Towards Enhanced Inverters in New England

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PJM Stakeholder Meeting

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Union of Concerned Scientists

High Level of Activity

- ISO-NE prepared forecast of DG
- Massachusetts Technical Standards Review Group developed from state proceeding
- ISO-NE promotion of Enhanced Inverter capabilities
- Interaction with IEEE and EPRI efforts on Enhanced Inverter capabilities

ISO-NE Planning Department

Final Interim PV Forecast

States	Annual Total MW (MW, AC nameplate rating)											Totals
	Thru 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
CT	73.1	51.4	46.4	66.4	46.4	46.4	46.4	46.4	46.4	46.4	46.4	561.8
MA	361.6	187.2	138.1	138.1	138.1	131.6	131.6	131.6	131.6	131.6	131.6	1,752.8
ME	8.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	30.0
NH	8.2	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	35.4
RI	10.9	8.1	6.3	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	62.8
VT	31.7	22.8	16.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	6.8	141.8
Annual Policy-Based MWs	493.6	274.5	211.9	223.3	198.6	192.1	148.7	148.7	17.1	14.4	2.2	1,925.0
Annual Post-Policy MWs	0.0	0.0	0.0	0.0	4.7	4.7	48.0	48.0	179.7	182.4	192.2	659.7
Annual Nondiscounted Total (MW)	493.6	274.5	211.9	223.3	203.3	196.7	196.7	196.7	196.7	196.7	194.4	2,584.7
Cumulative Nondiscounted Total (MW)	493.6	768.1	980.1	1,203.3	1,406.6	1,603.3	1,800.1	1,996.8	2,193.6	2,390.3	2,584.7	2,584.7
Discounted MWs												
Total Discounted Annual	493.6	247.1	180.1	178.6	150.1	145.2	123.5	123.5	57.7	56.4	49.7	1,805.6
Total Discounted Cumulative	493.6	740.7	920.8	1,099.4	1,249.5	1,394.7	1,518.3	1,641.8	1,699.5	1,755.9	1,805.6	1,805.6
Final Summer SCC (MW) Based on 35% [Assume Winter SCC equal to zero]												
Annual: Total Discounted SSCC (MW)	172.8	86.5	63.0	62.5	52.5	50.8	43.2	43.2	20.2	19.7	17.4	632.0
Cumulative: Total Discounted SSCC (MW)	172.8	259.2	322.3	384.8	437.3	488.2	531.4	574.6	594.8	614.6	632.0	632.0

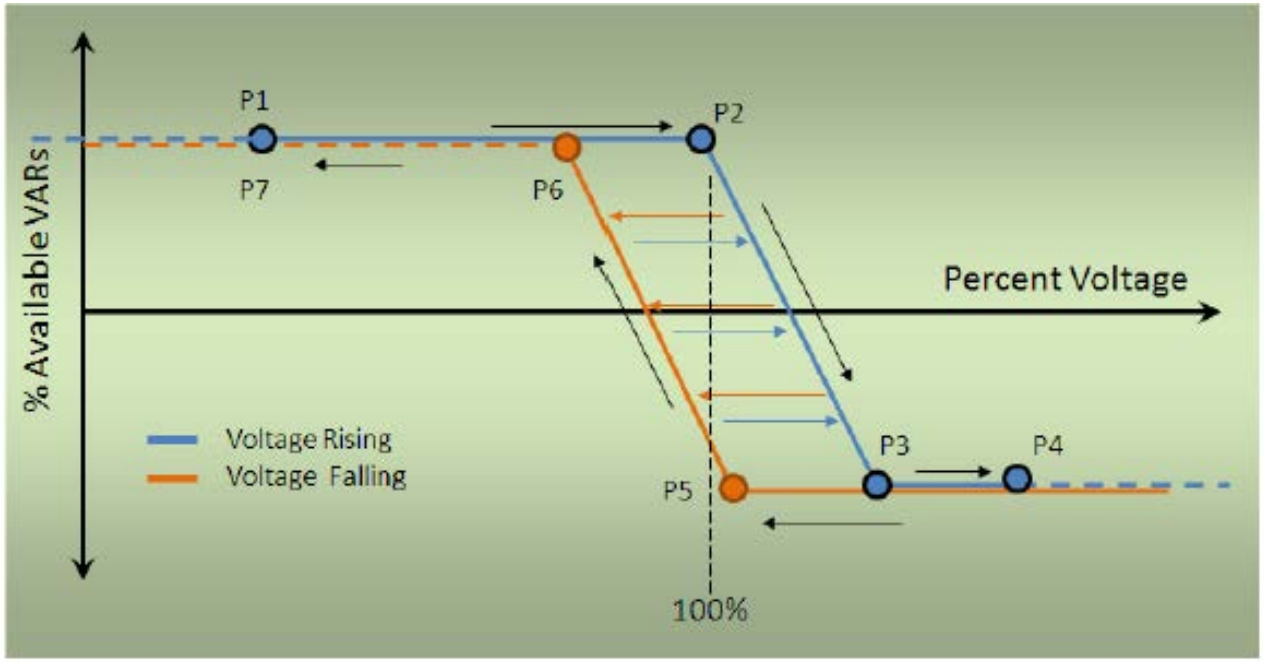
Notes:

(1) Yellow highlighted cells indicate that values contain post-policy MWs

Massachusetts Technical Standards Review Group

Chair: Babak Enayati, National Grid
Vice-Chair: Michael Conway, Borrego Solar Systems

- Topics include DG power factor/ Var control and ride-through



Example from EPRI "Common Functions for Smart Inverters" 11/2012

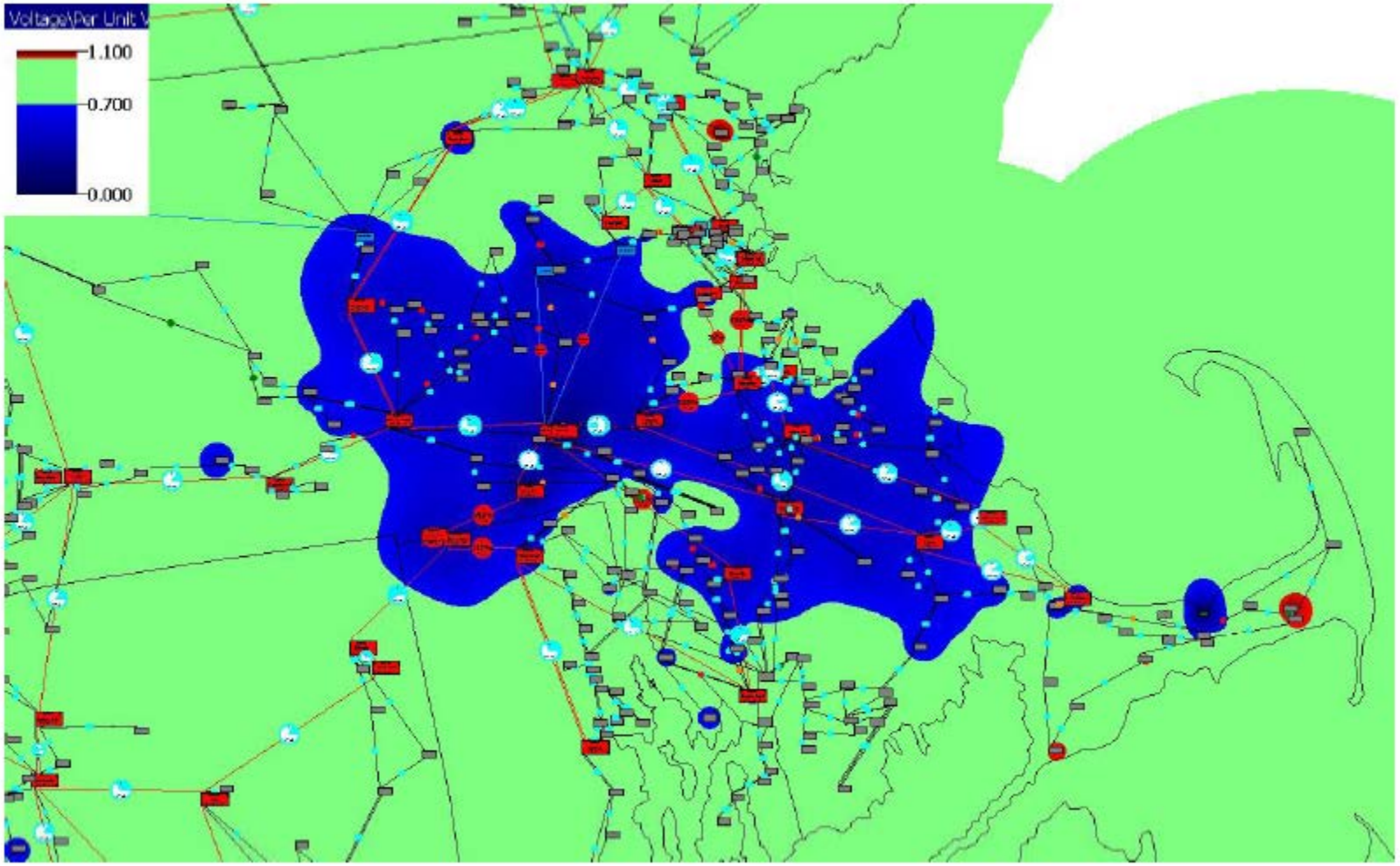
Short Circuit Analysis

- To understand how transmission faults might impact DER in New England, the ISO had a consultant and a transmission owner test several three-phase short circuits on the transmission system
- Testing was done with a model of the existing transmission system and with all existing generation on line
- A sensitivity test was done with a number of generators off line to simulate a light load period (a spring day with high levels of solar and wind generation)

Short Circuit Analysis

- Limited testing indicates that three-phase short circuit on the 345 kV transmission system with all generators in service can result in low voltages over a significant area
- The following plot show the extent of low voltages that could occur for a fault on the 345 kV system in western Norfolk county in Massachusetts

Low Voltage for 345 kV Fault in Massachusetts With All Generators On



Low Voltage for 345 kV Fault in MA With Min Gen

- Sensitivity testing indicates that low voltages can be more severe and extend to a wider area during light load periods when local generation is off line
- ISO's consultant tested the same three-phase fault on the 345 kV system in western Norfolk county simulating a light load scenario
- The following table illustrates how the low voltages caused by a short circuit can vary significantly based on generation dispatch

Low Voltage for 345 kV Fault in MA With Min Gen

Location	Miles From Fault	Voltage-Min Generation	Voltage-Max Generation
Palmer	50 (west)	.53	>.75
Ashburnham	50(northwest)	.41	>.75
Bourne	60(southeast)	.24	.56
Chatham	90(southeast)	.29	.48
Scituate	40(east)	.19	.45
Hyde Park	20(east)	.13	.19
Sterling	40(northeast)	.35	.58

ISO Continues to Address PV Interconnection Challenges

- The ISO met with several members of DG Forecast Technical Review Committee on 3/14/14
  - Focused on California's efforts to amend state interconnection standards
  - Plan to meet with additional experts in the near term
- IEEE 1547 Inaugural Revisions Meeting
  - ISO will attend this April 23- 25 meeting
  - http://grouper.ieee.org/groups/scc21/1547/1547_index.html
- Massachusetts Distributed Generation Working Group
  - ISO participating, next meeting is April 16
  - https://sites.google.com/site/massdgic/home/interconnection/distributed-generation-working-group
- ISO to meet with the states in coming months