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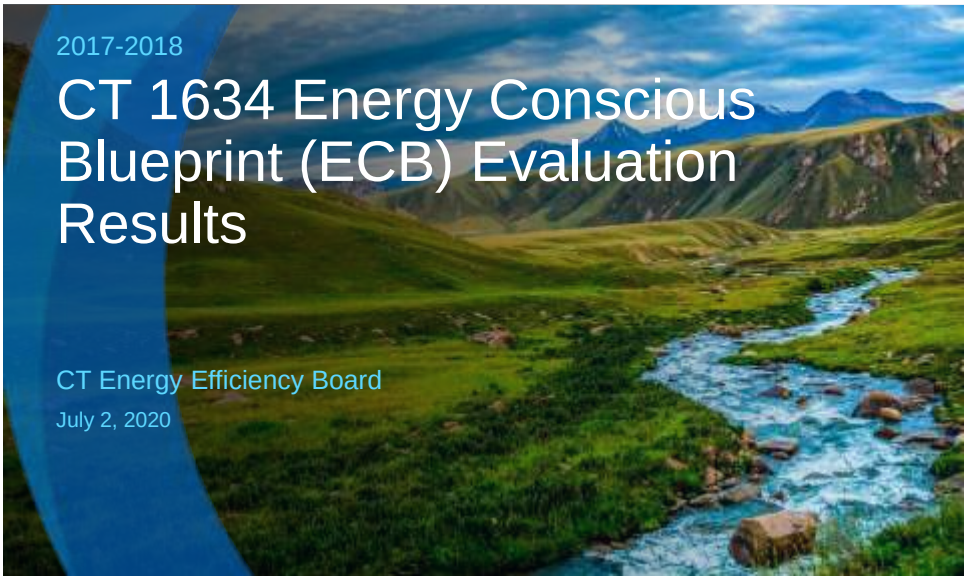

Meeting Agenda

- ECB Study Objectives
- Sampling / Stratification
- Findings
- ECB Study Comparison
- Baseline Study
- Conclusions and Recommendations
- Q&A

ECB Overview – Study Objectives

Study Objectives

- Provide gross savings (retrospective) realization rates for electric energy, electric demand, and natural gas energy
- Update gross savings (prospective) realization rates for electric energy, electric demand, and natural gas energy
- Evaluate demand savings with appropriate rigor to meet the ISO New England standards
- Investigate separate realization rates for true comprehensive new construction projects
- Support future updates to the Connecticut Program Savings Document

Sampling / Stratification

Strata	# of Unique Measures	Population Reported Savings (kWh or therms)	Sampled Measures	Sampled Measures Reported Savings (kWh or therms)	Sampled Reported Savings (% of Pop)
Cooling, Electric	643	10,906,169	43	2,350,748	22%
Lighting, Electric	721	41,405,184	33	6,915,628	17%
Heating, Electric	117	1,285,371	17	452,331	35%
Custom / Other, Electric	222	12,405,684	48	5,855,699	47%
Process, Electric	449	36,031,608	77	11,996,550	33%
Heating, Gas	515	1,345,263	30	179,697 (therms)	13%
Domestic Hot Water, Gas	101	108,869	11	14,096 (therms)	13%
Custom / Other, Gas	45	637,374	15	186,005 (therms)	29%
Total Electric	**2,152**	**103,192,682**	**218**	**27,570,956**	**27%**
Total Gas	**661**	**2,091,506**	**56**	**379,798**	**18%**

Summary of Findings

Evaluated Savings

Strata	Realization Rate (kWh)	Realization Rate (summer kW)	Realization Rate (winter kW)	Realization Rate (natural gas therms)	Electric Energy Precision (90% confidence)
Cooling, Electric	70%	73%	48%	NA	12.9%
Lighting, Electric	129%	105%	117%	NA	16.3%
Heating, Electric	98%	94%	93%	NA	9.0%
Custom / Other, Electric	99%	97%	106%	NA	3.9%
Process, Electric	80%	114%	112%	NA	7.4%
Heating, Gas	NA	NA	NA	95%	8.5%
Domestic Hot Water, Gas	NA	NA	NA	92%	12.9%
Custom / Other, Gas	NA	NA	NA	91%	19.4%
Total	**101%**	**99%**	**111%**	**95%**	**8.4%**

True New Construction

Strata	Sampled Measures		Realization Rate (kWh)		Realization Rate (summer kW)		Realization Rate (winter kW)		Realization Rate (natural gas therms)	
	TNC	NR	TNC	NR	TNC	NR	TNC	NR	TNC	NR
Cooling, Electric	34	9	80%	36%	81%	48%	100%	36%	NA	NA
Lighting, Electric	32	1	119%	447%	104%	64%	115%	447%	NA	NA
Heating, Electric	16	1	98%	100%	86%	42%	93%	100%	NA	NA
Custom / Other, Electric	19	29	89%	105%	105%	98%	97%	105%	NA	NA
Process, Electric	1	76	86%	82%	237%	86%	257%	82%	NA	NA
Heating, Gas	16	14	NA	NA	NA	NA	NA	NA	99%	89%
Domestic Hot Water, Gas	6	5	NA	NA	NA	NA	NA	NA	89%	93%
Custom / Other, Gas	3	12	NA	NA	NA	NA	NA	NA	97%	90%
Total	**127**	**147**	**110%**	**87%**	**103%**	**86%**	**106%**	**106%**	**98%**	**90%**

ECB Study Comparison

2012/13 Study Conclusions	2017/18 Study Findings
• Calculation errors in reported savings greatly impacted realization rates. Recommended improvements to engineering review process.	• Calculation errors were not found to be the greatest impact to realized energy savings
• Recommended electronic forms for program documentation be used to streamline project qualification.	• The majority application documents were scanned from physical forms
• Simulation models were not provided for five high performance building design projects sampled. Recommend participants provide final simulation files.	• The team requested and received energy models for some but not all of sampled measures
• Non-boiler measures realized low realization rates due to inaccurate estimates for non-boiler operations, math errors, and one project with overstated process cooling. Recommend revision to 2015 PSD assumptions to estimate operating efficiency.	• Estimates for non-boiler operations and math errors were not found to be a driving impact to realization rates
• Future ECB evaluations should use error ratios in this study to meet desired precision targets.	• The 2017/18 study used the 2012/13 error ratios for estimating sample sizes
• Remove dual enthalpy economizers	• Dual enthalpy economizers were found in the 2017/18 population

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ECB Study Comparison

Strata	Realization Rate (kWh)		Realization Rate (summer kW)		Realization Rate (winter kW)		Realization Rate (natural gas therms)	
	2012-2013	2017-2018	2012-2013	2017-2018	2012-2013	2017-2018	2012-2013	2017-2018
HVAC	85%		66%		108%			
Cooling, Electric		70%		73%		48%		NA
Lighting, Electric	116%	129%	114%	105%	112%	117%		NA
Heating, Electric		98%		94%		93%		NA
Custom / Other, Electric	96%	99%	98%	97%	45%	106%		NA
Compressed Air	49%		55%		58%			
Process, Electric	102%	80%	105%	114%	111%	112%		NA
Gas-Boiler							96%	
Heating, Gas		NA		NA		NA		95%
Domestic Hot Water, Gas		NA		NA		NA		92%
Custom / Other, Gas		NA		NA		NA	68%	91%
Total	**84%**	**101%**	**85%**	**99%**	**90%**	**111%**	**78%**	**95%**

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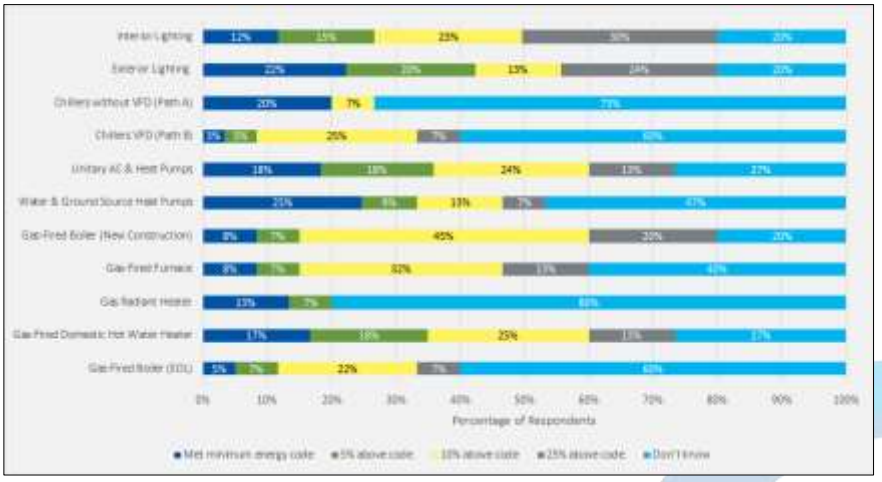
Baseline Study (Added Task)

- Investigate installed efficiency margin above code for lighting, HVAC, water heating and boiler equipment in new construction through market actor interviews



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Conclusions and Recommendations

Dual Enthalpy Economizers (PSD)

- **We recommend removing dual enthalpy economizer measures from PSD and ECB offered measures.**
- Dual enthalpy economizers were evaluated to realize little to no savings for facilities in Connecticut based on energy model simulation of sampled measures.

Lighting Hours of Use (PSD)

- **We recommend incorporating the light logger data from this study with other lighting studies to support a PSD update**
- Light logger data from 16 facilities indicate actual lighting hours of use were higher than reported. Reported hours of use were self-reported or based on the facility type from the 2017 CT PSD.

Conclusions and Recommendations

Compressed Air (PSD)

- **We recommend adding variable speed air compressor and compressed air dryer measures to future PSD updates**
- Compressed air upgrades account for ~15% of all annual electric savings in the ECB program. Air compressor measures are not included as a standard measure in the CT PSD.

Chiller Calculations (PSD)

- **We recommend savings be calculated using an 8,760 hourly spreadsheet calculation methodology.**
- Reported chiller energy savings calculations utilized weather-bin calculation methodology which may not appropriately account for variable weather during peak demand periods.

Conclusions and Recommendations

Air Compressor Load Profiles

- **We recommend utilizing pre- or post-implementation power metering or trend data to update the compressor hours of use, average load, and line pressure.**
- Meter data from 44 sampled compressed air measures indicated reported load profiles were not representative of actual operation resulting in reduced realized electric energy and demand savings.

Air Compressor Calculations

- **We recommend updating the calculation methodology to calculate demand savings as the difference in average demand between the baseline and installed air compressors during peak periods. Additionally, the calculations should allow for inputs to the average loads during summer and winter peak periods.**
- Reported demand savings for the majority of sampled air compressor measures were calculated as the difference in maximum demand between the baseline and installed air compressors multiplied by the seasonal peak coincidence factors from the PSD. During peak periods, meter data indicate the average demand was consistently lower than reported.

Conclusions and Recommendations

Chiller Load Profiles

- **We recommend adopting greater scrutiny of load profiles in all chiller measures, including post-implementation metering or trending**
- Power metering results for five sampled chiller measures indicate lower total energy use and savings than reported.

True New Construction

- **We recommend including a TNC designation within the measure tracking databases. By tracking TNC, utilities and evaluators may assess the impact of TNC measures throughout the ECB program.**
- Measures installed as True New Construction are not consistently documented in the measure tracking databases from the utilities with this designation.

Conclusions and Recommendations

Tracking Measure Database Detail

- **We recommend improving the detail provided in the measure description data entry within the tracking database for each measure. By improving measure descriptions, the reliability of measure type stratification for evaluation purposes may be improved.**
- The data entry values for each measure within the measure tracking databases varied by utility and program year. Additionally, the measure description data entry varied in detail and quality.

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