

DG Interconnection Seminar

October 20, 2016

National Grid

1101 Turnpike Street, North Andover, MA 01845

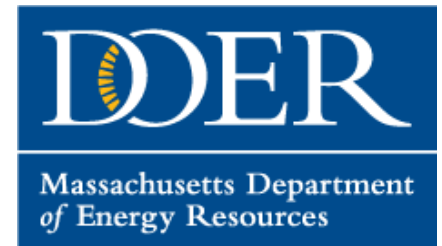
Auditorium



Co-Hosts

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Agenda

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- 8:30 Registration**
- 9:00 Welcome, Opening Remarks – Kevin G. Kelly / John Kennedy**
- 9:15 Interconnection Process & Timing – Jim Ryan**
- 10:00 Interconnection Developments – Tim Roughan**
- 10:40 Break**
- 10:45 First Bill Walk Down - National Grid Panel**
- 11:10 Interconnection Technical Session - National Grid Panel**
- 11:30 Post ISA Coordination & Wrap up - Vishal Ahirrao**
- 12:00 Questions and Answer Session - National Grid Panel**
- 12:30 Adjourn**

Logistics & Introductions

- Facilities
 - Emergency Exits
 - Restrooms
 - Designated smoking areas
 - Mobile Phones
- Introductions
 - DOER / Mass CEC
 - MA Utilities
 - Guests

Safety Moment – Fall Sun Glare

- **Wear good pair of polarized sunglasses**
- **Anticipate sun glare at areas where glare may be a factor; use your sun visor**
- **Adjust travel times**
- **Clean windshield; dirty glass can act as a prism; don't forget the inside**
- **Avoid vinyl cleaners that give dashboard high-gloss finish**
- **Clean headlights; dirty headlights can reduce efficiency as much as 90 percent**
- **Allow more space between you and vehicle in front of you; glare will cause unexpected slowdowns**
- **Keep scanning; look for flashes of light at hilltops, curves and intersections that may indicate the headlights of other vehicles**
- **Nights are becoming longer too and we lose advantage of color and contrast that we have during the day. Depth-perception and peripheral vision are diminished.**

DOER Welcome Slide

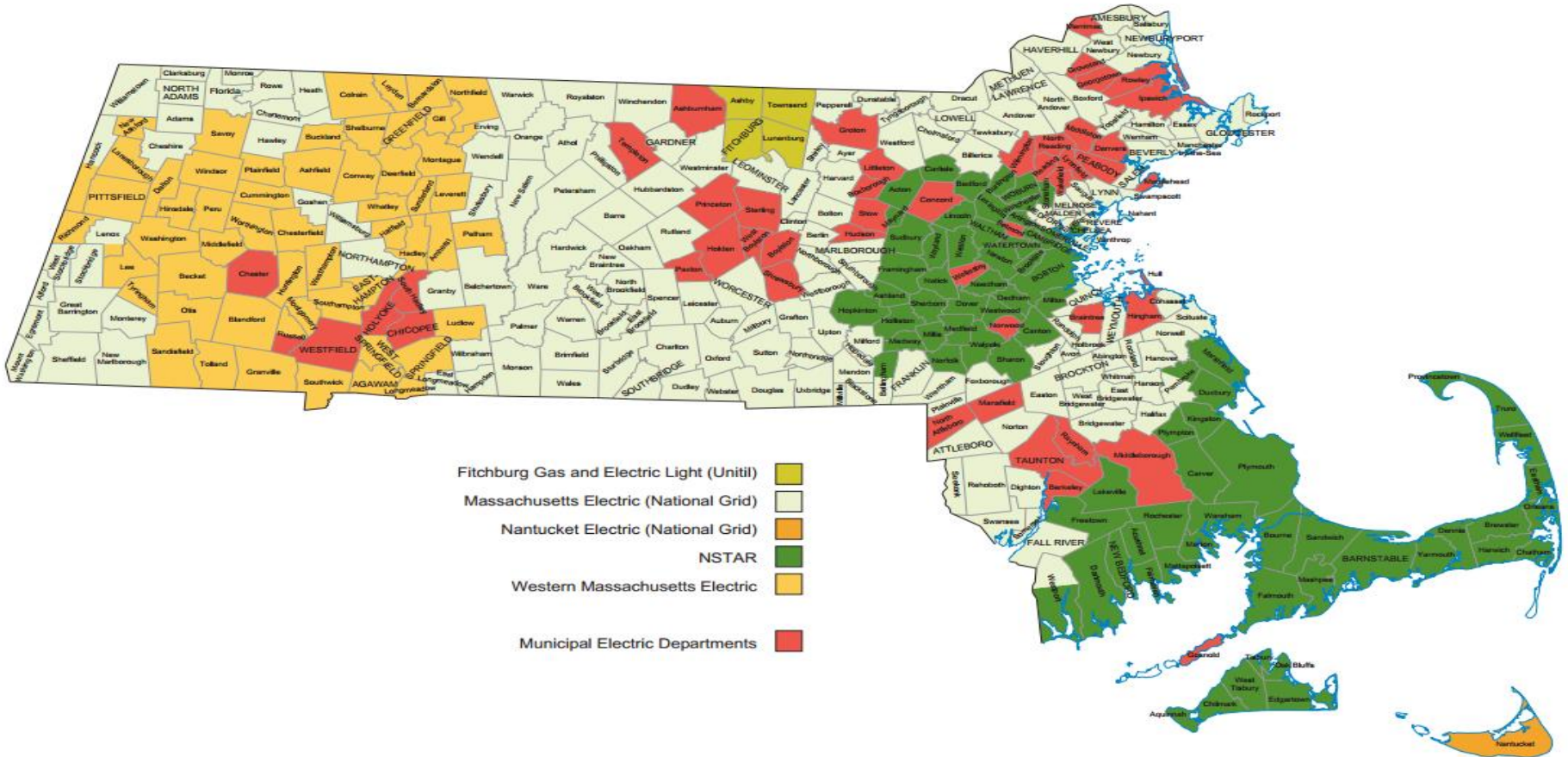
DOER's role in Distributed Generation:

- **Assisting with incentives for clean energy**
 - **Portfolio Standards (RPS/SRECs/APS)**
 - **Net Metering**
- **Increasing awareness about policies**
 - **Interconnection**
 - **Rates**
 - **System Planning / Service Quality**
- **Advising on new policies**
 - **Streamlining Interconnection**
 - **Hands-on assistance with challenging projects**

Massachusetts Electric Utilities

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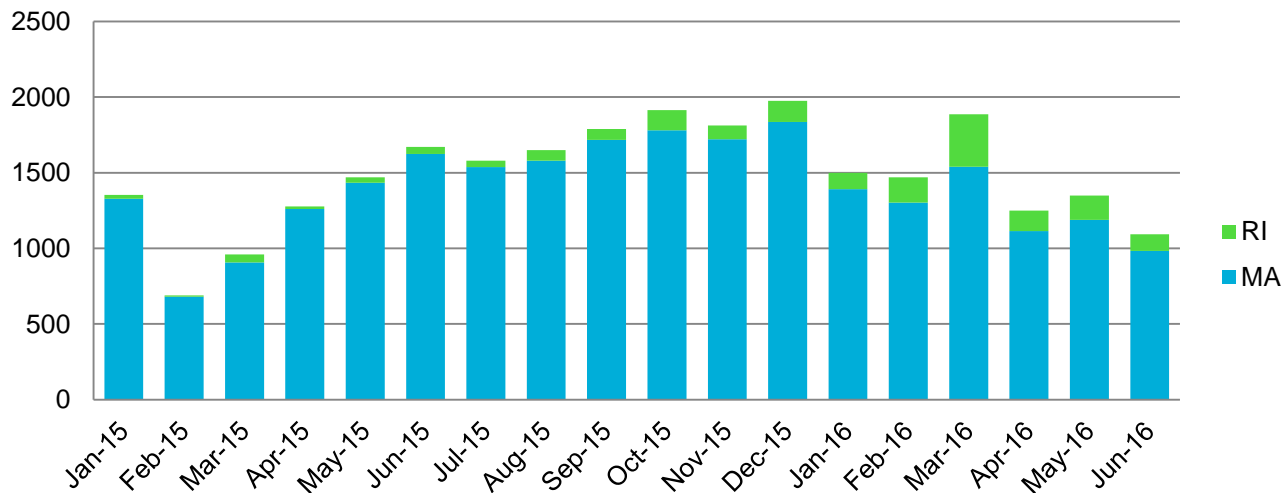
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DG Activity Trends - NE

- Received **8,549** interconnection applications representing about **190 MW** thru June 2016 compared to **7,421** applications / **278 MW** same period last year.
- Small (<100kW) Interconnection application are triggering large studies because of the aggregate generation on the circuit.

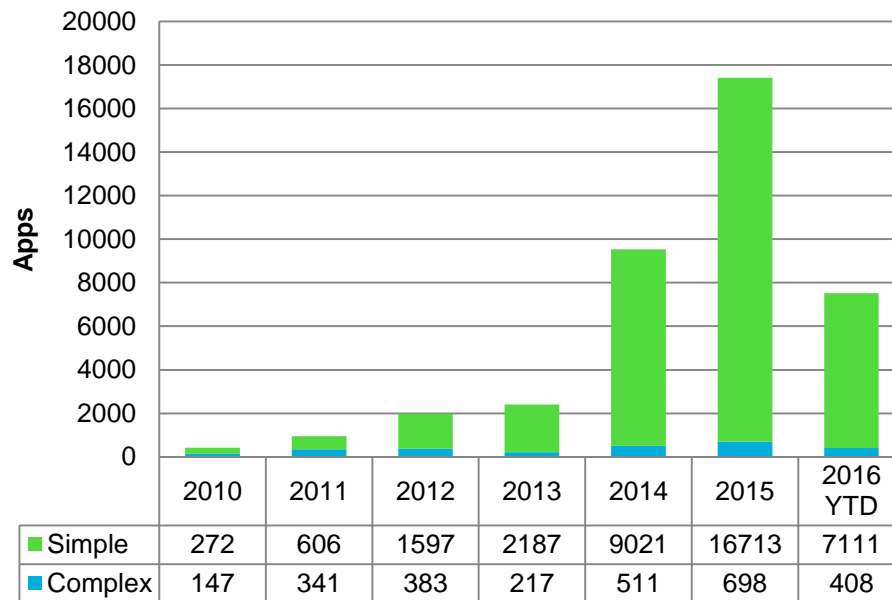
NE Applications Received



DG Activity Trends - MA

- Received 7,519 applications representing 138.1 MW YTD through June 2016
- Received 7,237 applications representing 248 MW during the same period last year

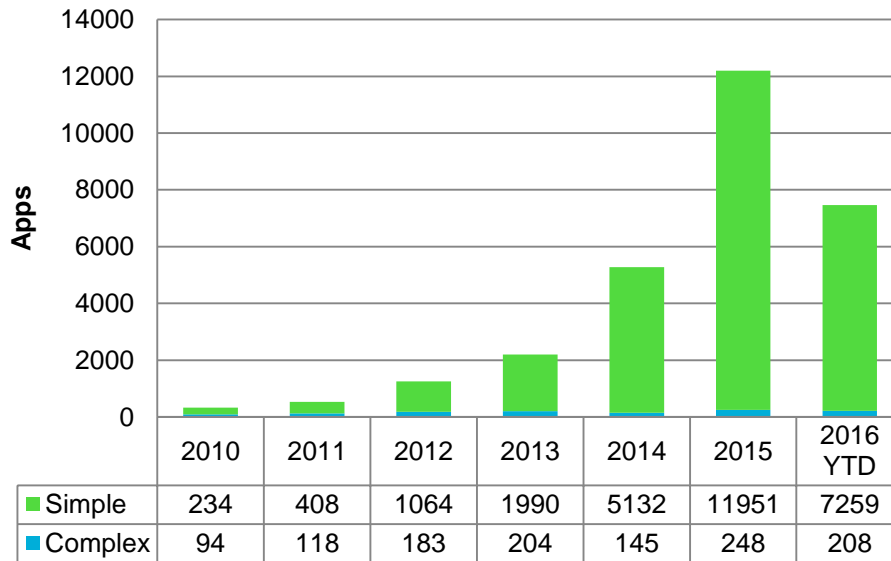
MA Apps Rec'd



DG Activity Trends - MA

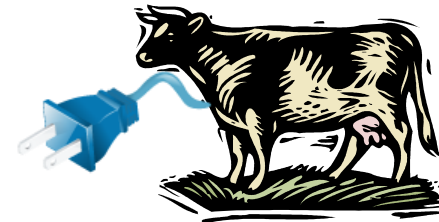
- Interconnected 7,467 apps representing 82 MW YTD through June 2016
- Interconnected 4,994 apps representing 57.7 MW during the same period last year

MA Apps Int'd



DG Interconnection Process

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Technical Sales & Engineering Support


Interconnection Discussion Agenda

- The purpose of the Interconnection Process
- Interconnection Process
 - Steps
 - Costs
 - Timetable
- Common Missteps
- Contacts and links for additional information

Importance of the Interconnection Process

- **Safety** of utility workers and general public
- **No adverse impact** to power quality, in terms of:
 - Islanding
 - Transient Voltage Conditions
 - Noise and Harmonics
 - Frequency
 - Voltage Level
 - Machine Reactive Capability
- **Per tariff: customers cannot interconnect without an interconnection agreement and approval.** You proceed at your own risk if you don't have utility approval.
- Billing implications

Interconnection Process Steps

- 
- Pre-Application
 - Simplified Application
 - Expedited/Standard Application
 - Impact Study and Detailed Study
 - Conditional Approval (to construct DG system)
 - National Grid Construction
 - Witness Test
 - Authorization to Interconnect

https://www.nationalgridus.com/masselectric/home/energyeff/4_interconnection-process.asp

http://ngridustest/narragansett/home/energyeff/4_interconnection-process.asp

Pre-Application Report

Customer provides:

- Contact and alternative contact Information
- Facility Location (street address with cross streets, including town, and a Google Map still picture and GPS coordinates):
- Generation type, size (AC kW), single or three phase, service configuration:
- Stand-alone (no on-site load, not including parasitic load)?
- If there is existing service at the Proposed Facility site, provide: Interconnecting Customer Account Number
- Site minimum and maximum (if available) current or proposed electric loads:
- Is new service or service upgrade needed?

Utility provides:

- Circuit voltage, circuit number
- Whether single or three phase is available near site; If single phase – distance from three phase service;
- Aggregate of connected Facilities (kW) on circuit;
- Aggregate of not yet connected (kW) on circuit
- Whether the Interconnecting Customer is served by an area network, a spot network, or radial system;
- Identification of feeders within ¼ mile
- Other potential system constraints or critical items

It Starts With The Application

- **A complete complex application package includes:**
 - Complete application, signed and dated, with generator info
 - Pre-application (for projects over 500kW)
 - Application Fee (\$300 minimum; \$4.50 / kW – max of \$7,500)
 - PE-Stamped 1-line diagram showing metering (relay settings if < 500kW)
 - Site Diagram showing electric service location, generator location, AC Utility Disconnect, metering, access to metering and disconnect
- Documentation problems “stop the clock” (Reference ESB756 as a guide to avoid customer/contractor holds in the process).
- Electronic documents preferred - however, mail first page of application with application fee

Simplified Review Path

- Single phase, UL Listed, inverter based systems **15kW** (was previously 10 kW) or less on a single phase service on a radial feed
- Three phase, UL List, inverter based systems **25kW** or less on a three phase service on a radial feed.
- Listed (*UL 1741.1*) inverters, that comply with current IEEE 1547 standard, or have nationally recognized test lab results
- Additional 5 days for review if screen 5 is not met (project isn't compatible with existing service, e.g. loading on existing service transformer, etc.)
 - Does not apply to non-listed inverters or other generators (induction / synchronous / asynchronous)
 - Does not apply to aggregate generation capacity of listed inverters that exceed the above-mentioned limits

Simplified Review Path

- Submit complete, signed application
- Approval usually within 10 business days, unless project not compatible with service
- Install system and get Certificate of Completion (COC) signed by local wiring inspector – submit to utility with electrical permit
- Utility will change meter for net metering
- Utility inspects within 10 days of receipt of COC – utility can waive inspection
- Advantages of Simplified
 - No cost to customer (95% of cases)
 - Waived Application and Witness Test Fees
 - Rapid approval

	Simplified Process
Eligible Facilities	Listed Small Inverter DG
Acknowledge Receipt of Application (Note 2)	(3 days)
Review Application for Completeness	10 days
Complete Review of All Screens	15 days - 20 Days (note 3)
Send Executable Agreement (Note 4)	Done
Construction Schedule	By Mutual Agreement
Total Maximum Days (Note 5)	25/30 days (Pg. 44, Note 5)
Notice/ Witness Test	< 1 day with 10 day notice or by mutual agreement

Expedited Review Path

- Single phase customers with listed single-phase inverter based systems **>15 kW** on a radial feed
- Three phase customers with listed three-phase inverter based systems **>25kW** on a radial feed
- Maximum size is based on review of screens
- **Does not Apply to:**
 - Non-listed inverters or other generators (induction / synchronous / asynchronous)
 - When aggregate generation capacity of listed inverters exceeds the above-mentioned limits

Expedited Review Path

- Often little or no System Modifications required. If meter only – usually no cost
- Application fee plus any Supplemental Review charges up to 30 hours of engineering time @ \$150/hr. (if needed)
- Relay control system must be well defined to make supplemental review easier.
- Witness test fee of up to \$300 plus travel may be required

	Expedited
Eligible Facilities	Listed Inverter DG
Acknowledge Receipt of Application (Note 2)	(3 days)
Review Application for Completeness	10 days
Complete Review of All Screens	25 days
Complete Supplemental Review (if needed) (Note 3)	20 days or Standard Process
Send Executable Agreement (Note 4)	10 days
Construction Schedule	By Mutual Agreement
Total Maximum Days (Note 5)	45/65 days (Note 5)
Notice/ Witness Test	< 1 day with 10 day notice or by mutual agreement

Supplemental Review

- If any screens are not passed, the Company may provide a **Supplemental Review Agreement** before providing an Interconnection Service Agreement
- Key threshold is whether aggregate generation is less than **67%** of minimum load on the feeder. Other screens review voltage quality, reliability and safety to reduce the potential need for impact studies.
- Customer signs agreement and pays fee (max \$4,500).
- Supplemental Review may determine if any System Modifications are required. If no Impact Study is needed an Interconnection Service Agreement will be sent to customer detailing:
 - System Modifications, reasoning, and costs
 - Specifics on protection requirements
- If Supplemental Review cannot determine requirements, an Impact Study Agreement (or equal) will be sent to the customer. Shifts to standard process.

Standard Review Path

- Applies to:
 - Non-listed inverters or other generators:
 - Induction, Synchronous, Asynchronous
- Large-scale PV (500kW or greater)
- Most CHP systems
- *** Any project that requires more than 30 hours of engineering time to identify System Modifications.

Standard Review Path

- After initial review customer may need to enter Standard Process
- Impact Study will determine impact on EPS, other customers, other generators
- Detailed Study will determine System Modifications required and cost (Risk of Islanding)
- ISO notification may be required
- Transmission Study may be required
- Interconnection Service Agreement provided after studies completed
- Witness test fee is actual cost
- There is a “Standard Process Complex Projects” track
- Allows more time for studies (see notes 4 and 5, pg. 48 MDPU 1248)

	Standard
Eligible Facilities	Any DG
Acknowledge Receipt of Application (Note 2)	(3 days)
Review Application for Completeness	10 days
Complete Standard Process Initial Review	20 days
Send Follow-on Studies Cost/Agreement	5 days
Complete Impact Study (if needed)	55 days
Complete Detailed Study (if needed)	30 days
Send Executable Agreement (Note 3)	15 days
Construction Schedule	By Mutual Agreement
Total Maximum Days (Note 5)	135/200 days (Note 5)
Notice/ Witness Test	10 days or by mutual agreement

Technical Issues: Limits on Distribution EPS - Radial

- Interconnection Applications on **non-dedicated** circuits:
 - Largest wind application is 4.5 MVA on 13 kV class circuits
 - Largest Solar application is 6 MVA on 23 kV class circuits
- Interconnection Applications on **express(no load)** circuits:
 - Largest wind application is 30 MVA on 34.5 kV class circuits
 - Largest Solar application is 14 MVA on 13 kV class circuits

M.D.P.U. 1248 Tariff Update

- New Definitions
- Revised definitions to align with net metering definitions as applicable
- New definitions related to the new Group Study process, Section 3.4
- New definition of “Compliance Documentation”
- New definition of “Landowner” to set up new Landowner Consent Agreement (Exhibit I / Attachment 6 to ISA)
- Revised definition of “Nameplate Capacity” (in general section, as well as in Schedule Z)
- Revised definition of “Time Frames” to refer to annual reporting of compliance with the timeline enforcement mechanism (“TEM”), established by D.P.U. 11-75-F

Timeline Compliance And “Holds”

- Study “on hold” until company receives the requested info from customer
- If an applicant requests additional time at or near a milestone, the Company will get additional time to achieve that milestone
- If an applicant requests a significant project change -- as determined by the company - the applicant will be required to submit a new interconnection application
- Recent examples – change of inverter could necessitate longer study and be deemed moderate/ significant change (case by case basis)
- At any time, an applicant may request a review of time-frame compliance by the company, and the company must respond within ten business days
- There is a process to remove customers from the “queue” if they don’t abide by the timelines or extensions
- Customer can request refund of application fee if the Company does not comply with timeline(s)

Interconnection Costs

- Application Fee
- Studies: Supplemental Review, Impact Study, Detailed Study, Transmission
 - Not all projects will require Impact or Detailed Studies, or System Mods
- System Modifications
- Witness Test Fee(s)
- Design, construction and installation of the Interconnection Facilities

Common Application Mistakes

- Application not signed and dated
- Name on application differs from name on utility account
- Address of facility incorrect
- Ownership of property not identified
- Utility account or meter number not included or incorrect
- Number of inverters not indicated
- Landowner not identified
- If new service, call Work Order Service group (800-375-7405): request service and write application “pending” account number and WR#.

Documentation Mistakes

- Legal Info Document incorrectly represents intent of the parties
 - Third party ownership of generator
 - Legal Info Doc used to prepare Interconnection Service Agreements
- 1-line Diagram Errors:
 - Diagram doesn't showing all equipment, including all metering
 - Transformer impedance data (% Z; X/R ratio) missing
 - Relay settings and islanding detection needed on larger projects
- Site Plan Errors:
 - Doesn't show location of metering, or incoming service, or transformer, or access road, or AC Utility Disconnect

Completion Documentation

- PE-Stamped As-Built 1-line Diagrams – signed and dated
- Certificate Of Completion – signed and dated
- Commissioning Memo – signed and dated
- Schedule Z – signed and dated with correct account numbers
- Municipal Inspection – if needed – Inspector MUST call in
- Net Metering Allocation (could be a Qualifying Facility instead)
- (5) quality photos needed (with legible labels/plaques)
 - AC Utility Disconnect
 - Inverters / Generator
 - Pad-mount transformer
 - Current Limiting Device
 - Meter Socket

Behind the scenes at the utility...

- Review and replacement of metering, modifications to billing
- Modifications to protection systems as required (e.g. replace or install fusing, install switch, modify breaker/recloser set-points, transfer trip, etc.)
- Larger generators require review by NEPOOL reliability committee and registration with ISO-NE
- Adding generation asset to geographic information systems, maps, system one-lines, dispatch systems, etc.
- Publish internal special operating guidelines for utility field personnel on larger generators.
- Set up future testing for relay protection, meter calibration, insurance tracking, etc.

Many Stakeholders Involved

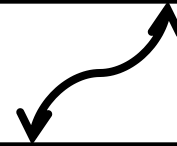
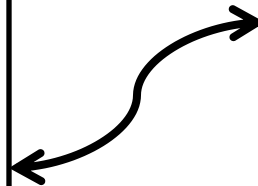
Utility

- Application analyst – processes application, agreements and assists with construction coordination
- Lead Engineer for reviews/studies
- Relay Engineering
- Distribution Planning
- Distribution Dispatch
- Distribution Design Engineering
- Meter Operations
- Meter Engineering
- Meter Data Services
- Relay Telecom Operations
- Inspection team
- Customer Service / Billing
- Legal...

Interconnecting Customer

- Customer
- Equipment vendor
- Lead contractor
- Electrician
- Electrical Engineer (PE)
- Relay Engineer
- Relay testing firm
- Legal

ISO-NE
(If necessary)



Summary and Recommendations

- **Submit your interconnection application with National Grid early**, during conception phase before committing to buy no matter how simple or small the DG might be.
- You can always request general utility information about a specific location from your utility
- Large interconnection applications take longer to study
- The Interconnection Tariff is a wealth of information
- Time frames are standard working days and do not include delays due to missing information or force majeure events

National Grid Contacts & Tariff Links



Director: Kevin G. Kelly | (978) 725-1325

Manager-NE: John Kennedy | (401) 784-7221

MA: Vishal Ahirrao | (781) 907-3002, Alex Kuriakose | (781) 907-1643, Eric Munzert | (781) 907-3833, Bob Moran | (508) 897-5656, Hakob Mkrtchyan | (781) 907-1516, John Rathbun | (631) 755-5376, Jim Ryan | (781) 907-2462, Colin Sullivan | (781) 907-2937, Patrick Sullivan | (781) 907-1686
(Filling four additional FTE's)

RI: Diane Edwards | (401) 784-7221 , Harmony Smith | (401) 267-6622

Screening Team: Andy Garsils | (631) 755-5303, Nicolae Gari | (781) 907-2018,
Joshua Dibia | (516) 545-4778

Analysts: Chandra Bilsky | (401) 784-7174, Pam Hill | (508) 860-6673

Department Email: Distributed.Generation@nationalgrid.com

MA Website: http://www.nationalgridus.com/masselectric/business/energyeff/4_interconnection-process.asp

RI Website: https://www.nationalgridus.com/narragansett/home/energyeff/distributed_generation.asp

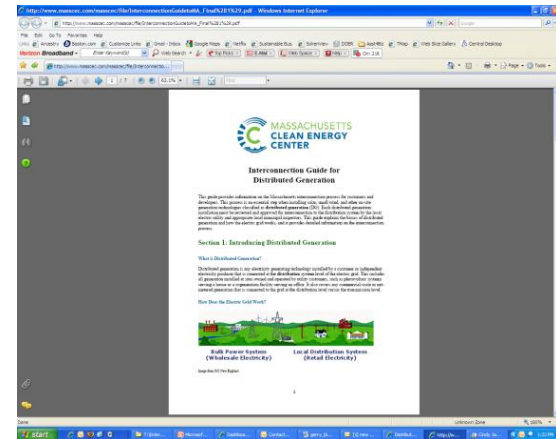
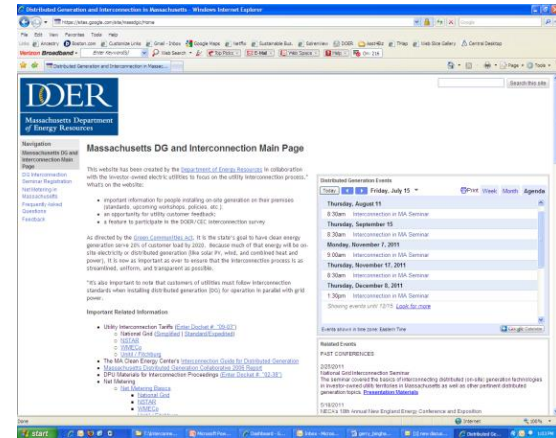
Customer Contact Center: 1-800-322-3223

Other MA Utility Contacts & Tariff Links

- **Eversource ~ NSTAR (Eastern Mass) DG team**
 - **Pyong Bruce Kim(Simplified) | (781) 441-8285 (Pyong.Kim@eversource.com)**
 - **Complex | (781) 441-8196**
 - **Email: emdg@eversource.com**
 - **<https://www.eversource.com/Content/ema-c/residential/programs-services/customer-generation>**
- **Eversource ~WM DG team (WMECo)**
 - **Phone: 413-787-1087**
 - **Email: wmdg@eversource.com**
 - **<https://www.eversource.com/Content/wma/residential/programs-services/customer-generation>**
- **Unitil**
 - **Phone: 603-773-6480**
 - **Email: (generator@unitil.com)**
 - **<http://www.unitil.com/energy-for-residents/electric-information/distributed-energy-resources/renewable-energy-generation>**

Other Information Resources

- **MA DG and Interconnection Website:**
<http://sites.google.com/site/massdgc/>
- **Net Metering Basics:**
<https://sites.google.com/site/massdgc/home/net-metering>
- **Interconnection Guide for Distributed Generation (Mass-CEC):**
<http://files.masscec.com/uploads/attachments/InterconnectionGuideforDistributedGeneration.pdf>



Process & Recent Events

- Net Metering
- ISO-New England
- Group Study Process
 - Other Events

Regulatory ~ Tim Roughan

Net Metering in Massachusetts

- December 2009 Net Metering Tariff, updated July 2012 by DPU.
 - DPU has issued clarifying orders in August 2012, and July 2013
- Net Metering means the process of measuring the difference between electricity delivered by a Distribution Company and the electricity generated by a Class 1, Class II, or Class III Net Metering Facility and fed back to the Distribution Company.
- Three Classes of Net Metering Facilities in Net Metering Tariff:
 - Class 1: Any generator up to 60 KW is eligible
 - Class 2: Agricultural, anaerobic digester, solar, or wind net metering facility over 60 KW but less than or equal to 1 MW (for municipal or government it's "per unit")
 - Class 3: Agricultural, anaerobic digester, solar, or wind net metering facility over 1 MW but less than or equal to 2 MW (for municipal or government it's "per unit")

Net Metering Credits

- Energy use is “netted” over the billing period, typically a month
- If there is net energy usage, Host Customer is billed for net purchases.
 - If there is net energy sales, credit is export kWh times the following
 - Credit is calculated on host customer’s rate

Class	min	max	Type	Credit the following charges			
				Default Service kWh **	Dist-ribution kWh	Trans-mission kWh	Trans-ition kWh
I	0	60 KW	Agricultural, Anaerobic Digestion, Solar, Wind	X	X	X	X
I*	0	60 KW	All Other				
II	>60 KW	1 MW	Agricultural, Anaerobic Digestion, Solar, Wind	X	X	X	X
III	>1 MW	2 MW	Agricultural, Anaerobic Digestion, Solar, Wind	X	Gov’t only	X	X

- Customer still responsible for customer charges and demand charges, even if net export
- Tariff allows credits to be allocated (with limitations)

Notes: 1.) Class I* All Other (Non-Renewable) = Credited at average monthly clearing price set by ISO-NE.
2.) Default Service kWh ** = Fixed default service rate.

Net Metering Changes April 2016

- Increased private percentage from 4% to 7%
 - Increases from 205 MWs to 360 MWs
- Increased public percentage from 5% to 8%
 - Increases from 256 MWs to 410 MWs
- Reduces private compensation to 60% of current for Class I, II systems, close to current Class II compensation
 - Class II and III are now essentially equivalent
 - In effect once 1,600 MWs DC are qualified

Net Metering

- Class 2 and Class 3 projects will need a production meter on generation.
- Net Metering is limited to 7% of each utility's peak MW for private and 8% of peak for public projects.
- Contribution towards total is posted on each utility's web site and updated monthly; also MASSACA website updated daily www.massaca.org

Private: Available, Interconnected, Reserved and Pending Capacity (Values in kW)

Company	Net Metering Cap	Interconnected (a)	Reserved Cap Allocations (b)	Pending Cap Allocations (c)	Capacity Available Under Cap (e)	Waiting List (d)
NGrid	359,170	144,434	201,667	408	12,662	19,199

Cap data as of 7/19/16

Public: Available, Interconnected, Reserved and Pending Capacity (Values in kW)

Company	Net Metering Cap	Interconnected (a)	Reserved Cap Allocations (b)	Pending Cap Allocations (c)	Capacity Available Under Cap (e)	Waiting List (d)
NGrid	410,480	213,150	115,440	9,119	72,771	0

- All non-Simplified Applications for net metering must receive a Cap Allocation via the System of Assurance (SoA) at <http://www.MassACA.org>.
- Guidance on submitting an Application for Cap Allocation is available at:
 - <http://www.massaca.org/help.asp>,
 - via the Help@MassACA.org email,
 - or the MassACA Helpline (877) 357-9030
- Need to determine whether project is a “Public” or a “Private” Facility
 - **Public:** Host Customer is certified as a Municipality or Other Governmental Entity by the DPU and has Class II or Class III Facility. Host Customer allocates to only customers who are certified Public. Ten MW limit per entity in Massachusetts.
 - Must apply to DPU to be certified as a Public Facility
 - Host Customer and all allocated customers must get this certification as a Public Facility
 - Need to send copy of certificate(s) to utility
 - **Private:** All other Host Customers.

Net Metering 'Eligibility'

- **Three Factor Approach (order 11-11C, issued 8/24/12)**
 - **Single parcel / single interconnection point / single meter**
 - **Enacted to limit gaming and limits one meter per parcel of land with a limit of 2 MWs on the parcel for private entities**
 - **A governmental entity can have a total of 10 MWs of net-metered accounts throughout the state or on a parcel**
 - **No more 6 – 1 MW projects on a parcel**
 - **We can not provide more than one interconnection point (POI)**
 - **Otherwise separate metered project could earn higher credits than if it was behind an existing meter**

Net Metering 'Eligibility'

- 11-11E issued 7/1/13
 - Allows for 'an exception for optimal interconnection'.
 - Utility can have more than one interconnection point and meter for technical and/or operational reasons
 - Still only allows one net-metering facility per parcel
 - Customers can petition DPU for exceptions
 - Can have a separate meter for net metering facility along with other non-net meter meters on the single parcel
- Company will determine if customer's proposed configuration is technically 'eligible' for net metering as soon as it can
 - Could be upon application, or not until the project has been through screening or initial review
 - Customer must be 'qualified' for net metering by applying to the SoA.
 - Company can not provide net metering without proof of this 'qualification'. If on waiting list we could set up customer as a QF (**Qualifying Facility**) and pay for excess at the hourly clearing price at the ISO-NE for the load zone where project is located.

Net Metering – filling out Schedule Z

- **Need to fill out Schedule Z**
- **Next four (4) slides show how to fill out**
- **Company will not allow any customer to bid in capacity to the ISO-NE Forward Capacity Market**

Net Metering – filling out Schedule Z

- Allocation of credits from host site
- Make sure the amount of net metering credits expected on an annual basis can be used to pay allocatee accounts
 - Can't allocate to each individual electric account more than the amount of its annual bill
 - Need to look at 2-3 years of billings by account to determine percent allocation by account of the total
 - E.g., if police station averages 15% of the total town's electric bills, then insert 15% into Schedule Z for the police station account.
 - Company can not cut checks after the fact to 'fix' a mis-allocation, so please do the math upfront

For Example Only – Your Answers May Vary

Schedule Z – Additional Information Required for Net Metering Service

Please fill out the form completely.

Primary Account Holder

Host Customer Name: John Doe Telephone: 413-123-4567

Address of Facility: 123 Main Street, Town, MA 01000

Billing Account Number: 541234567891

Meter Number: 112233445 Application ID Number: 2A100-2000

Is the Host Customer a: _____ Municipality _____ Other Governmental Entity

If so, submit certification provided by the DPU when obtained.

Complete if applicable, otherwise leave blank

A) Is the Host Customer applying for net metering service an electric company, generation company, aggregator, supplier, energy marketer, or energy broker, as those terms are used in M.G.L. c. 164, §§ 1 and 1F and 220 C.M.R. §11.00?

No
 Yes (you are not eligible for net metering service)

NOTE: Definitions are:

“Electric company” means a corporation organized under the laws of the commonwealth for the purpose of making by means of water power, steam power or otherwise and for selling, transmitting, distributing, transmitting and selling, or distributing and selling, electricity within the commonwealth, or authorized by special act so to do, even though subsequently authorized to make or sell gas; provided, however, that electric company shall not mean an alternative energy producer; provided further, that a distribution company shall not include an entity which owns or operates a plant or equipment used to produce electricity, steam and chilled water, or an affiliate engaged solely in the provision of such electricity, steam and chilled water, where the electricity produced by such entity or its affiliate is primarily for the benefit of hospitals and nonprofit educational institutions, and where such plant or equipment was in operation before January 1, 1986; and provided further, that electric company shall not mean a corporation only transmitting and selling, or only transmitting, electricity unless such corporation is affiliated with an electric company organized under the laws of the commonwealth for the purpose of distributing and selling, or distributing only, electricity within the commonwealth. G.L. c. 164, § 1.

“Generation company” means a company engaged in the business of producing, manufacturing or generating electricity or related services or products, including but not limited to, renewable energy generation attributes for retail sale to the public. G.L. c. 164, § 1.

“Aggregator” means an entity which groups together electricity Customers for retail sale purposes, except for public entities, quasi-public entities or authorities, or subsidiary organizations thereof, established under the laws of the commonwealth. G.L. c. 164, § 1.

“Supplier” means any supplier of generation service to retail Customers, including power marketers, brokers and marketing affiliates of distribution companies, except that no electric company shall be considered a supplier. G.L. c. 164, § 1.

For the terms “energy marketer” and “energy broker,” please use the definition for “Electricity Broker,” which means an entity, including but not limited to an Aggregator, which facilitates or otherwise arranges for the purchase and sale of electricity and related services to Retail Customers, but does not sell electricity. Public Aggregators shall not be considered Electricity Brokers. 220 C.M.R. 11.02.

Does not apply to solar or wind

B) If applying for Net Metering as an Agricultural Net Metering Facility, please answer the following questions:

1) Is the Agricultural Net Metering Facility operated as part of an agricultural business?
 Yes
 No (the facility is not eligible for Net Metering as an Agricultural Net Metering Facility)

Complete if applicable, otherwise leave blank

2) Has the Commissioner of the Department of Agriculture recognized the business as an agricultural business?
 Yes
 No

3) Is the Agricultural Net Metering Facility located on land owned or controlled by the agricultural business mentioned in Item B.1 above?
 Yes
 No (the facility is not eligible for Net Metering as an Agricultural Net Metering Facility)

4) Is the energy from the Agricultural Net Metering Facility used to provide electricity to metered accounts of the agricultural business mentioned in Item B.1 above?
 Yes
 No (the facility is not eligible for Net Metering as an Agricultural Net Metering Facility)

Complete if applicable, otherwise leave blank

C) If applying for neighborhood net metering, please answer the following questions:

1) Are all participants served by the same distribution company? Yes No
2) Are all participants served by the same ISO-NE load zone? Yes No
3) Do all participants reside in the same municipality? Yes No

NOTE: If any of the answers to the questions in Item C are no, then the facility is ineligible for neighborhood net metering unless granted an exception by the Department of Public Utilities under 220 C.M.R. §18.09(6).

D) Please indicate how the Host Customer will report to the Company the amount of electricity generated by the net metering facility. The information is due twice each year: (1) by January 31 for the prior year’s generation; (2) by September 30 for the year-to-date generation:

Provide the Company access to their ISO-NE GIS account
 Provide the Company access to their metering or inverter data
 Provide the Company with a report in writing of the generation by January 31 and again on September 30 each year

E) For any Billing Period in which the Host Customer earns Net Metering Credits, please indicate how the Distribution Company will apply them:

Select One

Apply all of the Net Metering Credits to the account of the Host Customer (Skip Items F and G)
 Allocate all the Net Metering Credits to the accounts of eligible Customers (Class I and II Net Metering Facilities skip Item F)
 Both apply a portion of the Net Metering Credits to the Host Customer’s account and allocate a portion to the accounts of eligible Customers (Class I and II Net Metering Facilities skip Item F)

For the terms "energy marketer" and "energy broker," please use the definition for "Electricity Broker," which means an entity, including but not limited to an Aggregator, which facilitates or otherwise arranges for the purchase and sale of electricity and related services to Retail Customers, but does not sell electricity. Public Aggregators shall not be considered Electricity Brokers. 220 C.M.R. 11.02

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- 3) Is the Agricultural Net Metering Facility located on land owned or controlled by the agricultural business mentioned in Item B.1 above?
 Yes
 No (the facility is not eligible for Net Metering as an Agricultural Net Metering Facility)
- 4) Is the energy from the Agricultural Net Metering Facility used to provide electricity to metered accounts of the agricultural business mentioned in Item B.1 above?
 Yes
 No (the facility is not eligible for Net Metering as an Agricultural Net Metering Facility)

Complete if applicable otherwise leave blank

C) If applying for neighborhood net metering, please answer the following questions:

- 1) Are all participants served by the same distribution company? Yes No
- 2) Are all participants served by the same ISO-NE load zone? Yes No
- 3) Do all participants reside in the same municipality? Yes No

NOTE: If any of the answers to the questions in Item C are no, then the facility is ineligible for neighborhood net metering unless granted an exception by the Department of Public Utilities under 220 C.M.R. §18.09(6).

D) Please indicate how the Host Customer will report to the Company the amount of electricity generated by the net metering facility. The information is due twice each year: (1) by January 31 for the prior year's generation; (2) by September 30 for the year-to-date generation:

- Provide the Company access to their ISO-NE GIS account
- Provide the Company access to their metering or inverter data
- Provide the Company with a report in writing of the generation by January 31 and again on September 30 each year

E) For any Billing Period in which the Host Customer earns Net Metering Credits, please indicate how the Distribution Company will apply them:

- Apply all of the Net Metering Credits to the account of the Host Customer (Skip Items F and G)
- Allocate all the Net Metering Credits to the accounts of eligible Customers (Class I and II Net Metering Facilities skip Item F)
- Both apply a portion of the Net Metering Credits to the Host Customer's account and allocate a portion to the accounts of eligible Customers (Class I and II Net Metering Facilities skip Item F)

Select One

F) If the Host Customer has a Class III Net Metering Facility, please indicate below the range that best represents the number of eligible Customer accounts to which Net Metering Credits would be allocated. Alternatively, please complete Item G. This information will allow the Company to exercise its option to purchase Net Metering Credits from the Host Customer rather than allocating such credits.

The Company will notify the Host Customer within 30 days of the filing of Schedule Z whether it will allocate or purchase Net Metering Credits. If the Company elects to purchase Net Metering Credits, the Company will render payment by issuing a check to the Host Customer each Billing Period, unless otherwise agreed in writing by the Host Customer and Company. If the Company elects to allocate Net Metering Credits, the Host Customer must complete Item G and submit the revised Schedule Z to the Company.

- Allocate Net Metering Credits to fewer than 50 eligible Customer accounts (Skip Item G)
- Allocate Net Metering Credits to 100 or fewer eligible Customer accounts (Skip Item G)
- Allocate Net Metering Credits to more than 100 eligible Customer accounts (Skip Item G)

G) Please state the total percentage of Net Metering Credits to be allocated.

% Amount of the Net Metering Credit being allocated. The total amount of Net Metering Credits being allocated shall not exceed 100%. Any remaining percentage will be applied to the Host Customer's account.

Please identify each eligible Customer account to which the Host Customer is allocating Net Metering Credits by providing the following information (attach additional pages as needed):

NOTE: If a designated Customer account closes, the allocated percentage will revert to the Host Customer's account, unless otherwise mutually agreed in writing by the Host Customer and the Company.

Customer Name: (Customer Name as listed on Electric Bill)

Service Address: (Service Address as listed on Electric Bill. This is NOT the Mailing Address)

Billing Account Number: (Billing Account number as listed on Electric Bill)

If public entity, DPU Public Classification ID: (Complete if applicable, otherwise leave blank)

Amount of Net Metering Credit Allocated: (Amount being allocated to this account) %

Complete if applicable otherwise leave blank

Customer Name: _____

Service Address: _____

Billing Account Number: _____

If public entity, DPU Public Classification ID: _____

Amount of Net Metering Credit Allocated: _____ %

Complete if applicable otherwise leave blank

Customer Name: _____

Service Address: _____

Billing Account Number: _____

If public entity, DPU Public Classification ID: _____

Amount of Net Metering Credit Allocated: _____ %

Customer Name: _____

Service Address: _____

Billing Account Number: _____

If public entity, DPU Public Classification ID: _____

Amount of Net Metering Credit Allocated: _____ %

Net Metering – filling out Schedule Z, last page

Customer Name: _____
Service Address: _____
Billing Account Number: _____
If public entity, DPU Public Classification ID: _____
Amount of Net Metering Credit Allocated: _____ %

Customer Name: _____
Service Address: _____
Billing Account Number: _____
If public entity, DPU Public Classification ID: _____
Amount of Net Metering Credit Allocated: _____ %

H) The Company may elect to seek to obtain capacity payments from ISO-NE for the electricity generated by Class II and III Net Metering Facilities. The Company will notify the Host Customer within 30 days of the filing of Schedule Z whether it will assert title to the right to seek those capacity payments. If the Company elects to assert title to those capacity payments, the Company will include any capacity payments received from ISO-NE in the Company's annual Net Metering Recovery Surcharge reconciliation.

I) The terms of this Schedule Z shall remain in effect unless and until the Host Customer executes a revised Schedule Z and submits it to the Company. Unless otherwise required herein or mutually agreed to in writing by the Host Customer and the Company, a revised Schedule Z shall not be submitted more than twice in any given calendar year.

J) A signature on the application shall constitute certification that (1) the Host Customer has read the application and knows its contents; (2) the contents are true as stated, to the best knowledge and belief of the Host Customer; and (3) the Host Customer possesses full power and authority to sign the application.

Host Customer (Signature)

← *Primary Account Holder*

Host Customer (Print)

Date

Please return Schedule Z to:

Western Massachusetts Electric Company
Attention: WMECO DG
55 Russell Street
Hadley, MA 01035-9455
Email: wmecodg@nu.com
Fax: 413-585-1709

Net Metering Production Reporting

- **Net Metering Tariff requires reporting of generator's kWh output.**
- **Class 1 Facilities to provide in writing by January 31 and September 30**
- **Class 2 and Class 3 Facilities may participate in production tracking system (PTS).**
 - **Mass CEC provided PTS data to the utilities, still working through implementation issues**
 - **Utility can request data from Class 2 and 3 Facilities**

Net Metering Summary

- If planning to Net Meter, submit Schedule Z with interconnection application or as soon as is practical.
- Correctly fill out Schedule Z.
 - Host Customer is primary account holder on the electric account.
 - Must be signed by Host Customer.
- If allocating, verify name/address/account info of electric customer(s) or will need to submit corrected form.
- Host Customer must apply to DPU for certification as a Municipality or Other Governmental Entity and submit confirmation to Distribution Company.
 - If allocating credits to customers, those customers must also obtain certification.
- Must obtain a qualified cap allocation from Mass ACA. (If on waiting list and still looking to interconnect became a Qualifying Facility.)
- Production reporting is required.
- Class II and III Facilities - ISO registration required and associated ISO-NE OP 18 metering.

When is ISO-NE Notification or Study Required?

■ Proposed Plan Applications (PPA):

- 0 - 0.999 MW cumulative increase* - no form required
- 1.000 - 4.999 MW cumulative increase* - notification form required to go to Reliability Committee.
 - Submitted after Impact Study is completed.
 - Transmission Owner submits PPA if generator is not a NEPOOL participant.
 - If generator is NEPOOL participant, Transmission Owner must review PPA first.
- > 4.999 MW cumulative increase* - PPA and studies required to go to Stability and Transmission Task Forces and Reliability Committee
 - After Impact Study completed, determine if any Substation / Transmission upgrades required.
 - Transmission Owner and Task Forces need to agree if transmission study will/will not be required.
 - Transmission Owner submits PPA if generator is not a NEPOOL participant.
 - If generator is NEPOOL participant, Transmission Owner must review PPA first.
 - A stability model will likely be required.

■ Refer to Planning Procedure 5-1

* NOTE = cumulative increase from last approved PPA

Compensation if not Net Metered

- If the customer will never export power – no concern.
- If customer will export power – they can sell their exported power to the market through a registered market participant.
 - Customer becomes or works with a registered market participant to sell power.
 - Customer must pay for all power they use.
- Customer with a **Qualifying Facility** (QF) certificate (≥ 1 MW) from FERC for the generator, can receive compensation under the local utility's Power Purchase Schedule (PPS) rate.
(The PPS Short Run Energy rate is the ISO-NE locational marginal price (LMP).)

FERC QF page: <http://www.ferc.gov/industries/electric/gen-info/qual-fac.asp>

State vs. ISO-NE Interconnection Process

- **This presentation will review the interconnection standard (Interconnection Tariff) applicable to generators that will connect (grid tied) to the Distribution System (either to a 69 kV line or lower).**
- **Generally, generation systems are considered DG if they are going to connect to the distribution system. In this case, the owner must follow the local utility's interconnection process.**
- **If you would like to apply to the transmission system (generally larger systems), you need to apply to the New England Independent System Operator (ISO-NE), and are not considered DG.**
- **If you will be selling your power to a third party, you may have to apply through ISO-NE even for a distribution system interconnection**
- **If circuit is already "FERC Jurisdictional" you may need to apply to ISO-NE.**
http://www.iso-ne.com/genrtion_resrcs/nwgen_inter/index.html

When is an Interconnection Request Submitted to ISO-NE?

- **Interconnecting generation to a distribution circuit which already has a wholesale transaction (FERC Jurisdictional), and, the project plans to sell power to a third party**
- **Increasing capacity of an existing generating facility***
- **Materially modify an existing generating facility***
- **Changing from energy only (NR) to energy and capacity unit (CNR)**
- **There is no minimum size**

*** NOTE = Generation facility with wholesale sales of electricity in interstate commerce (i.e. not Net Metered or compensated under Power Purchase Schedule as a QF).**

Group Study Process

- **Pilot Period - 12 months started June 1st**
- **Pilot is in selected areas**
- **Points From Tariff MA 1248, Section 3.4.1:**
 - **Company shall require Interconnecting Customer (IC) within Common Study Area to participate in group study whenever a Group exists**
 - **If IC wishes to continue outside of Group then that IC shall be studied after the completion of the Group Study**
 - **Each member of Group shall pay percentage of Group Study costs based on capacity**
 - **Cost Allocations shall be assessed on basis of applied capacity**

- **ISO-NE OP 14 changes for asset registration**
 - **Utilities required to set up wholesale assets for all net metered projects > 60 kW**
 - **Need to offset net metering subsidies by wholesale revenues**
 - **Multiple projects on same feeder > 5 MWs in total will trigger additional study and equipment requirements**
 - **Lead Market Participant (LMP) and Designated Entity (DE) roles require significant changes in studies and on-going operation**

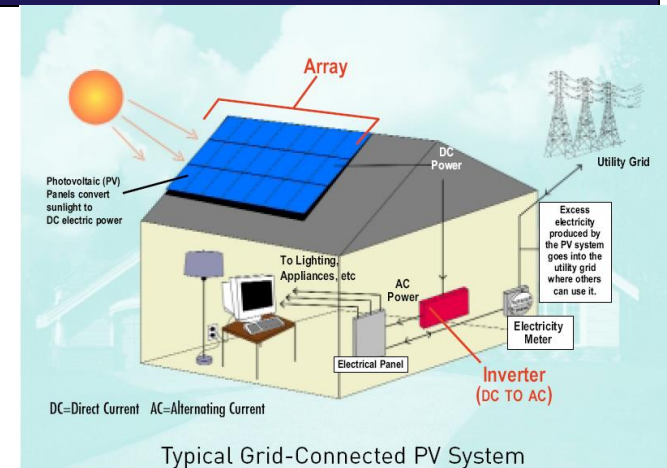
Break: 5 Minutes, then Follow up Questions

Technical Aspects of Integrating DG with the National Grid's EPS

Retail Connections Engineering

Technical Discussion

- **Interconnection Standards** - Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards
- **Technical Issues** Integrating Distributed Generation with the Utility Distribution EPS
 - *Potential Impacts of DG on Distribution EPS*
 - *System Modeling Studies*
 - *Transformer Limits*
 - *Radial Systems versus Secondary Network Systems*
 - *Anti-Islanding*
 - *Under 600 V Net Metered DG Connections*
 - *Upper Range Interconnection Costs*
 - *End-to-end Interconnection Process*



Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

What are **industry standards and codes** that apply to **DG interconnections** to the EPS?

- **IEEE standards applicable to DG installations:**
 - **IEEE 929** “*IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems*”
 - **IEEE 1094** “*IEEE Recommended Practice for the Electrical Design and Operation of Windfarm Generating Stations*”
 - **IEEE 1547** “*Standard for Distributed Resources Interconnected with Electric Power Systems*”

Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

■ Federal Government

- **FERC SGIP** “Small Generator Interconnection Procedure”
<http://www.ferc.gov/EventCalendar/Files/20050512110357-order2006.pdf>

■ Regional

- **NERC Standard FAC-001-0** - Facility Connection Requirements
- **Standard PRC-002-NPCC-01** - Disturbance Monitoring

■ State Government

- **New York Department of Public Service (NY DPS)**
 - PSC NY Standardized Interconnection Requirements for Distributed Generation Connected to the Distribution EPS (NY SIR)
 - Niagara Mohawk d/b/a National Grid tariff, P.S.C. 220
- **Massachusetts Department of Public Utilities (MA DPU)**
 - Massachusetts Electric d/b/a National Grid tariff, M.D.P.U. 1248
- **Rhode Island Public Utilities Commission (RI PUC)**
 - Narragansett Electric d/b/a National Grid tariff, R.I.P.U.C. 2078
https://www.nationalgridus.com/non_html/shared_interconnectStds_RI.pdf



Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

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Each utility has their requirements pursuant to the regulations that govern them as varying from state-to-state based on the NESC.

ESB 750 Specifications for Electrical Installations

ESB 756 General Requirements for Parallel Generation Connected to a National Grid Owned EPS

- *Appendix A Requirements for Parallel Generation Connected to National Grid Facilities in NY*
 - *Appendix B Distributed Generation Connected To National Grid Distribution Facilities per the NYS SIR*
 - - *Appendix C Distributed Generation Connected To National Grid Distribution Facilities per the MA SIDG (September 2015, Version 3.0)*
 - *Appendix D Distributed Generation Connected To National Grid Distribution Facilities per the RI SCDG (R.I.P.U.C. 2078, November 2011 tariff.)*
 - *Appendix E Requirements for Parallel Generation Connected to National Grid Facilities in New Hampshire*
- ✓ *The Appendices to ESB 756 are intended for jurisdictional-specific requirements.*

http://www.nationalgridus.com/non_html/shared_constr_esb756.pdf

Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

Key Points for Electric Service Requirements:

- Require some means of **disconnect and main overcurrent protection**, i.e., **service equipment**.
- Billing **meters secure**.
- Interface points clear to **avoid potential operating and safety problems**.



Key Points for **Parallel** **Generation** Requirements:

- **Company determines the interconnect voltage and method of interconnection.**
- **Prior notification to and approval by the Company is required for any generation to be installed or operated in parallel with the Company EPS.**

www.nationalgridus.com/electricalspecifications

Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

- **ESB 756** references all requirements for parallel generation connected to National Grid facilities located in Upstate New York, Massachusetts, and Rhode Island.

The **purpose** of this National Grid Electric System Bulletin (ESB) is to:

- 1. Provide general requirements and recommendations for all generators connected in parallel with the electric power system (EPS) operated by National Grid (Company).** Stand alone generators serving isolated load, which can never be connected in parallel with the Company EPS, are not subject to these requirements.
- 2. Ensure compliance with NERC Standard FAC-001-0 – Facility Connection Requirements, effective April 1, 2005.** Along with all of the Company's Electric System Bulletins, the most current version of ESB 756 is available electronically on its National Grid USA web page at: www.nationalgridus.com/electricalspecifications.
- 3. Ensure that the electrical reliability and security of the Company EPS and the larger power system grid is maintained following connection of the parallel generator to the utility supply.**
- 4. Refer Generator-owners to the applicable FERC or state-specific tariff regulations pertaining to parallel generators.**

Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

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■ Product Standards

Applicable standards:

➤ UL 1703 | UL 61730 | **UL 1741**

■ **UL 1741 “Inverters,
Converters and Charge
Controllers for Use in
Independent Power Systems”**

➤ IEC 61215 | IEC 61646 | IEC
61730



Underwriters
Laboratories
Photovoltaics

Home > Industries > Energy >
Renewable Energies > Photovoltaics

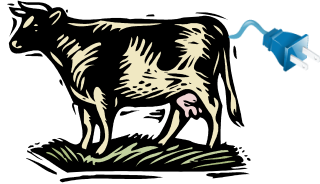


<http://www.ul.com/>

✓ **Inspections are needed
for safe, quality
installations!**

Technical Issues

Integrating Distributed Generation with the Utility Distribution EPS



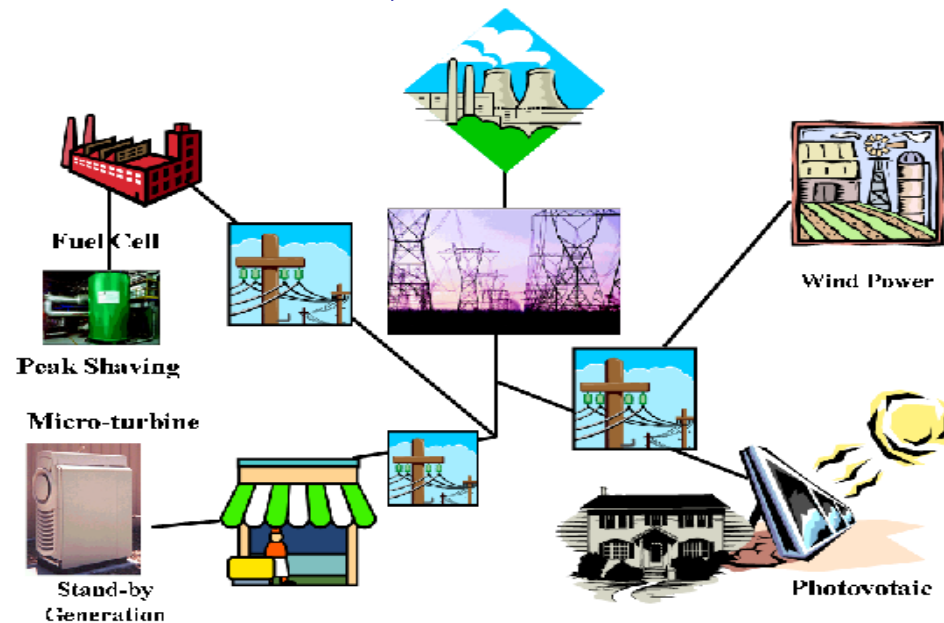
- Potential Impacts of DG on Distribution EPS
- System Modeling Studies
- Transformer Limits
- Radial Systems versus Secondary Network Systems
- Anti-Islanding

Technical Issues

Integrating Distributed Generation with the Utility Distribution EPS

■ Potential Impacts of DG on Distribution EPS

Customer generation connected to the distribution system can cause a variety of system impacts including **steady state and transient voltage changes, harmonic distortion, and increased fault current levels.**



Technical Issues

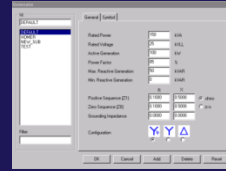
Integrating Distributed Generation with the Utility Distribution EPS

■ System Modeling Studies

The **purpose of impact studies** is to identify the severity of system impacts of the Customer's generators and the upgrades needed to avoid problems on the Company's distribution electric power system (EPS).

- ***Careful engineering can effectively eliminate the potentially adverse impacts that DG or distributed resource (DR) penetration could impress on the electric delivery system, such as exposing system and customer equipment to potential damage, decrease in power quality, decrease in reliability, extended time to restoration after outage, and potential risks to public and worker safety.***

Technical Issues: System Modeling Studies



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- The **IEEE** supports the following **system issues** that the utility industry faces with DG penetration on the local EPS, **but not limited to**:
 - ✓ **voltage**
 - ✓ **capacitor operations**
 - ✓ **flicker and voltage regulator and LTC operations**
 - ✓ **protection coordination**
 - ✓ **feeding faults after utility protection opens**
 - ✓ **interrupting rating of devices**
 - ✓ **faults on adjacent feeders**
 - ✓ **fault detection**
 - ✓ **ground source impacts and ground fault overvoltages**
 - ✓ **single phase interruption on three phase line**
 - ✓ **recloser coordination**
 - ✓ **thermal overload and conductor burndown**
 - ✓ **risk-of-islanding:**
 - ✓ **loss of power grid and sensitivity under light load**
 - ✓ **vulnerability and overvoltages**
 - ✓ **system restoration and network issues**
 - ✓ **harmonic distortion contributions**
 - ✓ **power system stability and impact to bulk power network**
 - ✓ **system reinforcement**
 - ✓ **metering**
 - ✓ **telemetry**

Technical Issues

Integrating Distributed Generation with the Utility Distribution EPS

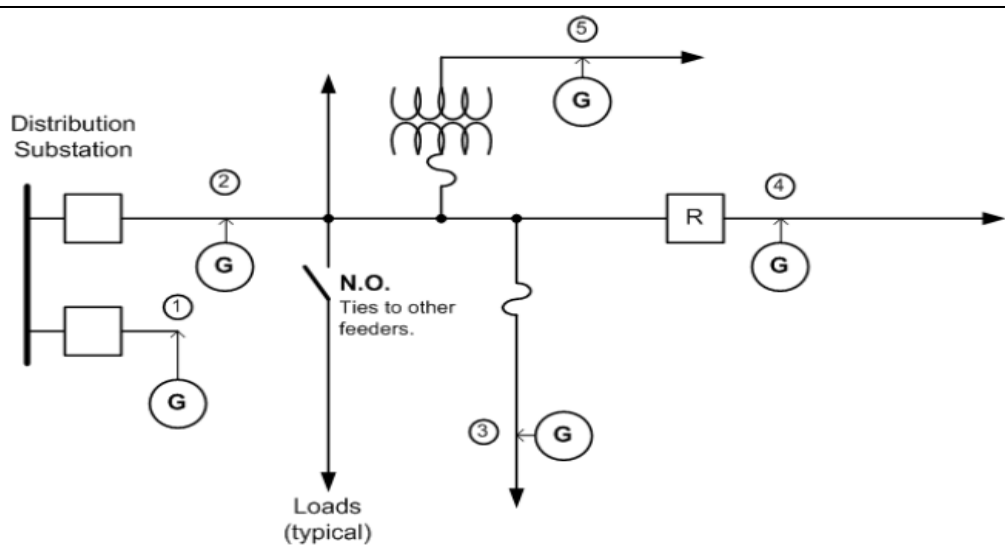
- **Transformer Limits- DG Installations less than 600V**
 - The utility distribution transformers continuous duty nameplate rating is applied to sizing for DG Customer installations to ensure reliability of the supply.
 - Exceeding transformer nameplate rating from DG sources affects the transformer normal loading capability and transformer life cycle becomes shortened.
 - Replacement later due to overload by DG causes burden on other customers on same feed!

Technical Issues

Integrating Distributed Generation with the Utility Distribution EPS

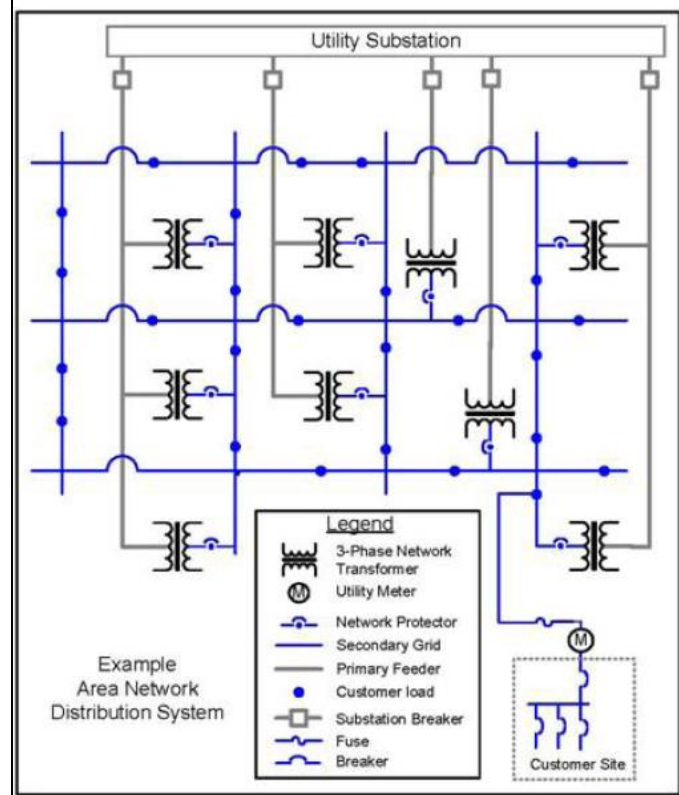
■ Radial Systems versus Secondary Network Systems

Area Networks consist of one or more primary circuits from one or more substations or transmission supply points arranged such that they collectively feed secondary circuits serving one (a spot network) or more (an area network) Interconnecting Customers.



“O” - DG Interconnection Location Point on Feeder

1. Express (dedicated) radial feeder
2. Feeder Main
3. Feeder Branch protected by fuse
4. Sectionalized Feeder Main
5. Feeder Branch protected by fuse with ratio transformer

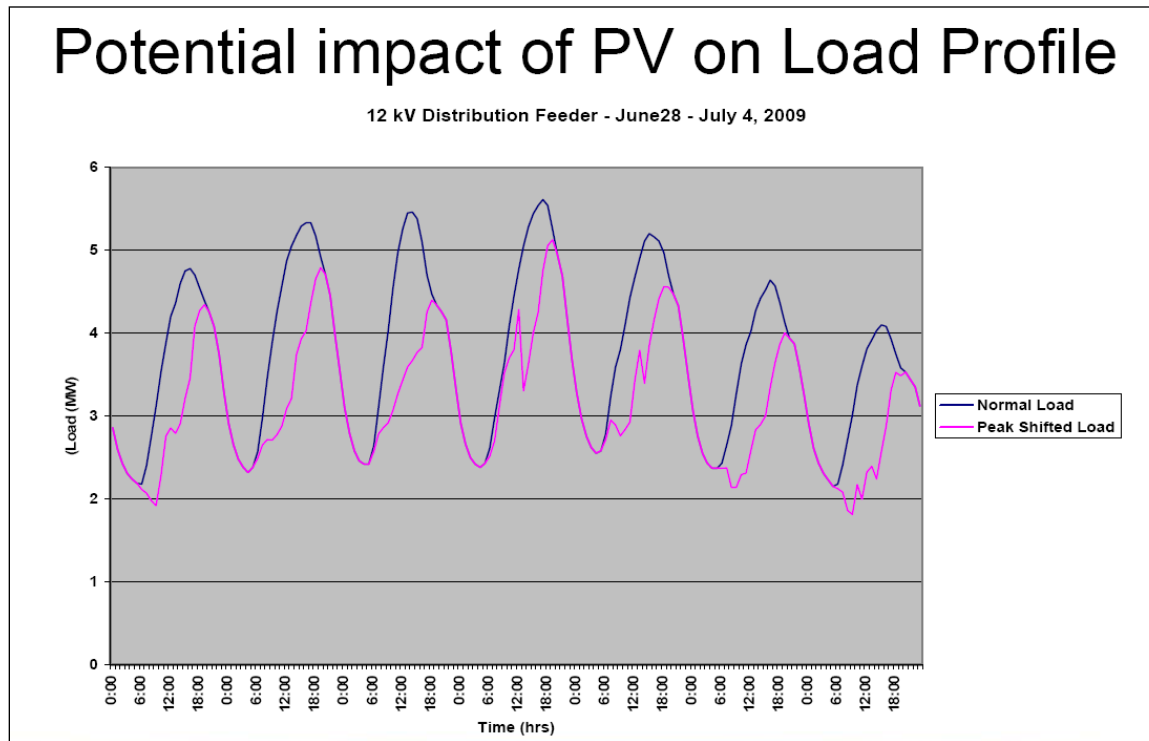


Technical Issues: Limits on Distribution EPS - Radial

- **DG saturation** refers to the point at which large amounts of parallel generation are installed, whether by a single large facility or multiple facilities in aggregate, such that it becomes technically infeasible to operate on a single distribution feeder.
 - A resulting example is **excessive voltage regulation issues** associated with intermittent resources like solar and wind. *IEEE 1547 is recognized by the applicable Company tariff, P.S.C. 220 Rule 53 providing technical guidance whereby voltage regulation impacted by DG is a limiting factor.*
- It is expected due to the DG market that distribution feeders in many areas will reach the saturation point based on the application growth rate in those areas.
 - **Stability issues due to generation exceeding the feeder load** causing back feed to the transmission system will need to be addressed where DG saturation occurs.

Technical Issues: Limits on Distribution EPS - Radial

- DG reduces load on the system
- Multiple systems on a line can pose unique challenges



Technical Issues: Limits on Distribution EPS - Radial

Example: Intermittent Resources - Large PV Inverter-based DG:

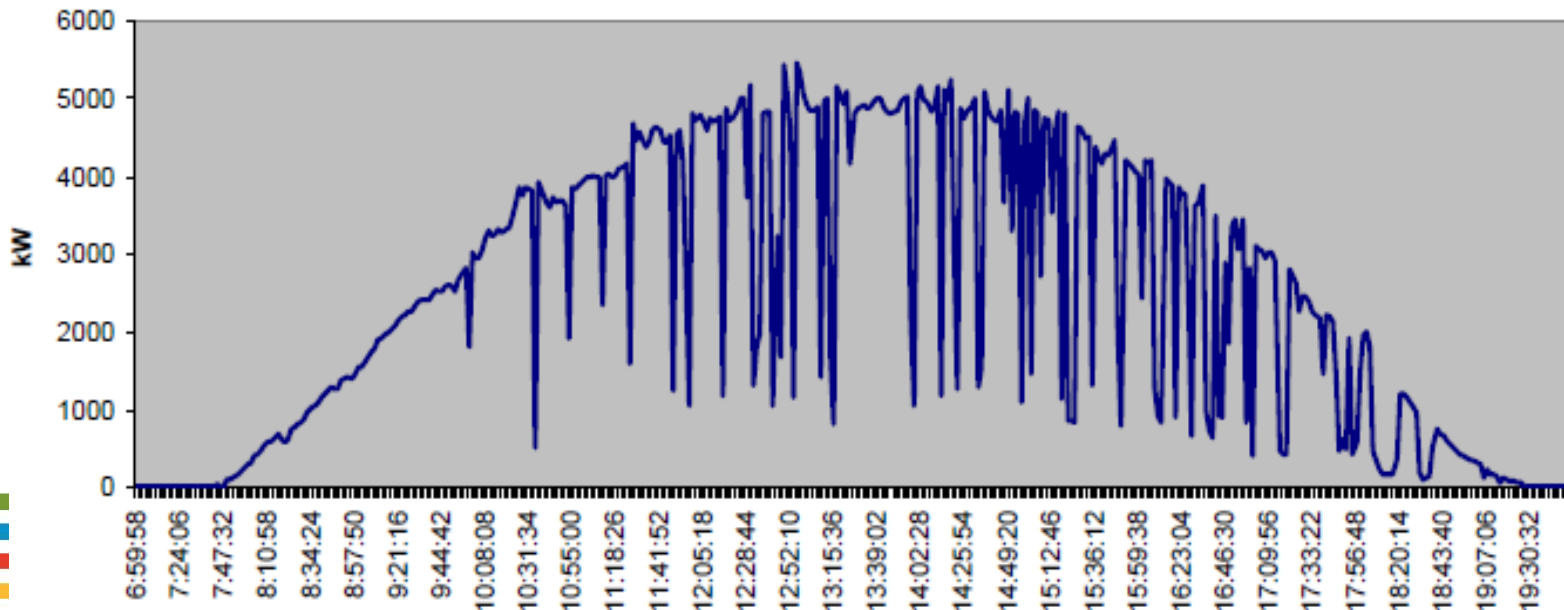
- Ramp rates of large PV inverter-based generators can affect EPS operations and power quality.
- Geographic diversity effects not yet fully understood.

✓ First check – “How is EPS affected and how much is acceptable on it (other customers on the feeder)?”



Courtesy of BP Solar

6 MW Unit
Adjusted Output



Technical Issues

Integrating Distributed Generation with the Utility Distribution EPS

■ Anti-Islanding

- **IEEE 1547** requires any Distributed Generator (DG) on a distribution feeder to be **detected and be tripped offline within 2 seconds upon formation of an island*** from the Area Electric Power System (EPS).

*An **island** is a condition in which a portion of an Area EPS is energized solely by one or more Local DGs while it is electrically separated from the rest of the Area EPS.*

- The utility industry recognizes Direct Transfer Trip (DTT) as good utility practice that provides a definitive islanding detection means to disconnect the DG and protect the EPS and the customers it serves.

*DTT has inherent **high costs and physical limitations** of installing leased telecommunication line on the EPS and at the generator(s).*

* The DG's internal protection system is designed with protective functions according to IEEE 1547 to ensure that there is proper voltage, frequency, and phase angle conditions between the Company's EPS and the DG system, before the generator is permitted to parallel (5 minutes after the Company circuit is energized).

Technical Issues

Integrating Distributed Generation with the Utility Distribution EPS

National Grid uses **three main “tests”**; *any determine if communication assisted protection (DTT) is required for exceeding minimum load issue or a protection issue or operating concern*:

1. **“Feeder Light Load versus Generation Test”** – *is the aggregate generation* greater than the feeder’s light load?*
 - * **Percentage permissible** is based on types of DG, i.e. rotating machine, inverter-based, mix of each and system reactive power and impedance characteristics as studied on a case basis.
2. **“Fault Sensitivity and Temporary Overvoltage Test”** – *can the DG facility detect pertinent faults that would occur on the feeder, or line section of the feeder? – can run on times over 2 seconds cause temporary over voltages to exceed equipment ratings and affect other customer equipment?*
3. **“Feeder Selectivity Test”** – *can the DG facility be connected to another circuit that has an automatic transfer scheme enabled?*

Note:

- ✓ DG Customer’s protective device coordination study demonstrates **generation voltage and/or frequency protection will trip within 2.00 seconds** for the loss of the utility source (e.g. feeder breaker trip). *This will require subsequent compliance verification of the relays and their trip functional tests.*

Technical Issues

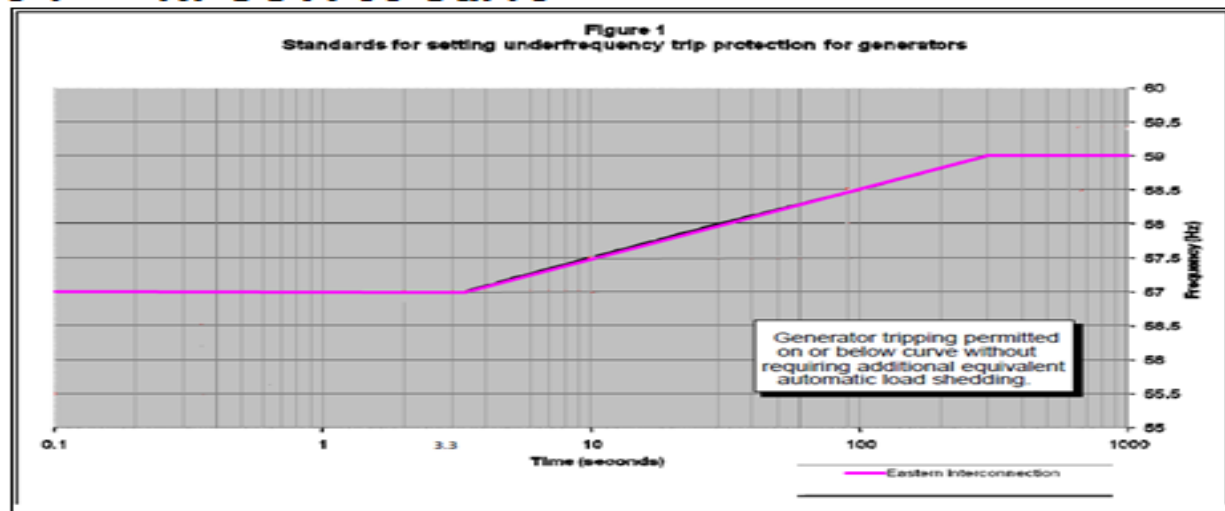
NPCC Requirements for Generator Tripping

The M.D.P.U. No. 1248, Section 4.2.3.2.1b: Interconnection system response to abnormal frequency clearing times. Clearing time is considered as the time that it takes the relay to initiate a trip plus the breaker operating time.

- The adjustable under frequency set point shall comply with the NPCC Directory 12 curve for setting under frequency trip protection on DR1 larger than 30kW. Per the NPCC A-03 curve, if the setting falls above the curve, there must be an equivalent amount of load shed when tripped, which in this case cannot be done and therefore the 81 under frequency must be set below the curve.
- Per NPCC Directory 12 Curve: Document A-03 Exhibit 4.9 page 5: “Generators should not be tripped for under-frequency conditions in the area above the curve in Figure 1.”

<https://www.npcc.org/Standards/Directories/Directory12%20Full%20Member%20clean%2020150330%20GJD.pdf>

Figure 1 NPCC A-03 Curve



Technical Issues

NPCC Requirements for Generator Tripping

Continued...

The M.D.P.U. No. 1248, Section 4.2.3.2.1b: Interconnection system response to abnormal frequency clearing times. Clearing time is considered as the time that it takes the relay to initiate a trip plus the breaker operating time.

Table 2 – Interconnection system response to abnormal frequencies

DR size	Frequency range (Hz)	Clearing time (s)^a
$\leq 30 \text{ kW}$	> 60.5	0.16
	< 59.3	0.16
$> 30 \text{ kW}$	> 60.5	0.16
	$< \{59.8 - 57.0\}$ (adjustable setpoint)	Adjustable 0.16 to 300
	< 57.0	0.16

^a DR $\leq 30 \text{ kW}$, maximum clearing times; DR $> 30 \text{ kW}$, default clearing times

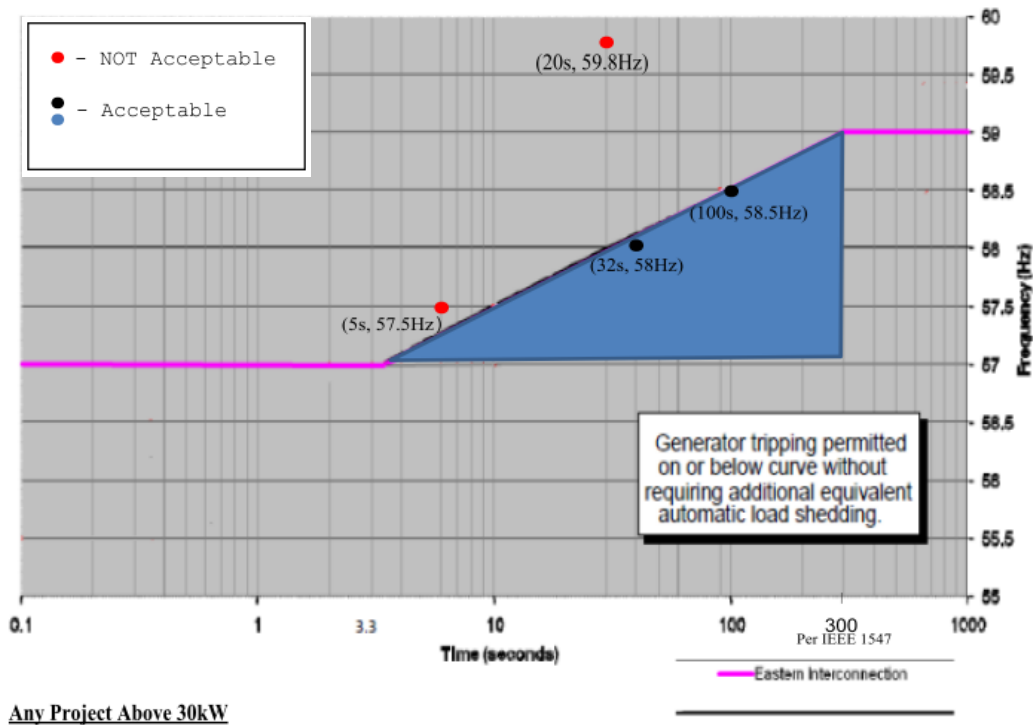
- Clarifying points to avoid potential Issues causing non-compliance to the NPCC and IEEE 1547 standard
- Aggregate generation under 30kW is acceptable if documentation is provided showing UL1741 “LISTED” inverters
- Aggregate generation greater than 30kW: UL1741 “LISTED” inverters are required to provide confirmation of settings from above table. This means if multiple string inverters less than 30kW are used for a site that aggregates greater than 30 kW, the appropriate settings from the table should be loaded in the inverters for UL 1741 testing.

Technical Issues

NPCC Requirements for Generator Tripping

Examples:

For Adjustable Under Frequency Setpoint required by IEEE 1547-2003
Acceptable setting range to comply with the NPCC Directory 12 Curve "Standards for Setting Underfrequency Trip Protection for Generators" for the Eastern Interconnection



Example 1:

81U	UNDER-FREQUENCY RELAY	STEP 1: PICKUP 57 HERTZ , TIME DELAY 10 CYCLES
		STEP 2: PICKUP 58.5 HERTZ , TIME DELAY 6,000 CYCLES
81O	OVER-FREQUENCY RELAY	PICKUP 60.5 HERTZ , TIME DELAY 10 CYCLES

Example 2:

81U	57.0 Hz	0.16 SEC (10 CYCLE) DELAY
	59.0 Hz	300 SEC (18,000 CYCLE) DELAY
81O	60.5 Hz	0.16 SEC (10 CYCLE) DELAY

*Times listed are total clear (should include breaker/interrupter time, detection time, etc.)

Technical Issues: Small Net Metered DG Installations less than 600V

- ✓ **Where taps and splices are to be considered ahead of service equipment and on the load side of the Company's revenue meter, please refer to the following guidance according to ESB 750 and the NEC.**
- 1. *The proposed tap or splice shall be made in an approved enclosure external from the revenue meter enclosure (**taps and splices not allow ahead of service equipment or in meter socket!** Refer to ESB 750-2010 "Blue Book").*
- 2. *The junction (line tap) box and conduit for service conductors shall meet NEC requirements for the specific installation and its location.*
- 3. ***Rigid galvanized steel conduit*** *should be used between the revenue meter socket enclosure, junction (line tap) box, existing main service equipment, and distributed generator service equipment.*
- 4. *Wire bending radius shall meet NEC requirements and not cause undue pressure on terminations to devices.*
- 5. *Service conductor splice shall be in accordance with the NEC and listed materials.*
- 6. *The Distributed Generator system's disconnect shall be listed and labeled service equipment and installed immediately adjacent to the existing service equipment. (See definition of "service equipment" in Section 2.0 of ESB 750.)*
- 7. *Each service equipment shall be **labeled** according to the NEC (see Article 230).*
- 8. *Service grounding system shall be installed in accordance with the NEC for the two adjacent service equipment means (see **Article 250**).*
- 9. *The Distributed Generator system connection **shall comply with the applicable Company tariff, ESB 756 Appendix B, or C, or D as applicable, and the NEC.***
- 10. *Where modifications to existing service equipment are proposed, the installer shall obtain the manufacturer requirements in writing (see 110.3(B) in the NEC). (This will be required for the local AHJ Code Enforcement requirements to be met.)*
- 11. *An approved electrical inspection certificate of the premises wiring changes is required according to **Section 1.9 in ESB 750.***

Technical Issues: Upgrades and System Modifications

Description	Estimate
Replace Voltage Regulator (small)	\$36,915
Replace Voltage Regulator (large)	\$39,550
Replace Regulator Controller	\$15,776
Replace 15kV Class Fused Cutout	\$680
Replace Pole Mount Transformer	\$19,374
Replace Pad Mount Transformer	\$16,451
Replace Capacitor Bank	\$13,173
Replace Load Break Switch	\$12,370
Replace Recloser	\$29,955
Fuse Link K Types 100A (Installation)	\$246
New Primary Meter and Overhead Transformer	\$39,631
Replace Capacitor Bank Controls	\$4,532
15kv class circuit line extension / mile cost (new construction)	\$251,866
25kv class circuit line extension / mile cost (new construction)	\$563,761
15kv class circuit line extension / mile cost (existing construction)	\$162,752
25kv class circuit line extension / mile cost (existing construction)	\$401,534

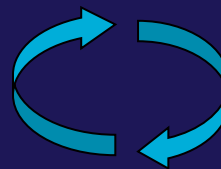
Check on Pole mounted transformer costs think this for step down

Install new recloser?

Notes:

- 1) Distribution EPS relates to 15kV class system.
- 2) These are representative estimates only and are not inclusive of all costs [*i.e. land rights, removal costs, taxes, etc.*] which will vary from job to job and that they are presented here for **order-of-magnitude** purposes only.

Technical Issues: Technical Process End-to-End



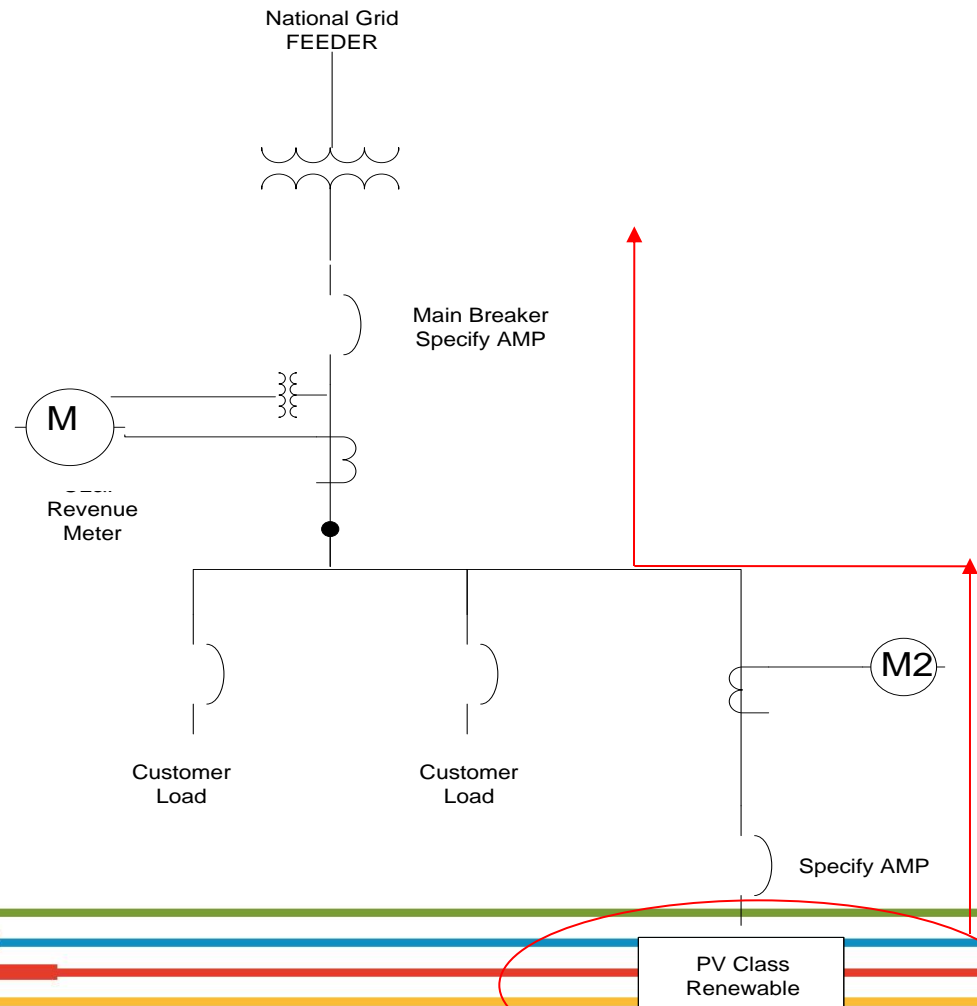
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Refer to the appropriate **Appendix** of ESB 756 for the state jurisdiction where **DG** application is made.

- For example in **Upstate NY, or MA, or RI**, see **ESB 756 Appendix B, or C, or D**
 - See **Section 3.0** for *Customer Interface Procedures*
 - See **Exhibit 2** for *Company milestone requirements for projects not covered by the simplified process (i.e. complex)*
- Ensure all technical information required in the DG application under the applicable National Grid tariff is **complete and legible**. *Additional manufacturer technical data may be submitted for understanding the specified electric source's characteristics to perform the studies.*

Technical Issues: Technical Submittals for Utility Review

**Recommended
Guidelines for
Residential and
Commercial Single-
line Diagram
Submittals** (see *Exhibit 5
& Figures 1 & 2 in ESB 756
Appendix B, or C, or D*)



Post ISA Coordination

Engineering, Procurement & Construction Process (Overview)

Post ISA Coordination - Engineering, Procurement & Construction Process Overview

ISA Execution

- Payment Plan
- Kick-off Meeting
- Preliminary Engineering
- Milestone Plan

Design

- Field Investigation
- Detailed Design Sketches and Specifications
- Construction grade estimates

Procurement/ Permits

- Procuring Long Lead items
- Securing Easements, Right of Way access and/or Environmental permits/ licenses

Customer Interface: TSES, Customer Service, and Customer Solutions

Engineering

- Recloser and Primary Meter
- Company System Updates
- Compliance Verification

Construction

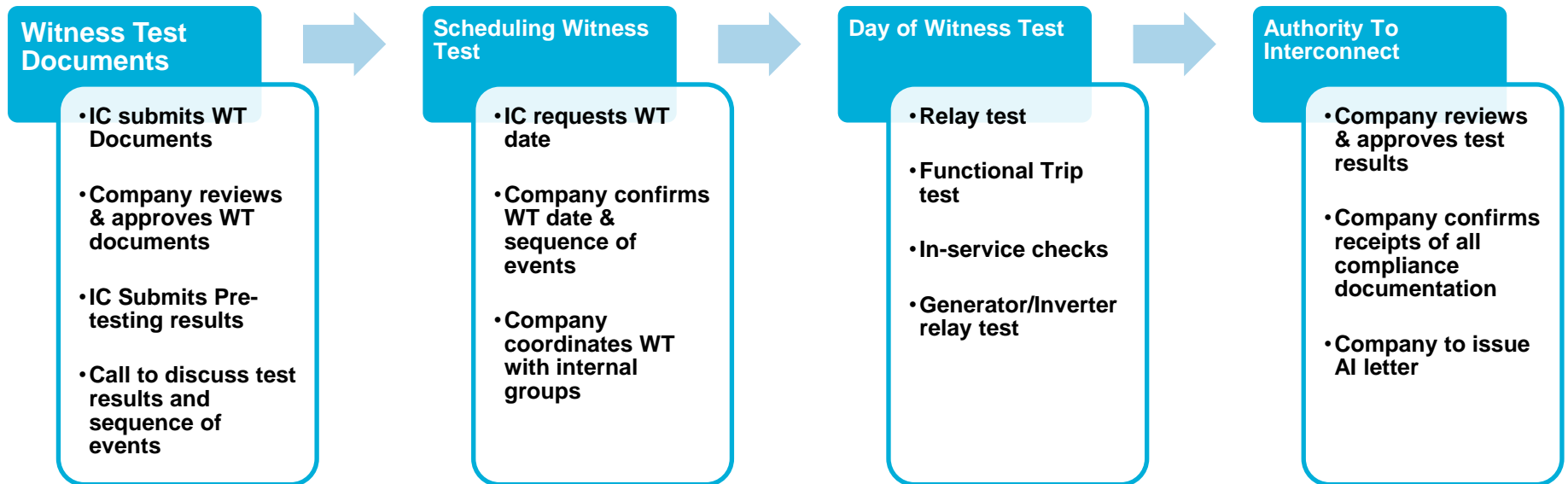
- Advanced notice for scheduling
- Field Check
- Outage coordination
- Construction

Energization, Testing & Commissioning

- Field Commissioning and Energization
- Relay Test
- RTU Test
- Customer Commissioning

Post ISA Coordination (cont'd)

Witness Testing Process Overview



- In case of IPP, the site will **ONLY** be energized first time on the day of the witness test after successful completion of relay test and functional trip test.
- Customer shall perform pre-testing using their own generator source.
- The Company needs at least 10 day advance notice to schedule a witness test.
- It is recommended to submit witness test documents at least 30 days prior to the witness test.

Post ISA Coordination

Key Items

- Developing Project Schedule including Interconnection Tasks
- Procuring communication lines for Interconnection – MPLS circuit and Telephone line
 - Verizon High Voltage Protection Requirements
 - Other Utility Costs
- Design/ Equipment Changes
- Municipal Inspection
- Verizon Pole Installation and Payment
- Testing and Commissioning Plan
 - Test Procedure
 - Energization Plan
 - Long term O&M Arrangement

Plan Ahead!

Note: *Please plan ahead for all close-out activities, like witness testing, as they can be time consuming to coordinate and complete. Please keep all critical milestone date or deadline of commercial operation of the system in mind while planning for witness test.*

Post ISA Coordination (*cont'd*)

Witness Testing

- **The Company in general witness below tests as defined in IEEE 1547-2003 for an interconnection:**
 - Relay Test
 - Functional Trip Test
 - In-Service Checks
 - Generator/ Inverter Test
- **Pre-requisite to Schedule a Witness Test**
 - Certificate of Completion and/or Municipal Inspection
 - Compliance Documentation (including revisions to submitted Schedule Z)
 - Witness test procedure & Energization plan, if applicable
 - Customer pre-testing results
- **Witness Test Procedure**
 - Contact information for the day of the witness test and brief project description
 - Visual inspection and equipment test results
 - Relay test, Functional trip test, In service checks, and Generator/inverter test
 - One-line and/or three-line diagram, if applicable control logic AC & DC elementary diagrams

Future 2016 DG Seminars – MA/RI

Date	Utility
July 21 (today)	National Grid (Waltham, MA)
August 24	Eversource West (Hadley, MA)
September 14	Eversource East (Westwood, MA)
September 22	National Grid (RI – Webinar)
October 20	National Grid (North Andover, MA)
November 3	Eversource West (Hadley, MA)
December 8	National Grid (Lincoln, RI)
December 14	Eversource East (Westwood, MA)

Thank you for participating!

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Q&A

Contact for Following-Up Questions:

Email: Distributed.Generation@nationalgrid.com

Supplemental Information

- Additional useful information...

Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

■ NFPA

- **NFPA 70** “*National Electrical Code*” (**NEC**)
- **NFPA 70B** “*Recommended Practice for Electrical Equipment **Maintenance***”
- **NFPA 70E** “*Standard for Electrical **Safety** in the Workplace*”
- **NFPA 850** “*Recommended Practice for **Fire Protection** for Electrical Generating Plants and High Voltage Direct Current Converter Stations*”

Interconnection Standards – Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards

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Codes for Installing Renewable Energy Sources

■ **Article 690 National Electrical Code**

- Requirements for **Photovoltaic Installations** in Premises Wiring

■ **Article 692 National Electrical Code**

- Requirements for **Fuel Cell Installations** in Premises Wiring

■ **Article 694 National Electrical Code**

- Requirements for **Wind Electric System Installations** in Premises Wiring

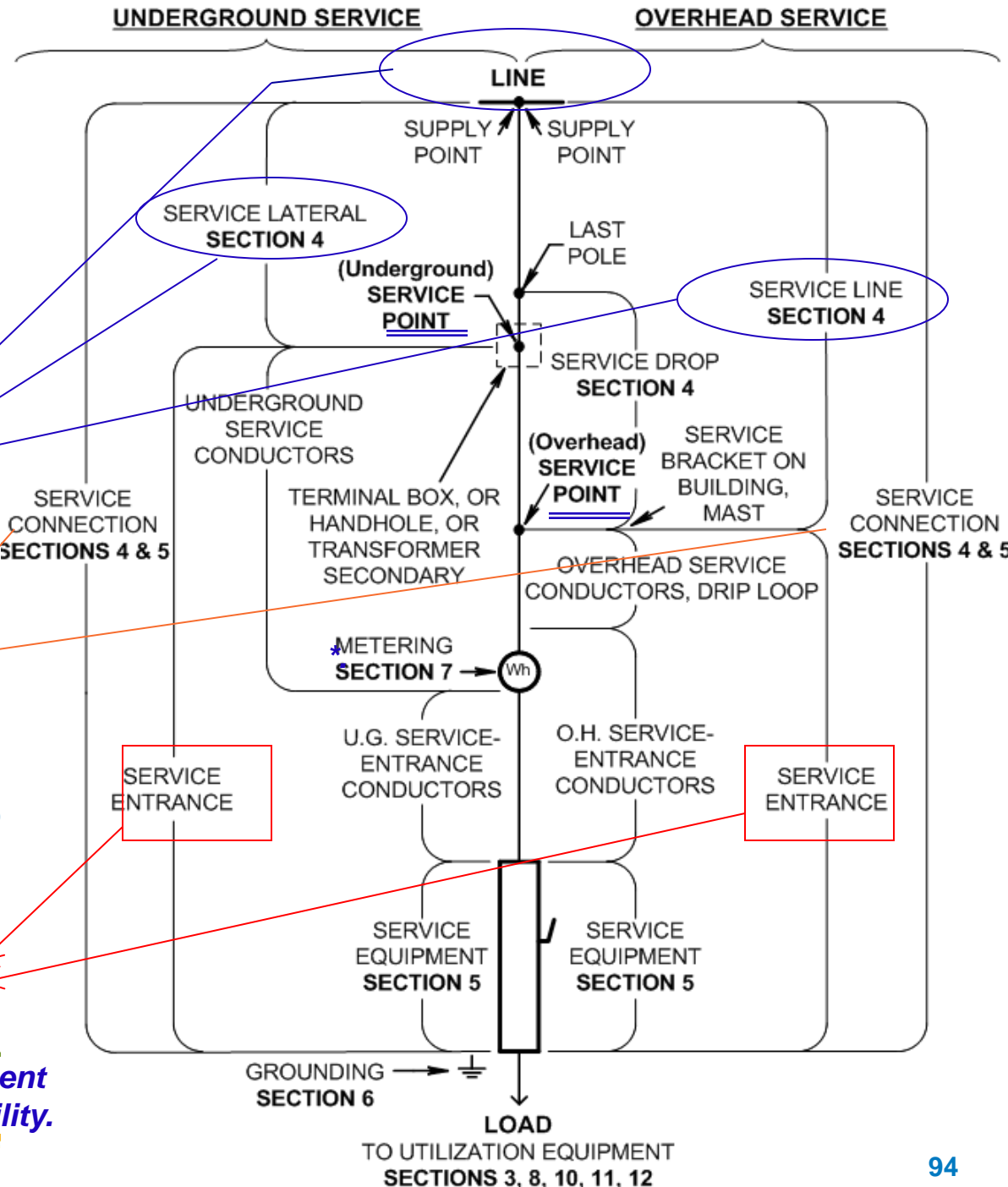
■ **Article 705 National Electrical Code**

- Requirements for **Interactive Installations** in Premises Wiring

✓ ***Inspections are needed for safe, quality installations!***

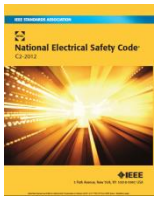


ESB 750 Figure 2-1 TYPICAL SERVICE INSTALLATION DIAGRAM BELOW 600 VOLTS – EXCLUDING NETWORK



➤ Supply Side

NEC Rule 011
NEC 90.2(B)



➤ includes the service lateral or service line, service entrance conductors, meter provision, service equipment, and grounding where the Electric Utility has Mutual Interest

➤ Premises Wiring

* NESC applicable for equipment under exclusive control by utility.

NEC 90.2(A)



Technical Issues: System Modeling Studies

- **Some IEEE standards used in interconnection studies:**
 - **IEEE 519** “*Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*”
 - **IEEE 1453** “*Recommended Practice for Measurement and Limits of Voltage Flicker on AC Power Systems*”
 - **IEEE C37.90.1** “*Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus*”
 - **IEEE C37.90.2** “*Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers*”
 - **IEEE C37.90.3** “*Standard Electrostatic Discharge Tests for Protective Relays*”

2014 NEC



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Premises Wiring Requirements for DG Installations

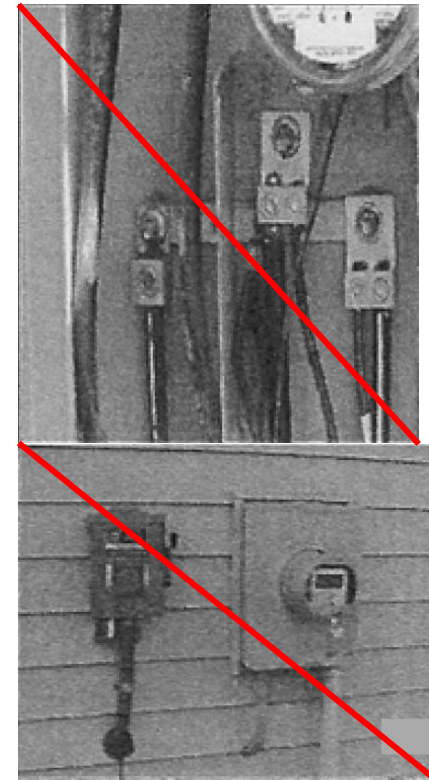
■ Highlights of Major Changes Related to DG

- Adopted by NFPA members June 2013, NFPA Standards Council made effective Aug. 2013 – 3745 proposals/1625 comments processed in this 3-year cycle
- 4 new articles added: 393, 646, 728, 750
- Code-wide changes: Requirements for DC systems; Changing voltage threshold of 600 volts to 1000 volts; More prescriptive requirements for markings
- 250.167 requires ground fault detection on DC systems
- 408.4(B) requires switchgear, switchboards, and panelboards having more than 1 source of power to be marked indicating where all sources originate
- 690.12 has new provisions for rapid shutdown of PV systems on buildings when utility supply is de-energized within 10 seconds – this originated from First Responders
- 690.35 requires ground fault protection for ungrounded PV DC systems to be listed
- 690.47(D) clarifies ground- and pole- mounted PV arrays require a grounding electrode system
- 690.81 is a new listing requirement for PV wire used in systems over 600 V not exceeding 2 kV
- Article 694 revised to apply to wind electric systems regardless of size – previously it applied to 100 kW and less

Technical Issues: Small Net Metered DG Installations less than 600V

➤ Taps Ahead of Service Equipment for DG Interconnection – Concerns

- *The Company's position is consistent with the rules and regulations for electric service contained in the Company's ESB 750-2010 "blue book" regarding taps and splices ahead of service equipment and in meter sockets.*
 - *In addition, our rules are consistent with other utility practices.*
- *Taps and splices in meter sockets having National Grid meters are prohibited according to the electric service requirements of ESB 750.*
 - *Doing so causes undue pressure on the meter socket blocks, increasing the chance of the blocks breaking, and causing a flash when the meter is removed.*



Technical Issues: (cont'd) Small Net Metered DG Installations less than 600V

Taps Ahead of Service Equipment for DG Interconnection – Concerns

