RI Distributed Generation Seminar

July 15, 2015

Commerce RI Office

315 Iron Horse Way, Suite 101

Providence, RI 02908

Agenda

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8:30 a.m. Registration

9:00 a.m. Welcome Message, Introductions, Presentation Overview – John Kennedy / Kevin Kelly

9:10 a.m. Interconnection Process - John Kennedy

9:40 a.m. ISO-New England and Net Metering - Tim Roughan

10:10 a.m. DG: Electric Power System Impacts and Issues Created – Caleb George / John Teixeira

10:30 a.m. Break

10:40 a.m. RI DG Contract & RE Growth Programs – Corinne DiDomenico / Omar Muneeruddin

11:30 a.m. Questions and Answer Session - National Grid Panel

12:00 p.m. Conclude

Safety Moment: Avoid the Danger Zone

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- Overhead power lines are not insulated, and carry enough energy to cause serious injury or even death. Regard all wires as live.
- Keep yourself, your co-workers, tools, and vehicles at least 10 feet away from electric lines and equipment.
- Stay alert. Keep ladders at least 10 feet away from power lines when carrying, moving, and raising them.
- Make sure the area is clear of wires before working near trees or shrubs.
- Never attach or tie anything off to power lines or electrical equipment.
- If you need to dig, first call Dig Safe at 1-888-dig-safe (1-888-344-7233) to get underground utilities marked.
- The benefits of DG quickly lose their meaning if someone gets hurt.

Logistics & Introductions

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- Facilities
  - Emergency Exits
  - Restrooms
  - Mobile Phones
- Introductions
  - RI OER
  - Commerce RI
  - National Grid Staff

RI OER Welcome Slide

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RI OER's role in Distributed Generation:

- Assisting with incentives for promotion of clean energy
  - Portfolio Standards (RPS/RECs)
  - Net Metering
  - RI DG Contract Program
  - Renewable Energy Growth Program
- Increasing awareness about policies
  - Interconnection
  - Rates
  - System Planning / Service Quality
- Advising on new policies
  - Streamlining Interconnection
  - Hands-on assistance with challenging projects

Commerce RI Welcome Slide

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Commerce RI's role in Distributed Generation:

- Renewable Energy Fund:
  - The Commerce RI Renewable Energy Fund (REF) is dedicated to increasing the role of renewable energy throughout the state. The REF provides grants and loans for renewable energy projects with the potential to make electricity in a cleaner, more sustainable manner, while stimulating job growth in the green technology and energy sectors of Rhode Island's economy. Using funds from the 'system benefit charge' on electric bills and Alternative Compliance Payments, Commerce RI will fund renewable energy projects in small-scale solar, feasibility studies and commercial development.

DG Activity Trends - NE

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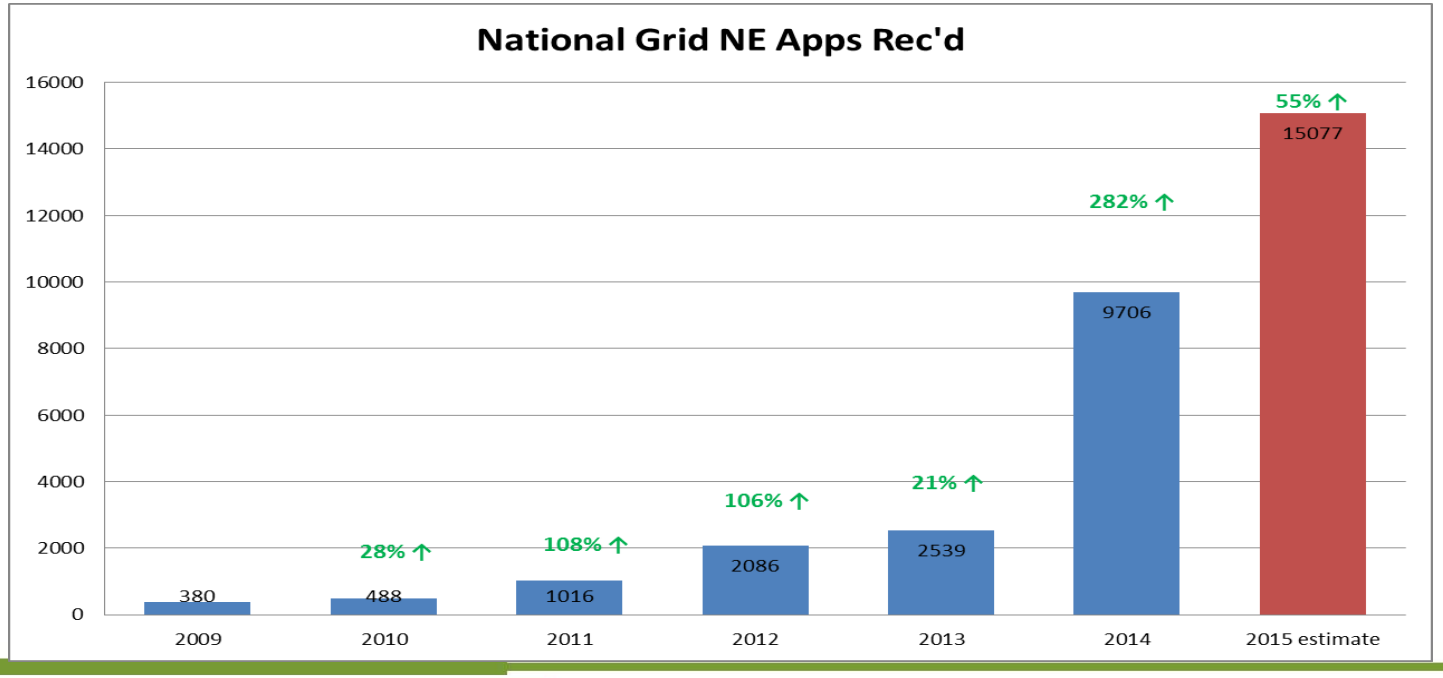
- Received 7,399 interconnection applications representing about 268 MW thru June 2015 compared to 3,069 applications / 148 MW same period last year.
- Small (<100kW) Interconnection application are triggering large studies because of the aggregate generation on the circuit.
- Received over 1,600 applications in June alone



DG Activity Trends - RI

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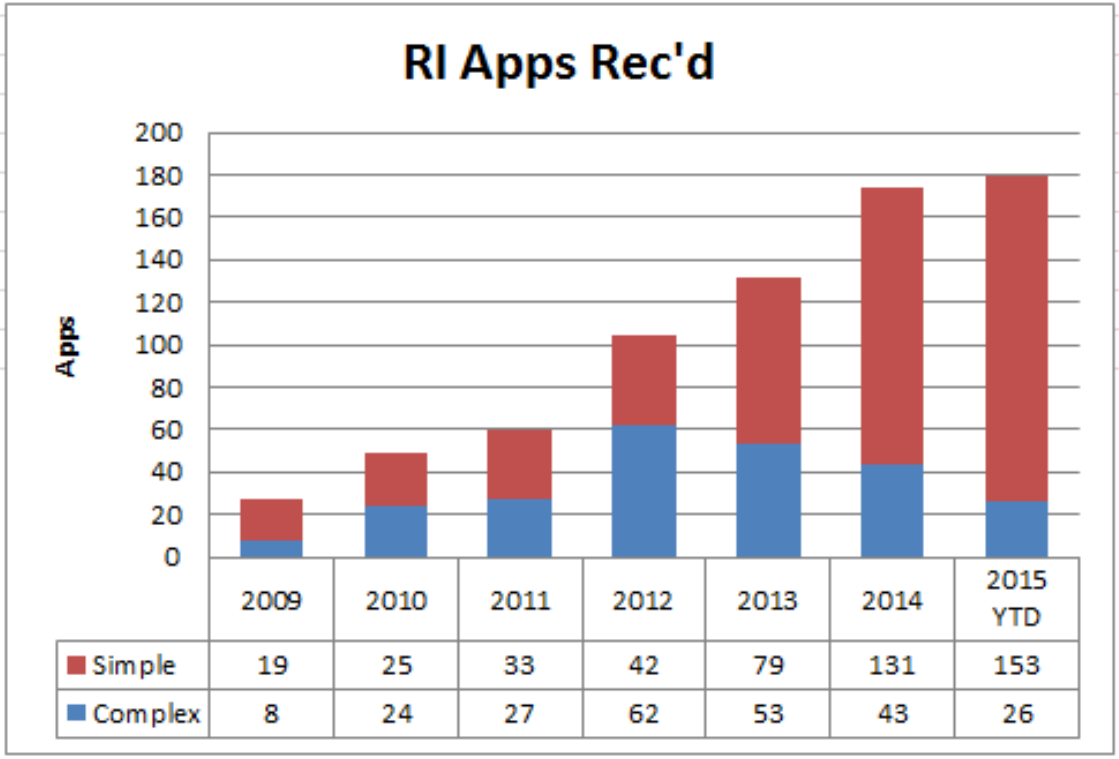
- Received 179 applications representing 28.5 MW of interconnection applications YTD
- Received 46 applications representing 5.3 MW of interconnection same period '14



	2009	2010	2011	2012	2013	2014	2015 YTD
Simple	19	25	33	42	79	131	153
Complex	8	24	27	62	53	43	26

DG Activity Trends - RI

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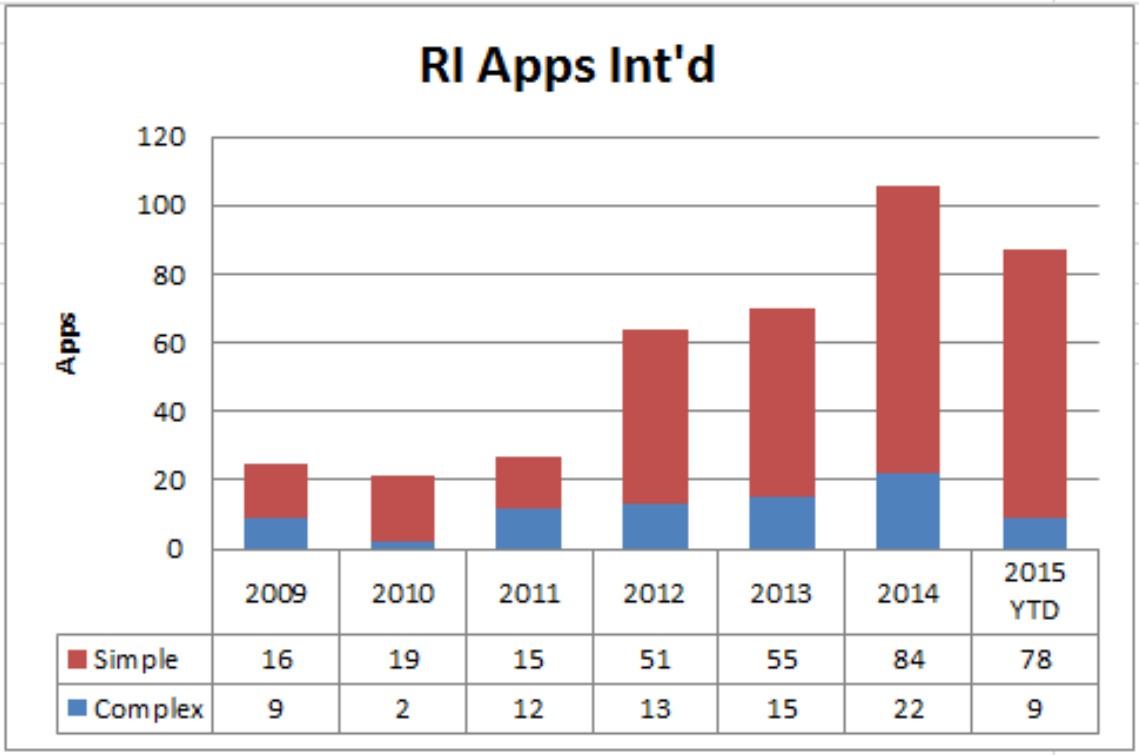
- **Interconnected 87 applications representing 2.7 MW of interconnection applications YTD**
- **Interconnected 36 applications representing 3.8 MW of interconnection same period '14**



	2009	2010	2011	2012	2013	2014	2015 YTD
Simple	16	19	15	51	55	84	78
Complex	9	2	12	13	15	22	9

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Interconnection Process – John Kennedy

Distributed Generation and the Electric Grid

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Two Types of grid-connected DG

- **Behind Meter: DG system is used to partially or fully supply an on-site load. Any unused electricity is exported to the distribution system (most projects follow the state interconnection process; *there are exceptions that follow the ISO process*).**

- **Direct Connect: DG system does not supply an on-site load, and is connected directly to the distribution system (*all* such "wholesale energy projects" follow the ISO-NE Interconnection process)**

RI PUC Interconnection Tariffs

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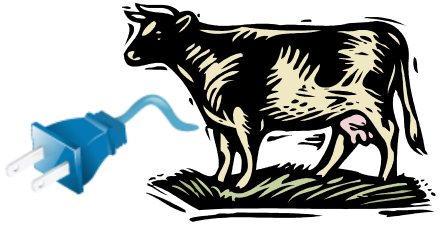
- The RI PUC adopted a revised tariff titled, " RIPUC #2078, Standards for Connecting Distributed Generation", on November 30, 2011.
  - Includes interconnection standards and renewable energy interconnection process.
  - Current version of "Standards for Interconnecting Distributed Generation" is can be found at: https://www.nationalgridus.com/narragansett/home/energyeff/4_interconnect.asp

- The RI PUC adopted a revised tariff titled "RIPUC #2075, Net Metering Provision.
  - Includes Eligible Net Metering Rate Classes and Technologies
  - Current version of "Net Metering Provision " can be found at: https://www.nationalgridus.com/narragansett/home/energyeff/4_net-mtr.asp




Importance of the Interconnection Process

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- Following the interconnection process is important because a DG system changes the one-way power flow from the utility to customer, which can present dangers to utility workers if proper equipment is not installed

- While robust and capable of handling minor disturbances, the quality of grid power is extremely important. The interconnection process ensures the DG meets safety, reliability, & power quality requirements with regard to:
  - Islanding
  - Transient Voltage Conditions
  - Noise and Harmonics
  - Frequency
  - Voltage Level
  - Machine Reactive Capability

- It is essential that each DG customer receive an Interconnection Service Agreement with the utility before installing their facility. You are proceeding at your own risk to if you choose to install your system without utility approval.

Interconnection Process Steps

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- Pre-Application
- Simplified and Expedited Application
- Standard Application
- Impact Study and Detailed Study
- Conditional Approval
- 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

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Customer needs to provide:

Contact Person; Mailing Address; Telephone; E-Mail Address

Alternative Contact Information (e.g., system installation contractor or coordinating Facility Information:

Proposed 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

Generator 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 to provide:

Circuit voltage at the substation;
Circuit name;
Circuit voltage at proposed Facility;
Whether Single or three phase is available near site; If single phase – distance from three phase service;
Aggregate connected Facilities (kW) on circuit;
Submitted complete applications of Facilities (kW) on circuit that have not yet been interconnected;
Whether the Interconnecting Customer is served by an area network, a spot network, or radial system;
Identification of feeders within ¼ mile of the proposed interconnection site through a snap-shot of GIS map or other means;
Other potential system constraints or critical items that may impact the proposed Facility.

Everything starts with the Application

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- A complete complex application package includes:
  - All appropriate sections of 4-page application completely filled out. Customer will likely need assistance from vendor/engineer.
  - Application fee : This fee covers the initial review. If Feasibility Study requested, the Application Fee is waived in lieu of Feasibility Study Fee. See Table 2 of RI PUC 2078 tariff for fee amounts.
  - Stamped electric one-line diagram, preferably showing relay controls (one copy) (Stamped by Rhode Island Electrical PE)
  - Site diagram (one copy)
  - One copy of any supplemental information (if electronic – single copy acceptable)
  - Identify electric customer and owner of proposed generation
  - Schedule B if planning to Net Meter
- Errors or problems with application will slow down the process and *"stop the clock"*
- Send Electronic copy of all documents preferred if possible – Easier to distribute, saves paper, and is faster. However, submit first page of application with application fee.

Interconnection Review Paths

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- **There are three different interconnection review paths a project can follow based on generation type, size, customer load and the characteristics of the grid where the system is to be located.**

- **Without delays**

- **Days listed apply to Company business days under normal business days.**

Simplified	Expedited	Standard
For PV and other inverter based technologies served by radial systems, 10k W or less 1-Phase or up to 25k W 3-Phase [Note: Simplified Spot Network path is 30-90 days]	For inverter-based systems greater than 10 kW 1-Phase or greater than 25 kW 3-Phase and other systems of all sizes that are served by radial systems and meet other requirements.	All projects not eligible for simplified or expedited review, including all systems on networks
Typical Projects: small PV, demonstrations or homeowner wind	**Typical Projects:** certified large renewables, cogeneration, and other turbine or engines of any size	**Typical Projects:** uncertified large projects, unusually complex projects or projects of any size located on networks
Total Maximum Days: 15*	Total Maximum Days: 40 – 60*	Total Maximum Days: 125-150*

Responsibility of Costs

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- Interconnecting customer responsible for:
  - Application Fee
    - Simplified Process: Fee Waived (except for Simplified spot network)
    - Expedited and Standard: $3/kW ($300 min and $2,500 max)
  - Renewable DG: Feasibility Study Fee is required in lieu of Application Fee
  - Costs of impact and detailed studies if required
  - Grid modification requirements – can include ongoing charges
  - Witness Test Fee
  - Costs associated with design, construction and installation of the facility and all associated interconnection equipment on the customer's side of the meter
  - Many projects will not require impact or detailed studies or EPS upgrades
  - See Fee Schedule for details

Interconnection Process: Fee Schedule

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	Simplified	Expedited	Standard		Simplified Spot Network
	Listed Small Inverter	Listed DG	Any DG including Renewable DG not requesting a Feasibility Study or ISRDG	Renewable DG requesting a Feasibility Study or ISRDG	Listed Inverter ≤ 15 kW
Application Fee (covers Screens)	0 (Note 1)	$3/kW, minimum $300, maximum $2,500	$3/kW, minimum $300, maximum $2,500	N/A	≤$3/kW $100, >3 kW $300
Supplemental Review or Additional Review (if applicable)	N/A	Up to 10 engineering hours at $125/hr ($1,250 maximum) (Note2)	N/A	N/A	N/A
Standard Interconnection Initial Review	N/A	N/A	Included in application fee (if applicable)	N/A	N/A
Feasibility Study	N/A	N/A	N/A	Residential : ≤25kW: $0 >25kW: $50 Non-residential: ≤100kW: $100 ≤250kW: $300 250kW–1MW: $1,000 >1MW: $2,500	N/A
Impact Study or ISRDG	N/A	N/A	Actual cost (Note 3)	Residential : ≤25kW: $0 >25kW: $100 Non-residential: ≤100kW: $500 ≤250kW: $1,000 250kW–1MW: $5,000 >1MW: $10,000 (Note 4)	N/A
Detailed Study (if required)	N/A	N/A	Actual cost (Note 3)	Actual cost (Note 3)	N/A
Facility Upgrades	N/A (Note 5)	Actual cost	Actual cost	Actual cost	N/A
O&M (Note 6)	N/A	TBD	TBD	TBD	N/A
Witness Test	0	Actual cost, up to $300 + travel time (Note 7)	Actual Cost	Actual Cost	0 (Note 8)

Third Party Ownership

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- Application must include information for both generation owner (interconnecting Customer) and electric or retail customer (Customer)
- Utility will correspond with owner, customer and installer
  - Listing email addresses for all parties on application makes communication easier and faster
- Utility will enter into agreement with our electric customer (Exhibit H of RIPUC #2078 tariff)

- ***Note:** Any Ownership change would require updated documentation submitted to the Utility Company

Behind the scenes at utility…

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- 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.

Interconnection Process: Summary and Recommendations

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- ***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 National Grid by requesting a Pre-application Report.**
- **Large interconnection application take longer to study**
- **Stand alone (no load behind the meter) interconnection application take longer to study**
- **Interconnection timeframes do not apply to Electric Power System construction if required.**

Interconnection Process: Summary and Recommendations (cont'd)

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- Review our DG Website and The Interconnection Standard. Both provide a wealth of information.
- Time frames are standard working days and do not include delays due to missing information.
- Interconnection expenses such as application fees, required studies, potential system modifications and witness tests should be budgeted into each project.
- Hire an engineer to help with application process.
- ISO-NE notification not included in time frame.
- Interconnection applications have increased significantly in the past few years – APPLY EARLY!

National Grid Contacts & Tariff Links

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

MA: Chandra Bilsky | (401) 784-7174, **Colin Sullivan**| (781) 907-2937

Bob Moran | (508) 897-5656, **Hakob Mkrtchyan** | (781) 907-1516

Alex Kuriakose | (781) 907-1643, **Jim Ryan** | (781) 907-5528

Vishal Ahirrao | (781) 907-3002, **Sean Diamond** | (781) 907-2611

Nicholae Gari | (781) 907-2018

RI: John Kennedy | (401) 784-7221, **Andy Garsils** | (631) 755-5303

CHP: John Rathbun | (631) 755-5376

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

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Net Metering & ISO-NE changes – Tim Roughan

Net Metering in Rhode Island

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- 2015 Net Metering Provision Tariff

  - **"Eligible Net Metering Resource"** shall mean eligible renewable energy resource as defined in R.I.G.L. Chapter 39-26-5 including biogas created as a result of anaerobic digestion, but, specifically excluding all other listed eligible biomass fuels.

  - **"Eligible Net Metering System"** shall mean a facility generating electricity using an Eligible Net Metering Resource that is reasonably designed and sized to annually produce electricity in an amount that is equal to or less than the Renewable Self-generator's usage at the Eligible Net Metering System Site measured by the three (3) year average annual consumption of energy over the previous three (3) years at the electric distribution account(s) located at the Eligible Net Metering System Site.

Net Metering in Rhode Island (cont'd)

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- **"Eligible Net Metering System Site" shall mean the site where the Eligible Net Metering System is located or is part of the same campus or complex of sites contiguous to one another and the site where the Eligible Net Metering System is located or a farm in which the Eligible Net Metering System is located.**
  - **Except for an Eligible Net Metering System owned by or operated on behalf of a public entity or multi-municipal collaborative through a municipal net metering financing arrangement, the purpose of this definition is to reasonably assure that energy generated by the Eligible Net Metering System is consumed by net metered electric delivery service account(s) that are actually located in the same geographical location as the Eligible Net Metering System.**

Net Metering in Rhode Island (cont'd)

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- Except for an Eligible Net Metering System owned by or operated on behalf of a public entity or Multi-municipal Collaborative through a Municipal Net Metering Financing Arrangement, all of the Net Metered Accounts at the Eligible Net Metering System Site must be the accounts of the same customer of record and customers are not permitted to enter into agreements or arrangements to change the name on accounts for the purpose of artificially expanding the Eligible Net Metering System Site to contiguous sites in an attempt to avoid this restriction. However, a property owner may change the nature of the metered service at the delivery service accounts at the site to be master metered (as allowed by applicable state law) in the owner's name, or become the customer of record for each of the delivery service accounts, provided that the owner becoming the customer of record actually owns the property at which the delivery service account is located.

- As long as the Net Metered Accounts meet the requirements set forth in this definition, there is no limit on the number of delivery service accounts that may be net metered within the Eligible Net Metering System Site.

Net Metering Credits

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- Energy use is "netted" over the billing month
  - If there is net energy use – utility will bill customer for net use
  - If net energy export – export kWh * the following
    - Renewable installations will be credited at near retail rate for excess kWh (minus conservation and renewable energy charges).
- Tariff allows credits to be allocated (with limitations)
- Customer still responsible for customer charges and demand charges

			Credit the following charges			
min	max	Type	Default Service	Distribution	Transmission	Transition
0	5,000 KW	Renewable	X	X	X	X

Net Metering Credits (cont'd)

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- If there is excess at the end of the year
  - "Excess Renewable Net Metering Credit" shall mean a credit that applies to an Eligible Net Metering System for that portion of the Renewable Self-generator's production of electricity beyond one hundred percent (100%) and no greater than one hundred twenty-five (125%) percent of the Renewable Self-generator's own consumption at the eligible net metering system site during the applicable billing period. Such Excess Renewable Net Metering Credit shall be equal to the Company's avoided cost rate, defined for this purpose as the Standard Offer Service kilowatt-hour (kWh) charge for the rate class and time-of-use billing period, if applicable, applicable to the delivery service account(s) at the Eligible Net Metering System Site.

- Customer must file Schedule B in the net-metering tariff to apply

Net Metering Summary

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- If planning to Net Meter, submit Schedule B with interconnection application
- Correctly fill out Schedule B
  - Name must match electric account of Host Customer
  - Must be signed by Host Customer
- If allocating, verify name/address/account info of customer(s) – or will need to submit corrected form

Compensation if not Net Metered

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- 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.
  - If customer has a Qualifying Facility (QF) certificate from FERC for the generator, they can "sell" to local utility (Power Purchase Schedule).
  - Customer can work with any registered market participants to sell power
  - Customer must pay for all power they use.

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

ISO-NE OP14

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- Company, under the tariffs, is obligated to reduce costs of net metering, DG contract, and new Renewable Energy Growth programs to all other customers
  - Company does this by setting up wholesale assets at the ISO-NE and uses wholesale revenues received to offset payment to DG customers – this is regulated by the ISO-NE's Operating Procedure number 14 (OP14)
    - Example: if net metered customers receive credits of 16c per kWh, and the Company receives wholesale revenues of 6c per kWh, then all other customers only have to pay the above market costs of 10c per kwh, not the full 16c.
  - Projects < 5 MWs can be set up as settlement only generators (SOGs) as most are currently with National Grid as the lead market participant (LMP) with no further requirements

ISO-NE OP14

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- For a single project of 5MWs or greater, or the aggregate DG on a common line with no other distribution customers separating them is 5 MWs or greater, then OP14 requires the DG (or multiple DGs) to be set up as a ‘modeled generator”.
  - This requires the LMP to be able to dispatch the DG(s) upon ISO-NE command in the event of a system problem (i.e., over-voltage conditions, other emergency events, etc.)
    - As National Grid is not the owner or operator of the DG(s), it cannot be the LMP and the customer(s) would have to take on this role
    - In this case, the DG(s) would have to be the LMP
      - Requires a designated entity (DE) the ISO-NE can call 24/7/365 to render dispatch instructions.
      - Requires real-time telemetry from the project to the ISO-NE

ISO-NE OP14 – example diagrams

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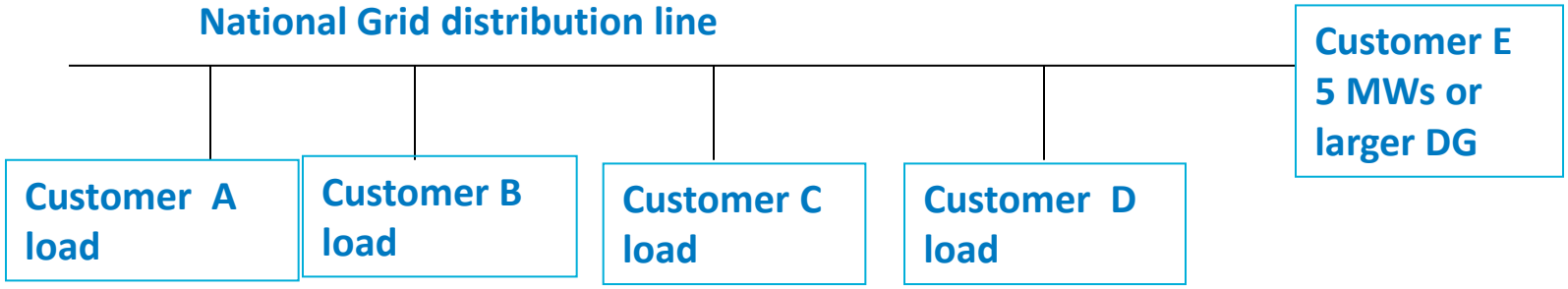
Example 1 – single project 5 MWs or larger, customer E would need to comply with the modeled generator requirements of OP14



ISO-NE OP14 – example diagrams

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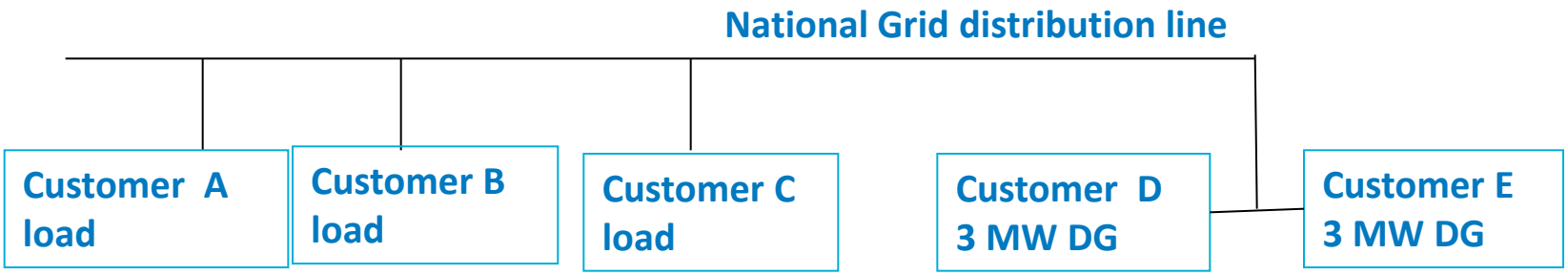
Example 2 – two projects of 5 MWs or larger on a common line, customers D and E would need to comply with the modeled generator requirements of OP14



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Technical Aspects of Integrating DG with National Grid's EPS – Caleb George / John Teixeira

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

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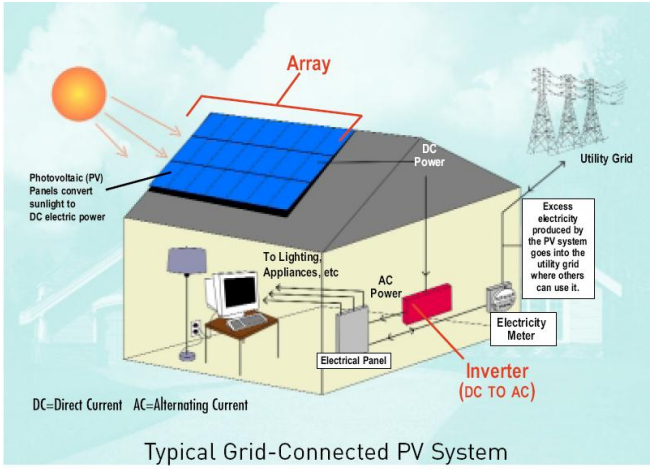
- **Interconnection Standards** - *Industry Standards, Codes, Regulatory Rules, Local Rules, Product Standards*
- **Technical Issues** Integrating Distributed Generation with the Utility Distribution EPS
  - *Potential Impacts of DG on Distribution EPS*
  - *System Modeling Studies*
  - *Transformer 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*



Typical Grid-Connected PV System

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

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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

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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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- **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. 1219
  - **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 (**Being revised for new NY SIR, Feb. 2014.**)*

- ***Appendix C*** *Distributed Generation Connected To National Grid Distribution Facilities per the MA SIDG (**Being revised for new M.D.P.U. 1219, May 2013 tariff.**)*

- ***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

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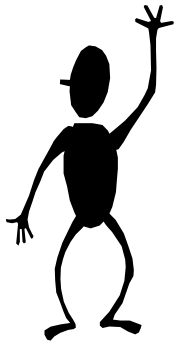
Key Points for Electric Service Requirements:

- 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

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- **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

http://www.ul.com/

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

Technical Issues
Integrating Distributed Generation with the Utility Distribution EPS

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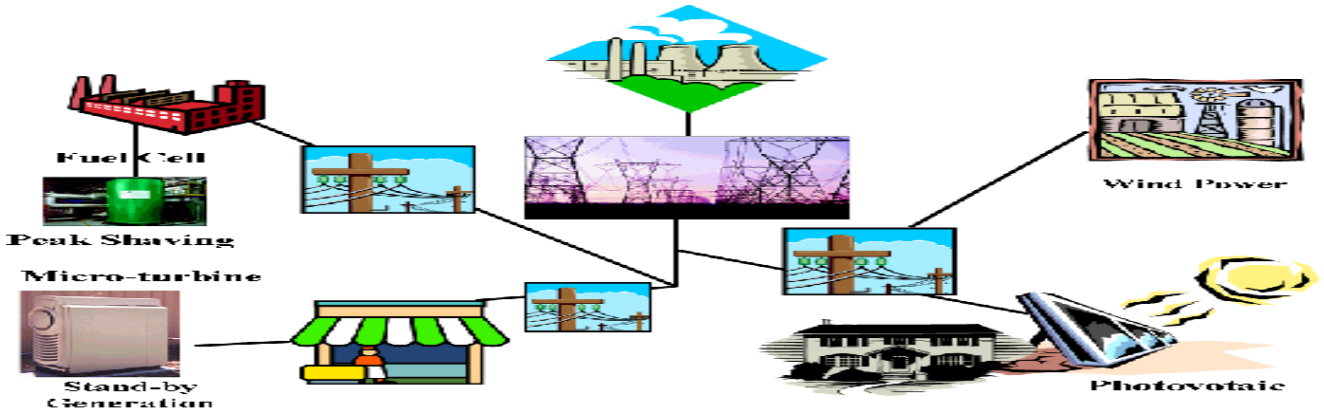
- Potential Impacts of DG on Distribution EPS
- System Modeling Studies
- Transformer Limits
- Radial Systems versus Secondary Network Systems
- Anti-Islanding

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**.

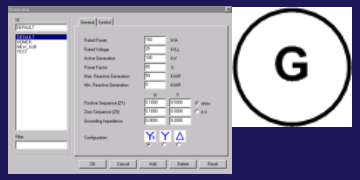


System Modeling Studies

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***
  - ✓ ***telemetering***

Technical Issues:
System Modeling Studies

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- **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"*

Technical Issues
Integrating Distributed Generation with the Utility Distribution EPS

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- **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 ratepayers!

Technical Issues
Integrating Distributed Generation with the Utility Distribution EPS

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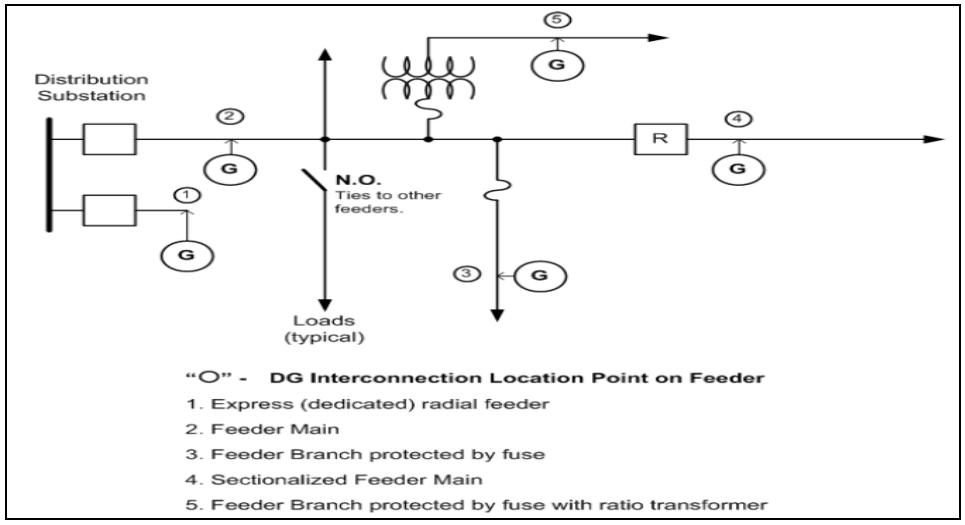
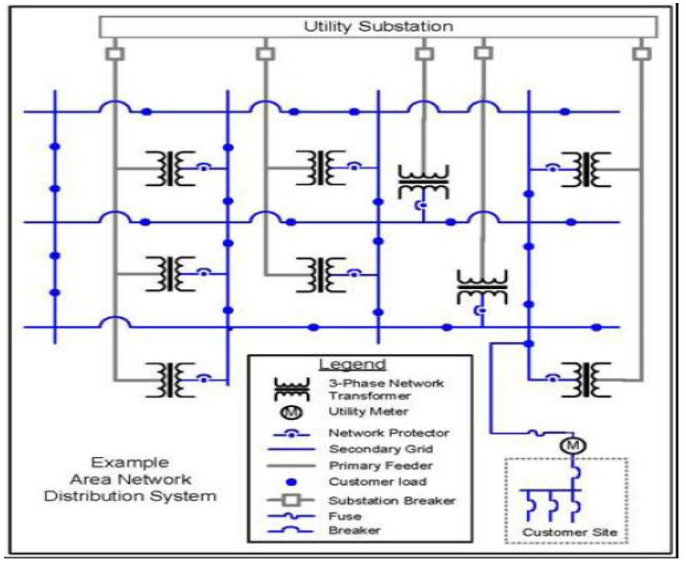
Radial Systems versus Secondary Network Systems

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.





Technical Issues:
Limits on Distribution EPS - Radial

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- **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

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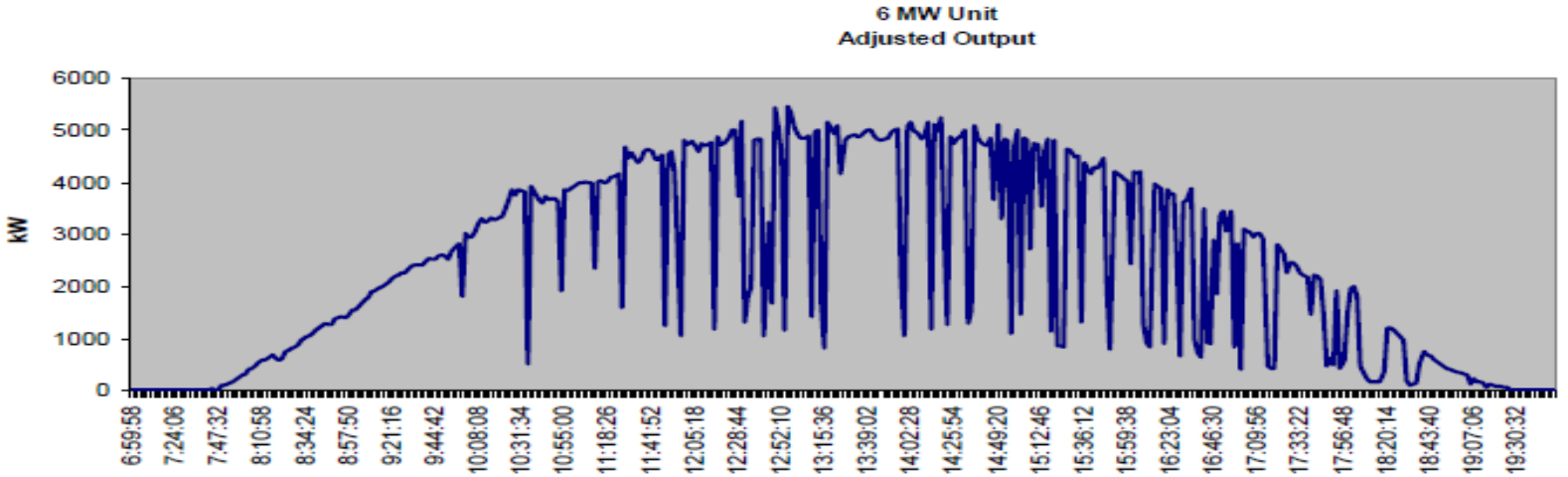
Example: **Intermittent Resources –**

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*)?"



Technical Issues
Integrating Distributed Generation with the Utility Distribution EPS

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- **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:
Small Net Metered DG Installations less than 600V

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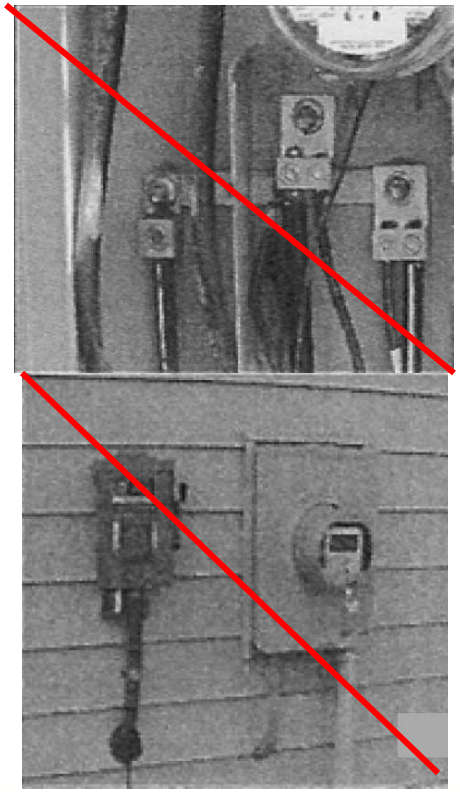
Taps Ahead of Service Equipment for DG Interconnection – Concerns

- ***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

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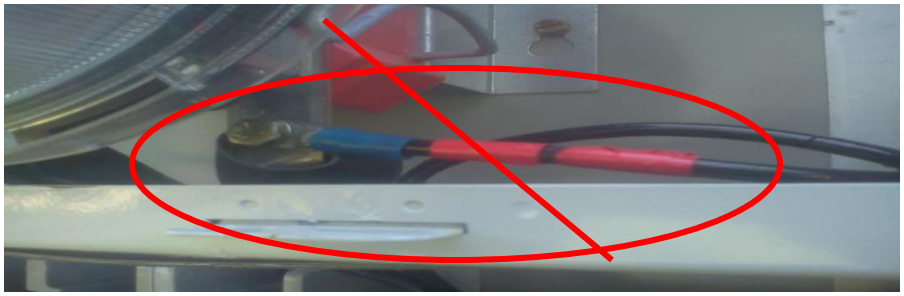
- **Taps Ahead of Service Equipment for DG Interconnection – Concerns**



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

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- ✓ ***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.*
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

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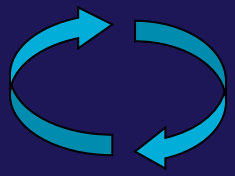
Typical Costs & Schedules for Upgrades

• Distribution Feeder		
– Regulator	$60-200K	2-6 mos.
– Cap move	$3-10K	1-3 mos.
– New Capacitor	$17-25K	1-6 mos.
– Re-conductor	$200-400k/mi	6-12 mos.
– Express Feeder	$350-600k/mi	8-18 mos.
• Transformer		
– Line Xfrmr	$2-25K	1-3 mos.
– Substation Xfrmr	$2-4 million	18-24 mos.

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.*

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BREAK

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Renewable Energy Growth Program – Corinne DiDomenico & Omar Muneeruddin, Environmental Transactions

Renewable Energy (RE) Growth Program

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- Highlights and eligibility requirements of Program
- Approved 2015 Program classes and targets
- Small-Scale Solar < 25 kW
  - Application to payment process
  - 2015 Standard Performance Based Incentives
  - REC Registration and Certification
- Solar > 25 kW and Other Technologies
  - Application to payment process
  - 2015 Standard Performance Based Incentives
  - Web application demonstration

RE Growth Program Overview

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Highlights:

- 160 MW of nameplate capacity over five years, plus any remaining DG Standard Contract capacity (3.3 MW)
- Quadruples capacity vs 40 MW DG Standard Contract Program
- Tariff-based - no contracts
- 20-year Tariff length (except Small-Scale Solar, which offers 15 or 20 year tariff lengths)
- Streamline continuous open enrollment for Small-Scale Solar customers ("first come, first served")
- Simplified application process for non-residential customers and "stand-alone" systems (web application)

Eligibility Requirements:

- Eligible Renewable Energy Classes as approved by PUC
- Not fully financed, under construction, or already operating
- Have a completed Impact Study Renewable DG (ISRDG) and/or Interconnection Service Agreement prior to enrollment
- Interconnect to Narragansett Electric Company distribution system and located in ISO-NE load zone
- Not a segment of a larger project
- Site control

Approved 2015 Program Classes/Targets

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Renewable Energy Class (Nameplate kW)	Annual Target (Nameplate kW)
Small-Scale Solar (1-25 kW)	3,000
Medium-Scale Solar (26-250kW DC)	4,000
Commercial-Scale Solar (251-999 kW DC)	5,500
Large-Scale Solar (1,000-5,000 kW DC)	6,000
Wind (1,500-5,000 kW)	5,000
Anaerobic Digestion (up to 1,000 kW)	1,500
Small-Scale Hydropower (up to 1,000 kW)	

Small-Scale Solar (25 kW or less): Continuous Open Enrollment

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- Apply via Interconnection Application
- Projects can elect to receive 1) a direct payment or 2) a combination of direct payment and bill credits
- Projects have 24 months from time of award of Certificate of Eligibility to meet requirements for payment under the tariff

Pre-Enrollment

- Eligible Facilities criteria
  - Interconnection Application
  - On-site load requirements for bill credits
- Residential and non-residential customers
- Not already operating

Annual Continuous Enrollment

- No separate Enrollment Application
- Elect to participate via Interconnection Application
- First come, first served
- No competitive bid required

Award Certificate of Eligibility

- Award Certificate of Eligibility
- Construction
- Interconnection

24 months

Payment for RECs*

- Renewable Energy Resources Eligibility Form - PUC approval
- NEPOOL GIS
- Non-residential systems can opt to receive direct payment or combination of direct payment and bill credit

*Renewable Energy Certificates

Small-Scale Solar (25 kW or less): Standard Performance Based Incentive 2015 Program Year

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Renewable Energy Class (Nameplate kW)	Ceiling Price/Standard PBI (cents/kWh)	Annual Target (Nameplate MW DC)
Small-Scale Solar – Host Owned* (1-10 kW DC)	41.35 (15-yr Tariff)	3.0
Small-Scale Solar – Host Owned* (1-10 kW DC)	37.75 (20-yr Tariff)	
Small-Scale Solar – 3rd Party Owner* (1-10 kW DC)	32.95 (20-yr Tariff)	
Small-Scale Solar (11-25 kW DC)	29.80 (20-yr Tariff)	

*Projects must submit an affidavit confirming if the project is host owned or third party owned.

Small-Scale Solar < 25 kW
REC Registration and Certification

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- All projects are required to obtain certification from the RI PUC of the project as an Eligible Renewable Energy Resource and register with NEPOOL GIS as a condition for payment under the Tariffs.
- National Grid is seeking approval from the RI PUC to aggregate the Small-Scale Solar Projects for these purposes.
- Upon approval, the Company will register the projects with NEPOOL GIS and obtain RI PUC certification on the project's behalf
  - Certification Assignment and Aggregation Form
- A project may elect to pursue RI PUC certification on its own
- Projects will not be paid until such certification is obtained
- All projects are required to cooperate as needed

Solar >25 kW and Other Technologies

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- Web-based application during two-week open enrollment periods
  - 9 AM Eastern Prevailing Time August 3, 2015 through 5 PM Eastern Prevailing Time August 14th, 2015
- ngrid.com/REGrowth
  - Applicants provide info on Project Technical Details; Ownership/Site Control; Bid Pricing; Interconnection; Financing/Development Costs
  - Project Segmentation and Tax Credit Eligibility Affidavit
- Solar >250 kW and DG projects for Other Eligible Technologies required to submit competitive priced bid ($/kWh) for output of facility.
- Selection of projects based on ranking of pricing bids at or below applicable ceiling price for each technology class
  - Projects awarded a Certificate of Eligibility (COE) will be paid Performance-Based Incentive (PBI) equal to their respective bid price
- Medium-Scale Solar (26 - 250 kW) projects are not required to submit competitive priced bid – selected on a “first come, first served” basis and paid Standard PBI
- Must be operational within 24 months of award of Certificate of Eligibility
  - 36 months for anaerobic digestion; 48 months for hydropower

Solar >25kW and Other Technologies: Application Overview

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Pre-Open Enrollment

- Eligible Facilities criteria
  - Approved Class
  - Interconnection to Narragansett Elec. Load zone
- Not already operating
- Interconnection Application
- ISRDG/ISA*
- Site Control

Open Enrollment

- Two Week Period
- Short-form web-based application
- Application completeness and timeliness requirements

Project Selection

- Based on lowest priced bids at or below applicable ceiling price
- Performance Guarantee Deposit

Award Certificate of Eligibility

- Company issues COE to Medium Solar projects
- Provide list of selected larger projects to PUC
- PUC awards Certificate of Eligibility to larger projects
- Construction
- Interconnection

24 months**

Payment for Output

- Output Certification
- ISO-NE & NEPOOL GIS
- Renewable Energy Resource Eligibility Form - Commission approval

Impact Study for Renewable Distributed Generation and/or valid Interconnection Service Agreement required prior to enrollment

**36 months for anaerobic digestion projects, 48 months for hydropower

Solar >25 kW and Other Technologies: Standard Performance Based Incentive 2015 Program Year

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Renewable Energy Class (Nameplate kW)	Enrollment Target (Nameplate kW)	Standard PBI *applicable to Medium-Scale Solar only* (cents/kWh)	Ceiling Price w/ITC (cents/kWh)	Ceiling Price w/ PTC (cents/kWh)	Ceiling Price w/o ITC/PTC (cents/kWh)
Medium-Scale Solar (26-250kW DC)	4,000	24.40	24.40	N/A	N/A
Commercial-Scale Solar (251-999 kW DC)	5,500	N/A	20.95	N/A	N/A
Large-Scale Solar (1,000-5,000 kW DC)	6,000	N/A	16.70	N/A	N/A
Wind (1,500-5,000 kW) 1,500-2,999 kW 3,000-5,000 kW	5,000	 N/A N/A	 18.40 18.20	 19.85 19.45	 22.75 22.35
Anaerobic Digestion (up to 1,000 kW) 150-1,000vkW	1,500	N/A	N/A	20.20	20.60
Small-Scale Hydropower (up to 1,000 kW) 10-250 kW 251-1,000 kW		 N/A N/A	 N/A N/A	 19.80 18.55	 21.35 20.10

Solar >25 kW and Other Technologies: Web Application Demonstration

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The following demonstration is provided to help customers better understand how to use the RE Growth web application. Application inputs are provided as an example and are not necessarily representative of actual RE Growth Program application data.

Future 2015 DG Seminars – MA/RI

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Date	Utility
April 29	**National Grid (Providence, RI)**
May 13	WMECo [NU] (Hadley, MA)
June 4	Eversource[NU] (Westwood, MA)
July 23	**National Grid (Waltham, MA)**
TBD	**National Grid (Providence, RI**
August 26	WMECo [NU] (Hadley, MA)
September 18	Eversource[NU] (Westwood, MA)
October 15	**National Grid (North Andover, MA)**
TBD	**National Grid (Providence, RI)**
November 5	WMECo [NU] (Hadley, MA)
December 10	Eversource[NU] (Westwood, MA)

Other Information Resources

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RI PUC Website: http://www.ripuc.org/utilityinfo/electric.html

RI OER Website: http://www.energy.ri.gov/index.php

State of Rhode Island
Office of Energy Resources

Commerce RI: http://www.**commerceri**.com

Commerce RI

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Thank you for participating!

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Q&A

Contact for Following-Up Questions:

Email: Distributed.Generation@nationalgrid.com