Estimates of Building Component Energy Savings for Use in a Property Condition Assessment

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Abstract

ASTM is developing a standard guide for building energy performance evaluation in the context of a property condition assessment (PCA). The guide requires the estimation the energy savings that might be achieved with energy efficiency upgrades of building components that are at or near the end of their useful life. This report provides simplified estimates of energy savings from component upgrades, based on parametric energy simulations using the DOE reference models for large office, medium office and retail buildings. Whole building energy savings percentages were calculated for medium and higher efficiency component upgrades. The percentage savings metrics can be applied to the actual energy use of a building to estimate the savings for various component upgrades.

1. Introduction

ASTM is developing a Standard Guide for Building Energy Performance and Improvement Evaluation in the Assessment of Property Condition ("BEPIE standard") [ASTM 2019]. The purpose of the standard is to define a practice for "incorporating building *energy performance* into an assessment of existing property condition, and specifically into a *property condition assessment (PCA)* on a building involved in a *commercial real estate transaction*." One of the requirements of the practice is to estimate the energy savings that might be achieved with energy efficiency upgrades of building components that are at or near the end of their useful life. The standard provides guidance on how to estimate such savings for a "screening assessment" that does not entail the level of detailed analysis typically used for an energy audit (e.g. as in ASHRAE Standard 211 [ASHRAE 2018]). Toward that end, this report provides coarse estimate of energy savings from component upgrades, based on parametric energy simulations.

While the primary audience for this report are PCA service providers conducting a PCA in accordance with the BIPIE standard, the report may also be useful for others interested in simple estimates of energy savings for building component upgrades.

The report is organized as follows:

- Section 2 describes the methodology and scope.
- Section 3 presents the savings estimates in tabular and graphical format.
- Section 4 concludes.
- Appendix A presents the savings estimates in graphical form.

2. Methodology and Scope

The ASTM BIPIE standard committee desired savings estimates for the following component characteristics:

- Boiler efficiency
- Chiller COP
- Packaged rooftop unit efficiency
- Envelope infiltration rate
- Lighting power density
- Window U-value and solar heat gain

The aim was to develop a methodology that would facilitate energy savings estimation using simple a "look-up table" approach.

LBNL conducted parametric energy simulations to calculate the potential whole building energy use intensity savings (expressed as a percentage of whole building energy use intensity) that may be achieved by replacing existing low efficiency systems with higher efficiency systems. These savings can then be applied to the actual measured energy use intensity of a given building to estimate the savings from each component upgrade. We used the EnergyPlus building energy simulation software [DOE 2019a]. While such energy simulations are not as useful for determining *actual* energy use, they are effective for estimating the *relative* impact of changes in component efficiency.

The analysis was conducted using the DOE reference models [DOE 2019b], which are available for different building types, vintages, and climate zones. For this analysis, the scope included:

- three building types: large office, medium office and retail;
- three vintages: pre-1980, post-1980, new construction;
- all sixteen climate zones in the US.

The reference model specifications are documented in Deru et al. [2011]. These models were developed to be representative of given building types and sizes and have been used extensively for stock-level energy analysis.

For each building model, we ran simulations for low, medium and high efficiency levels for each component, and calculated the corresponding percentage energy savings. Section 3 presents the different efficiency levels for each metric and the corresponding savings.

3. Savings estimates

The savings estimates on the following pages are organized by building type and climate zone. For each combination of building type and climate zone (one per page), there are tables for each of the three vintages. Each table indicates the efficiency level metrics and whole building EUI percentage savings for medium and high efficiency relative to low efficiency. Appendix A presents the EUI data.

Large Office – Climate Zone 1A (Miami, Florida)

Large Office - Pre1980 - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.1	0.2
Chiller COP [-]	5.2	5.77	6	2.2	3
Cooling tower fan power [kBtu/h]	207	197	187	0.2	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.8	0.8
Lighting power density [W/sf]	1.5	0.79	0.70	16.5	18.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.50; 0.25	0.25; 0.27	5.3	4.9

Large Office - Post1980 - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0	0.1
Chiller COP [-]	5.2	5.77	6	2.1	2.9
Cooling tower fan power [kBtu/h]	187	178	169	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.8	0.8
Lighting power density [W/sf]	1.5	0.79	0.70	17.2	19.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.50; 0.25	0.25; 0.27	0.8	0.4

Large Office - New - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0	0.1
Chiller COP [-]	5.2	5.77	6	2.2	3
Cooling tower fan power [kBtu/h]	168	160	152	0.2	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.7	0.8
Lighting power density [W/sf]	1.5	0.79	0.70	17.4	19.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.50; 0.25	0.25; 0.27	0.8	0.3

Large Office – Climate Zone 2A (Houston, Texas)

Large Office - Pre1980 - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.6	1.1
Chiller COP [-]	5.2	5.77	6	1.7	2.3
Cooling tower fan power [kBtu/h]	203	193	184	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2.2	2.3
Lighting power density [W/sf]	1.5	0.79	0.70	15.4	17.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.37; 0.25	0.25; 0.27	8.3	8.7

Large Office - Post1980 - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.5	1
Chiller COP [-]	5.2	5.77	6	1.6	2.2
Cooling tower fan power [kBtu/h]	180	171	162	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2.6	2.7
Lighting power density [W/sf]	1.5	0.79	0.70	15.8	17.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	4.3	4.7

Large Office - New - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.5	0.9
Chiller COP [-]	5.2	5.77	6	1.7	2.3
Cooling tower fan power [kBtu/h]	161	153	145	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2.8	3
Lighting power density [W/sf]	1.5	0.79	0.70	16.6	18.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	4	4.1

Large Office – Climate Zone 2B (Phoenix, Arizona)

Large Office - Pre1980 - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.4	0.8
Chiller COP [-]	5.2	5.77	6	1.4	1.9
Cooling tower fan power [kBtu/h]	200	190	181	0.2	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	1.4	1.5
Lighting power density [W/sf]	1.5	0.79	0.70	16	18.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.37; 0.25	0.25; 0.27	7.6	7.8

Large Office - Post1980 - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.3	0.7
Chiller COP [-]	5.2	5.77	6	1.3	1.8
Cooling tower fan power [kBtu/h]	179	170	161	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	1.5	1.6
Lighting power density [W/sf]	1.5	0.79	0.70	16.4	18.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	3.6	3.8

Large Office - New - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.3	0.6
Chiller COP [-]	5.2	5.77	6	1.4	1.9
Cooling tower fan power [kBtu/h]	160	152	145	0.2	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	1.6	1.7
Lighting power density [W/sf]	1.5	0.79	0.70	16.9	19.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	3.7	3.8

Large Office – Climate Zone 3A (Atlanta, Georgia)

Large Office - Pre1980 - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	0.8	2.2
Chiller COP [-]	5.2	5.77	6	1.2	1.6
Cooling tower fan power [kBtu/h]	201	191	181	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	4	4.3
Lighting power density [W/sf]	1.5	0.79	0.70	14.3	16.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	11.4	12.1

Large Office - Post1980 - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.9	1.8
Chiller COP [-]	5.2	5.77	6	1.1	1.5
Cooling tower fan power [kBtu/h]	175	166	158	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	4.5	4.8
Lighting power density [W/sf]	1.5	0.79	0.70	14.8	16.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.25	0.33; 0.25	0.25; 0.27	4.8	5.7

Large Office - New - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.5	1
Chiller COP [-]	5.2	5.77	6	1.2	1.6
Cooling tower fan power [kBtu/h]	151	144	137	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	5	5.2
Lighting power density [W/sf]	1.5	0.79	0.70	17	19.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.25	0.33; 0.25	0.25; 0.27	2.3	2.5

Large Office – Climate Zone 3B (Las Vegas, Nevada)

Large Office - Pre1980 - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	0.3	0.9
Chiller COP [-]	5.2	5.77	6	0.9	1.2
Cooling tower fan power [kBtu/h]	181	172	163	0.2	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.7	0.8
Lighting power density [W/sf]	1.5	0.79	0.70	17.3	19.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	7.5	7.2

Large Office - Post1980 - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.3	0.6
Chiller COP [-]	5.2	5.77	6	0.8	1
Cooling tower fan power [kBtu/h]	157	150	142	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.8	0.8
Lighting power density [W/sf]	1.5	0.79	0.70	18.1	20.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.33; 0.25	0.25; 0.27	2.3	2.1

Large Office - New - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.1	0.2
Chiller COP [-]	5.2	5.77	6	0.8	1.1
Cooling tower fan power [kBtu/h]	134	127	121	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.5	0.5
Lighting power density [W/sf]	1.5	0.79	0.70	19.2	21.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.25	0.33; 0.25	0.25; 0.27	0.1	-0.3

Large Office – Climate Zone 3C (San Francisco, California)

Large Office - Pre1980 - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	0.7	1.9
Chiller COP [-]	5.2	5.77	6	0.4	0.5
Cooling tower fan power [kBtu/h]	155	147	140	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2.1	2.2
Lighting power density [W/sf]	1.5	0.79	0.70	16.2	18.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	10.2	10.4

Large Office - Post1980 - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.7	1.4
Chiller COP [-]	5.2	5.77	6	0.4	0.5
Cooling tower fan power [kBtu/h]	138	131	125	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2.3	2.4
Lighting power density [W/sf]	1.5	0.79	0.70	16.7	18.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.39	0.33; 0.25	0.25; 0.27	5.7	6

Large Office - New - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.4	0.8
Chiller COP [-]	5.2	5.77	6	0.4	0.5
Cooling tower fan power [kBtu/h]	125	119	113	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2.2	2.4
Lighting power density [W/sf]	1.5	0.79	0.70	18.2	20.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.33; 0.25	0.25; 0.27	3.7	3.7

Large Office – Climate Zone 4A (Baltimore, Maryland)

Large Office - Pre1980 - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	1.4	3.6
Chiller COP [-]	5.2	5.77	6	0.9	1.2
Cooling tower fan power [kBtu/h]	199	189	180	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	6.7	7.1
Lighting power density [W/sf]	1.5	0.79	0.70	12.2	13.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	14	15.4

Large Office - Post1980 - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.4	2.6
Chiller COP [-]	5.2	5.77	6	0.9	1.2
Cooling tower fan power [kBtu/h]	175	166	158	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	7.7	8.1
Lighting power density [W/sf]	1.5	0.79	0.70	12.9	14.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.36	0.31; 0.36	0.25; 0.27	5.5	7.1

Large Office - New - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.1	2.2
Chiller COP [-]	5.2	5.77	6	0.9	1.2
Cooling tower fan power [kBtu/h]	158	150	142	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8	8.5
Lighting power density [W/sf]	1.5	0.79	0.70	14.7	16.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	4.9	6.5

Large Office – Climate Zone 4B (Albuquerque, New Mexico)

Large Office - Pre1980 - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	1	2.5
Chiller COP [-]	5.2	5.77	6	0.6	0.7
Cooling tower fan power [kBtu/h]	154	146	139	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	5	5.3
Lighting power density [W/sf]	1.5	0.79	0.70	14.9	16.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	11.1	12.4

Large Office - New - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	0.6	1.2
Chiller COP [-]	5.2	5.77	6	0.5	0.7
Cooling tower fan power [kBtu/h]	120	114	108	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	5.3	5.5
Lighting power density [W/sf]	1.5	0.79	0.70	17.2	19.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	3	4.2

Large Office - Post1980 - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1	2
Chiller COP [-]	5.2	5.77	6	0.5	0.7
Cooling tower fan power [kBtu/h]	136	130	123	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	5.2	5.4
Lighting power density [W/sf]	1.5	0.79	0.70	15.1	17
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.36	0.31; 0.36	0.25; 0.27	6.2	7.7

Large Office – Climate Zone 4C (Seattle, Washington)

Large Office - Pre1980 - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	1.5	3.9
Chiller COP [-]	5.2	5.77	6	0.3	0.4
Cooling tower fan power [kBtu/h]	165	157	149	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	6	6.3
Lighting power density [W/sf]	1.5	0.79	0.70	12.8	14.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	14.7	16.4

Large Office - New - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.1	2.1
Chiller COP [-]	5.2	5.77	6	0.3	0.4
Cooling tower fan power [kBtu/h]	127	121	115	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	6.8	7.2
Lighting power density [W/sf]	1.5	0.79	0.70	15.6	17.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	5.2	7.1

Large Office - Post1980 - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.4	2.8
Chiller COP [-]	5.2	5.77	6	0.3	0.4
Cooling tower fan power [kBtu/h]	147	140	133	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	6.2	6.5
Lighting power density [W/sf]	1.5	0.79	0.70	13.5	15.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.39	0.31; 0.36	0.25; 0.27	8.4	10.3

Large Office – Climate Zone 5A (Chicago, Illinois)

Large Office - Pre1980 - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	1.7	4.4
Chiller COP [-]	5.2	5.77	6	0.6	0.8
Cooling tower fan power [kBtu/h]	179	170	162	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	9.4	10
Lighting power density [W/sf]	1.5	0.79	0.70	10.2	11.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.31; 0.38	0.25; 0.27	7.4	9.1

Large Office - Post1980 - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	2.1	4.1
Chiller COP [-]	5.2	5.77	6	0.6	0.8
Cooling tower fan power [kBtu/h]	176	167	159	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.3	10.9
Lighting power density [W/sf]	1.5	0.79	0.70	9.9	11.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.39	0.31; 0.38	0.25; 0.27	7.2	8.9

Large Office - New - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.8	3.6
Chiller COP [-]	5.2	5.77	6	0.6	0.8
Cooling tower fan power [kBtu/h]	156	148	140	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.5	11.2
Lighting power density [W/sf]	1.5	0.79	0.70	11.9	13.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.38	0.25; 0.27	7	8.8

Large Office – Climate Zone 5B (Boulder, Colorado)

Large Office - Pre1980 - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	1.1	2.9
Chiller COP [-]	5.2	5.77	6	0.4	0.5
Cooling tower fan power [kBtu/h]	135	128	122	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	7.4	7.7
Lighting power density [W/sf]	1.5	0.79	0.70	13.2	14.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.31; 0.38	0.25; 0.27	6.6	8.3

Large Office - Post1980 - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.4	2.7
Chiller COP [-]	5.2	5.77	6	0.4	0.5
Cooling tower fan power [kBtu/h]	132	126	120	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	7.7	8.1
Lighting power density [W/sf]	1.5	0.79	0.70	13	14.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.39	0.31; 0.38	0.25; 0.27	6.3	8.1

Large Office - New - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.1	2.1
Chiller COP [-]	5.2	5.77	6	0.4	0.6
Cooling tower fan power [kBtu/h]	117	111	105	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8.2	8.7
Lighting power density [W/sf]	1.5	0.79	0.70	15.3	17.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.38	0.25; 0.27	4.7	6.3

Large Office – Climate Zone 6A (Minneapolis, Minnesota)

Large Office - Pre1980 - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	2	5.4
Chiller COP [-]	5.2	5.77	6	0.4	0.6
Cooling tower fan power [kBtu/h]	177	168	160	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.8	11.5
Lighting power density [W/sf]	1.5	0.79	0.70	8.7	9.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.30; 0.4	0.25; 0.27	8.4	9.8

Large Office - Post1980 - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	2.5	4.8
Chiller COP [-]	5.2	5.77	6	0.4	0.6
Cooling tower fan power [kBtu/h]	174	165	157	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	12.3	13.1
Lighting power density [W/sf]	1.5	0.79	0.70	8.7	9.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.39	0.30; 0.4	0.25; 0.27	6.6	8.2

Large Office - New - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	2.4	4.6
Chiller COP [-]	5.2	5.77	6	0.5	0.6
Cooling tower fan power [kBtu/h]	154	146	139	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	11.9	12.7
Lighting power density [W/sf]	1.5	0.79	0.70	10.2	11.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.30; 0.4	0.25; 0.27	8.7	10.1

Large Office – Climate Zone 6B (Helena, Montana)

Large Office - Pre1980 - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	1.6	4.4
Chiller COP [-]	5.2	5.77	6	0.2	0.3
Cooling tower fan power [kBtu/h]	133	126	120	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.2	10.8
Lighting power density [W/sf]	1.5	0.79	0.70	10.2	11.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.30; 0.4	0.25; 0.27	8.1	9.7

Large Office - Post1980 - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	2	3.8
Chiller COP [-]	5.2	5.77	6	0.2	0.3
Cooling tower fan power [kBtu/h]	131	125	118	0.1	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.9	11.5
Lighting power density [W/sf]	1.5	0.79	0.70	10.3	11.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.39	0.30; 0.4	0.25; 0.27	6.3	8

Large Office - New - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	1.8	3.5
Chiller COP [-]	5.2	5.77	6	0.2	0.3
Cooling tower fan power [kBtu/h]	115	109	104	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	11.3	12
Lighting power density [W/sf]	1.5	0.79	0.70	12.3	13.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.30; 0.4	0.25; 0.27	7.3	8.8

Large Office – Climate Zone 7A (Duluth, Minnesota)

Large Office - Pre1980 - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	2.4	6.4
Chiller COP [-]	5.2	5.77	6	0.2	0.3
Cooling tower fan power [kBtu/h]	154	146	139	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	12	12.8
Lighting power density [W/sf]	1.5	0.79	0.70	7.2	8.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.28; 0.45	0.25; 0.27	10.2	10.9

Large Office - Post1980 - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	2.9	5.7
Chiller COP [-]	5.2	5.77	6	0.2	0.3
Cooling tower fan power [kBtu/h]	162	154	146	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	14.2	15
Lighting power density [W/sf]	1.5	0.79	0.70	7.5	8.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.49	0.28; 0.45	0.25; 0.27	8.4	9.1

Large Office - New - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	2.8	5.5
Chiller COP [-]	5.2	5.77	6	0.3	0.4
Cooling tower fan power [kBtu/h]	145	137	130	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	13.2	14.1
Lighting power density [W/sf]	1.5	0.79	0.70	9	10.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.49	0.28; 0.45	0.25; 0.27	11.2	11.7

Large Office – Climate Zone 8A (Fairbanks, Alaska)

Large Office - Pre1980 - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	80	90	3.3	8.7
Chiller COP [-]	5.2	5.77	6	0.1	0.1
Cooling tower fan power [kBtu/h]	136	129	123	0	0
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	13.9	14.8
Lighting power density [W/sf]	1.5	0.79	0.70	4.9	5.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.25; 0.45	0.25; 0.27	10.7	11.1

Large Office - Post1980 - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	4.1	8.1
Chiller COP [-]	5.2	5.77	6	0.1	0.1
Cooling tower fan power [kBtu/h]	159	151	143	0	0
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	15.8	16.9
Lighting power density [W/sf]	1.5	0.79	0.70	4.9	5.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.615	0.25; 0.45	0.25; 0.27	9.7	10.1

Large Office - New - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Boiler efficiency [%]	75	82	90	3.9	7.6
Chiller COP [-]	5.2	5.77	6	0.1	0.1
Cooling tower fan power [kBtu/h]	111	105	100	0	0
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	15.7	16.8
Lighting power density [W/sf]	1.5	0.79	0.70	6.2	7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.46; 0.3	0.25; 0.45	0.25; 0.27	9.2	9.3

Medium Office – Climate Zone 1A – (Miami, Florida)

Medium Office - Pre1980 - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	1.5	4.5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	-0.3	-0.4
Lighting power density [W/sf]	1.5	0.79	0.70	15.8	17.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.50; 0.25	0.25; 0.27	7.4	6.9

Medium Office - Post1980 - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	1.7	5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	1.6	1.8
Lighting power density [W/sf]	1.5	0.79	0.70	15.1	17.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.50; 0.25	0.25; 0.27	1.8	1.6

Medium Office - New - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	1.7	4.8
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	1.5	1.6
Lighting power density [W/sf]	1.5	0.79	0.70	16.4	18.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.50; 0.25	0.25; 0.27	1.7	1.4

Medium Office – Climate Zone 2A – (Houston, Texas)

Medium Office - Pre1980 - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.2
Chiller COP [-]	3.35	3.55	4	1.2	3.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.4	0.4
Lighting power density [W/sf]	1.5	0.79	0.70	15.3	17.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.37; 0.25	0.25; 0.27	7.4	7.3

Medium Office - Post1980 - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	1.3	3.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.2	3.4
Lighting power density [W/sf]	1.5	0.79	0.70	14.9	16.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	4.2	4.4

Medium Office - New - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	1.3	3.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.7	4
Lighting power density [W/sf]	1.5	0.79	0.70	15.7	17.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	4.4	4.6

Medium Office – Climate Zone 2B – (Phoenix, Arizona)

Medium Office - Pre1980 - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	1.5	4.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.7	0.7
Lighting power density [W/sf]	1.5	0.79	0.70	14.4	16.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.37; 0.25	0.25; 0.27	10.1	10

Medium Office - Post1980 - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	1.5	4.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3	3.2
Lighting power density [W/sf]	1.5	0.79	0.70	14.5	16.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	5	5.3

Medium Office - New - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	1.5	4.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.4	3.6
Lighting power density [W/sf]	1.5	0.79	0.70	15.6	17.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	5.5	5.8

Medium Office – Climate Zone 3A – (Atlanta, Georgia)

Medium Office - Pre1980 - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.6
Chiller COP [-]	3.35	3.55	4	0.9	2.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2	2.1
Lighting power density [W/sf]	1.5	0.79	0.70	13.9	15.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	8.2	8.3

Medium Office - Post1980 - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	0.9	2.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	4.9	5.2
Lighting power density [W/sf]	1.5	0.79	0.70	14.2	16
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.25	0.33; 0.25	0.25; 0.27	3.9	4.3

Medium Office - New - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	1	2.8
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	5.9	6.2
Lighting power density [W/sf]	1.5	0.79	0.70	15.6	17.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.25	0.33; 0.25	0.25; 0.27	2.2	2.6

Medium Office – Climate Zone 3B – (Las Vegas, Nevada)

Medium Office - Pre1980 - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	0.3	0.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	-0.7	-0.8
Lighting power density [W/sf]	1.5	0.79	0.70	17.2	19.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	5.3	4.9

Medium Office - Post1980 - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	0.7	1.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.8	0.8
Lighting power density [W/sf]	1.5	0.79	0.70	17.2	19.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.33; 0.25	0.25; 0.27	2.9	2.7

Medium Office - New - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	0.7	2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	1	1.1
Lighting power density [W/sf]	1.5	0.79	0.70	18.1	20.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.25	0.33; 0.25	0.25; 0.27	0.4	0

Medium Office – Climate Zone 3C - (San Francisco, California)

Medium Office - Pre1980 - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.2
Chiller COP [-]	3.35	3.55	4	0.1	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	0.3	0.3
Lighting power density [W/sf]	1.5	0.79	0.70	16.3	18.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	5.2	5

Medium Office - Post1980 - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	0.3	1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	2.7	2.8
Lighting power density [W/sf]	1.5	0.79	0.70	15.8	17.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.39	0.33; 0.25	0.25; 0.27	5.1	5.4

Medium Office - New - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0
Chiller COP [-]	3.35	3.55	4	0.4	1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.5	3.7
Lighting power density [W/sf]	1.5	0.79	0.70	17	19.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.33; 0.25	0.25; 0.27	3.7	3.9

Medium Office – Climate Zone 4A – (Baltimore, Maryland)

Medium Office - Pre1980 - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.4
Chiller COP [-]	3.35	3.55	4	0.6	1.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	5.3	5.5
Lighting power density [W/sf]	1.5	0.79	0.70	11.3	12.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	8.6	9.5

Medium Office - Post1980 - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.3
Chiller COP [-]	3.35	3.55	4	0.7	2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8.2	8.7
Lighting power density [W/sf]	1.5	0.79	0.70	12.3	13.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.36	0.31; 0.36	0.25; 0.27	4	5.3

Medium Office - New - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.3
Chiller COP [-]	3.35	3.55	4	0.8	2.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	9.6	10.2
Lighting power density [W/sf]	1.5	0.79	0.70	13.6	15.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	4	5.4

Medium Office – Climate Zone 4B - (Albuquerque, New Mexico)

Medium Office - Pre1980 - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.7
Chiller COP [-]	3.35	3.55	4	0.6	1.8
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.1	3.3
Lighting power density [W/sf]	1.5	0.79	0.70	13.3	15
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	7.5	8.5

Medium Office - Post1980 - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	0.6	1.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	5.7	6
Lighting power density [W/sf]	1.5	0.79	0.70	14	15.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.36	0.31; 0.36	0.25; 0.27	5	6.2

Medium Office - New - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	0.7	1.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	6.8	7.1
Lighting power density [W/sf]	1.5	0.79	0.70	15.4	17.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	3	4.3

Medium Office – Climate Zone 4C - (Seattle, Washington)

Medium Office - Pre1980 - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1
Chiller COP [-]	3.35	3.55	4	0.2	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	4.7	5
Lighting power density [W/sf]	1.5	0.79	0.70	11.5	12.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	7.3	8.1

Medium Office - Post1980 - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	0.3	0.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	7	7.4
Lighting power density [W/sf]	1.5	0.79	0.70	12.7	14.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.39	0.31; 0.36	0.25; 0.27	6.7	8.2

Medium Office - New - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	0.3	0.8
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8.4	8.9
Lighting power density [W/sf]	1.5	0.79	0.70	14.2	16
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	4.4	6.1

Medium Office – Climate Zone 5A - (Chicago, Illinois)

Medium Office - Pre1980 - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.3
Chiller COP [-]	3.35	3.55	4	0.4	1.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	9.8	10.3
Lighting power density [W/sf]	1.5	0.79	0.70	8.6	9.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.31; 0.38	0.25; 0.27	5.2	6.3

Medium Office - Post1980 - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.6
Chiller COP [-]	3.35	3.55	4	0.4	1.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	11.6	12.4
Lighting power density [W/sf]	1.5	0.79	0.70	9.8	11.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.39	0.31; 0.38	0.25; 0.27	5.2	6.5

Medium Office - New - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.7
Chiller COP [-]	3.35	3.55	4	0.5	1.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	12.8	13.6
Lighting power density [W/sf]	1.5	0.79	0.70	11.2	12.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.38	0.25; 0.27	5.5	6.8

Medium Office – Climate Zone 5B – (Boulder, Colorado)

Medium Office - Pre1980 - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.3
Chiller COP [-]	3.35	3.55	4	0.4	1.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	6.7	7.1
Lighting power density [W/sf]	1.5	0.79	0.70	11.1	12.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.31; 0.38	0.25; 0.27	4.2	5.3

Medium Office - Post1980 - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.3
Chiller COP [-]	3.35	3.55	4	0.5	1.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8.6	9.1
Lighting power density [W/sf]	1.5	0.79	0.70	12.1	13.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.39	0.31; 0.38	0.25; 0.27	4.5	5.8

Medium Office - New - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.3
Chiller COP [-]	3.35	3.55	4	0.5	1.5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.2	10.8
Lighting power density [W/sf]	1.5	0.79	0.70	13.8	15.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.38	0.25; 0.27	4.2	5.6

Medium Office – Climate Zone 6A – (Minneapolis, Minnesota)

Medium Office - Pre1980 - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	3
Chiller COP [-]	3.35	3.55	4	0.3	0.8
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	12.1	12.8
Lighting power density [W/sf]	1.5	0.79	0.70	7.1	7.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.30; 0.4	0.25; 0.27	6.4	7.2

Medium Office - Post1980 - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.9
Chiller COP [-]	3.35	3.55	4	0.4	1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	14.1	14.9
Lighting power density [W/sf]	1.5	0.79	0.70	8.6	9.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.39	0.30; 0.4	0.25; 0.27	4.8	5.9

Medium Office - New - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1
Chiller COP [-]	3.35	3.55	4	0.4	1.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	14.9	15.8
Lighting power density [W/sf]	1.5	0.79	0.70	9.7	11
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.30; 0.4	0.25; 0.27	6.7	7.7

Medium Office – Climate Zone 6B – (Helena, Montana)

Medium Office - Pre1980 - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.2
Chiller COP [-]	3.35	3.55	4	0.2	0.5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.8	11.4
Lighting power density [W/sf]	1.5	0.79	0.70	8	9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.30; 0.4	0.25; 0.27	5.7	6.5

Medium Office - Post1980 - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.6
Chiller COP [-]	3.35	3.55	4	0.2	0.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	12.5	13.2
Lighting power density [W/sf]	1.5	0.79	0.70	9.4	10.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.39	0.30; 0.4	0.25; 0.27	4.6	5.6

Medium Office - New - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.7
Chiller COP [-]	3.35	3.55	4	0.3	0.8
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	14	14.8
Lighting power density [W/sf]	1.5	0.79	0.70	11	12.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.30; 0.4	0.25; 0.27	6.1	7

Medium Office – Climate Zone 7A – (Duluth, Minnesota)

Medium Office - Pre1980 - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	3.7
Chiller COP [-]	3.35	3.55	4	0.1	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	14.4	15.4
Lighting power density [W/sf]	1.5	0.79	0.70	5.6	6.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.28; 0.45	0.25; 0.27	8.2	8.1

Medium Office - Post1980 - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.2
Chiller COP [-]	3.35	3.55	4	0.2	0.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	16.3	17.3
Lighting power density [W/sf]	1.5	0.79	0.70	7.5	8.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.49	0.28; 0.45	0.25; 0.27	6.1	6.3

Medium Office - New - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.3
Chiller COP [-]	3.35	3.55	4	0.2	0.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	17.1	18.2
Lighting power density [W/sf]	1.5	0.79	0.70	8.7	9.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.49	0.28; 0.45	0.25; 0.27	8.3	8.2

Medium Office – Climate Zone 8A– (Fairbanks, Alaska)

Medium Office - Pre1980 - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.3
Chiller COP [-]	3.35	3.55	4	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	17.4	18.6
Lighting power density [W/sf]	1.5	0.79	0.70	3.3	3.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.25; 0.45	0.25; 0.27	9.2	8.8

Medium Office - Post1980 - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.8
Chiller COP [-]	3.35	3.55	4	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	19.9	21.2
Lighting power density [W/sf]	1.5	0.79	0.70	5.3	6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.615	0.25; 0.45	0.25; 0.27	7.2	7.2

Medium Office - New - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.4
Chiller COP [-]	3.35	3.55	4	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	20.2	21.6
Lighting power density [W/sf]	1.5	0.79	0.70	6.1	6.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.46; 0.3	0.25; 0.45	0.25; 0.27	7.6	7.2

Retail – Climate Zone 1A – (Miami, Florida)

Retail - Pre1980 - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	1.6	4.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.6	3.8
Lighting power density [W/sf]	3.3	1.1	0.93	38.5	40.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.50; 0.25	0.25; 0.27	1.7	1.7

Retail - Post1980 - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	1.6	4.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.5	3.7
Lighting power density [W/sf]	3.3	1.1	0.93	37.6	39.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.50; 0.25	0.25; 0.27	0.4	0.4

Retail - New - 1A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	0.1
Chiller COP [-]	3.35	3.55	4	1.6	4.5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	4.8	5
Lighting power density [W/sf]	3.3	1.1	0.93	43.9	46.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.50; 0.25	0.25; 0.27	0.5	0.4

Retail – Climate Zone 2A – (Houston, Texas)

Retail - Pre1980 - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.3
Chiller COP [-]	3.35	3.55	4	1.1	3.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8.3	8.8
Lighting power density [W/sf]	3.3	1.1	0.93	31.9	33.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.37; 0.25	0.25; 0.27	1.5	1.6

Retail - Post1980 - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.3
Chiller COP [-]	3.35	3.55	4	1	3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8.7	9
Lighting power density [W/sf]	3.3	1.1	0.93	33.5	35.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	0.9	1

Retail - New - 2A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.3
Chiller COP [-]	3.35	3.55	4	1.1	3.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	12.4	13.1
Lighting power density [W/sf]	3.3	1.1	0.93	38.3	40.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	1.1	1.3

Retail – Climate Zone 2B – (Phoenix, Arizona)

Retail - Pre1980 - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1
Chiller COP [-]	3.35	3.55	4	1.3	3.8
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	7.7	8.1
Lighting power density [W/sf]	3.3	1.1	0.93	32.1	33.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.37; 0.25	0.25; 0.27	1.9	2

Retail - Post1980 - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1
Chiller COP [-]	3.35	3.55	4	1.2	3.5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	8.3	8.6
Lighting power density [W/sf]	3.3	1.1	0.93	34.2	36.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	1.1	1.2

Retail - New - 2B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.1
Chiller COP [-]	3.35	3.55	4	1.2	3.5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	11.8	12.5
Lighting power density [W/sf]	3.3	1.1	0.93	38.2	40.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.37; 0.25	0.25; 0.27	1.5	1.8

Retail – Climate Zone 3A – (Atlanta, Georgia)

Retail - Pre1980 - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.7
Chiller COP [-]	3.35	3.55	4	0.7	1.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	12.9	13.6
Lighting power density [W/sf]	3.3	1.1	0.93	25.5	27
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	1.2	1.4

Retail - Post1980 - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.7
Chiller COP [-]	3.35	3.55	4	0.6	1.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	13.5	14.1
Lighting power density [W/sf]	3.3	1.1	0.93	26.3	27.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.25	0.33; 0.25	0.25; 0.27	0.7	0.9

Retail - New - 3A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.8
Chiller COP [-]	3.35	3.55	4	0.6	1.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	18.1	19
Lighting power density [W/sf]	3.3	1.1	0.93	33	34.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.25	0.33; 0.25	0.25; 0.27	0.7	0.9

Retail – Climate Zone 3B – (Las Vegas, Nevada)

Retail - Pre1980 - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.1
Chiller COP [-]	3.35	3.55	4	0.3	0.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.5	3.7
Lighting power density [W/sf]	3.3	1.1	0.93	37.4	39.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	1.4	1.4

Retail - New - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1.2
Chiller COP [-]	3.35	3.55	4	0.2	0.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	7.6	8
Lighting power density [W/sf]	3.3	1.1	0.93	43.1	45.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.25	0.33; 0.25	0.25; 0.27	0.2	0.3

Retail - Post1980 - 3B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	1
Chiller COP [-]	3.35	3.55	4	0.2	0.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	3.2	3.2
Lighting power density [W/sf]	3.3	1.1	0.93	38.6	40.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.25	0.33; 0.25	0.25; 0.27	0.6	0.6

Retail – Climate Zone 3C – (San Francisco, California)

Retail - Pre1980 - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.5
Chiller COP [-]	3.35	3.55	4	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	9.6	10.1
Lighting power density [W/sf]	3.3	1.1	0.93	26.7	28.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.33; 0.25	0.25; 0.27	0.7	0.9

Retail - Post1980 - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.6
Chiller COP [-]	3.35	3.55	4	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	10.2	10.8
Lighting power density [W/sf]	3.3	1.1	0.93	26.1	27.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.39	0.33; 0.25	0.25; 0.27	0.4	0.6

Retail - New - 3C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	2.9
Chiller COP [-]	3.35	3.55	4	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	16.7	17.7
Lighting power density [W/sf]	3.3	1.1	0.93	33	34.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.33; 0.25	0.25; 0.27	0.3	0.6

Retail – Climate Zone 4A – (Baltimore, Maryland)

Retail - Pre1980 - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.3
Chiller COP [-]	3.35	3.55	4	0.4	1.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	19.5	20.5
Lighting power density [W/sf]	3.3	1.1	0.93	18	18.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	1.3	1.4

Retail - Post1980 - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.3
Chiller COP [-]	3.35	3.55	4	0.3	1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	19.8	20.7
Lighting power density [W/sf]	3.3	1.1	0.93	18.1	19
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.36	0.31; 0.36	0.25; 0.27	0.9	1

Retail - New - 4A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.3
Chiller COP [-]	3.35	3.55	4	0.4	1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	25	26.2
Lighting power density [W/sf]	3.3	1.1	0.93	25.6	27
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	0.9	1

Retail – Climate Zone 4B – (Albuquerque, New Mexico)

Retail - Pre1980 - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	3.5
Chiller COP [-]	3.35	3.55	4	0.4	1.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	15.9	16.7
Lighting power density [W/sf]	3.3	1.1	0.93	21.5	22.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	0.9	1

Retail - Post1980 - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	3.4
Chiller COP [-]	3.35	3.55	4	0.3	0.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	16.3	17
Lighting power density [W/sf]	3.3	1.1	0.93	21.4	22.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.36	0.31; 0.36	0.25; 0.27	0.8	0.9

Retail - New - 4B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	3.5
Chiller COP [-]	3.35	3.55	4	0.3	0.9
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	22.3	23.4
Lighting power density [W/sf]	3.3	1.1	0.93	29.8	31.4
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	0.7	0.8

Retail – Climate Zone 4C – (Seattle, Washington)

Retail - Pre1980 - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.3
Chiller COP [-]	3.35	3.55	4	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	18	18.9
Lighting power density [W/sf]	3.3	1.1	0.93	16.6	17.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	1.2; 0.54	0.31; 0.36	0.25; 0.27	1.3	1.3

Retail - Post1980 - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.2
Chiller COP [-]	3.35	3.55	4	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	18.4	19.4
Lighting power density [W/sf]	3.3	1.1	0.93	16.5	17.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.72; 0.39	0.31; 0.36	0.25; 0.27	1	1.1

Retail - New - 4C

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.6
Chiller COP [-]	3.35	3.55	4	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	23	24.3
Lighting power density [W/sf]	3.3	1.1	0.93	23.1	24.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.36	0.25; 0.27	1	1

Retail – Climate Zone 5A – (Chicago, Illinois)

Retail - Pre1980 - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.4
Chiller COP [-]	3.35	3.55	4	0.2	0.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	24.6	25.9
Lighting power density [W/sf]	3.3	1.1	0.93	13	13.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.31; 0.38	0.25; 0.27	1	1.1

Retail - Post1980 - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.3
Chiller COP [-]	3.35	3.55	4	0.2	0.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	24.8	26
Lighting power density [W/sf]	3.3	1.1	0.93	13.5	14.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.39	0.31; 0.38	0.25; 0.27	1.1	1.2

Retail - New - 5A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.5
Chiller COP [-]	3.35	3.55	4	0.2	0.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	29.3	30.8
Lighting power density [W/sf]	3.3	1.1	0.93	20.7	21.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.38	0.25; 0.27	1.3	1.3

Retail – Climate Zone 5B – (Boulder, Colorado)

Retail - Pre1980 - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.5
Chiller COP [-]	3.35	3.55	4	0.2	0.7
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	21.5	22.5
Lighting power density [W/sf]	3.3	1.1	0.93	15.9	16.8
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.31; 0.38	0.25; 0.27	1	1

Retail - Post1980 - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.3
Chiller COP [-]	3.35	3.55	4	0.2	0.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	21.8	22.7
Lighting power density [W/sf]	3.3	1.1	0.93	16.5	17.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.59; 0.39	0.31; 0.38	0.25; 0.27	1.1	1.1

Retail - New - 5B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	4.6
Chiller COP [-]	3.35	3.55	4	0.2	0.6
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	27.1	28.4
Lighting power density [W/sf]	3.3	1.1	0.93	24.8	26.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.31; 0.38	0.25; 0.27	1.1	1.1

Retail – Climate Zone 6A – (Minneapolis, Minnesota)

Retail - Pre1980 - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	6
Chiller COP [-]	3.35	3.55	4	0.2	0.5
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	27.4	28.8
Lighting power density [W/sf]	3.3	1.1	0.93	10.6	11.2
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.30; 0.4	0.25; 0.27	1.2	1.2

Retail - Post1980 - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.9
Chiller COP [-]	3.35	3.55	4	0.2	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	27.7	29
Lighting power density [W/sf]	3.3	1.1	0.93	11	11.6
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.39	0.30; 0.4	0.25; 0.27	1	1

Retail - New - 6A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	6.2
Chiller COP [-]	3.35	3.55	4	0.2	0.4
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	31.3	32.9
Lighting power density [W/sf]	3.3	1.1	0.93	17.2	18.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.30; 0.4	0.25; 0.27	1.6	1.5

Retail – Climate Zone 6B – (Helena, Montana)

Retail - Pre1980 - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.5
Chiller COP [-]	3.35	3.55	4	0.1	0.3
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	26.1	27.4
Lighting power density [W/sf]	3.3	1.1	0.93	11.1	11.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.30; 0.4	0.25; 0.27	1.2	1.1

Retail - Post1980 - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.4
Chiller COP [-]	3.35	3.55	4	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	26.4	27.7
Lighting power density [W/sf]	3.3	1.1	0.93	11.5	12.1
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.39	0.30; 0.4	0.25; 0.27	1	0.9

Retail - New - 6B

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	5.9
Chiller COP [-]	3.35	3.55	4	0.1	0.2
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	29.9	31.5
Lighting power density [W/sf]	3.3	1.1	0.93	17.4	18.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.39	0.30; 0.4	0.25; 0.27	1.5	1.3

Retail – Climate Zone 7A – (Duluth, Minnesota)

Retail - Pre1980 - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	6.6
Chiller COP [-]	3.35	3.55	4	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	29.6	31.2
Lighting power density [W/sf]	3.3	1.1	0.93	8.1	8.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.28; 0.45	0.25; 0.27	1.6	1.3

Retail - Post1980 - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	6.5
Chiller COP [-]	3.35	3.55	4	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	30.5	32.1
Lighting power density [W/sf]	3.3	1.1	0.93	8.5	8.9
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.49	0.28; 0.45	0.25; 0.27	1	0.7

Retail - New - 7A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	6.9
Chiller COP [-]	3.35	3.55	4	0	0.1
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	32.9	34.7
Lighting power density [W/sf]	3.3	1.1	0.93	13.3	14
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.57; 0.49	0.28; 0.45	0.25; 0.27	1.6	1.1

Retail – Climate Zone 8A – (Fairbanks, Alaska)

Retail - Pre1980 - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	7.6
Chiller COP [-]	3.35	3.55	4	0	0
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	32	33.9
Lighting power density [W/sf]	3.3	1.1	0.93	5	5.3
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.62; 0.41	0.25; 0.45	0.25; 0.27	1.6	1.4

Retail - Post1980 - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	7.5
Chiller COP [-]	3.35	3.55	4	0	0
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	34.2	36.1
Lighting power density [W/sf]	3.3	1.1	0.93	5.4	5.7
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.52; 0.615	0.25; 0.45	0.25; 0.27	0.9	0.6

Retail - New - 8A

Component	Low eff value	Med eff value	High eff value	Med eff site EUI savings [%]	High eff site EUI savings [%]
Furnace efficiency [%]	80	80	90	0	7.9
Chiller COP [-]	3.35	3.55	4	0	0
Infiltration rate [cuft/s·sf]	0.0037	0.00099	0.00082	34.8	36.9
Lighting power density [W/sf]	3.3	1.1	0.93	8.1	8.5
Window: Uvalue [Btu/h·sf·°F]; SHGC [-]	0.46; 0.3	0.25; 0.45	0.25; 0.27	2	1.6

4. Conclusions

The energy savings data presented in this report can be used by PCA providers and others to estimate the energy savings from efficiency upgrades for boilers, chillers, roof top units, lighting, envelope air tightness, and windows. Percentage savings were developed for large office, medium office and retail building types, for three vintages and sixteen climate zones. The percentage savings were calculated for medium and higher efficiency component upgrades. The percentage savings metrics can be applied to the actual energy use of a building to estimate the savings for a given building.

7. References

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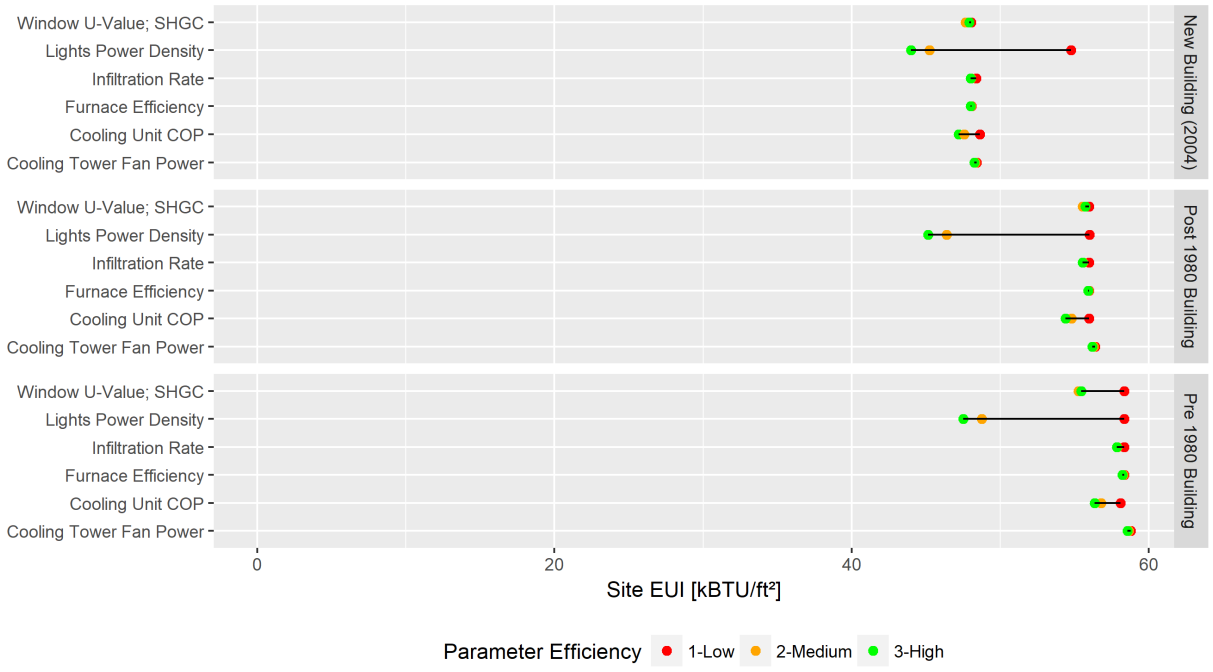
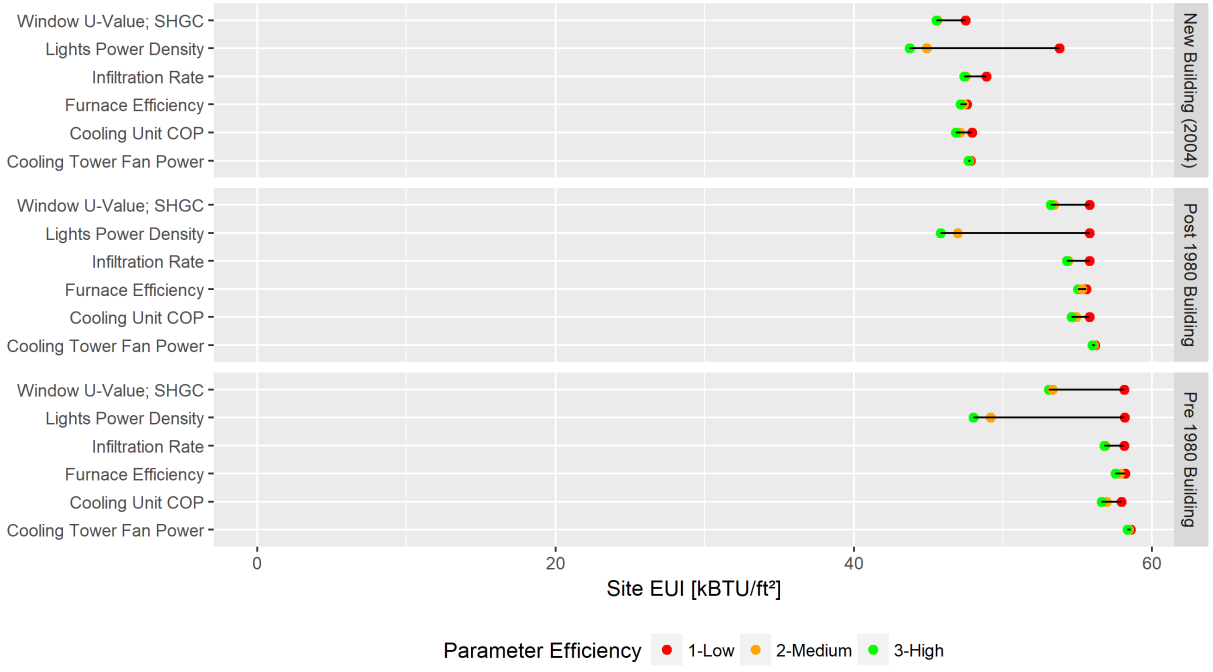
Appendix A: Modeled energy use intensity data

This appendix presents the modeled energy use intensity from which the percentage savings estimates were calculated. For each combination of building type and climate zone (one figure), there are graphs for each of the three vintages.

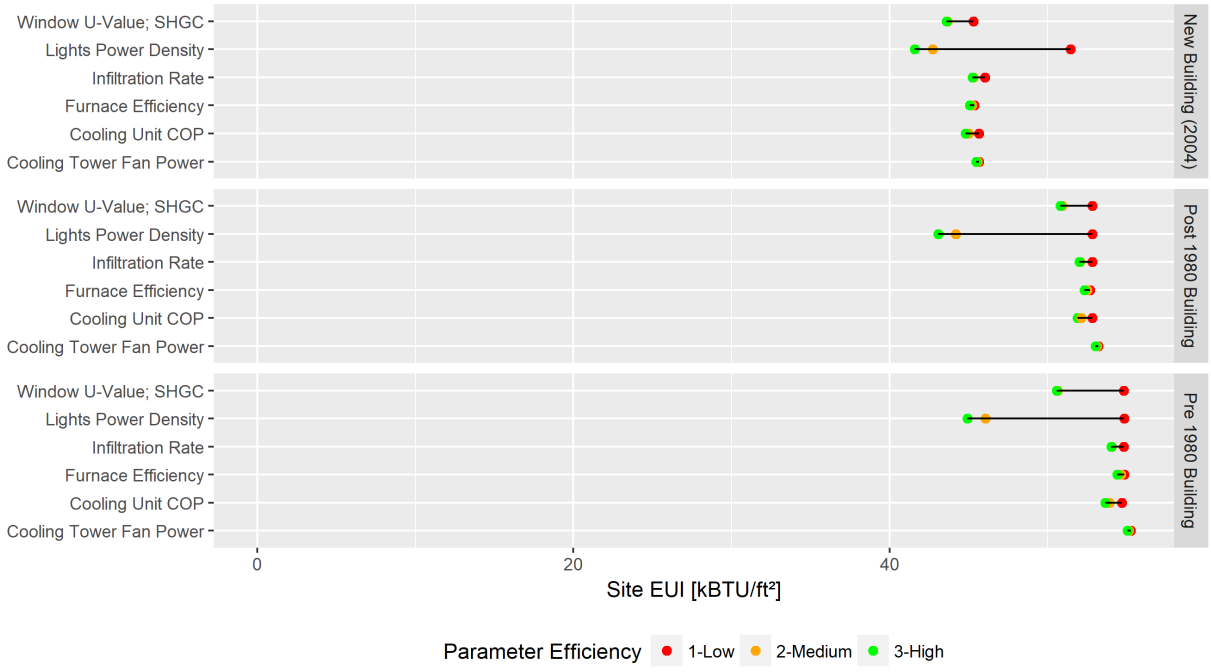
Large Office – Climate Zone 1A (Miami, Florida)



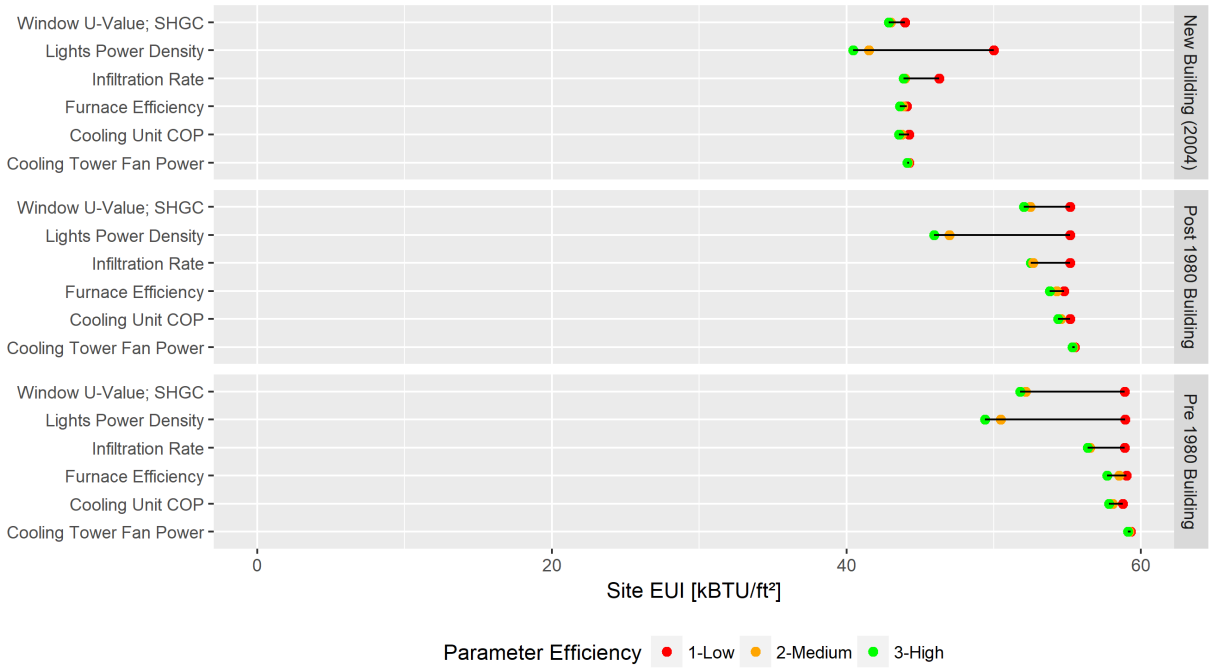
Large Office – Climate Zone 2A (Houston, Texas)



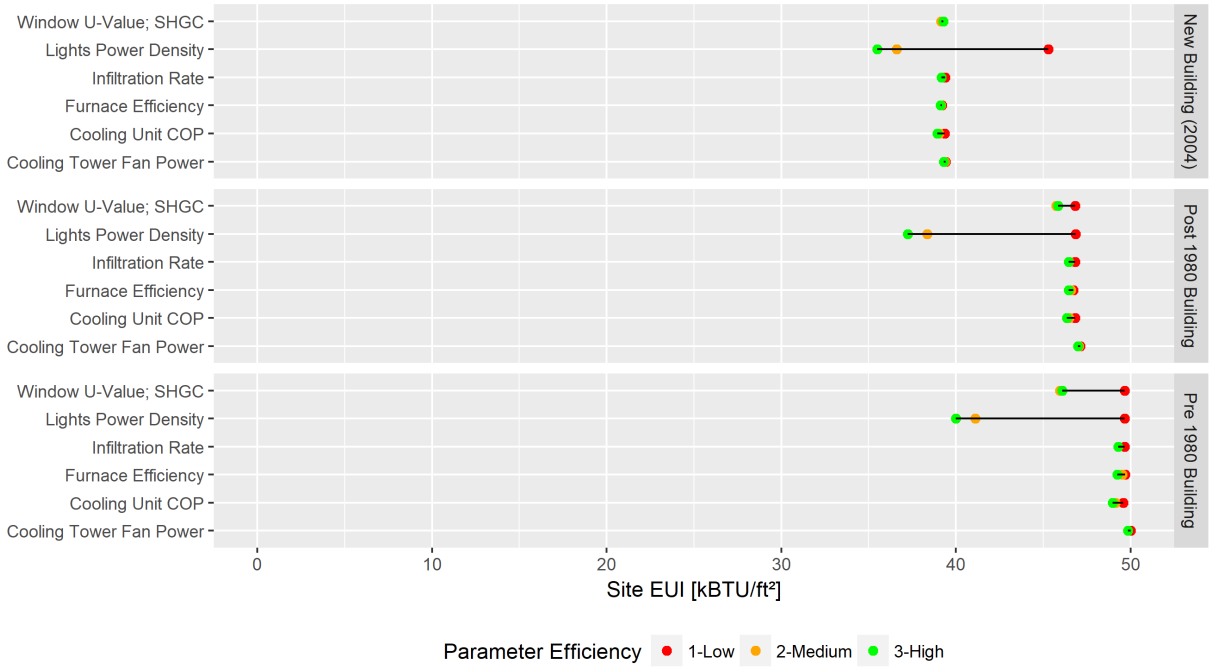
Large Office – Climate Zone 2B (Phoenix, Arizona)



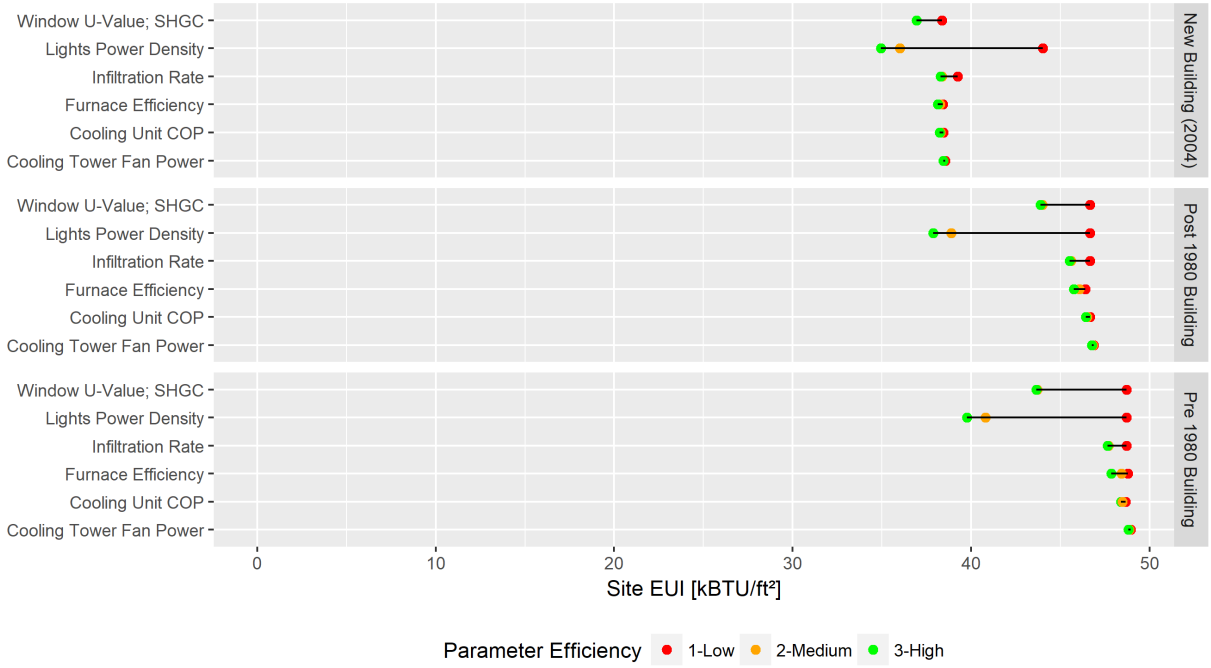
Large Office – Climate Zone 3A (Atlanta, Georgia)



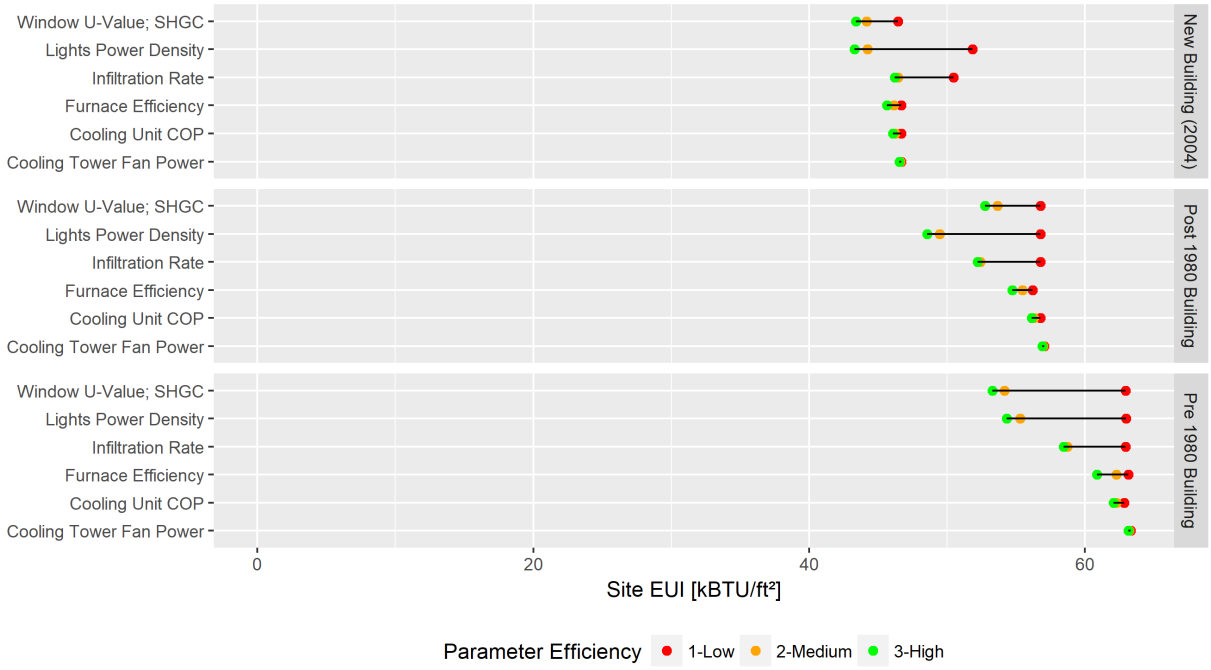
Large Office – Climate Zone 3B (Las Vegas, Nevada)



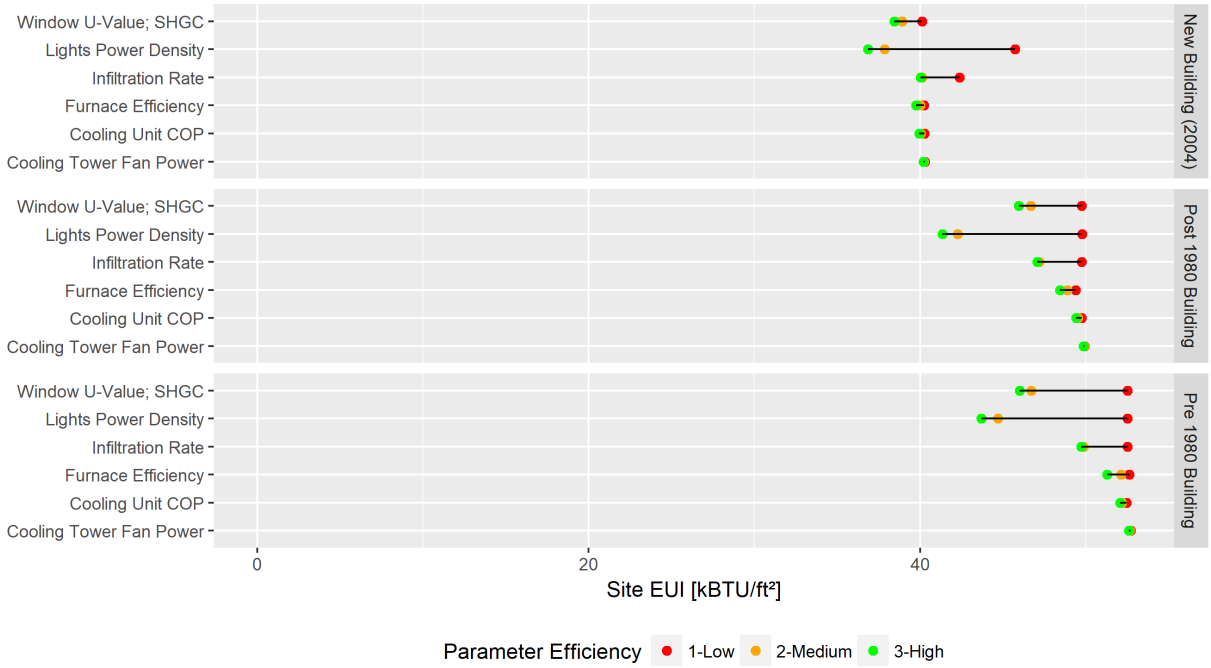
Large Office – Climate Zone 3C (San Francisco, California)



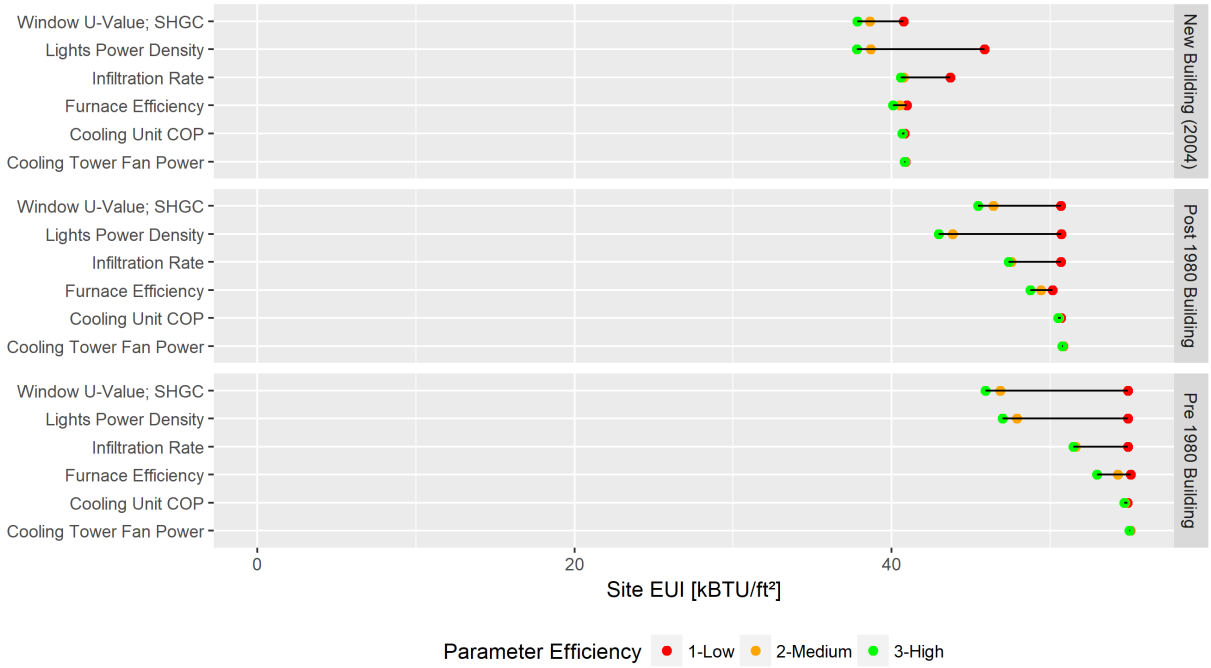
Large Office – Climate Zone 4A (Baltimore, Maryland)



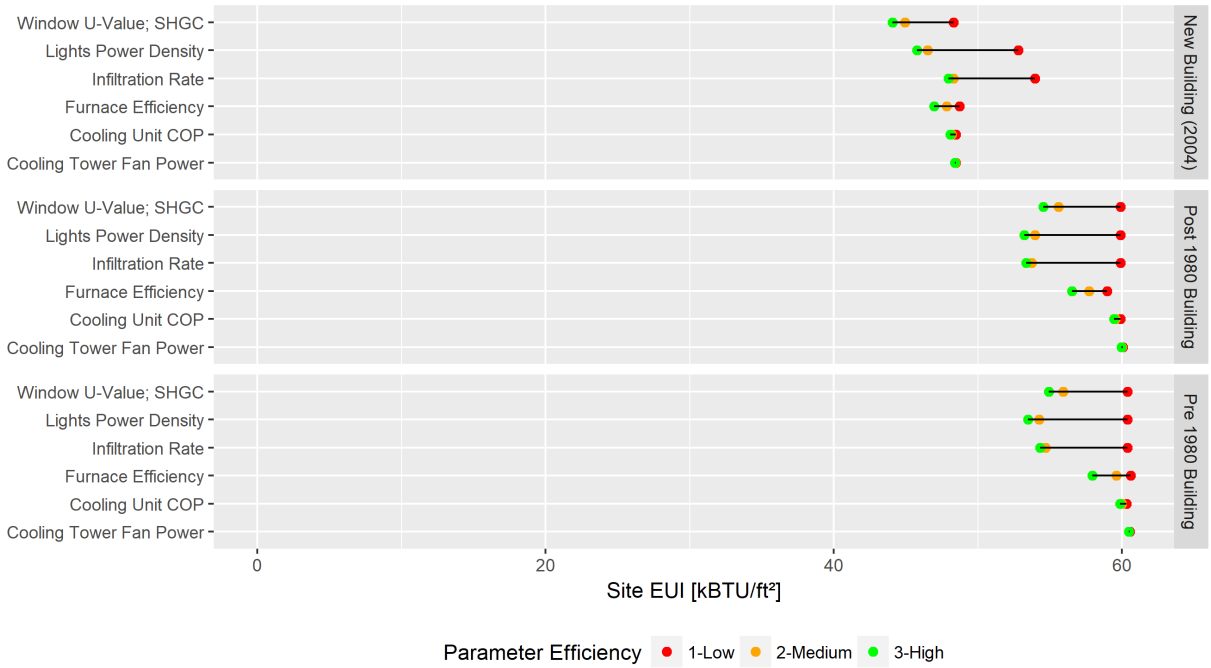
Large Office – Climate Zone 4B (Albuquerque, New Mexico)



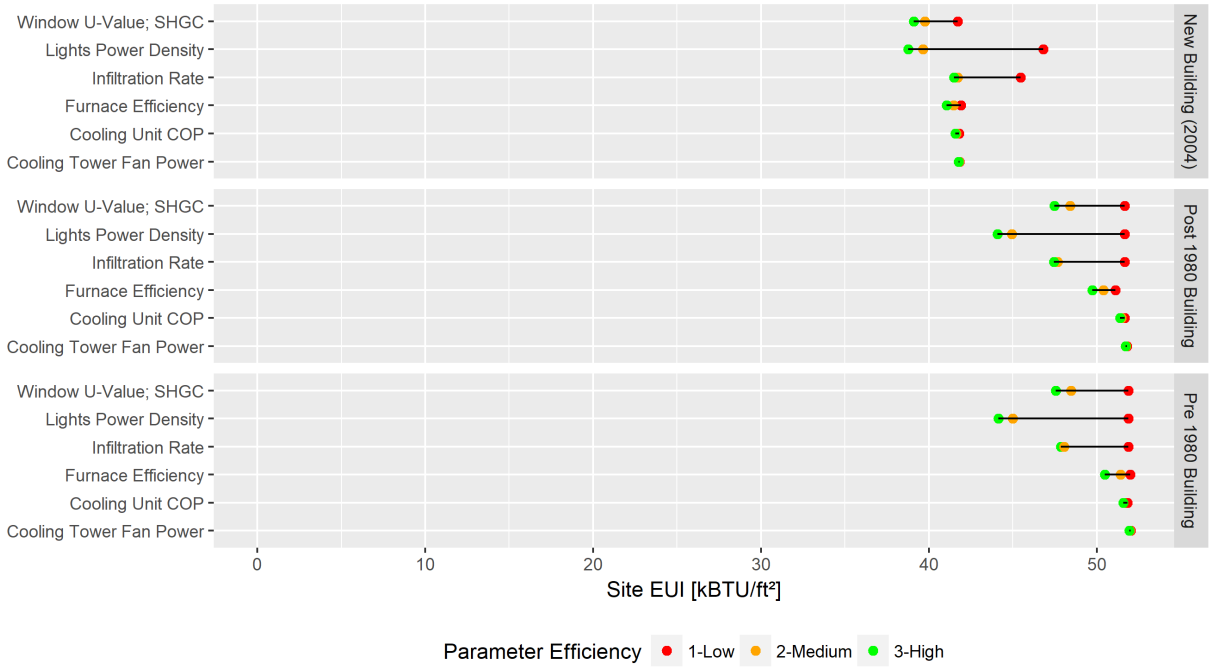
Large Office – Climate Zone 4C (Seattle, Washington)



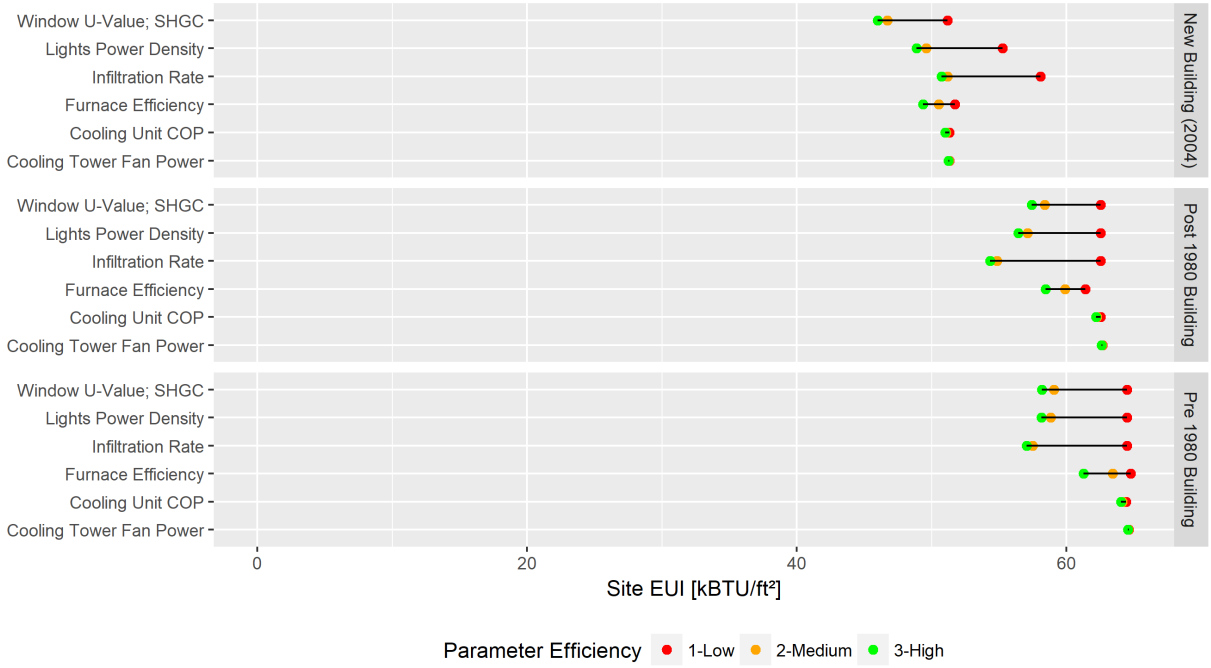
Large Office – Climate Zone 5A (Chicago, Illinois)



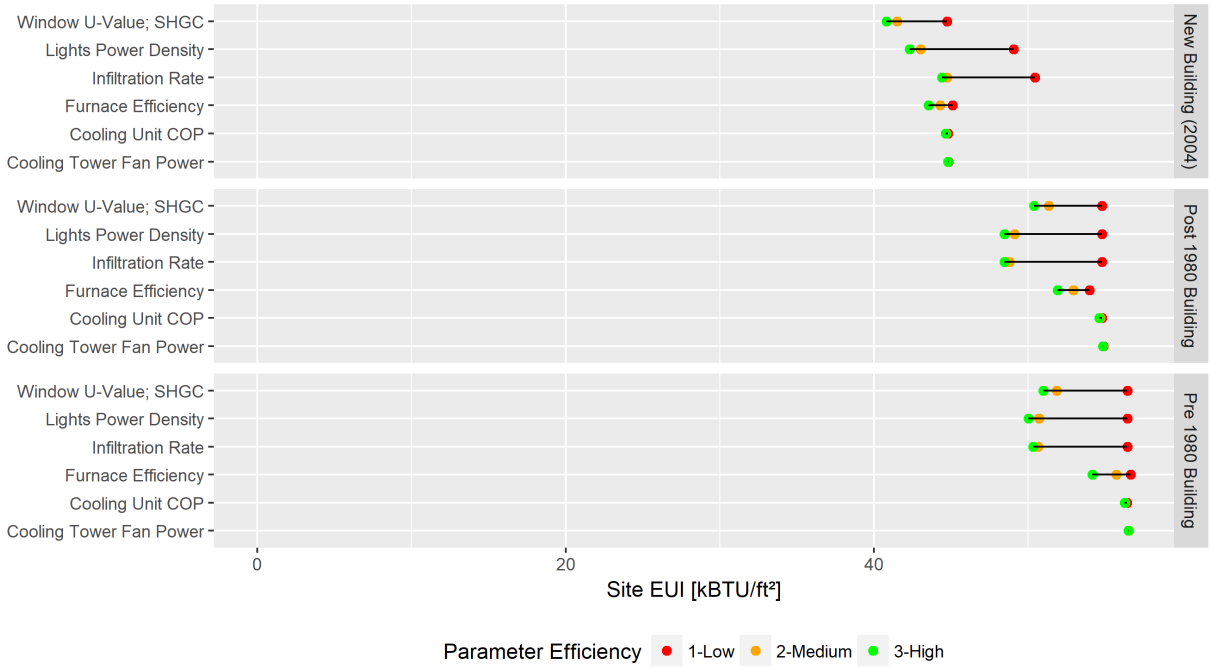
Large Office – Climate Zone 5B (Boulder, Colorado)



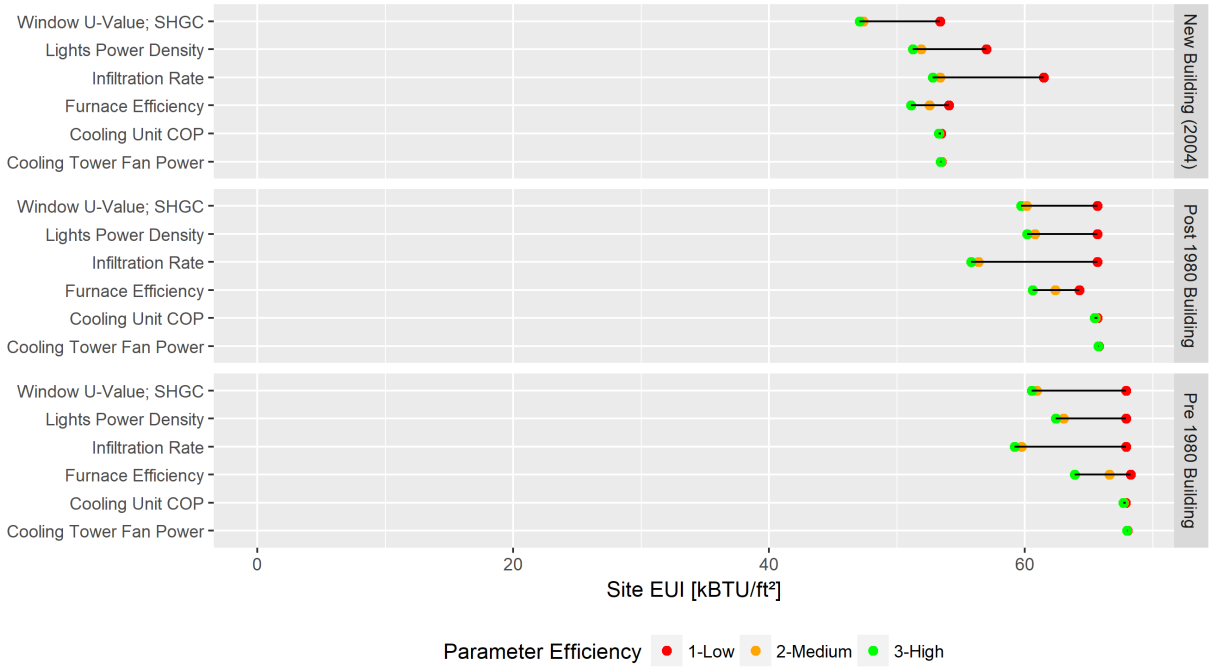
Large Office – Climate Zone 6A (Minneapolis, Minnesota)



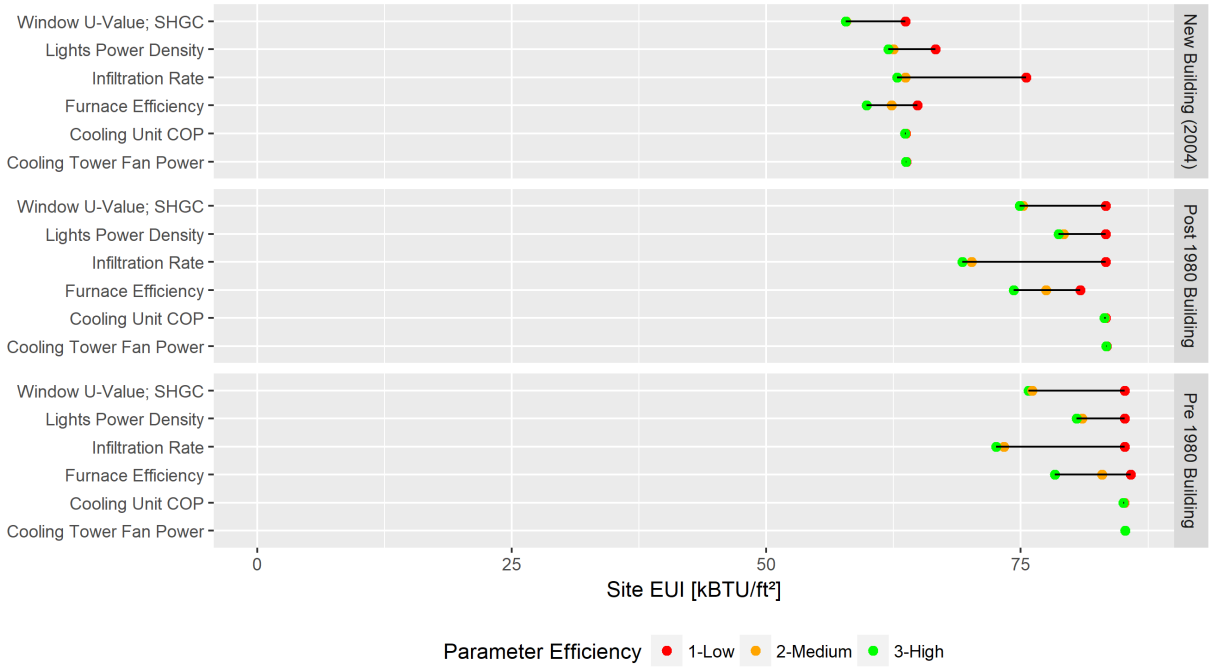
Large Office – Climate Zone 6B (Helena, Montana)



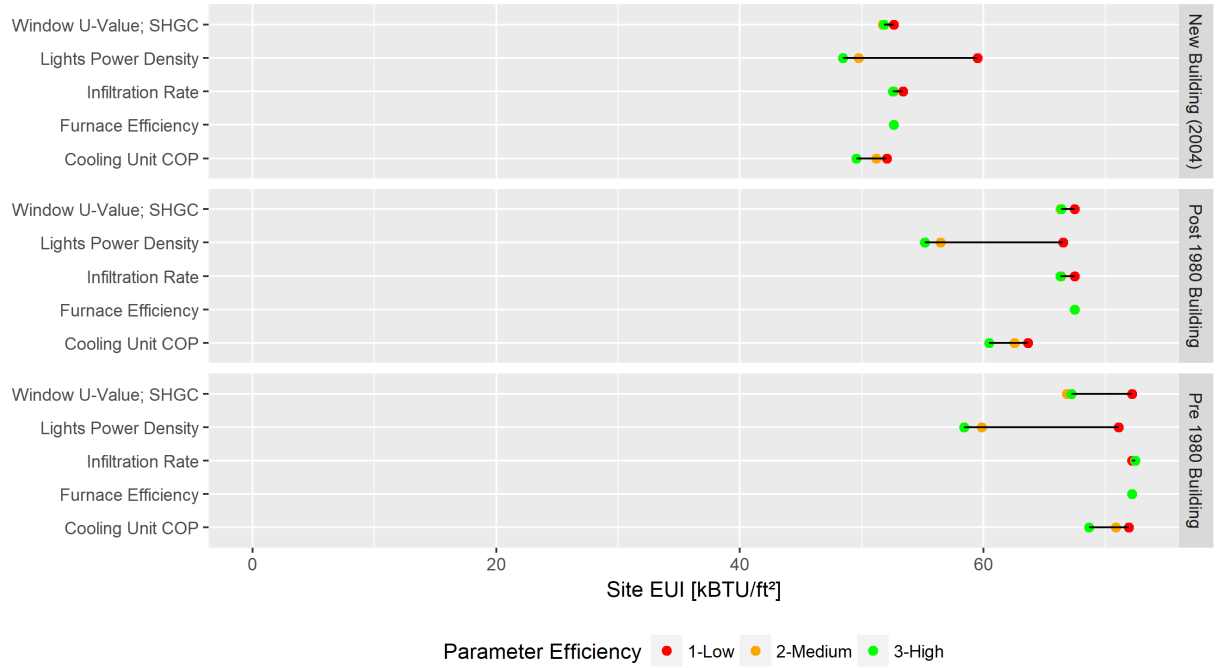
Large Office – Climate Zone 7A (Duluth, Minnesota)



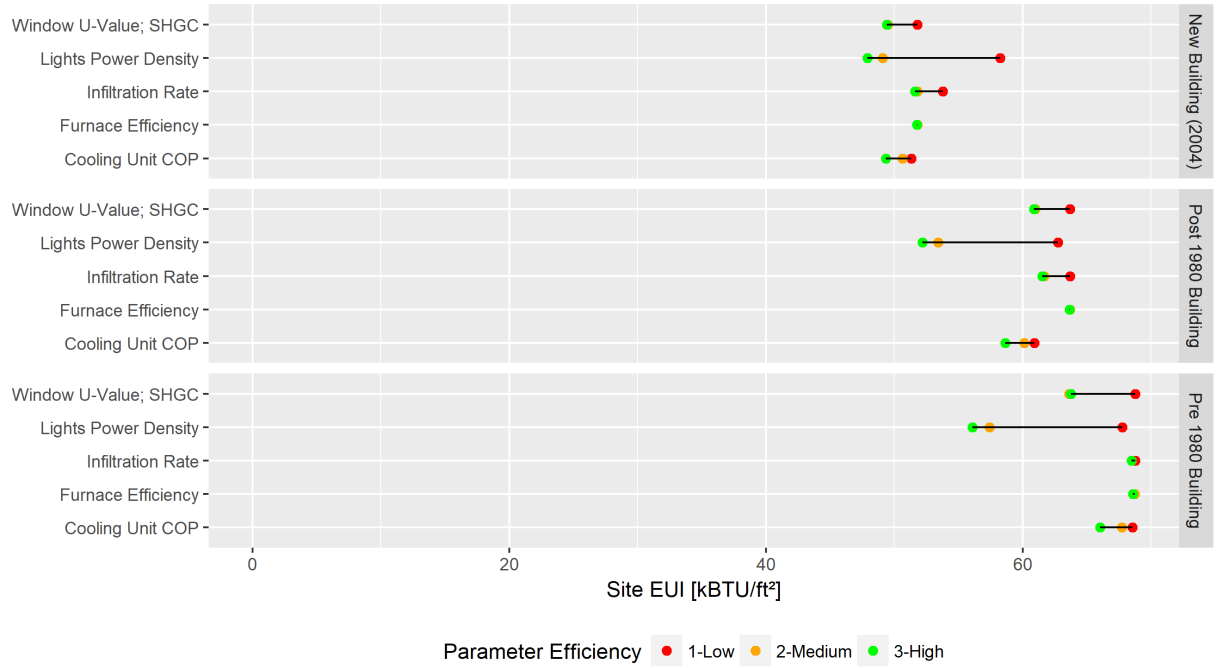
Large Office – Climate Zone 8A (Fairbanks, Alaska)



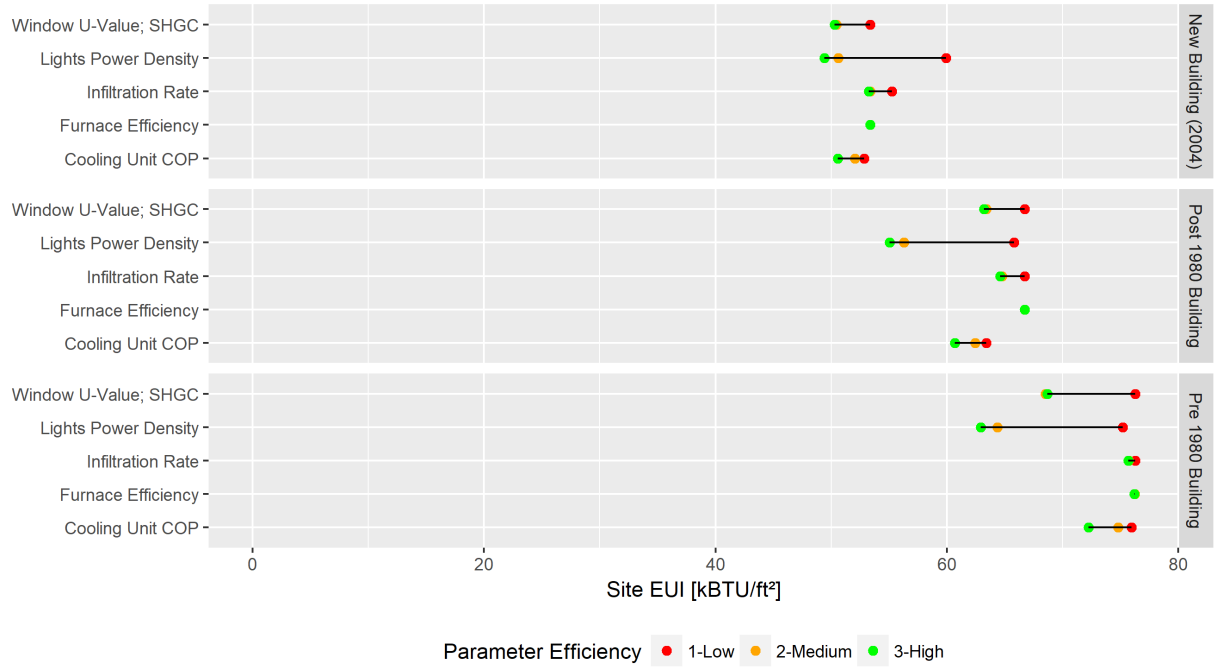
Medium Office – Climate Zone 1A (Miami, Florida)



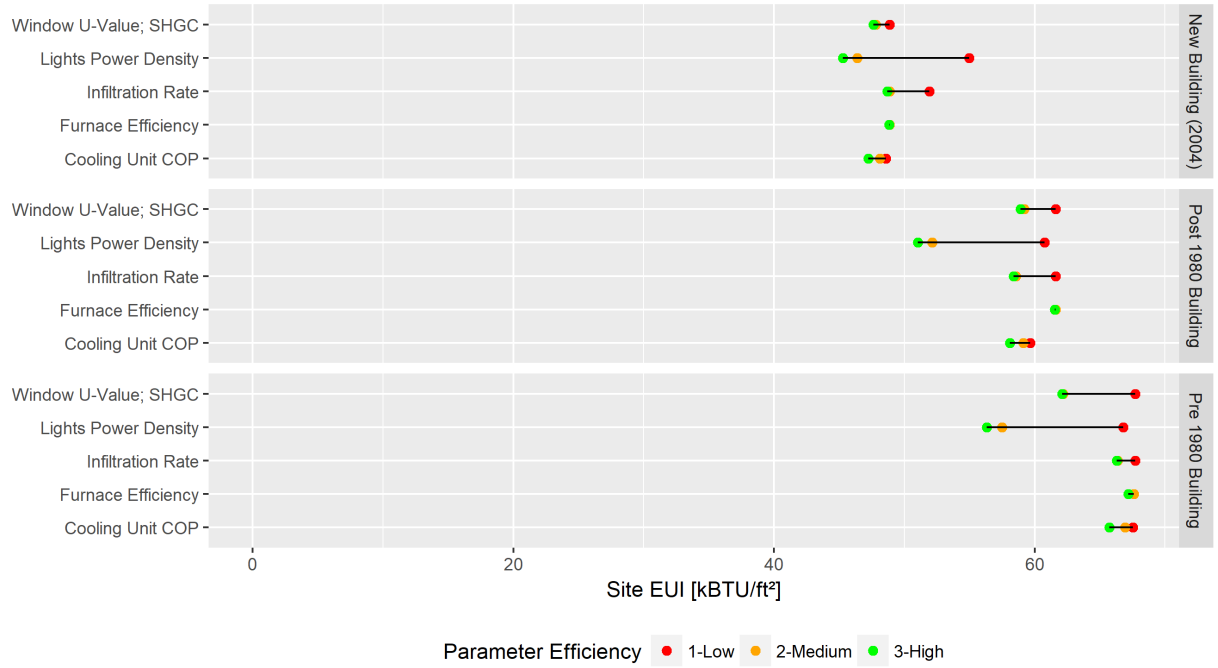
Medium Office – Climate Zone 2A (Houston, Texas)



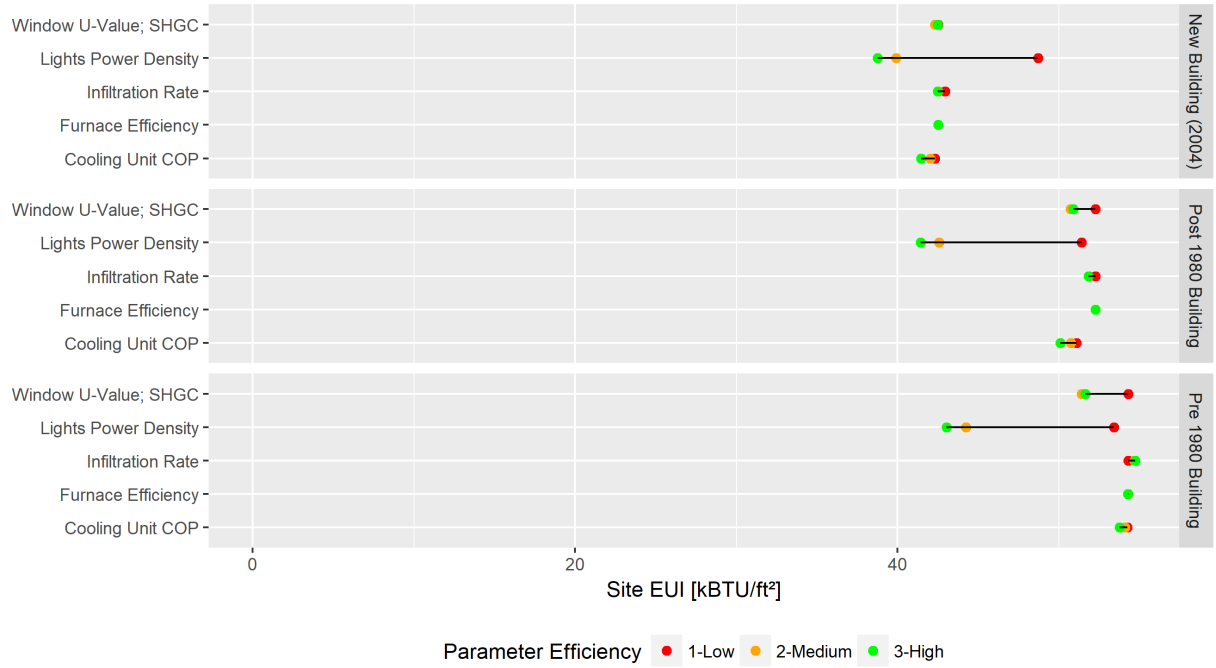
Medium Office – Climate Zone 2B (Phoenix, Arizona)



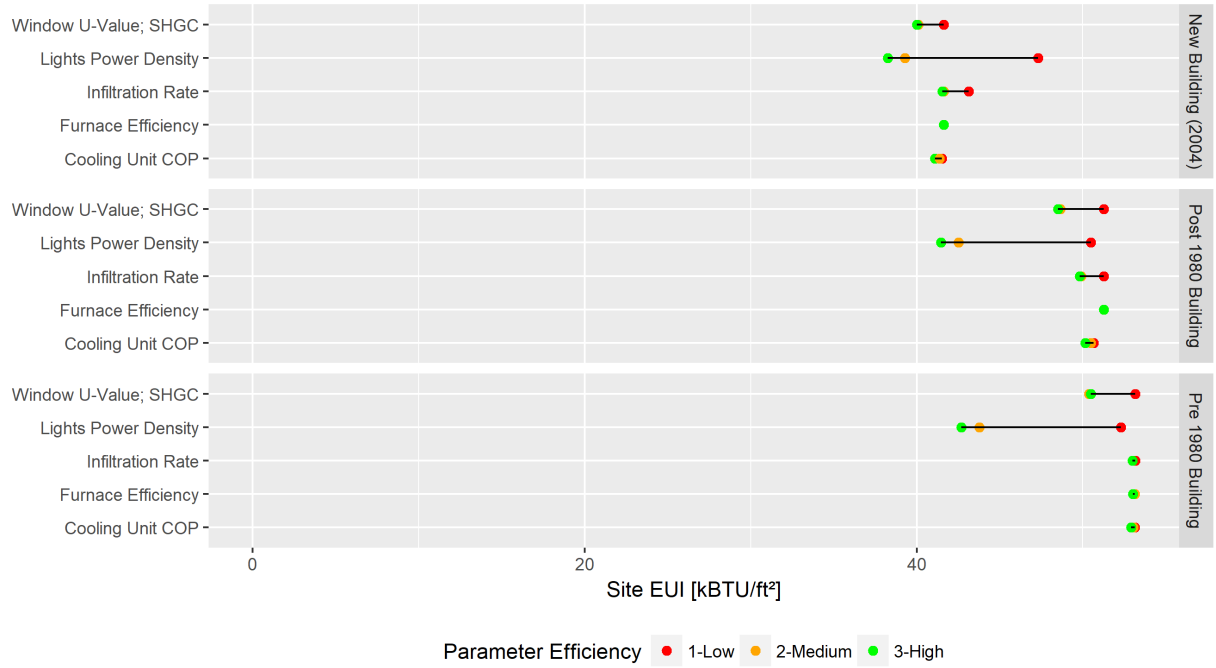
Medium Office – Climate Zone 3A (Atlanta, Georgia)



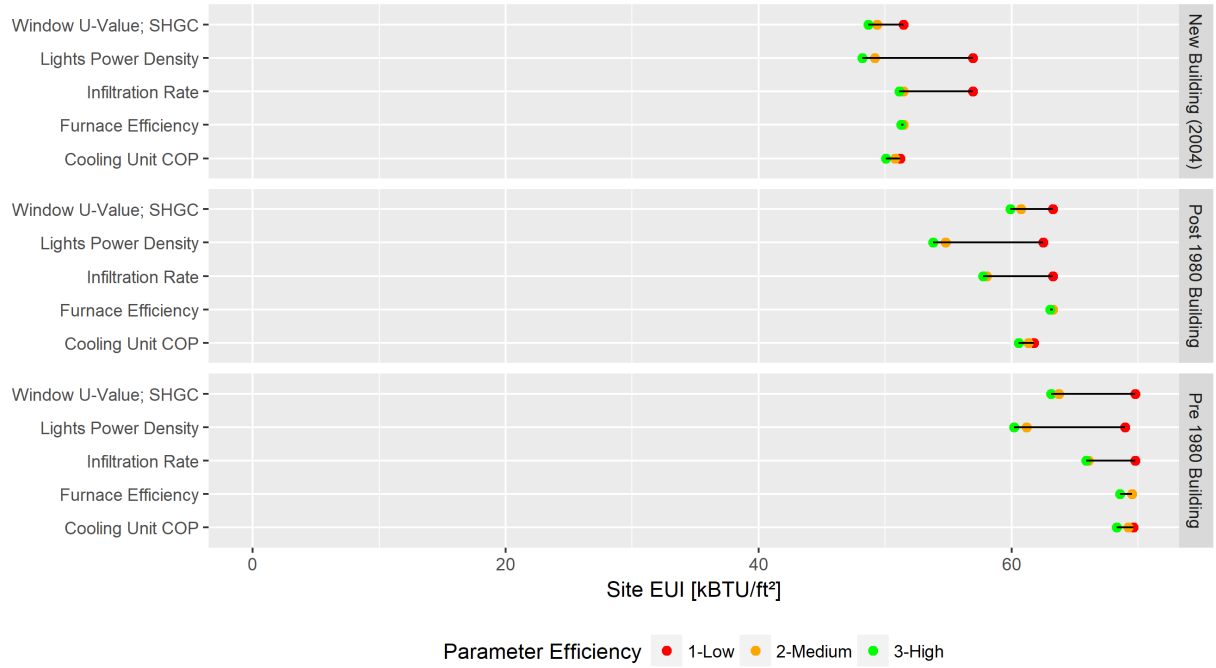
Medium Office – Climate Zone 3B (Las Vegas, Nevada)



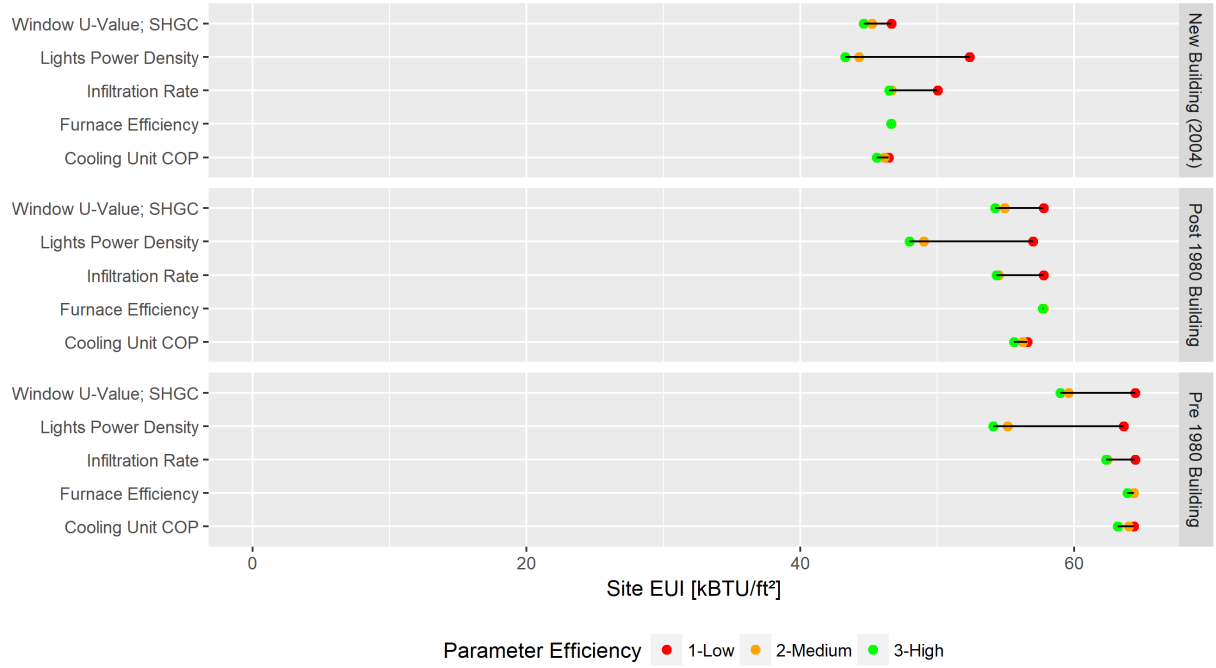
Medium Office – Climate Zone 3C (San Francisco, California)



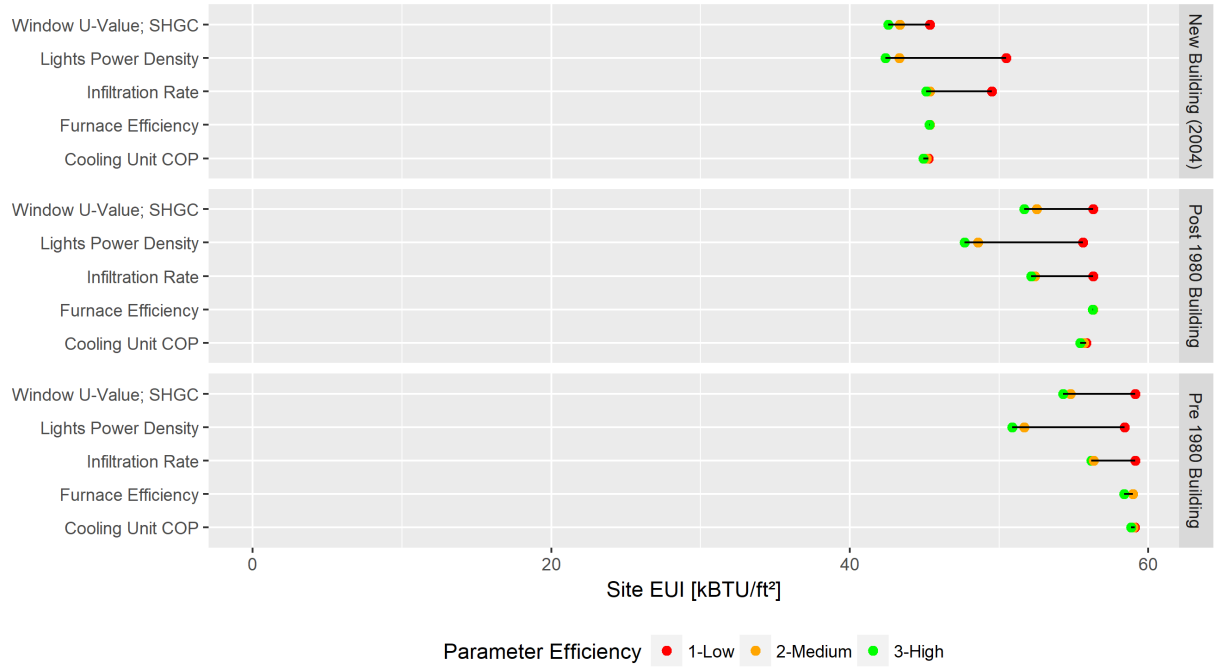
Medium Office – Climate Zone 4A (Baltimore, Maryland)



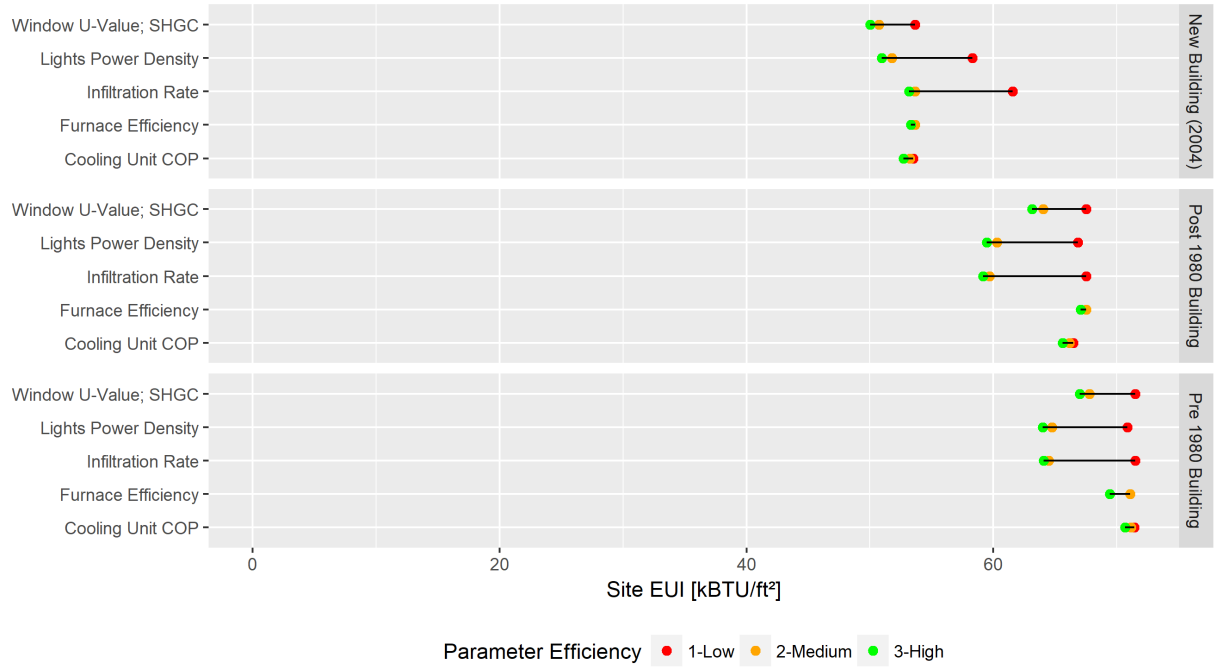
Medium Office – Climate Zone 4B (Albuquerque, New Mexico)



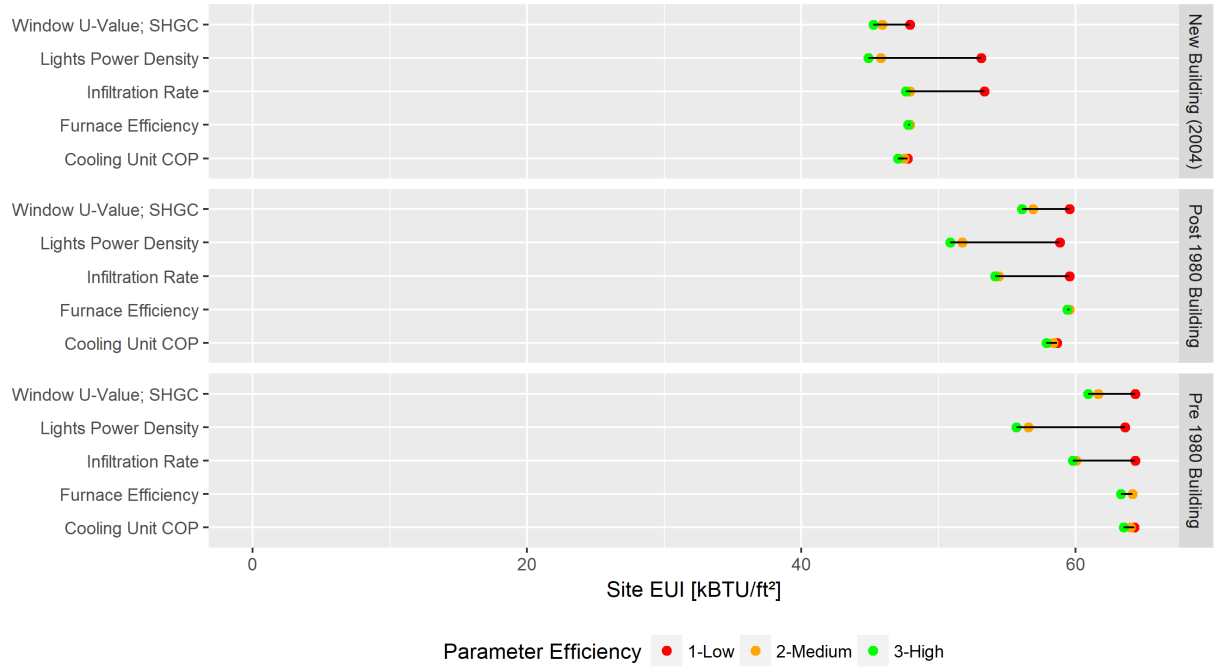
Medium Office – Climate Zone 4C (Seattle, Washington)



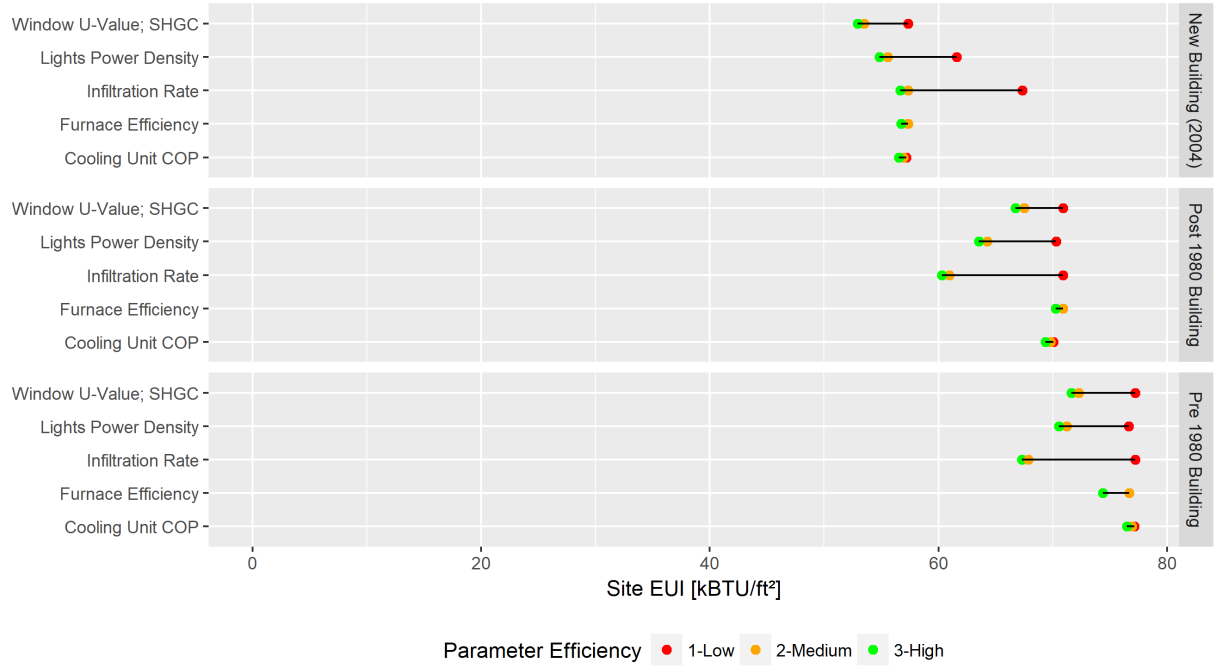
Medium Office – Climate Zone 5A (Chicago, Illinois)



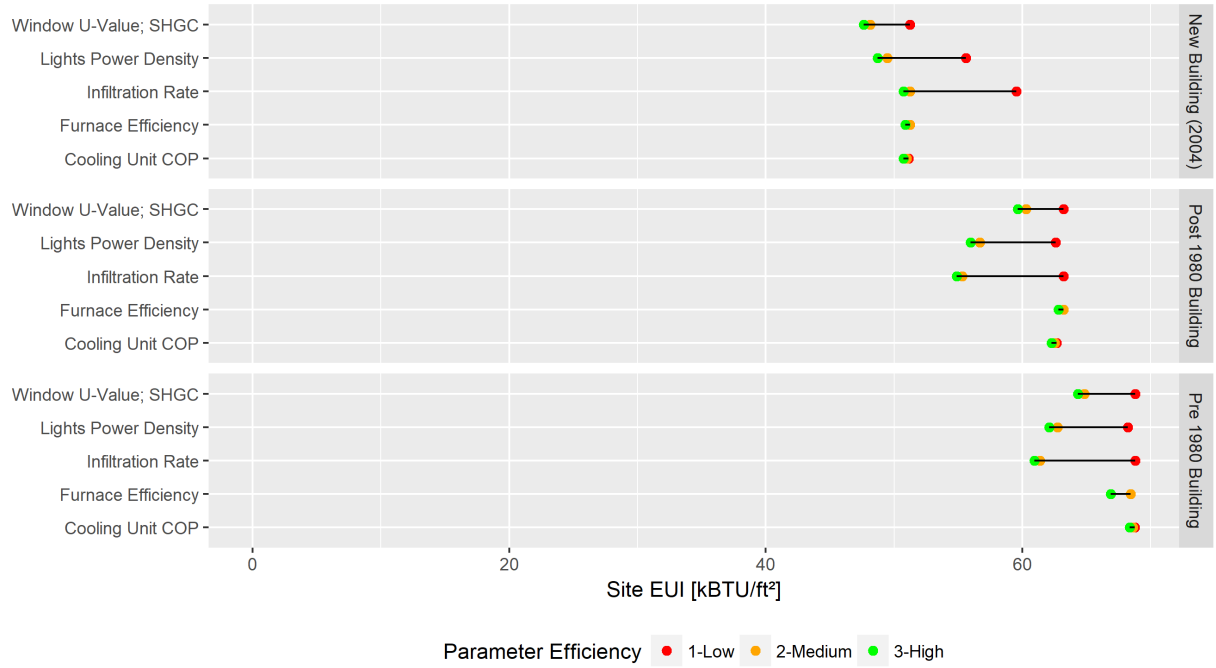
Medium Office – Climate Zone 5B (Boulder, Colorado)



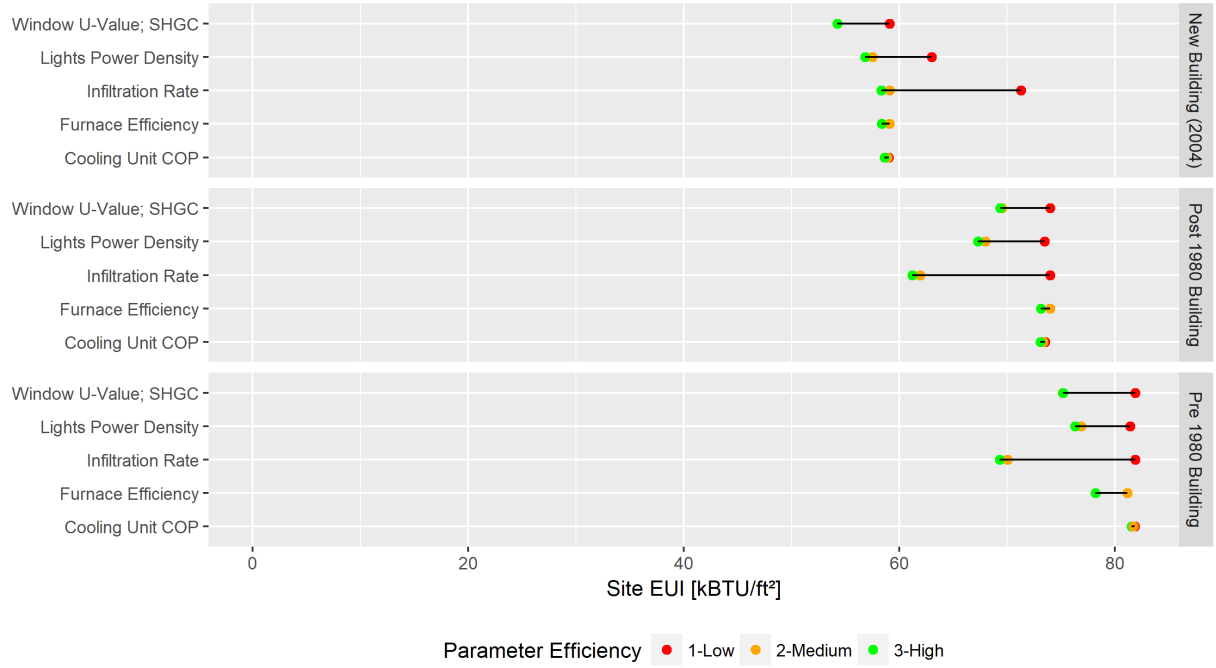
Medium Office – Climate Zone 6A (Minneapolis, Minnesota)



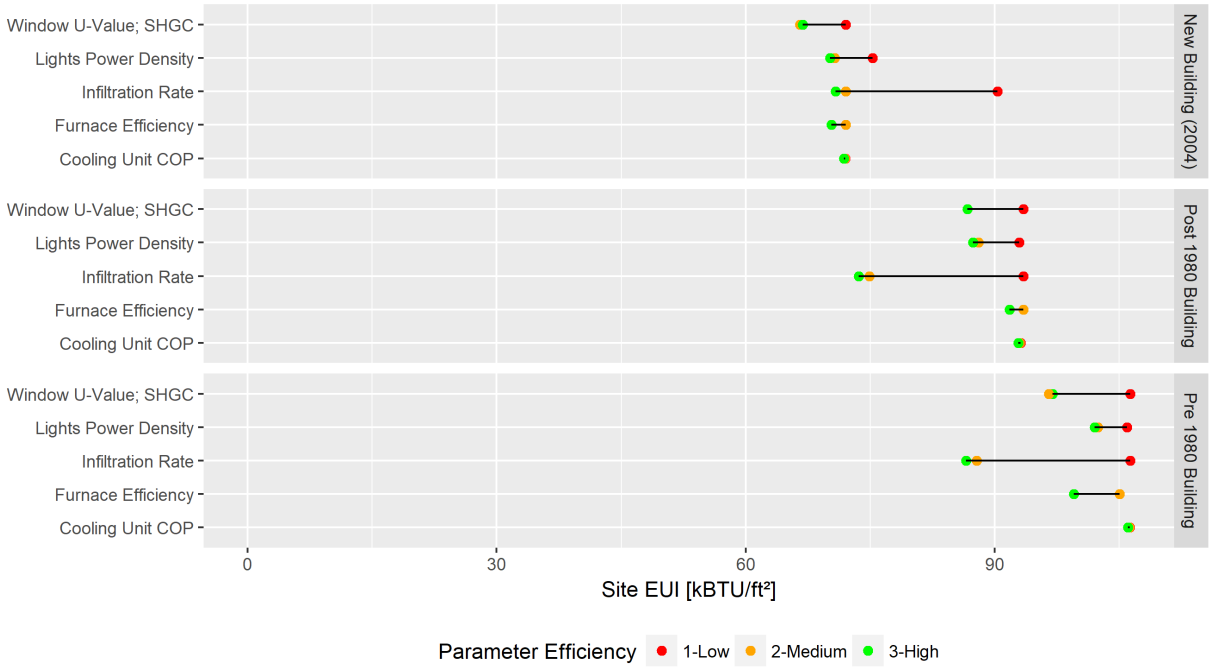
Medium Office – Climate Zone 6B (Helena, Montana)



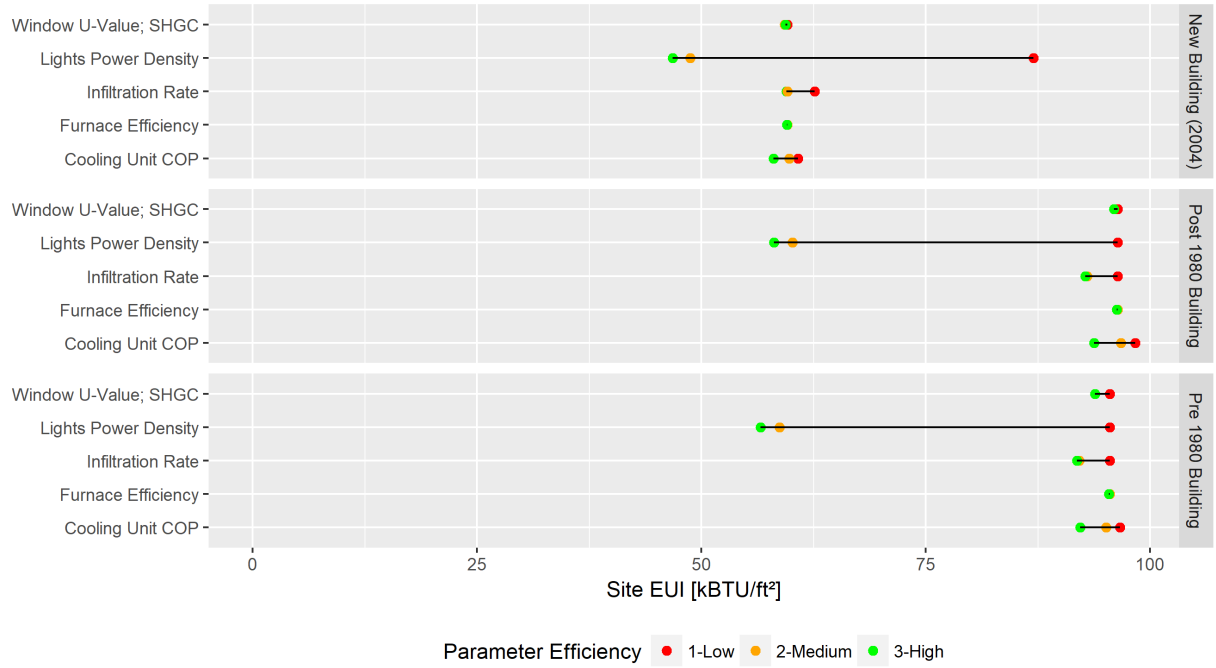
Medium Office – Climate Zone 7A (Duluth, Minnesota)



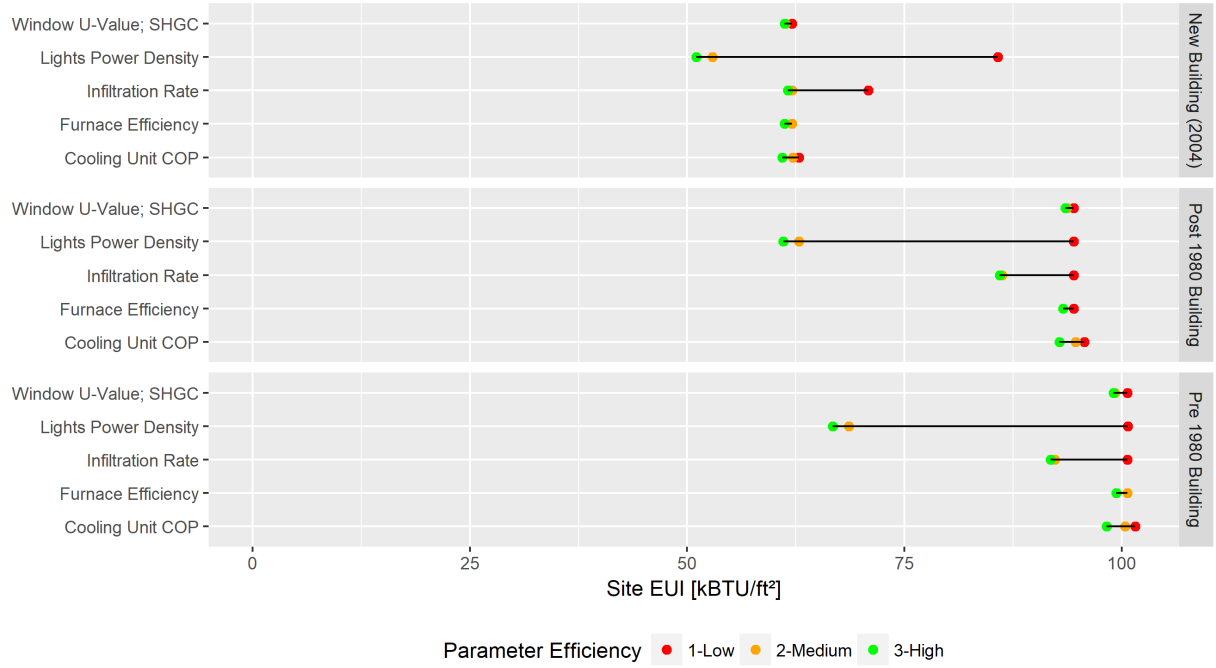
Medium Office – Climate Zone 8A (Fairbanks, Alaska)



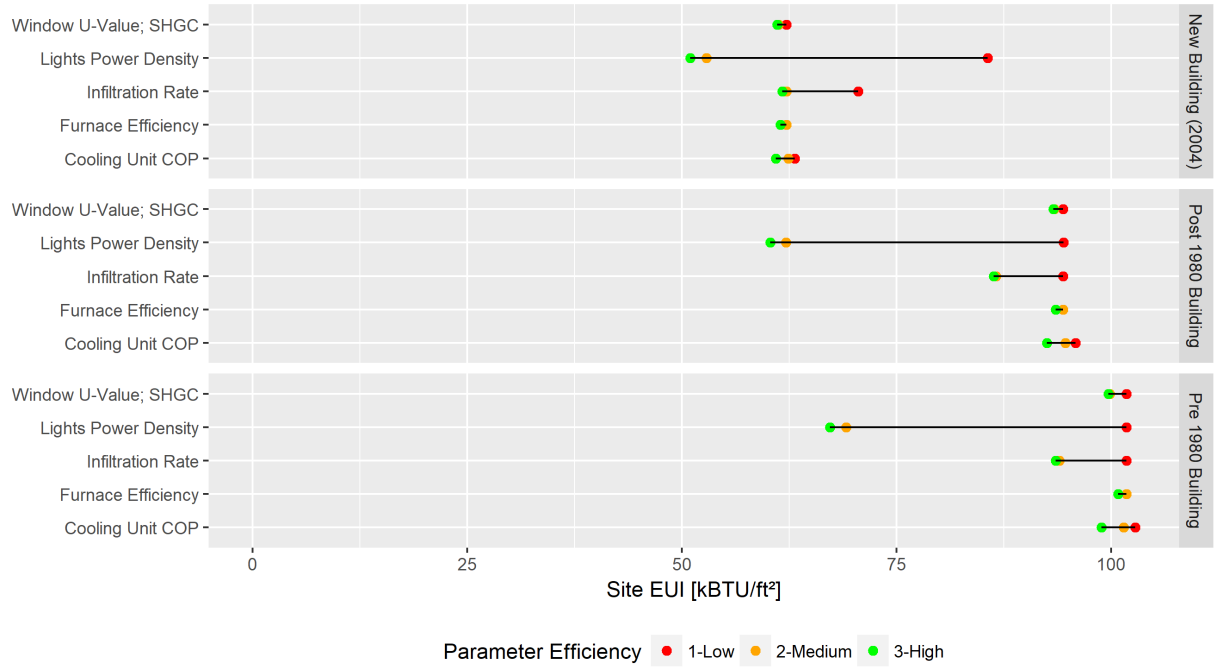
Retail – Climate Zone 1A (Miami, Florida)



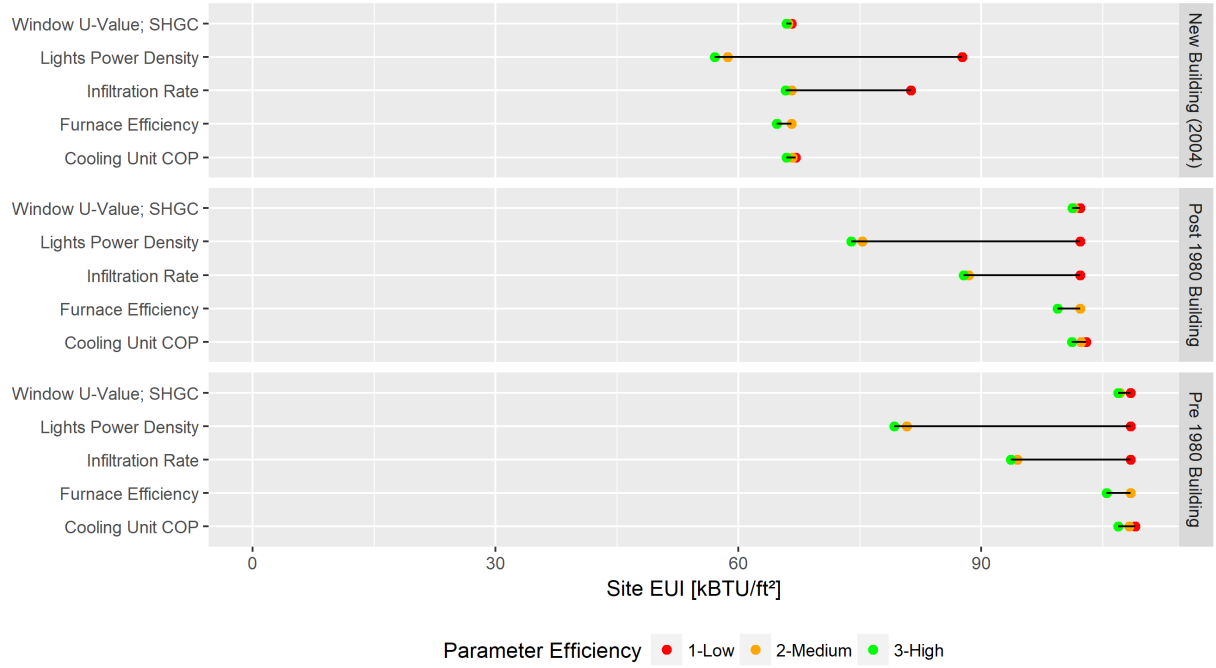
Retail – Climate Zone 2A (Houston, Texas)



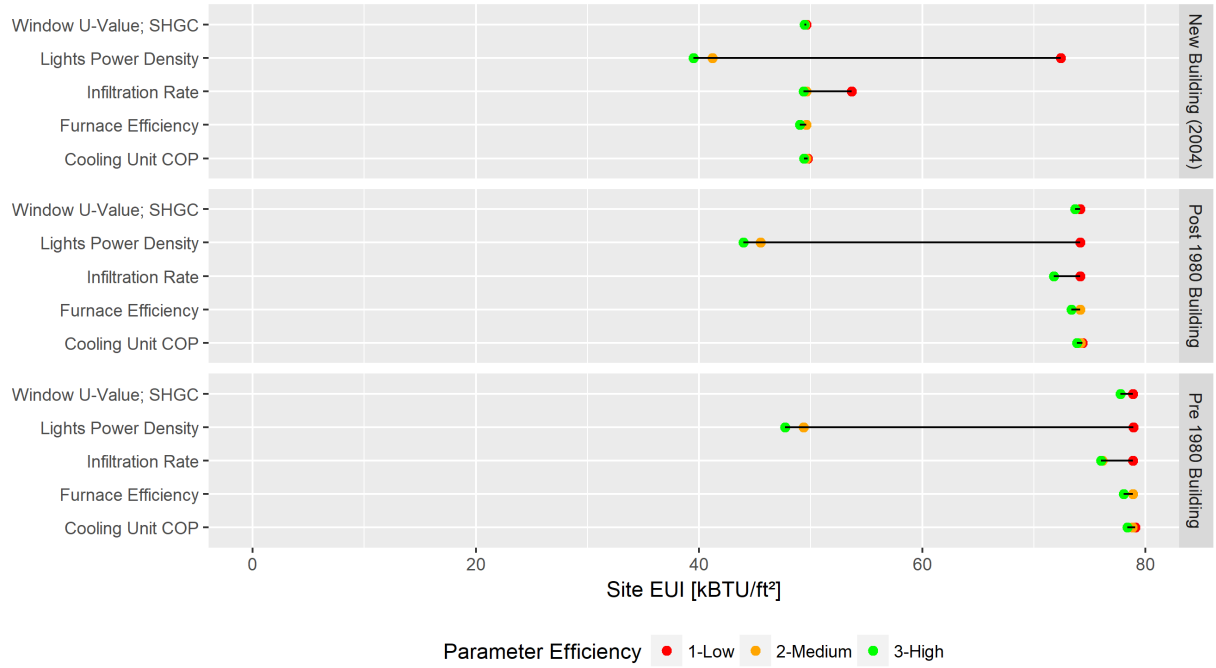
Retail – Climate Zone 2B (Phoenix, Arizona)



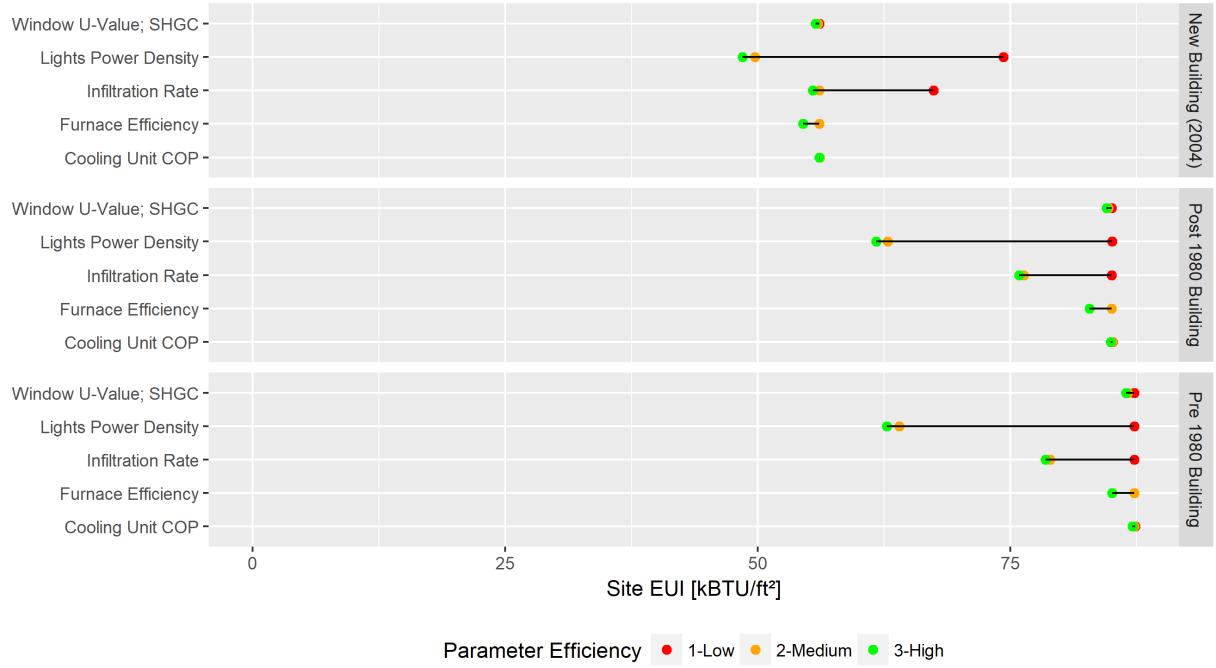
Retail – Climate Zone 3A (Atlanta, Georgia)



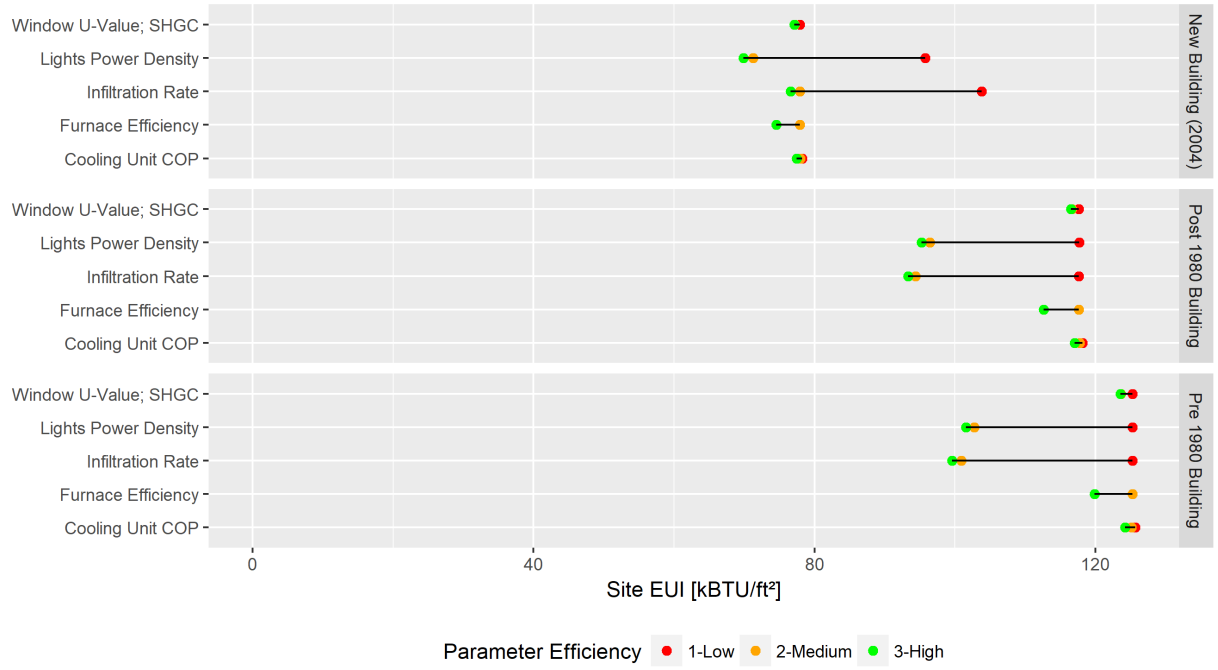
Retail – Climate Zone 3B (Las Vegas, Nevada)



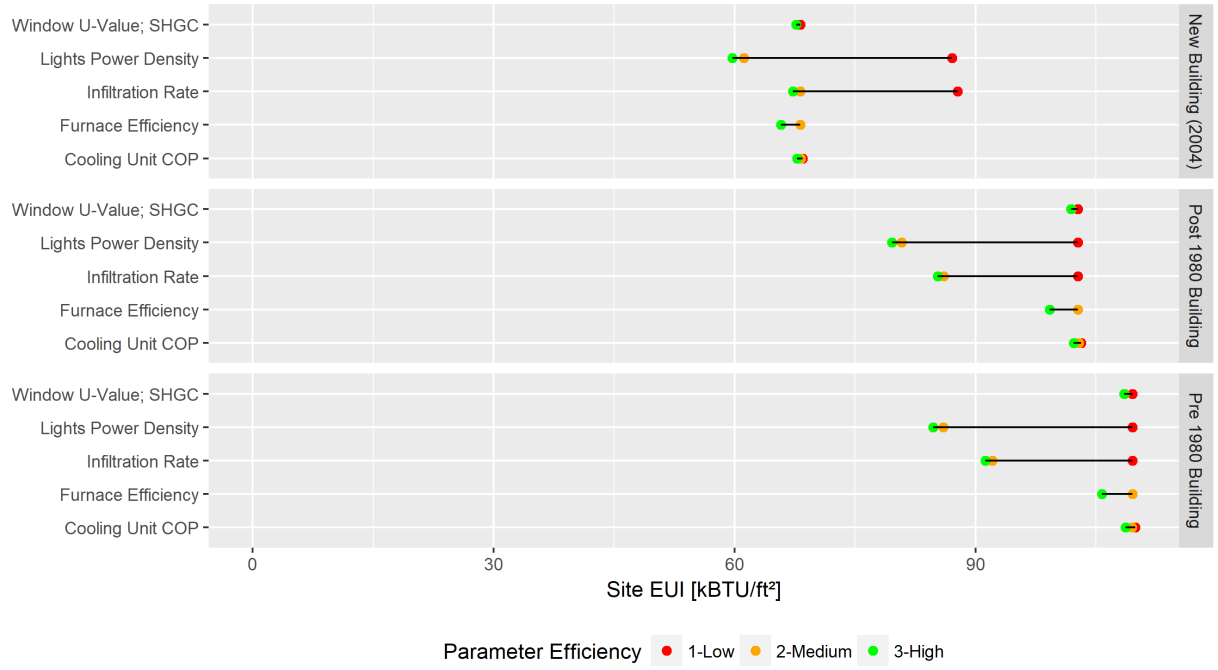
Retail – Climate Zone 3C (San Francisco, California)



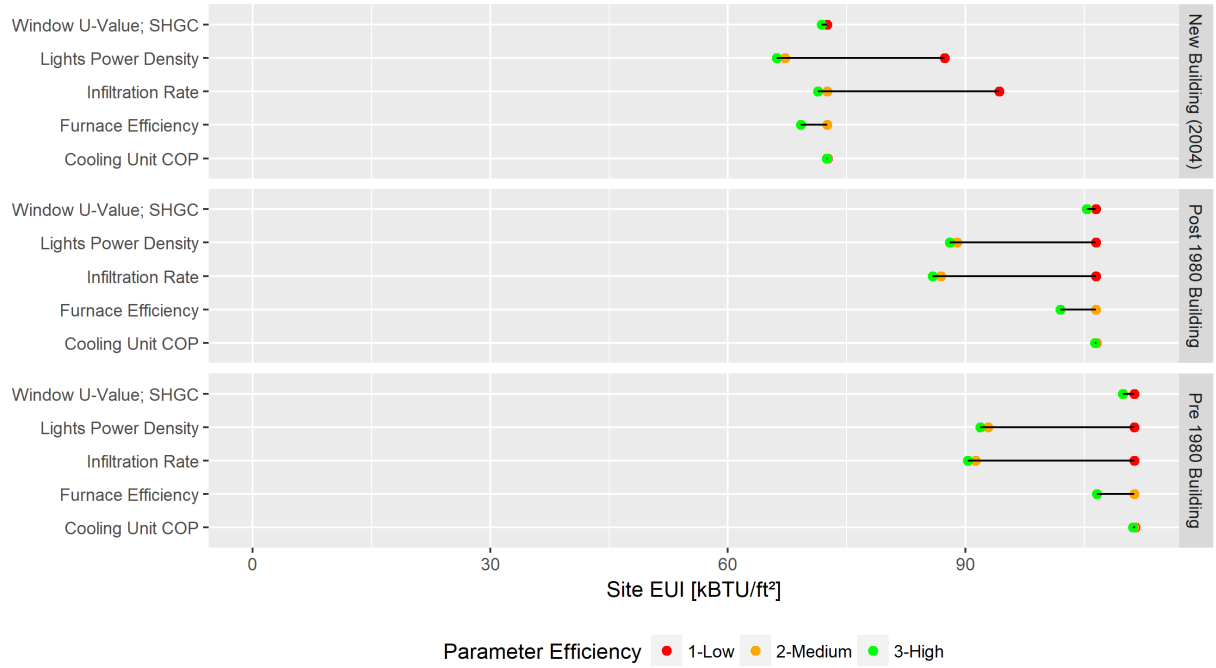
Retail – Climate Zone 4A (Baltimore, Maryland)



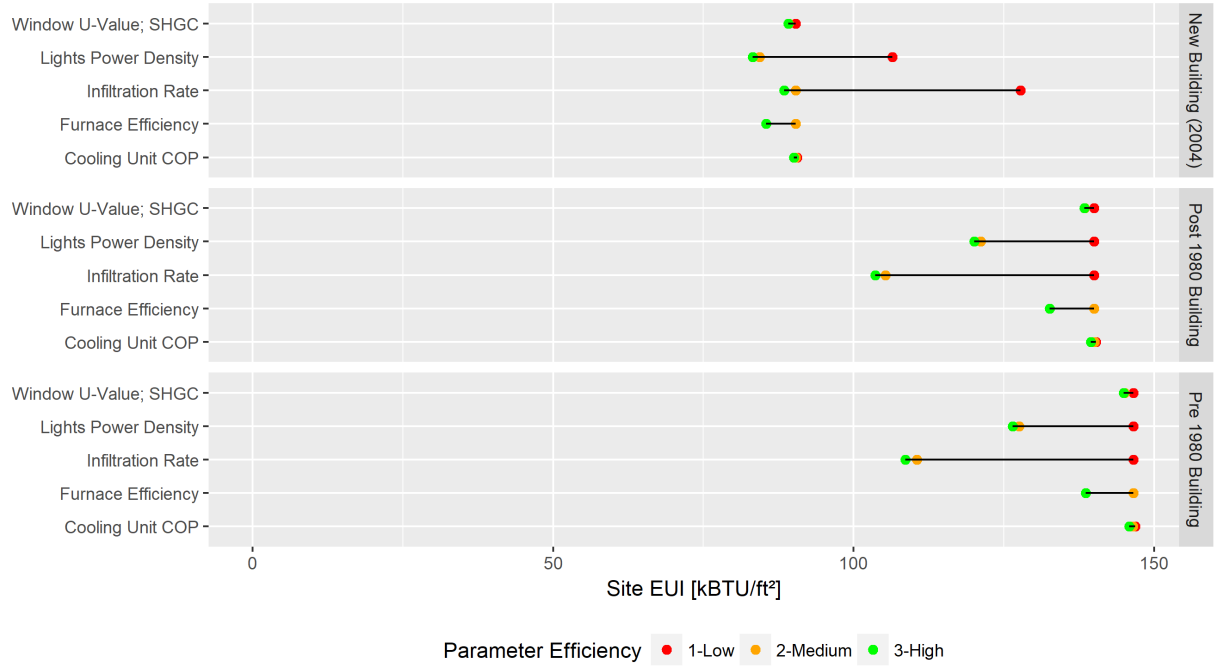
Retail – Climate Zone 4B (Albuquerque, New Mexico)



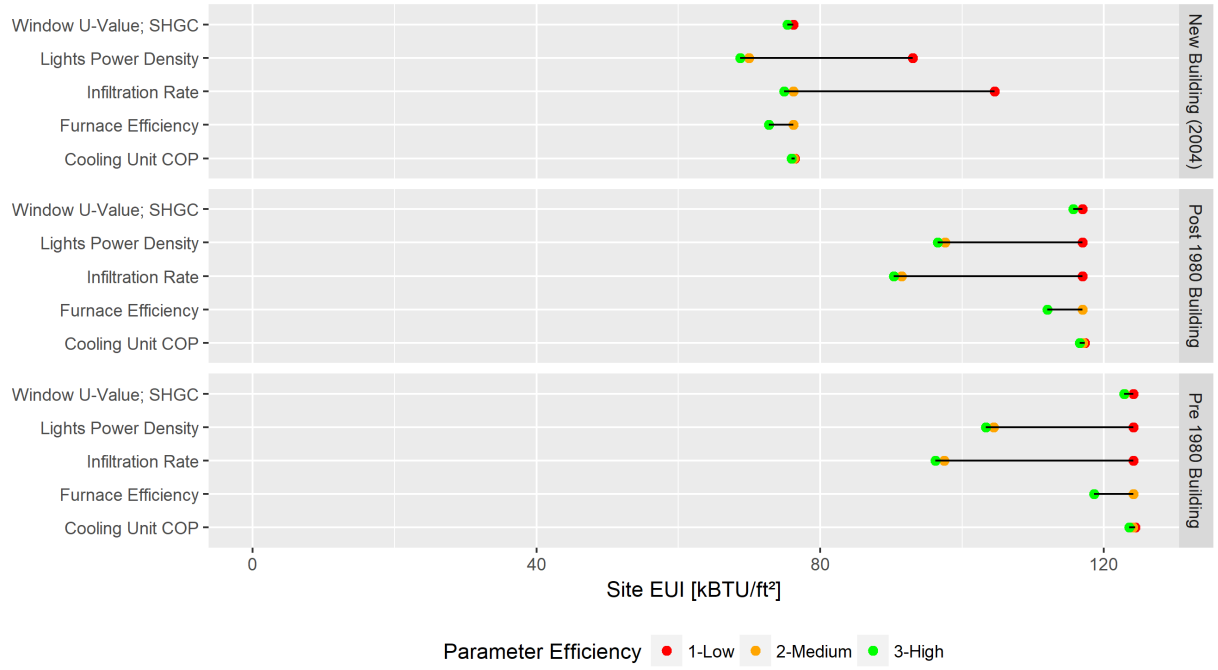
Retail – Climate Zone 4C (Seattle, Washington)



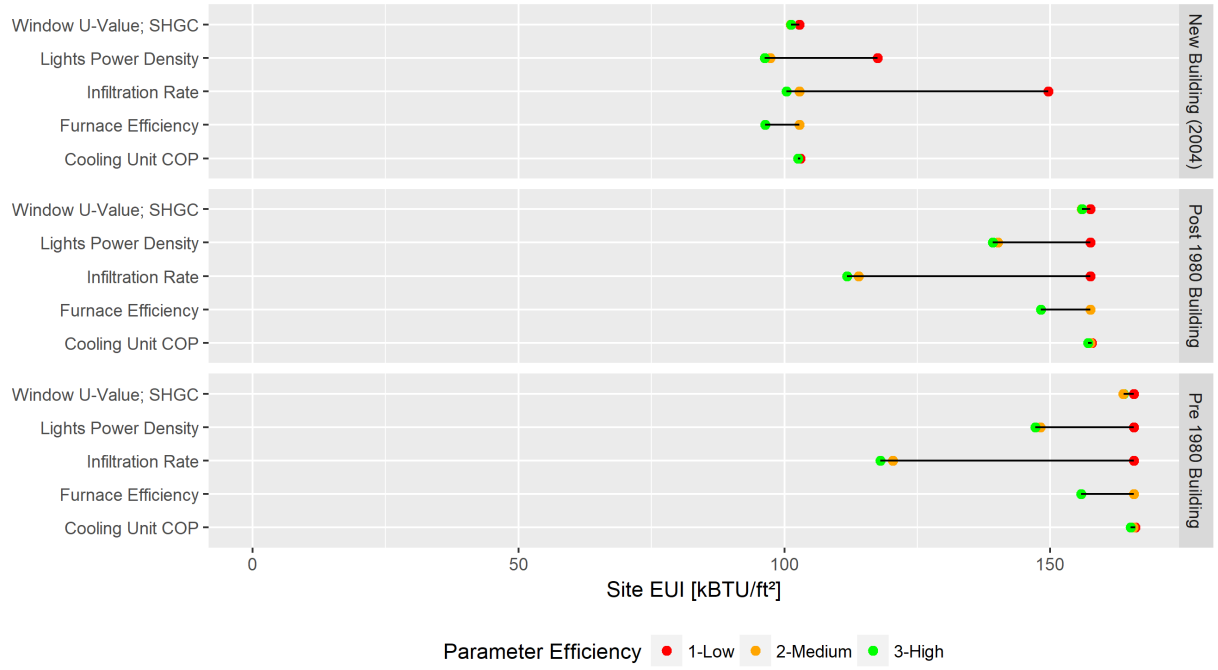
Retail – Climate Zone 5A (Chicago, Illinois)



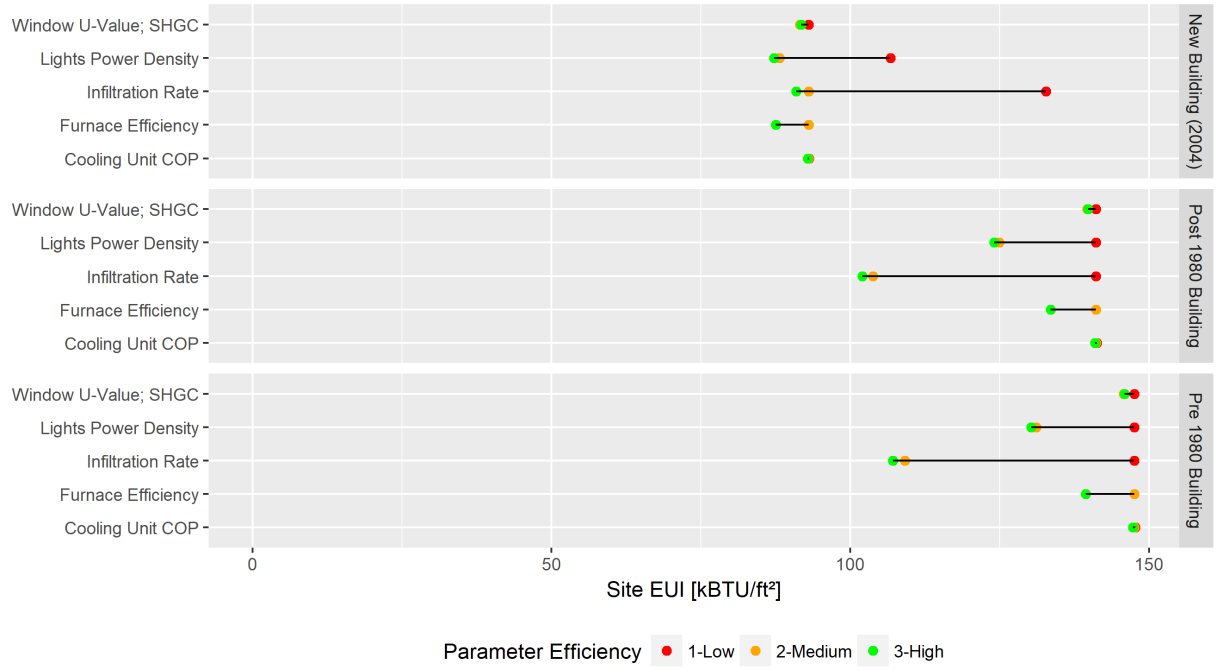
Retail – Climate Zone 5B (Boulder, Colorado)



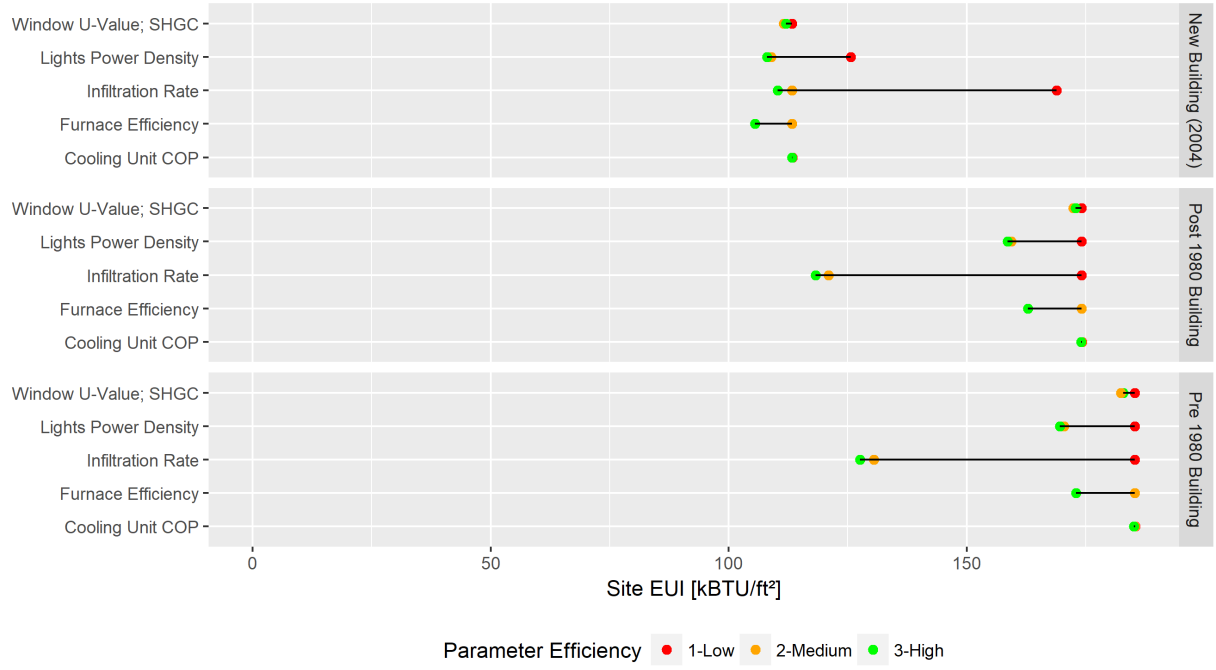
Retail – Climate Zone 6A (Minneapolis, Minnesota)



Retail – Climate Zone 6B (Helena, Montana)



Retail – Climate Zone 7A (Duluth, Minnesota)



Retail – Climate Zone 8A (Fairbanks, Alaska)