BEUDO Procedures

Information and data contained in this document is in support of regulations pertaining to the Ordinance entitled "Building Energy Use," Chapter 8.67 of the Municipal Code of the City of Cambridge.

This document shall be amended as needed to include information required to comply with BEUDO.

I. Covered Property and Baselines

A. Requests to report and comply with an alternative Covered Property configuration (See Regulations IV.B.) must be submitted by December 31 of the first Compliance year of the property. The form may be found <here>
The City will approve requests for alternate configuration within 60 days of the request.

B. Requests to comply as a Multi-Use Building (See Regulations section I.D.) may be approved only after any requests for Alternative Configurations of the default Covered Property have been approved by the City.

C. Requests for an Alternative Baseline may be submitted before approval has been determined for an Covered Property Alternative Configuration, and must be submitted by December 31 of the year prior to the first Compliance year of the property. Approval of the Alternative Baseline request will be contingent upon the approval of the Covered Property Alternative Configuration request.

II. Third Party Verification

Individuals from the following organizations are accredited to serve as an Approved Verification Body when completing Third Party Verification of a Covered Property's energy data.

Organization	Profession	Credential
AABC Commissioning Group (ACG)	Commissioning Professional	Certified Commissioning Authority (CxA)
American Institute of Architects (AIA)	Architect	Registered Architect (RA)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	Commissioning Professional	Commissioning Process Management Professional Certification (CPMP)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	Energy Auditor	Building Energy Assessment Professional (BEAP)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	Energy Auditor	Building Energy Modeling Professional (BEMP)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	Energy Manager	Operations and Performance Management Professional (OPMP)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	Commissioning Professional	Certified Building Commissioning Professionals (BCxP)
Association of Energy Engineers (AEE)	Commissioning Professional	Existing Building Commissioning Professional (EBCP)
Association of Energy Engineers (AEE)	Energy Auditor	Certified Energy Auditor (CEA)
Association of Energy Engineers (AEE)	Energy Auditor	Certified Measurement and Verification Professional (CMVP)
Association of Energy Engineers (AEE)	Energy Auditor	SEP Performance Verifier
Association of Energy Engineers (AEE)	Energy Manager	50001 Certified Practitioner in Energy Management Systems
Association of Energy Engineers (AEE)	Energy Manager	Certified Energy Manager (CEM)
Association of Energy Engineers (AEE)	Commissioning Professional	Certified Building Commissioning Professional (CBCP)
BREEAM USA	Building Operator	BREEAM USA In-Use Assessor
Building Commissioning Association (BCA)	Commissioning Professional	Certified Commissioning Professional (CCP)
Building Commissioning Association (BCA)	Commissioning Professional	Associate Commissioning Professional (ACP)
Energy Management Association (EMA)	Energy Manager	Energy Management Professional (EMP)
National Council of Architectural Registration Boards (NCARB)	Architect	Licensed Architect
National Society of Professional Engineers (NSPE)	Engineer	Professional Engineer (PE)
Northwest Energy Efficiency Council Midwest Energy Efficiency Alliance	Building Operator	Building Operator Certification (BOC) [Level 2 for Boston]
Passive House Institute US (PHIUS)	Commissioning Professional	Phius Certified Verifier
Passive House Institute US (PHIUS)	Energy Modeler	Phius Certified Consultant
Passive House Institute US (PHIUS)	Certified Passive House Consultant	Certified Passive House Consultant (CPHC) Training
U.S. Green Building Council (USGBC)	Energy Auditor	LEED Advanced Professional (AP) Building Operations & Maintenance
Building Owners and Managers Institute (BOMI) International	Energy Auditor	RPA/FMA High Performance Designation (RPA/FMA-HP)

III. Reduction Schedules

A. Alternative Baselines

A Covered Property which chooses an Alternative Baseline, once approved, will comply with the following schedule. Pursuant to 8.67.100(4), "A Covered Property that uses an alternative Baseline shall comply with performance requirements that include an additional 2.5% reduction for every year between the start of its Baseline and 2018."

	Non-residential of 100,000 square feet or greater								
Selected baseline	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**	**2015-2016**	**2016-2017**	**2017-2018**	**2018-2019**
Compliance Period 1: 2026 to 2029	66.7%	68.1%	69.6%	71.1%	72.7%	74.4%	76.2%	78.0%	80%
Compliance Period 2: 2030 to 2034	33.3%	34.0%	34.8%	35.6%	36.4%	37.2%	38.1%	39.0%	40%
Compliance Period 3: 2035 onwards	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0%
	Non-residential 25,000 to 99,999 square feet								
Selected baseline	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**	**2015-2016**	**2016-2017**	**2017-2018**	**2018-2019**
Compliance Period 1: 2026 to 2029									
Compliance Period 2: 2030 to 2034	50.0%	51.1%	52.2%	53.3%	54.5%	55.8%	57.1%	58.5%	60%
Compliance Period 3: 2035 to 2039	33.3%	34.0%	34.8%	35.6%	36.4%	37.2%	38.1%	39.0%	40%
Compliance Period 4: 2040 to 2044	16.7%	17.0%	17.4%	17.8%	18.2%	18.6%	19.0%	19.5%	20%
Compliance Period 5: 2045 to 2049	8.3%	8.5%	8.7%	8.9%	9.1%	9.3%	9.5%	9.8%	10%
Compliance Period 6: 2050 onwards	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0%

For example, if Property X is 150,000 Covered Square Feet and used the default baseline, in Compliance Period 2 they are expected to reduce their emissions to 40% of that baseline number. If Property X instead elects to use years 2012-2013 as the baseline years, then their expectations for reduction change to 34.8% of the baseline number.

B. New Covered Properties

The reduction schedules for a New Covered Property, see Regulations IV.B.iv, is found below.
The percentages in each cell represent the reduction in emissions from the Baseline years that must be demonstrated for that compliance year.

New Covered Properties > 100,000 square feet

Year of COO	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	Baseline		--	--	--	--	--	80%	60%	60%	60%	40%	40%	40%	20%	20%	
2019		Baseline		--	--	--	--	80%	60%	60%	60%	40%	40%	40%	20%	20%	0
2020			Baseline		--	--	--	80%	60%	60%	60%	40%	40%	40%	20%	20%	0
2021				Baseline		--	--	--	80%	60%	60%	60%	40%	40%	40%	20%	0
2022					Baseline		--	--	--	80%	53%	53%	53%	27%	27%	27%	0
2023						Baseline		--	--	--	80%	53%	53%	53%	27%	27%	0
2024							Baseline		--	--	--	80%	53%	53%	53%	27%	0
2025								Baseline		--	--	--	80%	40%	40%	40%	0
2026									Baseline		--	--	--	80%	40%	40%	0
2027										Baseline		--	--	--	80%	40%	0
2028											Baseline		--	--	--	80%	0
2029												Baseline		--	--	--	0
2030													Baseline		--	--	0
2031														Baseline		--	0
2032															Baseline		0
2033																	0
2034																	0

New Covered Properties <100,000 square feet

Year of COO	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
2018												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2019												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2020												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2021												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2022												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2023												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2024												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2025												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2026												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2027												80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2028													80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2029														80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	20%	20%	20%	0%
2030															80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	20%	0%
2031																80%	80%	80%	80%	80%	60%	60%	60%	60%	60%	40%	40%	40%	40%	40%	20%	0%
2032																	75%	75%	75%	75%	75%	50%	50%	50%	50%	50%	25%	25%	25%	25%	25%	0%
2033																		75%	75%	75%	75%	75%	50%	50%	50%	50%	50%	25%	25%	25%	25%	0%
2034																			75%	75%	75%	75%	75%	50%	50%	50%	50%	50%	25%	25%	25%	0%
2035																				75%	75%	75%	75%	75%	50%	50%	50%	50%	50%	25%	25%	0%
2036																					75%	75%	75%	75%	75%	50%	50%	50%	50%	50%	25%	0%
2037																						75%	75%	75%	75%	50%	50%	50%	50%	50%	50%	0%
2038																							66%	66%	66%	66%	66%	33%	33%	33%	33%	0%
2039																								66%	66%	66%	66%	66%	33%	33%	33%	0%
2040																									66%	66%	66%	66%	66%	33%	33%	0%
2041																										66%	66%	66%	66%	66%	33%	0%
2042																											50%	50%	50%	50%	50%	0%
2043																												50%	50%	50%	50%	0%
2044																													50%	50%	50%	0%
2045																														50%	50%	0%
2046																															50%	0%
2047																																0%
2048																																
2049																																

IV. Emissions Factors

A. Emissions Factor Methodology

- Emissions Factors for **Grid Electricity** will be published for each compliance period by January 1 of the year prior to the start of each compliance period. These factors will be developed and published by the City using data published by ISO New England, NEPOOL, and any other relevant governmental sources as well as forecasted load and electricity generation. A residual methodology calculation method will be applied in order to account for Massachusetts renewable portfolio standards.

    - Annually, the City may publish Emission Factors for Grid Electricity per Regulations Section VII.D.3. These values will be published in this document and other relevant locations by April 1 of the year following the compliance year. Covered Property owners electing to use the higher of the two calculated values may do so using this <form>

- Emissions Factors for **natural gas, propane, fuel oil, diesel oil, and kerosene** will be published for each compliance period by January 1 of the year prior to the start of each compliance period. These factors will be based on the standard scientific values utilized by Energy Star Portfolio Manager at the time of publication.

- Emissions Factors for energy produced by **local Generation Facilities** (or District Energy Systems [DES]) will be determined annually using the efficiency method of the World Resources Institute. Owners of Local Generation Facilities may apply to alternatively calculate Emission Factors for their energy outputs using the Energy Content Method per Regulations Section VII.E.i.3. The form to submit an application may be found <here>.

B. Emissions Factors

Compliance Period 1: 2026-2029

Energy Source	Units	Emissions Factors and Multipliers			
		2026	2027	2028	2029
Electricity					
Electric Grid Residual Factor	Kg CO2e/MWh	418	427	435	444
Annual RPS Minimum	%	30	33	36	39
Other Fuel sources					
Natural Gas	Kg CO2e/MMBtu	53.11	53.11	53.11	53.11
Propane	Kg CO2e/MMBtu	61.95	61.95	61.95	61.95
Fuel Oil (No. 1)	Kg CO2e/MMBtu	73.49	73.49	73.49	73.49
Fuel Oil (No. 2)	Kg CO2e/MMBtu	74.20	74.20	74.20	74.20
Fuel Oil (No. 4)	Kg CO2e/MMBtu	75.28	75.28	75.28	75.28
Fuel Oil (No. 5 & No. 6)	Kg CO2e/MMBtu	74.26	74.26	74.26	74.26
Diesel	Kg CO2e/MMBtu	75.16	75.16	75.16	75.16
Kerosene	Kg CO2e/MMBtu	75.44	75.44	75.44	75.44
Generating Facilities					

District Steam (Vicinity)					
Steam (MIT)					
Hot Water (MIT)					
Chilled Water (MIT)					
Electricity (MIT)					
Steam (Harvard)					
Hot Water (Harvard)					
Chilled Water (Harvard)					
Electricity (Harvard)					
Steam (Biogen)					
Hot Water (Biogen)					
Chilled Water (Biogen)					
Electricity (Biogen)					

This section to be filled in

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Indirect GHG Emissions																
Electric Grid Residual Factor (kgCO2e/MWh)	443	399	365	353	366	392	377	379	379	334	372	405	401	429	409	412
Annual RPS Minimum	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	16%	18%	20%	22%	24%	27%
RPS-only Electric Emissions Factor (kgCO2e/MWh)	418	376	344	322	337	351	338	334	331	284	311	328	320	335	312	299
Direct GHG Emissions																
Natural Gas	53.07	53.07	53.07	53.07	53.11	53.11	53.11	53.11	53.11	53.11	53.11	53.11	53.11	53.11	53.11	53.11
Propane	61.50	61.50	61.50	61.50	61.50	64.25	64.25	64.25	64.25	64.25	64.25	64.25	61.95	61.95	61.95	61.95
Fuel Oil (No. 1)	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.49	73.49	73.49	73.49
Fuel Oil (No. 2)	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.20	74.20	74.20	74.20
Fuel Oil (No. 4)	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.28	75.28	75.28	75.28
Fuel Oil (No. 5 & No. 6)	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	74.26	74.26	74.26	74.26
Diesel	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	75.16	75.16	75.16	75.16
Kerosene	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	75.44	75.44	75.44	75.44
Locally Generated Outputs																
District Steam (Vicinity)																
Steam (MIT)																
Hot Water (MIT)																
Chilled Water (MIT)																
Electricity (MIT)																
Steam (Harvard)																
Hot Water (Harvard)																
Chilled Water (Harvard)																
Electricity (Harvard)																
Steam (Biogen)																
Hot Water (Biogen)																
Chilled Water (Biogen)																
Electricity (Biogen)																

This section to be filled in

C. Calculating Emissions

Electricity

For a covered property **with no qualifying additional Renewable Electricity purchases**:

Electric Emissions [kg CO2e] = (Electricity consumed from the grid [MWh] x [100% - Annual RPS Minimum Requirement]) x Electric Grid Residual Factor [kg CO2e/MWh]

For a covered property that **does purchase additional qualifying Renewable Electricity** to apply to their emissions:

Electric Emissions [kg CO2e] = [(Electricity consumed from the grid [MWh] x [100% - Annual RPS Minimum Requirement]) - voluntary RE purchases [MWh]] x Electric Grid Residual Factor [kg CO2e/MWh]

Other Fuels

Fuel Source Emissions [metric tons CO2e] = Energy consumed [MMBTU] x Fuel Source Emissions Factor

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D. Time of Use Methodology

The following steps describe how Covered Properties that choose to use a time-of-use electricity emissions factor may do so:

1. Identify the total amount of residual generation from unclaimed non-emitting and unclaimed emitting generators for the year, by resource type.
    - Source: NEPOOL (New England Power Pool) GIS residual mix by fuel report
    - Notes: Although NEPOOL GIS publishes some data on a quarterly basis, the residual mix by fuel report is only displayed at the end of Q4. This is because RPS-eligible and zero-emissions certificates are banked during Q1 to Q3. To see the total annual amount of unclaimed generation, pull the report from Q1 to Q4 of the given year.
2. Download the hourly generation profile for all resources in each hour of the year, by resource type.
    - Source: U.S. Energy Information Administration (EIA), Form 930
    - Notes: EIA collects hourly data from ISO New England's (ISO-NE) API and publishes it via its Form 930. Users can click "Download Data" and select "New England" from the

Balancing Authority/Region Files tab to retrieve hourly generation data dating back to 2015.

3. Calculate the hourly residual generation profile from unclaimed non-emitting and unclaimed emitting generators, by resource type. For each resource type with unclaimed generation reported by NEPOOL GIS, calculate the ratio of unclaimed to total generation by dividing the annual unclaimed generation reported by NEPOOL GIS by the annual total generation reported by EIA Form 930. Multiply this ratio by the corresponding resource type's hourly generation timeseries (downloaded in Step 2). The sum of this new hourly generation profile should equal NEPOOL GIS's reported annual unclaimed generation. The sum of the hourly generation across unclaimed emitting resources and unclaimed, non-emitting resources is the total hourly residual generation.

    - Sources: NEPOOL GIS, EIA Form 930
    - Notes: For the NEPOOL GIS resource types for which ISO-NE does not report hourly generation profiles (such as wood and biomass), use the hourly generation profile called "Other."

4. For each resource type, multiply the hourly residual generation profile with the associated emissions rate (zero for non-emitting resources). Sum up the hourly emissions across all resource types to estimate the unclaimed ("residual") emissions for that hour.

5. Account for imports. New England currently relies on imports for 15–20 percent of energy needs. To account for this:

    - Identify the total annual residual imported energy and associated residual CO_2 emissions from NEPOOL GIS.
        - Divide the Carbon Dioxide column by the percent of the residual mix made up by the Import System Mix row to get the residual CO_2 emissions rate from imports in pounds per MWh. Multiply the result by the number of certificates assigned to the Import System mix row to get the total residual CO_2 emissions in pounds from imports. This number purely represents CO_2 emissions, so further calculations would be needed to calculate a CO_{2eq} rate, such as scaling the CO_2 emission rate based on a national or grid-region-specific ratio of CO_{2eq} to CO_2 emissions.
    - Identify the hourly CO_2 emissions imported column from the EIA 930 data.
    - Distribute the annual CO_2 emissions on an hourly basis using the CO_2 emissions imported hourly shape from EIA 930.
    - Add the hourly residual import system mix generation to the results of step 3. Then, add the hourly residual CO_2 emissions from imports to the result of step 4.
    - Note: This methodology does not need to account for exports. It needs to account for imports because the calculations are performed on a per-MWh basis and the import mix

in a given hour is much different than the ISO-NE mix. By contrast, the export mix from ISO-NE should approximately match the native generation mix staying in New England.

6. For each hour, divide the residual emissions by the residual generation to calculate the final residual emissions rate.

    - Note: The result should be in kg/kWh or similar units.

7. Apply the resulting residual time-of-use emission rate to individual buildings' time-of-use energy consumption after accounting for any BEUDO-qualified purchased renewables. To account for hourly profile of renewable generation:

    - Known generation profile: If the Property Owner can provide the hourly generation profile for any qualified renewables they purchase, first subtract that generation profile from the buildings' time-of-use energy consumption.

    - Unknown generation profile: If the Property Owner purchased additional qualified renewables for which they do not have the hourly generation profile, sum the annual generation from these resources with purchases by the supplier and any allowable banked excess hourly renewables. Subtract this sum from the total remaining grid electricity use. Scale the building's remaining time-of-use energy consumption by the following ratio: total non-qualified grid electricity use divided by total grid electricity use.

E. Comparison of Grid to DES Electricity production [This section intentionally left blank]

V. Renewable Electricity

A. Per Regulations VIII.B.i., Covered Property Owners must submit information regarding their Renewable Electricity purchases (proposed or completed) to the City for review and approval. This process is intended to provide Owners with assurance regarding the application of resulting RECs to their Covered Property's annual compliance.

    i. Information regarding approved procurement types must be submitted to the City by April 1 of the year following the first compliance year in which the resultant RECs are to be used for BEUDO compliance. The form may be found <here>.

B. Additional Approved Procurement Types

    i. Renewable Electricity procurement structures which are not described in the BEUDO Regulations may be submitted to the City pursuant to BEUDO Regulations IX.B.iii.3.

ii. To submit a new procurement type for approval, information must be submitted to the City prior to any applicable contract signing and at least 90 calendar days prior to the intended use of the resulting Renewable Electricity for compliance. The form to submit may be found <here>.