Minnesota Hosting Capacity Analysis

MIPSYCON – November 8, 2017

Chris Punt, P.E.
Outline

- What is Hosting Capacity?
- Background
- DRIVE
- Results
- Visualization
- Accuracy
- Timeline
- Next Steps
The Electric Power Research Institute (EPRI) has defined hosting capacity as the amount of DER that can be accommodated on the existing system without adversely impacting power quality or reliability.

What is Hosting Capacity?
What is Hosting Capacity?

Fundamental Requirements

- **Granular**: Capture unique feeder-specific responses
- **Repeatable**: As distribution feeders change
- **Scalable**: System-wide assessment
- **Transparent**: Clear and open methods for analysis
- **Proven**: Validated techniques
- **Available**: Utilize readily available utility data and tools
What is Hosting Capacity?

Differing Methodologies
– Iterative vs. Streamlined
  • Iterative
    – More data intensive
    – More accurate for interconnection studies
  • Streamlined
    – Faster processing
What is Hosting Capacity?

Usage

- Tools for identifying location:
  - Hosting capacity map
  - Substation DG queue

- Interconnection application activities:
  - Pre-application data process
  - Application screening process
  - Engineering study process

Cost/complexity/time → Level of information/accuracy
Background

Minn. Stat. § 216B.2425, subd. 8. requires that a utility operating under an approved multiyear rate plan:

– shall conduct a distribution study to identify interconnection points on its distribution system for small-scale distributed generation resources and shall identify necessary distribution upgrades to support the continued development of distributed generation resources, and shall include the study in its report required under subdivision 2.
Background

12/1/15 – Filed first Grid Modernization Report
6/28/16 – MPUC Order to complete Hosting Capacity Analysis
12/1/16 – Filed first Hosting Capacity Report
3/20/17 – Filed Supplemental Comments due to MPUC Information Request
5/05/17 – Filed Reply Comments addressing all stakeholders concerns
6/15/17 – MPUC Hearing
8/01/17 – MPUC Order for next analysis
11/1/17 – Filed second Hosting Capacity Report
Background

August 1, 2017 Commission Order

- Detailed enough to provide developers with a starting point
- Detailed enough to inform future Distribution System Planning Efforts
- Downloadable results
- Provide methodology, assumptions, details, etc. in Report
- Report on accuracy of the analysis
- File Hosting Capacity report on annual basis (November 1st)
- Color coded map
Distribution Resource Integration and Value Estimation

- Developed by EPRI
- Utilizes Synergi models
- Produces tabular and visual results
- User Group
  - NY Joint Utilities
  - Southern Co
  - Salt River Project
  - TVA
Methodologies

- Analysis: Adds DER to the feeder
  - Small Distributed
  - Large Centralized
  - Large Distributed
• 2017 Key Analysis Assumptions
  – 0.98 leading power factor of new DG installations
  – Daytime Minimum loading at 20% of Peak
  – Substation and Transmission Capacity exists
  – “Year ahead” capacity projects added
  – Solar Gardens
    • Anticipated additions through signed interconnection agreements
DRIVE

Power Factor Impact

Unity => 2.5 MVA

0.98 => 5.0 MVA

0.95 => 8.75 MVA
## Thresholds

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Threshold</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Over-Voltage</td>
<td>High voltage exceeds nominal voltage by threshold</td>
<td>105%</td>
<td>ANSI C84.1 Range A – Maintain quality of service to customers</td>
</tr>
<tr>
<td>Primary Voltage Deviation</td>
<td>Change in Voltage from no DER to full DER</td>
<td>3%</td>
<td>MN Tariff Section 10, Sheet No. 146 – Maintain power quality for customers</td>
</tr>
<tr>
<td>Regulator Voltage Deviation</td>
<td>Change in bandwidth from no DER output to full DER output at a regulated node</td>
<td>50%</td>
<td>Prevent reliability and power quality issues by avoiding excessive regulator operations</td>
</tr>
<tr>
<td>Thermal for Discharging DER</td>
<td>Element rating</td>
<td>100%</td>
<td>Continue reliable customer service by staying within the normal ratings of existing elements</td>
</tr>
<tr>
<td>Additional Element Fault Current</td>
<td>Deviation in feeder fault currents</td>
<td>10%</td>
<td>Based on worst case scenarios from internal studies – maintain customer reliability</td>
</tr>
<tr>
<td>Breaker Relay Reduction of Reach</td>
<td>Deviation in breaker fault current</td>
<td>10%</td>
<td>Based on worst case scenarios from internal studies – maintain customer reliability</td>
</tr>
</tbody>
</table>
– Minimum Hosting Capacity – The Maximum Amount of DER that can be accommodated anywhere on the feeder

– Maximum Hosting Capacity – The Maximum Amount of DER that can be accommodated at one point on the feeder
Results

• 2017 – 1047 feeders
  – Average min hosting capacity = 1.5 MW
    • Approximately 75% limited by Over-Voltage and 25% limited by Thermal Overloads
    • Small percentage limited by reduction of reach, additional fault current, and voltage deviation
    • 177 feeders with zero hosting capacity
    • 619 feeders with 1 MW or greater of hosting capacity
  – Average max hosting capacity = 6.1 MW
  – Feeders with more hosting capacity had:
    • Higher concentration of load
    • Shorter feeder lengths
    • Higher voltages
Results
Visualization

- Mapping Results
  - Security vs. Usability
Hosting Capacity is difficult to compare to Interconnection Studies
- Different models and modeling techniques
- Changing Criteria
- Differing Assumptions
- Interconnection studies didn’t originally contain baseline hosting capacity
- Many of the hosting capacity results already contained projects that had been studied

Processes are evolving and will better align and stabilize with each iteration
Accuracy

• Compared 15 Locations

<table>
<thead>
<tr>
<th></th>
<th>Number of feeders/applications</th>
<th>Number of favorable results</th>
<th>Number of unfavorable results</th>
<th>Value in which unfavorable Hosting Capacity results were below approved value (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Screens</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>700</td>
</tr>
<tr>
<td>2017 Screens</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>2017 Studies</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>300</td>
</tr>
</tbody>
</table>

• Mostly favorable results
• Hosting Capacity was conservative where unfavorable
Timeline

• 2017 Process
  – Pre Work (January - May)
    • GIS improvements and map testing
    • Upgrade and Test software – DRIVE and Synergi
    • Threshold setting and buy-in
    • Synergi Training/Documentation
    • Source Impedance creation
  – Build Models (June - August) => Integrate with planning cycle in future
    • Model existing generation
    • Utilize forecasted 2018 peak data and interconnection queue process
  – Run DRIVE to perform the analysis (August - September)
  – Format results and map (September - October)
  – Write Report (October)
Next Steps

• Distribution Planning
  – Part of Process
  – Utilize Results
• Continued Improvements
  – Tool
  – Modeling
  – Process improvements
• Mapping
  – Detail
  – Features
• Industry Collaboration
• Methods for Increasing Hosting Capacity

* Source: ICF – Integrated Distribution Planning Report