Update on PV Data and Modeling Considerations

Distributed Generation Forecast Working Group

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Overview

- Update on PV data sources
  - NEPOOL GIS
  - ISO's wholesale energy market
  - MA DOER data
  - EIA Form 861
- PV panel degradation rates
- Results of MA PV installed cost analysis, 2008-2013
  - MA SREC project data

Introduction

- The ISO continues to seek the best sources of PV data to use in the distributed generation (DG) forecast process
  - This presentation will discuss some sources of PV data and their usefulness for DG forecasting purposes
  - Stakeholder input welcome
- Two other areas for DG forecast consideration
  - PV panel degradation rate
  - Results of MA PV installed cost analysis, 2008-2013 (future DG forecasts)

Background

- Existing ISO load forecast practices capture existing DG, including PV, through historical load trends
  - ISO seeks to improve forecast methodology by gaining a better understanding of existing and future PV amounts, locations, and production
- Much of the PV installed in New England is not registered in ISO's wholesale energy market
- Future use of PV forecast for planning purposes will require knowledge about the existing capacity and production profile
  - This data will be necessary to effectively avoid double-counting
- There are a number of potential sources of PV production data
- Ideally, ISO would be provided with total hourly PV production, cumulative installed PV capacity and its geographic distribution
- In the absence of these data, ISO may be able to use some combination of:
  1. Total known installed PV capacity over time – currently have incomplete data
  2. Hourly production data from a subset of PV installations
  3. Quarterly total energy production from NEPOOL GIS

Comparison of PV Data Sources

NEPOOL GIS, MA SREC, and ISO Settlements

- Tabulated to the right is the quarterly PV energy production (second and third quarters of 2013) reflected in NEPOOL GIS, MA SREC reporting, and ISO settlements
- Based on our review:
  - MA SRECs represent approximately 80% of total PV energy reported to NEPOOL GIS in the region
  - According to settlements data, approximately 30% of total PV energy reported to NEPOOL-GIS is registered in ISO's energy market
  - According to GIS data, less than 6% of PV energy is from ISO settlements assets (i.e., assets with 'MSS' tag)

Data Source	Q2 2013 PV Energy (GWh)	Q3 2013 PV Energy (GWh)
NEPOOL GIS[1] – Total	114.4	131.9
NEPOOL GIS[1] – 'MSS' portion only	6.5	7.3
MA DOER – Minted SRECs[2]	91.8	95.7
ISO-NE Settlements[3]	36.5	39.4

Sources:

1 – NEPOOL GIS data at https://www.nepoolgis.com/

2 – MA DOER data, note that Q3 value is preliminary, available at: http://www.mass.gov/eea/docs/doer/rps-aps/srecs-minted-and-expected-122013.xlsx

3 – ISO-NE Net Energy and Peak Load by Source, available at: http://www.iso-ne.com/markets/hstdata/rpts/net_eng_peak_load_sorc/energy_peak_source.xls

NEPOOL GIS –PV Nameplate Capacity by State

As of early January 2014

- Tabulated to the right are the total numbers and aggregate capacity associated with PV registrations in the NEPOOL GIS System
- Some observations include:
  - Individual PV nameplate capacities (not shown) appear to represent a mixture of AC and DC ratings
  - A number of GIS-registered units in MA are yet to be operational
  - Based on DGFWG information collected to date, PV capacity in some states seems especially low
    - e.g., VT
  - Some registrations represent aggregates of a number of projects

State	# Registrations	Nameplate Capacity (MW)
Connecticut	158	45.04
Maine	20	0.87
Massachusetts	4,360	603.85
New Hampshire	36	2.342
Rhode Island	13	6.27
Vermont	28	18.20
Total	**4,615**	**676.57**

Considerations for Using NEPOOL GIS PV Data

- There is an economic incentive for PV to register and report to NEPOOL GIS, since it cannot otherwise garner REC revenue
- Based on aggregate PV nameplate capacities reported to GIS, it appears that the majority of PV installed in the region is registered; however, some PV is not
  - The percent share of registration appears to vary from state to state, depending in part on policy support mechanisms
- Nameplate capacities for PV are not reliable – AC vs. DC
- PV assets that settle in ISO's energy market may not reflect this status in NEPOOL GIS
  - Therefore, GIS data is not a good indicator of the portion of PV production that is from ISO settlement assets

EIA Form 861 Data

- Data published annually, includes:
  - Distributed generation – "industrial and commercial generators of less than 1 megawatt (1,000 kilowatts) installed at or near a customer's site, or other sites within the system"
    - Includes nameplate capacity by technology type
  - Net metered facilities up to 2 MW by utility, customer class, and technology including:
    1. Total nameplate capacity (AC)
    2. Number of facilities
    3. Total energy sold back to utility
- Considerations:
  - Data is not released until end of October of the following year
  - Energy output in net metered data reflects net energy exported to grid, not total production
  - The net metered and DG datasets listed above do not appear to be mutually exclusive
  - Does not include sites that are both: 1) not net metered, and 2) industrial/commercial DG < 1 MW (e.g., projects > 1 MW within municipal utility territories that do not have net metering)
  - Does not include projects > 2 MW

Source: US Energy Information Agency: http://www.eia.gov/electricity/data/eia861/

Additional Comments on Sources of PV Data

- No single source of comprehensive data
- Likely will not be able to obtain total historical hourly energy production by state
  - Monthly energy production by state is likely possible
  - ISO is currently researching methods of developing and using representative subsets of data to represent total known PV fleet
- ISO will rely on distribution utility data for cumulative installed capacity
  - Improved data sharing from utilities would be helpful
    - Operation dates of PV installations would enable greater clarity concerning incremental growth in PV over time

Solar PV Module Degradation Rate*

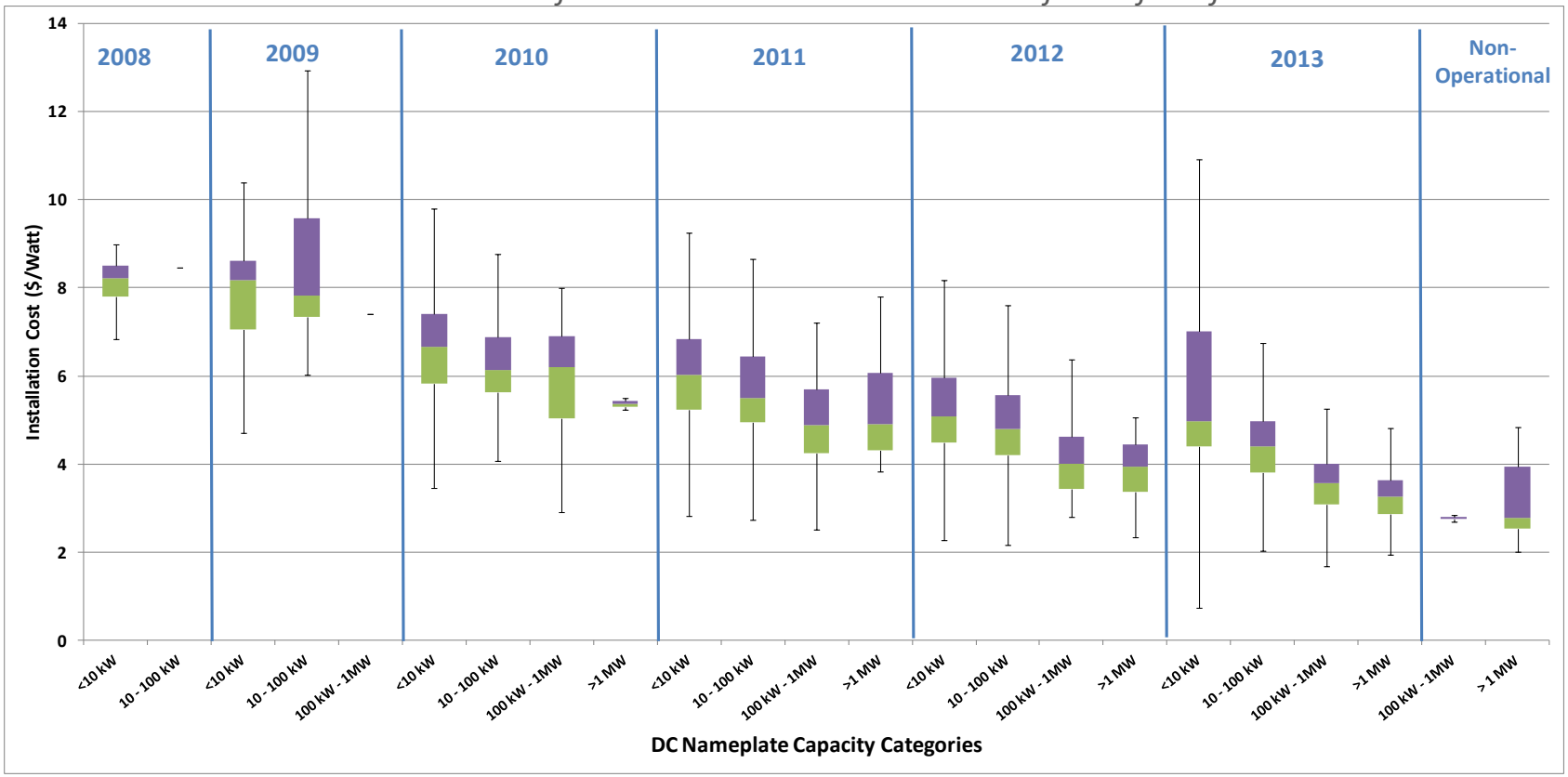
- Degradation rates are a quantification of a solar module's power decline over time
- Degradation rates vary by module technology and climate
- NREL assembled and reviewed nearly 2,000 degradation rates from the literature
- In general, NREL found that most modules degrade at a rate of 0.5%/year (median value), meaning:
  - after first 10 years of life, can expect approximately 95.1% of power production
  - after first 20 years of life, can expect approximately 90.5% of peak power and total energy output
- Takeaway: The composite age of a PV fleet is an important consideration when forecasting its future energy and power production

*Reference: National Renewable Energy Laboratory, *Photovoltaic Degradation Rates – an Analytic Review,* Progress in Photovoltaics, 2011.

MA SREC Project Cost Data Analysis

Boxplot of Cost Data By Project Size Class, 2008-Present

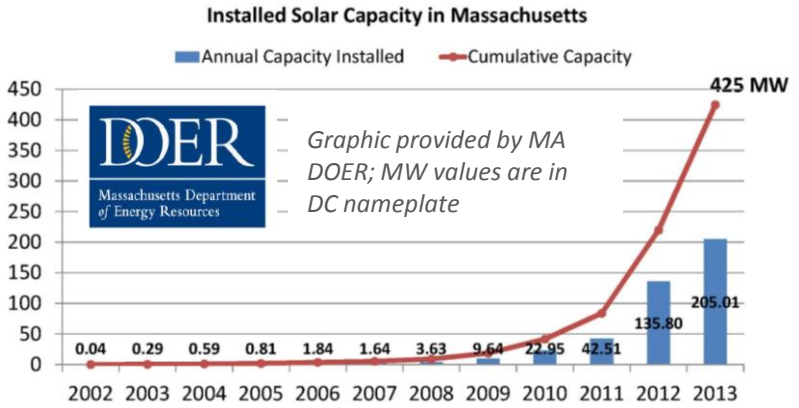
Note: All cost values below reflect current dollars and are not adjusted for inflation



Key: Bottom of green box and top of purple box represent 25th and 75th percentile values, respectively
Median value is represented by value where two boxes meet
"Whiskers" represent the outer value limits in the data that are not considered statistical outliers

MA SREC Project Cost Data

Median Project Cost ($/Watt$_{DC}$ in 2013$) By Size Class, 2008-Present



Note: Costs below are per DC watt nameplate rating; assuming an 83% DC-to-AC derate factor, a multiplier of 1.2 could be used to estimate $/Watt$_{AC}$

Size Class	Year						
	2008	2009	2010	2011	2012	2013	Non-Op
<10 kW	$8.88	$9.16	$7.12	$6.27	$5.29	$4.98	
10 - 100 kW	$6.57	$8.45	$6.56	$5.71	$4.99	$4.40	
100 kW - 1MW		$6.61	$6.63	$5.08	$4.16	$3.55	$2.75
>1 MW			$5.99	$4.90	$4.14	$3.29	$2.77

Notes: All cost values are adjusted to 2013 dollars based on inflation rate (Consumer Price Index)

Summary

- ISO continues to seek and analyze sources of PV production data that may be useful for the DG forecast process
- PV system age is important factor in forecasting production profile associated with existing and future PV
- PV installed costs in MA have decreased significantly over the period between 2008 and 2013

Questions