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REALPAC

Energy Profiles Limited

Normalized Energy Use Intensity (NEUI) Methodology

Commercial Office Buildings

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Intended Use & Adoption

The REALPAC Normalized Energy Use Intensity (NEUI) Methodology: Commercial Office Buildings ("REALPAC NEUI Methodology") provides users with a way to calculate the energy use intensity of an office building, while taking into consideration a number of factors, such as weather and occupancy. It is intended that the REALPAC NEUI Methodology will provide building owners and managers with a reliable way to calculate the energy use intensity of their building portfolios based on current conditions, and that it will be adopted by the commercial real estate industry. As more building owners and managers adopt the REALPAC NEUI Methodology, the energy intensity of their buildings can be compared and benchmarked.

Scope & Future Updates

The REALPAC NEUI Methodology will be updated over time through feedback and review from industry to ensure that it remains current and valuable to users. The examination and comparison of energy expended in the generation and delivery of different energy types to the building, as well as computation of resulting emissions, are broader perspectives that could be addressed in the future but are not within the scope of the REALPAC NEUI Methodology and Tool at this time. The REALPAC NEUI Methodology is designed as an internal tool that building owners and managers can use to calculate and report a building's energy use intensity and does not involve voluntary industry reporting and benchmarking, as was the case with REALPAC's previous 20 by '15 program. The REALPAC NEUI Methodology is currently only designed for commercial office buildings but may be expanded to other asset classes in the future.

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1. Introduction

In September 2009, the Real Property Association of Canada ("REALPAC") adopted an energy consumption target for office buildings of 20 equivalent kilowatt-hours of total energy use per square foot of building area per year ("20 $ekWh/ft^2$/year"), to be achieved by 2015. For short, "20 by '15".

In response to industry demands for clarity and guidance around calculating building energy consumption, a sub-committee was formed in April 2010 that led to the development and release of the REALPAC Energy Normalization Methodology (the "Original Methodology"). After incorporating industry commentary and feedback, the Original Methodology formed the basis of the REALPAC Benchmarking Survey, which was conducted annually for reporting years 2009-2015. Through this period, office building performance improved steadily, and the original target of 20 $ekWh/ft^2$ is now routinely surpassed across Canada.

The COVID-19 pandemic has exposed gaps in the Original Methodology that have reduced its effectiveness in evaluating building performance in periods of very low occupant density. At the same time, through years of analysis on hundreds of buildings, opportunities to improve the Original Methodology were identified. These factors have led to a comprehensive review and update of the Original Methodology, with a view to unleashing the next wave of investment in energy and carbon reductions over the coming decades. The result is the updated REALPAC Normalized Energy Use Intensity (NEUI) Methodology: Commercial Office Buildings (the "REALPAC NEUI Methodology").

For any energy use target or whole building performance evaluation to be used as a powerful management tool, it must be based on a foundation of accurate and robust data, credible and equitable assumptions, and a replicable methodology. The REALPAC NEUI Methodology discusses the technical details behind each of its key elements and calculations and the processes by which the total energy use of an office building is calculated. The explanations of the assumptions and procedures behind the REALPAC NEUI Methodology are geared towards helping all users (owners, operators, and energy professionals) understand how their building energy use intensity metric is calculated and to provide a transparent approach. The REALPAC NEUI Methodology incorporates industry expertise as well as international best practices and can be used as a tool for calculating and reporting a building's energy use intensity.

2. Background

Data supporting the original “20 by ‘15” target was based on normalized energy usage that was collected from national, large-scale pilot projects conducted by the Canada Green Building Council (CaGBC) in 2008. These pilot projects engaged more than 40 commercial office and government real property owners, involved 144 buildings totalling 48 million ft^2, and created a large, detailed database of Canadian office building energy performance. The pilot project data was normalized for weather differences across the country by using ratios of heating degree days (HDDs) and cooling degree days (CDDs) between the Environment Canada weather station closest to the building and the Toronto City weather station. Further normalizations for material space, occupancy, and energy source differences between buildings (such as data centres, retail space, and electric heat) were performed as part of the analysis and allowed for the benchmarking of the buildings’ energy performance against one another. Normalization procedures were reconceptualized and enhanced for the Original Methodology.

The ongoing collection of building energy use data since 2010 has led to the development of an updated model building energy breakdown reflecting current best practice, along with an updated proportionate energy use (% of total) for each system component of the model building. Figure 1, below, displays an example of the new model building energy breakdown.

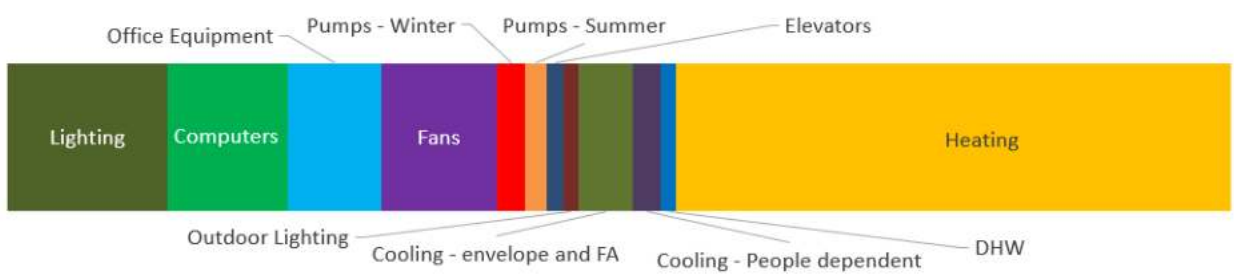

Figure 1: New Model Building Energy Breakdown (2021)

This new model building energy use breakdown provides a basis for the various assumptions and types of calculations chosen.

2.1. Purpose and Principles

The development of the Original Methodology followed the basic principles of transparency, simplicity, credibility, verifiability, inclusivity, and relevance. These guiding principles, which were also adhered to during the discussions and decision-making processes behind the REALPAC NEUI Methodology, are outlined below:

1) **Transparency** – to disclose sufficient and appropriate information regarding issues addressed, references used, and decisions made during the development process, as well as providing clear explanations of calculations to allow users to have confidence in the development and use of the REALPAC NEUI Methodology and related documents/tools.
2) **Simplicity** – to keep the REALPAC NEUI Methodology and integrated procedures easy to understand and manageable for building owners, managers, engineers, and energy

professionals who may have a wide range of background experience and knowledge in building energy computation.

3) **Credibility** – to include both international and national standards as well as industry best practices within the REALPAC NEUI Methodology to increase its integrity and to promote its widespread adoption and use.
4) **Verifiability** – to allow for third-party assurance regarding data collection and input, thus increasing the reliability of the resulting metric and the meaningfulness of comparisons between buildings.
5) **Inclusivity** – to encourage participation throughout the industry by making the procedure applicable to a wide range of buildings, as well as easily understood and accessible.
6) **Relevance** – to ensure the calculated energy use intensity for a building accurately reflects the total building energy consumption (before and after normalization) and that the assumptions and approaches taken reflect current best practices in the industry.

Further statements and objectives that support the REALPAC NEUI Methodology and its approach, consistent with those of the Original Methodology, are listed below:

1) The REALPAC NEUI Methodology must incent participation by a large number and wide range of office buildings across Canada to encourage significant, country-wide reductions in energy use.
2) Many landlords have concerns regarding their office buildings being "special" or "different" and thus not being eligible to participate due to factors such as tenant energy consumption; the REALPAC NEUI Methodology must therefore be broadly applicable and inclusive of most, if not all, types of office buildings and tenant-mixes.
3) Where property management has jurisdiction/control over energy consumption (e.g., enclosed best practices credit parking), the REALPAC NEUI Methodology is designed to preferentially give a 'best practices credit' as opposed to allowing a given load in question to be simply removed by submetering it. This is seen as a technique to promote/reward sites pursuing best practices.
4) Where property management does not have jurisdiction/control (e.g., where tenant energy consumption varies significantly and unavoidably due to space functionality, such as with high intensity energy use data centres, 24/7 operations, and retail space), the REALPAC NEUI Methodology must allow for the adjustment/removal of such excess tenant energy consumption. The Original Methodology proposed that such energy use be submetered. This type of adjustment has been maintained in the REALPAC NEUI Methodology to avoid penalizing property owners for the activities and energy usage of their tenants and to incent tenants to reduce their energy consumption through submetering of energy use.
5) Assumptions were used throughout the calculation procedures within the REALPAC NEUI Methodology and have been updated based on current industry best practices.
6) Further adjustments could be used in the REALPAC NEUI Methodology which could increase the accuracy of the calculations, but this would also increase the complexity and difficulty of the REALPAC NEUI Methodology; therefore, consistent with the Original Methodology, the REALPAC NEUI Methodology aims to address only material variables to maintain simplicity.

Following the above guiding principles, an updated REALPAC NEUI Tool (the "Tool," which is an Excel spreadsheet) was created based on the REALPAC NEUI Methodology and the agreed upon assumptions contained within it. The intent of the REALPAC NEUI Tool is to readily enable calculations for a single building and allow independently prepared calculations to be tested for accuracy. Images from the Tool are used throughout to illustrate key concepts of the approach.

2.2. REALPAC NEUI Methodology Development

The approach taken to develop the REALPAC NEUI Methodology, including the guiding principles discussed above, aims to allow energy use intensity reporting that accounts fairly for buildings with different physical and operational characteristics. These variables or building characteristics are adjusted/normalized to allow for a fair comparison of energy use in different buildings across the country. The variables that have been deemed material and are adjusted/normalized in the REALPAC NEUI Methodology can be categorized into six general areas:

- Building area
- Types of energy consumed in the building (e.g., steam or natural gas)
- High intensity or exceptional energy use (e.g., space type adjustments for parking, retail, data centres, call centres)
- Normalization for weather variations (between locations and over time)
- Normalization for people-dependent variations, occupant density, and operating hours
- Normalization for lease condition (i.e., leased vs vacant space)

The REALPAC NEUI Methodology is based on an example model building with the following characteristics:

- Uses natural gas heating systems
- Has an occupant density of 2.3 people/1,000 ft^2 when fully occupied
- Is occupied by its tenants for 65 hours/week
- Is subject to 568.1 cooling degree days and 3034.7 heating degree days, consistent with the Original Methodology
- Is fully leased

The energy breakdown associated with the model benchmark building is depicted in Figure 2, below:

Component of Model EUI	Totals (ekWh/ft^2)
Lighting	2.01
Computers	1.50
Office Equipment	1.17
Fans	1.44
Pumps - Winter	0.36
Pumps - Summer	0.27
Elevators	0.20
Outdoor Lighting	0.20
Cooling - envelope and FA	0.67
Cooling - People dependent	0.36
DHW	0.19
Heating	6.94
Totals	15.31

Figure 2: Model Building EUI Breakdown

This table forms the backbone of the REALPAC NEUI Methodology and the origination of the various assumptions that affect the input data and calculations. The way by which each component of the model building is adjusted is laid out in the following sections of this document.

3. Building Eligibility Requirements

3.1. Building Designation

REALPAC has chosen to use the ENERGY STAR definition of office space to describe the types of commercial buildings that are eligible to use the REALPAC NEUI Methodology. As defined by ENERGY STAR, the term office space "applies to facility spaces used for general office, professional and administrative purposes" and encompasses all areas of the building that house functions or activities supporting office, professional and administrative work such as kitchens, lobbies, atria, storage, conference rooms, fitness facilities, elevator shafts, and stairways.[1]

3.2. Physical and Operational Characteristics

The REALPAC NEUI Methodology is applicable to those buildings that meet the physical and operational parameters outlined as follows:

- The exterior gross area of each individual building (excluding parking lots and garages) must be over 20,000 ft^2, as measured using the BOMA International publication *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3-2018)*, described in detail in Section 4.2.
- More than 50% of the building's exterior gross area (excluding parking lots and garages) must regularly function as "office space", as defined in Section 3.1, above.[2]
- If a parking structure is attached to the building and would be included in the calculation of exterior gross area, and/or the parking structure is on the same utility meter as the main building, it must be included in the measurement of gross floor area and energy consumption.[3]
    - In addition, the combined floor area of all parking structures is not to exceed the total gross floor area of the building (the exterior gross area of the building minus the total parking area of the building).[4]
    - If the combined floor area of all parking structures exceeds the total gross floor area of the building, the building may meet the parameters of the REALPAC NEUI Methodology, but only if the energy use of that entire parking area is submetered (as per submetering specifications outlined in Section 5.1).
- For multi-tower office parks, each tower or building is to be treated as an individual, freestanding building, with energy use calculated separately for each tower or building.

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[1] U.S. Environmental Protection Agency, *Property Types in Portfolio Manager* (ENERGY STAR: n.d.). https://www.energystar.gov/buildings/benchmark/understand_metrics/property_types.
[2] U.S. Environmental Protection Agency, 2009 Professional Engineer's Guide to the ENERGY STAR® Label for Commercial Buildings (ENERGY STAR: 2009), 4.
[3] Ibid., 2.
[4] Ibid., 2.

- Exceptions to this rule include office parks or tower complexes whose owners or managers can demonstrate the energy use of the complex is consistently captured on only one utility account (one for each fuel type or energy source).
- If this requirement can be fulfilled and validated, the complex may be considered as a single whole.
- This exception also applies to buildings that are supplying energy (e.g., hot water, power, steam) to adjacent buildings.

4. Area[5]

4.1. Building Area Definition

The BOMA International publication entitled *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3 - 2018)* defines *exterior gross area* as "the total *floor* area contained within the *measure line* (generally, the outside surface of the *exterior enclosure* of a *building*), including structured *parking*." It is this method of measurement which should be followed when calculating *exterior gross area* and, subsequently, *gross floor area* (defined as the *exterior gross area* minus the structured *parking* area). ***Gross floor area*** is used as the denominator in calculating the ekWh/ft^2/year metric for each individual *building.*

4.2. Measuring Building Area

A summary adaptation of the BOMA standard method for calculating *exterior gross area* ("EGA") is outlined below with further steps to calculate *gross floor area* ("GFA"). The standard is available in full at BOMA International's website (boma.org). An example of how to record and disclose different types of spaces on each *floor* of a *building* is displayed in Figure 3, below. Definitions of terms used can be found in Appendix A: Abbreviations, Acronyms, and Definitions.

Method Summary:

1. Measure and record the total area bordered by the *measure line* on each *floor* of the *building*, including *basements* and *parking* garages.
2. If there are any *connectors*, *unclassified mezzanines*, *restricted headroom* areas, or *vault spaces* contained within the *measure line*, ensure that these areas are captured in the total area measurement recorded in Step 1.
3. Measure and record the *void* areas (these do not include occupant voids) that are contained within the *measure line* on each *floor* of the *building*.
4. Measure and record any *exterior circulation* areas that are contained within the *measure line* on each *floor* of the *building* and that have been captured in the total area measurement recorded in Step 1.
5. On a floor-by-floor basis, subtract the *void* area and the *exterior circulation* area, as measured in Steps 3 and 4, from the total area measured in Step 1, and record the resulting values.
6. Add the value for each *floor*, as calculated in Step 5, to get the total EGA of the *building* and record.

[5] Italicized terms contained in Section 4: Area, are the same as those used in the BOMA standard and/or are defined in Appendix A: Abbreviations, Acronyms, and Definitions.

7. Measure and record all *parking* areas (as defined by BOMA) on each *floor* and sum to get the total *parking* area of the *building*. This should include all types of structured *parking* (*enclosed*, semi-enclosed, and/or unenclosed, if applicable) but exclude on-grade parking.
8. Subtract the total *parking* area from the total EGA to get the total GFA.

Examples of space types to be included in *exterior gross area* calculations are *basements*, *external circulations*, *floors*, *major vertical penetrations*, *permanent mezzanines*, *occupant voids*, structured *parking*, and *penthouses*, as defined by BOMA. Other spaces that should be included in the total area measures but are optional to disclose are *connectors*, *unclassified mezzanines*, *restricted headroom*, and *vault spaces*.[6]

	A	B	C	D	E	F	G
1	**Exterior Gross Area ("EGA") and Gross Floor Area ("GFA") Calculations**						
2							
3	FLOOR	TOTAL LEVEL AREA	VOID AREA	EXTERIOR CIRCULATION AREA	**TOTAL EGA**	PARKING AREA	**TOTAL GFA**
4		Measure	Measure	Measure	= Column B - Column C - Column D	Measure	= Column E - Column F
5	Penthouse Level	6,000	0		6,000	0	
6	3rd Level	25,000	5,000		20,000	0	
7	2nd Level	25,000	5,000		20,000	0	
8	1st Level	25,000	0	1,000	24,000	0	
9	Basement 1	40,000	0		40,000	25,000	
10	Basement 2	40,000	0		40,000	25,000	
11	**Building Totals**				150,000	50,000	100,000
12	* Values should be in square feet						

Figure 3: Example of Exterior Gross Area and Gross Floor Area Calculations[7]

Once the building's *exterior gross area* and *gross floor area* have been measured, these values are to be recorded. If the building has both *enclosed* and semi-enclosed/unenclosed structured *parking*, these two measures should be recorded separately as only the energy consumption of *enclosed parking* will be adjusted for in the normalization procedures.

If accurate building area measurements are not available, the *gross building area*, as defined by BOMA in *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3 - 2018),* may be used as an approximation of the GFA described in the REALPAC NEUI Methodology. The *gross building area*, not including unenclosed spaces, is only a close approximation of GFA and is thus only recommended for internal (within individual organizations) benchmarking purposes; it does not replace the GFA (as defined here) as the correct measure to be used in the REALPAC NEUI Methodology.

4.3. Areas of High Intensity or Exceptional Energy Use

Tenant or building areas with high intensity or exceptional energy use should be submetered. As described in detail in Section 5.1, submetered energy use should be recorded on meters that have been approved by Measurement Canada (or "approval type" meters), or on billing-grade/revenue-

[6] BOMA International, BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3 – 2018) (BOMA International: 2018), 6.
[7] Adapted from BOMA International's BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3-2018*)*.

grade power or energy meters, or on meters that have documentation supporting their performance as being within specified limits.

The high intensity or exceptional energy use space types addressed in the REALPAC NEUI Methodology include data centres, call centres, retail, enclosed parking, and “other” space types. If the building has not submetered any of these space types, the spaces are not to be adjusted for. If the building has submetered some or all of these space types, the total areas (either individual areas entered separately or the sum of all of the individual areas throughout the building that fall into each space type category entered as a total) are to be accounted for.

If there is enclosed parking, the associated gross floor area is calculated as the exterior gross area (EGA) minus the building gross floor area (GFA), and an adjustment is made to account for it. Please refer to Section 7.2.1.1 for further details.

5. Energy

In general, measures of site energy rather than source energy make up the total building energy usage in the REALPAC NEUI Methodology, as the purpose is to calculate and compare the actual energy use within the building and not the amount of energy expended in the generation and delivery of all energy types to the building.

The exception is district energy, where consumption used for the REALPAC NEUI Methodology must represent all input energy required to deliver the heating/cooling energy to the property (i.e., including distribution losses). This allows energy consumption to be evaluated on an apples-to-apples basis with heating/cooling energy generated on-site.

Examination and comparison of energy expended in the generation and delivery of different energy types to the building, as well as computation of resulting emissions, are broader perspectives that could be addressed in the future but are not within the scope of the REALPAC NEUI Methodology and Tool at this time.

5.1. Energy Data Collection and Input Requirements

Guidelines for collecting energy consumption data for all energy sources are as follows:

- Utility bills, fuel supplier invoices, or readings from utility meters, whole facility meters, or submeters are acceptable sources of energy use data.[8]
    - Types of energy meters (including submeters) that are acceptable include Measurement Canada “approval type” meters, billing-grade or revenue-grade meters, and meters of a comparable type to those utilized by the utility supplier.[9]
    - Energy use measurements from load monitoring meters, energy management meters, utility bill reconciliation ("check") meters, Measurement Canada exempt meters, and/or any non-Measurement Canada approved revenue grade meters may

[8] Efficiency Valuation Organization, *Core Concepts: IPMVP* (EVO: 2016), 29.
[9] For information on “Approval Type” meters, see Type Approval requirements on the Measurement Canada website.

  - be utilized where documentation can be provided to confirm that measuring accuracy is within 3% of energy supplied.[10]
  - Metered data can be recorded hourly, daily, or monthly, and/or shorter periods can be combined into longer periods (e.g., hourly combined into daily periods).[11]
- Some utility bills may report both adjusted and non-adjusted data.
  - For electricity, users must use the non-adjusted electricity data (i.e., the metered usage at the building, not including adjustments for delivery losses).
  - For natural gas, users must use the metered usage that has been adjusted for temperature and pressure by the utility supplier, as per regulatory standards.
- A minimum of 12 consecutive months of energy data (one calendar year) from all active meters, energy sources, and fuel types used in the building is required. An entire year's worth of energy use data is needed to capture the effects of weather patterns on energy use within a full operating cycle.[12] The Tool will prorate the data to a 365-day year, as needed.
- The Tool requires energy consumption for the period January 1–December 31 to be entered for each selected year. Not all utility bills are aligned with the exact calendar year, thus the user is to enter the data that best corresponds to the full 12-month year under review. Any utility bill reading or metering period (not billing period) that begins after the 15th of the month should be entered as consumption for the following month.
  - For example, the value of electricity use recorded on a utility bill that reports consumption from December 18th to January 16th would be entered into the cell in the row labelled "Jan" with the "From" and "To" dates being Jan 1 and Jan 31 respectively.
- The Tool requires an energy consumption amount to be entered in both the first and last row of each table.
  - For example, a building with natural gas use billed each quarter would enter the first quarter's energy use into the row labelled "Jan", the second and third quarters' energy use into the rows that best approximate the period of use, and the fourth quarter's energy use into the row labelled "Dec".
- Actual billed energy use is required as input for calculations since estimated energy use is not accurate and, therefore, not acceptable. Where utility suppliers employ estimated readings, the reading immediately before the reported period and the final reading of the reported period must both be actual readings.
- Actual billed energy use, as recorded on the utility bill, is required as input for calculations since converted, standardized, averaged, or extrapolated energy use, previously normalized or adjusted energy use, and/or manipulated energy use is not accurate and, therefore, is not acceptable. Where utility suppliers have made errors in readings, corrections to the readings/consumption amounts may be made, but no other alterations to the original energy data are acceptable.

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[10] The limits of error from the *Electricity and Gas Inspection Regulations (SOR/86-131)* were used as a guideline for the appropriate limits of error for other types of energy meters, which would be considered valid for use in the REALPAC NEUI Methodology.
[11] Efficiency Valuation Organization, *Core Concepts: IPMVF* (EVO: 2016), 29.
[12] Ibid., 29.

- Inventory measurements may be necessary for fuels stored on-site.[13]

Once the appropriate data have been collected for the period under review, they are entered into the Tool, as illustrated in Figure 4, below:

	Account Number:	1029375647		
	Electricity		System specific conversion factor:	
			Units:	kWh
Month	**From**	**To**	**Billing**	**Consumption**
Jan	19-Dec-18	18-Jan-19	30	195,120
Feb	18-Jan-19	20-Feb-19	33	228,960
Mar	20-Feb-19	19-Mar-19	27	195,120
Apr	19-Mar-19	17-Apr-19	29	200,160
May	17-Apr-19	22-May-19	35	236,160
Jun	22-May-19	20-Jun-19	29	198,000
Jul	20-Jun-19	25-Jul-19	35	231,120
Aug	25-Jul-19	20-Aug-19	26	177,120
Sep	20-Aug-19	19-Sep-19	30	194,400
Oct	19-Sep-19	22-Oct-19	33	207,360
Nov	22-Oct-19	20-Nov-19	29	192,240
Dec	20-Nov-19	18-Dec-19	28	187,920
			364	2,443,680.0
365 day normalization			365	**2,450,391.4**
Conversion to ekWh				**2,450,391.4**

Figure 4: Example of Entries for Energy Use Data

Figure 4, above, is an example of energy consumption data entries within the Tool. There are up to ten (10) tables that can be populated for all energy types to facilitate individual meter tracking, if desired. The reading dates (not the billing dates) as recorded on the building's utility bills must be entered in the appropriate columns, as well as the energy use corresponding to each period. The energy source and units used to measure that energy use are also to be chosen from drop-down menus in the appropriate cells.

[13] Ibid., 27

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6. Actual Building Energy Use

This section describes the calculations performed on energy data entered into the Tool, which result in an actual building energy intensity value for a specific year period.

6.1. Prorating Billing Days and Energy Use

Once all of the building's energy use has been entered into the Tool, the number of billing days may not sum to 365, and therefore, the summed building energy use may not be accurately capturing an entire year period. The Tool will automatically prorate the energy consumption totals for each energy source to normalize for these potential irregularities in billing periods and reading dates.

Account Number: 1029375647

Electricity

System specific conversion factor:

Units: kWh

Month	From	To	Billing	Consumption
Jan	19-Dec-18	18-Jan-19	30	195,120
Feb	18-Jan-19	20-Feb-19	33	228,960
Mar	20-Feb-19	19-Mar-19	27	195,120
Apr	19-Mar-19	17-Apr-19	29	200,160
May	17-Apr-19	22-May-19	35	236,160
Jun	22-May-19	20-Jun-19	29	198,000
Jul	20-Jun-19	25-Jul-19	35	231,120
Aug	25-Jul-19	20-Aug-19	26	177,120
Sep	20-Aug-19	19-Sep-19	30	194,400
Oct	19-Sep-19	22-Oct-19	33	207,360
Nov	22-Oct-19	20-Nov-19	29	192,240
Dec	20-Nov-19	18-Dec-19	28	187,920
			364	2,443,680.0
365 day normalization			365	**2,450,391.4**
Conversion to ekWh				**2,450,391.4**

Figure 5: Example Building Energy Use Table with Prorated Electricity Use

For example, total kWh consumption of 2,443,680 kWh is prorated in Figure 5, above, to 2,450,391 kWh by a formula that adjusts the kWh total by the average amount of energy used per day in the last period multiplied by the difference between the total number of billing days and 365. The Tool adjusts for any difference in total billing days of up to 30 days.

6.2. Converting Energy Consumption into ekWh

After prorating the energy consumption, the summed annual energy consumption is converted from the respective energy units into ekWh. The "Energy Efficiency Planning and Management Guide" and "Heating with Gas" documents from Natural Resources Canada ("NRCan") are used as references for converting energy units.[14, 15] In addition, the average of published factors from two district heating providers and three district cooling providers were used to provide a default value for converting their recorded units into ekWh. Enwave values were used as default value for conversion of Deep Lake Water Cooling ("DLWC") energy into ekWh. The conversion factors used in the calculations are listed in Figure 6, below.

Energy Conversions	Divide the number of:	by:	To obtain
Heat energy	megajoules (MJ)	3.6*	ekWh
	gigajoules (GJ)	0.0036*	ekWh
	British thermal units (BTUs)	3412*	ekWh
	Therms(thrm)	0.03412*	ekWh

Energy/Fuel	Multiply the number of:	by:	To obtain
Natural gas	Cubic feet (cf)	0.2931*	ekWh
	100 cubic feet (ccf)	29.31*	ekWh
	Cubic meters (m3)	10.35*	ekWh
Propane	Litres (L)	7.028*	ekWh
Fuel oil (#2)	Litres (L)	10.611*	ekWh
District steam	kilo-lbs (klbs)	468.54ǂ	ekWh
	million pounds (Mlbs)	468542.4ǂ	ekWh
District cooling	ton-hours (ton-h)	0.9¥	ekWh
Deep lake water cooling	ton-hours (ton-h)	0.327£	ekWh

* Conversion factors per NRCan.

ǂ Conversion factor based on three distict energy providers w ith an assumed efficiency of 75%

¥ Conversion factor represents an average reported kW/ton value of tw o disstrict cooling providers in Toronto

£ Conversion factor as per Enwave

Figure 6: Energy Conversion Factors

For District Energy systems, there exists an option for the user to enter a system-specific conversion factor into the Tool, if the average "default" value, as listed above, does not adequately represent the efficiency of the system or technology used.

- If the user has documents that support an alternative conversion factor than those listed above (e.g., verification reports, manufacturer guarantees, or performance specifications from the utility supplier), then the user can enter a value into the appropriate cell(s) in the Tool and the conversion calculation will incorporate that value. An explanation should be entered into the Tool supporting the use of an alternative conversion factor.
- The value should represent all input energy required to deliver the heating/cooling energy to the property. In other words: distribution losses should be included. This allows energy consumption to be evaluated on an apples-to-apples basis with heating/cooling energy generated on-site.

[14] NRCan & OEE, "Appendix B: Energy Units and Conversion Factors," *Energy Efficiency Planning and Management Guide* (Office of Energy Efficiency: 2002), 180-2.
[15] NRCan & OEE, *Heating with Gas* (Energy Publications: 2012).

- If the user does not have an alternative value to those provided above, and/or does not have supporting documentation regarding the validity of an alternative value, the cell(s) must be left blank. This will cause the default values to be used.

7. Normalized Energy Use Intensity

Building energy use is normalized for a specific year through a five-step process:

1. Calculate the **Actual Energy Use Intensity (Actual EUI)** as the gross energy use divided by the gross floor area (Section 7.1).
2. Calculate the **Adjusted Energy Use Intensity (Adjusted EUI)** by accounting for any enclosed parking and/or exceptional energy use (Section 7.2).
3. Calculate the **Adjusted Model EUI** to account for weather and location, vacancy, weekly hours of operation, and occupant density (Section 7.3).
4. Calculate the **Energy Normalization Factor, n_f.** The Energy Normalization Factor, n_f, is calculated as Model EUI / Adjusted Model EUI (Section 7.4).
5. Calculate the **Normalized Energy Use Intensity (NEUI)** by multiplying the Adjusted EUI by the normalization factor, n_f (Section 7.5).

The following sections explain each of these steps and use the same sample building throughout to illustrate the various calculations.

7.1. Step 1: Calculate the Actual Energy Use Intensity (Actual EUI)

At this point, all energy sources have been entered into the Tool and the totals have been converted into ekWh.

The Actual Energy Use Intensity is calculated by taking the sum of all prorated energy use and dividing that total by its gross floor area (GFA), measured in ft^2.

$$\text{Actual EUI} = \frac{\sum \text{annual energy use}}{\text{GFA}}$$

7.1.1. Calculation of Actual EUI

For a 243,997 ft^2 building with a total prorated energy use of 2,919,367 ekWh, the actual energy use intensity is calculated as follows:

$$\text{Actual EUI} = \frac{5{,}369{,}755}{243{,}997} = 22.01\ \text{ekWh/ft}^2$$

7.2. Step 2: Calculate the Adjusted Energy Use Intensity (Adjusted EUI)

In some cases, tenants have special functions or operations that require the use of excess amounts of energy. It would be unfair to penalize a building for such tenant energy use, which is an unavoidable function of their specific business operations. Accordingly, the REALPAC NEUI

Methodology and Tool allow for adjustments due to high intensity or exceptional energy use in tenant spaces that are submetered. These adjustments help normalize building energy consumption regardless of their tenant mix.

High intensity or exceptional energy is grouped into one of three categories:

- Enclosed parking
- Exceptional use affiliated with office space (e.g., data centres, call centres, etc.)
- Exceptional use affiliated with retail activities (e.g., retail tenants, fitness centres)

Inputs in the Tool for high intensity or exceptional energy use are entered at the bottom of the Data Input tab. This table is illustrated in Figure 7, below.

Space	Area (ft^2)	Annual Energy Consumption					
		Electricity	Thermal				Total (kWh)
			Value	Source	Units	ekWh	
Enclosed Parking	27,231	--	--	--	--	--	--
Exceptional Use - Office							
Data Centre	4,000	400,000		(Drop-down)	(Drop-down)		400,000
Call Centre				(Drop-down)	(Drop-down)		
Cell tower	0	500,000		(Drop-down)	(Drop-down)		500,000
Other: (please specify)				(Drop-down)	(Drop-down)		
Totals, office	4,000	900,000	--	--	--		900,000
Exceptional Use - Retail							
Retail space #1	3,000	300,000	500	Natural gas	GJ	138,889	438,889
Retail space #2				(Drop-down)	(Drop-down)		
Other: (please specify)				(Drop-down)	(Drop-down)		
Other: (please specify)				(Drop-down)	(Drop-down)		
Totals, non-office	3,000	300,000	--	--	--	138,889	438,889

Figure 7: Input Table for High Intensity and Exceptional Energy Use Data

7.2.1. Enclosed Parking

The Tool automatically calculates the area of enclosed parking as the difference between the exterior gross area (EGA) and gross floor area (GFA) associated with the building. If this area is greater than 0 ft^2, an assumed 'best practices' value of 1.16 ekWh per square foot of parking area is applied and removed from the total building energy intensity measurement.

7.2.1.1. Calculation of Enclosed Parking Credit

An enclosed parking credit, PC, is calculated with the following equation:

$$\mathrm{PC} = \frac{\text{Parking Lot electricity use}}{\mathrm{GFA}_{building}}$$

where:

Parking Lot electricity use is $\mathrm{GFA}_{\text{parking lot}}\ \ 1.16\ \mathrm{ekWh/ft^2}$

For the sample building with a GFA of 243,997 ft^2 and enclosed parking of 27,231ft^2, the enclosed parking credit is calculated as shown in Figure 8, below:

Enclosed Parking area (ft^2)	Enclosed Parking credit		GFA (ft^2)	Enclosed Parking adjustment (ekWh/ft^2) (+ve = credit)
	(ekWh/ft2)	kWh		
27,231	1.16	31,588	243,997	**0.13**

Figure 8: Calculation of Enclosed Parking Credit

Note that the adjustment for enclosed parking does not factor in heating.

7.2.2. Exceptional Use - Office

The Tool allows an adjustment for any space in the building typically classified as office that has exceptional energy use associated with it. Examples include call centres and data centres where equipment serving these spaces may exceed more traditional office-type lighting and plug loads. The tool requires these loads/spaces to be submetered.

The area associated with these exceptional loads is generally the space associated with the equipment itself, and not the space it is serving. For example, if a tenant with an occupied space of 20,000 ft^2 has a data centre of 1,000 ft^2 serving its operations, the area of 1,000 would be entered in the Tool. For loads such as radio antennas and cell towers that do not typically 'occupy' office space, an area of 0 ft^2 would be entered.

To 'convert' any space identified as Exceptional Use – Office back to normal office space, people-dependent loads are added back to the space. These are based on the people-dependent component of the Model EUI, namely 1.99 ekWh/ft^2.

7.2.2.1. Calculation of Exceptional Use – Office Credit

An Exceptional Use – Office credit, EC_O, is calculated with the following equation:

$$EC_O = \frac{\sum_{Energy}(\text{Exceptional Use - Office}) - PDC_{OH} \cdot \sum_{Area}(\text{Exceptional Use - Office})}{GFA_{building}}$$

where:

PDC_{OH} is the nominal people-dependent Model EUI component, measured in ekWh/ft.

For a building with:

- a GFA of 243,997 ft^2,
- a data centre of 4,000 ft^2 and annual consumption of 400,000 kWh, and
- a cell tower with submetered consumption of 500,000 kWh,

the Exceptional Use – Office credit is calculated as shown in Figure 9, below:

Total Exceptional Use - Office		People-dependent loads to be added back (ekWh)	Net Exceptional Use - Office (ekWh)	GFA (ft^2)	Exceptional Use - Office adjustment ($ekWh/ft^2$) (+ve = credit)
ekWh	ft^2				
900,000	4,000	7,960	892,040	243,997	**3.66**

Figure 9: Calculation of Exceptional Use - Office Credit

7.2.3. Exceptional Use - Retail

The Tool allows an adjustment for any space in the building typically classified as Retail. Examples include restaurants, convenience stores, dry cleaners, and fitness centres. The Tool requires these spaces to be submetered.

Exceptional use associated with retail is only removed if the bundle of spaces has an energy use intensity greater than the building's EUI, after adjusting for any Enclosed Parking and/or Exceptional Use – Office credits. Space identified as Exceptional Use – Retail is not adjusted with people-dependent loads. Rather the space is removed from the building's total.

7.2.3.1. Calculation of Exceptional Use - Retail Credit

An Exceptional Use – Retail credit, EC_R, is calculated with the following equation:

$$EC_R = EUI_{building} - \frac{EUI_{building} \cdot GFA_{building} - \sum_{Energy} (\text{Exceptional Use - Retail})}{GFA_{building} - \sum_{Area} (\text{Exceptional Use - Retail})}$$

where:

$EUI_{building}$ is building's EUI, adjusted for Enclosed Parking and Exceptional Use - Office

For a building with:

- a GFA of 243,997 ft^2,
- an EUI of 18.22 $ekWh/ft^2$, after adjusting for Enclosed Parking and Exceptional Use – Office, and,
- a retail space of 3,000 ft^2 and total annual consumption of 438,899 kWh,

The Exceptional Use – Retail credit is calculated as shown in Figure 10, below:

Total Exceptional Use - Retail			Actual EUI, adjusted for parking, office (ekWh/ft^2)	Exceptional Use EUI > Actual EUI? (Y/N)	Resultant Building Energy Use (ekWh)	Resultant GFA (ft^2)	Resultant EUI (ekWh/ft2)	Exceptional Use - Retail adjustment (ekWh/ft^2) (+ve = credit)
ekWh	ft^2	EUI (ekWh/ft^2)						
438,889	3,000	146.3	18.22	Y	4,007,238	240,997	16.63	**1.59**

Figure 10: Calculation of Exceptional Use – Retail Credit

7.2.3.2. Calculation of Adjusted EUI Calculation Credit

The Adjusted EUI is calculated by taking the Actual EUI and applying any high intensity/exceptional use adjustments and/or enclosed parking credits.

$$\text{Adjusted EUI} = \text{Actual EUI - Enclosed Parking credit - Exceptional Use - Office credit - Exceptional Use - Retail credit}$$

For a building with an Actual EUI of 22.01 ekWh/ft^2 (Section 7.1), an Enclosed Parking credit of 0.13 ekWh/ft^2 (Section 7.2.1.1), an Exceptional Use – Office credit of 3.66 ekWh/ft^2 (Section 7.2.2.1), and an Exceptional Use – Retail credit of 1.59 ekWh/ft^2 (Section 7.2.3.1), the Adjusted EUI is calculated as:

$$\text{Adjusted EUI} = 22.01 - 0.13 - 3.66 - 1.59 = 16.63\ \text{ekWh/ft}^2$$

7.3. Step 3: Calculate the Adjusted Model Energy Use Intensity (Adjusted Model EUI)

The Adjusted Model Energy Use Intensity (Adjusted Model EUI) is calculated by adjusting the components of the model building for:

- weather,
- people (occupant density and operating hours), and,
- lease condition (leased vs. vacant).

The breakdown of how each component of the model building is affected by the above is summarized in Figure 11.

Component of Model EUI	Not affected by External Factors	Dependent on HDDs	Dependent on CDDs	Dependent on People	Totals (ekWh/ft^2)
Lighting	1.80			0.21	**2.01**
Computers	1.20			0.30	**1.50**
Office Equipment	1.00			0.17	**1.17**
Fans	1.00			0.44	**1.44**
Pumps - Winter	0.36				**0.36**
Pumps - Summer	0.05			0.22	**0.27**
Elevators	0.05			0.15	**0.20**
Outdoor Lighting	0.20				**0.20**
Cooling - envelope and FA	0.00		0.67		**0.67**
Cooling - People dependent	0.00			0.36	**0.36**
DHW	0.05			0.14	**0.19**
Heating	0.00	6.94			**6.94**
Totals	**5.71**	**6.94**	**0.67**	**1.99**	**15.31**

Figure 11: Model Building End-Use Breakdown by Adjustment Parameter – Occupied/Leased

For vacant space (i.e., where there is no occupancy, and where the space is no longer leased) the Model Building End-Use Breakdown is shown in Figure 12, below:

Component of Model EUI	Not affected by External Factors	Dependent on HDDs	Dependent on CDDs	Dependent on People	Totals (ekWh/ft^2)
Lighting	1.80				**1.80**
Computers	1.20				**1.20**
Office Equipment	1.00				**1.00**
Fans	1.00				**1.00**
Pumps - Winter	0.36				**0.36**
Pumps - Summer	0.05				**0.05**
Elevators	0.05				**0.05**
Outdoor Lighting	0.20				**0.20**
Cooling - envelope and FA	0.00		0.50		**0.50**
Cooling - People dependent	0.00				**0.00**
DHW	0.05				**0.05**
Heating	0.00	5.00			**5.00**
Totals	**5.71**	**5.00**	**0.50**	**0.00**	**11.21**

Figure 12: Model Building End-Use Breakdown by Adjustment Parameter – Vacant

A few important notes on the vacant model EUI:

- *Vacant* space is different than *leased but unoccupied* space. Property managers are obligated to condition leased space. They are not, however, obligated to condition vacant space.
- The energy use associated with heating and cooling a vacant space has been reduced to account for this.

7.3.1. Weather Adjustments

In theory, location/weather normalization, or weather "correction", is a mathematical adjustment of the data that accounts for variations in outside air temperature, thus enabling a like-for-like comparison of energy consumption in buildings over ***time*** (year-over-year) and ***location***, where different climate conditions may exist.

To accommodate and encourage all commercial office buildings in Canada to calculate their normalized energy use intensity, the Tool incorporates a simple normalization of the ekWh/ft^2/year value for weather variations between year periods and within geographical areas. This approach is verifiable, replicable, and is based upon best practices within the industry.

7.3.1.1. Weather Data and Requirements

As with the required energy use data, weather data for the normalization procedure encompasses one full year (January 1 to December 31). Weather data is collected from 15 major city centres across Canada, collectively representing the largest markets in commercial real estate. These cities include:

Calgary, AB	Kelowna, BC	St Johns, NL
Charlottetown, PEI	Montreal, QC	Toronto, ON
Edmonton, AB	Ottawa, ON	Vancouver, BC
Fredericton, NB	Quebec City, QC	Victoria, BC
Halifax, NS	Regina, SK	Winnipeg, MB

For the REALPAC NEUI Methodology, the weather data for each building site is sourced from Environment Canada weather stations that are situated at the international airports (or largest domestic airports) of the 15 city centres listed above. This historical weather data is stored on the National Climate Data and Information Archive website (http://www.climate.weather.gc.ca) and is easily reviewable, searchable, and downloadable. The data collected and reviewed by Environment Canada at the individual weather stations are recorded as outdoor dry-bulb temperatures in degrees Celsius and are updated daily on Environment Canada's National Climate Data and Information Archive website. Heating degree days (HDDs) and cooling degree days (CDDs) are based on a balance point temperature of 15ºC.

A "Standard Weather Year," consisting of 568.1 cooling degree days and 3034.7 heating degree days has been chosen as the reference year to which all weather in all locations for each new reporting year will be normalized. This is consistent with the Original Methodology.

The Tool contains lists of the HDDs and CDDs for each year and at each of the city centre locations, as shown in Figure 13, below.

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City	CDD						HDD					
	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
Kelowna, BC	754.1	619.3	705.4	626.4	610.7	572.3	2623.9	2642.0	3217.7	2917.7	3117.0	2917.6
Victoria, BC	377.1	334.4	335.5	309.7	287.7	287.6	1729.9	1732.6	2125.5	1890.2	2027.6	1970.7
Halifax, NS	398.9	393.9	381.9	451.6	375.6	386.6	3194.5	2769.1	2882.1	3042.4	3177.9	2839.4
Charlottetown, PEI	403.1	420.5	421.0	485.2	368.0	493.2	3710.7	3415.8	3428.1	3673.3	3706.0	3368.3
Fredericton, NB	536.1	518.5	530.2	588.9	435.2	581.2	3839.1	3541.1	3647.5	3792.3	3874.2	3525.7
St Johns, NL	150.9	217.8	196.8	248.4	142.9	242.7	3970.3	3686.3	3766.3	3806.0	3938.1	3613.6
Calgary, AB	412.3	328.1	454.7	417.8	263.5	346.9	3563.6	3494.3	3998.6	4246.7	4310.5	3956.9
Edmonton, AB	373.4	334.5	351.2	360.4	217.5	273.0	4393.3	4179.0	4714.4	5011.0	5019.5	4906.2
Winnipeg, MB	610.5	552.3	508.9	659.3	544.9	206.4	4385.3	4203.7	4543.2	4976.7	5115.1	3718.5
Montreal, QC	773.6	844.8	698.0	883.4	684.1	810.6	3521.8	3276.5	3325.8	3572.1	3647.2	3191.4
Ottawa, ON	692.8	789.1	596.7	787.9	592.6	712.9	3719.2	3540.1	3585.8	3770.5	3920.6	3445.1
Quebec City, QC	479.3	476.8	419.1	550.9	406.1	521.8	4145.4	3921.5	4036.7	4263.7	4362.6	3940.6
Regina, SK	519.3	487.2	561.8	557.6	430.6	159.1	4351.6	4076.5	4592.6	5095.0	5139.8	3677.0
Toronto, ON	783.6	999.3	760.5	940.7	721.1	884.5	3031.5	2743.7	2805.1	3047.9	3149.2	2740.5
Vancouver, BC	400.3	317.3	361.8	356.3	359.5	307.5	1655.4	1685.8	2095.7	1866.4	1988.6	1889.5

Figure 13: Example Table of HDD and CDD

7.3.1.2. Weather-Dependent Normalization Calculations and Examples

The breakdown of the model building energy use identifies which components of the building are affected by variations in weather (namely, heating and cooling). Only these specific components are adjusted for weather according to year and geographic location relative to the Standard Weather Year.

Normalization for the portion of the reference model energy impacted by heating and cooling are calculated as follows:

For cooling energy (CE) loads:

$$\mathrm{CE_X} = \mathrm{CE_o}\left(\frac{\mathrm{CDD_X}}{\mathrm{CDD_o}}\right)$$

where:

CE_x is the total annual cooling for the model building at a given location and year

CE_o is the annual cooling energy for the model building (e.g., 0.67 ekWh/ft^2 for leased model)

CDD_x is the total annual cooling degree days for the given location and year

CDD_o is the total annual cooling degree days for the model building (568.1 cooling degree days)

Likewise, for heating energy (HE) loads:

$$\mathrm{HE_X} = \mathrm{HE_o}\left(\frac{\mathrm{HDD_X}}{\mathrm{HDD_o}}\right)$$

where:

HE_x is the total annual weather-dependent energy use for the model building at a given location and year

HE_o is the annual heating energy use for the model building (e.g., 6.94 ekWh/ft^2 for leased model)

HDD_x is the total annual heating degree days for the given location and year

HDD_o is the total annual heating degree days for the model building (3034.7 heating degree days)

For example, total weather-dependent cooling and heating energy use associated with the leased and vacant model buildings in Toronto, ON in 2020 is as shown in Figure 14, below.

Component of Model EUI	Building Location	Year	Occupancy Status	Model EUI weighting (ekWh/ft^2)	Variable	Standard Weather Year	Site	Adjusted Model EUI weighting (ekWh/ft^2)
Cooling - envelope and FA	Toronto, ON	2020	Leased	0.67	CDD	568.10	884.5	**1.04**
			Vacant	0.50	CDD	568.10	884.5	**0.78**
Heating			Leased	6.94	HDD	3034.70	2,740.5	**6.27**
			Vacant	5.00	HDD	3034.70	2,740.5	**4.52**

Figure 14: Model EUI: Adjusting for Weather

7.3.2. People-Dependent Adjustments

Building energy use varies with the number of people and the number of hours they are present. Loads impacted by the building's population and hours of use include lighting, computer and plug loads, plus any associated cooling required for these loads.

The REALPAC NEUI Methodology incorporates a simple normalization of the ekWh/ft^2/year value for variations in building population and weekly hours of use. The following sections describe the assumptions made and procedures used to adjust energy consumption relative to variations in these factors.

7.3.2.1. Population Data and Requirements

The number of occupants is defined as the number of workers who are present during the main shift. It is not the same as the total number of employees and visitors to the building each day.[16]

Users are encouraged to calculate the annual average number of workers present in their building during the main shift/normal hours of use and enter this value into the Tool.

[16] U.S. Environmental Protection Agency, *ENERGY STAR – Portfolio Manager – Glossary* (ENERGY STAR: n.d.), https://portfoliomanager.energystar.gov/pm/glossary.

The Methodology normalizes the number of occupants based on the occupant density, defined as the number of occupants per 1,000 ft^2 *of leased space*.

7.3.2.2. Weekly Hours of Use Data and Requirements

The weekly hours of operation are defined as the number of hours per week that a building (or space within a building) is occupied by a majority of the tenant employees, averaged over the year under review.[17] Weekly operating hours are not the same as lighting or HVAC schedules, nor do they include the working schedules of cleaning, security, or maintenance staff. The Methodology uses a default value for weekly operating hours of 65 hours of operation per week.

If the hours of use of different tenant areas are known to be different or can be measured accurately as per the definition above, users can use a weighted average approach to calculate operating hours for the whole building. A simplified example is described below:

Building XYZ with a GFA of 100,000 ft^2 has two tenants, Alpha Corp. and Beta Inc.

- Alpha's office area is 30,000 ft^2 and they do not have submetering of electricity use. They run two shifts, 5 days a week, with hours of use at 90 hours/week.
- Beta's office area is 70,000 ft^2 and they do not have submetering of electricity use. They run their business during normal operating hours (approx. 8am – 6pm), 5 days a week, with hours of use at 55 hours/week.

Thus, the formula would be:

$$\frac{90 \times 30{,}000 + 55 \times 70{,}000}{100{,}000} = 65.5 \text{ hours/week}$$

In a single-tenant building, the above weighted average approach can also be used to calculate hours of use for the whole building. Areas of the building housing various functional groups, business units, or project teams may operate on different/extended schedules, thus the separation of "operational areas" can be done by comparing hours of use in "operational areas" rather than tenant areas, so long as the "operational areas" are at least 75% occupied for the indicated hours.

7.3.2.3. Vacancy Data and Requirements

Vacancy is defined as space that is neither leased nor occupied. It is generally reported as a percentage of the total leasable space.

Users must calculate their building vacancy, averaged over the 12-month period of review. Vacancy can be calculated periodically or for the entire year under review, but the number used for the calculation must be the annual average.

[17] Ibid.

7.3.2.4. Calculation of People-Dependent Adjustments

Normalization for the people-dependent loads is a three-step process:

1. Adjust for occupant density, then
2. Adjust for weekly hours of operation, then,
3. Adjust for vacancy.

a) Adjustments for Occupant Density

The people-dependant loads (PDLs) of the Model EUI are adjusted for occupant density using the following equation:

$$\mathrm{PDC_O} = \mathrm{PDL} \cdot \mathrm{occ.adj}$$

where:

$\mathrm{PDC_O}$ is a people-dependent load of the model EUI, adjusted for occupancy

$\mathrm{occ.adj}$ is the occupancy adjustment factor

The occupancy adjustment factor is calculated as the number of reported occupants per 1,000 ft^2 of leased space divided by the occupant density of the model building (namely 2.3 people per 1,000 ft^2).

Some adjustments may be constrained to reflect the reality of commercial office operations. For example, lighting kWh/ft^2 is not expected to exceed that of the Model Building EUI load because all base building lighting is already assumed to be on. Loads may also be constrained by lease agreements; even if a space is not occupied, Property Managers may nonetheless be obligated to condition the space.

Figure 15, below, summarizes the people-dependent loads adjusted for occupant density, assuming 4.10 people/1,000 ft^2. Adjustment limits are also indicated for each component of the model EUI. If the adjustment factor lies outside the range defined by the limits, then appropriate limit is adhered to. Blanks in the adjustment columns indicate no limits are applied.

Component of Model EUI	People Dependent Load (ekWh/ft^2)	Occ. Dens. (adjusted for vacancy) (ppl/1,000sqft)		Adjustment limits (% of load)		People Dependent Load, adjusted for occupants (ekWh/ft^2)
		value	adjustment factor	min.	max.	
Lighting	0.21	4.10	178%	50%	100%	0.21
Computers	0.30			50%		0.53
Office Equipment	0.17			50%	120%	0.20
Fans	0.44			80%		0.78
Pumps - Summer	0.22			80%	120%	0.26
Elevators	0.15			80%		0.27
Cooling - people dependent	0.36			--	--	0.42
DHW	0.14			80%	120%	0.17

Figure 15: Model EUI: Adjusting for Occupant Density (with Limits)

Limits to people-dependent loads are expressed in the Tool as a percentage of the nominal people-dependent load.

b) Adjustment for Weekly Hours of Operation

The adjustment for weekly hours of operation takes the people-dependent loads adjusted for occupancy (‘PDC_Os’) and applies an adjustment factor, calculated as the weekly hours of the site divided by the weekly hours of the Model Building (65 hours per week)

$$PDC_{OH} = PDC_O \cdot hrs.adj$$

where:

PDC_{OH} is the people-dependent EUI component (adjusted for occupant density and weekly hours)

$hrs.adj$ is the weekly hours adjustment factor calculated as site weekly hours of the site divided by model reference (i.e., 65 hours/week).

The adjustment factor for weekly hours of operation is always equal to or greater than 100%, as the model assumes, consistent with ENERGY STAR in Canada, that there is no material impact on energy use for weekly hours of operation less than 65 hours/week.

For a building with Model EUI components adjusted for occupant density as summarized in Figure 15, above, the people-dependent EUI components adjusted for both hours and occupant density are as follows (see Figure 16, below):

Component of Model EUI	People Dependent Load (ekWh/ft²)	Occ. Dens. (adjusted for vacancy) (ppl/1,000sqft)		Adjustment limits (% of load)		People Dependent Load, adjusted for occupants (ekWh/ft²)	Reported hours		Adjusted People Dependent Load (ekWh/ft²)
		value	adjustment factor	min.	max.		value	adjustment factor	
Lighting	0.21	4.10	178%	50%	100%	0.21	50.00	100%	**0.21**
Computers	0.30			50%		0.53			**0.53**
Office Equipment	0.17			50%	120%	0.20			**0.20**
Fans	0.44			80%		0.78			**0.78**
Pumps - Summer	0.22			80%	120%	0.26			**0.26**
Elevators	0.15			80%		0.27			**0.27**
Cooling - people dependent	0.36			--	--	0.42			**0.42**
DHW	0.14			80%	120%	0.17			**0.17**
								Total, People Dependent adjusted	**2.84**

Figure 16: Model EUI: Adjusting for Hours

c) Adjustment for Vacancy

The Model EUI is adjusted for vacancy by calculating the weighted average of the adjusted Model EUI loads for the leased portion of the building with those of the weather-adjusted vacant Model EUI. The weighted average EUI of a given model component $C_{OH,W}$ is calculated as follows:

$$C_{OH,W} = C_{OH,L} \cdot (1 - VR(\%)) + C_{OH,V} \cdot VR(\%)$$

where:

$C_{OH,L}$ is the given EUI component (adjusted for occupant density and hours) associated with the leased Model EUI

$C_{OH,V}$ is the given EUI component associated with the vacant Model EUI

$VR(\%)$ is the average vacancy ratio

For a building with weather adjusted components, as summarized in Figure 14, above, people-dependent EUI components, as summarized in Figure 16, above, and an assumed average vacancy of 10%, the Adjusted Model EUI is calculated as follows:

Component	Adjusted Model EUI		
		Average vacancy:	10.0%
	Leased	Vacant	Weighted
Not affected by external factors	5.71	5.71	5.71
HDD Dependent	6.27	4.52	6.1
CDD Dependent	1.04	0.78	1.01
People Dependent	2.84	0.00	2.56
			15.38

Figure 17: Calculating Adjusted Model EUI with Vacancy

7.4. Step 4: Calculate Energy Normalization Factor, n_f

The energy normalization factor, n_f, is calculated by dividing the Model EUI by the Adjusted Model EUI (Section 7.3):

$$n_f = \frac{\text{Model EUI}}{\text{Adjusted Model EUI}}$$

For a building with an Adjusted Model EUI of 15.31 ekWh/ft^2, n_f is calculated as:

$$n_f = \frac{15.31}{15.38} = 0.995$$

This is also demonstrated for the sample building used in the examples above in Figure 18, below:

Average vacancy: 10.0%

Component	Adjusted Model EUI			Model EUI (for reference)
	Leased	Vacant	Weighted	
Not affected by external factors	5.71	5.71	5.71	5.71
HDD Dependent	6.27	4.52	6.1	6.94
CDD Dependent	1.04	0.78	1.01	0.67
People Dependent	2.84	0.00	2.56	1.99
			15.38	**15.31**

Normalization Factor n_f: **0.995**

Figure 18: Calculation of Normalization Factor, n_f

7.5. Step 5: Calculate the NEUI

The Normalized Energy Use Intensity (NEUI) is calculated by multiplying the normalization factor, n_f (Section 7.4), by the Adjusted EUI (Section 7.2).

$$\text{NEUI} = n_f \cdot \text{Adjusted EUI}$$

For a site with an Adjusted EUI of 16.63 ekWh/ft^2 and a normalization factor of 0.995, the NEUI is calculated as shown in Figure 19, below:

Adjusted EUI:	16.63	ekWh/ft^2/year
Normalization Factor:	0.995	
NEUI	**16.55**	ekWh/ft^2/year

Figure 19: Calculation of NEUI

8. Appendix A: Abbreviations, Acronyms, and Definitions

8.1. Abbreviations and Acronyms

ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BOMA Canada	Building Owners and Managers Association of Canada
BOMA BEST	BOMA Building Environmental Standards
Btu	British thermal units
CaGBC	Canada Green Building Council
ccf	100 cubic feet
CDD	cooling degree day
cf	cubic feet
DCiE	data centre infrastructure efficiency
EGA	exterior gross area
ekWh	equivalent kilowatt hours
EVO	Efficiency Valuation Organization
GFA	gross floor area
GJ	gigajoule
HDD	heating degree day
IPMVP	International Performance Measurement and Verification Protocol
klbs	kilo-pounds
kWh	kilowatt hour
L	litre
m^3	cubic metre
MJ	megajoule
Mlbs	million pounds
NRCan	Natural Resources Canada
PUE	power usage effectiveness
REALPAC	Real Property Association of Canada
thm	Therm
ton*h	ton-hour
W	watt
Wh	watt-hour

8.2. Definitions

Many of the definitions listed below that are related to the measurement of building area have been taken directly from the BOMA International standard, *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3-2018).*

Those definitions attributable to this standard have been identified with an asterisk (*).

*__Basement__ – a floor of a building that has an elevation below that of the average adjacent grade plane by a distance of more than two thirds of the vertical dimension between the elevation of that floor level and the elevation of the floor immediately above it. A building may have more than one basement level; all are included in the definition of a basement.

*__Building__ – a contiguous and undivided shelter comprising a partially or totally enclosed space, erected by a means of a planned process of forming and combining materials.

British thermal units – standard unit of measure used to denote heat energy in fuels and/or the ability of systems to heat or cool. One BTU is approximately the amount of energy needed to heat one pound of water one degree Fahrenheit.

Call centre – a department or business wholly focused on telephone inquiries. Call centres usually provide a centralized point of contact for an organization and support telephone selling, after-sales service, telephone helplines, or information services, either for a parent organization or on a contract basis for other businesses.

*__Connector__ – a covered or enclosed bridge, walkway, tunnel, or other similar connecting element between two separate buildings.

Data centre (computer) – "refers to buildings specifically designed and equipped to meet the needs of high density computing equipment, such as server racks, used for data storage and processing. Typically these facilities require dedicated uninterruptible power supplies and cooling systems. Data centre functions may include traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, and/or hosting facilities."[18]

ekWh – equivalent amount of kilowatt hours of energy from different fuel sources.

*__Enclose(d)__ – to separate the inside of a building from the outside, affording protection from the elements appropriate to the occupancy and the local climate. All enclosed space must have a roof.

*__Exterior enclosure__ – the wall, roof or soffit that constitutes the envelope necessary to enclose a building. The exterior enclosure generally determines the location of the measure line.

*__Exterior gross area (EGA)__ – the total of all the horizontal floor areas (as viewed on a floor plan) of all floors of a building contained within their measure lines, excluding voids (with the exception of occupant voids), interstitial space, unexcavated space, and crawl space. This includes the exterior gross area of every floor in the building, including basements, mechanical floors, mezzanines, penthouses, and structured parking without the removal of column area or other structural elements within the measure line.

*__External circulation__ – unenclosed pedestrian circulation providing the minimum path for access to tenant suites, egress stairs, elevators, refuge areas, toilets, and building entrances, and required by local building code to meet egress requirements, only when there are no fully enclosed pedestrian corridors serving a floor or portion (such as a wing) thereof.

*__Floor__ – a normally horizontal, load bearing structure and constituting the bottom level of each story in a building, including its associated permanent mezzanine, if any exists.

Gigajoule – one billion joules of energy.

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[18] U.S. Environmental Protection Agency, *Property Types in Portfolio Manager* (ENERGY STAR: n.d.). https://www.energystar.gov/buildings/benchmark/understand_metrics/property_types.

Gross floor area (GFA) – in the REALPAC NEUI Methodology, the exterior gross area of a building minus the parking area (as defined by BOMA International). Other definitions of gross floor area may exist but are not applicable in the REALPAC NEUI Methodology.

*__Measure line__ – a horizontal line on the outermost structural or architectural surface of the exterior face of the exterior enclosure, or at the exterior edge of any external circulation of a given floor of a building. In determining the measure line, do not consider overhangs, pilasters, columns, awnings, eaves, cornices, sills, ledges, casing, wainscoting, gutters, downspouts, chimneys, signs, shutters, attached electrical or mechanical systems, decorative projections and the like that protrude beyond such surface or edge.

Megajoule – one million joules of energy.

*__Mezzanine__ – an intermediate horizontal load bearing structure that lies between a floor and the floor or roof immediately above, which contains a fraction (usually 1/3) of the area of the floor below, where there exists adequate headroom above and below the mezzanine, and which shares service areas (e.g., toilets, fan rooms) with the floor immediately below it.

There are three types of mezzanines that are measured as follows:

1. *Temporary mezzanines* – non-permanent (built with the intention of being removed or relocated), often tenant improvements, are supported upon the floor but otherwise not part of the building structure and used most frequently (but not exclusively) in retail and industrial occupancy for storage of goods and materials or as part of manufacturing processes. Such mezzanines are not measured as part of construction gross area or exterior gross area of a floor or building.
2. *Permanent mezzanines* – not built with the intention of being removed and share building systems (e.g., HVAC, lighting, power). In a multi-story building containing elevators, the existence of an elevator stop at a mezzanine indicates that it is permanent. Such mezzanines are always measured as part of construction gross area and exterior gross area of the floor immediately below.
3. *Unclassified mezzanines* – cannot be classified as either temporary or permanent, are included in construction gross area and exterior gross area, though are always disclosed when presenting area measurements.

*__Occupant void__ – a floor opening between two or more adjacent floors created by removal of floor area by or for the occupant that would otherwise be included in the exterior gross area or construction gross area of the floor.

*__Parking__ – enclosed structured floor area used for transient storage of motor vehicles, including associated circulation and building services (such as exhaust fans and ducts that serve the parking area), but not including the loading docks, sally ports, and building service areas such as enclosed auxiliary lobbies used to enter a building from parking areas.

*__Penthouse__ – fully enclosed floor area located on the roof level of a building that occupies less than all of the roof.

*__Restricted headroom__ – For occupiable space: Space that does not meet the requirement of the International Building Code, section 1208.2, Minimum Ceiling Heights, including subsections thereof. For all other space: Space that has a clear ceiling height of less than 7’-0” (approximately 213 cm).

Retail store – “refers to individual stores used to conduct the retail sale of non-food consumer goods such as Department Stores, Discount Stores, Drug Stores, Dollar Stores, Hardware Stores, and Apparel/Specialty Stores (e.g., books, clothing, office products, sporting goods, toys, home goods, and electronics). Buildings containing multiple stores should be classified as enclosed mall, lifestyle centre, or strip mall.”[19] In the REALPAC NEUI Methodology, the definition of retail space includes stores, restaurants, food court areas, fitness clubs and/or other businesses providing consumer goods and services.

*__Vault space__ – sub-grade space that is enclosed and contiguous to a basement that extends below the adjacent ground plane past the property line, often under a public right-of-way, such as a sidewalk or alley.

*__Void__ – absence of a floor within the exterior enclosure of a building greater than ten square feet (1 square meter) where a floor might otherwise be expected or measured, that is typically in the plane of the upper floors adjacent to multi-story atria or lobbies, light wells, auditoria, or the area adjacent to a partial floor, permanent mezzanine, or unclassified mezzanine at a given floor level. Only the lowest floor of a multi-story space, such as an atrium, or a well, or lobby, is included in construction gross area and exterior gross area.

[19] U.S. Environmental Protection Agency, *Property Types in Portfolio Manager* (ENERGY STAR: n.d.). https://www.energystar.gov/buildings/benchmark/understand_metrics/property_types.

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