Staff Subcommittee on Energy Resources and the Environment
Staff Subcommittees on Energy Resources

Preparing for a Future with Abundant DER
Preparing for a Future Grid with Abundant Distributed Energy Resources

Subcommittee on Energy Resources and the Environment
NARUC Summer Policy Summit, San Diego
July 16, 2017

Scott Murtishaw, Interim Supervisor
Customer Generation Section
CPUC Energy Division
Cornerstones of the Distribution Resources Plan

1. *Identify* Available DER Hosting Capacity across the Distribution Grid
   - Replace rules-of-thumb with more sophisticated analytics

2. *Facilitate* Interconnection for DERs with Capacity below Available Hosting Capacity

3. *Identify* Where DERs can Provide the Most Locational Value

4. *Direct* DERs to High-Value Locations
   - Use various procurement and incentive mechanisms
Integration Capacity Analysis Methodology Development and Working Group Coordination

2017 NARUC Summer Policy Summit

Mark Esguerra, PE
Pacific Gas and Electric Company
Grid Integration and Innovation

July 16, 2017
What does Integration Capacity Analysis (ICA) Evaluate?

**Distribution Resources Plan (DRP) Guidance on ICA**

- Specify available hosting capacity on distribution grid
- Results down to line section or node level
- Ability to improve efficiency of interconnection process

**Key Characteristics Required for ICA**

- Establish common methodology among utilities
- Avoid "rule of thumb" approaches
- Incorporate new technologies and DER capabilities (i.e. Smart Inverters)
- Publish results via online maps for customers
- Can be performed on regular intervals system wide
Collaborative Innovation

• Industry working group has been established to get feedback and input to help improve the methodologies

• The working group is public and free to participate

• Information can be found at the two websites below

ICA Working Group Timeline

<table>
<thead>
<tr>
<th>2016</th>
<th>2017</th>
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<tbody>
<tr>
<td>Q1</td>
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<td>Q4</td>
<td>Q4</td>
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- ACR on ICA Demo
- Revised Demo A Plan
- Final Demo A Report
- Ruling on Short Term
- ICA Criterion Report
- Status Report on Long Term ICA
- Short Term ICAWG Report
- Long Term Mtgs.
- Long Term ICAWG Report

http://drpwg.org/
http://www.cpuc.ca.gov/General.aspx?id=5071
Development of new methodology was required in order to calculate DER Integration Capacity.
Modeling geospatial distribution circuits is extremely helpful
- Customer loading and forecast data downloaded from SmartMeters
- Granular modeling is critical

Software Tools
- Batch automated power flow is necessary for an efficient ICA
- Scripts needed to properly analyze and extract large amounts of data relevant for ICA
Analyzing and Understanding Hourly Profiles

- SCADA can be useful, but it’s not everywhere
- Smart Meters are useful, but it doesn’t tell the whole story
- Raw historical data is useful, but isn’t the future
- PG&E utilizes software to provide enhanced load shapes based on metered data and locational variation between customer types and statistical occurrence
Evaluation of Important Power System Criteria

Various aspects of the power system must be analyzed to determine possible impacts

**Thermal**
- Determines limits based on equipment thermal ratings

**Power Quality / Voltage**
- Determines limits that do not create power quality to operate outside prescribed thresholds

**Protection**
- Determines limits that ensure protection equipment can still operate as designed

**Safety / Reliability**
- Determines limits that reduce impacts to safe and reliable operation of the grid during abnormal conditions

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**Initial Analysis**
- Establish Granularity
- Model and Extract Data
- Evaluate Criteria

**Future Analysis**
- ......more
- Expand Knowledge

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**Power System Criteria**

**Thermal**
- Substation Transformer
- Circuit Breaker
- Primary Conductor
- Line Devices

**Power Quality / Voltage**
- Transient Voltage
- Steady State Voltage
- Voltage Regulator Impact
- Substation Load Tap Changer Impact
- Harmonic Resonance
- Tx Voltage Impact

**Protection**
- Reduction of Reach
- Interrupting Capability
- Fuse Coordination
- Sympathetic Tripping
- Tx Protection

**Safety / Reliability**
- Out of Phase Reclosing
- Operational Flexibility
- Tx Penetration
- Tx System Frequency
- Tx System Recovery
- ......more
PG&E analyzed all three phase line sections for about 3,000+ distribution circuits

- Helps customers and developers in optimally locating DER
- Initially colored by PV Results
- Exploration of new interfaces and data sharing techniques will occur in DRP discussions

Locational Integration Capacity on PG&E Website

Provide capacities for 10 different types of DER

- Substation (Bank and Feeder) limits are provided
- Line Section Level results provide a range indicating different capacities based on where interconnection on line section.
- IOU coordination with ICA Working Group will determine best consistent method for result publication this year

Long term work is to create path forward for how ICA progresses in methodology and utilization

- Enhancements of online maps displaying ICA results
- Improve data sharing of ICA (e.g. more accessible and user friendly)
- Incorporation of Smart Inverters and other voltage regulation devices
- Expand methodology to incorporate load modifying resources (e.g. Non generation DER such as EE and DR)
- Improve modeling of DER load profile shapes
- Engage non IOU validation and comparison of hosting capacity results
- Planning Use Case - Establish how ICA is used in the planning context
Locational Value of DERs

Presentation to:
NARUC Summer Policy Summit,
Staff Subcommittee on Energy Resources and the Environment
July 16, 2017

By:
Dhaval Dagli, Regulatory Affairs, SCE
Distribution Resources Plan (DRP)

• Analytical Frameworks
  • Grid Integration Capacity Analysis (ICA)
  • Quantification of Distributed Energy Resources’ (DER) locational value (aka locational net benefits analysis or LNBA)
    • Growth scenarios forecast
• Demonstration Projects
  • ICA maps
  • LNBA Calculator
    • Other demos
• Policy issues
Locational Net Benefits Analysis (LNBA) Tool

- Optimal location for DERs = available hosting capacity + locational benefits greater than costs
- LNBA Tool calculates locational benefits on an indicative basis
  - Distribution investment deferral value + locational avoided costs
- Distribution investment deferral value identified based on DER services
  - Distribution capacity services
  - Voltage support services
  - Reliability (back-tie) services
  - Resiliency (microgrid) services
- Comparison with costs occurs outside of LNBA calculator
  - DER deployment, interconnection, integration costs
# LNBA Tool – Project Deferral Value Calculation

First load forecast year (e.g.: 2016)
Discount Rate (%/yr)
Generic default inflation rate (%/yr)

Case to use for allocated hourly costs (Base, Low, High):

Deferral Yrs indicated by DER Dashboard

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### Project cost and need information

#### Equipment Information
- **Location Identifier (user text)**: DPA 1
- **Location Mapping info (User text)**: Location 1234
- **Equipment type**: Primary Feeder
  - **Equipment Inflation (%/yr)**: 2.0%
  - **Revenue Requirement Multiplier**: 165.0%
  - **O&M Inflation Rate (%/yr)**: 2.0%
  - **Book life (yrs)**: 25
  - **O&M Factor (Annual O&M$/Project Cost $)**: 12.0%

#### Cost Information
- **Capital Cost ($000)**: $2,000.0
- **Incremental O&M Cost ($000)**: $240.0
- **Cost yr basis**: 2015

#### Project install/commitment year

- **2017**
- **2018**
- **2019**
- **2020**

#### Cumulative MW reduction needed for deferral

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<th>Year</th>
<th>MW Reduction</th>
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<td>1</td>
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<td>3</td>
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<tr>
<td>4</td>
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**User input: Tool wide financial data**

**Discount Rate (%/yr)**: 7.00%
**Generic default inflation rate (%/yr)**: 2.00%

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**User input: Project specific details**

(equipment type defines project financial assumptions)

**User input: Yearly peak need summarized from user input hourly project need**

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**Energy for What’s Ahead™**
LNBA Tool: Other Avoided Costs Calculation

User inputted hourly DER solution profile

Calculated lifetime hourly avoided cost values

User Input for DER Hourly Shape

<table>
<thead>
<tr>
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<th>DER at meter (kW)</th>
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Hourly Lifecycle Avoided Cost

Lifecycle Value from DER by Component ($)

<table>
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<tr>
<th>Component</th>
<th>Value</th>
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<tr>
<td>Circuit 1102</td>
<td>$1,998,095</td>
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<tr>
<td>Energy</td>
<td>$1,998,095</td>
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<tr>
<td>Gen Capacity</td>
<td>$362,696</td>
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<tr>
<td>Ancillary Services</td>
<td>$18,462</td>
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<tr>
<td>CO2</td>
<td>$794,182</td>
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<td>RPS</td>
<td>$808,743</td>
</tr>
<tr>
<td>Flex RA</td>
<td>-$168,364</td>
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</tbody>
</table>
Heatmap of LNBA Results

Legend

Substations
- Distribution
- Subtransmission

SCE Service Territory

Demo B - LNBA Short-term, Planning

- $
- $$
- $$$
- $$$$
Questions?
Locational Net Benefits Assessment & Distribution Infrastructure Deferral

Limitations, Opportunities & Next Steps

Kenneth Sahm White
Director, Policy & Economic Analysis
Clean Coalition
831.295.3437 mobile
sahm@clean-coalition.org
**LNBA Value Components**

Value categories are refined and adjusted for local variation

System-wide Average or Location Specific Benefit Value layers
(Assessed as applicable to each layer)
- HV System Transmission
- LV Transmission Territory
- Sub-transmission Area
- Distribution Planning Area
- Distribution substation
- Circuit
- Line section
- Transformer
- Meter Load
- BTM load

= Total Stacked Value
Value categories are refined and adjusted for local variation

1. Frequency regulation
2. Spin
3. Ramp
4. Black start
5. Real-time energy balancing
6. Energy arbitrage
7. Resource Adequacy
8. Intermittent resource integration: wind (ramp/voltage support)
9. VER/ PV shifting, Voltage sag, rapid demand support
10. Supply firming
11. Peak shaving: load shift
12. Transmission peak capacity support (deferral)
13. Transmission operation (short duration performance, inertia, system reliability)
14. Transmission congestion relief
15. Distribution peak capacity support (deferral)
16. Distribution operation (volt/VAR support)
17. Outage mitigation
18. Time-of-use (TOU) energy cost management
19. Power quality
20. Back-up Power
LNBA - Distribution Marginal Cost Impacts

<table>
<thead>
<tr>
<th>Variable Costs</th>
<th>Grid Side</th>
<th>Supply Side</th>
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<tbody>
<tr>
<td>Voltage</td>
<td>Ancient Services</td>
<td>Plant Following</td>
</tr>
<tr>
<td>KVAR</td>
<td>Wind/Cloud Firming</td>
<td>Current hour LMP</td>
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<tr>
<td>Power Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line Losses</td>
<td></td>
<td></td>
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<tr>
<td>Limiting Factors</td>
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</table>

<table>
<thead>
<tr>
<th>Fixed Costs / Capacity</th>
<th>Asset Protection</th>
<th>Capacity Premium</th>
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<tbody>
<tr>
<td>Circuit Capacity Deferral</td>
<td></td>
<td>10 Year LMP Forecasts</td>
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<tr>
<td>Bank Capacity Deferral</td>
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<td>Future Covariance</td>
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<td>Future Congestion</td>
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Time
Minutes
Hours
Months
Years
## Distribution Infrastructure Deferral Evaluation

### Project Screening & Selection Process

<table>
<thead>
<tr>
<th>Scoring Metrics</th>
<th>Features</th>
<th>Higher Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screen 1: Technical</strong>&lt;br&gt; (Which projects have DER options)</td>
<td>Four DER services: Capacity, Voltage, Reliability, Micro-grid</td>
<td>Thermal mitigation service</td>
</tr>
<tr>
<td><strong>Screen 2: Project Timing</strong>&lt;br&gt; (rules out many potential projects)</td>
<td>Sufficient lead time within planning cycle</td>
<td>3-5 years&lt;br&gt;Allows for procurement &amp; Contingency options</td>
</tr>
<tr>
<td><strong>DER Attribute Requirements</strong></td>
<td>DER capacity to deferral ratio (MW/MWh reduction, duration, &amp; timing profile)</td>
<td>Lower DER capacity requirement &amp; Higher siting potential</td>
</tr>
<tr>
<td><strong>Project Timing Certainty</strong></td>
<td>volatility in historic and forecast load growth</td>
<td>Nearer term need &amp; Low volatility</td>
</tr>
<tr>
<td><strong>Financial Assessment</strong></td>
<td>Higher deferral value</td>
<td>Expensive projects/DER capacity</td>
</tr>
<tr>
<td><strong>Customer Composition</strong>&lt;br&gt; (Market Assessment)</td>
<td>High load reduction to participant ratio</td>
<td>Customers with large loads</td>
</tr>
<tr>
<td><strong>Distribution Topology</strong></td>
<td>Geographic and customer range</td>
<td>Larger area &amp; number of potential participants (substation needs)</td>
</tr>
</tbody>
</table>
Distribution Resources Planning in California

Brad Heavner
Policy Director, CALSEIA
July 16, 2017
Circuit Load Profile – 576 Hours Per Year

Source: SCE ICA Report Dec 2016
Measuring Locational Value
<table>
<thead>
<tr>
<th>Date &amp; Time (Hour Beg)</th>
<th>2025</th>
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<td>3.750</td>
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**Load Reduction Need in LNBA Tool**

31
• Where are there constraints that are difficult to surmount?
• Where will capacity additions be more expensive?
• Where is long-term load growth expected?
• In which areas would DER grid services be most effective?
Thank you!

Brad Heavner
Policy Director, CALSEIA
brad@calseia.org
415-328-2683
Staff Subcommittee on Energy Resources and the Environment