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Grid Modernization Investments: Evaluation and Cost Recovery

Utah DPU Grid Modernization Collaborative Workgroup

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Agenda

- Grid Modernization Overview
- Evaluating Cost Effectiveness
- Cost Allocation for a New Era
- Rate Design Considerations
Key Takeaways

• The complexity of the modern grid requires new investments and operations necessitating the consideration of new methods of cost allocation and rate design

• Grid modernization is the means, not the end

• Grid modernization investments can enable new benefits to be considered in their evaluation and cost allocation

• Cost allocation follows time-based methods

• Use newly available load and system data
1 Our Changing Grid
The 1992 Grid

Illustrative traditional electric system

Generation
Transmission
Distribution

Transmission lines 765, 500, 230 and 138 kV

Subtransmission customer 26 kV or 69 kV
Primary customer 13 kV or 4 kV
Secondary customers 120 V or 240 V

Generating station
Generator step-up transformer
Transmission customer 138 kV or 230 kV
Substation step-down transformer
Line transformer

Digitalization and Decentralization

Illustrative modern electric system

- **Smart appliances**
  - Can shut off in response to frequency fluctuations.

- **Processors**
  - Execute special protection schemes in microseconds.

- **Demand management**
  - Use can be shifted to off-peak times to save money.

- **Sensors**
  - Detect fluctuations and disturbances, and can signal for areas to be isolated.

- **Storage**
  - Energy generated at off-peak times could be stored in batteries for later use.

- **Generators**
  - Energy from small generators and solar panels can reduce overall demand on the grid.

Wind and Solar

- Capital intensive
- No fuel
- Capacity value varies by region
Storage

• Capital intensive
• Multiple purposes:
  • Shift energy to high-value periods
  • Location: At wind/solar farms, or to support T&D
  • Very reliable capacity
  • Ancillary services
  • Resilience
Customer-Sited Resources

- Shift net peak hours for both generation and delivery
- Distribution system can provide upstream benefits
Energy Efficiency

• Implemented at customer level
• Saves generation, transmission & distribution
Demand Response

- Peaking and load shifting with little utility investment
- Substitution of data and controls for both capital and fuel
Electric Vehicles

- Potential very large additional load
- High incremental costs if not managed
- But can be almost all off-peak, or even flatten net load
Climate Change

- System investments for reliability / resilience
- Extreme weather, changes to resource adequacy
Smart Grid and Big Data

- Reduce system costs and lower losses
- Granular customer and distribution system data
- Demand Response can be targeted
- Storage locations can be optimized
2 Grid Modernization Investments
Grid Modernization Defined

- Grid modernization is the means, not the end
- The integration of new technologies that can make the system more efficient, less costly, and capable of operating at a high quality with high penetrations of variable generation resources and distributed energy resources.

https://gridarchitecture.pnnl.gov/media/Modern-Distribution-Grid-Volume-III.pdf
Reliability and Operational Efficiency
Investments that enable reliable, safe, efficient operations

• Greater system awareness – outage identification
• Remote control – connect / disconnects

Examples:
- Advanced Metering Infrastructure
- Field Area Network
- Fault Location, Isolation and Service
- Integrated Volt Var Optimization
- ADMS – DMS, DRMS, CVR
DER Integration

Investments that expand visibility, control, and optimization of DERs within grid operations

Examples:

- Distributed Energy Resource Management Systems (DERMS)
- Hosting capacity tools
- IEEE 1547, smart inverters enabled
DER Utilization

Investments that enable greater customer and utility awareness of energy use and behavior

Examples:

- Customer program design – (e.g. DR, ES, EV)
- Rate design - TOU, CPP
- Improved program evaluation and planning/targeting/forecasting
- Non-wires alternatives, planning tools
USDOE Modern Distribution Grid

### Applications

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

- Locational Value Analysis
- Dynamic Analysis
- Optimization Analytics
- Market Oversight
- Market Settlement
- DER Portfolio Optimization

- Hosting Capacity
- Probabilistic Planning
- Smart Meters
- Advanced Meters
- Volt-var Management
- DER Management

### Core Components

- Power Quality
- Fault Analysis
- Automated Field Devices
- Advanced Protection
- SCADA

- DER/Load Forecasting
- Power Flow Analysis
- Network Model
- GIS
- OMS
- DMS

- Operational Data Management
- Sensing and Measurement
- Operational Communications (WAN/FAN/NAN)
- Physical Grid Infrastructure
50 States of Grid Modernization Actions

## Xcel Minnesota 2019 IDP

### Table 2: Grid Modernization Capital Expenditures Budget – NSPM Electric (Millions)

<table>
<thead>
<tr>
<th>Component</th>
<th>MYRP Case Period</th>
<th>5-Year Period</th>
<th>10-Year Period</th>
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<tr>
<td></td>
<td>2020</td>
<td>2021</td>
<td>2022</td>
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<tr>
<td>ADMS³</td>
<td>$6.5</td>
<td>$1.0</td>
<td>$3.0</td>
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<tr>
<td>AMI⁴</td>
<td>$14.0</td>
<td>$28.9</td>
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<tr>
<td>FAN⁵</td>
<td>$14.7</td>
<td>$37.3</td>
<td>$36.8</td>
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<tr>
<td>FLISR</td>
<td>$3.5</td>
<td>$8.6</td>
<td>$6.6</td>
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<tr>
<td>IVVO</td>
<td>$0.1</td>
<td>$6.5</td>
<td>$9.8</td>
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<tr>
<td>Total</td>
<td>$38.8</td>
<td>$82.3</td>
<td>$200.2</td>
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PGE Distribution Automation Roadmap

Figure 26. PGE’s expected five-year roadmap for distribution automation

<table>
<thead>
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<th>Distribution automation roadmap – five-year expected view</th>
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</thead>
<tbody>
<tr>
<td><strong>2021</strong></td>
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<tr>
<td>FLISR</td>
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<tr>
<td>Volt/VVO</td>
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<td>SFCI</td>
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</tbody>
</table>

https://edocs.puc.state.or.us/efdocs/HAD/um2005had104621.pdf
Dominion Energy Virginia - 10 yr. Grid Transformation Plan

- Phase 2 Proposed June 2021
- $669 million over 2 yr.
- Phase 1: Improving Reliability and Resilience
- Phase 2: Investments to facilitate and optimize integration of DERs
  - Smart metering infrastructure, intelligent grid devices
  - Data management, device control
- Customer Benefits:
  - Reliability improvements, energy and demand savings, more accurate and timelier customer information, improved resilience of service to critical infrastructure

Modern Integrated Distribution Planning

Comprehensive Electric Planning

Resource & Transmission Planning

Key Takeaways

• The complexity of the modern grid requires new investments and operations necessitating the consideration of new methods of cost allocation and rate design

• Grid modernization is the means, not the end

• The interrelated nature of investments drives the need for coordinated planning and development of multi-year roadmaps
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