

Hawaiian Electric Grid Modernization Strategy example

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.
Technology Maturity

![Diagram of Technology Maturity]

**Classic Technology S-Curve**

1. R&D (including pilots)
2. Operational Demonstrations
3. Early Commercial Deployment
4. Mature Deployment
5. Obsolete & Replace

**Field Automation Example (2017)**

- R&D (including pilots)
- Operational Demonstrations
- Early Commercial Deployment
- Mature Deployment
- Obsolete & Replace

- Advanced Switches
- DSCADA
- DMS
- Distribution STATCOM
- Distribution Power Flow Controllers
- Solid-State Transformers
- NVO

**Current Adoption**

- Pre-Operational Adoption
- Operational Adoption

March 1, 2019
Grid Mod Roadmap
Reliability, Resilience & Operational Efficiency

Example of Grid Mod investments that may be needed over a 10 yr planning horizon

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1. Reliability, Resilience & Operational Efficiency

- Advanced Distribution Protection
- Expanded Automation in Substations
- Distribution SCADA
- Broadband Communications to Distribution Substations
- Volt/Var Optimization
- Customer Outage Portal
- OMS, GIS, DMS Systems
- Multi-Use Field Area Network
- Intelligent Automated Field Switches
- Grid Sensing, Measurement & Cyber-Secure Information
- Aging Infrastructure Replacement & Storm Hardening
Integrated Planning & Grid Modernization

IDP identifies “Where”, “When” and “How much”
Integrated Planning & Grid Modernization

- Customer Needs & Policies
  - System Forecast & Scenarios
  - Resource & Transmission Planning
  - Sourcing DER Provided Services

- Long Term Distribution Planning
  - 5-10+ years
  - Reliability & Resilience Needs
  - Service Quality Improvements
  - Capacity Upgrades/NWA for Load & DER

- Grid Modernization Strategy

- Integrated System Planning
  - Granular Locational Forecasts & Scenarios
  - Current Distribution Assessment
  - Distribution Asset Management
  - Near-term Distribution Planning
  - 1-3 years
  - Reliability & Service Quality Improvements
  - Near-term Enhancements for Load & DER

Source: P. De Martini
Integrated Planning & Grid Modernization

Customer Needs & Policies

System Forecast & Scenarios

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Granular Locational Forecasts & Scenarios

Current Distribution Assessment

Distribution Asset Management

Near-term Distribution Planning 1-3 years
- Reliability & Service Quality Improvements
- Near-term Enhancements for Load & DER

Grid Modernization Strategy

Grid Mod Implementation Plans

Source: P. De Martini
Integrated Planning & Grid Modernization

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Grid Modernization Strategy

Grid Mod Implementation Plans

Source: P. De Martini
3 Volume Report Released in 2017

MODERN DISTRIBUTION GRID
Volume I: Customer and State Policy Driven Functionality
Version 1.1
March 27, 2017

MODERN DISTRIBUTION GRID
Volume II: Advanced Technology Maturity Assessment
Version 1.1
March 27, 2017

MODERN DISTRIBUTION GRID
Decision Guide
Volume III
June 28, 2017

https://gridarchitecture.pnnl.gov/modern-grid-distribution-project.aspx