GRID MODERNIZATION INITIATIVE
PEER REVIEW
GMLC 1.4.25 - Distribution System Decision Support Tool Development and Application

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April 18-20, 2017
Sheraton Pentagon City – Arlington, VA
**Project Description**
Identify strategies and provide technical assistance to state regulators and utilities that focus on advanced electric distribution planning methods and tools, with a focus on incorporating emerging grid modernization technologies and the significant deployment of DER

**Value Proposition**
- The electric distribution systems are aging and in need of expensive upgrades
- Large amounts of DERs are being integrated to distribution systems in U.S.
- PUCs and decision makers have asked for assistance in understanding the distribution systems, and prioritizing upgrades

**Project Objectives**
- Provide technical assistance to state regulators in partnership with NARUC
- Identify gaps in existing and emerging planning practices & approaches
- Compile information on existing planning tools, identify gaps and necessary functions
- Provide technical assistance to electric utility industry and associated stakeholders
Project Participants and Roles

Michael Coddington – NREL (Utility Practices)
Lisa Schwartz – LBNL (Regulatory)
Juliet Homer – PNNL (Tools & Regulatory)

<table>
<thead>
<tr>
<th>Lab</th>
<th>FY16 $</th>
<th>FY17 $</th>
<th>FY18 $</th>
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<td>NREL</td>
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<td>LBNL</td>
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<td>PNNL</td>
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</table>
7.0 Institutional Support

7.1 Provide Technical Assistance to States and Tribal Governments
- Task 7.1.1 Provide TA to all states

7.2 Support Regional Planning and Reliability Organizations

7.3 Develop Methods and Resources for Assessing Grid Modernization
- Enhance utility distribution planning methods & tools
- Provide TA to state PUCs and utilities
- Support industry dialogue with concept papers

7.4 Conduct Research on Future Electric Utility Regulations

**MYPP vision for Institutional Support area**
- Leverage technical expertise, analytical tools, models and data to support and manage institutional change in a period of rapid and potentially disruptive technological innovation
- Directly address high priority grid modernization challenges and needs
- Convene key grid stakeholders as an honest-broker for collaborative dialogues on grid modernization
- Create an over-arching suite of grid-related “institutional” analysis, workshops and dialogues
Approach

- Support Regulatory Agencies – Deliver in-person training courses for state PUCs on emerging distribution planning practices, methods and tools, with support and guidance from NARUC and a state PUC advisory group. *Beginning summer 2017*

- Continue engagement with APPA and NRECA; Identify the highest priority TA on distribution system tools and needs that this team can provide to support coops and public power. Share information with other GMLC teams. *2017 & 2018*

- Engage with small, medium and larger-sized utility partners with the goal of assessing their needs. *2017 & 2018*
  - Goal will be to develop new methods and tools to support all sized utilities as they look to improve their distribution planning methods and how they engage their regulators.

- Provide detailed assessment of existing distribution planning tools, capabilities, gaps and recommendations for filling those gaps. *April 2017 & 2018*
<table>
<thead>
<tr>
<th>Milestone (FY16-FY18)</th>
<th>Status</th>
<th>Due Date</th>
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<tbody>
<tr>
<td>4.1 – Produce summary memo on the distribution system planning needs of public power and rural cooperatives and suggested approaches for working with APPA and NRECA on advancing emerging planning methods.</td>
<td>Completed</td>
<td>9/16</td>
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<tr>
<td>1.5 - Organize a planning workshop at the IEEE ISGT 2016 conference and issue workshop proceedings document that reports on advanced distribution system planning approaches, tool sets and remaining challenges discussed at the conference.</td>
<td>Completed</td>
<td>9/16</td>
</tr>
<tr>
<td>1.1 - Provide summary memo on the status of emerging distribution planning practices by states and remaining challenges for addressing high levels of DER penetration in distribution systems.</td>
<td>Completed</td>
<td>12/16</td>
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</table>
Identified opportunities to support distribution planning activities of the American Public Power Association and National Rural Electric Cooperative Association. Shared this information with other GMLC teams.

Organized an education program on distribution planning at the IEEE Smart Grid conference.

Established an advisory group of state public utility commissions (PUCs) to identify distribution planning needs and a training program to help meet those needs, in partnership with the National Association of Regulatory Utility Commissioners (NARUC).

Facilitated and presented at PUC workshops (WA, OR, MN), MGA, and NARUC winter meetings on establishing a distribution planning process integrated with resource and transmission planning and interconnection processes integrated with distribution planning.

Summary report on status of emerging distribution planning practices when addressing high DER levels.
Results from Distribution System Tools Report:

Focus on Analysis Types & Applications

- Power Flow Analysis
- Power Quality Analysis
- Fault Analysis
- Dynamic Analysis

Maturity Levels ranking:

0 – None of the DSA tools offer this function
1 – Only a small number of DSA tools offer it
2 – More than 50% of DSA tools offer it
3 – Most or all tools offer the function

This report has provided significant input into the DSPx project

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<table>
<thead>
<tr>
<th>Distribution System Analysis Types and Applications</th>
<th>Maturity Level</th>
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<tbody>
<tr>
<td>Power Flow Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Peak Capacity Planning Study</td>
<td>3</td>
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<tr>
<td>Voltage Drop Study</td>
<td>3</td>
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<tr>
<td>Ampacity Study</td>
<td>3</td>
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<tr>
<td>Contingency and Restoration Study</td>
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<tr>
<td>Reliability Study</td>
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<td>Load Profile Study</td>
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<tr>
<td>Stochastic Power Flow Study</td>
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<tr>
<td>Volt/var Study</td>
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<tr>
<td>Real-Time Performance</td>
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<tr>
<td>Power Quality Analysis</td>
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<tr>
<td>Voltage Sag and Swell Study</td>
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<tr>
<td>Harmonics Study</td>
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<tr>
<td>Fault Analysis</td>
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<tr>
<td>Arc Flash Hazard Analysis</td>
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<tr>
<td>Protection Coordination Study</td>
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<tr>
<td>Fault Location Identification</td>
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<tr>
<td>Dynamic Analysis</td>
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<tr>
<td>Long-Term Dynamics</td>
<td>1</td>
</tr>
<tr>
<td>Electromechanical Dynamics</td>
<td>2</td>
</tr>
<tr>
<td>Electromagnetic Dynamics</td>
<td>3</td>
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Major Utility Types & Possible Needs

- ~2000 municipal Utilities
- Average 2200 meters
- Serve 15% of market
- Own & maintain 7% of U.S. distribution feeders
- ~1300 municipals have a single substation!
- Most municipal utilities are very small, and distribution planning is less demanding

- ~900 cooperative utilities
- Average 13,000 meters
- Serve 12% of market
- Own & maintain 42% of U.S. distribution Feeders
- Many cooperatives leverage external partners for planning
- May be opportunities to assist NRECA and members with planning

- ~210 investor-owned utilities (IOU)
- Average 400,000 meters per IOU
- Serve 73% of market
- Own & maintain 50% of U.S. distribution feeders
- Typically have large Electric Distribution Planning departments
- Regulated utilities, under new scrutiny in distribution planning

Data from EIA, NRECA, APPA, EEI
NREL-led IEEE Report on Alternatives to Traditional Distribution System Planning with Con Edison:

- Long-term Forecast showed Brooklyn Queens networks would see overloads on peak days
- Traditional approach was to build out distribution circuits, add substation transformers & switchgear, and new transmission upgrades (all underground)
- Cost estimate to serve all of this new load >$1Billion
- NY DPU via NY REV seeks alternatives from Con Edison rather than traditional investments

Many solutions were employed, including Energy Efficiency measures, Fuel Cells, Solar PV systems, Volt-VAR Optimization, Demand Response, Gas-Fired Distributed Generation, Battery Energy Storage Systems (BESS), and more.....
Response to December 2016 Program Review

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Response</th>
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<tr>
<td>There are a number of similar projects providing technical assistance to</td>
<td>Coordination efforts have continued throughout the project, and meetings</td>
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<td>regulators including DSPx and 1.3.22 (NY REV).</td>
<td>are planned with DSPx team for May, 2017.</td>
</tr>
<tr>
<td>A description of coordination across TA projects would be very helpful at</td>
<td>Coordination among various TA projects is critical, and is discussed in</td>
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<td>the Annual Peer Review.</td>
<td>upcoming slide</td>
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Project 1.4.25 received a “Green Light” in the Go/No-Go review
1.4.29: Future Electricity Utility Regulation – Contribute design and implementation options. Electric utility regulation is a key aspect of this project as this team works to educate regulators on existing and emerging planning methods and tools.

1.3.5 DER Siting and Optimization Tool for CA – NY and CA regulators are coordinating on tool development and demonstration

1.2.1: Grid Architecture – Apply evolving grid architecture with distribution planning tools and methods.

1.3.22: Technical Support to the NYS REV Initiative – Partner with NY utilities and BNL team to understand advanced approaches in distribution system upgrades, planning, non-wires alternatives. Continue evaluation of alternative distribution planning methods used by Con Edison in the Brooklyn-Queens Demand Management project.

1.1: Foundational Analysis for GMLC Establishment – Validate and demonstrate grid performance metrics

Next Generation Distribution System Platform (DSPx) – Coordinate with DSPx and provide inputs as requested. E.g., the distribution planning tools report.
Next Steps and Future Plans

✔ Training for PUC commissioners & staff starting summer of 2017, with additional training locations in 2018. Training agendas will reflect PUC Advisory Group and NARUC feedback.

✔ Continue engaging with APPA and NRECA to seek opportunities for joint collaboration with respect to planning and tools

✔ Focus on larger utility industry participants and evaluate gaps and needs for those larger entities

✔ Continue the development of the Next Phase Electric Distribution System Tools and Gaps Report for 2017-2018

✔ Publish a technical report that summarizes major distribution system analyses, applications and tools - April 2017

✔ Publish a technical report that identifies remaining gaps, development requirements, and lessons learned on distribution system planning tools - April 2018