



# Regional Demand Reduction Demonstrations

2018

Summary of Eversource Demand Hypotheses Being EVERS URCE Investigated

- Addressing demand reduction effectively requires assessing impacts at 3 levels
  - 1) ISO level, 2) Distribution level and 3) Customer level
- Each level has different impact attributes
  - <u>ISO level</u>: Reduced ICAP Tags and Reduced Install Capacity Requirements.
  - <u>Distribution level</u>: Solutions flexible enough to impact the differing load characteristics across rate classes and reliable enough to defer distribution upgrades.
  - <u>Customer level</u>: Various customer types (or personas) present different characteristics, with differing solution opportunities.
     Opportunities for immediate customer specific savings through non-coincident peak load reductions.

#### ISO Level - Forecast Shows Declining Energy Use and Flat Demand Growth



SUMMER PEAK DEMAND (MW)

#### ANNUAL ENERGY USE (GWh)



Source: Draft Final 2018 CELT ISO-NE and States Annual Energy and Seasonal Peak Forecasts

#### ISO Level - Why Demand is Important





# Distribution Level - What benefits can active demand provide to distribution system?



Loads by Rate Class on an Illustrative Peak Day



- We need solutions that can impact all rate classes
- Can we delay or defer the need for distribution infrastructure upgrades?

# Misalignment between business case and energy use presents opportunities



**Quick Service Coffee Restaurant** 





Date: 07/20/2015

## Large Retail: Big Box Store



Average Weekday Peak Day: 07/20/2015 15:00



# **Eversource Massachusetts**

Eversource MA Demonstration Projects: DPU 16- **EVER** 178

- On October 31, 2016, Eversource (NSTAR and WMECO) filed a petition with Massachusetts DPU requesting approval to test demand reduction offerings for C&I customers
  - Research questions on cost-effective demand reduction technologies
- On October 30, 2017, DPU approved the proposed projects with the requested budget: DPU 16-178
- Eversource issued a competitive RPF for vendors to participate in demonstration projects

#### **Eversource Peak Load Reduction Projects**



Central Question: How can we develop strategies and deploy technology to have an impact at three levels of the system- ISO, distribution, customer.

#### Eversource is investigating multiple types of peak demand reduction solutions **Thermal Storage**





**Software & Controls** 





#### **Demand Response**



Integrated energy efficiency and demand reduction approaches remain a priority.

#### **Demonstration Project Summaries**



Demonstration	Target Sites	Target Savings (MW)
Battery Storage		
1. Battery: Daily dispatch	3	1.25
2. Battery: Targeted dispatch	10	1.25
Thermal Energy Storage		
3. Thermal: A/C ice storage	19	0.5
4. Thermal: Phase change materials	11	1.5
Software & Controls		
5. BAS Controls	18	5.5
Demand Response		
6. DR: Large C&I	24	7.0
7. DR: Small C&I	600	1.5

#### Eversource MA Demonstration Project Budget Summary



Solution Technology	Total Participant	
	Incentive + STAT	
Battery Storage	\$5,000,000	
Thermal Storage	\$3,900,000	
Software & Controls	\$4,140,000	
Active Demand Response	\$5,270,000	
Large C&I	\$3,250,000	
Small C&I	\$2,020,000	
Total	\$18,310,000	

Budgets and demonstration project sizes were developed using vendor responses to PA issued RFI

PP&A	Marketing	Participant Incentive & STAT	Evaluation and Market Research	Total Program Costs
\$800,000	\$400,000	\$18,310,000	\$1,951,000	\$21,461,000

## Battery Storage: Daily Dispatch



Participating Customers (#)	Target Savings (MW)
3 - 5	1.25

Technology:	Long-duration lithium ion batteries with energy management software
Target Customers:	Water/Wastewater, Big Box, Office or Higher Ed - Selected facilities must have ample load to drop and high demand or ICAP charges.
Customer Benefits:	Cost effectively reduce summer peak demand, winter price peaks and customer energy cost.
Program Offer:	Approx. 70% of the Total Project Cost within 2 Years

## **Battery Storage: Daily Dispatch**



**Vertical Sectors** 

All Sectors

#### Building Type

- Base Load above 250kW
- <u>Outdoor</u> space for battery storage for 10 year term
  - Approximately the size of 6 parking spaces
  - close as possible to existing switchgear
- Site above the flood plane
- Customer eligible to participate in Demand Response Programs
- "Peakier" the load profile the better



TESLA



#### **Battery Storage: Targeted Dispatch**



Participating Customers (#)	Target Savings (MW)
10 - 12	1.25

Technology:	Short-duration lithium ion batteries
	with energy management software

Customer Benefits: Cost effectively reduce four specific types of demand peaks:

- summer ICAP peak
- summer utility peaks
- monthly customer peaks
- winter price peaks

Program Offer: Approx. 70% of the Total Project Cost within 2 Years

## **Battery Storage: Targeted Dispatch**

#### 

#### **Vertical Sectors**

All Sectors

#### **Building Type**

- Base Load above 125kW
- <u>Outdoor</u> space for battery storage for 10 year term
  - Approximately the size of 4-6 parking spaces
  - close as possible to existing switchgear
- Site above the flood plane
- Customer eligible to participate in Demand Response Programs
- "Peakier" the load profile the better





# Storage Example - Paired with Distributed Generation



# Hot, humid day that becomes overcast. 750kW of solar comes offline, causing spike in demand.



Storage provides an offtake of energy that may allow co-gen units to run at higher capacity or mitigate the need to curtail solar generation.

#### Storage Example - Peak Shaving



## For this example, we took the original load shape of a university on the peak day and added a 500 kW/ 2000 kWh battery



This example only uses half the capacity for peak load shaving, reserving capacity for other uses.

## Thermal Storage: A/C Ice Storage



Participating Customers (#)	Target Savings (MW)
19	0.5

Technology:	<ul> <li>Air Conditioning Ice Storage Systems ("Ice Bear" by Ice Energy) with energy management software</li> <li>systems will be connected to existing roof or ground mounted packaged air conditioning systems.</li> </ul>
Target Customers:	C&I customers with >25 kW load Must have packaged AC 80% Eastern Mass, 20% Western Mass
Customer Benefits:	Cost-effectively reduce summer air conditioning peak loads
Program Offer:	Approx. 100% of the Total Project Cost

## Thermal Storage: A/C Ice Storage



#### Ice Bear 30 – Designed for commercial and industrial applications



## Thermal Storage: A/C Ice Storage



## Powered by ice

Ice Bear charges by making ice during offpeak hours and discharges by using the stored ice to cool buildings during peak hours. Our smart Ice Bear battery reduces peak cooling electricity by 95% for up to 6 hours a day, every day.



Vertical Sectors

All Sectors

**Building Type** 

- 10 to 20 ton size refrigerant-based packaged HVAC units used for cooling low rise (less than three story) buildings
- Existing A/C Compatibility with Ice Bear equipment
  - Genbright and Ice Energy will provide a listing
- Space Required for additional roof equipment and Ice Bear interconnection
  - space to place the Ice Bear (~5' x ~9')
- Ice Bears can be applied to buildings under construction, as retrofit applications to existing HVAC equipment, or installed during an HVAC equipment replacement process

#### **Thermal Storage: Phase Change Material**



Participating Customers (#)	Target Savings (MW)
11	1.5

Technology:	Phase Change Material (PCM) installed in refrigerated/frozen spaces with controls installed on facility's HVAC system
Target Customers:	C&I, Food Distribution, etc. Must have cold storage 80% Eastern Mass, 20% Western Mass
Customer Benefits:	Cost-effectively reduce year-round peak loads in accordance with a peak demand reduction schedule Equipment resiliency – emergency back-up (outages, etc.)
Program Offer:	Approx. 100% of the Total Project Cost

## Thermal Storage: Phase Change Material



**Vertical Sectors** 

Industrial, Manufacturing, Retail

**Building Type** 

- Industrial and Commercial Retail Freezers
- Refrigerated warehousing, logistics, transportation and distribution freezers
- Multi-site restaurant and grocery store freezers





## Software & Controls: BMS Control



Participating Customers (#)	Target Savings (MW)				
18	5.5				

Technology:	Demand response/demand limiting software either integrated to existing BMS or commanding new relay based override system.
Target Customers:	Medium/Large C&I (Industrial, restaurant, retail), Must have Central A/C
Customer Benefits:	Cost-effectively reduce year-round peak loads, Manage ICAP tag for next year Access to energy software platform
Program Offer:	Approx. 100% of the Total Project Cost

#### Software & Controls: BMS Control



**Target Customers:** 

Vertical

 Industrial, Manufacturing, Commercial Office (Owner Occupied and Tenant spaces), Retail

Building Type

- 80% Eastern Mass, 20% Western Mass
- Large commercial, greater than 200,000 sq ft.
- Ideally with Existing BMS
- Desire to reduce demand and demand charges continuously

Usage

- > 500 kW demand
- 70% Load Factor or less (i.e. demand significantly higher than average load)
- Ability to curtail ~ 200 kW
- >10% of load only 1% of time

## **Demand Response: Large Commercial**



Participating Customers (#)	Target Savings (MW)				
24	7.0				

Technology:	Demand Response solution offered to existing DR customers currently participating in ISO-NE Forward Capacity Market (FMC).
Target Customers:	Large C&I customers in the FCM
Customer Benefits:	Additional revenue generated from additional DR hours Ability to manage ICAP tag for next year
Program Offer:	Revenue stream from Demand Response pilot program beyond that from the FCM. Summer 2018, Winter 2018/2019, Summer 2019

## **Demand Response: Large Commercial**



Target Customers: Existing EnerNOC FCM (Forward Capacity Market) Demand Response Customers

Vertical

Industrial, Manufacturing, Retail, Commercial Office (Owner Occupied and Tenant spaces)

Building Type

- 80% Eastern Mass, 20% Western Mass
- Large C&I, greater than 200,000 sq ft.
- Desire to reduce demand charges, ICAP tag, introduce new revenue stream

Usage

- > 750 kW demand
- Ability to curtail ~ 250 kW
- Existing DR curtailment plan in place

## **Demand Response: Small Commercial**



Participating Customers (#)	Target Savings (MW)
600	1.5

Technology:	Demand Response solution offered to small businesses by use of Wi-Fi or cellular based thermostats - setpoint adjustments or cooling lockout.
Target Customers:	Small Business customers, must have central AC
Customer Benefits:	Free Thermostat(s), installation and \$100 incentive/t'stat Ability to manage demand portion of utility bill Ability to manage ICAP tag for following year. \$50 annually for participation.
Program Offer:	During summer ISO-NE peak demand hours or Eversource forecasted monthly peaks. Curtailment up to 10 times from $1 - 6$ pm, up to 40 hours total per summer. Can opt out up to 2 times.

## **Demand Response: Small Commercial**



Target Customers: Small / Medium Business Customers

Vertical

Small / Medium Business of any type willing to curtail during summer months

**Building Type** 

- 80% Eastern Mass, 20% Western Mass
- RTU cooling and willing to adjust temp/lockout 2 4 deg F delta
- Looking to reduce monthly and ICAP peaks

#### Usage

- < 200 kW demand</p>
- Ability to curtail cooling via Thermostat or relay lockout.





# **Unitil Massachusetts**



## RESI Solar PV Demonstration with Battery Storage

1.Can Battery Storage flatten out the solar curve to create a level capacity resource?

2. Determination of off-peak Grid Charging vs. Solar PV Charging percentages.

3. Determination of Battery kWh Needed per kW of Solar PV Installed.

#### **RESI Solar PV Curve**



#### RESI Solar PV with Battery Storage "Curve"





# **Eversource Connecticut**

#### Connecticut C&I DR Pilot Research Questions



- What are the functional DEMAND REDUCTION control capabilities of and costs for Advanced/Smart energy management controls that sense, provide feedback and use algorithms to monitor demand?
- What are the functional DEMAND REDUCTION capabilities of and costs for Advanced Thermostatic Controllers used to manage Roof Top AC units?
- Can demand monitoring applied with the Advanced Thermostatic Controllers or Advanced/Smart energy management controls be used to assess and develop possible responsive demand capabilities (DEMAND RESPONSE)?
- Can the integration of automated demand controls and monitoring, into existing facility operator systems, familiarize operators with the demand control concept and facilitates their adoption of BEHAVIORIAL DEMAND REDUCTION measures that further reduce peak load?

#### Results of 2017 Activity



#### DR Pilot Results summary - Summer 2017

				Projected	kW (NCP)	Actual kW (NCP)		Seaso (NCP X 0.2	nal Peak 25 as Proxy)	Summer On-Peak kW	
Customer	Audit	Installation	Total Cost	Projected kW Saved	Cost per Projected kW	Actual kW Saved	Actual Cost Per kW	NCP X 0.25	Cost/kW @ NCP X 0.25	Summer On- Peak Savings	Cost/kW @ On-Peak
Site A Large Office	\$10,800	\$104,820	\$115,620	332	\$348	83	\$1,393	20.75	\$5,572	342	\$338
Site B Small Manufacturing	\$1,914	\$46,710	\$48,624	65	\$748	-21	(\$2,315)	-21	(\$2,315)	25	\$1,945
Site C Large Office Campus	\$16,675	\$172,077	\$188,752	737	\$256	0	\$0	0	\$0	409	\$461
Site D High School	\$4,350	\$28,509	\$32,859	75	\$438	85	\$387	21.25	\$1,546	15	\$2,191
Site E Small Manufacturing	\$1,914	\$25,793	\$27,707	55	\$504	23	\$1,205	5.75	\$4,819	25	\$1,108
Site F Small Manufacturing	\$1,914	\$43,393	\$45,307	104	\$437	19	\$2,385	4.75	\$9,538	-16	(\$2,832)
Site G Medium Manufacturing	\$3,456	\$40,832	\$44,288	165	\$268	-17	(\$2,605)	-17	(\$2,605)	34	\$1,303
Site H Medium Manufacturing	\$3,456	\$34,118	\$37,574	159	\$236	32	\$1,174	8	\$4,697	18	\$2,087
Site I Small Manufacturing	\$3,158	\$33,000	\$36,158	101	\$358	95	\$381	23.75	\$1,522	228	\$159
		Totals ==>	\$576,890	1,793		299		46.25		1,080	
					Projected Avg Cost Per kW		Actual Cost Per kW		Actual Cost (Seasonal Calculation)		Actual Cost (On-Peak Hours)
					\$322		\$1,929		\$12,473		\$534

#### CT Large C&I - Lessons Learned



- Accurate estimates of demand reduction potential from cycling roof top units require taking additional steps above name plate performance assessment:
  - Age and condition of units
  - Assessment of impact from varying Out Door Air conditions
  - Assessment of internal thermal characteristic on unit operation is critical (when are units operating/cycle rate at varying conditions)
  - Metering, where possible, is advisable
- Facilities with loads driven by outdoor air conditions (like office buildings) are more predictable and therefore lend themselves more readily to automated demand reduction controls
- Facilities with loads not always driven by outdoor air conditions (like manufacturing buildings) are less predicable and harder to control but, have a higher potential for behavioral demand reductions
- The level of responsibility that building operators have, regarding demand costs, seem to have an impact on the successful integration and operation of demand controls
- The level of interest that the responsible building have regarding electric demand, in general, and demand reduction specifically...has a big impact on the success of demand reduction strategies, especially behavioral reductions

#### **Connecticut - Residential Load Control Pilot**



# Program design includes a Direct Install of Wi-fi Thermostats, Bring Your Own Thermostats, and Smart Plugs/Smart Switches

- Thermostat enrollment of 2,262 exceeded the targeted 2,000 units by 13.1%.
- All 304,000 residential customers w/ email on file, 3 touches in BYOT email campaigns. The campaign ran from February 21 - April 10. Results:
  - Open rate: 26.3%
  - Click-through rate (of those emailed): 2.1%
  - Click-through rate (of those who opened the email): 8.9%
  - HES customers are 2.5 x more likely to open a DR email solicitation.

- Smart plug response exceeded targeted 1,000 units by 43%.
- Campaign ran from March 22 through April 31 with the following results:
  - 7 emails total
  - Open rate: 22.2%
  - Click-through rate (of those emailed): 1.3%
  - Click-through rate (of those who opened the email, the traditional measurement): 6.2%
  - HES customers are 3.9 x more likely to open a DR email solicitation.

- Smart Switch enrollment was 246 loads enrolled, 98% of targeted 250 units.
- Campaign ran from March 28th through April 11th.
- 21,079 customers were included in 3 separate emails, with one touch each, with the following results:
  - Open rate: 25.3%
  - Click-through rate (of those emailed): 0.6%
  - Click-through rate (of those who opened the email): 2.6%
  - HES customers are 7.2 x more likely to open a DR email solicitation.

#### Connecticut - Residential Load Control Pilot -Enrollment Results



Device		Device Target	Customers Devices Enrolled Enrolled		Devices Active		% of Enrolled	% of Target					
	Honeywell			332	2	51	16		516	5			
Smart Thermostat	Ecobee	BYO Direct Install	2,000	261 158	419	362 234	596	2,266	362 234	5 9 6	2,210	97.5%	110.5%
	Nest			61	0	1,1	54		1,09	98			
Smart Plug/Room AC		1,000	484		1,432		326		6	22.8%	32.6%		
Smart Switch/Electric DHW		250	22	0	16	68	245			28	11.4%	11.2%	

#### **Results:**

- 4 degree offset appears to have deeper savings than cycling strategy
- Smart plugs and switches (binary on/off) not as successful as cycling or offset
- Different savings values from different thermostat manufacturers



# Other Regional Demonstrations

Key Takeaways from Cape Light Compact (CLC) Residential Demand Response Demonstration



- Important to incorporate DLC for mini-splits when targeting air conditioning load
- Be ready by June 1
  - Peak day was June 13, early by historical standards
- Must actively re-recruit past participants
- Weather is the driver varies year-to-year
- At program scale, will need to recruit already-installed thermostats
  - Must carefully consider which thermostat model(s) to incorporate in to platform

National Grid MA Demonstrations - Overview



- National Grid included a DR Demonstration Offering in the 2016-2018 Plan
  - Residential demonstration with a target of 2.6 MW of peak demand reduction
  - C&I demonstration with a target of 41 MW of peak demand reduction

Commercial and Industrial Customers

"Performance Based" – Customer Incentive of about \$35 per kW per Year



Residential and Small Commercial Customers

"Pay for Connected Device" – Customer Incentive of about \$30 per Thermostat per Year

Supported devices so far



ecobee



Honeywell

Nest

#### Key Takeaways from National Grid - Cost Effectiveness





Cost effectiveness of the Residential Demonstration is still a challenge. However, we are taking steps to reduce all possible costs to achieve cost effectiveness before the end of the demonstration.

Taken Verbatim from November 2017 EEAC presentation

#### MA Rate Case: Performance Based Ratemaking-System Peak Demand Reduction Metric



- Eversource has developed two metrics on System Peak Demand
  - 1. Measurable actions under the Company's control with overall reduction target
  - 2. Annual report on peak load reduction activities not under the Company's control, but of interest to stakeholders
- Peak Demand Reduction Target is to reduce peak demand by 7% of the Company's forecast of distribution system peak demand, or by 383.6 MW, during 20 of the top 40 load hours in 2022.

Measure	Estimated Reduction MWs
Energy Efficiency	289.53
Demand Response	70
Company-Owned Storage	*
Company-Owned Solar	10.88
Upgrading Standard Technology	8.70
Volt/VAR Optimization	4.5
TOU/TVR Rates	**
Reduced Line-Losses	***
TOTAL	383.61

**Illustrative Breakdown of Peak Load Reductions** 

\*No specific commitments at this time \*\* Accounted for in reporting metric \*\*\*Accounted for in other measures

#### AESC Update on Capacity Costs



- Avoided capacity costs are driven by actual and forecast clearing prices in ISO New England's Forward Capacity Market (FCM).
- Forecasted capacity <u>prices</u> are based on the experience in recent auctions and expected changes in demand, supply, and market rules.

#### AESC 2018 capacity prices (2018 \$ / kW-month)

Commitment Period (June to May)	FCA	AESC 2018	AESC 2015
2018/2019	9	\$9.81	\$13.60
2019/2020	10	\$7.28	\$11.85
2020/2021	11	\$5.35	\$11.89
2021/2022	12	\$4.74	\$12.29
2022/2023	13	\$4.84	\$12.20
2023/2024	14	\$4.94	\$11.93
2024/2025	15	\$5.22	\$12.55
2025/2026	16	\$5.65	\$12.55
2026/2027	17	\$6.13	\$12.64
2027/2028	18	\$6.60	\$12.37
2028/2029	19	\$7.07	\$13.08
2029/2030	20	\$7.54	\$13.42
2030/2031	21	\$6.60	-
2031/2032	22	\$7.07	-
2032/2033	23	\$7.54	-
2033/2034	24	\$6.60	-
2034/2035	25	\$7.07	-
2035/2036	26	\$7.54	-
15-year levelized		\$6.52	\$12.32
Percent Difference		-47%	-

Notes: All prices are in 2018 \$ per month. Levelization periods are 2015/2016 to 2029/2030 for AESC 2015 and 2018/2019 to 2032/2033 for AESC 2018. Real discount rate is 2.43 percent for AESC 2015 and 1.34 percent for AESC 2018. Source: AESC 2015 Exhibit 5-32.

Summary slides taken from http://ma-eeac.org/wordpress/wpcontent/uploads/AESC-2018-EEAC-Presentation-v3-032918f.pdf

#### Metrics for Measuring Demand Reduction





#### High level objectives

- What problem(s) are you trying to solve?
  - Craft metrics so that they are providing a solution to a problem
- Ensure that metrics are not at odds with each other
  - Many peak load reducing measures are actually load additive
- Too many metrics may confuse the objective