Coordinated Grid Planning with Considerations for Resilience and Equity

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US Department of Energy

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Addressing Scale within Integrated Planning Processes

Address state/community objectives through an IDSP process and align with regional planning efforts.

IDPs align community and state policy goals into multi-year investment strategies.

Alignment of community and state strategies with regional, multi-state strategies.
Integrated Distribution System Planning

Distribution planning across the U.S. addresses 3 key overlapping areas of focus to meet customer needs

Key considerations:

- Convergence of state energy policy objectives and priorities with utility/3rd-party planning processes
- Integration of customer and 3rd-party systems with utility systems
- Coordination, control, and application of distributed energy resources (DERs)
- Improvement in reliability, resilience and operational efficiency
- The application of advanced sensing, communications, control, information management, and computing technologies to enable the above
- The application of grid architecture to ensure the building of a coherent system that is scalable
- Business process redesign to support effective planning, grid operations, and market operations
Objectives-Based Planning

Creating a shared understanding among stakeholders of strategies for incorporating resilience and equity into current grid modernization practices is essential. Without clear objectives, it becomes difficult to assess whether resulting plans are responsive and if key stakeholders will accept them.

Continuous Improvement

Policy Goals & Consumer Preferences → Reliability
Resilience
Energy Justice
Efficiency
Decarbonization
Cost Effectiveness → Formulation of Planning Objectives & Criteria → Planning Analysis & Solution Identification → Strategic Investment Roadmap → Implementation → Performance Measurement via Metrics

Near-term infrastructure deployment combined with long-term investment strategy

State, Tribe, & Community Policymakers → Regulators & Boards → Utilities

Includes active participation by stakeholders and the public

Policy goals to planning objectives
Planning objectives to investment strategies

Asset hardening & refresh
Outage management systems
Adaptive protection technology
Modeling and simulation tools
Secure communications
Control/coordination of system assets and DERs
Application of energy storage & microgrids
Spectrum of Resilience Measures

**Less sophisticated, yet foundational**

- Hardening infrastructure
- Ensuring adequate emergency management capabilities
- Back-Up provisions (e.g., fuel)

**Robust Asset Management:**

- Asset monitoring
- Failure prediction
- Data analysis (GIS)

**More sophisticated, requires advanced grid capabilities**

- Monitoring and control of system state to enable adaptive response capabilities in real-time and for predictive analysis (modeling, simulation, and analytical platforms)
- Real-time control and coordination of system assets, including inverter-based resources (DERs), and microgrids to adapt to emergency situations

Note: FPL and more advanced utilities undertake continuous improvement of hardening and asset management practices and have built information platforms for emergency crews. Utilities e.g., PJM and Austin Energy are also implementing real-time sensing and controls to mitigate wildfires and control assets under emergency conditions. All the above activities are in play and best practices are available.
Emerging Distribution System Planning Inputs

Distribution planning increasingly dependent upon IRP/bulk power planning, local sustainability & resilience plans, and use of DER

Source: P. De Martini
Planning Objectives

A well-designed integrated distribution system planning process provides a framework for translating policy objectives into holistic infrastructure investment strategies.
Coordinated Processes within IDSP

Given the need to deploy technological solutions that address current socio-economic concerns, distribution system planning now requires a coordinated effort across the policy, regulatory, and utility decision domains with active stakeholder engagement throughout.
Threat-Based Risk Assessment

<table>
<thead>
<tr>
<th>Policy Development</th>
<th>Regulation</th>
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<tr>
<td>E.G., policies on:</td>
<td>• Provision of planning objectives and criteria to utilities, plus metrics</td>
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<tr>
<td>• Tax-based funding for resilience measures</td>
<td>• Integrated planning guidelines</td>
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<tr>
<td>• Treatment of vulnerable or disadvantaged populations</td>
<td>• Evaluation and approval of utility plans</td>
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<tr>
<td>• Establishment of special committees, studies, and working groups</td>
<td>• Establishment of working groups</td>
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</table>

Planning guidance to utilities
Utility Planning and Analysis
Utility annual and long-term plans to address resilience and grid modernization

Tiering of key infrastructure and populations
Formulation of resilience-based objectives and metrics

Threat-Based Risk Assessment
Where: risk = f(threat, vulnerability, consequence)

Threat assessment: identification and prioritization
Threat scenarios: assessment of impact of threat on infrastructure and populations

Forecasting of threat severity (low, medium, and high)

COASTAL FLOOD RISKS TO COASTAL ASSETS AND ENERGY INFRASTRUCTURE

- Projected coastal flood risks due to sea-level rise and a “Sandy-like” hurricane storm surge
- Projected asset-level inundation depths to energy and fuel infrastructure
- Assigned risk scores based on projected exposure and severity of impacts
- Developed visualization tools to enable stakeholders to investigate asset-specific risks in post-analysis

Critical Infrastructure in Maine

From Tom Wall, Center for Climate Resilience and Decision Science, Argonne National Laboratory
Resilience Planning Components (from HECO RWG)

Conducted jointly with stakeholders.*
Utilities perform engineering analysis to determine impacts, assess gaps, and develop solution options.


Determine planning objectives and metrics

Sample Objectives (from Hawaii RWG):
- Reduce outage risk during severe events
- Increase ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially catastrophic event
- Reduce restoration and recovery time following a severe event
- Optimize cost (including capital and operating costs)
- Return critical and priority customers’ power within specified time
- Return power to other customers within specified time

Resilience Metric (from Hawaii RWG): Resilience Index that tracks restoration times with stated targets for critical, priority, and other customers

Identify and prioritize threats

Perform a threat assessment with key federal, state, and local stakeholders, as appropriate, to identify the potential threats and assess the risk of their probable impacts. See: FEMA Comprehensive Preparedness Guide (CPG) 201, Table 1, for a comprehensive list of threats (https://www.fema.gov/sites/default/files/2020-04/CPG201Final20180525.pdf)

Develop threat scenario reference cases

Develop reference cases for each threat scenario (e.g., low, moderate, severe) that characterize the threat and its impact on the grid, customers, and other critical infrastructures (e.g., hospitals, water/wastewater treatment, vulnerable individuals/populations, telecommunications, energy, and emergency services). Apply forecasts of future weather/climate threats.

Tiering and prioritization of key customers and infrastructure

Identify and prioritize key customers and infrastructure sectors with focus on system recovery and public safety and well-being:
- Develop and apply criteria for identifying/prioritizing key customers and infrastructure based on priority and urgency. Categorize by tiers, e.g., Tier 1 represents critical customers/infrastructures, Tier 2 represents priority customers/infrastructures, and Tier 3 represents others. (Hawaii criteria are on page 40.) Criteria development is a shared responsibility of the critical infrastructure sectors.
- Alignment of tiering and prioritization needed with sectors/customers under existing emergency management, homeland security, and hazard mitigation/resiliency frameworks.

Determine capability gaps and solutions

Determine gaps in capabilities, including utility capabilities and self/back-up supply capabilities and requirements, and develop solutions. Apply cost-effectiveness framework (BCA vs least-cost/best-fit). Key customers and critical infrastructure owners/operators partner with utilities, other energy companies, and the government in developing local resilience solutions that can provide resilient power for essential service providers and enhance the overall resilience of the grid for all customers in mutually beneficial projects. Considerations include:
- Implementing asset hardening practices, where needed
- Developing and implementing load management/load curtailment capabilities
- Maintaining ample onsite fuel supplies
- Deployment of temporary emergency power generators
- Partnering with utilities and the government to develop local microgrids
- Utilizing grid-forming inverters so that renewables and DERS can provide a black-start capability
- Ensuring availability of adequate road clearing equipment to speed recovery of key roads, etc.
Dimensions & Approaches of Energy Equity

Source: Wallsgrove et al., 2021 [https://iejusa.org/section-1-defining-energy-justice/]
## Energy Equity Metrics

<table>
<thead>
<tr>
<th>Procedural and Recognition (due process and accountability)</th>
<th>Distributive (affordability and availability)</th>
<th>Restorative (intra- and inter-generational sustainability and responsibility)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Representativeness and inclusiveness of planning processes for all affected stakeholders</td>
<td>• Electricity cost burden (i.e., household electricity bills/income)</td>
<td>• Economic (e.g., job training/job quality; energy resource ownership/governance; reparation of electricity cost burden shouldered by energy burdened communities)</td>
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<td>• Responsiveness of planning processes to public participation and fairness of decisions</td>
<td>• Electricity affordability gap</td>
<td>• Environmental (e.g., natural resource replenishment; generation/storage resource siting)</td>
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<tr>
<td>• Transparency of planning processes and decisions</td>
<td>• Electricity quality (e.g., geographic disaggregation of outage frequency/severity; restoration efficiency)</td>
<td>• Social (e.g., improvements in household-human development index; establishment of safeguard/grievance redress mechanisms)</td>
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<td>• Electricity program (e.g., tax credits; energy efficiency) and technology (e.g., BTM solar and storage) accessibility and performance (e.g., participation/investment demographics; distribution of savings/costs, reliability/resilience, or other benefits/burdens)</td>
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<td></td>
<td>• Social burden (i.e., effort and ability to access critical services)</td>
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Section 40101(d) Formula Grants to States & Indian Tribes | netl.doe.gov
## Taxonomy Example

<table>
<thead>
<tr>
<th>Objective</th>
<th>Attribute</th>
<th>Capability</th>
<th>Function</th>
<th>Technology</th>
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</thead>
<tbody>
<tr>
<td>Enable customer choice</td>
<td>Information to support customer decisions</td>
<td>Provide online customer access to relevant &amp; timely information by 2020 for small business &amp; residential customers</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>Time interval metering</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>Meter communications</td>
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NH PSC’s Staff Conceptual Functional Roadmap

- NWA Market Operations
  - Yr 1: Market Oversight, Settlement Procedures, DER Portfolio Management
  - Yr 2: DER NWA Sourcing
  - Yr 3: Market Information Sharing
  - Yr 4: Fault Management
  - Yr 5: Voltage/Var & Power Quality Management
  - Yr 6: Asset Management
  - Yr 7: Dist. System Model
  - Yr 8: Communication Networks and Infrastructure
  - Yr 9: Sensing & Measurement
  - Yr 10: Distributed Controls, Real-time DER Operation, T&D Interface Coordination, Integrated Operational Engineering & System Operations

- Grid Operations Enhancements
  - Yr 1: Dist. Information Sharing, Scenario-Based Planning
  - Yr 2: Long-term System Planning, Forecasting DER and Demand
  - Yr 3: Interconnection Process, Loc. Value Analysis
  - Yr 4: Integrated Resource T&D Planning

- Planning Enhancements
# Xcel Energy 15-Year Grid Mod Roadmap (2019)

<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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<tr>
<td>ADMS</td>
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<td>TOU Rate Pilot</td>
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<td>AMI</td>
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<td>FAN</td>
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<td>FLISR</td>
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<td>Underlying IT Infrastructure</td>
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<tr>
<th>Other Planned or Potential Future Investments</th>
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<tr>
<td>DRMS</td>
<td>Substation Upgrades and Additional Distribution Automation</td>
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<td>Customer Platform</td>
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<td>OMS Integration</td>
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<td>MDMS Enhancement</td>
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<td>HAN</td>
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<td>Volt/Var Management (IVVO)</td>
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<td>Data Hardware</td>
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<td>Data Analytics Use Cases</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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- **= Regulatory Approved**
- **= Near-Term Investment**
- **= Other Planned / Budgeted**
- **= Potential Future**
Questions