The Clean Energy States Alliance (CESA)
& the RPS Collaborative present

State Leadership in Clean Energy: Award-Winning Programs in New Hampshire & Rhode Island

Hosted by
Val Stori, Project Director, CESA
July 13, 2016

Housekeeping

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RPS Collaborative

- With funding from the Energy Foundation and the US Department of Energy, CESA facilitates the **Collaborative**.
- Includes **state RPS administrators**, **federal agency representatives**, and other stakeholders.
- Advances dialogue and learning about RPS programs by **examining the challenges and potential solutions** for successful implementation of state RPS programs, including **identification of best practices**.
- To sign up for the Collaborative listserv to get the **monthly newsletter** and announcements of **upcoming events**, see: www.cesa.org/projects/state-federal-rps-collaborative

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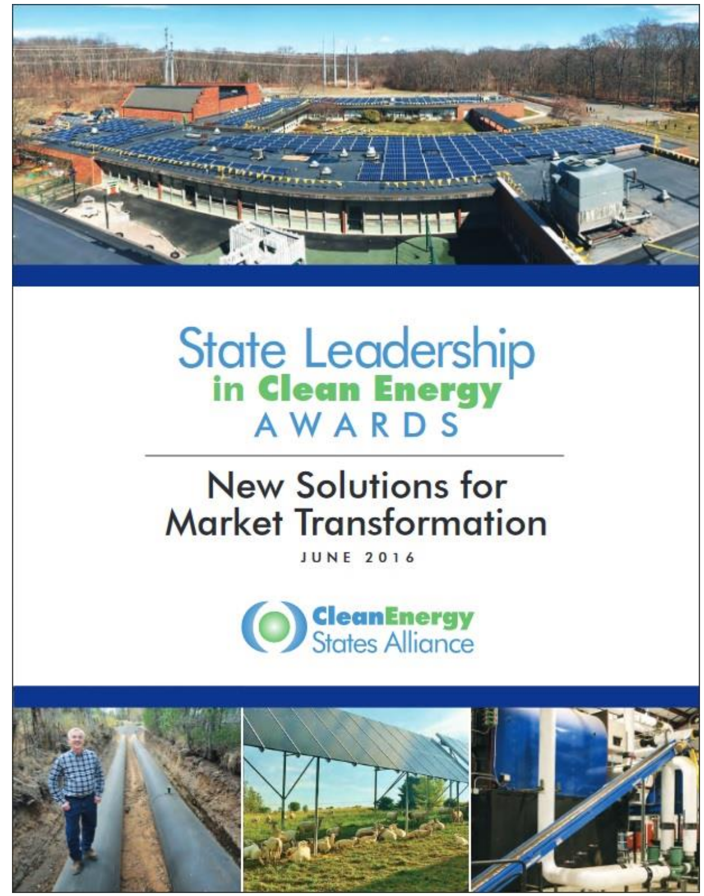
The 2016 State Leadership in Clean Energy Awards

More information, including case studies about the winning programs and information about upcoming webinars, is available at: http://cesa.org/projects/state-leadership-in-clean-energy/2016/.



Today's Guest Speakers

- **Elizabeth Nixon**, Energy Analyst, New Hampshire Public Utilities Commission Sustainable Energy Division
- **Barbara Bernstein**, Energy Analyst, New Hampshire Public Utilities Commission Sustainable Energy Division
- **Danny Musher**, Chief of Program Development, Rhode Island Office of Energy Resources

NEW HAMPSHIRE'S THERMAL RENEWABLE PORTFOLIO STANDARD PROVISIONS

Barbara Bernstein and Elizabeth Nixon
NH Public Utilities Commission
July 13, 2016

RPS Legislation

- Enacted in July 2007. RSA 362-F.
- Established REC requirement for 4 classes:
  - Class I: New sources (wind, biomass, methane gas, etc.) and new capacity added to existing biomass, LFG, and hydro facilities (Began operation after January 1, 2006)
  - Class II: Photovoltaic systems
  - Class III: Existing biomass < 25 MW and landfill gas facilities
  - Class IV: Existing small hydro facilities < 5 MW

RPS Legislation –Thermal

- SB218 became effective June 19, 2012.
- Created Class I sub-class for useful thermal renewable energy.
- Class I REC requirement of 0.2% to be met with thermal resources beginning 2013; delayed by an Order of the Commission to January 1, 2014 at 0.4%.
- Legislation (SB 148 and HB542) in 2013 revised the % obligation to ramp it up faster
- *Required NHPUC to adopt procedures for the* ***metering****, verification, and reporting of useful thermal energy output.* RSA 362-F:13 VI-a

T-REC Rule Development

- Held several stakeholder meetings starting in August 2012
- Hired consultant
- Draft consultant report (September 2013)
- Too complex –included metering of and subtraction of parasitic load (e.g., electricity to run pumps)
- Developed draft rules (April 2014)
- Issued Commission Order No. 25,678 (DRM 14-095) (June 2014)
- Final Rules (December 2014)
- Allowed REC certification back to beginning of 2014

% Obligation

Calendar Year	Total Requirement	Total Class I	Thermal Class I	Class II	Class III	Class IV
2008	4.00%	0.00%	0.00%	0.00%	3.50%	0.50%
2009	6.00%	0.50%	0.00%	0.00%	4.50%	1.00%
2010	7.54%	1.00%	0.00%	0.04%	5.50%	1.00%
2011	9.58%	2.00%	0.00%	0.08%	6.50%	1.00%
2012	5.55%	3.00%	0.00%	0.15%	1.40%	1.00%
2013	5.80%	3.80%	0.00%	0.20%	0.50%	1.30%
2014	7.20%	5.00%	0.40%	0.30%	0.50%	1.40%
2015	8.30%	6.00%	0.60%	0.30%	0.50%	1.50%
2016	9.20%	6.90%	1.30%	0.30%	0.50%	1.50%
2017	17.60%	7.80%	1.40%	0.30%	8.00%	1.50%
2018	18.50%	8.70%	1.50%	0.30%	8.00%	1.50%
2019	19.40%	9.60%	1.60%	0.30%	8.00%	1.50%
2020	20.30%	10.50%	1.70%	0.30%	8.00%	1.50%
2021	21.20%	11.40%	1.80%	0.30%	8.00%	1.50%
2022	22.10%	12.30%	1.90%	0.30%	8.00%	1.50%
2023	23.00%	13.20%	2.00%	0.30%	8.00%	1.50%
2024	23.90%	14.10%	2.00%	0.30%	8.00%	1.50%
2025 and thereafter	24.80%	15.00%	2.00%	0.30%	8.00%	1.50%

Est. MWH RECs

Calendar Year	Total Retail Sales to Retail Customers (MWh)*	Total Class I	Thermal Class I	Class II	Class III	Class IV	Total Obligation
2008	10,550,550	0	0	0	369,269	52,753	422,022
2009	10,202,233	51,011	0	0	459,100	102,022	612,134
2010	10,631,756	106,318	0	4,253	584,747	106,318	801,634
2011	10,610,657	212,213	0	8,489	689,693	106,107	1,016,501
2012	10,681,310	320,439	0	16,022	149,538	106,813	592,813
2013	10,832,470	411,634	0	21,665	54,162	140,822	628,283
2014	10,797,801	539,890	43,191	32,393	53,989	151,169	777,442
2015	10,836,883	650,213	65,021	32,511	54,184	162,553	899,461
2016	10,956,089	755,970	142,429	32,868	54,780	164,341	1,007,960
2017	11,076,606	863,975	155,072	33,230	886,128	166,149	1,949,483
2018	11,198,448	974,265	167,977	33,595	895,876	167,977	2,071,713
2019	11,321,631	1,086,877	181,146	33,965	905,730	169,824	2,196,396
2020	11,446,169	1,201,848	194,585	34,339	915,694	171,693	2,323,572
2021	11,572,077	1,319,217	208,297	34,716	925,766	173,581	2,453,280
2022	11,699,370	1,439,022	222,288	35,098	935,950	175,491	2,585,561
2023	11,828,063	1,561,304	236,561	35,484	946,245	177,421	2,720,454
2024	11,958,172	1,686,102	239,163	35,875	956,654	179,373	2,858,003
2025	12,089,711	1,813,457	241,794	36,269	967,177	181,346	2,998,248

*2008 -2014 figures are based on MWH Sales reported on the E2500 RPS Compliance Reports. 2015 are based on estimates provided by the distribution utilities. 2016 to 2025 figures assume 1.1 percent annual growth in sales based on ISO New England's 2015 Regional System Plan.

Key Provisions - Definition

Useful Thermal Energy means

renewable energy derived from Class I sources that can be metered and is delivered in NH to an end user in the form of direct heat, steam, hot water, or other thermal form that is used for heating, cooling, humidity control, process use or other valid thermal end use requirements and for which fuel or electricity would otherwise be consumed. RSA 362-F:2, XV-a.

Eligible Thermal Technologies

- Solar Thermal
- Geothermal - Ground Source Heat Pumps
- Thermal Biomass Renewable Energy Technologies
- Biomass Combined Heat and Power Facilities
- To be REC eligible, systems must have begun operation after January 1, 2013.

Emission Requirements - Biomass

- PM: 0.1 lb/MMBtu for 3-30 MMBtu/hr;
  0.02 lb/MMBtu for >30 MMBtu/hr
- NOx: 0.075 lb/MMBtu for ≥ 100 MMBtu/hr
- Best Management Practices (annual tune-ups; combustion efficiency) for <100 MMBtu/hr
- Additional emission requirements for electric REC eligibility

Measuring and Metering Thermal Energy

- Boundary for thermal measurement – before delivery to distribution
- Measuring thermal energy:
  - Air/Water Systems: based on flow, temperature, and specific heat
  - Steam systems: based on flow and specific enthalpy (temp. & pressure)
- Metering
  - Must meet accuracy of EN1434 standard for air/water systems
  - Must meet accuracy of ±3% for steam systems; or
  - Must meet accuracy of ±5% or better; RECs discounted; or
  - Alternative methodology

Measuring and Metering Thermal Energy (continued)

- Parametric monitoring for small sources allowed:
  - Solar Thermal: operating hours of pump and SRCC rating taking into account shading/orientation losses
  - Geothermal: operating hours of pump and HC and COP
  - Thermal Biomass: operating hours and fuel input and purchase records

- Small/Large Threshold - 200,000 Btu/hr of heat input

REC Calculation

- Measure thermal output
- Discount for meter accuracy if meter does not meet standard for air/water or ±3% for steam systems
- Discount for operating energy and thermal energy storage losses for large sources
- RECs reported to NEPOOL GIS in mWh (1 mWh = 3.412 MMBtu)

REC Calculation–
Parasitic Energy Discount Factors

- Solar Thermal: 3.0%
- Geothermal: 3.6%
- Thermal Biomass: 2.0%
- Actual Metering of Parasitic Load
- Only for large sources

Verifying and Reporting Thermal Energy

- RECs retroactive to January 1, 2014 if source certified to be eligible to create RECs
- Professional Engineer must attest to the thermal energy metering/measurement methodology
- Independent monitor must inspect facility initially
- Independent monitor must verify and report thermal output to NEPOOL GIS

Verifying and Reporting Thermal Energy – Independent Monitor (IM) Qualifications

- Electric:
  - Electrician
  - Professional Engineer
  - Certified Building Analyst Professional or Certified Mechanical Professional
  - Certified Energy Manager
  - Home Energy Rater
  - IM in another state
- Thermal:
  - Professional Engineer
  - Certified Building Analyst Professional or Certified Mechanical Professional
  - Certified Energy Manager
  - Home Energy Rater
  - IM in another state
  - For geothermal: IGSHPA Accredited Geothermal Installer
  - For solar thermal: NABCEP Certified Solar Heating Installer

Program Participants *to Date*

Table 1: Thermal Participants		
Biomass	# participants	MW equ.
Hospitals (2)	2	5.9697392
Business (3)	3	3.1652989
Schools (7)	7	1.214068
Total Biomass	*12*	*10.349106*
Geothermal		
Residential	4	0.0162075
Business	2	0.0272567
Total Geothermal	*6*	*0.0434642*
Total Thermal	*18*	*10.39257*

Benefits of Program

- Local Resource/Local Economy
  - Spurred growth of the biomass heating industry
  - Displaces heating oil
  - Keeps dollars in the State
  - Provides an additional revenue stream for participants

- Environmental Aspects
  - Helps support forest health
  - Increased efficiency from newer, renewable technologies
  - More stringent emissions standards required for biomass facilities

For Example

- One NH biomass facility displaced ≈ 280,000 gallons of # 2 fuel oil over the past 2 years with 7,043 tons of wood chips
- Wood purchased from a local vendor, supporting the local economy.
- Generated approximately 7,800 thermal RECs over the past two years.

Lessons Learned

- RPS programs CAN include thermal & provide economic benefit!
- To date, no solar thermal applications
- Biomass systems under 191,000MMBTU/hr have not participated to date.
- We've been asked to simplify administration.
  - How to do this & maintain integrity to be determined.
- Application modifications to assist review.

Contact info

- Website: http://www.puc.nh.gov/Sustainable%20Energy/Class%20I%20Thermal%20Renewable%20Energy.html
- Barbara Bernstein: barbara.bernstein@puc.nh.gov
  603-271-6011
- Liz Nixon: elizabeth.nixon@puc.nh.gov
  603-271-6018

Specific Metering Methodologies

Measuring and Metering Thermal Energy Proposed Methodology – Solar Thermal

- $Q_g = (dm/dt) * c_p (To - Ti) * t$

Where:

- Q_g = heat generated in the collector loop (Btu)
- dm/dt = mass flow of the collector working fluid measured near the inlet to the solar storage tank (lbm/hour)
- c_p = specific heat of the collector fluid (Btu/lbm-°F)
- Ti = collector loop inlet temperature measured near the outlet of the solar storage tank (°F)
- To = collector loop outlet temperature measured near the inlet to the solar storage tank (°F)
- t = frequency at which data readings are recorded (hr)

Measuring and Metering Thermal Energy Proposed Methodology – Geothermal

- Q_g = (dm/dt) * c_p * [To –Ti] * t

Where:

- Q_g = heat generated in the ground loop (Btu)
- dm/dt = mass flow measured near the outlet of the ground loop (lbm/hour)
- c_p = specific heat of the working fluid (Btu/lbm-°F)
- t = frequency at which data readings are recorded (hr)
- Ti = ground loop inlet temperature measured at the inlet to the ground loop (°F)
- To = ground loop outlet temperature measured at the outlet from the ground loop (°F)

Measuring and Metering Thermal Energy Proposed Methodology – Biomass

- $Q_g = [dm_{out}/dt *(h_{out}) * t]-[dm_{in}/dt *(h_{in}) * t]$

Where:

- Q_g = Thermal energy generated from biomass (in Btu)
- dm_{out}/dt = mass flow (lbm/hr) metered upstream of distribution and downstream of parasitic loads
- h_{out} = specific enthalpy (Btu/lbm) at metering point determined by temperature and pressure (for superheated steam) data
- dm_{in}/dt = mass flow (lbm/hr) of water into the pumps
- h_{in} = specific enthalpy at metering point (Btu/lbm), which will be a function of the enthalpy of incoming condensate and make-up water prior to the first condensate or feedwater pumps; and
- t = intervals at which readings are recorded (hr)

Measuring and Metering Thermal Energy Proposed Methodology – Biomass

- $Q_g = [dm_{out}/dt * (h_{out}) * t] - [dm_{in}/dt * (h_{in}) * t]$

Where:

- Q_g = Thermal energy generated from biomass (in Btu)
- dm_{out}/dt = mass flow (lbm/hr) metered upstream of distribution and downstream of parasitic loads
- h_{out} = specific enthalpy (Btu/lbm) at metering point determined by temperature and pressure (for superheated steam) data
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- h_{in} = specific enthalpy at metering point (Btu/lbm), which will be a function of the enthalpy of incoming condensate and make-up water prior to the first condensate or feedwater pumps; and
- t = intervals at which data readings are recorded (hr)

Measuring and Metering Thermal Energy Proposed Methodology – Small Solar Thermal

- $Q = (R * t * (1-L) * 1000) / h$

Where:

- Q = thermal energy generated (Btu)
- R= SRCC OG100 rating on Mildly Cloudy C (kBtu/day)
- L = Orientation and shading losses calculated based on solar model such as Solar Pathfinder, T-sol, Solmetric,or other model approved by the Commission(%)
- t = total operating run time (hrs) of the circulating pump as metered
- h= 11 hours/day (conversion factor)

Measuring and Metering Thermal Energy Proposed Methodology – Small Geothermal

- $Q = [HC * (COP - 1) * t] / COP$

Where:

- Q = thermal energy generated (Btu)
- HC = AHRI certified heating capacity at partial load (Btu/hr)
- COP = AHRI Certified Coefficient of Performance
- t = total operating run time (hrs) of pump as metered during heating mode (Entering Water Temperature > Leaving Water Temperature)

Measuring and Metering Thermal Energy Proposed Methodology – Small Biomass

- $Q = (D * R * V * EC * ASE * t)$

Where:

- Q = thermal energy generated by the biomass system (Btu)
- D = default pellet density (lbm/in^3) = 0.0231 lbm/in^3
- R = auger revolutions per hour
- V = default auger feed volume (in in^3/auger revolutions)
- EC = default energy content of pellet fuel (Btu/lbm) = 7870 Btu/lbm
- ASE = default thermal efficiency expressed as percentage based manufacturer's warranty of average seasonal thermal efficiency or a default thermal efficiency of 65%
- t = total auger run time (hr) as metered

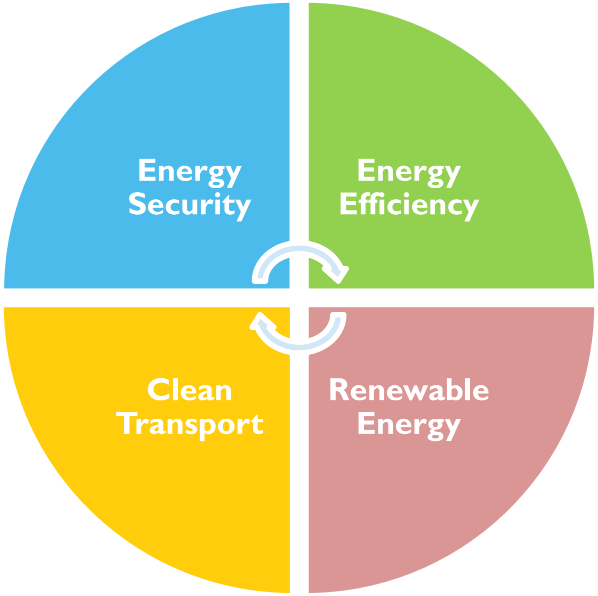
System Reliability Procurement Solar DG Pilot Project

Danny Musher
RI Office of Energy Resources
July 13, 2016

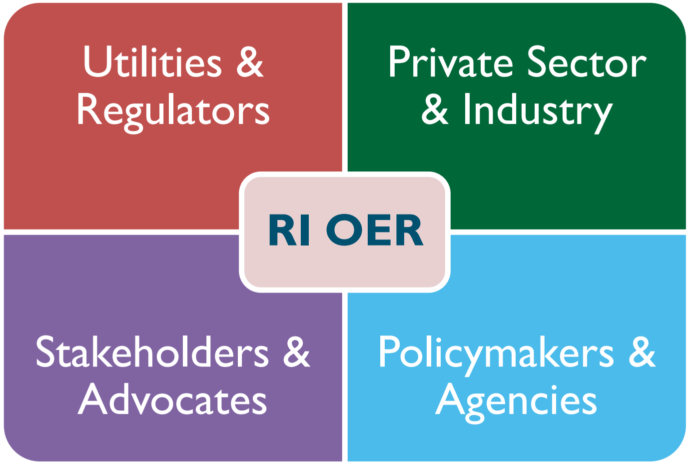
"Leading Rhode Island to a secure, cost-effective, and sustainable energy future."

RI Office of Energy Resources

Leading Rhode Island to a secure, cost-effective, and sustainable energy future.



OER is the lead state agency on energy policy and programmatic matters



OER works closely with diverse partners to advance Rhode Island as a national leader in the clean energy economy

STATE OF RHODE ISLAND
OFFICE OF ENERGY RESOURCES

SRP Solar DG Pilot Project

- OER's SRP Solar DG Pilot explored how distributed solar photovoltaics could provide value to Rhode Island's electric grid.
- The Pilot's goal was to better understand the costs and benefits of solar distributed generation and its ability to reduce peak loads on the distribution system, possibly helping to defer traditional utility capital investments.
- The Pilot used a multi-pronged approach to successfully mobilize the local community and solar market, exceeding goals for solar adoption in the Pilot area.
- Preliminary estimates indicate that solar resources enrolled through the Pilot could provide enough peak load reduction to defer a new substation feeder—originally estimated to cost $2.93 million—by two to four years.

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System Reliability Procurement

- Rhode Island's Least-Cost Procurement law requires electric and gas utilities to invest in all cost-effective energy efficiency
- The law has a "System Reliability Procurement" (SRP) provision focused on maximizing the benefits of clean energy resources to the state's energy and distribution systems
- SRP planning must evaluate if "non-wires alternatives" (NWA) – e.g. EE, DG, DR – can defer or avoid conventional utility infrastructure projects

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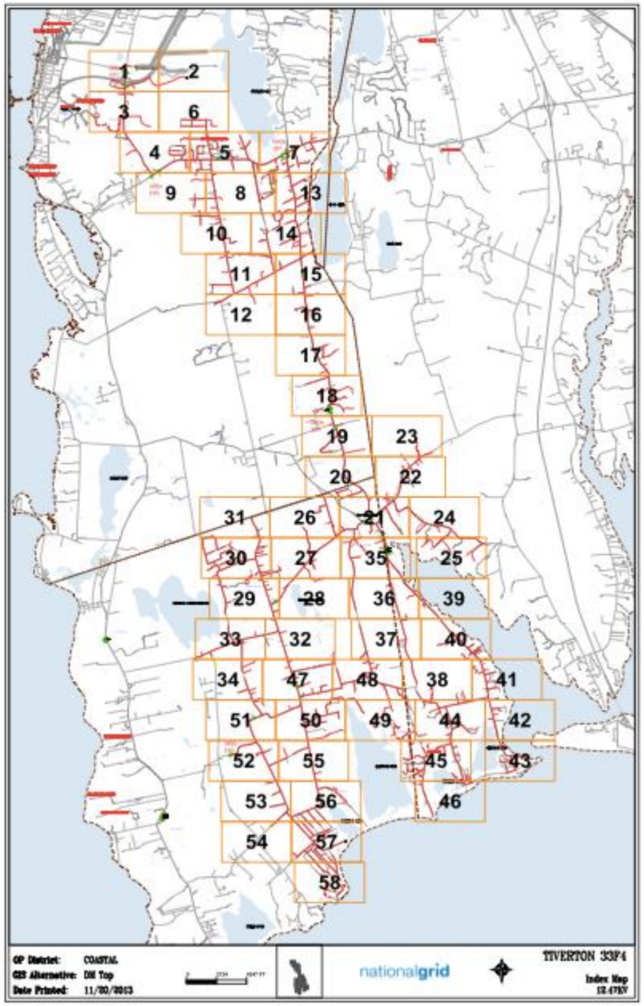
SRP in Action - DemandLink™

- National Grid is conducting an SRP pilot "DemandLink™" in the towns of Tiverton and Little Compton
- The pilot targets summer afternoon distribution system peak loads with EE and DR
- Aimed at deferring a $2.93 million substation feeder



What is the role of solar?

- **OER directed RGGI funds to supplement DemandLink™ with a coordinated distributed solar component**

- **A scoping study conducted by Peregrine Energy Group, Inc. helped inform pilot design**
  - How much solar should be deployed?
  - What configurations would provide maximum distribution benefit?
  - Which strategies should be used to recruit projects?

State of Rhode Island
Office of Energy Resources

Portfolio of Pilot Resources

- **Two components:**
  1. Open solicitation for competitive proposals
  2. Locally-based Solarize initiative

		1 Grid Support Solar Field(s)	2 Solarize Residential	3 Small Commercial	4 Total
1	Gross Capacity (kW)	280	160	80	520
2	Average Distribution Contribution Percentage (DCP)	50%	45%	45%	
3	Distribution Contribution (kW)	142	72	36	250
4	Portfolio Allocation	57%	29%	14%	100%

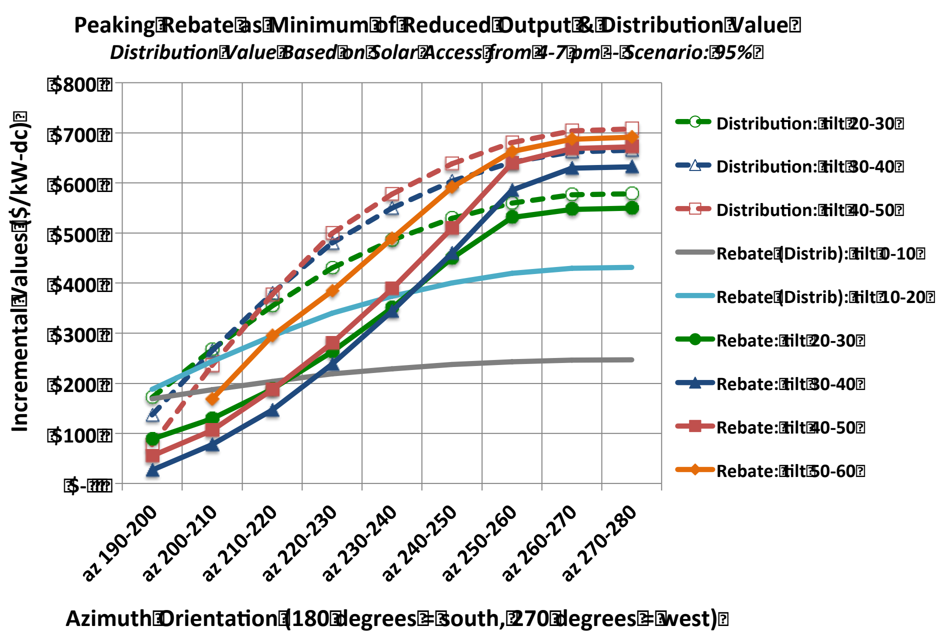
Features of Pilot Design

- **Open solar solicitation fully integrated with state's Renewable Energy Growth Program**
  - Projects required to bid into REG Program
  - For SRP Solar DG Pilot, competitively-awarded grants were based solely on incremental costs to maximize projects' benefit to distribution system

Azimuth Orientation	Nameplate Capacity Needed to Contribute 140 kW-AC of "Peak Contribution" Capacity
180	544
190	444
200	383
210	338
220	308
230	289
240	276
250	267
260	261
270	256
1-axis	245
2-axis	232

Features of Pilot Design

- **Solarize incentives designed to enroll west-facing projects to meet late-afternoon peak**
  - Sliding-scale incentives were offered for west-facing projects based on the minimum of: (1) incremental value to distribution system and (2) lost revenue as compared to a south-facing system



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Overall Pilot Results

- **Pilot enrolled 735 kW of solar DG, exceeding original goal of 520 kW**
  - Solicitation: 250 kW single-axis tracking system awarded grant
  - Solarize: 67 customers signed contracts for 485 kW of capacity
- **Solar estimated to contribute 362 kW of peak load reduction, and two to four years of infrastructure upgrade deferral**

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Lessons Learned & Next Steps

- Replicable model of successful deployment of solar resources to address a distribution need
- OER is conducting a process and impact evaluation study, with field monitoring in 2016 and 2017
- Results of the pilot will inform the future direction of NWA distribution planning in Rhode Island

Thank You!

Danny Musher
Chief, Program Development
RI Office of Energy Resources
Danny.Musher@energy.ri.gov

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Thank you for attending our webinar

Val Stori
Project Director, CESA
val@cleanegroup.org

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Upcoming Webinars

- **State Leadership in Clean Energy: Award-Winning Programs in Connecticut and Oregon**, Tuesday, July 19, 2-3:30pm ET (11am-12:30pm PT)

- **State Leadership in Clean Energy: Award-Winning Programs in California and New York**, Tuesday, July 26, 2-3:30pm ET (11am-12:30pm PT)

Details at www.cesa.org/webinars