


Connecticut Energy Efficiency Board
C1630: Largest Savers Evaluation
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Agenda


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- Methodology
- Results
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Overview

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Overview: Study Objectives

1. Evaluate the energy and peak demand savings impacts for a census of the largest projects supported by the Energize CT initiative.
2. Provide stakeholders with findings that are relevant and useful to potentially reducing future evaluation costs:
 - Qualitative feedback regarding the quality of savings estimates for large C&I projects.
 - Investigate trends in key variables that impact evaluation sample size, such as coefficients of variation, and provide guidance on trends for use in future evaluation sample design.
 - Make data from this study available for potential incorporation into future work, and initiate a process for other evaluations to do the same moving forward.

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Overview: Evaluation Population

Evaluation population definition

- Program years: 2013-2015
- Utilities: Eversource and United Illuminating
- Programs: all C&I projects in Energize CT programs
- All largest savers projects came from either EO or ECB programs

		kWh	Summer kW	Winter kW	Gas CCF
ECB	2013	9,417,205	1,584	734	460,073
	2014	31,735,741	4,166	3,252	1,163,070
	2015	41,051,978	7,296	4,320	1,153,417
	Total	82,204,924	13,026	8,306	2,776,560
EO	2013	12,275,279	1,239	1,022	220,432
	2014	96,143,148	10,517	9,758	2,334,997
	2015	93,273,286	11,254	8,962	2,664,541
	Total	201,691,713	23,010	19,743	5,219,970

Reported ECB and EO savings for program years 2013-2015

Overview: Project Definition

- Included all measures with claimed savings in each project
- Dropped projects that were not located at one physical address and/or served by the same utility meter
- Dissimilar savings types (kWh, kW, gas ccf) were aggregated using avoided cost

Methodology

Methodology: Project Selection

- Target = census of 30 largest projects in Energize CT initiative
- Ranked projects from all C&I programs by total avoided cost from reported savings
- Requested billing data and project files for largest 60 projects
- 15 UI and 45 Eversource
- Developed Site Specific M&V Plans for largest 35 projects
- 22 from EO and 13 from ECB
- Evaluated 34 of 35 projects

Methodology: Data Collection and Analysis

- **M&V used both high rigor and low rigor evaluation approaches**
- **Low rigor = leverage PSD algorithms and on-site verification**
- Examples: nameplate information, operational conditions, setpoints, schedules
- **High rigor = followed the IPMVP**
- Examples: power metering, billing data analysis, light logging, calibrated energy models
- IPMVP Options A and B – lighting, VFDs, refrigeration
- IPMVP Options C and D – whole building measure such as EMS, some HVAC, and envelope improvements
- **Measure-level analysis approach varied based on measure type and contribution to project's overall savings**
- **Measure(s) with largest avoided cost in each project received high rigor evaluation**

Methodology: Evaluation Rigor

Reported Savings Evaluated by Evaluation Rigor

		kWh	Summer kW	Winter kW	Gas CCF
ECB	Low Rigor	13,029,280	1,856	1,496	162,426
	High Rigor	8,643,899	1,493	1,280	75,360
	% High Rigor	40%	45%	46%	32%
EO	Low Rigor	4,434,211	211	108	549,110
	High Rigor	15,561,518	2,039	1,691	637,723
	% High Rigor	78%	91%	94%	54%
Total	Low Rigor	17,463,491	2,067	1,605	711,536
	High Rigor	24,205,417	3,532	2,970	713,083
	% High Rigor	58%	63%	65%	50%

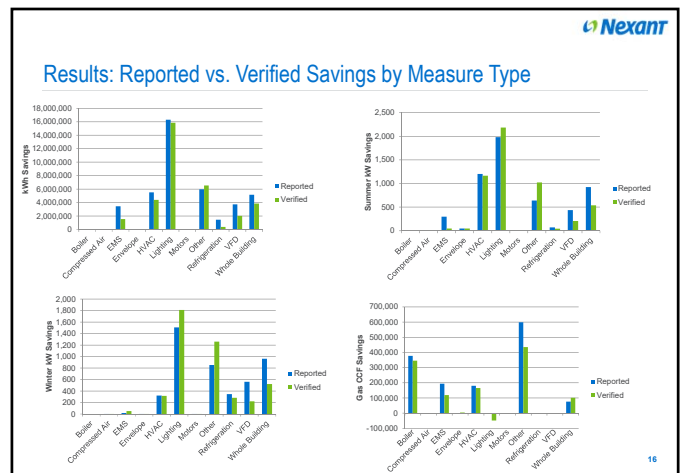
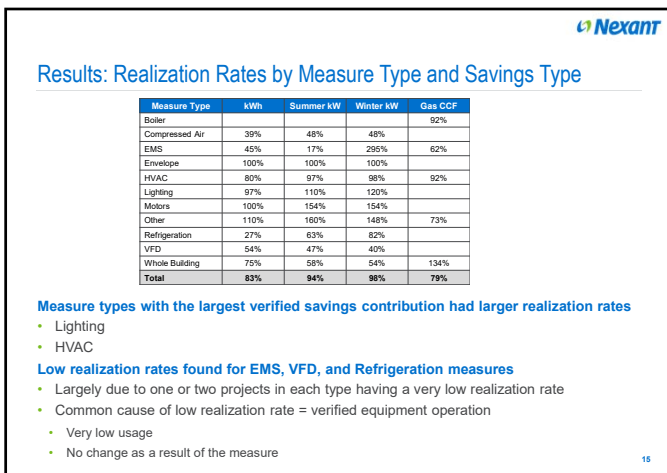
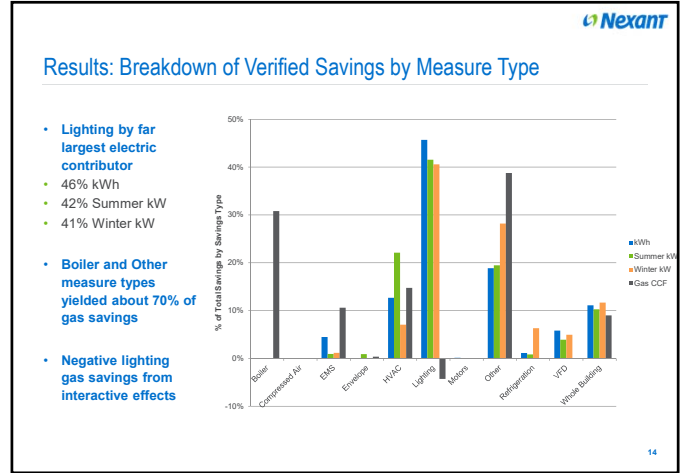
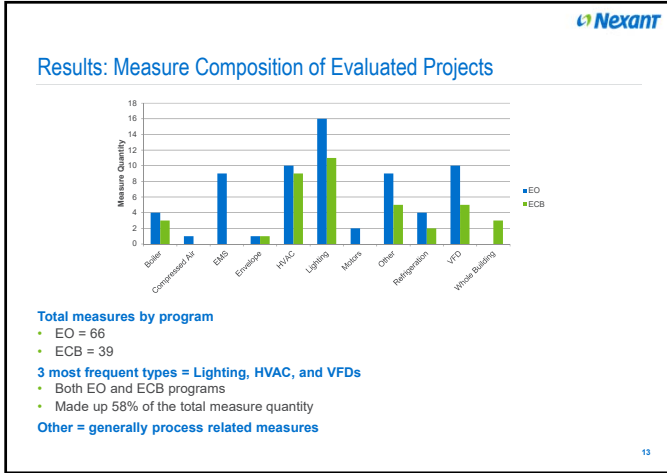
Percent of Total Program Reported Savings Evaluated

		kWh	Summer kW	Winter kW	Gas CCF
ECB	Low Rigor	16%	14%	18%	6%
	High Rigor	12%	12%	15%	3%
	Total	28%	26%	33%	9%
EO	Low Rigor	2%	1%	1%	11%
	High Rigor	8%	9%	9%	12%
	Total	10%	10%	9%	23%

Results

Results: Overall

		ECB	EO	Total
kWh	Reported	21,673,179	19,995,729	41,668,908
	Verified	19,404,802	15,273,681	34,678,483
	Realization Rate	90%	76%	83%
Summer kW	Reported	3,349	2,250	5,599
	Verified	3,093	2,166	5,259
	Realization Rate	92%	96%	94%
Winter kW	Reported	2,776	1,799	4,575
	Verified	2,431	2,033	4,465
	Realization Rate	88%	113%	98%
Gas CCF	Reported	237,786	1,186,833	1,424,619
	Verified	219,316	903,912	1,123,228
	Realization Rate	92%	76%	79%





Results: Realization Rate Comparison

- Comparison of Largest Savers results to most recent EO and ECB impact evaluations
- EO and ECB used different end use definitions
- Largest Savers results were rolled up using each evaluation's definitions to allow for comparison
- Caveats on making direct comparisons
 - Evaluation rigor
 - Sample sizes



Results: Realization Rate Comparison - ECB

Measure Type	Most Recent ECB Evaluation				Largest Savers - ECB Projects Only				Largest Savers - Overall						
	Measure Quantity	kWh	Summer KW	Winter kW	Gas CCF	Measure Quantity	kWh	Summer KW	Winter kW	Gas CCF	Measure Quantity	kWh	Summer KW	Winter kW	Gas CCF
Compressed Air	26	49%	55%	58%							1	39%	48%	48%	
HVAC	57	85%	66%	108%		9	77%	99%	72%		19	80%	97%	98%	
Lighting	32	102%	114%	112%		11	111%	111%	132%		27	97%	110%	120%	
Process	21	102%	105%	111%											
HP/EO/Other	10	96%	98%	45%		15	89%	68%	64%		46	73%	78%	85%	
Boiler	17				96%	3				88%	7				92%
Other	26				68%	6				94%	19				74%

- HVAC – generally <100% realization rates
- Operational set points, chiller plant configuration, building occupancy, assumed building max load
- Lighting – approximately 100-120%
- Gas
 - Boiler – assumed level of boiler usage during non-winter months
 - Other – parameter assumed to dictate equipment use, lower operating hours, controls not used



Results: Realization Rate Comparison - EO

Measure Type	Most Recent EO Evaluation				Largest Savers - EO Projects Only				Largest Savers - Overall						
	Measure Quantity	kWh	Summer KW	Winter kW	Gas CCF	Measure Quantity	kWh	Summer KW	Winter kW	Gas CCF	Measure Quantity	kWh	Summer KW	Winter kW	Gas CCF
Lighting	67	89%	115%	144%		16	75%	108%	100%		27	97%	110%	120%	
Non-Lighting Electric	44	112%	168%	228%		41	77%	92%	119%		65	74%	85%	87%	
Overall Electric	111	98%	127%	172%		57	76%	96%	113%		92	83%	94%	98%	
Gas	33				84%	18				76%	26				79%

- Lighting
 - kWh RRs low – logged hours of use different than estimated, controls not found as reported
 - Relatively few significant fixture quantity discrepancies
- Gas
 - Lower operating hours/heating load
 - Incorrect baseline and retrofit boiler efficiencies




Results: Coefficient of Variation

Coefficient of variation (c.v.) = standard deviation + mean

Measure Type	Quantity of Measures Evaluated	kWh C.V.	Summer kW C.V.	Winter kW C.V.	Gas C.V.
Lighting	27	0.67	0.77	1.15	-
HVAC	19	0.44	0.41	0.66	0.19
VFD	15	0.75	1.42	2.19	-
Other	14	0.61	0.38	1.32	0.45
Overall	105	0.98	1.11	1.68	0.58

Assumed c.v. values per ISO-NE M-MVDR:

- Homogeneous population = 0.5
- Heterogeneous population = 1.0




Results: Coefficient of Variation Comparison - ECB

Measure Type	Most Recent ECB Evaluation				Largest Savers - ECB Projects Only				Largest Savers - Overall				
	Measure Quantity	Summer kWh	Winter kW	Gas CCF	Measure Quantity	Summer kWh	Winter kW	Gas CCF	Measure Quantity	Summer kWh	Winter kW	Gas CCF	
Electric	Compressed Air	26	2.18	1.36	1.28								
	HVAC	57	1.41	1.82	1.82	9	0.43	0.38	0.42	19	0.44	0.41	0.66
	Lighting	32	0.62	0.72	0.84	11	0.38	0.65	0.92	27	0.67	0.77	1.15
	Process	21	0.68	2.54	2.19								
	HPBD/Other	10	0.78	1.7	1.7	15	0.56	1.04	0.27	48	1.01	1.49	1.86
	Electric Overall	146	0.99	1.62	1.53	35	0.62	0.93	1.17	94	0.98	1.11	1.68
Gas	Boiler	17			0.46	3			0.03	7			0.66
	Other	26			0.97	6			0.28	22			0.52
	Overall	43			0.71	9			0.28	29			0.58

- HVAC – c.v. values much lower in this evaluation
- Range of measure-level realization rates narrower in this evaluation than previous ECB evaluation
 - Largest savers = 25 to 785% for kWh and 23 to 149% for summer kW
 - Previous ECB evaluation = -29 to 871% for kWh and 0 to 1,573% for summer kW
- Lighting and Electric overall fairly consistent across both previous program evaluations and Largest Savers

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Results: Coefficient of Variation Comparison - EO

Measure Type	Most Recent EO Evaluation				Largest Savers - EO Projects Only				Largest Savers - Overall			
	Measure Quantity	Summer kWh	Winter kW	Gas CCF	Measure Quantity	Summer kWh	Winter kW	Gas CCF	Measure Quantity	Summer kWh	Winter kW	Gas CCF
Lighting	67	0.59	0.66	1.17	16	0.43	0.77	0.86	27	0.67	0.77	1.15
Non-Lighting Electric	44	1.37	1.74	0.91	41	1.19	1.54	2.58	65	0.92	1.20	1.84
Overall Electric	111	0.86	1.23	1.09	57	1.00	1.35	2.28	92	0.98	1.11	1.68
Gas	33			0.95	20			0.61	29			0.58


- Non-lighting electric
- kWh and summer kW similar
- Winter kW – high c.v. value in Largest Savers due primarily to two projects with high savings variance
- Overall electric
 - Fairly consistent kWh (~0.8 – 1.0) and Summer kW (~1.1 - 1.6)
 - Winter kW – Largest Savers found a larger c.v. for same reason as non-lighting electric – several projects with high savings variance
- Gas - overall consistency across both previous program evaluations and Largest Savers (0.71 – 0.96)

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Reimagine tomorrow.

Observations and Recommendations

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Observations and Recommendations

Technical Analyses

Observation – Equipment operation

- Schedule, loading, governing setpoints
- One of the most common sources of variance between reported and verified savings estimates
- Use of different data sources
 - Verified savings had access to metered data while reported savings usually didn't – especially for ECB projects

Recommendation – Equipment operation

- When feasible and applicable, consider:
 - Pre-retrofit metering (EO)
 - Commissioning activities (ECB)

Observation – Interactive effects

- Inconsistently taken into account
- Gas heating penalty for lighting projects infrequently calculated

Recommendation – Interactive effects

- As a general practice and whenever applicable, account for interactive effects

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