

x1931-6: HOU Documentation/Update Study

Saroj Karki, Project Engineer
June 21, 2021

Agenda

- Study Background and Outcomes
- Methodology
- Results
- Conclusions



Empowering you to make
smart energy choices



Study Background

HOU – Hours of use
FLH – Full-load hours
RR – Realization rate
PSD – Program Savings Document
C&I – Commercial and Industrial
CAV – Constant Air Volume

- ❑ The PSD reports *lighting, heating, cooling, HVAC fan motor, chilled water pump, and heating pump* default HOU/FLH values for 60 C&I facility types.
- ❑ The default C&I HOU/FLH values in the PSD are unsourced.
 - Current PSD HOU values “have been developed over the years and are taken into account during program evaluations.”
 - Left to evaluation RRs to “true up” deviation from real-world data.
- ❑ The outcomes of this study are:
 - Updated C&I default HOU/FLH values (as reported in PSD Appendix 5).
 - Referenced documentation of the updated HOU/FLH values.

Literature Review Methodology

- ❑ Literature Review
 - We compared the current and archived versions of the PSD to track the changes in the PSD HOU/FLH values.
 - We investigated ASHRAE handbooks (1980, 1985, and recent versions), evaluation reports, and nearby TRMs (NY, MA, and RI) to attempt to find the source of PSD HOU/FLH values.
 - We reviewed existing CT evaluation reports to determine availability of updated HOU/FLH values or supporting data.

Literature Findings – Lighting End Use

□ Lighting HOU

- Except for 12 C&I facilities, the PSD’s default C&I lighting HOU values have not been updated since 2005.
- The 2021 PSD lighting HOU values are based on the following studies:
 - *RLW Analytics, 2006 MA and CT Utilities 2004-05 Lighting HOU for School Buildings Baseline Study*
 - *DNV, 2020 C1635 Impact Evaluation of PY 2016 and 2017 Energy Opportunities (EO) Program*
 - *TRC, 2020 x1941 Multifamily Impact Evaluation, PSD savings Review*
- We identified updated lighting HOU values and documented the source of updated values for 45 C&I facilities based on:
 - *DNV, 2019 MA C&I lighting HOU study.*
 - *DNV, 2020 C1635 Impact Evaluation of PY 2016 and 2017 Energy Opportunities (EO) Program*

Literature Review Findings – All other End Uses

End Use	Review Findings	2021 CT PSD Source	Updated Source
HVAC Fan	The HVAC fan motor FLH values in the PSD are assumed to be the same as lighting and have not been updated since 2005.	Unidentified source	Developed based on eQuest simulation of DOE-2 commercial building prototypes.
Heating Pump	The heating pump HOU values in the PSD are assumed to be 5,376 hours for all 60 C&I facilities and have not been updated since 2005.	Unidentified source	Developed based on eQuest simulation of DOE-2 commercial building prototypes.
Heating/Heat Pump	The heating FLH values have not been updated since 2005.	Unidentified source	Developed based on eQuest simulation of DOE-2 commercial building prototypes.
Cooling	The cooling FLH values have not been updated since 2005.	Unidentified source	Developed based on eQuest simulation of DOE-2 commercial building prototypes.
CHWP and Cooling Towers	The CHWP and cooling towers HOU values have not been updated since 2005.	Unidentified source	Developed based on eQuest simulation of DOE-2 commercial building prototypes.

eQuest Simulation Methodology

Commercial Building Prototypes

- We gathered NY commercial building prototypes for 22 C&I facilities. We used prototype models with weather and local building practices adjustments made for Poughkeepsie, NY.
- The prototypes were simulated in eQuest using Hartford weather data.
- The *heating, cooling, HVAC fan motor, chilled water pump, and heating pump* HOU/FLH values were obtained from eQuest simulation results.
- Assumptions:
 - FLH values for large commercial buildings are based on VAV systems with economizers.
 - The NY prototype models were available for 22 commercial facilities. We mapped each of the 60 PSD facility types with one of the 22 models based on operational similarities.

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Results – Lighting HOU

- Updated HOU values for a sample of commercial buildings are presented here. The final deliverables will include the updated HOU/FLH values for all applicable building types.
- Lighting HOU values

Facility Type	CT PSD Values	Updated Values	Difference %
Bakery	2,854	5,438 [1]	91%
Dormitory	3,066	4,026 [1]	31%
Fast Food	6,376	5,018 [1]	-21%
High School	2,967	2,967 [2]	0%
Hospital	5,564	5,413 [1]	-3%
Multi-Family (Common Areas)	6,388	6,388 [3]	0%
Town Hall	3,748	4,181 [2]	10%

Description	Value
Average % difference	7%
Minimum % difference	-65%
Maximum % difference	150%
Count of facilities with updated values larger than current PSD values	17
Count of facilities with updated values smaller than current PSD values	11

[1] DNV GL, 2019 MA C&I Lighting Hours of Use Study
 [2] DNV-GL, 2020 C1635 Impact Evaluation of PY 2016 & 2017 Energy Opportunities (EO) Program
 [2] TRC, 2020 x1941 Multifamily Impact Evaluation, PSD Savings Review

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Results – Heating and Cooling FLH

□ Heating and cooling FLH Values

Facility Type	CT PSD Values		Updated Values		Differences %	
	Cooling FLH	Heating FLH	Cooling FLH	Heating FLH	Cooling FLH	Heating FLH
Auto Repair	837	1,171	437	3,122	-48%	167%
Dormitory	709	1,418	875	644	23%	-55%
Fast Food	1,139	594	710	1,413	-38%	138%
Full Service Restaurant	854	1,140	670	1,341	-22%	18%
Grocery	837	1,172	463	1,008	-45%	-14%
High School	594	1,637	331	456	-44%	-72%
Hospital	1,308	270	1,376	581	5%	115%
Office	797	1,278	1,023	495	28%	-61%
Light Industrial	681	1,470	678	1,278	0%	-13%
Lodging (Hotel/Motel)	708	1,418	1,077	753	52%	-47%
University (No Dorm)	594	1,637	825	471	39%	-71%
Warehouse	648	1,533	356	881	-45%	-43%

Description	Cooling FLH Value	Heating FLH Value
Average % difference	24%	42%
Minimum % difference	-63%	-71%
Maximum % difference	576%	344%
Count of facilities with updated values larger than current PSD values	29	44
Count of facilities with updated values smaller than current PSD values	30	16

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Results – HVAC Fan FLH

□ HVAC Fan FLH

- Fan operating hours reported here are equivalent FLH and not run time hours. For CAV systems, the equivalent FLH and run time hours are same.

Facility Type	CT PSD Values	Updated Values	Difference %
Auto Repair	4,055	6,421	58%
Dormitory	3,066	3,833	25%
Fast Food	6,376	5,835	-8%
Grocery	4,055	4,545	12%
Hospital	7,674	5,633	-27%
Office	3,748	4,031	8%
Light Industrial	2,857	4,618	62%
Lodging (Hotel/Motel)	3,064	3,421	12%
University (No Dorm)	2,187	2,341	7%
Warehouse	2,602	3,604	39%

Description	Value
Average % difference	42%
Minimum % difference	-71%
Maximum % difference	344%
Count of facilities with updated values larger than current PSD values	44
Count of facilities with updated values smaller than current PSD values	16

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Results – Heating Pump and CHWP HOU

□ Heating pump and CHWP HOU

Facility Type	Ct PSD Values		Updated Values		Differences %	
	Heating Pump	CHWP	Heating Pump	CHWP	Heating Pump	CHWP
Auto Repair	5,676	1,878	2,024	2,069	-64%	10%
Fast Food	5,676	2,713	1,840	1,880	-68%	-31%
Full Service Restaurant	5,676	1,923	1,660	1,696	-71%	-12%
Grocery	5,676	1,877	1,433	1,465	-75%	-22%
High School	5,676	1,205	1,953	1,953	-66%	62%
Hospital	5,676	3,180	7,881	8,760	39%	175%
Office	5,676	1,767	5,629	5,629	-1%	219%
Light Industrial	5,676	1,446	1,456	1,488	-74%	3%
Lodging (Hotel/Motel)	5,676	1,521	1,079	1,102	-81%	-28%
University (No Dorm)	5,676	1,205	3,833	3,833	-32%	218%

Description	Heating Pump Value	CHWP Value
Average % difference	-47%	60%
Minimum % difference	-80%	-47%
Maximum % difference	63%	681%
Count of facilities with updated values larger than current PSD values	8	36
Count of facilities with updated values smaller than current PSD values	51	24

Conclusions and Recommendations

- Current PSD C&I lighting HOU values are based on a 2004-2005 study. We recommend updating lighting HOU values based on recent studies.
- The source and recency of the PSD's heating and cooling HOU/FLH values are unknown. We recommend updating HOU/FLH values based on simulation of commercial building prototypes.
- The commercial prototypes were simulated in eQuest using Hartford (inland) weather data. We recommend running the prototype models using Bridgeport (coastal) weather data as well.
 - If one set of statewide HOU/FLH values is desired, they should reflect a weighted average of inland and coastal values.

Conclusions and Recommendations (cont'd)

- ❑ Revision to HOU/FLH values may cause a “domino effect” to RRs in PSD Appendix 3.
- ❑ The RRs reflect differences in real-world operation as compared with PSD's FLH/HOU values. The RRs need to be adjusted if and when the utilities update the FLH/HOU values.
- ❑ We are working with the EA Team to quantify RR adjustments, which will require data requests of prior evaluation studies. Aiming to complete this added research in time for 2022 PSD.
 - ❑ Worst case alternative: ad-hoc adjustment of RRs in utilities' tracking systems after PSD is posted.

Thank You

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Saroj.Karki@dnv.com
916-256-3930 x275

www.dnv.com