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Pacific Northwest
NATIONAL LABORATORY

Relative Credits for Extra Efficiency Code Measures

Technical Brief

January 2019

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U.S. DEPARTMENT OF ENERGY

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Pacific Northwest National Laboratory
Richland, Washington 99352

Contents

Background on Technical Briefs

This study was conducted by Pacific Northwest National Laboratory (PNNL) in support of the U.S. Department of Energy (DOE) Building Energy Codes Program (BECP). BECP was founded in 1993 in response to the *Energy Policy Act of 1992*, and fulfills several key functions specified under federal statute and related to building energy codes. Section 307 of ECPA, as amended, requires DOE to periodically review the technical and economic basis of the voluntary building energy codes, such as the International Energy Conservation Code (IECC) and Standard 90.1, and participate in the industry process for review and modification, including seeking adoption of all technologically feasible and economically justified energy efficiency measures. (42 U.S.C. 6836(b)) Section 304(a) of ECPA, as amended, also directs DOE to review published editions of the IECC and Standard 90.1, and issue a determination as to whether the revised edition would increase energy efficiency in residential and commercial buildings, respectively.

PNNL supports this mission by evaluating concepts being considered for future code updates, conducting technical reviews and analysis of potential changes and their associated impacts, including energy savings analysis, cost-effectiveness analysis, and providing guidance on how changes can be more readily adopted by adopting states and localities. This helps to ensure successful implementation of advancing technologies, construction practices, and related industry standards, and encourages building practices that are proven affordable and efficient.

This technical brief represents a compilation of relevant information on a specified concept. An overview of the concept is presented, followed by supporting technical analysis, related research and recommended code language. Additional context may also be provided, such as known consideration in previous model code development, state code proceedings, or incorporation in existing codes or standards. Each brief is intended as a resource for interested and affected stakeholders, particularly those charged with considering impacts of proposed code updates. Further technical assistance may be available from PNNL to adapt content to the needs of individual states or municipalities, such as specific building types, climate weightings, or utility rates.

Learn more at www.energycodes.gov.

This Revision 1 supersedes the original December 2018 publication.

1.0 Relative Credits for Extra Efficiency Measures

Energy codes have traditionally contained *mandatory* and *prescriptive* items. Mandatory measures must be complied with in all situations while prescriptive measures can be traded with other efficiency measures by following a performance path. Recent editions of the International Energy Conservation Code (IECC) also include extra efficiency measures, and one of these measures must be selected to satisfy an 'additional' efficiency requirement. Such a structure is currently employed in section C406 of the IECC, and similar approaches have been considered for ASHRAE Standard 90.1 as well as state building codes. This approach has the advantage of providing increasing levels of performance, while maintaining flexibility in allowing the designer to optimize the most appropriate technologies and efficiency measures based on the attributes of the project.

1.1 Overall Summary

This technical brief investigates the relative performance of additional energy efficiency measures that are commonly applied in commercial buildings, including a valuation of current IECC-provided options, with the goal of identifying additional approaches that save energy in prominent building types while ensuring equity and maintaining design flexibility. An array of systems and efficiency measures are evaluated, ranging from improved equipment and control strategies, to envelope systems, and onsite renewables. The analysis informs a proposed points-based approach—a structure similar to that currently utilized in the commercial chapter of the IECC, which can be adapted to new technologies, construction practices, and advancing energy-efficiency goals in the future.

The technical analysis was conducted as follows:

- Prototype models are used in the analysis. Their development, and associated climate locations, are described in detail in the quantitative determination[1] and are available for download.[2] Four building prototypes were used to capture the difference between building types:
  - Medium office
  - Primary School
  - Mid-rise Apartment
  - Stand Alone Retail
- EnergyPlus™ was used to evaluate each measure in the four prototypes in all U.S. climate zones, except in cases where there is not a strong interaction with building HVAC systems, where standard engineering calculations were used. This applies to service hot water, renewable energy, and kitchen equipment. Dedicated outdoor air systems (DOAS) savings were estimated rather than modeled, as discussed in the Appendix.
- Using average annual commercial energy prices, cost savings for each measure are calculated as a percentage of building total annual energy cost.

[1] Halverson M, M Rosenberg, W Wang, J Zhang, V Mendon, R Athalye, Y Xie, R Hart, and S Goel. 2014. *ANSI/ASHRAE/IES Standard 90.1-2013 Determination: Quantitative Analysis*. Pacific Northwest National Laboratory, Richland, WA. https://www.energycodes.gov/sites/default/files/documents/901-2013_finalCommercialDeterminationQuantitativeAnalysis_TSD.pdf.

[2] Download from http://www.energycodes.gov/development/commercial/90.1_models.

- The cost percentages are converted to credit points, with the goal of not being exactly equivalent, but to provide approximate relative equivalency between measures. One point is assigned for each 0.25% of building energy cost savings.

The additional efficiency measures save energy by reducing energy use directly or reducing the heating or cooling loads in the building, resulting in lower HVAC energy use. The measure would require different items to be added to construction, depending on the combination of credits selected. The requirements for each measure are discussed under the individual items.

1.2 Technical Considerations

How does the proposed measure compare to what's required in current codes?

The current additional efficiency package options are all considered equal in the 2018 IECC, and any one item must be selected to comply with the extra efficiency provision. However, there is a great deal of variation in the energy savings, as shown in in Figure 1, which compares several of the items in climate zones 4C and 5B. The number preceding the label of each option refers to the IECC C406 section option, for example .2 for section C406.2, HVAC efficiency improvement. In addition, some users of the IECC have expressed difficulty using the HVAC option, indicating that heating efficiency increases specified are not readily available in commercial packaged equipment.

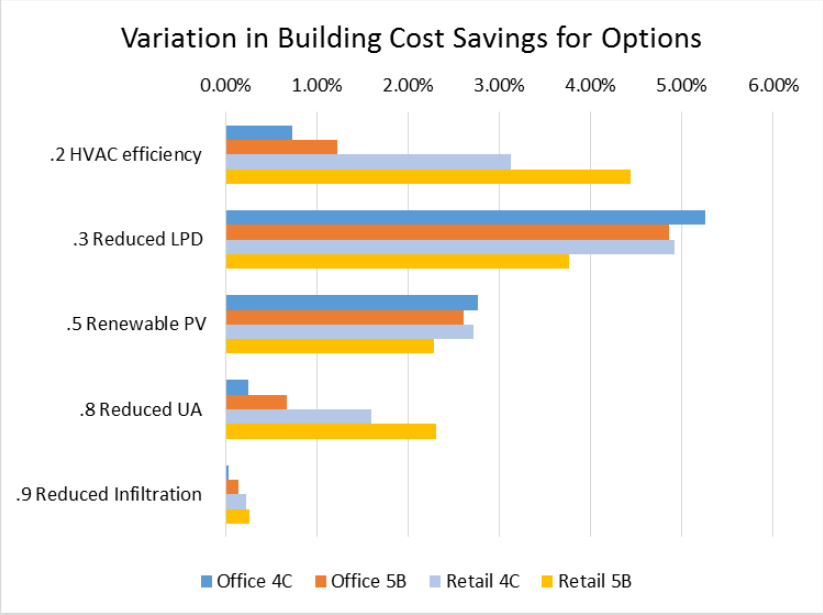

Figure 1. Comparison of selected C406 efficiency options

The tech brief evaluates the different options based on building simulation prototype evaluation, and assigns each item a credit value based on relatively equivalent energy savings. The proposal also separates heating and cooling HVAC efficiency options, as there are different benefits from each of these systems in different parts of the country. There is also a second level of lighting power reduction added for earning additional credits. More options are also added for water heating and efficient kitchen appliances. In addition, the application of the credits to tenant infills in core and shell buildings is clarified.

Why is an energy efficiency credit assignment method superior to other approaches?

The extra efficiency credit approach allows for designer and builder flexibility. While it is slightly more complicated to select multiple items and add up points, in many cases credit would be given for measures that are often included in buildings but not previously accounted for. Furthermore, using points rather than "just pick one" considers the relative value of options and better accounts for the impact of climate. In Figure 2, the credits for measures in the medium office are plotted so the range of savings across measures and climate zones can be seen. The values are based on one credit representing 0.25% savings of total energy cost for the prototype building in the specified climate zone.

The climate zone impact is fairly broad, especially for cooling efficiency and building envelope measures. The spread is also broad for lighting reduction and plug load controls, as the reduced heat load must be made up by the heating system in colder climates, while in warmer climates there is added savings in the cooling system. Assigning the points relative to building energy cost savings rewards measures appropriate to the location of the building, and accounts for benefits more fairly across measures.

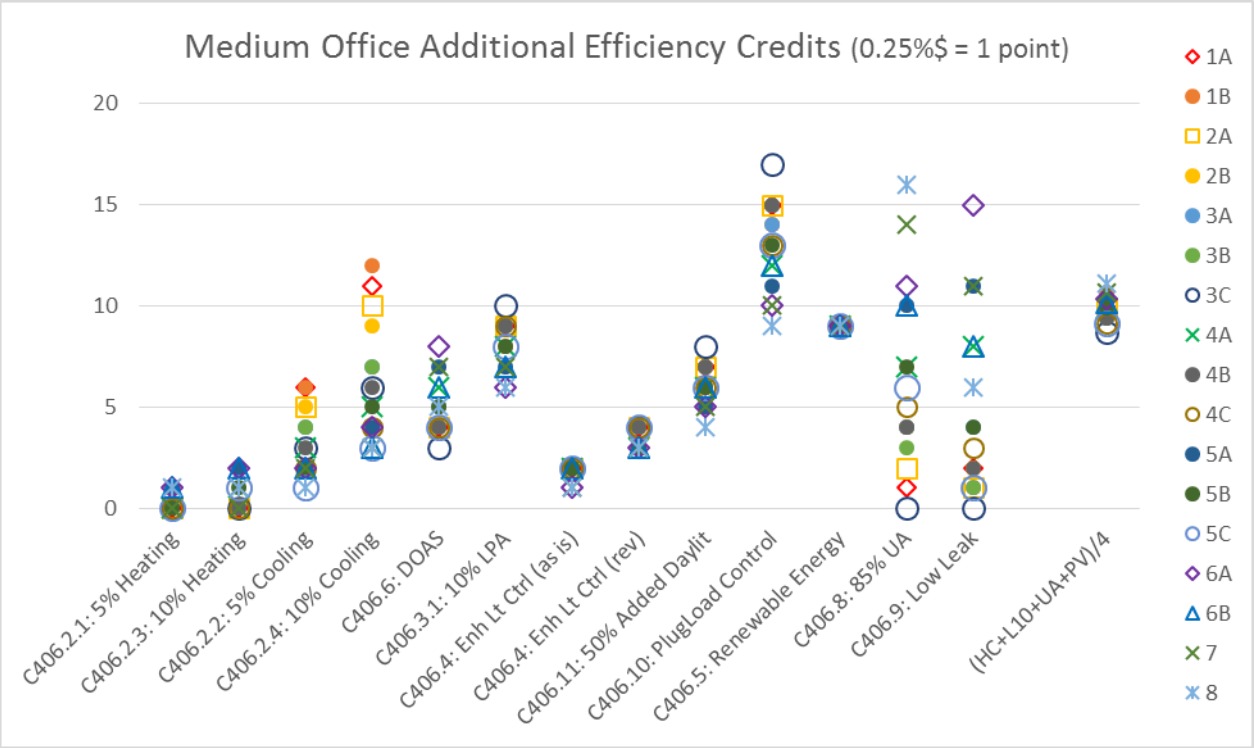

Figure 2. Range of points for medium office efficiency options

The points resulting from averaging four typical C406 measures (10% HVAC, 10% LPA, Renewable and 85% UA) are shown as the last item on the right side of Figure 2. These four average around 10 points across climate zones, while lighting power allowance—a popular option selection—averages around 8 points across climate zones. Selecting 10 points or 2.5% savings of building energy cost as the target of a point-based system makes sense as being slightly ahead or roughly equal to the approach followed in the 2018 IECC. If we compare this 10 credit target to the available points from the existing C406 measures based on averaging available credits across climate zones, we find that offices have 40, apartments have 35, schools have 28, retail has 38, and other buildings have 45. In all cases, the 10 points can be achieved with only two of the measures available. In most cases (excluding apartments) a 15% lighting power

reduction would provide all 10 points needed. If additional C406 measures are adopted, then there would be more points available on average.

What strategies are considered to minimize compliance burdens?

To achieve savings from a combination of multiple measures under the 2018 IECC, the only recourse is to follow the performance path that requires a building model. Including a simple table of points for measures in different building types and climate zones bypasses the need for full performance modeling, which can be expensive relative to savings for smaller buildings. The end result is a performance-based approach that can be applied with the simplicity of a prescriptive approach.

Are there existing codes and standards that take a similar approach?

The outlined approach is based on the structure currently employed in the IECC for commercial buildings. It just shifts from a "pick one" approach to one that selects adequate measures from the options to meet a required point level. It is also similar to packages of measures that have been utilized in both residential and commercial energy codes, particularly in the Pacific Northwest. The Washington code has successfully used such a structure to balance energy performance, design flexibility, and evolving technologies.

1.3 Energy and Cost Impacts – General Approach

Energy Savings: A general description of the energy savings rationale is discussed for each existing and new measure. An analysis of energy impact is documented in the appendix, and the results are assigned in the energy efficiency credit point tables. More detail on the energy savings analysis is presented in the Appendix.

Cost Impact: The current proposal does not require more investment, but rather expands existing options permitted under the 2018 IECC. The intention is to promote relative savings equity amongst current options, and identify additional options to increase flexibility and more effectively utilize new technologies and construction practices. There is not expected to be an increased cost, as several of the evaluated options are included in current code. In some cases, costs may be reduced, as the outlined approach provides partial credit for selected items as well as credit for items that may have previously been included in the building design without credit. Costs, and cost effectiveness, are not evaluated for individual measures due to the vast number of potential combinations amongst building types, climates, and selected options. Actual costs will vary based on the items selected by the building designer—architects, engineers, and other involved trades—based on the needs and goals of the individual project.

2.0 Extra Efficiency Measure Credits

The additional efficiency measure credits are addressed in two sets. First, credits for existing 2018 IECC options are addressed as a group, with minor changes or additions. Then extra measures, including both new measures and additional changes to existing measures that are appropriate to consider separately are listed independently, so they can be distinguished from existing requirements and considered by the appropriate consensus processes or adopting jurisdictions. In all cases, savings are shown independently for individual measures.

2.1 Existing 2018 IECC Section C406 measures

The existing measures contained in IECC Section C406 are addressed together. Some minor adjustments are made to enhance flexibility, as discussed under sample code language.

2.1.1 How Energy is Saved

Each measure impacts one or more building performance parameters. The specific parameter changes that are made to EnergyPlus™ models or engineering calculation methods are included for each measure in the Appendix. The current IECC C406 items save energy in the following ways:

- **More efficient HVAC heating performance** (C406.2) saves energy by improving the heating or cooling system efficiency. The current measure requires a 10% increase in both heating and cooling efficiencies. This measure would be modified to provide separate credits by end use and acknowledge two levels of efficiency improvements, as outlined below:
  - Medium efficiency HVAC heating performance (C406.2.1) is a 5% improvement in efficiency over the existing minimum requirement.
  - Medium efficiency HVAC cooling performance (C406.2.2) is a 5% improvement in efficiency over the existing minimum requirement.
  - High Efficiency HVAC heating performance (C406.2.3) is a 10% improvement in efficiency over the existing minimum requirement.
  - High Efficiency HVAC cooling performance (C406.2.4) is a 10% improvement in efficiency over the existing minimum requirement
- **Reduced lighting power 10%** (C406.3) saves energy by reducing the allowed lighting power installed in the building. This results in a direct reduction of lighting energy use and also reduces cooling energy use. There is some increase in heating energy use in some climates to offset the reduction in heat from lighting, but the overall energy use goes down. This option would be modified by adding the option to get more credits when reducing lighting power by more than 15%.
- **Enhanced lighting controls** (C406.4) saves energy by reducing occupancy sensor and daylight responsive control area size so that control can be more responsive to localized conditions and needs. Savings can also be achieved from individual occupant dimming control. With the required individual addressability of luminaires, there is a potential for specific area tuning, although the current language does not explicitly require tuning.
- **On-site supply of renewable energy** (C406.5) saves energy by replacing a portion of conventional metered energy sources with renewable sources such as photo-voltaic panels or thermal solar for space or service water heating. Based on the attributed savings relative to other measures, the required level of renewable energy is reduced and the flexibility to increase the renewable energy for more credits is included.
- **Dedicated outdoor air system**: (C406.6) saves energy by potentially reducing fan energy in variable air volume systems and adding energy recovery ventilation systems where they are not required under Section C403.7.4.
- **High-efficiency service water heating** (Section C406.7) saves energy by reducing the energy used to heat service hot water. The current energy recovery measure is adjusted to a lower share of water heating to better balance the points with other credits. In addition to the current energy recovery measure, this option would be expanded by adding two more service water heating options:
  - Heat pump water heaters where electric resistance water heaters are allowed.

  - Higher efficiency gas water heaters.

- **Enhanced envelope performance** (C406.8) saves energy by reducing the heat loss and gain in a building through increased insulation or improved fenestration in the building envelope. This reduces building HVAC loads and results in less energy used for heating and cooling.
- **Reduced envelope air infiltration** (C406.9) saves energy by requiring building leakage testing and an improved limit for leakage below what is typically achieved either with the optional testing or based on the material air barrier method. A lower leakage rate results in less infiltration of outside air that needs to be heated or cooled to maintain comfort conditions.

2.1.2 Sample Code Language

In the suggested code language, changes are made to allow for the following:

- The requirement for selecting one item is replaced by a requirement to achieve 10 energy efficiency credits. Each credit is equal to 0.25% of building energy cost, so the requirement is to save about 2.5% of the building energy cost.
- Rather than just a list of options to choose from, the options describe what each credit requires and tables are provided that list the available energy efficiency credits by building type and climate zone.
- The requirements related to tenant infills of core and shell buildings are clarified so that when buildings are completed under multiple permits, the extra efficiency requirements are properly carried out.
- For the HVAC equipment efficiency improvement, heating and cooling are separated into discrete credits and efficiency levels are included for both 5% and 10% credits.
- An alternative prorated credit is made available for lighting power reductions greater than 15%.
- Based on comparison with other measures, the required level of renewable energy is reduced and the flexibility to increase the renewable energy for more points is included.
- The existing service hot water recovery option is reduced from 60% to 30% of annual water heating use, to better align this high efficiency option with others. When service water heat recovery is required elsewhere (Section C403.9.5), the amount is reduced from 100% to 70% of annual water heating use, as this doubles the 35% temperature rise requirement in C403.9.5.
- Two service hot water options are added: high efficiency gas water heaters and heat pump water heaters.

Sample code language is outlined below based on the current 2018 IECC. Similar language can also be adapted to state and local codes that are based on the IECC or contain similar provisions. Similar concepts could also be applied to ASHRAE Standard 90.1.

SECTION C406
ADDITIONAL EFFICIENCY REQUIREMENTS ~~PACKAGE OPTIONS~~

C406.1 Additional Energy Efficiency Credit Requirements. New b~~B~~uildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5). Where a building contains multiple use groups, credits from each use group shall be weighted by the floor area of each group to determine the weighted average building credit. ~~comply with one or more of the following:~~

~~1. More efficient HVAC performance in accordance with Section C406.2.~~
~~2. Reduced lighting power in accordance with Section C406.3.~~
~~3. Enhanced lighting controls in accordance with Section C406.4.~~

~~4. On-site supply of renewable energy in accordance with Section C406.5.~~
~~5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.~~
~~6. High-efficiency service water heating in accordance with Section C406.7.~~
~~7. Enhanced envelope performance in accordance with Section C406.8.~~
~~8. Reduced air infiltration in accordance with Section C406.9~~

Add Tables C406.1(1) through C406.1(5).
Note: Added tables not shown underlined for clarity.
Note: If needed, use credits for climate zone 1A in 0A and 1B in 0B.

Table C406.1(1) Additional Energy Efficiency Credits for Group B Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% Heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% Cooling	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% Heating	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% Cooling	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3.1: 10% LPA	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4:Digital Lt Ctrl	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: Renewable	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: DOAS	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.1: SWH HR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: SWH NG eff	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: SWH HP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: 85% UA	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Low Leak	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6

Table C406.1(2) Additional Energy Efficiency Credits for Group R and I Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% Heating	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% Cooling	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% Heating	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% Cooling	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3.1: 10% LPA	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
C406.4: Digital Lt Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: Renewable	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: DOAS	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.1: SWH HR	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.2: SWH NG eff	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.3: SWH HP	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: 85% UA	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Low Leak	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3

Table C406.1(3) Additional Energy Efficiency Credits for Group E Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% Heating	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% Cooling	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% Heating	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% Cooling	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3.1: 10% LPA	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Digital Lt Ctrl	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: Renewable	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: DOAS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.1: SWH HR*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.7.2: SWH NG eff*	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406.7.3: SWH HPWH*	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: 85% UA	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Low Leak	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3

* for schools with full service kitchens or showers

Table C406.1(4) Additional Energy Efficiency Credits for Group M Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% Heating	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% Cooling	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% Heating	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% Cooling	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3.1: 10% LPA	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Digital Lt Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: Renewable	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: DOAS	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.1: SWH HR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: SWH NG eff	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: SWH HP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: 85% UA	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Low Leak Env	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3

Table C406.1(5) Additional Energy Efficiency Credits for Other* Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% Heating	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% Cooling	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% Heating	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10% Cooling	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3.1: 10% LPA	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Digital Lt Ctrl	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: Renewable	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: DOAS	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.1: SWH HR**	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.2: SWH FF eff**	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.3: SWH HPWH**	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: 85% UA	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Low Leak Env	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4

* Other occupancy groups include all Groups except for Groups B, R, I, E, and M.

** for occupancy groups listed in C406.7.1

C406.1.1 Tenant spaces. Tenant spaces shall comply with sufficient options from Tables C406.1(1) through C406.1(5) to achieve a minimum number of 5 credits, where credits are selected from Section C406.2, C406.3, C406.4, C406.6 or C406.7. ~~Alternatively, tenant spaces shall comply with Section C406.5 w~~ Where the entire building complies using credits from Section C406.5, C406.8 or C406.9, tenant spaces within the building shall be deemed to comply with this section. ~~is in compliance~~.

Exception: Previously occupied tenant spaces that comply with this code in accordance with Section C501.

C406.2 More efficient HVAC equipment performance.

Equipment shall exceed the minimum efficiency requirements listed in Tables C403.3.2(1) through C403.3.2(97) ~~by 10 percent, in addition to the requirements of Section C403. Where multiple performance requirements are provided, the equipment shall exceed all requirements by 10 percent.~~ and *Variable refrigerant flow systems* ~~shall exceed~~ listed in the energy efficiency provisions of ANSI/ASHRAE/IES~~NA~~ 90.1 ~~by 10 percent.~~ in accordance with Sections C406.2.1, C406.2, C406.2.3 or C406.4. Equipment shall also meet applicable requirements of Section C403. Energy efficiency credits for heating shall be selected from C406.2.1 or C406.2.3 and energy efficiency credits for cooling shall be selected from C406.2.2 or C406.2.4. Selected credits shall include a heating or cooling energy efficiency credit or both. Equipment not listed in Tables C403.3.2(1) through C403.3.2(97) and *Variable refrigerant flow systems* not listed in the energy efficiency provisions of ANSI/ASHRAE/IES 90.1 shall be limited to 10 percent of the total building system capacity for heating equipment where selecting C406.2.1 or C406.2.3 and cooling equipment where selecting C406.2.2 or C406.2.4.

Note: If equipment efficiency tables for VRF or other items are added by another proposal, then remove the reference to the ASHRAE 90.1 tables and adjust the table number reference range to include all HVAC equipment tables.

C406.2.1 More efficient HVAC heating performance. Equipment shall exceed the minimum heating efficiency requirements by 5 percent.

C406.2.2 More efficient HVAC cooling performance. Equipment shall exceed the minimum cooling and heat rejection efficiency requirements by 5 percent. Where multiple cooling performance requirements are provided, the equipment shall exceed the annual energy requirement, including IEER, SEER, and IPLV.

C406.2.3 High efficiency HVAC heating performance. Equipment shall exceed the minimum heating efficiency requirements by 10 percent.

C406.2.4 High efficiency HVAC cooling performance. Equipment shall exceed the minimum cooling and heat rejection efficiency requirements by 10 percent. Where multiple cooling performance requirements are provided, the equipment shall exceed the annual energy requirement, including IEER, SEER, and IPLV.

C406.3 Reduced lighting power. Buildings shall comply with Section C406.3.1 or C406.3.2.

C406.3.1 Reduced lighting power 10 percent. The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be less than 90 percent of the total lighting power allowance calculated in accordance with Section C405.3.2.

C406.3.2 Reduced lighting power more than 15 percent. Where the total connected interior lighting power calculated in accordance with Section C405.3.1 is less than 85 percent of the total lighting power allowance calculated in accordance with Section C405.3.2, additional energy efficiency credits shall be determined based on Equation 4-12, rounded to the nearest whole number.

$$AEEC_{LPA} = AEEC_{10} \times 10 \times (LPA - LPD) / LPA \quad \text{(Equation 4-12)}$$

Where:

$AEEC_{LPA}$ = C406.3.2 additional energy efficiency credits

LPD = total connected interior lighting power (W/ft^2, or W/m^2) calculated in accordance with Section C405.3.1

LPA = total lighting power allowance (W/ft^2, or W/m^2) calculated in accordance with Section C405.3.2

$AEEC_{10}$ = C406.3.1 credits from Tables C406.1(1) through C406.1(5)

C406.4 Enhanced digital lighting controls. Interior lighting in the building shall have the following enhanced lighting controls that shall be located, scheduled and operated in accordance with Section C405.2.2.

1. Luminaires shall be configured for continuous dimming.
2. Luminaires shall be addressed individually. Where individual addressability is not available for the luminaire class type, a controlled group of not more than four luminaries shall be allowed.
3. Not more than eight luminaires shall be controlled together in a *daylight zone.*
4. Fixtures shall be controlled through a digital control system that includes the following function:
    - 4.1. Control reconfiguration based on digital addressability.
    - 4.2. Load shedding.
    - 4.3. Individual user control of overhead general illumination in open offices.
    - 4.4. Occupancy sensors shall be capable of being reconfigured through the digital control system.
5. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions in Item 4.
6. Functional testing of lighting controls shall comply with Section C408.

C406.5 On-site renewable energy. Buildings shall comply with Section C406.5.1 or C406.5.2.

C406.5.1 Basic Renewable Credits. The total minimum ratings of on-site renewable energy systems shall be one of the following:

1. Not less than ~~1.71~~ 0.86 Btu/h per square foot (~~5.4~~ 2.7 W/m^2) or ~~0.50~~ 0.25watts per square foot (~~5.4~~ 2.7 W/m^2) of conditioned floor area.
2. Not less than ~~3~~ 2 percent of the annual energy used within the building for building mechanical and service water heating equipment and lighting regulated in Chapter 4.

C406.5.2 Enhanced Renewable Credits. Where the total minimum ratings of on-site renewable energy systems exceeds the rating in C406.5.1(1), additional energy efficiency credits shall be determined based on Equation 4-13, rounded to the nearest whole number.

$$AEEC_{RRa} = AEEC_{2.5} \times RRa / RR_1 \quad \text{(Equation 4-13)}$$

Where:

$AEEC_{RRa}$ = C406.5.2 additional energy efficiency credits

RRa = actual total minimum ratings of on-site renewable energy systems (Btu/h-ft^2, W/ft^2, or W/m^2)

RR_1 = minimum ratings of on-site renewable energy systems (Btu/h-ft^2, W/ft^2, or W/m^2) required by C406.5.1(1)

$AEEC_{2.5}$ = C406.5.1 credits from Tables C406.1(1) through C406.1(5)

C406.6 Dedicated outdoor air system. Buildings containing equipment or systems regulated by Section C403.3.4, C403.4.3, C403.4.4, C403.4.5, C403.6, C403.8.4, C403.8.5, C403.8.5.1, C403.9.1, C403.9.2, C403.9.3 or C403.9.4 shall be equipped with an independent ventilation system designed to provide not less than the minimum 100-percent outdoor air to each individual occupied space, as specified by the *International Mechanical Code.* The ventilation system shall be capable of total energy recovery. The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.

C406.7 Reduced energy use in service water heating. Buildings shall comply with Sections C406.7.1 and either C406.7.2, C406.7.3 or C406.7.4.

C406.7.1 Building type. To qualify for this credit, the building shall contain one of ~~shall be of~~ the following use groups and the additional energy efficiency credit shall be prorated by conditioned floor area of the portion of the building comprised of the following use groups. ~~types to use this compliance method~~:

1. *Group R*-1: Boarding houses, hotels or motels.
2. Group I-2: Hospitals, psychiatric hospitals and nursing homes.
3. Group A-2: Restaurants and banquet halls or buildings containing food preparation areas.
4. Group F: Laundries.
5. *Group R*-2.
6. Group A-3: Health clubs and spas.
7. Group E: Schools with full-service kitchens or locker rooms with showers.
8. ~~7~~. Buildings showing a service hot water load of 10 percent or more of total building energy loads, as shown with an energy analysis as described in Section C407.

C406.7.2 ~~1~~ Recovered or renewable water heating ~~Load fraction~~. The building service water-heating system shall have one or more of the following that are sized to provide not less than ~~60~~

30 percent of the building's annual hot water requirements, or sized to provide ~~100~~ 70 percent of the building's annual hot water requirements if the building is required to ~~shall otherwise~~ comply with Section C403.9.5:

1. Waste heat recovery from service hot water, heat recovery chillers, building equipment, or process equipment.
2. *On-site renewable energy* water-heating systems.

C406.7.3 Efficient fossil fuel water heater. The combined input-capacity-weighted-average equipment rating of all fossil fuel water heating equipment in the building shall be not less than 95% Et or 0.95 EF. This option shall receive only half the listed credits for buildings required to comply with C404.2.1.

C406.7.4 Heat pump water heater. Where electric resistance water heaters are allowed, all service hot water system heating requirements shall be met using heat pump technology with a combined input-capacity-weighted-average EF of 3.0. Air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior.

C406.8 Enhanced envelope performance. The total UA of the building thermal envelope as designed shall be not less than 15 percent below the total UA of the building thermal envelope in accordance with Section C402.1.5.

C406.9 Reduced air infiltration. Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the building envelope shall not exceed 0.25 cfm/ft^2 (2.0 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception: For buildings having over ~~2~~50,000 square feet (~~2~~5 000 m2) of conditioned floor area, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

2.2 Dwelling and Sleeping Unit Lighting Efficacy

Currently, a 10% lighting reduction in lighting power allowance is required for this extra efficiency option; however dwelling units and sleeping units can follow the residential lighting efficacy requirements. As a result, the applicability of option C406.3 is unclear for multi-family buildings. This measure would make clear the 10% lighting reduction applies to areas in a multi-family building that are not dwelling units and sleeping units and would apply a higher efficacy rating than in the residential lighting requirements.

2.2.1 How Energy is Saved

To achieve this extra efficiency credit, this measure would increase the efficacy requirement for lamps in permanently installed fixtures and make them more in line with lamps available today.

2.2.2 Rationale

This measure provides more clarity for multi-family buildings for the extra efficiency credit. Lamps meeting the higher efficacy requirement are readily available and appropriate for an optional credit.

2.2.3 Sample Code Language

In the suggested code language, changes are made to allow for the following:

- A provision is added to clarify that for the reduced lighting power credit the dwelling and sleeping unit areas also require an increase in lighting efficacy.

Sample code language is outlined below based on the current 2018 IECC. Similar language can also be adapted to state and local codes that are based on the IECC or contain similar provisions. Similar concepts could also be applied to ASHRAE Standard 90.1.

C406.3 Reduced lighting power. Buildings shall comply with Section C406.3.1 and dwelling units and sleeping units within the building shall comply with C406.3.2.

C406.3.1 Reduced lighting power 10%. The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be less than 90 percent of the total lighting power allowance calculated in accordance with Section C405.3.2.

C406.3.2 Lamp efficacy. Not less than 95 percent of the interior lighting power (watts) from lamps in permanently installed light fixtures in dwelling units and sleeping units shall be provided by lamps with a minimum efficacy of 65 lumens per watt.

Note: If the C406 energy efficiency credit proposal passes; renumber lamp efficacy to C406.3 and include the row listed below in energy efficiency credit tables (Note: Added tables not shown underlined for clarity.):

Table C406.1(1) Additional Energy Efficiency Credits for Group B Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.3.3 Lamp efficacy	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(2) Additional Energy Efficiency Credits for Group R and I Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.3.3 Lamp efficacy	2	2	2	2	1	2	2	1	1	1	1	1	1	1	1	1	1

Table C406.1(3) Additional Energy Efficiency Credits for Group E Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.3.3 Lamp efficacy	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(4) Additional Energy Efficiency Credits for Group M Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.3.3 Lamp efficacy	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(5) Additional Energy Efficiency Credits for Other Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.3.3 Lamp efficacy	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

2.3 Enhanced Lighting Controls

Compared to the existing enhanced lighting controls in C406.4, the proposal below provides for more certain savings through light level tuning with the option of lumen maintenance control.

2.3.1 How Energy is Saved

Enhanced lighting controls (Section C406.4) can save energy by tuning maximum light levels to just what is needed throughout the building. Making this requirement explicit and requiring documentation can actually achieve greater savings.

2.3.2 Sample Code Language

In the suggested code language, changes are made to allow for the following:

- Definitions are added for lumen maintenance controls and high end trim. These definitions are adapted from NEMA-LSD-64. The high end trim definition exactly matches the NEMA definition, and the lumen maintenance definition is adjusted to refer to luminaire power rather than lamp power.
- The area required with the specified controls is adjusted to 90%. Under current language, all luminaires in the building would need to meet the control requirements. This does not make sense for areas like mechanical and electrical rooms, stairwells, and restrooms, where the specified controls would not provide an energy benefit.
- A requirement for high end trim was added for any areas with lumen maintenance controls, plus 50% of the remaining area. High end trim or tuning accounts for the fact that maximum lighting with full output at the lighting power allowance level typically provides more lighting than necessary, due to increments in luminaire size and limits on exact luminaire spacing. Requiring tuning that reduces light levels and power by at least 15%, along with documentation in the lighting functional testing process will reduce light levels. While the original language for this type of control provides the capability to tune, without the trim requirement, there is not a strong argument for savings actually occurring. Lumen maintenance controls also start with a lower light level and adjust the lighting upward to compensate for lumen and dirt depreciation. Requiring tuning can result in more than the minimum savings shown.

Sample code language is outlined below based on the current 2018 IECC. Similar language can also be adapted to state and local codes that are based on the IECC or contain similar provisions. Similar concepts could also be applied to ASHRAE Standard 90.1.

Add the following definitions:

LUMEN MAINTENANCE CONTROLS: A lighting control strategy that adjusts luminaire power over time to maintain constant light output as luminaires age, dirt accumulates or both. This strategy allows for energy savings in the life of the system then increases power as the system ages.

HIGH END TRIM: A lighting control strategy that sets the required maximum light level for each space.

C406.4 Enhanced digital lighting controls. At least 90 percent of the building floor area shall have ~~I~~interior lighting ~~in the building shall have~~ with the following enhanced lighting controls for luminaires providing *general lighting*, that shall be located, scheduled and operated in accordance with Section C405.2~~.2~~.

1. Luminaires shall be configured for continuous dimming.
2. Luminaires shall be addressed individually. Where individual addressability is not available for the luminaire class type, a controlled group of not more than four luminaries shall be allowed.
3. Not more than eight luminaires shall be controlled together in a *daylight zone.*
4. Fixtures shall be controlled through a digital control system that includes the following function:
    4.1. Control reconfiguration based on digital addressability.
    4.2. Load shedding.
    4.3. Individual user control of overhead general illumination in open offices.
    4.4. Occupancy sensors shall be capable of being reconfigured through the digital control system.
5. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions in Item 4.
6. Functional testing of lighting controls shall comply with Section C408. *High end trim* controls shall be enabled and configured to limit the initial maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw for the following:
    6.1 All areas that have *lumen maintenance controls*, and
    6.2 50% of the remaining floor area.

Note: If the C406 energy efficiency credit proposal passes; replace the enhanced digital controls row with the rows listed below in energy efficiency credit tables (strikeout and underline snot shown for clarity):

Table C406.1(1) Additional Energy Efficiency Credits for Group B Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.4: Digital Lt Ctrl	4	4	4	4	4	4	4	3	4	4	3	3	4	3	3	3	3

Table C406.1(2) Additional Energy Efficiency Credits for Group R and I Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.4: Digital Lt Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(3) Additional Energy Efficiency Credits for Group E Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.4: Digital Lt Ctrl	3	4	3	4	3	4	3	4	5	4	4	5	3	4	4	3	2

Table C406.1(4) Additional Energy Efficiency Credits for Group M Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.4: Digital Lt Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(5) Additional Energy Efficiency Credits for Other Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.4: Digital Lt Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

2.4 Controlled Receptacles

This adds automatically controlled receptacles to IECC Section C406 are addressed together.

2.4.1 How Energy is Saved

Controlled receptacles (Section C406.10) saves energy by turning off unneeded equipment during unoccupied hours. As shown in Figure 3, office equipment is one of the highest energy costs in typical buildings representing 29% of the total cost on a building (Hart and Xie 2014). While the efficiency of office equipment is increasing it still represents a proportionally higher percentage of energy usage in buildings today.

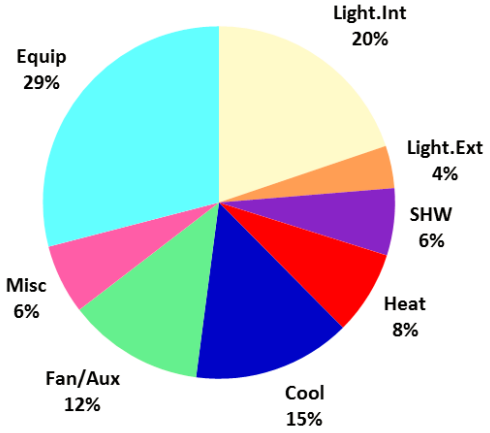

Figure 3. End-use cost for buildings in all U.S. climate zones

2.4.2 Rationale

This measure provides more flexibility to building designers when it is added to the energy efficiency credit choices. The recommended language requires location of controlled receptacles adjacent to non-controlled receptacles. That requirement would avoid "daisy chained" power strips and extension cords from the non-controlled receptacles to their office equipment to avoid their equipment from being automatically turned off. The recommended language was adopted by the Seattle Nonresidential Energy Code and would require that either a split receptacle be installed that would contain both a controlled and uncontrolled receptacle, or the uncontrolled receptacle be located no more than 12" from the controlled receptacle.

The estimated savings are estimated to be 0.49 kWh/ft^2 in small office and 0.61 kWh/ft^2 in large office spaces through reduced equipment run times and other plug loads that are connected to the receptacle. These requirements are currently in ASHRAE Standard 90.1-2010 and 2013, in the Washington State Nonresidential Energy Code and the Seattle Energy Code.

2.4.3 Sample Code Language

The recommended code change would require that 50% of receptacles installed in private offices, open offices, conference rooms, breakrooms, individual workstations, and classrooms, including those installed in modular partitions and modular office workstation systems be controlled either by an occupancy sensor or a time-of-day control device.

Sample code language is outlined below based on the current 2018 IECC. Similar language can also be adapted to state and local codes that are based on the IECC or contain similar provisions. Similar concepts could also be applied to ASHRAE Standard 90.1.

C406.10 Controlled Receptacles. At least 50 percent of all 125 volt 15- and 20-ampere receptacles installed in private offices, open offices, conference rooms, breakrooms, individual workstations, and classrooms, including those installed in modular partitions and modular office workstation systems, shall be controlled as required by this section. Either split receptacles shall be provided, with the top receptacle(s) controlled, or a controlled receptacle shall be located within 12 inches (0.3 M) of each uncontrolled receptacle. Alternatively, non-controlled receptacles in a single modular workstation located not more than 72 inches from a controlled receptacle serving that workstation. Controlled receptacles shall be visibly differentiated from standard receptacles and shall be controlled by one of the following automatic control devices:

1. An occupant sensor that turns receptacle power off when no occupants have been detected for a maximum of 20 minutes, or
2. A time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be capable of providing an independent schedule for each portion of the building not to exceed 5,000 square feet (2,300 m^2) and not to exceed one full floor. The device shall be capable of being overridden for periods of up to two hours by an override switch accessible to occupants. Any individual override switch shall control the controlled receptacles for a maximum area of 5,000 square feet (460 m^2).

Exception to C406.10: Receptacles designated for specific equipment requiring 24-hour operation, for building maintenance functions, or for specific safety or security equipment.

Note: If the C406 energy efficiency credit proposal passes; include the rows listed below in energy efficiency credit tables (Note: Added table rows not shown underlined for clarity):

Table C406.1(1) Additional Energy Efficiency Credits for Group B Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.10: Plug Load Ctrl	15	14	15	15	14	15	17	12	15	13	11	13	13	10	12	10	9

Table C406.1(2) Additional Energy Efficiency Credits for Group R and I Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.10: Plug Load Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(3) Additional Energy Efficiency Credits for Group E Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.10: Plug Load Ctrl	20	19	20	20	20	21	22	20	21	21	20	20	21	18	19	17	15

Table C406.1(4) Additional Energy Efficiency Credits for Group M Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.10: Plug Load Ctrl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(5) Additional Energy Efficiency Credits for Other Group Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.10: Plug Load Ctrl	18	17	18	18	17	18	20	16	18	17	16	17	17	14	16	14	12

2.5 Extra Daylight Area Control

This measure extends the basic or primary daylit area by adding 50% more daylit area. Note that if a separate proposal requiring daylighting in secondary daylit areas is included in the IECC, then this extra efficiency option should not be included, as savings are based on the current 2018 IECC requirements for daylighting in only the primary toplit and sidelit areas.

2.5.1 How Energy is Saved

Current daylighting requirements in the IECC and 90.1 require control only in primary daylit areas. Expanding the daylit control area (Section C406.11) saves energy by reducing lighting power when daylighting is available in these areas.

2.5.2 Rationale

This measure provides more flexibility to building designers when it is added to the energy efficiency credit choices. It specifically provides an expansion in the daylit area. Which allows lighting to be reduced in a larger portion of the building with daylight responsive controls.

2.5.3 Sample Code Language

In the suggested code language, an additional item is added to the C406 list that requires 50% additional daylit area compared to the base code requirements, including any additional daylit area required when building window wall ration exceeds 30%. If this measure is considered for 90.1 it would be an alternative to the extra control credit allowed for secondary daylit zone *daylight responsive control*. Energy efficiency credits are provided by building type except for the R occupancy group.

Sample code language is outlined below based on the current 2018 IECC. Similar language can also be adapted to state and local codes that are based on the IECC or contain similar provisions. Similar concepts could also be applied to ASHRAE Standard 90.1.

C406.11 Extra Area Daylight Responsive Controls. Building shall not use the energy efficiency credits for Section C406.7, enhanced lighting control, and shall provide continuous dimming *daylight responsive controls* for 150% of the area required to have *daylight responsive controls* in toplit zones and sidelit zones in Section C405.2.3 or as required by Section C402.4.1.1. Toplit and sidelit zones as defined in Sections C405.2.3.2 and C405.2.3.3 shall be controlled separately from adjacent daylight zones.

Note: If the C406 energy efficiency credit proposal passes; include the rows listed below in energy efficiency credit tables (Note: Added tables not shown underlined for clarity.):

Table C406.1(1) Additional Energy Efficiency Credits for Group B Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.11: Added Daylit	7	6	7	7	6	7	8	6	7	6	5	6	6	5	6	5	4

Table C406.1(2) Additional Energy Efficiency Credits for Group R and I Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.11: Added Daylit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(3) Additional Energy Efficiency Credits for Group E Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.11: Added Daylit	2	1	2	2	3	3	3	3	3	2	3	3	3	1	2	NA	NA

Table C406.1(4) Additional Energy Efficiency Credits for Group M Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.11: Added Daylit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table C406.1(5) Additional Energy Efficiency Credits for Other Group Occupancies

Climate Zone:	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.11: Added Daylit	3	2	3	3	3	3	4	3	3	3	3	3	3	2	3	2	NA

2.6 Efficient Kitchen Equipment

Efficient kitchen equipment can provide significant energy savings.

2.6.1 How Energy is Saved

Kitchen equipment uses a large share of building energy use in restaurants, schools, dormitories, hotels, and other facilities with full service kitchens. More efficient equipment (Section C406.12) saves energy by improving the heat transfer to the cooking process, either through better equipment insulation or other innovations in the appliances.

2.6.2 Rationale

This measure provides more flexibility to building designers when it is added to the energy efficiency credit choices. It specifically addresses the large energy use of kitchen equipment. Equipment with large energy use that has been available in high efficiency versions for many years includes:

- Gas and electric fryers
- Warming ovens
- Steam cookers
- Dishwashers

2.6.3 Sample Code Language

In the suggested code language, changes are made to allow for the following:

- A section is added to Section C406 covering efficient kitchen equipment in occupancies that have a commercial kitchen.
- Specifications for high efficiency kitchen equipment are added in tables, including commercial fryers, steam cookers, ovens, and dishwashers.
- A formula is included to calculate energy efficiency credits if that measure passes.

Sample code language is outlined below based on the current 2018 IECC. Similar language can also be adapted to state and local codes that are based on the IECC or contain similar provisions. Similar concepts could also be applied to ASHRAE Standard 90.1.

C406.12 Efficient Kitchen Equipment. For buildings and spaces designated as Group A-2, or facilities that include a commercial kitchen with at least one gas or electric fryer, all fryers, dishwashers, steam cookers and ovens shall comply with all of the following:

1. Achieve performance levels in accordance with the equipment specifications listed in Tables C406.12 (1) through (4) when rated in accordance with the applicable test procedure.
2. Be installed prior to the issuance of the Certificate of Occupancy.
3. Have associated performance levels listed on the construction documents submitted for permitting.

Note: If the C406 energy efficiency credit proposal passes; include the following language and equation:

Energy efficiency credits for efficient kitchen equipment shall be independent of climate zone and determined based on Equation 4-12, rounded to the nearest whole number.

$$AEEC_K = 20 \times AreaK / AreaB \quad \text{(Equation 4-12)}$$

Where:

$AEEC_K$ = C406.12 additional energy efficiency credits

AreaK = Floor area of full service kitchen (ft^2 or m^2)

AreaB = Gross floor area of building (ft^2 or m^2)

Table C406.12 (1)
Minimum Efficiency Requirements: Commercial Fryers

	Heavy-Load Cooking Energy Efficiency	Idle Energy Rate	Test Procedure
Standard Open Deep-Fat Gas Fryers	≥ 50%	≤ 9,000 Btu/hr	ASTM Standard F1361-07
Standard Open Deep-Fat Electric Fryers	≥ 83%	≤ 800 watts	
Large Vat Open Deep-Fat Gas Fryers	≥ 50%	≤ 12,000 Btu/hr	ASTM Standard F2144-09
Large Vat Open Deep-Fat Electric Fryers	≥ 80%	≤ 1,100 watts	

Table C406.12 (2)
Minimum Efficiency Requirements: Commercial Steam Cookers

Fuel Type	**Pan Capacity**	**Cooking Energy Efficiency[a]**	**Idle Rate**	**Test Procedure**
Electric Steam	3-pan	50%	400 watts	ASTM Standard F1484-99
	4-pan	50%	530 watts	
	5-pan	50%	670 watts	
	6-pan and larger	50%	800 watts	
Gas Steam	3-pan	38%	6,250 Btu/h	
	4-pan	38%	8,350 Btu/h	
	5-pan	38%	10,400 Btu/h	
	6-pan and larger	38%	12,500 Btu/h	

a. Cooking Energy Efficiency is based on heavy load (potato) cooking capacity

Table C406.12 (3)
Minimum Efficiency Requirements: Commercial Dishwashers

Machine Type	High Temp Efficiency Requirements		Low Temp Efficiency Requirements		Test Procedure
	Idle Energy Rate[a]	Water Consumption[b]	Idle Energy Rate[a]	Water Consumption[b]	
Under Counter	≤ 0.50 kW	≤ 0.86 GPR	≤ 0.50 kW	≤ 1.19 GPR	ASTM Standard F1696-15, Standard Test Method for Energy Performance of Stationary-Rack,Door-Type Commercial Dishwashing Machines ASTM Standard F1920-15, Standard Test Method for Performance of Rack Conveyor Commercial Dishwashing Machines
Stationary Single Tank Door	≤ 0.70 kW	≤ 0.89 GPR	≤ 0.60 kW	≤ 1.18 GPR	
Pot, Pan , and Utensil	≤ 1.20 kW	≤ 0.58 GPR	≤ 1.00 kW	≤ 0.58 GPSF	
Single Tank Conveyor	≤ 1.50 kW	≤ 0.70 GPR	≤ 1.50 kW	≤ 0.79 GPR	
Multiple Tank Conveyor	≤ 2.25 kW	≤ 0.54 GPR	≤ 2.00 kW	≤ 0.54 GPR	
Single Tank Flight Type	Reported	GPH ≤ 2.975x + 55.00	Reported	GPH ≤ 2.975x + 55.00	
Multiple Tank Flight Type	Reported	GPH ≤ 4.96x + 17.00	Reported	GPH ≤ 4.96x + 17.00	

[a] Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heater(s) and controls. Booster heater (internal or external) energy consumption should not be part of this measurement unless it cannot be separately monitored.

[b] GPR = gallons per rack; GPSF = gallons per square foot of rack; GPH = gallons per hour; x = sf of conveyor belt (i.e., W*L) /min (max conveyor speed).

Table C406.12 (4)
Minimum Efficiency Requirements: Commercial Ovens

Fuel Type	Classification	Idle Rate	Cooking-Energy Efficiency, %	Test Procedure
Convection Ovens				
Gas	Full-Size	≤ 12,000 Btu/h	≥ 46	ASTM F1496 - 13
Electric	Half-Size	≤ 1.0 Btu/h	≥ 71	
	Full-Size	≤ 1.60 Btu/h		
Combination Ovens				
Gas	Steam Mode	≤ 200P[a]+6,511 Btu/h	≥ 41	ASTM F2861 - 14
	Convection Mode	≤ 150P[a]+5,425 Btu/h	≥ 56	
Electric	Steam Mode	≤ 0.133P[a]+0.6400 kW	≥ 55	
	Convection Mode	≤ 0.080P[a]+0.4989 kW	≥ 76	
Rack Ovens				
Gas	Single	≤ 25,000 Btu/h	≥ 48	ASTM F2093 - 11
	Double	≤ 30,000 Btu/h	≥ 52	

a. P = Pan Capacity: The number of steam table pans the combination oven is able to accommodate as per the ASTM F – 1495 – 05 standard specification.

3.0 References

Hart R and B Liu. 2015. *Methodology for Evaluating Cost-effectiveness of Commercial Energy Code Changes*. PNNL-23923, Rev1, Pacific Northwest National Laboratory for U.S. Department of Energy; Energy Efficiency & Renewable Energy. https://www.energycodes.gov/development/commercial/methodology.

Hart R and J Zhang. 2018. *Cost-effectiveness Analysis of Hi-rise Residential Building Air Leakage Testing*. https://www.energycodes.gov/sites/default/files/documents/TBD.pdf.

Hart R and Y Xie. 2014. *End-Use Opportunity Analysis from Progress Indicator Results for ASHRAE Standard 90.1-2013*. PNNL-24043, Pacific Northwest National Laboratory, Richland, WA. http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24043.pdf

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Wiss J. 2014. *ASHRAE 1478-RP Measuring Airtightness of Mid- and High-Rise Non-Residential Buildings*. Elstner Associates, Inc. for ASHRAE. https://www.ashrae.org/resources--publications/periodicals/enewsletters/esociety/2014-12-10-articles/completed-research-december-2014.

Appendix

General Approach to Extra Efficiency Credit Analysis

Most measures were analyzed with EnergyPlus. Some were evaluated with manual calculations. For the energy plus analysis baselines, Prototype models for Medium Office, Mid-rise Apartment, Stand Alone Retail, and Primary School were used. The baselines matched the 2018 IECC with the following adjustments to account for changes expected to be accepted into the 2021 IECC:

- Lighting power allowances from addendum BB and BW to 90.1-2016 were used
- HVAC efficiencies proposed for 90.1-2019 were used

The measures analyzed and their applicability to the prototypes is shown below:

Measure	Office	Apartment	School	Retail	Calc
C406.2.1: 5% Heating Efficiency Improvement	X	X	X	X	E+
C406.2.2: 5% Cooling Efficiency Improvement	X	X	X	X	E+
C406.2.3: 10% Heating Efficiency Improvement	X	X	X	X	E+
C406.2.4: 10% Cooling Efficiency Improvement	X	X	X	X	E+
C406.3.1: 10% LPA Reduction	X	X	X	X	E+
C406.3.3 Lamp efficacy 95%/65 Lm/W		X			E+
C406.4: Basic Digital Lite Ctrl	X		X		50% of Revised
C406.4: Revised Digital Lite Ctrl	X		X		E+
C406.5: Renewable (PV)	X	X	X	X	E+
C406.6: DOAS	X	X	X	X	Average similar
C406.7: SWH Efficiency Improvement		X	X		Manual
C406.8: 85% of required UA	X	X	X	X	E+
C406.9: Low Leakage Envelope (0.25 cfm/ft^2)	X	X	X	X	E+
C406.10: PlugLoad 50% control	X		X		E+
C406.11: 150% Daylit of primary	X		X		E+
C406.12: Kitchen Equipment Improvement			X		Manual

Energy Prices

Residential sector pricing is appropriate for most dwelling and sleeping units. These are used in scenario 1, while the commercial prices selected by the ASHRAE 90.1 committee are used in Scenario 3. Residential prices are sourced from EIA data for the 12-month period from November 2017 to October 2018. Heating prices are weighted by typical sector fuel use weighting for natural gas and oil, resulting in a blended fossil fuel price expressed in $ per therm. Uniform present value factors (UPV) for the scenario 1 analysis account for both fuel escalation and present value discounting. For heating, they are weighted for the fuel mix. UPV 30-year factors are adjusted to a 40-year life by applying the equivalent year 1-30 net discount rate for the 30 year UPV to years 31-40,

Energy Type			Unit Price		Weight	UPV,30	UPV,40
Natural Gas	10.55	$/ kCuFt	$1.0169	$/therm	87.7%	22.75	22.75
Heating Oil	3.01	$/ gal	$2.1700	$/therm	12.3%	28.67	28.67
Blended Fossil Rate			**$1.1588**	**$/therm**		23.48	**27.25**
Electricity			**$0.1290**	**$/kWh**		21.45	**25.09**

Basis of Analysis

For each measure, the parameter changes or other approach to analysis is described:

C406.2.1: 5% Heating Efficiency Improvement

This measure was analyzed in EnergyPlus by modifying the heating efficiency with 5% improvement over baseline efficiency as shown below:

Gas Furnace	Baseline	Heat05	Prototypes
< 225 (AFUE) > 225 (Et)	81% 80%	85% 84%	Medium Office Standalone Retail Primary School Mid-rise Apartment
Boiler	**Baseline**	**Heat05**	**Prototypes**
<300 (AFUE) 300-2500 (Et) > 2500 (Ec)	82% 80% 82%	86% 84% 86%	Primary School

C406.2.2: 5% Cooling Efficiency Improvement

This measure was analyzed in EnergyPlus by modifying the efficiency of the DX coil with 5% improvement over baseline efficiency as shown below:

Electrically Operated Unitary air conditioner (Split & Single Package):EER

	Baseline	Cool05	Prototypes	
<65 KBtuh	14	14.7	**Single Package** Medium Office Standalone Retail PrimarySchool	**Split** Mid-rise Apartment
65 – 135 Kbtuh	11	11.55		
135 – 240 KBtuh	10.80	11.34		
240 – 760 KBtuh	9.8	10.29		
> 760 KBtuh	9.5	9.975		

C406.2.3: 10% Heating Efficiency Improvement

This measure was analyzed in EnergyPlus by modifying the heating efficiency with 10% improvement over baseline efficiency as shown below:

Gas Furnace	Baseline	Heat10	Prototypes
< 225 (AFUE) > 225 (Et)	81% 80%	89% 88%	Medium Office Standalone Retail Primary School Mid-rise Apartment
Boiler	**Baseline**	**Heat10**	**Prototypes**
<300 (AFUE) 300-2500 (Et) > 2500 (Ec)	82% 80% 82%	90% 88% 90%	Primary School

C406.2.4: 10% Cooling Efficiency Improvement

This measure was analyzed in EnergyPlus by modifying the efficiency of the DX coil with 10% improvement over baseline efficiency as shown below:

Electrically Operated Unitary air conditioner (Split & Single Package):EER

	Baseline	Cool10	Prototypes	
<65 KBtuh	14	15.4	**Single Package** Medium Office Standalone Retail PrimarySchool	**Split** Mid-rise Apartment
65 – 135 Kbtuh	11	12.1		
135 – 240 KBtuh	10.80	11.88		
240 – 760 KBtuh	9.8	10.78		
> 760 KBtuh	9.5	10.45		

C406.3.1: 10% LPA Reduction

For this measure lighting power density of each non-residential space was reduced by 10% compared to the baseline.

Prototype	Space	Baseline	LPA10
Primary School	Classroom	0.78	0.70
	Corridor	0.41	0.37
	Lobby	1.11	0.99
	Computer_room	0.78	0.70
	Mechanical room	0.95	0.85
	Bath	0.63	0.56
	Office	0.74	0.66
	Gym	0.9	0.81
	Kitchen	1.29	1.16
	Cafe	0.4	0.36
	Library	0.78	0.70
Medium office	Office	0.79	0.71
Retail Standalone	Back Space	0.43	0.38
	Core Retail	1.11	0.99
	Point of sale	1.12	1.008
	Front Retail	1.12	1.008
	Front Entry	1.11	0.999
Midrise Apartment	Office	0.74	0.666
	Corridor	0.41	0.369

C406.3.3 Lamp efficacy 95%/65 Lm/W

This measure was modeled in the mid-rise apartment prototype. The baseline lighting of the apartment units have 90% of regulated lights with 60 lumens/watt efficacy. In the measure case, the apartment lighting units were modeled with 95% of regulated lights with 65 lumens/watt efficacy. 80% of the apartment lights are considered to be regulated lights in both cases. Based on these assumptions the modeled LPDs in watts/sq feet for the baseline and measure case are as shown below:

Light type	Baseline LPD W/sq ft	Measure LPD W/sq ft
Regulated	0.44	0.37
Unregulated	0.27	0.27

C406.4: Basic Enhanced Digital Lite Control

The basic enhanced digital light control in the current IECC section C406.4 includes several control improvements; however, there is not a specific requirement to set up the controls to achieve reliable energy savings. Savings is taken as half the improved digital control savings.

C406.4: Improved Enhanced Digital Lite Control

This measure was modeled in the Medium Office and Primary School prototypes. The window area of both prototypes were increased to achieve a WWR > 30%. Savings for this measure are calculated based on the new baseline with WWR >30%. To meet the daylight control requirements, the percentage of gross floor area covered by daylighting controls in the Medium office baseline was increased to 25% and of the

primary school to 50%. To achieve this, daylight controls were added to secondary daylit zones in several spaces in the baseline.

In the measure case all daylit spaces have controls in both primary and secondary zones. Similar to the previous measure the baseline and measure case LPDs were adjusted to account for savings associated with high trim tuning.

Prototype	Space	Adjusted Base LPD W/sq ft	Measure LPD W/sq ft
Medium Office	Core spaces	0.79	0.76
	Perimeter type 1	0.78	0.76
	Perimeter type 2	0.76	0.76
Primary School	Classrooms type 1	0.77	0.75
	Classrooms type 2	0.75	0.75
	Corridors	0.41	0.39
	Lobby	1.10	1.07
	Mechanical	0.95	0.91
	Bath	0.63	0.61
	Offices	0.74	0.71
	Gym	0.88	0.87
	Kitchen	1.29	1.24
	Cafeteria	0.40	0.38
	Library	0.84	0.81

C406.5: Renewable (PV)

For this measure photovoltaics were included in the EnergyPlus models such that it generates approximately 1.71 Btu/h per square feet of conditioned floor area. Roughly 4% of the total building electricity use was met by PV. Note that the requirement was reduced to half to better align with other options.

Prototype	PV Requirement (kwh)	% of Total Electricity
OfficeMedium	26,877	4.3%
RetailStandalone	12,375	4.2%
SchoolPrimary	37,066	3.3%
ApartmentMidRise	16,910	3.7%

C406.6: DOAS

The savings for the dedicated outside air system (DOAS) measure was estimated rather than modeled for this analysis, due to several constraints.

- The current description in 2018 IECC for DOAS is somewhat unclear. The minimum recovery effectiveness is not specified, and there is no fan control specified, so it is unclear exactly how to model the potential savings. With no specification for effectiveness, a smaller and less expensive DOAS/ERV could be installed that could have much less energy recovery and potentially higher fan energy impact than related exhaust air energy recovery requirements.

- Modeling DOAS in the version of EnergyPlus the prototypes are currently in requires work arounds in many cases. A future analysis when the prototypes are upgraded to a version that directly supports multiple airflows in a zone will be more accurate.
- The exhaust air energy recovery requirements in the base code are highly variable in application based on system sizing and other design attributes. In the future, it may be appropriate to establish credits with a formula that reflects base building ERV requirements.

The approach taken to develop an estimate of credits differs slightly by building type:

- For the Medium Office and Standalone Retail prototypes the results of 10% heating and cooling efficiency improvement along with the infiltration reduction to 0.40 cfm/ft^2 are averaged. This provides a reasonable representation of savings from a measure that primarily impacts outside air conditioning.
- The Midrise Apartment was based on modeling[1] prepared for an ASHRAE Standard 90.1 proposal and those results are averaged similarly with the 10% efficiency improvement and infiltration reduction results to provide consistency across building types.
- The school was reviewed, and is was found that the outside air required in most zones was quite high (around 85%) so that in almost all climate zones, ERVs were already required, so there was no real benefit from a DOAS system with an ERV.

C406.7: SWH Efficiency Improvement

Service water heating equipment can benefit from efficiency improvements above base efficiency required. The current 2018 IECC language provides for energy recovery, while it is suggested that both a fossil fuel improvement and heat pump water heater can provide savings. The energy recovery requirements were reduced to better match other measures. For consistency, a natural gas water base is used for all the options. The parameters used are as follows:

SWH Measure	Base Condition	Measure Parameters
C406.7.1 Energy recovery or renewable	Natural Gas Et 80% on 100% load	Natural Gas Et 80% on 40% load; Remainder electric heat recovery chiller increase from 0.440 to 0.462 kW/ton chiller IPLV, plus a pump allowance.
C406.7.2 Fossil fuel efficiency improvement	Natural Gas Et 80% on 100% load	Natural Gas Et 95% on 100% load
C406.7.1 Heat pump water heater	Natural Gas Et 80% on 100% load	Electric EF of 3.0 on 100% load

C406.8: 85% of required UA

For this measure the U-factor of all envelope components was reduced by 15%. This across the board reduction provides equivalent load impact of various envelop components that have a weighted average reduction that results in an overall UA of 85% of the code required UA.

[1] Fecteau, Adam and Mike Moore. May 31, 2018. "Energy Cost Analysis for Energy Recovery Ventilation in Dwelling Units." Presented at ASHRAE 90.1 SSPC.

C406.9: Low Leakage Envelope (0.25)

For this measure the baseline envelope leakage of 1.0 cfm/square foot was adjusted to 0.25 cfm/ square foot.

C406.10: PlugLoad 50% control

This measure was modeled by adjusting the schedules of the applicable plug load equipment during unoccupied hours in the Medium Office and primary school prototypes.

C406.11: 150% Daylit of primary

This measure was modeled in the Medium Office and primary School prototypes. The WWR of these prototypes were adjusted to 35%. This measure was modeled by increasing the fraction of space area controlled by daylighting controls such that at least 150% of the area required to have daylight responsive controls in daylit zones have continuous dimming control. The fraction of area covered by daylight controls was increased from 25% to 37.5% in the Medium Office and from 50% to 75% in the Primary School prototypes.

C406.12: Kitchen Equipment Improvement

Kitchen equipment efficiency was based on an extensive analysis for California title 24 and the Pacific Northwest Regional Technical Forum.[1] To receive energy credit, the measure requires four types of equipment with major energy savings potential to be installed as part of the permit process. Definitions and reference standards for equipment efficiency are provided in tables. As a matter of course, the fryer provided the lion's share of the energy savings and energy efficiency credits are based on just the fryer savings. Since kitchen size and complexity varies, the result is normalized to a 1500 square foot kitchen, and the results are prorated to the kitchen area as a share of building area. For simplicity, cost savings from gas and electric fryers are averaged to arrive at the points available. Fryer savings results are as follows:

Bldg	Equipment Type	Savings per Fryer (kWh/yr or therms/yr)	# per site	Savings per site (kWh/yr or therms/yr)	Savings/sqft DOE Kitchen (1,500 sqft)	Savings Units
Restaurant	Electric Fryer	2,272	1.94	4,406	2.94	kWh/yr/sqft
Restaurant	Gas Fryer	781	1.94	1,515	1.01	therms/yr/sqft
Scndry school	Electric Fryer	855	0.99	848	-	kWh/yr/sqft
Scndry school	Gas Fryer	294	0.99	291	-	therms/yr/sqft
Retail	Electric Fryer	2,272	1.75	3,976	-	kWh/yr/sqft
Retail	Gas Fryer	781	1.75	1,367	-	therms/yr/sqft
Lodging	Electric Fryer	2,272	4.00	9,088	-	kWh/yr/sqft
Lodging	Gas Fryer	781	4.00	3,124	-	therms/yr/sqft

[1] Information from "Characterizing the Energy Efficiency Potential of Gas-fired Commercial Foodservice Equipment" report (CEC-500-2014-095) from October 2014 and the RTF foodservice measures (ovens, fryers, steamers, HFHC) updated in 2018.

Energy Savings Results

Based on the results of the Energy Plus and other analysis, the energy saving results for each prototype in each climate zone (CZ) are as follows:

C406.2.1: 5% Heat Efficiency Improvement

Heat05- Energy Savings per 1000 square feet

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	0.00	0.00	$0.00	0.0%	0.00	0.18	$0.16	0.0%	0.00	0.00	$0.00	0.0%	0.00	0.00	$0.00	0.0%
1B	0.00	0.01	$0.01	0.0%	0.00	0.80	$0.73	0.0%	0.00	0.47	$0.42	0.0%	0.00	0.03	$0.03	0.0%
2A	0.00	0.08	$0.08	0.0%	0.00	0.96	$0.87	0.1%	0.00	0.27	$0.24	0.0%	0.00	0.21	$0.19	0.0%
2B	0.00	0.05	$0.04	0.0%	0.00	1.27	$1.15	0.1%	0.00	0.90	$0.82	0.1%	0.00	0.18	$0.16	0.0%
3A	0.00	0.65	$0.59	0.1%	0.00	2.12	$1.92	0.1%	0.00	1.45	$1.32	0.1%	0.00	1.95	$1.76	0.1%
3B	0.00	0.24	$0.21	0.0%	0.00	2.71	$2.46	0.2%	0.00	1.97	$1.79	0.2%	0.00	0.65	$0.59	0.0%
3C	0.00	0.04	$0.04	0.0%	0.00	2.07	$1.87	0.2%	0.00	0.94	$0.85	0.1%	0.00	0.19	$0.17	0.0%
4A	0.00	1.31	$1.19	0.1%	0.00	3.33	$3.02	0.2%	0.00	2.79	$2.53	0.3%	0.00	1.87	$1.69	0.1%
4B	0.00	0.48	$0.44	0.0%	0.00	4.46	$4.04	0.3%	0.00	3.55	$3.22	0.3%	0.00	1.32	$1.20	0.1%
4C	0.00	0.62	$0.56	0.1%	0.00	5.93	$5.38	0.5%	0.00	5.13	$4.65	0.5%	0.00	2.20	$1.99	0.2%
5A	0.00	2.18	$1.98	0.2%	0.00	4.64	$4.20	0.3%	0.00	4.61	$4.17	0.4%	0.00	3.38	$3.07	0.2%
5B	0.00	1.15	$1.04	0.1%	0.00	6.88	$6.23	0.5%	0.00	6.61	$5.99	0.6%	0.00	3.16	$2.87	0.2%
5C	0.00	0.93	$0.84	0.1%	0.00	4.69	$4.25	0.4%	0.00	6.28	$5.70	0.6%	0.00	2.34	$2.12	0.2%
6A	0.00	3.23	$2.93	0.3%	0.00	7.63	$6.92	0.5%	0.00	7.79	$7.06	0.6%	0.00	5.91	$5.36	0.4%
6B	0.00	2.11	$1.92	0.2%	0.00	6.11	$5.54	0.4%	0.00	4.82	$4.37	0.4%	0.00	3.49	$3.16	0.2%
7	0.00	0.72	$0.65	0.1%	0.00	9.58	$8.69	0.7%	0.00	9.31	$8.44	0.8%	0.00	5.73	$5.20	0.4%
8	0.00	1.69	$1.53	0.1%	0.00	14.44	$13.09	1.0%	0.00	14.85	$13.46	1.1%	0.00	7.47	$6.78	0.5%

C406.2.2: 5% Cool Efficiency Improvement

Cool05- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	137.73	0.00	$14.73	1.4%	127.55	-0.04	$13.60	1.0%	121.27	0.00	$12.97	1.2%	75.82	0.00	$8.11	0.7%
1B	155.96	0.00	$16.68	1.5%	155.60	-0.17	$16.48	1.1%	176.51	0.00	$18.87	1.6%	78.79	0.00	$8.42	0.7%
2A	126.90	0.00	$13.57	1.3%	111.89	-0.22	$11.77	0.8%	109.91	0.00	$11.75	1.1%	61.66	0.00	$6.59	0.5%
2B	105.36	0.00	$11.26	1.1%	91.42	-0.29	$9.51	0.7%	112.83	0.00	$12.06	1.0%	51.78	0.00	$5.54	0.4%
3A	79.09	0.00	$8.46	0.9%	72.30	-0.33	$7.43	0.6%	69.64	0.00	$7.45	0.8%	35.07	0.00	$3.75	0.3%
3B	78.16	0.00	$8.36	0.9%	68.36	-0.34	$7.00	0.6%	76.16	0.00	$8.14	0.8%	36.72	0.00	$3.93	0.3%
3C	57.96	0.00	$6.20	0.7%	46.53	-0.44	$4.58	0.4%	26.44	0.00	$2.83	0.3%	17.54	0.00	$1.87	0.2%
4A	58.12	0.00	$6.21	0.7%	52.73	-0.05	$5.60	0.4%	49.50	0.00	$5.29	0.5%	27.66	0.00	$2.96	0.2%
4B	61.90	0.00	$6.62	0.7%	44.81	-0.49	$4.35	0.4%	52.42	0.00	$5.61	0.5%	27.33	0.00	$2.92	0.2%
4C	37.24	0.00	$3.98	0.5%	19.94	-0.57	$1.61	0.1%	13.39	0.00	$1.43	0.2%	10.62	0.00	$1.14	0.1%
5A	42.63	0.00	$4.56	0.5%	32.90	-0.08	$3.44	0.3%	26.77	0.00	$2.86	0.3%	19.02	0.00	$2.03	0.2%
5B	51.38	0.00	$5.49	0.6%	34.70	-0.04	$3.67	0.3%	39.49	0.00	$4.22	0.4%	21.73	0.00	$2.32	0.2%
5C	28.02	0.00	$3.00	0.3%	15.89	-0.66	$1.10	0.1%	5.06	0.00	$0.54	0.1%	7.16	0.00	$0.77	0.1%
6A	45.53	0.00	$4.87	0.5%	34.29	-0.13	$3.55	0.3%	30.49	0.00	$3.26	0.3%	19.84	0.00	$2.12	0.2%
6B	38.17	0.00	$4.08	0.4%	24.64	-0.08	$2.56	0.2%	24.41	0.00	$2.61	0.3%	16.38	0.00	$1.75	0.1%
7	43.30	0.00	$4.63	0.4%	28.43	-0.16	$2.89	0.2%	21.71	0.00	$2.32	0.2%	18.03	0.00	$1.93	0.1%
8	34.03	0.00	$3.64	0.3%	14.23	-0.26	$1.29	0.1%	9.67	0.00	$1.03	0.1%	14.00	0.00	$1.50	0.1%

C406.2.3: 10% Heat Efficiency Improvement

Heat10- Savings per 1000 square feet

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	0.00	0.00	$0.00	0.0%	0.00	0.34	$0.31	0.0%	0.00	0.00	$0.00	0.0%	0.00	0.00	$0.00	0.0%
1B	0.00	0.03	$0.02	0.0%	0.00	1.53	$1.39	0.1%	0.00	0.90	$0.81	0.1%	0.00	0.06	$0.06	0.0%
2A	0.00	0.16	$0.14	0.0%	0.00	1.83	$1.66	0.1%	0.00	0.51	$0.47	0.0%	0.00	0.39	$0.36	0.0%
2B	0.00	0.09	$0.08	0.0%	0.00	2.43	$2.20	0.2%	0.00	1.72	$1.56	0.1%	0.00	0.34	$0.31	0.0%
3A	0.00	1.23	$1.12	0.1%	0.00	4.05	$3.67	0.3%	0.00	2.77	$2.51	0.3%	0.00	3.71	$3.36	0.3%
3B	0.00	0.45	$0.41	0.0%	0.00	5.17	$4.69	0.4%	0.00	3.76	$3.41	0.3%	0.00	1.25	$1.14	0.1%
3C	0.00	0.08	$0.07	0.0%	0.00	3.95	$3.58	0.3%	0.00	1.80	$1.63	0.2%	0.00	0.36	$0.33	0.0%
4A	0.00	2.51	$2.27	0.2%	0.00	6.36	$5.77	0.5%	0.00	5.33	$4.83	0.5%	0.00	3.57	$3.23	0.3%
4B	0.00	0.92	$0.83	0.1%	0.00	8.51	$7.72	0.6%	0.00	6.78	$6.15	0.6%	0.00	2.52	$2.29	0.2%
4C	0.00	1.18	$1.07	0.1%	0.00	11.32	$10.26	0.9%	0.00	9.79	$8.87	1.0%	0.00	4.19	$3.80	0.3%
5A	0.00	4.17	$3.78	0.4%	0.00	8.85	$8.02	0.7%	0.00	8.79	$7.97	0.8%	0.00	6.46	$5.86	0.5%
5B	0.00	2.19	$1.98	0.2%	0.00	13.13	$11.90	1.0%	0.00	12.61	$11.43	1.1%	0.00	6.04	$5.47	0.4%
5C	0.00	1.78	$1.61	0.2%	0.00	8.96	$8.12	0.7%	0.00	12.00	$10.88	1.2%	0.00	4.47	$4.05	0.4%
6A	0.00	6.18	$5.60	0.5%	0.00	14.57	$13.21	1.0%	0.00	14.87	$13.47	1.2%	0.00	11.28	$10.23	0.8%
6B	0.00	4.04	$3.66	0.4%	0.00	11.67	$10.58	0.9%	0.00	9.20	$8.34	0.8%	0.00	6.65	$6.03	0.5%
7	0.00	1.37	$1.25	0.1%	0.00	18.29	$16.58	1.3%	0.00	17.77	$16.10	1.4%	0.00	10.94	$9.92	0.7%
8	0.00	3.23	$2.93	0.3%	0.00	27.56	$24.98	1.8%	0.00	28.35	$25.70	2.1%	0.00	14.27	$12.94	0.9%

C406.2.4: 10% Cool Efficiency Improvement

Cool10- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	271.16	0.00	$28.99	2.7%	247.28	-0.04	$26.40	1.9%	237.93	0.00	$25.44	2.3%	147.12	0.00	$15.73	1.3%
1B	306.95	0.00	$32.82	3.0%	305.20	-0.17	$32.48	2.1%	347.17	0.00	$37.12	3.1%	152.96	0.00	$16.35	1.3%
2A	249.77	0.00	$26.71	2.6%	216.94	-0.22	$23.00	1.7%	215.88	0.00	$23.08	2.2%	119.62	0.00	$12.79	1.1%
2B	207.40	0.00	$22.17	2.2%	179.83	-0.29	$18.96	1.4%	221.62	0.00	$23.70	2.0%	100.44	0.00	$10.74	0.9%
3A	155.65	0.00	$16.64	1.7%	141.14	-0.33	$14.79	1.1%	136.80	0.00	$14.63	1.5%	68.08	0.00	$7.28	0.6%
3B	153.84	0.00	$16.45	1.8%	134.46	-0.34	$14.07	1.1%	149.85	0.00	$16.02	1.5%	71.29	0.00	$7.62	0.6%
3C	113.07	0.00	$12.09	1.4%	89.39	-0.44	$9.16	0.8%	51.97	0.00	$5.56	0.6%	34.00	0.00	$3.64	0.3%
4A	114.37	0.00	$12.23	1.3%	102.98	-0.05	$10.97	0.9%	97.20	0.00	$10.39	1.1%	53.59	0.00	$5.73	0.5%
4B	121.83	0.00	$13.03	1.4%	86.83	-0.49	$8.84	0.7%	103.05	0.00	$11.02	1.1%	53.02	0.00	$5.67	0.5%
4C	73.29	0.00	$7.84	0.9%	37.67	-0.57	$3.51	0.3%	26.21	0.00	$2.80	0.3%	20.66	0.00	$2.21	0.2%
5A	83.96	0.00	$8.98	0.9%	64.22	-0.08	$6.79	0.6%	52.54	0.00	$5.62	0.6%	36.88	0.00	$3.94	0.3%
5B	101.11	0.00	$10.81	1.1%	67.27	-0.04	$7.16	0.6%	77.62	0.00	$8.30	0.8%	42.07	0.00	$4.50	0.4%
5C	53.77	0.00	$5.75	0.7%	30.50	-0.66	$2.66	0.2%	9.90	0.00	$1.06	0.1%	13.83	0.00	$1.48	0.1%
6A	89.66	0.00	$9.59	0.9%	66.93	-0.13	$7.04	0.5%	59.96	0.00	$6.41	0.6%	38.53	0.00	$4.12	0.3%
6B	75.16	0.00	$8.04	0.8%	47.32	-0.08	$4.99	0.4%	48.04	0.00	$5.14	0.5%	31.86	0.00	$3.41	0.3%
7	85.31	0.00	$9.12	0.9%	55.51	-0.16	$5.79	0.4%	42.64	0.00	$4.56	0.4%	34.91	0.00	$3.73	0.3%
8	67.03	0.00	$7.17	0.6%	27.34	-0.26	$2.69	0.2%	19.01	0.00	$2.03	0.2%	27.17	0.00	$2.90	0.2%

C406.3.1: 10% LPA Reduction

LPA10- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	214.60	0.00	$22.94	2.2%	258.25	-0.02	$27.60	1.9%	320.84	0.00	$34.30	3.1%	69.81	0.00	$7.46	0.6%
1B	212.42	-0.04	$22.68	2.1%	286.38	-0.05	$30.58	2.0%	358.42	-0.39	$37.97	3.1%	67.18	-0.02	$7.16	0.6%
2A	209.78	-0.15	$22.30	2.2%	264.37	0.04	$28.30	2.0%	379.45	-0.29	$40.31	3.8%	68.08	-0.06	$7.22	0.6%
2B	205.79	-0.11	$21.90	2.2%	270.31	0.09	$28.98	2.2%	395.43	-0.65	$41.69	3.6%	66.11	-0.07	$7.00	0.6%
3A	195.48	-0.67	$20.30	2.1%	247.47	0.00	$26.46	2.1%	369.67	-1.29	$38.35	3.9%	66.11	-0.36	$6.74	0.6%
3B	202.99	-0.40	$21.34	2.3%	270.61	0.64	$29.52	2.3%	375.07	-1.50	$38.74	3.6%	67.43	-0.21	$7.02	0.6%
3C	208.02	-0.12	$22.13	2.6%	240.00	-0.04	$25.62	2.2%	354.25	-0.95	$37.01	4.2%	67.59	-0.09	$7.15	0.7%
4A	180.20	-1.17	$18.20	1.9%	244.24	0.15	$26.25	2.1%	368.99	-2.57	$37.13	3.8%	60.43	-0.44	$6.07	0.5%
4B	197.09	-0.78	$20.37	2.2%	260.62	1.03	$28.80	2.3%	382.94	-2.65	$38.54	3.7%	68.25	-0.34	$6.99	0.6%
4C	185.43	-1.08	$18.85	2.1%	237.29	0.53	$25.86	2.2%	343.68	-4.08	$33.05	3.6%	64.38	-0.55	$6.39	0.6%
5A	172.85	-1.43	$17.19	1.7%	233.46	-0.10	$24.87	2.0%	300.25	-2.90	$29.47	3.0%	63.89	-0.64	$6.25	0.5%
5B	187.66	-1.21	$18.97	2.0%	255.92	1.04	$28.31	2.3%	376.98	-3.92	$36.76	3.4%	69.15	-0.59	$6.86	0.5%
5C	181.60	-1.52	$18.04	2.1%	225.35	-0.17	$23.94	2.1%	336.48	-4.74	$31.68	3.5%	63.39	-0.65	$6.19	0.5%
6A	170.21	-1.64	$16.71	1.6%	233.09	-0.86	$24.15	1.9%	453.70	-4.61	$44.33	4.0%	64.05	-0.77	$6.15	0.5%
6B	175.95	-1.60	$17.37	1.8%	234.21	-0.37	$24.71	2.0%	415.56	-3.34	$41.41	4.0%	65.61	-0.60	$6.47	0.5%
7	169.48	-0.49	$17.68	1.7%	228.99	-1.29	$23.32	1.8%	394.30	-4.67	$37.92	3.4%	64.46	-0.81	$6.16	0.5%
8	159.12	-0.77	$16.32	1.5%	234.85	-2.97	$22.42	1.6%	388.45	-5.90	$36.19	3.0%	62.57	-0.99	$5.79	0.4%

C406.3.3 Lamp efficacy 95%/65 Lm/W

Lefcy65- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	48.16	0.00	$5.15	0.4%
1B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	47.50	-0.03	$5.06	0.4%
2A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	46.35	-0.08	$4.88	0.4%
2B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	46.51	-0.08	$4.90	0.4%
3A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	45.36	-0.39	$4.49	0.4%
3B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	46.10	-0.24	$4.71	0.4%
3C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.37	-0.11	$4.64	0.4%
4A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	43.22	-0.43	$4.23	0.3%
4B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	46.10	-0.39	$4.57	0.4%
4C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.59	-0.58	$3.82	0.3%
5A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	42.65	-0.56	$4.05	0.3%
5B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.54	-0.60	$4.22	0.3%
5C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.01	-0.67	$3.67	0.3%
6A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	42.65	-0.65	$3.97	0.3%
6B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	43.47	-0.54	$4.16	0.3%
7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.49	-0.62	$3.87	0.3%
8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.00	-0.74	$3.71	0.3%

C406.4: Basic Enhanced Digital Light Control

The savings shown here matches the existing language for enhanced digital light control.

Basic Enhanced Lighting Control- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	46.36	0.00	$4.96	0.5%	52.00	-0.01	$5.55	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
1B	45.56	-0.01	$4.86	0.4%	68.04	0.01	$7.28	0.5%	NA	NA	NA	NA	NA	NA	NA	NA
2A	45.17	-0.03	$4.81	0.5%	54.38	0.00	$5.82	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
2B	44.29	-0.02	$4.72	0.5%	57.93	0.00	$6.19	0.5%	NA	NA	NA	NA	NA	NA	NA	NA
3A	41.64	-0.13	$4.34	0.5%	49.22	0.05	$5.31	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
3B	43.56	-0.08	$4.59	0.5%	63.32	0.29	$7.03	0.6%	NA	NA	NA	NA	NA	NA	NA	NA
3C	44.31	-0.02	$4.72	0.6%	47.30	-0.08	$4.99	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
4A	38.51	-0.21	$3.92	0.4%	52.98	0.10	$5.76	0.5%	NA	NA	NA	NA	NA	NA	NA	NA
4B	42.45	-0.15	$4.40	0.5%	65.01	0.45	$7.36	0.6%	NA	NA	NA	NA	NA	NA	NA	NA
4C	39.60	-0.21	$4.04	0.5%	53.07	0.22	$5.88	0.5%	NA	NA	NA	NA	NA	NA	NA	NA
5A	37.09	-0.26	$3.73	0.4%	53.80	-0.02	$5.74	0.5%	NA	NA	NA	NA	NA	NA	NA	NA
5B	40.09	-0.24	$4.07	0.4%	67.04	0.74	$7.84	0.6%	NA	NA	NA	NA	NA	NA	NA	NA
5C	38.95	-0.35	$3.84	0.4%	49.45	-0.26	$5.05	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
6A	36.52	-0.30	$3.63	0.3%	54.37	-0.06	$5.76	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
6B	37.71	-0.31	$3.75	0.4%	53.15	-0.02	$5.66	0.5%	NA	NA	NA	NA	NA	NA	NA	NA
7	36.62	-0.09	$3.83	0.4%	55.25	-0.46	$5.49	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
8	34.32	-0.14	$3.54	0.3%	44.88	-1.29	$3.63	0.3%	NA	NA	NA	NA	NA	NA	NA	NA

C406.4: Improved Enhanced Digital Light Control

The savings shown here matches the improved language for enhanced digital light control that requires tuning reduction of 15%.

Improved Enhanced Digital Lighting Control - Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost %	Electric kwh	Gas therm	Energy cost	Energy cost %	Electric kwh	Gas therm	Energy cost	Energy cost %	Electric kwh	Gas therm	Energy cost	Energy cost %
1A	92.72	0.00	$9.91	0.9%	104.00	-0.01	$11.11	0.8%	NA	NA	NA	NA	NA	NA	NA	NA
1B	91.11	-0.02	$9.73	0.9%	136.07	0.02	$14.57	1.0%	NA	NA	NA	NA	NA	NA	NA	NA
2A	90.33	-0.05	$9.61	0.9%	108.77	0.01	$11.64	0.8%	NA	NA	NA	NA	NA	NA	NA	NA
2B	88.57	-0.04	$9.43	1.0%	115.87	0.00	$12.39	0.9%	NA	NA	NA	NA	NA	NA	NA	NA
3A	83.29	-0.26	$8.67	0.9%	98.44	0.10	$10.61	0.8%	NA	NA	NA	NA	NA	NA	NA	NA
3B	87.12	-0.16	$9.17	1.0%	126.65	0.58	$14.06	1.1%	NA	NA	NA	NA	NA	NA	NA	NA
3C	88.62	-0.04	$9.44	1.1%	94.61	-0.15	$9.98	0.9%	NA	NA	NA	NA	NA	NA	NA	NA
4A	77.02	-0.43	$7.85	0.8%	105.95	0.20	$11.51	0.9%	NA	NA	NA	NA	NA	NA	NA	NA
4B	84.90	-0.30	$8.80	1.0%	130.03	0.90	$14.72	1.2%	NA	NA	NA	NA	NA	NA	NA	NA
4C	79.20	-0.42	$8.08	0.9%	106.14	0.45	$11.76	1.0%	NA	NA	NA	NA	NA	NA	NA	NA
5A	74.17	-0.52	$7.46	0.8%	107.60	-0.03	$11.48	0.9%	NA	NA	NA	NA	NA	NA	NA	NA
5B	80.18	-0.47	$8.15	0.9%	134.08	1.48	$15.68	1.3%	NA	NA	NA	NA	NA	NA	NA	NA
5C	77.90	-0.71	$7.69	0.9%	98.89	-0.53	$10.10	0.9%	NA	NA	NA	NA	NA	NA	NA	NA
6A	73.03	-0.60	$7.27	0.7%	108.73	-0.12	$11.51	0.9%	NA	NA	NA	NA	NA	NA	NA	NA
6B	75.42	-0.62	$7.50	0.8%	106.29	-0.04	$11.33	0.9%	NA	NA	NA	NA	NA	NA	NA	NA
7	73.24	-0.19	$7.66	0.7%	110.50	-0.93	$10.97	0.8%	NA	NA	NA	NA	NA	NA	NA	NA
8	68.63	-0.27	$7.09	0.6%	89.76	-2.58	$7.26	0.5%	NA	NA	NA	NA	NA	NA	NA	NA

C406.5: Renewable (PV)

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	454.40	0.00	$48.58	4.6%	420.44	0.00	$44.95	3.2%	415.32	0.00	$44.41	4.1%	437.99	0.00	$46.83	3.8%
1B	471.60	0.00	$50.42	4.6%	451.65	0.00	$48.29	3.1%	495.48	0.00	$52.98	4.1%	457.84	0.00	$48.95	3.8%
2A	440.19	0.00	$47.06	4.6%	404.67	0.00	$43.27	3.1%	401.88	0.00	$42.97	4.1%	428.28	0.00	$45.79	3.8%
2B	423.18	0.00	$45.25	4.6%	390.95	0.00	$41.80	3.1%	446.57	0.00	$47.75	4.0%	437.99	0.00	$46.83	3.8%
3A	401.17	0.00	$42.89	4.5%	366.77	0.00	$39.22	3.0%	393.12	0.00	$42.03	4.0%	410.21	0.00	$43.86	3.7%
3B	395.32	0.00	$42.27	4.5%	354.54	0.00	$37.91	3.0%	409.59	0.00	$43.79	3.9%	419.05	0.00	$44.81	3.8%
3C	365.23	0.00	$39.05	4.6%	330.90	0.00	$35.38	3.0%	335.39	0.00	$35.86	4.0%	381.90	0.00	$40.83	3.8%
4A	396.98	0.00	$42.45	4.4%	347.51	0.00	$37.16	3.0%	354.62	0.00	$37.92	3.8%	424.70	0.00	$45.41	3.7%
4B	386.32	0.00	$41.31	4.5%	334.06	0.00	$35.72	2.9%	380.53	0.00	$40.69	3.8%	418.02	0.00	$44.70	3.7%
4C	369.52	0.00	$39.51	4.5%	305.60	0.00	$32.67	2.8%	320.64	0.00	$34.28	3.6%	393.13	0.00	$42.03	3.7%
5A	401.46	0.00	$42.92	4.4%	330.49	0.00	$35.34	2.9%	335.79	0.00	$35.90	3.7%	423.44	0.00	$45.27	3.6%
5B	392.45	0.00	$41.96	4.5%	324.75	0.00	$34.72	2.8%	370.39	0.00	$39.60	3.6%	421.04	0.00	$45.02	3.6%
5C	359.48	0.00	$38.44	4.5%	313.95	0.00	$33.57	2.9%	312.60	0.00	$33.42	3.5%	389.38	0.00	$41.63	3.6%
6A	421.90	0.00	$45.11	4.3%	335.72	0.00	$35.90	2.8%	365.39	0.00	$39.07	3.5%	431.73	0.00	$46.16	3.5%
6B	394.60	0.00	$42.19	4.4%	328.90	0.00	$35.17	2.8%	375.13	0.00	$40.11	3.7%	433.04	0.00	$46.30	3.6%
7	439.64	0.00	$47.01	4.5%	330.80	0.00	$35.37	2.7%	355.56	0.00	$38.02	3.4%	437.98	0.00	$46.83	3.5%
8	463.08	0.00	$49.51	4.4%	320.11	0.00	$34.23	2.5%	358.17	0.00	$38.30	3.1%	448.55	0.00	$47.96	3.4%

C406.6: DOAS

DOAS- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	101.63	0.00	$10.87	1.0%	NA	NA	NA	NA	83.51	0.00	$8.93	0.8%	75.00	0.00	$8.02	0.6%
1B	110.52	0.01	$11.82	1.1%	NA	NA	NA	NA	122.21	0.32	$13.35	1.1%	117.05	0.96	$13.38	1.1%
2A	91.16	0.06	$9.80	1.0%	NA	NA	NA	NA	75.82	0.30	$8.38	0.8%	74.64	1.00	$8.89	0.7%
2B	85.22	0.05	$9.16	0.9%	NA	NA	NA	NA	84.41	1.05	$9.97	0.9%	75.10	2.98	$10.73	0.9%
3A	70.93	0.62	$8.15	0.9%	NA	NA	NA	NA	46.31	1.86	$6.64	0.7%	9.38	11.63	$11.54	1.0%
3B	56.89	0.19	$6.26	0.7%	NA	NA	NA	NA	50.96	1.72	$7.00	0.7%	8.59	5.79	$6.17	0.5%
3C	35.52	0.03	$3.83	0.4%	NA	NA	NA	NA	13.87	0.81	$2.22	0.3%	-46.71	0.52	-$4.52	-0.4%
4A	83.05	0.98	$9.76	1.0%	NA	NA	NA	NA	32.92	3.91	$7.07	0.7%	-2.47	21.82	$19.51	1.6%
4B	49.14	0.40	$5.61	0.6%	NA	NA	NA	NA	33.00	3.18	$6.41	0.6%	-11.50	12.64	$10.23	0.9%
4C	40.16	0.50	$4.75	0.5%	NA	NA	NA	NA	5.51	4.59	$4.75	0.5%	-36.64	18.61	$12.95	1.1%
5A	92.80	1.62	$11.39	1.2%	NA	NA	NA	NA	2.36	6.39	$6.04	0.6%	-23.30	30.19	$24.88	1.9%
5B	55.54	0.90	$6.76	0.7%	NA	NA	NA	NA	25.27	6.01	$8.15	0.8%	-18.16	20.24	$16.41	1.3%
5C	23.27	0.68	$3.11	0.4%	NA	NA	NA	NA	0.75	4.78	$4.41	0.5%	-28.91	20.39	$15.39	1.3%
6A	124.95	2.43	$15.56	1.5%	NA	NA	NA	NA	22.31	10.40	$11.82	1.1%	-21.70	39.49	$33.48	2.5%
6B	72.33	1.66	$9.24	1.0%	NA	NA	NA	NA	12.30	6.07	$6.82	0.7%	-25.50	28.90	$23.47	1.8%
7	101.23	0.69	$11.45	1.1%	NA	NA	NA	NA	15.86	10.85	$11.53	1.0%	-17.23	42.79	$36.95	2.7%
8	61.88	1.21	$7.72	0.7%	NA	NA	NA	NA	7.39	12.36	$11.99	1.0%	-25.77	50.87	$43.36	3.0%

C406.7.1: SWH Efficiency Improvement – Heat Recovery

SHW-HR-1- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	NA	NA	NA	NA	-0.31	3.34	$2.99	0.2%	NA	NA	NA	NA	-7.55	28.92	$25.41	2.4%
1B	NA	NA	NA	NA	-0.32	3.45	$3.09	0.2%	NA	NA	NA	NA	-7.66	29.01	25.47	2.3%
2A	NA	NA	NA	NA	-0.34	3.68	$3.30	0.2%	NA	NA	NA	NA	-8.28	31.36	27.54	2.7%
2B	NA	NA	NA	NA	-0.35	3.73	$3.34	0.2%	NA	NA	NA	NA	-8.32	31.52	27.68	2.6%
3A	NA	NA	NA	NA	-0.39	4.20	$3.76	0.3%	NA	NA	NA	NA	-9.38	35.53	31.20	3.2%
3B	NA	NA	NA	NA	-0.38	4.07	$3.65	0.3%	NA	NA	NA	NA	-9.10	34.45	30.26	3.0%
3C	NA	NA	NA	NA	-0.39	4.16	$3.73	0.3%	NA	NA	NA	NA	-9.49	35.96	31.58	3.6%
4A	NA	NA	NA	NA	-0.43	4.57	$4.10	0.3%	NA	NA	NA	NA	-10.32	38.79	34.06	3.4%
4B	NA	NA	NA	NA	-0.42	4.46	$4.00	0.3%	NA	NA	NA	NA	-10.07	37.85	33.23	3.4%
4C	NA	NA	NA	NA	-0.43	4.63	$4.15	0.4%	NA	NA	NA	NA	-10.50	39.79	34.94	3.8%
5A	NA	NA	NA	NA	-0.46	4.88	$4.37	0.4%	NA	NA	NA	NA	-10.97	41.54	36.48	3.6%
5B	NA	NA	NA	NA	-0.45	4.78	$4.29	0.3%	NA	NA	NA	NA	-10.68	40.75	35.80	3.5%
5C	NA	NA	NA	NA	-0.45	4.80	$4.30	0.4%	NA	NA	NA	NA	-10.92	41.36	36.32	4.0%
6A	NA	NA	NA	NA	-0.48	5.13	$4.60	0.4%	NA	NA	NA	NA	-11.42	43.57	38.28	3.6%
6B	NA	NA	NA	NA	-0.47	5.06	$4.53	0.4%	NA	NA	NA	NA	-11.37	43.05	37.81	3.6%
7	NA	NA	NA	NA	-0.50	5.40	$4.84	0.4%	NA	NA	NA	NA	-12.14	45.98	40.38	3.8%
8	NA	NA	NA	NA	-0.54	5.73	$5.14	0.4%	NA	NA	NA	NA	-12.92	49.24	43.25	3.9%

C406.7.2: SWH Efficiency Improvement – Fossil Fuel Efficiency

SHW-FFeff-2- Savings per 1000 square feet

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	NA	NA	NA	NA	0.00	1.94	$1.75	0.1%	NA	NA	NA	NA	0.08	15.22	$13.81	1.3%
1B	NA	NA	NA	NA	0.00	2.62	$2.37	0.2%	NA	NA	NA	NA	0.00	15.30	13.87	1.2%
2A	NA	NA	NA	NA	0.00	2.89	$2.62	0.2%	NA	NA	NA	NA	0.00	16.71	15.15	1.5%
2B	NA	NA	NA	NA	0.00	3.23	$2.93	0.2%	NA	NA	NA	NA	0.00	16.77	15.20	1.4%
3A	NA	NA	NA	NA	0.00	4.33	$3.92	0.3%	NA	NA	NA	NA	0.00	20.65	18.71	1.9%
3B	NA	NA	NA	NA	0.00	4.85	$4.40	0.3%	NA	NA	NA	NA	0.00	18.79	17.03	1.7%
3C	NA	NA	NA	NA	0.00	4.26	$3.86	0.3%	NA	NA	NA	NA	0.00	19.12	17.33	2.0%
4A	NA	NA	NA	NA	0.00	5.74	$5.20	0.4%	NA	NA	NA	NA	-0.08	22.28	20.19	2.0%
4B	NA	NA	NA	NA	0.00	6.81	$6.17	0.5%	NA	NA	NA	NA	-0.08	21.24	19.24	2.0%
4C	NA	NA	NA	NA	0.00	8.37	$7.58	0.7%	NA	NA	NA	NA	0.00	23.14	20.97	2.3%
5A	NA	NA	NA	NA	0.00	7.20	$6.53	0.5%	NA	NA	NA	NA	0.00	25.25	22.89	2.3%
5B	NA	NA	NA	NA	0.00	9.39	$8.51	0.7%	NA	NA	NA	NA	0.08	24.61	22.32	2.2%
5C	NA	NA	NA	NA	0.00	7.22	$6.54	0.6%	NA	NA	NA	NA	0.00	24.11	21.85	2.4%
6A	NA	NA	NA	NA	0.00	10.33	$9.36	0.7%	NA	NA	NA	NA	0.08	28.85	26.16	2.4%
6B	NA	NA	NA	NA	0.00	8.78	$7.96	0.6%	NA	NA	NA	NA	0.00	26.14	23.70	2.3%
7	NA	NA	NA	NA	0.00	12.42	$11.26	0.9%	NA	NA	NA	NA	0.00	29.93	27.13	2.5%
8	NA	NA	NA	NA	0.00	17.45	$15.82	1.2%	NA	NA	NA	NA	0.08	33.39	30.27	2.7%

C406.7.3: SWH Efficiency Improvement – Heat Pump Water Heater

SHW-HPWH-3- Savings per 1000 square feet																
CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	NA	NA	NA	NA	-82.00	11.08	$1.28	0.1%	NA	NA	NA	NA	-677.36	96.41	$14.97	1.4%
1B	NA	NA	NA	NA	-84.78	11.33	$1.21	0.1%	NA	NA	NA	NA	-676.57	96.69	15.30	1.4%
2A	NA	NA	NA	NA	-90.38	12.05	$1.26	0.1%	NA	NA	NA	NA	-755.09	104.53	14.02	1.4%
2B	NA	NA	NA	NA	-91.59	12.13	$1.21	0.1%	NA	NA	NA	NA	-769.11	105.06	13.00	1.2%
3A	NA	NA	NA	NA	-103.07	13.65	$1.35	0.1%	NA	NA	NA	NA	-890.30	118.44	12.17	1.2%
3B	NA	NA	NA	NA	-99.93	13.22	$1.30	0.1%	NA	NA	NA	NA	-860.61	114.85	12.09	1.2%
3C	NA	NA	NA	NA	-102.31	13.45	$1.25	0.1%	NA	NA	NA	NA	-919.07	119.87	10.40	1.2%
4A	NA	NA	NA	NA	-112.25	15.18	$1.76	0.1%	NA	NA	NA	NA	-982.61	129.29	12.14	1.2%
4B	NA	NA	NA	NA	-109.49	14.37	$1.32	0.1%	NA	NA	NA	NA	-958.31	126.15	11.89	1.2%
4C	NA	NA	NA	NA	-113.71	14.86	$1.31	0.1%	NA	NA	NA	NA	-1025.51	132.62	10.57	1.2%
5A	NA	NA	NA	NA	-119.84	16.18	$1.85	0.2%	NA	NA	NA	NA	-1062.89	138.47	11.88	1.2%
5B	NA	NA	NA	NA	-117.45	15.90	$1.85	0.1%	NA	NA	NA	NA	-1039.67	135.85	11.98	1.2%
5C	NA	NA	NA	NA	-117.79	15.32	$1.29	0.1%	NA	NA	NA	NA	-1069.96	137.86	10.56	1.2%
6A	NA	NA	NA	NA	-125.98	16.97	$1.91	0.1%	NA	NA	NA	NA	-1114.94	145.25	12.45	1.2%
6B	NA	NA	NA	NA	-124.24	16.78	$1.92	0.2%	NA	NA	NA	NA	-1104.75	143.50	11.96	1.2%
7	NA	NA	NA	NA	-132.64	17.83	$1.98	0.2%	NA	NA	NA	NA	-1179.46	153.26	12.82	1.2%
8	NA	NA	NA	NA	-140.84	18.86	$2.03	0.1%	NA	NA	NA	NA	-1268.34	164.12	13.16	1.2%

C406.8: 85% of required UA

UA85- Savings per 1000 square feet

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	36.72	0.00	$3.93	0.4%	83.45	0.12	$9.04	0.6%	99.90	0.00	$10.68	1.0%	91.63	0.00	$9.80	0.8%
1B	90.28	0.00	$9.66	0.9%	227.53	0.86	$25.11	1.6%	155.47	1.01	$17.54	1.4%	169.84	0.27	$18.40	1.4%
2A	52.52	-0.08	$5.54	0.5%	88.22	0.66	$10.03	0.7%	69.07	0.90	$8.20	0.8%	83.23	1.02	$9.83	0.8%
2B	82.41	0.01	$8.82	0.9%	131.90	0.74	$14.78	1.1%	103.27	1.71	$12.59	1.1%	127.28	1.03	$14.54	1.2%
3A	95.36	0.12	$10.30	1.1%	44.47	0.56	$5.27	0.4%	37.80	4.41	$8.04	0.8%	56.56	6.24	$11.71	1.0%
3B	59.10	0.02	$6.34	0.7%	111.02	1.18	$12.94	1.0%	54.11	3.68	$9.12	0.8%	82.66	3.43	$11.94	1.0%
3C	-6.22	0.01	-$0.65	-0.1%	22.50	1.12	$3.42	0.3%	12.26	1.85	$2.99	0.3%	6.09	1.15	$1.69	0.2%
4A	166.58	-0.37	$17.47	1.8%	39.70	0.26	$4.48	0.4%	67.72	7.28	$13.84	1.4%	31.94	8.17	$10.82	0.9%
4B	78.68	0.14	$8.54	0.9%	82.48	1.45	$10.13	0.8%	56.14	5.42	$10.92	1.0%	47.09	6.04	$10.51	0.9%
4C	105.46	0.25	$11.51	1.3%	21.18	2.02	$4.10	0.4%	14.96	7.41	$8.31	0.9%	10.29	8.46	$8.77	0.8%
5A	225.47	-0.05	$24.06	2.4%	33.16	2.35	$5.68	0.5%	-10.35	11.44	$9.26	1.0%	13.91	12.33	$12.66	1.0%
5B	152.75	0.36	$16.66	1.8%	67.83	3.46	$10.39	0.8%	34.20	10.24	$12.94	1.2%	38.20	11.23	$14.26	1.1%
5C	103.70	0.86	$11.87	1.4%	-2.48	0.71	$0.38	0.0%	4.27	8.83	$8.47	0.9%	-3.54	10.13	$8.80	0.8%
6A	281.36	0.13	$30.20	2.9%	55.17	9.25	$14.28	1.1%	32.62	15.63	$17.66	1.6%	16.05	16.58	$16.75	1.3%
6B	217.03	0.38	$23.55	2.4%	39.32	6.89	$10.45	0.8%	20.92	12.45	$13.53	1.3%	15.89	12.59	$13.11	1.0%
7	335.75	0.64	$36.48	3.5%	70.38	14.53	$20.70	1.6%	42.64	18.45	$21.28	1.9%	40.34	15.78	$18.62	1.4%
8	419.61	-0.23	$44.65	4.0%	81.39	23.49	$29.99	2.2%	36.67	25.57	$27.10	2.2%	18.28	21.19	$21.17	1.5%

C406.9: Low Leakage Envelope (0.25)

Infiltration 0.25 cfm/sq ft- Savings per 1000 square feet

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	44.44	0.00	$4.75	0.4%	34.52	0.02	$3.71	0.3%	16.87	0.00	$1.80	0.2%	187.79	0.00	$20.08	1.6%
1B	31.34	0.00	$3.35	0.3%	36.36	0.07	$3.95	0.3%	24.41	0.07	$2.67	0.2%	154.61	0.00	$16.53	1.3%
2A	30.51	0.04	$3.30	0.3%	22.76	0.13	$2.55	0.2%	14.74	0.51	$2.04	0.2%	85.70	1.41	$10.44	0.9%
2B	53.45	0.07	$5.78	0.6%	54.31	0.29	$6.07	0.5%	35.10	1.57	$5.17	0.4%	300.82	1.72	$33.72	2.7%
3A	71.84	0.82	$8.42	0.9%	10.48	0.03	$1.15	0.1%	2.70	3.50	$3.46	0.4%	56.48	12.36	$17.24	1.4%
3B	20.36	0.16	$2.32	0.2%	12.51	0.19	$1.51	0.1%	4.05	1.70	$1.98	0.2%	71.87	3.70	$11.04	0.9%
3C	-8.55	0.03	-$0.89	-0.1%	-6.61	0.26	-$0.47	0.0%	-12.49	0.81	-$0.60	-0.1%	-1.40	1.18	$0.92	0.1%
4A	165.23	0.53	$18.14	1.9%	1.46	-0.37	-$0.17	0.0%	1.80	7.94	$7.39	0.8%	25.27	20.21	$21.02	1.7%
4B	30.97	0.35	$3.63	0.4%	-0.94	0.02	-$0.09	0.0%	-5.85	3.46	$2.52	0.2%	24.37	7.90	$9.76	0.8%
4C	57.81	0.41	$6.55	0.7%	-9.16	0.23	-$0.77	-0.1%	-12.37	4.92	$3.13	0.3%	-38.69	14.10	$8.64	0.8%
5A	239.92	0.88	$26.45	2.7%	11.34	1.50	$2.57	0.2%	-46.01	12.78	$6.67	0.7%	-18.36	32.86	$27.82	2.2%
5B	80.23	0.66	$9.18	1.0%	-2.70	1.83	$1.37	0.1%	-4.05	6.71	$5.65	0.5%	0.58	16.61	$15.12	1.2%
5C	19.73	0.34	$2.41	0.3%	-11.08	0.04	-$1.14	-0.1%	-10.12	2.93	$1.58	0.2%	-48.57	8.31	$2.34	0.2%
6A	352.69	1.39	$38.97	3.7%	40.60	11.05	$14.36	1.1%	7.54	20.61	$19.49	1.8%	-3.70	47.15	$42.35	3.2%
6B	173.78	1.21	$19.68	2.0%	7.51	3.78	$4.23	0.3%	-15.41	11.18	$8.49	0.8%	-39.35	24.71	$18.20	1.4%
7	270.12	0.85	$29.65	2.8%	29.67	12.17	$14.20	1.1%	5.29	18.15	$17.02	1.5%	-33.01	34.67	$27.90	2.1%
8	146.64	0.51	$16.14	1.4%	26.44	8.95	$10.94	0.8%	3.71	10.86	$10.24	0.8%	-61.17	20.78	$12.30	0.9%

C406.10: PlugLoad 50% control

Plug Load 50- Savings per 1000 square feet

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost%
1A	376.51	0.00	$40.26	3.8%	659.30	-0.14	$70.37	4.9%	NA	NA	NA	NA	NA	NA	NA	NA
1B	369.16	-0.02	$39.45	3.6%	688.74	-0.55	$73.14	4.8%	NA	NA	NA	NA	NA	NA	NA	NA
2A	357.50	-0.06	$38.17	3.7%	650.77	-0.50	$69.13	5.0%	NA	NA	NA	NA	NA	NA	NA	NA
2B	341.55	-0.06	$36.46	3.7%	643.90	-0.60	$68.30	5.1%	NA	NA	NA	NA	NA	NA	NA	NA
3A	314.41	-0.33	$33.32	3.5%	615.21	-1.28	$64.61	5.0%	NA	NA	NA	NA	NA	NA	NA	NA
3B	334.45	-0.18	$35.59	3.8%	624.14	-0.80	$66.01	5.2%	NA	NA	NA	NA	NA	NA	NA	NA
3C	337.35	-0.05	$36.02	4.2%	598.12	-0.83	$63.20	5.4%	NA	NA	NA	NA	NA	NA	NA	NA
4A	280.64	-0.29	$29.74	3.1%	604.91	-1.79	$63.06	5.1%	NA	NA	NA	NA	NA	NA	NA	NA
4B	319.59	-0.30	$33.90	3.7%	617.57	-1.07	$65.06	5.3%	NA	NA	NA	NA	NA	NA	NA	NA
4C	278.51	-0.33	$29.48	3.4%	588.31	-1.47	$61.57	5.3%	NA	NA	NA	NA	NA	NA	NA	NA
5A	259.56	-0.30	$27.48	2.8%	586.40	-2.74	$60.21	4.9%	NA	NA	NA	NA	NA	NA	NA	NA
5B	293.64	-0.42	$31.01	3.3%	604.95	-2.40	$62.50	5.0%	NA	NA	NA	NA	NA	NA	NA	NA
5C	275.82	-0.45	$29.09	3.4%	584.93	-1.62	$61.08	5.2%	NA	NA	NA	NA	NA	NA	NA	NA
6A	253.44	-0.32	$26.80	2.5%	578.85	-4.70	$57.63	4.5%	NA	NA	NA	NA	NA	NA	NA	NA
6B	267.84	-0.44	$28.24	2.9%	586.14	-3.57	$59.43	4.8%	NA	NA	NA	NA	NA	NA	NA	NA
7	251.53	-0.15	$26.76	2.6%	579.68	-6.58	$56.01	4.3%	NA	NA	NA	NA	NA	NA	NA	NA
8	231.43	-0.22	$24.55	2.2%	559.47	-10.29	$50.49	3.7%	NA	NA	NA	NA	NA	NA	NA	NA

C406.11: 150% Daylit of primary

DL40- Savings per 1000 square feet

CZ	Medium Office				Primary School				Retail Standalone				Midrise Apartment			
	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost %	Electric kwh	Gas therm	Energy cost	Energy cost%	Electric kwh	Gas therm	Energy cost	Energy cost %
1A	164.56	0.00	$17.59	1.7%	59.38	-0.09	$6.27	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
1B	163.73	-0.02	$17.49	1.6%	36.88	-0.41	$3.57	0.2%	NA	NA	NA	NA	NA	NA	NA	NA
2A	161.61	-0.10	$17.19	1.7%	71.29	-0.38	$7.28	0.5%	NA	NA	NA	NA	NA	NA	NA	NA
2B	157.00	-0.04	$16.75	1.7%	58.33	-0.58	$5.71	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
3A	145.34	-0.25	$15.32	1.6%	83.53	-0.82	$8.19	0.6%	NA	NA	NA	NA	NA	NA	NA	NA
3B	152.02	-0.14	$16.12	1.7%	80.90	-0.45	$8.24	0.7%	NA	NA	NA	NA	NA	NA	NA	NA
3C	154.56	-0.10	$16.43	1.9%	81.24	-1.04	$7.74	0.7%	NA	NA	NA	NA	NA	NA	NA	NA
4A	132.65	-0.69	$13.56	1.4%	89.69	-0.65	$9.00	0.7%	NA	NA	NA	NA	NA	NA	NA	NA
4B	147.98	-0.28	$15.57	1.7%	95.59	-0.31	$9.94	0.8%	NA	NA	NA	NA	NA	NA	NA	NA
4C	137.16	-0.99	$13.77	1.6%	75.30	-3.84	$4.57	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
5A	127.16	-0.73	$12.94	1.3%	98.06	-1.88	$8.78	0.7%	NA	NA	NA	NA	NA	NA	NA	NA
5B	138.87	-0.41	$14.48	1.5%	87.77	0.31	$9.66	0.8%	NA	NA	NA	NA	NA	NA	NA	NA
5C	135.14	-1.75	$12.86	1.5%	93.22	-2.90	$7.34	0.6%	NA	NA	NA	NA	NA	NA	NA	NA
6A	125.30	-0.56	$12.89	1.2%	78.83	-5.08	$3.82	0.3%	NA	NA	NA	NA	NA	NA	NA	NA
6B	128.46	-0.47	$13.31	1.4%	78.16	-3.69	$5.02	0.4%	NA	NA	NA	NA	NA	NA	NA	NA
7	124.52	-0.13	$13.19	1.3%	69.75	-7.79	$0.40	0.0%	NA	NA	NA	NA	NA	NA	NA	NA
8	114.99	-0.41	$11.92	1.1%	24.79	-17.67	-$13.37	-1.0%	NA	NA	NA	NA	NA	NA	NA	NA

C406.12: Kitchen Equipment Improvement

Based on per kitchen savings as described under input parameters; not related to prototype or climate zone.

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