Distributed Generation Workgroup Webinar # 1

Overview of Interconnection Standards, Rules, and Procedures with NRRI, NREL, and EPRI

Friday, May 5, 2017
9am – 11am CST

LINK TO WEBINAR HERE

Docket No. 16-521
Commission Order
January 24, 2017

1. The Commission hereby delegates authority to the Executive Secretary to issue Notice(s), set schedules, and designate comment periods for the scope outlined in paragraphs 2 – 3 below. The Executive Secretary will, in cooperation with the Department of Commerce, convene a work group of appropriate size and composition, and may select a facilitator, to develop the record more fully.

2. The Commission will transition the Minnesota Interconnection Process to one based on the FERC SGIP and SGIA. The Executive Secretary will set schedules and take comments. It is anticipated that the Commission will consider the record and comments within 18 months of this order, to replace Attachments 1, 3, 4, and 5 to its 2004 Interconnection Standards in this Docket. The Executive Secretary will use the Joint Movants’ May 12, 2016 filing, generally, as the starting point for comments.

3. In the longer-term (nine to twenty-two months), the Executive Secretary will set schedules and take comments on updating the Minnesota interconnection technical standards. It is anticipated that the Commission will consider the record and comments within 24 months of this Order, to replace Attachment 2 to the Commission’s 2004 Interconnection Standards. This stage of work would incorporate newly revised national technical standards, and other issues identified as areas in need of updating.

4. The Commission hereby designates Commissioner Matthew Schuerger as lead commissioner pursuant to Minn. Stat. § 216A.03, Subd. 9, with authority to help develop the record necessary for resolution of the issues, and to develop recommendations to the Commission in this docket.
## Topics & Timeline for In-Person Meetings

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<th>Date</th>
<th>Topics</th>
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<td><strong>June 2</strong></td>
<td>Pre-app report; Application requirements; Queue type &amp; process; Material Modification Definition; Fast Track; Site Control</td>
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<td><strong>July 28</strong></td>
<td>Online application process; Engineering screens; Study process; process timelines/extensions; dispute resolution</td>
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<td><strong>Sept 15</strong></td>
<td>Insurance; Disconnect Switch; metering; Commissioning/inspection, testing, authorization; Design, procure, install, construct facilities/upgrades; advanced inverters</td>
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<td><strong>Nov 3</strong></td>
<td>Interconnection Agreement; process for updating; Transition issues; any outstanding issues</td>
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Agenda

• Description of NRRI/NREL Interconnection Paper
• Intro to interconnection issues – NREL
• Status in the states –NRRI
• Procedural issues & examples – NREL
  • Pre-application reports  • Queue management
  • Application requirements • “Material modifications”
  • Expedited, simplified process and fast-track criteria
• New York Case Study on Procedural Issues -- EPRI
• Audience discussion
• Follow-up and next steps
**Speaker Bios**

- **Tom Stanton** is Principal Researcher, Energy and Environment, at the National Regulatory Research Institute (NRRI), since fall 2010. A life-long resident of Michigan, Tom worked for Michigan’s state government for over 32 years, 10 years at the State Energy Office and over 22 years at the Michigan Public Service Commission. He earned a B.A. in Communications and M.A. in Journalism, both from Michigan State University, and an M.S. in Public Administration from Western Michigan University.

- **Michael Coddington** is a principal engineer at the National Renewable Energy Laboratory (NREL), where he has focused on interconnection codes, standards and FERC rules for the past nine years. He presently leads a multi-laboratory agreement focused on emerging Electric Distribution Planning approaches and tools. Prior to NREL, Michael spent nearly 20 years in the electric utility industry, where he focused on electric distribution system design and planning, key account management, and interconnected his first distributed generation system in 1992. Michael is presently working with LBNL and PNNL to develop electric distribution planning materials for state utility regulators and NARUC.

- **Kristen Ardani** is a Solar Program Lead for the NREL, focusing on efforts to reduce soft costs and transfer emerging technologies to market. Her areas of expertise include solar market analysis, PV system price-tracking, and non-hardware cost-reduction strategies. Ms. Ardani earned a Masters in International Affairs from University of California San Diego. She has been working for NREL since 2010.

- **Nadav Enbar** is a Principal Project Manager in the Integration of Distributed Renewables program at the Electric Power Research Institute (EPRI). He spearheads EPRI’s effort to evaluate innovative utility solar business models, forecast PV adoption, and document DER interconnection best practices. Prior to joining EPRI in 2010, he was a research director for an energy advisory firm, and also worked for energy consultancies.

- **Tom Key** is a Senior Technical Executive at EPRI, currently responsible for EPRI’s research program for integrating distributed resources. He is an IEEE Fellow, for contributions in the area of power systems and quality. He has also led programs on renewable and distributed generation, and on integrating PV power systems.
Tom Stanton and Michael Coddington are co-authoring a paper about interconnection standards, rules, and procedures, with the goal of finalizing this report in time for the NARUC Summer Policy Summit in July.

- We welcome the opportunity to learn from the Minnesota process, to help us identify important topics to include in our work. Please email me with ideas, questions, topics, and any articles, case studies, reports, etc., that you think we should consider.  tstanton@nrri.org

- As next slide shows, the entire process is complex. Today’s focus is on the early stages, as shown in the yellow-bordered boxes.
Typical interconnection process

Overview of DER Interconnection

Michael Coddington, Principal Engineer
National Renewable Energy Laboratory
Interconnection Stakeholders

- **Regulators / Legislators**
  (RPS, Ratepayer impacts,)

- **System Integrators**
  (Business goals, Ease of installation, Tax incentives)

- **PV System Owner**
  (Cost, Environmental impacts, Reliability)

- **Utility**
  (Impact on Electric System)

- **Authority Having Jurisdiction (AHJ)**
  (Proper Installation, Fees)
Interview with 21 U.S. Utilities in 2013

NREL partnered with EPRI, CPUC, DOE, SNL
“Typical” Utility Interconnection Process

- DER must meet IEEE 1547, UL1741

Applications Often vary by size, technology

Takeaway: Improved IEEE 1547 Standard should aid in getting more DER through the preferred path with improved fast-track screens

Install PV

Systems must be installed per NEC

PTO - Permission To Operate

NATIONAL RENEWABLE ENERGY LABORATORY
Screen 2.2.1.2, the “Penetration Screen”, has invoked significant controversy and has been seen as a bottleneck in many regions/states/utility territories. One option is to utilize “Hosting Capacity”

1. Is the application subject to the utility tariff?
2. **Aggregated DG <15% of Peak Load on line section** (2.2.1.2)
3. For connection to a spot network: DG is inverter-based, aggregated DG capacity is <5% of peak load & <50 kW
4. Aggregated DG contribution to maximum short circuit current is <10%
5. Aggregated DG does not cause protective device to exceed 87.5% of short circuit interrupting capability
6. DG interface is compatible with type of primary distribution line (wye/Delta)
7. For a single-phase shared secondary, Aggregated DG capacity <20kW
8. Resulting imbalance <20% of service transformer rating of 240 V service
9. Aggregated transmission connected DG capacity <10 MW for stability-limited area
10. Construction not required for interconnection
Typical Utility Concerns for DER Impacts

- Voltage Regulation
- Protection coordination
- Reverse power flow
- Unintentional islanding
- Increased equipment line duty
- Secondary network backfeed
- Variability due to clouds
- Capacitor switching
### Common Mitigation Strategies

<table>
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<tr>
<th>Type of Strategy in the Interconnection “Toolbox”</th>
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<tr>
<td>Modify protection settings/fuses</td>
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<tr>
<td>Advanced Inverter function use</td>
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<tr>
<td>Power factor controls</td>
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<tr>
<td>Voltage Regulation Devices and Controls</td>
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<tr>
<td>Direct Transfer Trip</td>
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<tr>
<td>Upgrade a feeder or line section</td>
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<tr>
<td>Communication/Control Technology</td>
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<tr>
<td>Grounding transformers</td>
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<tr>
<td>Limiting DER system size for location</td>
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My List of “Interconnection Best Practices”

• Open communication between utility & developer
• Online interconnection applications
  o Ease of tracking project status
  o Applications for small systems, for inverter-based, for synchronous, etc.
• Rational screening approach (often based on FERC SGIP)
• Supplemental screening options
  o Proposed Supplemental Screens are somewhat complex, for now....
  o “Safety Valve” approach to solve simple problems and avoid impact studies is an excellent option (e.g. replace secondary or transformer)
• Standard detailed impact study approach, software
• Cost-effective mitigation strategies
• Supportive regulatory organizations
  o Transparent state guidelines for guiding utility interconnection processes
• Overall streamlined, transparent processes
States overview

- DOE-sponsored Database of State Incentives for Renewables & Efficiency (DSIRE) shows standards or guidelines in all but four states.
  - Two of those states’ regulatory authorities (Alabama and Tennessee) determined that utilities already provide interconnection services, such that state standards are not needed.
- State standards are being updated as lessons are learned, technologies change, markets grow
Note: State standards differ in how the expedited review is structured. Some have multiple expedited levels, different fees, requirements and/or engineering screening.
Continued and rapid growth in distributed PV can challenge the “business as usual” utility interconnection application process.
Pre-Application Reports

- FERC Order 792-Included Pre-Application Reports in FERC Small Generator Interconnection Procedure
  - Requested by the interconnection customer by submitting data in a pre-application report request form (e.g., project contact information, project location, resource type and size, whether the resource will serve onsite load, etc.)
  - $300 Fee
  - Report to be provided within 20 business days of the interconnection customer’s request
  - Report to include existing information about a proposed point of interconnection.
  - E.g. (Capacity of existing and queued generation, voltage, circuit distance to substation, actual or estimated peak and minimum load data, limiting conductor ratings)
Benefits of Pre-Application Reports

Provide more transparency and certainty in the interconnection process, without compromising safety, reliability or power quality

- Reduce time and cost
- Improve customer-utility relations and communication
- Eliminate speculative applications

Source: PEPCO “Alternate Strategies for Pre-Application Reporting and Fast Track Analysis” https://www.nrel.gov/dgic/assets/pdfs/alternatereportingstrategies.pdf
Illinois: $300 fee. Report needs to include only “available data”... no new study required.

Massachusetts: No fee. Optional for < 500kW, required for >500kW. LSE has 10 business days to provide report. LSE identifies all feeders within ¼-mile of proposed site.

New Jersey: “Upon request, the EDC shall meet with an applicant who qualifies for level 2 or level 3 interconnection review, to assist them in preparing the application.”

Vermont: $300 fee. 10-day maximum. Only pre-existing data.
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Examples of Interconnection Best Practices

- Open communication between utility & developer
- Online interconnection applications
- Ease of tracking project status
- Rational screening approach
- Standard “Impact Studies” approach, software
- Cost-effective mitigation strategies
- Supportive regulatory organizations
- Overall streamlined, transparent processes
- Apply for Interconnection prior to construction

Example: Wisconsin PSC 199.02
- requirement for designated POC at each utility
- separation of processing, costs, and timelines for different sizes of systems
- specified timelines to complete the work in each phase of the process
- some clarity and transparency for various levels of review and study


Kristen Ardani and Robert Margolis
National Renewable Energy Laboratory

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC
This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Technical Report
NREL/TP-7500-59000
September 2015

Contract No. DE-AC36-08GO28308

http://www.nrel.gov/docs/fy15osti/65066.pdf
PG&E has dramatically reduced both cycle times and unit costs for Standard NEM

From Jan 2013 through Mar 2016

- Unit costs decreased by a factor of 10
- Resulting in ~$29M of administrative savings

Currently PTOs are issued within 3 Business Days for 90% of completed applications
Other Examples of Process Improvement

Each Hawaii IOU launched their own web-based Integrated Interconnection Queue (IIQ) as part of an October 2014 proposal to address the backlog of DG applications awaiting interconnection.

Allows PV installers to “self-certify” eligible residential projects, thereby acknowledging that all applicable AHJ permitting and utility interconnection requirements have been met.

Online, cloud-computing-based portal for its customers and installers to file applications; Parts of the filing are now automated and have e-signatures.

1) New quality service metric linked to interconnection application processing time; 2) Changes to screening procedures (increased minimum day time load threshold from 15% to 100%).
Subtopic: Hosting Capacity Maps

- **California:**


- **PEPCO, for DC, MD, NJ:** [http://www.pepco.com/Hosting-Capacity-Map.aspx](http://www.pepco.com/Hosting-Capacity-Map.aspx)
Topic 2: Application Process


- **Illinois**: requires on-line searchable interconnection procedures and attachments, plus forms that allow electronic data entry, plus electronic signatures and electronic submission (IAC 83(I)(c)466.60, m and n).

- **Maryland** on-line system:
• **Illinois** provides for expedited reviews for levels 1, 2, & 3.

• **Massachusetts**: Eversource Co. example of: (a) simplified process for radial circuits; (b) simplified for spot network or area network; © expedited/standard for others. [https://www.eversource.com/Content/ema-c/about/doing-business-with-us/builders-contractors/interconnections/massachusetts-application-to-connect](https://www.eversource.com/Content/ema-c/about/doing-business-with-us/builders-contractors/interconnections/massachusetts-application-to-connect)

• **Vermont**, Rule 5.506: Fast track screening complete in 15 days. Criteria depend on grid characteristics at point of common coupling.
**Massachusetts:** for National Grid... The Company decides, as defined by Company-specific technical standards, whether a proposed change is “significant” or “moderate.” Significant means the applicant starts all over from beginning. Moderate means the applicant does not have to reapply, and the Company will “endeavor to complete the Study earlier than that allotted time.”
Pre-Application reports are offered for $750.

Utilities have 10 days from receipt of a request form & payment

Information from applicant to utility and for report back to applicant are defined in Appendix D to NY SIR*

Voltage phasing, distance to 3φ, capacity, fault current, etc.

Utility provides a description of any site-related limits and identifies any concerns

Plant data requirements are well defined as an Application Check List item included in NY SIR

The NY requirements currently apply up to 5 MW

* New York Standard Interconnection Requirements, established 1999 and updated most recently Jan 2017.
Topic 1: Pre-Application Reports, Meetings
New York State Example (2)

- Requests for pre-applications are less common:
  - Since screening added in March 2016
  - With the 2016 development of Red Zone Maps

NGRID “DG Interconnection Siting Map”, updated as of March 2, 2017
Analysis Tools Enable Planning with DER
Hosting Capacity Maps Inform DER Developers

EPRI Hosting Capacity Maps courtesy of NYSEG/RGE

May 2017
Topic 2: Application Process
New York Example

- See NYSIR Appendix F:
  - Standard Form
  - Contract
  - Owner authorizing letter
  - Description and tech details
  - Certification
  - Data sheet and system diagram

- Verification testing by applicant required.
  - May be witnessed by the utility, and a formal letter of acceptance or a list of deficiencies shall be issued by the utility.

- Procedures vary for initiating required work orders, setting of the meter, and certifying completion.
“Expedited” in NY means:
- “Approved for interconnection based on size and type”
- Assumes application is complete and feeder has capacity (networks may be excluded).

NY requires expedited for <50kW if inverter-connected, and <25kW if rotating machine.
- The SIR encourages expedited treatment up to 300kW if inverter-connected and equipment is certified.

Note: “expedited” is not defined in SGIP. “Fast track” is an SGIP process that includes initial review as well as supplemental review.
Topic 3: Simplified & Fast Track Processes
New York Example (2)

- Fast-Track screening in NY means:
  - To apply “A preliminary set of screens”
  - The ideal set of required screens is still evolving
  - See the next slide for the preliminary set of screening criteria that is presently being considered in NY

- Aspirations for Preliminary Screening:
  - clear and simple tests,
  - requiring only readily available feeder data,
  - not requiring engineering judgement, and
  - working toward the future automation of these preliminary screens.

- Failing any preliminary screens then triggers supplemental screening or study options, see next two slides.
An Example of *Preliminary Screens*

A. Is the connection on a networked secondary system?
B. Does the installation use certified equipment?
C. Is the EPS rating exceeded with the addition of DG?
D. Is the aggregate DG, including any DG in the queue, less than 15% of the feeder peak load?
E. Voltage Change Indicator

Two Options

- Is new DG less than 10% of the feeder rating?
- Does new DG cause a voltage rise greater than 3% of nominal?
An Example of *Supplemental* Screens

G. Is supplemental protection necessary? (intends to apply the JU anti-islanding assessment requirement, flow chart, of 2/2017)

H. For non-certified DG, are the required relay protection functions included and configured properly (requires additional submittals with protection details to apply individual utility protection criterion)

I. Can aggregate DG cause voltage variations outside of ANSI limits?

\[
\frac{R_{EPS,MAX}}{V_{ll}^2} \times P_{DG} \times 100 < 5% \\
\]

- **V_{ll}** is average at PCC
- Consider any line regulators in the calculation.

J. If on a network, is the aggregate generation less than the minimum load on any network protector?
Objectives of Technical Evaluation:

1. **Preliminary** screens are well defined, with available system data, allowing a technician-level review and decision, and having the potential to be automated.

2. **Supplemental** screens are a next level of detail, complementing preliminary screens, considering aggregated DG:
   - they will require engineering judgment and sometimes involve definitions of required system upgrades;
   - they also leverage growing interconnection experience and expertise.

- **Studies** may be informed by screening and usually investigate:
  - steady-state overvoltage, risk of thermal overload, protection coordination and compatibility, changes in distribution system grounding, and voltage regulation within ANSI limits.
Queue management became a problem in NY with changing conditions:
- Evolving application practices
- Changing economics for solar PV
- Changing state incentives and virtual net metering options

Applications were suddenly for larger size systems, more difficult to fast track, and often requiring studies

Economic uncertainty stalled projects in queue

See NY DPS, Case 16-E-0560, attachment A, Queue Management Plan
Topic 5: “Material Modifications”
New York Example

- Related to queue position, NY now requires a property owner consent verification, payment for study and payment of 25% for grid upgrades
  - There is a cost for supplemental review or studies
  - Studies define upgrade requirements and associated costs.
- Regarding feeder capacity limits and potential upgrade costs, NY has recently put forth “cost sharing” rules for upgrades > $250k.
  - Applicability – aggregate size > 200kW, at the same PCC where upgrades benefit more than one project, single developer
  - Subsequent developers are required to pay prorated share

Note: the SGIP refers also to plant “operating characteristics” in material modifications. This brings up grid support functions. Most DG connected under IEEE 1547 2003 didn’t provide grid support. This is now changing with the new 1547 and ideas around smart inverters.
Next Steps

• **Prep Questions** for June 2 In-Person went out Wed. May 3rd to the DGWG email list. **NOTE:** Corrected Questions sent 5/5.

• **June 2nd In-Person Meeting:** Pre-app report; Application requirements; Queue type & process; Material Modification Definition; Fast Track; Site Control

• **June 23rd Webinar:** Online Application Process; Engineering Screens; Study Process; Process Timelines & Extensions; Dispute Resolution; Transmission Provider Engagement; Solar Pathways Update