PHIUS+ 2015 Protocol:
Multifamily Lighting + Miscellaneous Electric Loads v1

1 Primary Energy limit

1.1 Residential – low- and high-rise

Buildings considered residential include single-family detached housing, single-family attached housing, multifamily buildings, excepting hotels and motels.
The primary energy (PE) limit for both low and high-rise residential buildings is 6200 kWh/person.yr
For purposes of the PE limit, the number of persons, the design occupancy, is taken to be the Number of bedrooms+1, on a per unit or unit-by-unit basis (e.g., four two-bedroom units have a design occupancy of twelve, not nine.)

1.2 Nonresidential

The PE limit for nonresidential buildings is 11.1 kWh/ft^2 of iCFA (38 kBTU/ft^2 of iCFA).

iCFA is the interior-dimension (drywall to drywall) projected floor area of the conditioned spaces with at least seven feet ceiling height. It includes stairs, cabinets, interior walls, mechanical spaces, storage, but excludes open-to-below.

1.3 Mixed-use

The residential limit also applies if the building has common spaces and conditioned spaces that are not dwelling units, but that primarily serve the residents. Nonresident occupants of such common spaces (staff) are not included in the occupant count for determining the primary energy allowance. (Nor do they determine lighting and miscellaneous energy use, as explained in Section 2 below.)

If there are non-residential spaces designed to mainly serve non-resident customers/clientele, an additional PE allowance may be calculated based on the iCFA of those spaces. The nonresident occupants of such spaces, the staff and customers, are not included in the occupant count for determining the per-person portion of the primary energy allowance.

Certification staff may require separate modeling of the residential and nonresidential parts of a mixed-use building.

2 Lighting and Miscellaneous Loads

The basic protocol for lighting and miscellaneous electric loads is that they are calculated at 80% of RESNET (2013) levels for the "Rated Home". [1] RESNET's formulas are intended to apply to living/dwelling units, whether detached or attached, and strictly speaking to buildings of three stories or less. RESNET does not yet have protocol for multifamily common spaces. For PHIUS certification, the scope of the RESNET formulas is expanded to include multifamily buildings four stories or more in height, but applies only to the dwelling units. Supplemental protocol for

multifamily common spaces and certain outdoor loads follows Building America House Simulation Protocols (2014). [2] In the formulas, iCFA is used in place of RESNET's CFA and Building America's FFA. The RESNET lighting formulas have been expressed more compactly here but are algebraically equivalent to the published versions. There are additional options for calculating the energy use of pools and elevators.

2.1 Miscellaneous Electric Loads (MELs)

For whole-building certification:

$$\boldsymbol{MEL} = \boldsymbol{MEL}_{DWELL} + \boldsymbol{MEL}_{COMM} + \boldsymbol{MEL}_{YARD} \text{ (kWh/yr)}$$

$\boldsymbol{MEL}_{DWELL}$ accounts for the living units
$\boldsymbol{MEL}_{COMM}$ accounts for the common spaces (if the design includes any)
$\boldsymbol{MEL}_{YARD}$ accounts for Large / Uncommon Electric and Gas loads (if the design includes any)

To facilitate verification, the $\boldsymbol{MEL}_{DWELL}$ calculation must be itemized. This may be done by unit type or floor-by-floor.

For itemization by unit type *k*:

$$\boldsymbol{MEL}_{DWELL} = \sum_k units_k * (413 + 69 * Nbr_k + 0.91 * iCFA_k) * 0.8$$

$\boldsymbol{k}$ are the unit types
$\boldsymbol{units_k}$ is the number of units of type *k* in the building
$\boldsymbol{Nbr_k}$ is the number of bedrooms in a unit of type *k*
$\boldsymbol{iCFA_k}$ is the interior conditioned floor area of a unit of type *k* [3]
For purposes of this calculation, $\boldsymbol{iCFA_k}$ may include or exclude the projected floor area of interior partition walls within or between units, whichever approach is simpler to document.

For itemization by floor *n*:

$$\boldsymbol{MEL}_{DWELL} = \sum_n \left(units_n * 413 + 69 * Nbr_n + 0.91 * iCFA_{DWELL,n}\right) * 0.8$$

$\boldsymbol{n}$ are the floors
$\boldsymbol{units_n}$ is the number of units on floor *n*
$\boldsymbol{Nbr_n}$ is the number of bedrooms on floor *n*
$\boldsymbol{iCFA_{DWELL,n}}$ is the interior conditioned floor area of all the dwelling units on floor *n*, including the partition walls within and between units, but not including the floor area of the common spaces.
For purposes of this calculation, $\boldsymbol{iCFA_{DWELL,n}}$ may include or exclude the projected floor area of interior partition walls to common spaces, whichever approach is simpler to document.

For ***MEL***$_{COMM}$ add the following, or submit a more detailed accounting.

Multifamily Common Space MELs. [4]

Room Type	Electricity (kWh/yr)
Office	3.2 x iCFA
Workout room	9.8 x iCFA
Corridor/restroom/mechanical	0
Elevator	1,900

Alternate for Elevators: More detailed calculation may be made using:
https://www.thyssenkruppelevator.com/Tools/energy-calculator
http://www.schindler3300na.com/cgi-bin/calc/calc.pl

Although BAHSP has protocol for some "Multipurpose Room MELs", in a whole-building model any television, dishwasher, range, or microwave in a multipurpose room may be neglected – usage of these in the multipurpose room is assumed to displace usage in the units. However, any refrigerators or freezers in a multipurpose room should be added as additional appliances at their rated kWh/day.

For ***MEL***$_{YARD}$ use the table below or perform a more detailed calculation.

Large Uncommon Electric and Gas Loads [5]

Appliance	Electricity (kWh/yr)	Natural Gas (therms/yr)
Pool heater, gas	-	$3/0.014 \times F_{scale}$
Pool heater, electric	$10.1/0.0044 \times F_{scale}$	-
Pool pump	$158.5/0.07 \times F_{scale}$	-
Hot tub/spa heater, gas	-	$0.87/0.011 \times F_{scale}$
Hot tub/spa heater, electric	$49/0.048 \times F_{scale}$	-
Hot tub/spa pump	$59.5/0.059 \times F_{scale}$	-
Well pump	$50.8/0.127 \times F_{scale}$	-
Gas fireplace	-	$1.95/0.032 \times F_{scale}$
Gas grill	$0.87/0.029 \times F_{scale}$	-
Gas lighting	$0.22/0.012 \times F_{scale}$	-

Where the scaling factor, F_{scale} = (0.5 + 0.25 Nbr/3 + 0.25 iCFA/1920)
1 therm = 100 kBtu / [3.412 kBtu/kWh] = 29.3 kWh

Alternate for Pools/Spas: More detailed calculations may be made using this calculator:
http://energyexperts.org/CalculatorsTools/PoolEnergyUseCalculator.aspx

2.2 Lighting

2.2.1 Interior lighting

For whole-building certification:

$$LIGHTS_{INT} = LIGHTS_{INT,DWELL} + LIGHTS_{INT,COMM} \text{ (kWh/yr)}$$

$LIGHTS_{INT,DWELL}$ accounts for the living units. [6]
$LIGHTS_{INT,COMM}$ accounts for the common spaces (if the design includes any)

As with MELs, the $LIGHTS_{INT,DWELL}$ calculation must be itemized. This may be done by unit type or floor-by-floor.

For itemization by unit type k:

$$LIGHTS_{INT,DWELL} = \sum_k units_k * (0.2 + 0.8 * (4 - 3 * qFFIL)/3.7) * (455 + 0.8 * iCFA_k) * 0.8$$

$qFFIL$ is the ratio of the Qualifying interior Light Fixtures to all interior light fixtures in Qualifying interior Light Fixture Locations

For itemization by floor n:

$$LIGHTS_{INT,DWELL} = \sum_n (0.2 + 0.8 * (4 - 3 * qFFIL)/3.7) * \left(units_n * 455 + 0.8 * iCFA_{DWELL,n}\right) * 0.8$$

For $LIGHTS_{INT,COMM}$ use the table below for any of the listed Room Types that are included in the design, or submit a more detailed calculation.

Multifamily Common Space Lighting [7]

Room Type	Operating Hours (hrs/day)	W/ft^2
Central Restroom	1.6	0.9
Common Laundry	24	0.7
Common Mail	12	2.8
Common Office	9	1
Elevator	24	1.25
Equip. Room	0	1.5
Indoor Corridor	24	0.5
Multi-Purpose	12	1.1
Workout Room	16	0.9

$$LIGHTS_{INT,COMM} = (Operating\ hours * operating\ days\ * \frac{W}{ft^2} * iCFA_{COMM})/1000$$

Operating hours are per day
Operating days are per year
$\frac{W}{ft^2}$ is the lighting power density of the space
$iCFA_{COMM}$ is the interior conditioned floor area of each unique common space, not including interior partition walls.

2.2.2 Exterior Lighting

$$LIGHTS_{EXT} = LIGHTS_{EXT,DWELL} + LIGHTS_{EXT,COMM} + LIGHTS_{GAR}\ (kWh/yr)$$

$LIGHTS_{EXT,DWELL}$ pertains to exterior lighting for the dwelling units (balcony/porch or general building lights). [8]
$LIGHTS_{EXT,COMM}$ pertains to exterior lighting for the common spaces (exterior courtyards, exterior corridors/stairs, outdoor walkways etc.,)
$LIGHTS_{GAR}$ pertains only if the project includes a garage*

For itemization by unit type *k*:

$$LIGHTS_{EXT,DWELL} = \sum_k units_k * (1 - 0.75 * FFEL) * (100 + 0.05 * iCFA_k) * 0.8$$

FFEL is the Fraction of exterior fixtures that are Qualifying Light Fixtures

For itemization by floor *n*:

$$LIGHTS_{EXT,DWELL} = \sum_n (1 - 0.75 * FFEL) * (units_n * 100 + 0.05 * iCFA_n) * 0.8$$

For $LIGHTS_{EXT,COMM}$ use the table below for any of the listed Room Types that are included in the design, or submit a more detailed calculation.

Exterior Lighting [9]

Room Type	Operating Hours (hrs/day)	W/ft^2
Open Parking*	12	0.15
Outdoor Stairs	12	0.3
Outdoor Walkways	12	0.3

$$LIGHTS_{EXT,COMM} = (Operating\ hours * operating\ days\ * \frac{W}{ft^2} * iCFA_{COMM})/1000$$

Operating hours are per day
Operating days are per year
$\frac{W}{ft^2}$ is the lighting power density of the space
$iCFA_{COMM}$ is the interior conditioned floor area of each unique common space, not including interior partition walls.

Garage lighting may be calculated by the "80% RESNET" formula [10], BA default, or a more detailed calculation.

$LIGHTS_{GAR} = Units * 100*(1-0.75*FFGL) * 0.8$

Units is the total number of dwelling units in the building
FFGL is the fraction of garage fixtures that are Qualifying Light Fixtures.

Garage Lighting* [11]

Room Type	Operating Hours (hrs/day)	W/ft^2
Parking Garage*	24	0.2

*Note: PHIUS does not require projects to include lighting energy for an open parking lot/parking garage , block heaters, or vehicle charging in the energy model for certification. For now, PHIUS will consider this part of the 'transportation sector'.

References

1 *Mortgage Industry National Home Energy Rating Systems Standards*, Residential Energy Services Network (RESNET), Oceanside CA, 2013.
2 E. Wilson, C. Engebrecht Metzger, S. Horowitz, and R. Hendron, *2014 Building America House Simulation Protocols* (BAHSP), National Renewable Energy Laboratory (NREL) Technical Report NREL/TP-5500-60988, March 2014.
3 RESNET, op. cit., clause 303.4.1.7.2.1 "Residual MELs" and 303.4.1.7.2.6 "Televisions".
4 BAHSP, op. cit., Table 25. For Office and Workout room, footnote therein refers in turn to "Home Energy Usage Chart," Public Service of New Hampshire, 2013, and assumes 1h/wk usage.
5 BAHSP, op. cit., Table 26.
6 RESNET, op. cit., clause 303.4.1.7.2.2 Interior Lighting, and equation 5.
7 Building America "B10 Analysis – New Construction 2011-01-26" workbook, Detailed Lighting tab, C89:D101 and C120:L132
8 RESNET, op. cit., clause 303.4.1.7.2.3 Exterior Lighting, and equation 6.
9 B10 Analysis workbook, op. cit.
10 RESNET, op. cit., clause 303.4.1.7.2.4 Garage lighting, and equation 7.
11 B10 Analysis workbook, op. cit.