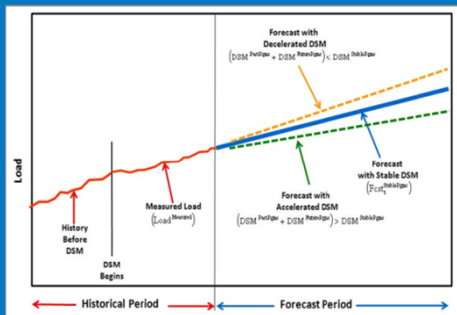


Update of Distributed Generation Consideration in National Grid's Forecasting & Distribution Planning Processes



December 19, 2016

Agenda

- Forecasting
 - Refined
- DG in Distribution Planning
 - Data Gathering
 - Modeling
 - Integration

Forecasted Distributed Generation - Solar

- First Step in New Forecasting Process
 - Track historical DG installations
 - Project for future installations
 - Review queue status
 - Review state policy
 - “Top-Down” approach
 - Last year - 40% nameplate peak contribution factor
 - This year – 21% nameplate peak contribution factor



Forecasting Energy Efficiency & DG (PV)

Rhode Island				Total			
SUMMER Peak (MW) and Energy Efficiency (EE)/PV Impacts							
Calendar Year	SYSTEM PEAK (50/50)			EE/DG REDUCTIONS		EE % of 'Reconstituted' Deliveries	PV % of 'Reconstituted' Deliveries
	Reconstituted (before reductions)	Final Forecast w/ EE Reduction only	Final Forecast (after all reductions)	EE Reduction Forecast	PV Reduction Forecast		
2003	1,788	1,783	1,783	5	0	0.3%	0.0%
2004	1,848	1,832	1,832	16	0	0.9%	0.0%
2005	1,787	1,760	1,760	27	0	1.5%	0.0%
2006	1,828	1,789	1,789	38	0	2.1%	0.0%
2007	1,898	1,849	1,849	49	0	2.6%	0.0%
2008	1,845	1,786	1,786	59	0	3.2%	0.0%
2009	1,889	1,816	1,816	73	0	3.9%	0.0%
2010	1,836	1,749	1,749	88	0	4.8%	0.0%
2011	1,937	1,836	1,836	101	0	5.2%	0.0%
2012	1,944	1,826	1,826	118	0	6.1%	0.0%
2013	1,980	1,837	1,835	142	2	7.2%	0.1%
2014	1,932	1,755	1,752	177	3	9.2%	0.2%
2015	2,058	1,843	1,839	215	5	10.5%	0.2%
2016	2,039	1,791	1,782	248	9	12.2%	0.4%
2017	2,093	1,817	1,793	278	24	13.2%	1.1%
2018	2,125	1,826	1,783	299	43	14.1%	2.0%
2019	2,149	1,828	1,780	320	49	14.9%	2.3%
2020	2,173	1,832	1,780	341	52	15.7%	2.4%
2021	2,200	1,839	1,786	361	53	16.4%	2.4%
2022	2,228	1,848	1,794	379	54	17.0%	2.4%
2023	2,255	1,858	1,804	397	55	17.6%	2.4%
2024	2,281	1,868	1,812	414	55	18.1%	2.4%
2025	2,307	1,877	1,821	430	56	18.6%	2.4%
2026	2,332	1,887	1,830	445	57	19.1%	2.4%
2027	2,357	1,897	1,840	459	57	19.5%	2.4%
2028	2,381	1,908	1,850	473	58	19.9%	2.4%
2029	2,405	1,919	1,861	486	58	20.2%	2.4%
2030	2,429	1,931	1,872	498	59	20.5%	2.4%
2031	2,453	1,943	1,883	510	60	20.8%	2.4%

For Discussion Only

DG in Distribution Planning – Data Gathering

Feeder Number	Existing Pending	Rating kW	Street No	Street Name	Suffix	City/Town Description
53-34F3	Pending	4000	0	HARTFORD	PIKE	Foster
53-34F1	Pending	2992.8	0	DANIELSON	PIKE	FOSTER
53-23F2	Pending	2500	300	JENCKES-HILL	RD	LINCOLN
53-23F5	Pending	2500	0	DOWLING-VILLAGE	BLVD	NORTH SMITHFIELD
53-34F2	Pending	2475	0	PUTNAM	PIKE	GLOCESTER
53-127W41	Pending	2320	600	BRONCO	HWY	BURRILLVILLE
53-26W1	Pending	2200	0	POUND-HILL	RD	NORTH SMITHFIELD
53-23F6	Pending	2016	0	SMITHFIELD	RD	NORTH PROVIDENCE
53-26W7	Pending	2000	90	TIFFT	RD	NORTH SMITHFIELD
53-34F1	Pending	1980	107	CUCUMBER-HILL	RD	FOSTER
53-23F5	Pending	1500	0	DOWLING-VILLAGE	BLVD	NORTH SMITHFIELD
53-26W3	Pending	1500	836	OLD-SMITHFIELD	RD	NORTH SMITHFIELD
53-34F3	Pending	1170	23	THEODORE-FOSTER	RD	NORTH SCITUATE
53-26W5	Existing	850	582	GREAT	RD	NORTH SMITHFIELD
53-26W5	Pending	828	582	GREAT	RD	NORTH SMITHFIELD
53-26W7	Pending	788.8	22	CHRISTIANSEN	WAY	NORTH SMITHFIELD
53-34F3	Pending	780	15	THEODORE-FOSTER	RD	NORTH SCITUATE
53-34F3	Pending	720	0	DANIELSON	PIKE	FOSTER

12:00:00 AM	0%
1:00:00 AM	0%
2:00:00 AM	0%
3:00:00 AM	0%
4:00:00 AM	0%
5:00:00 AM	0%
6:00:00 AM	1%
7:00:00 AM	18%
8:00:00 AM	38%
9:00:00 AM	52%
10:00:00 AM	63%
11:00:00 AM	72%
12:00:00 PM	77%
1:00:00 PM	75%
2:00:00 PM	69%
3:00:00 PM	59%
4:00:00 PM	45%
5:00:00 PM	27%
6:00:00 PM	12%
7:00:00 PM	7%
8:00:00 PM	2%
9:00:00 PM	1%
10:00:00 PM	1%
11:00:00 PM	0%
12:00:00 AM	0%

DG in Distribution Planning – Data Gathering

Feeder	Proposed Capacity (kW)	Existing Capacity (kW)	Fuel Type	Prime Mover	DG Type	Name Plate Rating kW
14F1	0	3.5	Solar	PV	Inverter Based - PV	3.5
14F1	0	5.5	Solar	PV	Inverter Based - PV	5.5
14F3	0	225	Hydro	Hydro	Synchronous	225
14F4	308	0	Solar	PV	Inverter Based - PV	308
27F2	500	0	Solar	PV	Inverter Based - PV	500
27F3	0	300	Solar	PV	Inverter Based - PV	300
27F4	224	0	Solar	PV	Inverter Based - PV	224
72F2	0	5.16	Solar	PV	Inverter Based - PV	5.16
72F5	5	0	Solar	PV	Inverter Based - PV	5
83F2	495	0	Solar	PV	Inverter Based - PV	495
87F1	100	0	Wind	Wind	Wind Turbine	100
87F1	220.8	0	Solar	PV	Inverter Based - PV	220.8
87F5	0	3.5	Solar	PV	Inverter Based - PV	3.5
TOTAL	1,853	543				2,395
76F1	0	5	Solar	PV	Inverter Based - PV	5
76F1	44.5	0	Solar	PV	Inverter Based - PV	44.5
76F2	0	42	Solar	PV	Inverter Based - PV	42
76F2	0	6	Solar	PV	Inverter Based - PV	6
76F5	0	4.3	Solar	PV	Inverter Based - PV	4.3
76F5	0	3.87	Solar	PV	Inverter Based - PV	3.87
76F5	0	2.75	Solar	PV	Inverter Based - PV	2.75
76F5		0				
76F5	2.5	0	Solar	PV	Inverter Based - PV	2.5
76F5	3.25	0	Solar	PV	Inverter Based - PV	3.25
76F6	0	75	Solar	PV	Inverter Based - PV	75
76F7	0	0.43	Solar	PV	Inverter Based - PV	0.43
76F7	100	0	Wind	Wind	Inverter Based - Wind	100
76F7	0		Solar	PV	Inverter Based - PV	
76F7	0	5	Solar	PV	Inverter Based - PV	5
76F7	0	4.5	Solar	PV	Inverter Based - PV	4.5
76F7	0	1	Solar	PV	Inverter Based - PV	1
76F7	2.75	0	Solar	PV	Inverter Based - PV	2.75
76F7	7.5	0	Solar	PV	Inverter Based - PV	7.5
7F1	0	0.86	Solar	PV	Inverter Based - PV	0.86
	161	151				311

■ First Study Area Subset

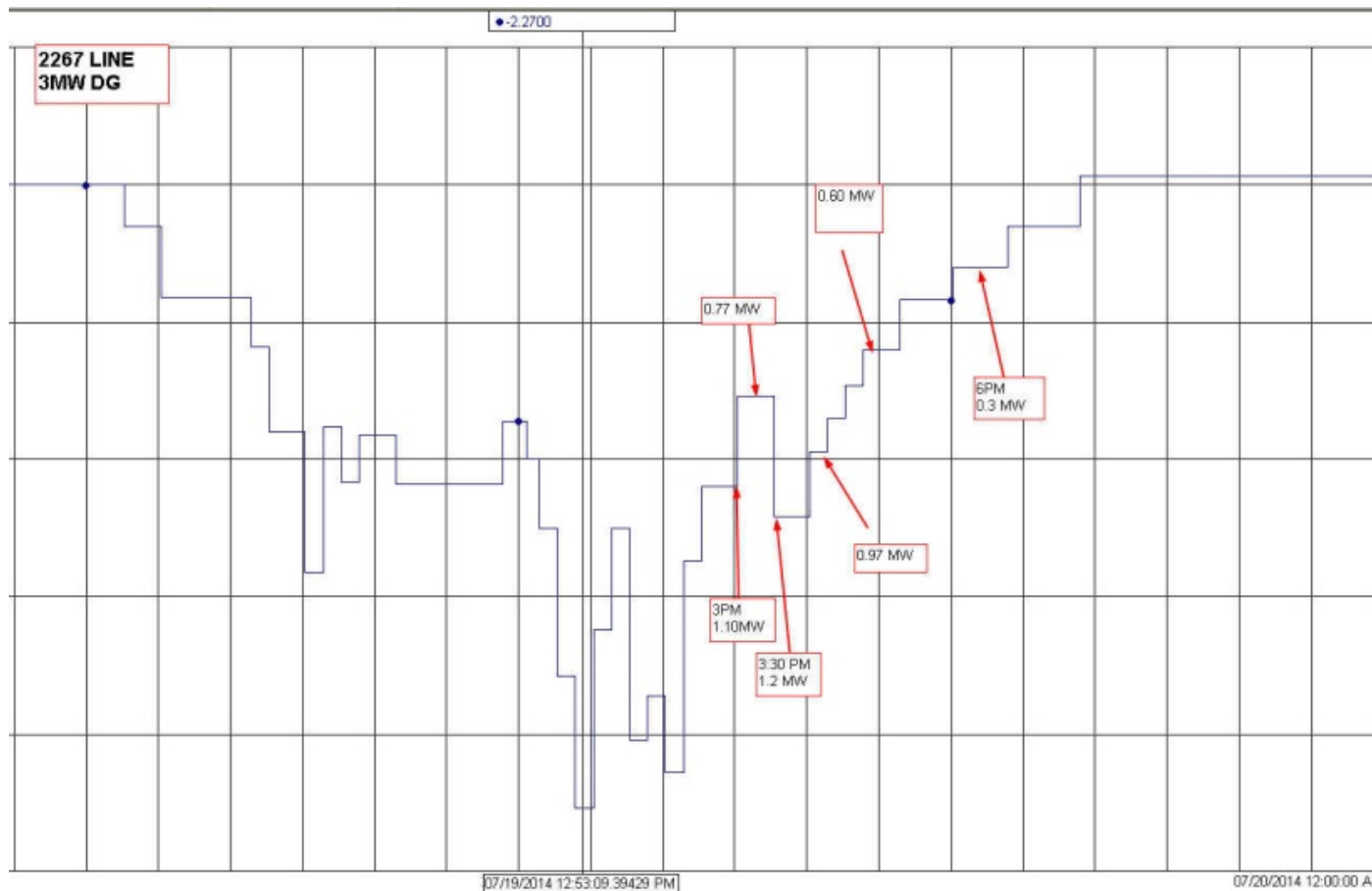
- ~2400 kW nameplate
- 4PM peak ~1100 kW at peak
 - Some impact over 13 feeder area
- 5PM peak ~648kW at peak
 - Minor impact over 13 feeder area
- 6PM peak ~288 at peak
 - Very minor impact over 13 feeder area

■ Second Study Area Subset

- ~311 kW nameplate
- Nameplate not significant enough for further analysis

DG in Distribution Planning – Data Gathering

- Observations of DG variability during peak day



For Discussion Only

Distribution Planning – Modeling – DG Off

- Green Circles = DG Sites
- 5-6PM Peak = 20% coincidence factor

Site	Feeder	kW nameplate	Type
A	28W40	2000	PV
B	28W50	2850	PV
C	28W51	1500	PV
D	28W51	1000	PV
E	28W51	1000	PV
F	28W51	2000	WT-Type 4
G	28W51	950	PV

For Discussion Only

Distribution Planning – Modeling – DG On

The screenshot displays a distribution network model with various components and data windows. Red arrows point from specific locations on the network map to the two 'Load Flow Box - Locked' windows. A green dashed arrow points from the 'Color Coding' window to the 'DG Sites' table.

Load Flow Box - Locked (Cable - 14285272)

	V base	KVLL	KVLN	i (A)	kVA	KW	KVAR	V%	pf	Unbel
A	117.6	13.5	7.8	491.2	3838.6	3705.6	1002.1	97.97	96.53	1.04
B	117.6	13.5	7.8	480.3	3753.0	3616.6	1002.5	97.97	96.37	-1.20
C	117.5	13.5	7.8	487.0	3802.2	3662.8	1019.9	97.88	96.34	0.17
Total:				11394	10985	3025				

Network ID: 28W51

Load Flow Box - Locked (Cable - 14285140)

	V base	KVLL	KVLN	i (A)	kVA	KW	KVAR	V%	pf	Unbel
A	119.0	13.7	7.9	455.8	3604.1	3585.6	364.9	99.13	99.49	-0.39
B	118.9	13.7	7.9	462.1	3650.9	3626.8	418.8	99.05	99.34	0.97
C	118.9	13.7	7.9	455.0	3596.2	3576.6	375.5	99.09	99.45	-0.58
Total:				10851	10789	1159				

Network ID: 28W50

Color Coding - Loading level color(%)

	Greater than (%)	Lower than or equal to (%)	Line width	Color
1	<input checked="" type="checkbox"/> 0.00	80.00	3	Blue
2	<input checked="" type="checkbox"/> 80.00	90.00	3	Green
3	<input checked="" type="checkbox"/> 90.00	95.00	4	Yellow
4	<input checked="" type="checkbox"/> 95.00	100.00	5	Orange
5	<input checked="" type="checkbox"/> 100.00	120.00	5	Red
6	<input checked="" type="checkbox"/> 120.00	999999.00	5	Dark Red

Table of DG Sites:

Site	Feeder	kW nameplate	Type
A	28W40	2000	PV
B	28W50	2850	PV
C	28W51	1500	PV
D	28W51	1000	PV
E	28W51	1000	PV
F	28W51	2000	WT-Type 4
G	28W51	950	PV

Legend:

- Green Circles = DG Sites
- 5-6PM Peak = 20% coincidence factor

DG in Distribution Planning – Integration

■ Integration

- Risk of Islanding – Required Equipment Changes
- Station Protection and Reverse Power Flow
 - Ex: Jepson Substation
- Company Testing
 - Smart Inverters
 - Energy Storage in Support of DG

Questions

