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Buildings

LOCAL LAW 97
Methodology for Converting Emissions Limits from Occupancy Groups to Energy Star Property Types for 2024-2029 Compliance Period

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CONTENTS

EXECUTIVE SUMMARY

New York City's Local Law 97 of 2019 (LL97), **Articles 28-320 & 28-321 of the New York City Administrative Code**, requires that the Department of Buildings (DOB) "provide a method for converting categories of uses under the United States Environmental Protection Agency (EPA) ENERGY STAR Portfolio Manager (ESPM) tool to the equivalent uses and occupancy groups set forth" in the law. Members of the LL97 Advisory Board and Working Groups also expressed a preference for aligning emissions limits with the **Property Types in Portfolio Manager**. The Portfolio Manager system is used by building owners as the reporting system for compliance with energy benchmarking requirements under Local Law 84 of 2009 (LL84) and Local Law 95 of 2016 (LL95). Using the Portfolio Manager Property Types better reflect actual energy consumption patterns of different buildings in New York City and offers the potential for improved simplicity, clarity, transparency, repeatability, accountability, and equity toward compliance for covered buildings under LL97.

The analysis presented herein was done to determine the ESPM conversion method and subsequent impact on LL97's 2024-2029 compliance period. A primary objective of the conversion was to maintain the same expected outcome in emissions reductions across the building sector as was expected under the original law.

This analysis which is further established through **1 RCNY 103-14** pursues the implementation of building emissions reduction compliance under LL97 using the classification that aligns with the widely adopted ESPM Property Types.

INTRODUCTION

New York City's Local Law 97 of 2019 (LL97) represents a first-of-its-kind approach to limiting greenhouse gas (GHG) emissions from large buildings. The law sets ten GHG intensity (GHGI) limits which were mapped to categories of buildings based on the city's Building Code use and occupancy groups for the first compliance period from 2024 through 2029. It also sets more stringent emissions limits from 2030 through 2034. These limits, which decrease over time, are established to put large buildings (those larger than 25,000 ft^2 in gross floor area) on a path to meet NYC's mandated target of reducing GHG emissions 80% from 2005 levels by 2050. A building's GHGI is measured in tons of carbon dioxide equivalent per square foot of built area (tCO$_2$e/ft^2).

The analysis of the ESPM conversion method presented in this document serves several purposes relating to LL97. First, it provides transparent and repeatable data cleaning steps for parties interested in analyzing NYC's energy benchmarking data. Second, it fulfills a requirement of the law that the city convert "categories of uses under the United States environmental protection agency Portfolio Manager tool to the equivalent uses and occupancy groups set forth in" LL97. The product of that conversion is the mapping of ENERGY STAR Portfolio Manager (ESPM) Property Types to the GHGI limits established in the law for the 2024 through 2029 period. Third, it presents the potential impacts of using ESPM Property Types, as compared to using the city's Building Code use and occupancy groups.

Data processing and analysis in this paper was performed in an IPython notebook using Google Collab. The notebook and analysis were developed by members of the NYC Department of Buildings (DOB) Analytics unit and the NYC Mayor's Office of Climate and Environmental Justice (MOCEJ). Guidance and review were provided by members of the Building Energy and Emissions Performance team from DOB.

1. Converting Emissions Limits from Occupancy Groups to Energy Star Property Types for the 2024-2029 Compliance Period

1.1 LL97's Original GHGI limit Assignment and the Requirement to Convert to ESPM Use Types

Before outlining the analysis performed in this paper, it is important to describe the process and data the city used to establish LL97's occupancy groups and emissions limits, as well as the section of the law that requires DOB to map these limits to ESPM Property Types.

§28-320.3.1 of LL97 sets ten annual building emissions limits in GHGI for the 2024-2029 compliance period. To determine these limits and the space types to which they apply, the city relied on two distinct systems of building categorization:

- **NYC Building Code Use and Occupancy Groups**
This categorization system classifies "all buildings and structures, and spaces therein, as to use and occupancy." These use types may be found on each building's Certificate of Occupancy (CO). A key limitation of this system is that there is no unified dataset showing each building's use and occupancy type. Records for buildings built before 2010 are not digitized. While the CO identifies the secondary, tertiary, and subsequent use types of a building in some cases, this level of detail is inconsistent, and the classification system has changed considerably over the city's history. The system is mainly concern with health and life safety, rather than energy usage patterns. The Building Code use and occupancy classifications are available in **Chapter 3 of the New York City Building Code**.

- **Department of Finance (DOF) Building Class**
The other source of building categorization is the code describing the major use of structures on a tax lot based on data from the NYC Department of Finance (DOF) Property Tax System. Building Class is available in a digital format for nearly every building in the city via the **Property Land Use Tax Output (PLUTO) Dataset**. Building Class is determined by DOF's property value assessors, typically through an assessment done from the street. The main use of the building is recorded, but secondary and additional use types are not available. The full list of Building Classes is available in **Appendix C of the PLUTO Data Dictionary**.

Based on the above considerations, the city used the DOF Building Class categories to estimate the use and occupancy identified on each building's CO. The city then grouped Building Code use and occupancy categories based on the similarity of use to create ten occupancy groups. Next, the city found the 75th percentile GHGI level of buildings within each of these ten occupancy groups using the 2017 energy and water benchmarking data,

which is collected by the city using the ESPM website. Those GHGI levels became the ten limits listed in LL97 for the 2024-2029 compliance period. Table 1, *LL97 Occupancy Group and their corresponding GHGI Limits*, lists the ten LL97 occupancy groups and their corresponding GHGI Limits pursuant to §28-320.3.1 of the law.

Group	Occupancy Type	GHGI Limit (tCO_2e/ft^2)
1	A: Assembly	0.01074
2	B: Business	0.00846
3	E: Educational & I-4: Custodial Care Facilities	0.00758
4	I-1: 24 Hour Residential Care	0.01138
5	F: Factory and Industrial	0.00574
6	B: emergency services, non-production laboratory, ambulatory health care, H: high hazard, I-2: 24 hour medical, I-3: 24 hour under restraint	0.02381
7	M: Mercantile	0.01181
8	R-1: transient residential	0.00987
9	R-2: apartments	0.00675
10	S: Storage and U: Utility and Miscellaneous	0.00426

Table 1. LL97 Occupancy Group and their corresponding GHGI Limits

During LL97's development, stakeholders raised concerns that the City's records (both DOF Building Class and NYC Building Code use and occupancy) were inaccurate in several cases and that ESPM property types provided a more suitable classification system. Energy benchmarking data is collected by the city via the ESPM website. Building owners self-report details of their properties' use types, size, and energy consumption through this tool. This yields a dataset that groups buildings into categories used in the Commercial Buildings Energy Consumption Survey (CBECS) and is based on similarities in the *energy use* profiles of buildings. This differs from the NYC Building Code use types which are based on fire and life safety and the DOF records which were developed for purposes of taxation. Owners must have a registered design professional (RDP) certify the use types reported for their building when reporting LL97 compliance.

To address stakeholders' concerns, LL97 requires DOB to convert Building Code use types to ESPM Property Types:

"*§28-320.3.1.* **Annual building emissions limits 2024-2029**. For calendar years 2024 through 2029 the annual building emissions limits for covered buildings shall be calculated pursuant to items 1 through 10 of this section. For the purposes of such calculation the department shall provide a method for converting categories of uses under the United States Environmental Protection Agency Portfolio Manager tool to the equivalent uses and occupancy groups set forth in this section."

1.2 Methodology: Mapping and Validating ESPM Property Types to LL97 GHGI Emissions Limits

As the City performed this remapping exercise it aimed to satisfy the requirements of §28-320.3.1 and preserve the expected level of environmental benefit of the law. This required a two-step process: first, calculating the projected GHG emissions reductions under LL97, and second, generating a file matching (or mapping) ESPM Property Types to LL97's ten GHG limits that would yield similar aggregate reductions in GHG emissions.

To perform these steps, the study team used the LL84 NYC energy benchmarking data for calendar year 2018 and pre-processed the data to improve data quality and address outlier data points. This pre-processing is described in detail in the *Data and Data Pre-Processing* section of this document. The study team chose the calendar year (CY) 2018 data, as it features a higher reporting compliance rate compared to the 2017 benchmarking data set.

A summary of the steps taken to perform this mapping is provided in *Figure 1, GHGI limit mapping process*, of this document.
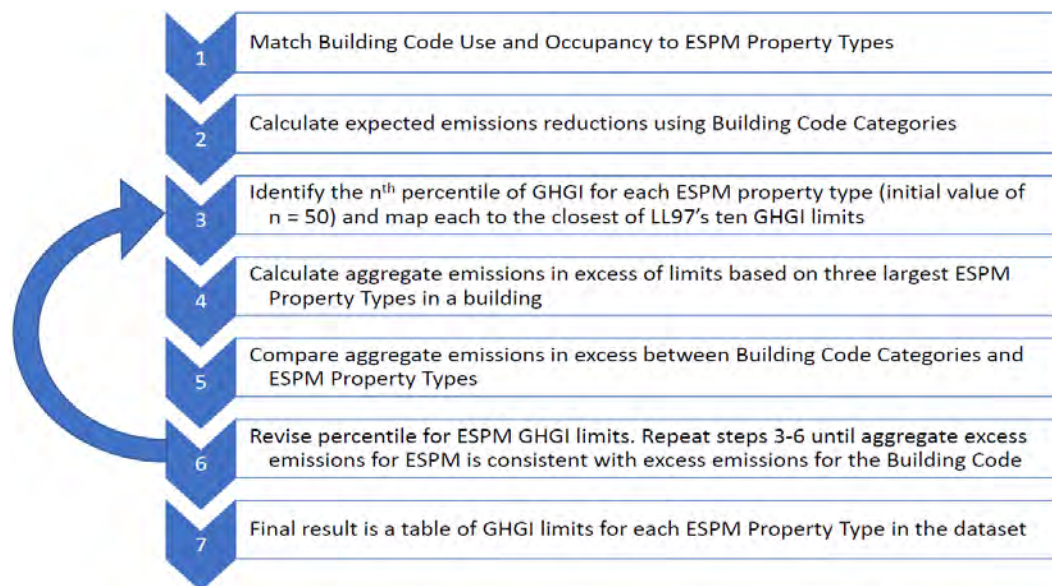

1	Match Building Code Use and Occupancy to ESPM Property Types
2	Calculate expected emissions reductions using Building Code Categories
3	Identify the nth percentile of GHGI for each ESPM property type (initial value of n = 50) and map each to the closest of LL97's ten GHGI limits
4	Calculate aggregate emissions in excess of limits based on three largest ESPM Property Types in a building
5	Compare aggregate emissions in excess between Building Code Categories and ESPM Property Types
6	Revise percentile for ESPM GHGI limits. Repeat steps 3-6 until aggregate excess emissions for ESPM is consistent with excess emissions for the Building Code
7	Final result is a table of GHGI limits for each ESPM Property Type in the dataset

Figure 1. GHGI Limit Mapping Process

1.3 Modeling Expected GHG Emission Reductions Under LL97

To estimate LL97's annual expected GHG emissions reductions, the city leveraged work begun by members of the LL97 Advisory Board's Building Technologies & Pathways (Commercial Buildings) Working Group. This Working Group matched ESPM Property Types to the most similar groups defined in the city's Building Code use and occupancy types, which are assigned to LL97 limits. This matching was performed by architects and engineers who work with

the NYC Building Code on a regular basis. The exercise was further refined by City staff with experience as Plan Examiners for the Department of Buildings.

Using the assigned Building Code occupancy for each ESPM Property type, the study team calculated the GHG limit for each building in the LL84 energy benchmarking data set, calculated their expected individual emissions reductions, and then aggregated these to represent the total emissions reductions expected by LL97. To do this the team applied the GHGI limits of the three largest use types based on Building Code Use and Occupancy type to evaluate total emissions of each building. The results of this process are referred to hereafter as **Building Code 3**. In this calculation the appropriate GHGI limit was applied for each of the three largest Property Types identified in each building in the data set. In this calculation, the appropriate GHGI limit was applied for each of the three largest Property Types identified in each building in the data set. Multiplying these GHGI limits by the corresponding square footage of each Property Type yielded a GHG limit for each Property Type in the building. These Property Type GHG limits were then summed for each building to find a building-level LL97 GHG limit. The expected GHG reduction for each building (assuming 100% compliance with LL97) was then calculated for each building by finding the difference between the observed GHG Annual Building Emissions and their Building Emission Limit. Finally, the study team summed each of these building-level expected GHG reduction values to find the total expected GHG reduction. Through this process the study team found that the original LL97 limit assignments based on Building Code Use and Occupancy types yields an aggregate GHG reduction target of **636,645 tCO₂e** based on the CY 2018 dataset.

1.4 Mapping ESPM Property Types to LL97's Ten GHG Limits and Validating Findings

The study team then developed a recursive method to match ESPM Property Types directly to LL97's ten GHG limits, without requiring an interpretation of buildings' use and occupancy types. These ten limit values are set in LL97. To do this the team grouped buildings by their Primary Property Type. A building's Primary Property Type is the use that represents 51% or more of that building's total area. Buildings without a Primary Property Type (i.e., those where no single use amounts to at least 51% of total area) are designated by the ESPM system as "Mixed Use". This Property Type is not useful in mapping to LL97 GHGI limits and this analysis does not assign a GHGI limit to the "Mixed Use" Property Type. However, buildings identified as Mixed Use are still included in this analysis to assess Annual Building Emissions and compliance impacts of converting to the ESPM Property Type system and are treated the same way other buildings are in that portion of the analysis.

Next, the team chose an initial compliance percentile of 50 to be applied across each of the Property Type groups. The GHGI value found at this percentile became that group's proxy emissions limit. Each proxy GHGI limit was

matched to the closest of the ten GHGI limits in LL97. This resulted in an assigned GHGI limit based on ESPM Property Type.

These assigned GHGI limits were then validated by calculating their impacts on total GHG emissions. This calculation was done in the same manner described in the section above, with the study team finding the emissions reductions of each of the three largest Property Types identified in each building in the data set and then summing those reductions to find total reductions across all the buildings in the dataset. The results of this process are referred to hereafter as **ESPM 3**. The total reduction calculated in this process was then compared to the target of 636,645 tCO_2e. At the 50th percentile, the ESPM 3 emission reduction estimate was higher than this target, so the percentile was adjusted following a recursive binary splitting method with the full ESPM 3 calculation being performed and tested during each iteration. This process was used to determine the percentile that yielded a total emissions reduction as close as possible to that achieved by LL97's original GHG limit assignments. This level was reached at the 81.127th percentile (rounded to 81.13th percentile in this report) and yielded a GHG emissions reduction equal to **636,399 tCO_2e**, 0.04% less than the target of 636,645 tCO_2e. Table 2, *Steps taken to optimize GHGI percentile target*, illustrates the steps taken in this process.

Iteration	Percentile Attempted	ESPM 3 Emissions Reduction (tCO_2e)	Difference From Target Reduction (tCO_2e)	Result
1	50	1,617,986	981,341	too high
2	75	775,490	138,845	too high
3	87.5	406,822	-229,822	too low
4	81.25	636,399	-245	too low
5	78.125	671,691	35,046	too high
6	79.687	667,149	35,046	too high
7	80.468	638,984	2,339	too high
8	80.859	638,760	2,339	too high
9	81.054	638,529	1,883	too high
10	81.152	636,399	-245	too low
11	81.103	638,529	1,883	too high
12	**81.127**	**636,399**	**-245**	**closest**

Table 2. Steps Taken to Optimize GHGI Percentile Target

Table 3, *Converting ESPM Property Types to LL97 GHGI Limit Groups*, shows the results of this mapping of 60 ESPM Property Types to the ten GHGI limits established in LL97 as calculated through the process described above. As an example of how to read this table, Group 1 in LL97 matches with the 81.13th percentile of GHGI for three ESPM Property Types. Furthermore, group 2 aligns with four ESPM Property Types.

- *Table 3. Converting ESPM Property Types to LL97 GHGI Limit Groups*
- *Orange rows are Property Types that received a lower a GHGI limit, while green indicates a higher limit, and white indicates the limit did not change.*
- *B* refers to spaces classified as Use and Occupancy types B civic administrative facility for emergency response services, B non-production laboratory, Group B ambulatory health care facility (Described in item 6 of §320.3.1)*

ESPM Primary Property Type	Building Code	GHGI Limit Group Based on Building Code	GHGI Limit Based on Building Code	GHGI at 81.13th Percentile	Assigned GHGI Limit Based on ESPM	Assigned GHGI Limit Group Based on ESPM	Change in GHGI Limit	Count of Properties *(exclude outlier)*	Total Square Footage *(exclude outlier)*
Enclosed Mall	M	7	0.01181	0.010725	0.01074	1	-0.00107	7	3,858,780
Other - Mall	M	7	0.01181	0.01051	0.01074	1	-0.00107	33	4,243,357
Medical Office	B	2	0.00846	0.010688	0.01074	1	0.00228	43	4,836,325
Other - Services	B	2	0.00846	0.010404	0.01074	1	0.00228	6	516,859
Lifestyle Center	M	7	0.01181	0.008322	0.00846	2	-0.00335	1	33,600
Performing Arts	A-1	1	0.01074	0.008756	0.00846	2	-0.00228	29	2,061,300
Financial Office	B	2	0.00846	0.008044	0.00846	2	0	19	13,506,383
Other - Education	B	2	0.00846	0.008421	0.00846	2	0	29	2,019,852
Retail Store	M	7	0.01181	0.007982	0.00758	3	-0.00423	163	19,794,355
Other - Lodging/Residential	R-1	8	0.00987	0.007928	0.00758	3	-0.00229	24	1,494,721
Residence Hall/Dormitory	R-1	8	0.00987	0.007499	0.00758	3	-0.00229	119	13,628,282
Adult Education	B	2	0.00846	0.007646	0.00758	3	-0.00088	8	516,365
Office	B	2	0.00846	0.00758	0.00758	3	-0.00088	1,534	378,930,219
Other - Public Services	B	2	0.00846	0.007469	0.00758	3	-0.00088	3	132,163
Manufacturing/Industrial Plant	F	5	0.00574	0.007193	0.00758	3	0.00184	170	18,447,392
Senior Care Community	I-2	6	0.02381	0.011219	0.01138	4	-0.01243	136	16,665,956
Wholesale Club/Supercenter	M	7	0.01181	0.011112	0.01138	4	-0.00043	9	2,995,741
Residential Care Facility	I-1	4	0.01138	0.011269	0.01138	4	0	28	2,259,647
Bowling Alley	A-3	1	0.01074	0.005856	0.00574	5	-0.005	3	105,072
Worship Facility	A-3	1	0.01074	0.005995	0.00574	5	-0.005	130	6,779,453
Personal Services (Health/Beauty, Dry Cleaning, etc.)	B	2	0.00846	0.005103	0.00574	5	-0.00272	1	25,782
Vocational School	E	3	0.00758	0.005346	0.00574	5	-0.00184	2	97,000
Distribution Center	S	10	0.00426	0.005452	0.00574	5	0.00148	92	8,449,395
Hospital (General Medical and Surgical)	I-2	6	0.02381	0.024332	0.02381	6	0	41	22,465,056
Laboratory	B*	6	0.02381	0.040307	0.02381	6	0	7	2,242,572
Other - Specialty Hospital	I-2	6	0.02381	0.018992	0.02381	6	0	15	7,374,396
Other – Technology/Science	B*	6	0.02381	0.021441	0.02381	6	0	6	1,248,001
Supermarket/Grocery Store	M	7	0.01181	0.019798	0.02381	6	0.012	52	3,195,999
Other - Restaurant/Bar	A-2	1	0.01074	0.022446	0.02381	6	0.01307	4	328,400
Data Center	B	2	0.00846	0.026156	0.02381	6	0.01535	1	1,074,536

ESPM Primary Property Type	Building Code	GHGI Limit Group Based on Building Code	GHGI Limit Based on Building Code	GHGI at 81.13th Percentile	Assigned GHGI Limit Based on ESPM	Assigned GHGI Limit Group Based on ESPM	Change in GHGI Limit	Count of Properties (exclude outlier)	Total Square Footage (exclude outlier)
Ambulatory Surgical Center	B*	6	0.02381	0.016593	0.01181	7	-0.012	2	561,895
Food Sales	M	7	0.01181	0.013742	0.01181	7	0	3	138,500
Food Service	M	7	0.01181	0.016373	0.01181	7	0	4	159,027
Strip Mall	M	7	0.01181	0.012742	0.01181	7	0	20	3,368,771
Movie Theater	A-1	1	0.01074	0.01654	0.01181	7	0.00107	9	544,589
Museum	A-3	1	0.01074	0.014748	0.01181	7	0.00107	8	922,552
Restaurant	A-2	1	0.01074	0.012619	0.01181	7	0.00107	7	413,343
Outpatient Rehabilitation/Physical Therapy	B	2	0.00846	0.016787	0.01181	7	0.00335	6	1,474,958
Urgent Care/Clinic/Other Outpatient	B	2	0.00846	0.012558	0.01181	7	0.00335	12	927,560
Fitness Center/Health Club/Gym	A-3	1	0.01074	0.009371	0.00987	8	-0.00087	5	179,999
Other - Entertainment/Public Assembly	A-3	1	0.01074	0.010079	0.00987	8	-0.00087	28	3,145,340
Other - Recreation	A-3	1	0.01074	0.009786	0.00987	8	-0.00087	10	785,940
Social/Meeting Hall	A-3	1	0.01074	0.010236	0.00987	8	-0.00087	13	956,307
Hotel	R-1	8	0.00987	0.010081	0.00987	8	0	359	54,029,931
Bank Branch	B	2	0.00846	0.009805	0.00987	8	0.00141	5	283,106
College/University	B	2	0.00846	0.009357	0.00987	8	0.00141	96	32,490,231
Refrigerated Warehouse	S-2	10	0.00426	0.01007	0.00987	8	0.00561	12	926,462
Convenience Store without Gas Station	M	7	0.01181	0.006371	0.00675	9	-0.00506	2	54,529
Automobile Dealership	B	2	0.00846	0.006722	0.00675	9	-0.00171	12	941,984
Library	B	2	0.00846	0.006996	0.00675	9	-0.00171	3	913,165
K-12 School	E	3	0.00758	0.006913	0.00675	9	-0.00083	187	15,631,576
Pre-school/Daycare	I-4	3	0.00758	0.006426	0.00675	9	-0.00083	15	703,846
Multifamily Housing	R-2	9	0.00675	0.007114	0.00675	9	0	11,916	1,107,877,812
Courthouse	A-3	1	0.01074	0.002618	0.00426	10	-0.00648	1	1,100,000
Transportation Terminal/Station	A-3	1	0.01074	0.002021	0.00426	10	-0.00648	1	26,000
Mailing Center/Post Office	B	2	0.00846	0.003502	0.00426	10	-0.0042	1	159,000
Repair Services (Vehicle, Shoe, Locksmith, etc.)	F-1	5	0.00574	0.004773	0.00426	10	-0.00148	13	716,628
Non-Refrigerated Warehouse	S-1	10	0.00426	0.004724	0.00426	10	0	263	23,510,555
Parking	S-2	10	0.00426	0.001997	0.00426	10	0	86	8,903,541
Self-Storage Facility	S-1	10	0.00426	0.002449	0.00426	10	0	139	13,707,625

1.5 Analyzing the Impacts of Grouping Buildings Using ESPM Property Types

The mapping method implemented in Table 3 of this document, provides improved clarity for compliance with LL97 because it reflects how building owners currently report their energy benchmarking data. It also maintains a similar level of environmental benefit that the law's original GHGI limits deliver in the 2024-2029 period. This approach yields similar compliance rates for most ESPM Property Types. Analysis and visualizations in the following pages illustrate the impacts of this approach.

This section examines the impact of the ESPM Property Type limits based on the Building Code 3 and ESPM 3 methods described above, which both consider the three largest Property Types in a building. For each of these methods we evaluate two key areas of impact: net reductions of GHG emissions and changes in compliance rates.

1.6 Impact on Greenhouse Gas Emissions Reductions

The analysis performed, as noted in Table 4 of this document, demonstrates that shifting from the Building Code based building categorization system to the proposed ESPM Primary Use Type system results in a roughly 0.04% decrease in GHG emissions reductions in the 2024-2029 compliance period. Assuming 100% compliance with the law, the original Building Code grouping is estimated to deliver a 636,645 tCO_2e reduction from 2018 levels, each year beginning in 2024. Modeling compliance with the ESPM categories, by comparison, is expected to deliver 636,399 tCO_2e reduction in this period.

	Building Code 3 Largest Uses	ESPM 3 Largest Uses
Total Emissions Reduction (tCO_2e)	636,645.11	636,399.34

Table 4. Total Annual Emissions Reductions Under Each Grouping Method

1.6.1 Changes in Whole Building Emissions Limits

Table 5, *Number of Properties with Changed Whole Building Emissions Limit*, reports the impacts of applying the GHGI limits established in this analysis.

Change in Whole Building Emissions Limit	# Properties	Percent of Properties
Increased	3,714	23%
No Change	11,410	71%
Decreased	907	5%
Total	16,031	100%

Table 5. Number of Properties with Changed Whole Building Emissions Limit

1.7 Impact on Compliance Rates

This section analyzes the shifts in compliance to non-compliance status during the 2024-2029 period that take place when adopting the ESPM Property Types categorization.

1.7.1 Count of Compliant Properties

As illustrated in Table 6 of this document, when viewed in aggregate, the count of properties complying with the law for 2024 based on 2018 benchmarking data is very similar between the Building Code and ESPM categorization methods. Of the 16,031 properties analyzed, 12,663 were found to be potentially in compliance under the Building Code method (with 3,368 out of compliance), while 12,496 were found to be potentially in compliance using the ESPM Property Type categorization (with 3,535 out of compliance). In other words, using the ESPM categorization results in 167 additional properties potentially being out of compliance with the law in 2024.

In Compliance 2024?	Count Building Code 3	Count ESPM 3
Not Compliant	3,368	3,535
Compliant	12,663	12,496
Total	16,031	16,031

Table 6. Comparison of Count of Compliance Between the Building Code and ESPM Grouping Methods

1.8 GHGI Limit Group 7

Figures 2 and 3 of this document show the percent of properties potentially in compliance under the Building Code 3 and ESPM 3 categorizations. Figures 21 and 22 of this document show that LL97 GHGI limit group 7 has a lower compliance rate under the ESPM 3 limit calculation than under the Building Code 3 calculation. This is partially due to the fact that LL97 groups 6 and 7 are the first and second highest emissions limit groups, respectively, and have a large range between them (group 6's GHGI limit = 0.02381 tCO_2e/ft^2 while and group 7's GHGI limit = 0.01181 tCO_2e/ft^2). It should be noted that seven of the ten ESPM Property Types in this figure received higher GHGI limits than previously assigned, while the other Property Types maintained the same limit. It should also be noted that 294 buildings are subject to the limits in Group 7 in the Building Code categorization, while only 71 face this limit group in the ESPM conversion. Of these 71 buildings in the ESPM 3 categorization, fewer total buildings are out of compliance than under the Building Code 3 categorization, but a higher proportion of those 71 is out of compliance. Group 7 has the second highest limit (0.01181 tCO_2e/ft^2), which is about half the limit of Group 6 (0.02381 tCO_2e/ft^2).
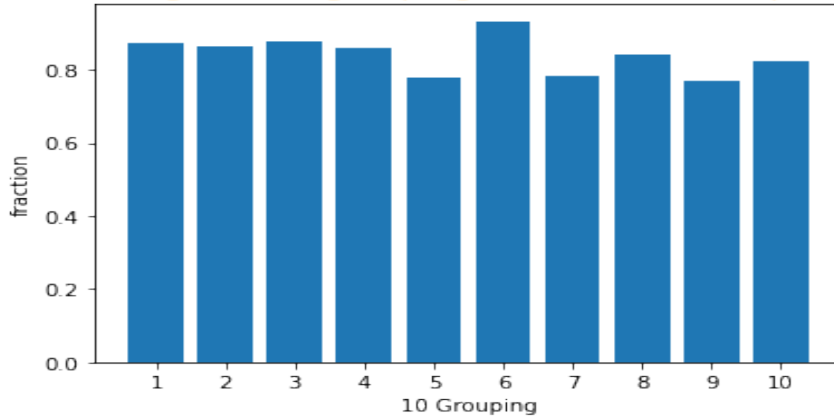
Figure 2. Building Code 3: Percent of Compliant Buildings
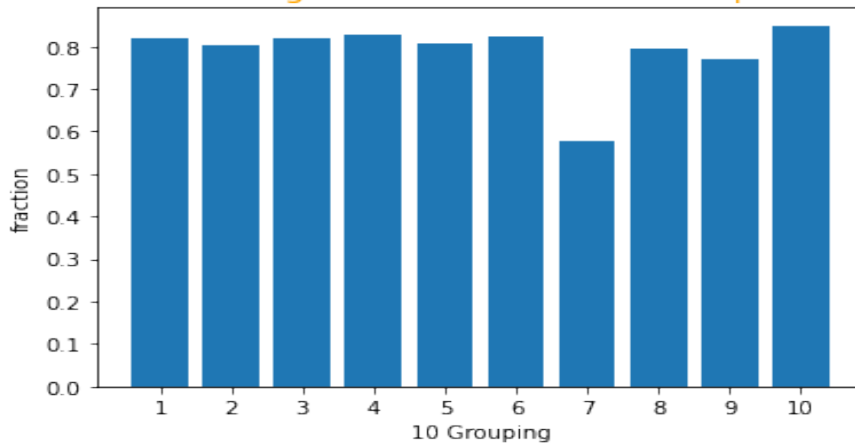
Figure 3. ESPM 3 Largest Uses: Percent of Compliant Buildings

1.9 Impact on Floor Area of Compliant Properties

This section, as further exemplified in Table 7 and Figures 4 and 5 of this document, considers compliance on a square footage basis, rather than by count of properties. Again, the relatively lower compliance rate observed in LL97 GHGI limit group 7 is evident when using ESPM Portfolio Manager Property Types to determine compliance. The primary reason for a low compliance rate is the same as described above: LL97 groups 6 and 7 are the first and second highest emissions limit groups, respectively, and there is a large range between group 6 (GHGI limit = 0.02381 tCO_2e/ft^2) and 7 (GHGI limit = 0.01181 tCO_2e/ft^2). The result is that most of the Property Types that map to group 7 have GHGIs at the 81.13rd percentile above the value of that limit. This yields a potentially lower compliance rate for buildings in this group.

The sum floor area of compliant properties under both categorization options is similar, as well. Of the 1.9 billion ft^2 of building area considered in this analysis,

1.51 billion ft^2 are potentially in compliance with 2024 limits when modeling the Building Code 3 categorization based on 2018 benchmarking data. By comparison, 1.49 billion ft^2 are under the 2024 targets when modeling the ESPM 3 Largest categorization.

	Building Code 3 Grouping	ESPM 3 Largest Uses
Non-compliant *(billion sq. ft.)*	0.32	0.34
Compliant *(billion sq. ft.)*	1.51	1.49
Total *(billion sq. ft.)*	1.83	1.83
Non-compliant %	17%	19%

Table 7. Aggregated Floor Area of Compliant Properties vs Non-Compliant Properties
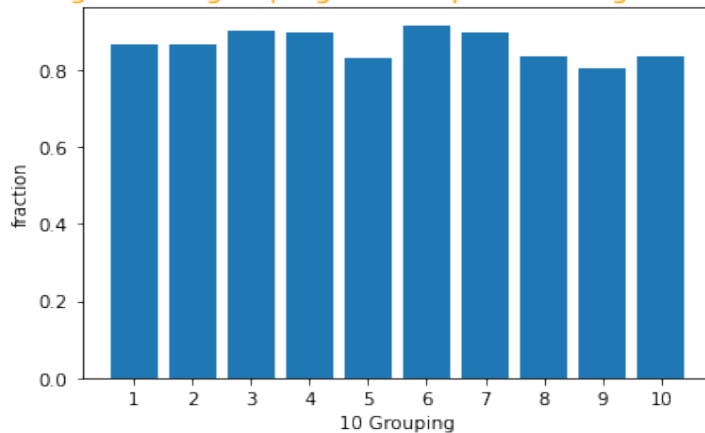
Figure 4. Building Code 3: Percent of Compliant Square Footage
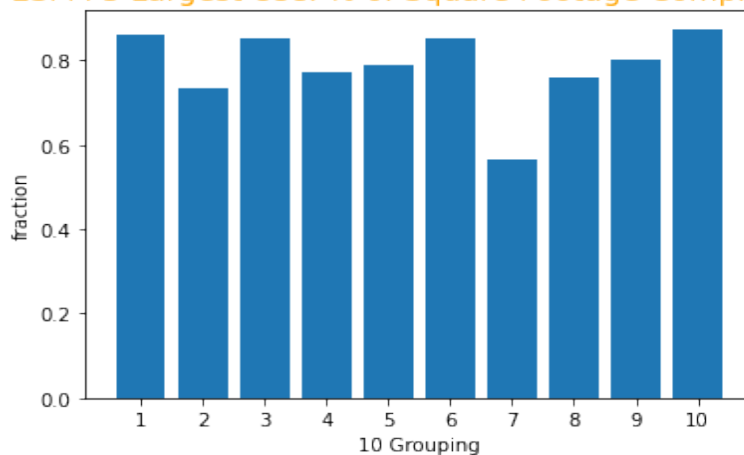
Figure 5. ESPM 3 Largest Uses: Percent of compliant square footage

1.10 Impact on Count of Properties Switching Compliance

The overall impact on compliance of converting to the ESPM categorization is arguably low. In this analysis, as noted in Table 8 of this document, 363 properties change compliance status, with 0.5% of all covered properties (98 properties) changing to compliant and 1.5% (265 properties) changing to non-compliant. These changes in compliance status are very small considering the degree of transformation in building categorization implemented in this study.

Table 8. Count of properties that switched compliance status

Compliance Change from Building Code 3 to ESPM 3	Count	Percent of Total
Change to Compliant	98	0.5%
Change to Non-Compliant	265	1.5%
No Change	15,668	94.2%
Total	16,031	100%

1.11 Conclusion

Assigning ESPM Portfolio Manager Property Types to the ten GHGI emissions limits listed in LL97 fulfills the requirements of §28-320.3.1 of the law and is reflected in **1 RCNY 103-14**.

Utilizing the property types available through the EPA's EnergyStar Portfolio Manager program will ensure that buildings are categorized based on common energy footprints and thus assigned more appropriate emissions limits. This will make the allocation of emissions reductions under the law more equitable. Furthermore, ESPM mapping makes compliance with the law more straightforward. Building owners will be able to report the actual use of their property spaces and not be constrained by potentially incorrect or outdated city records or categories based on criteria unrelated to energy use. This will make the emissions accounting and reporting process easier and more meaningful. Finally, the analysis shows that converting to ESPM Property Types in LL97 maintains the environmental benefits in GHG emissions reductions required under the law.

2. Appendix A: Data and Data Pre-Processing

The City relied primarily on its annually reported energy and water benchmarking data to establish the GHGI limits in LL97, to develop Table 3 of this document, and to analyze the impacts of applying Table 3 groupings for LL97 compliance. Due to the self-reported nature of the benchmarking data and limitations in data validation, it was necessary to perform a set of pre-processing steps to prepare the dataset for analysis and GHGI limit determination. Below is an outline of the data utilized and the pre-processing steps conducted to prepare NYC's 2018 benchmarking data for that analysis and to support the rulemaking process for LL97 of 2019.

2.1 Data

The data sets used in this analysis include:

1. **2018 Energy and Water Benchmarking Reports**, includes all data collected by the city under Local Law 84 of 2009 (LL84).

2. **2018 Covered Buildings List (CBL)**, the list of properties subject to LL84.

3. **A list of municipal properties**, which are managed by the Department of Citywide Administrative Services (DCAS). Municipal properties follow a separate pathway for GHG reductions in LL97.

4. **A list of public housing properties** that are managed by the NYC Housing Authority (NYCHA). NYCHA properties follow a voluntary track for GHG reductions in LL97.

It is important to note that the law puts buildings with more than 35% rent-regulated (defined in **§28-320.1** of the NYC Administrative Code) units on a separate compliance path and process that does not establish GHGI emissions limits. However, the City was not able to use NY State rent regulation data for this analysis and therefore did not separate this housing sector from the analysis.

Below is an overview of the steps taken in the IPython notebook to prepare a buildings emissions data set for GHGI analysis using LL84 benchmarking data as the primary file. As noted above, City-owned (DCAS) and public housing (NYCHA) properties are not subject to Article 320 of the law and are therefore removed from the data set used by the City.

2.2 Pre-Processing Method

Loading data:

- Load LL84 Benchmarking data
- Load LL84 Covered Building List data
- Load DCAS list
- Load NYCHA list
- Load Building Code mapping

Steps:

1. Create table to track records affected by each step
2. Remove records with missing or incomplete Borough, Block, and Lot numbers (BBLs)
3. Remove duplicate reports
4. Remove rows that are <=25k sqft
5. Remove benchmarking data's BBLs that are not in Covered Buildings List (CBL)
6. Remove DCAS properties
7. Remove NYCHA properties
8. Calculate GHG for each energy type for each record (i.e., BBL)
9. Create GHGI column
10. Two types of outlier filters were applied:
    a. Remove ESPM Property Type outliers >3 standard deviation from the mean
    b. Remove BBLs with total emissions > 1m tCo2e
11. Remove **Other** and **Single-Family Home** Property Type
12. Find the same GHGI value in the same property type, then manually remove
13. Create Building Code grouping
14. Determine emissions target using Building Code 3 grouping
15. Create ESPM grouping
16. Optimize GHGI limit assignments using ESPM 3 grouping

3. Appendix B: Distribution of GHGI Under Building Code and ESPM Categories

Before assessing the impacts of remapping LL97 GHGI limits to ESPM Property Type, we will view how GHGI is distributed for all covered buildings, within LL97's Building Code groupings, and within ESPM Property Type categories.

3.1 GHGI of all buildings covered by LL97

A view of the GHGI of all buildings covered by §28.320 of the law shows a right-skewed distribution. This indicates that the covered buildings under LL97 include a set of properties that are exceptionally high emitters. As indicated in Figure 6 of this document, the GHGI of the highest emitting building is 0.24647 tCO_2e and the mean GHGI value is 0.0055 tCO_2e.
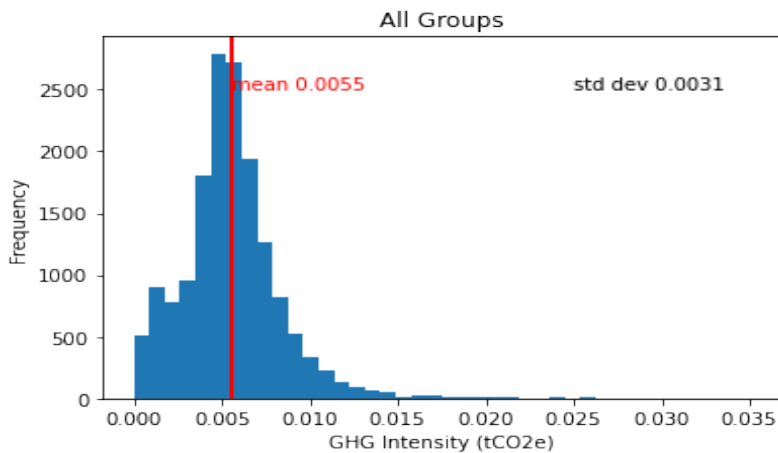
Figure 6. Distribution of GHGI for All Buildings

3.2 GHGI within Building Code Categories

First, we view the distribution of GHGI for all buildings under the original Building Code method in Figure 7 of this document.
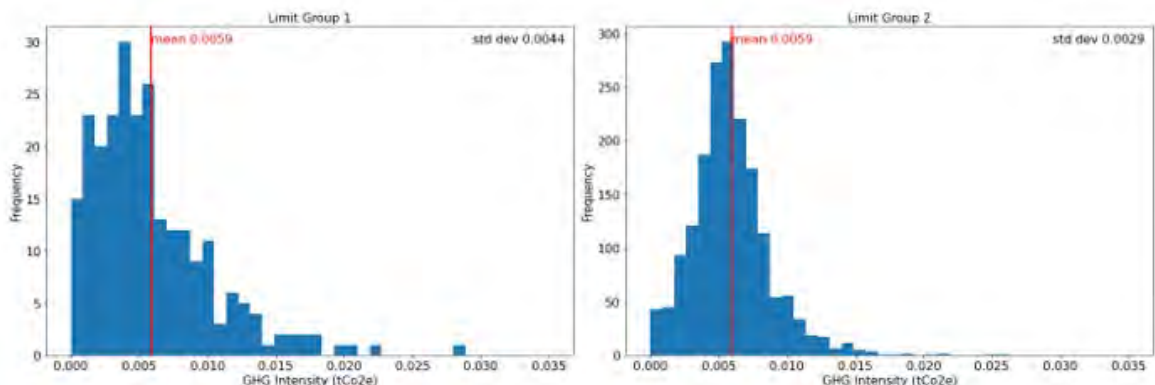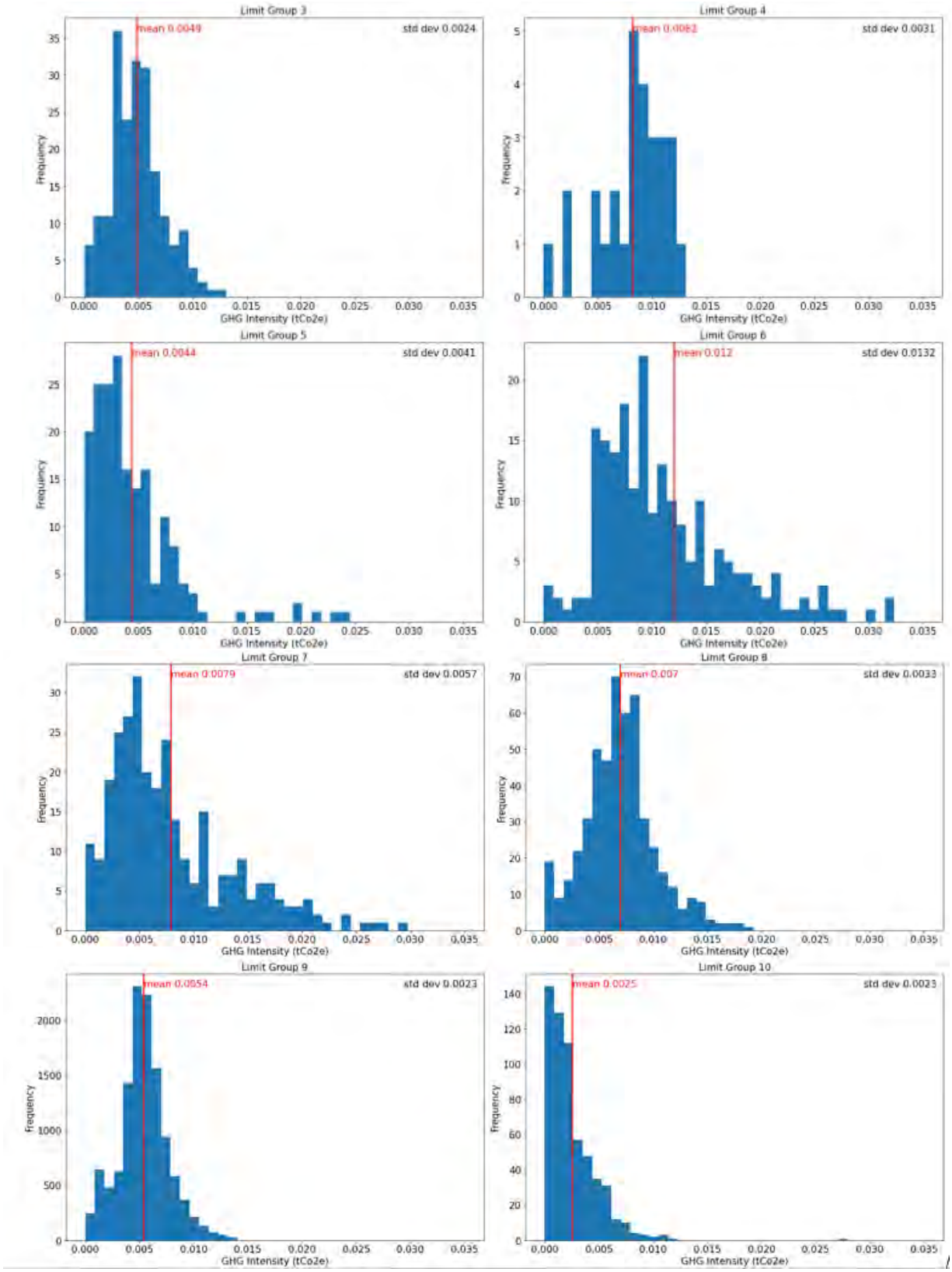
Figure 7. Distribution of GHGI for each Building Code group

3.3 GHGI within ESPM Primary Property Type Categories

The distribution of GHGI for all buildings grouped by their ESPM Primary Property Types are shown in Figure 8 of this document. Each building self-reports their Primary Property Type to the city in annual benchmarking reports. Buildings also report their second and third largest Property Types, as well as the corresponding square footage of each use type.
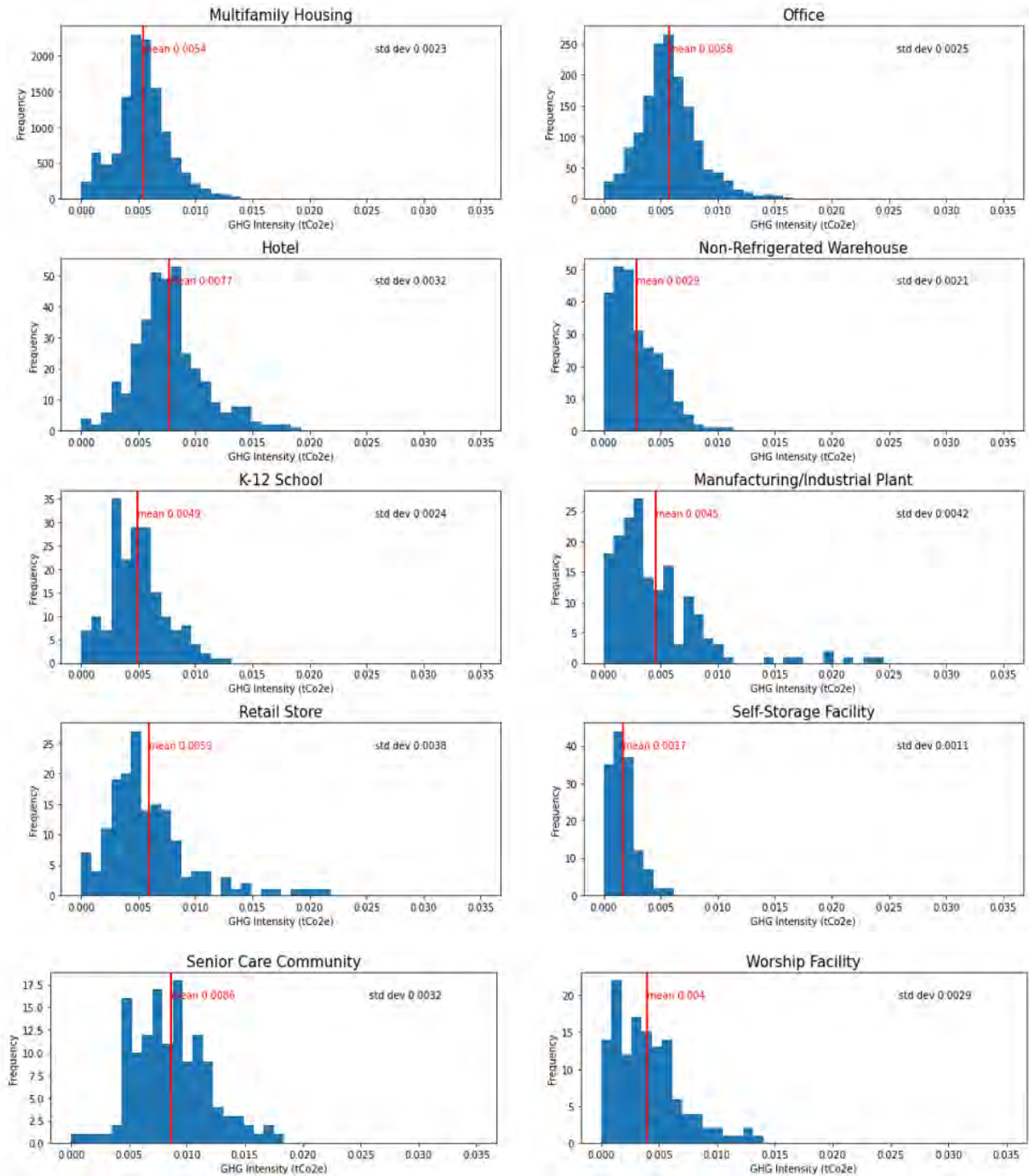
Figure 8. Distribution of GHGI for each ESPM Primary Property Type
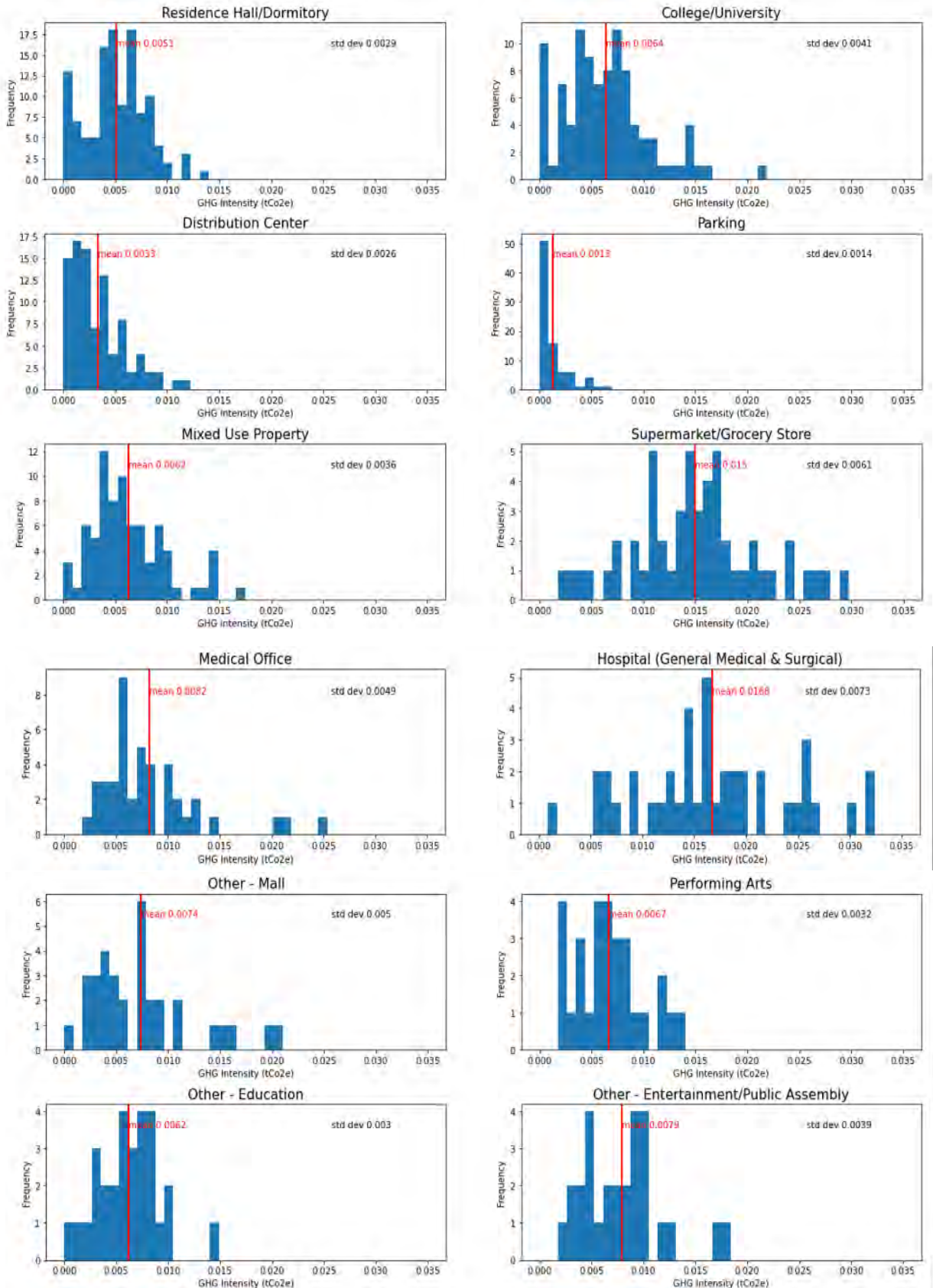
Figure 10. Distribution of GHGI for each ESPM Primary Property Type (cont.)
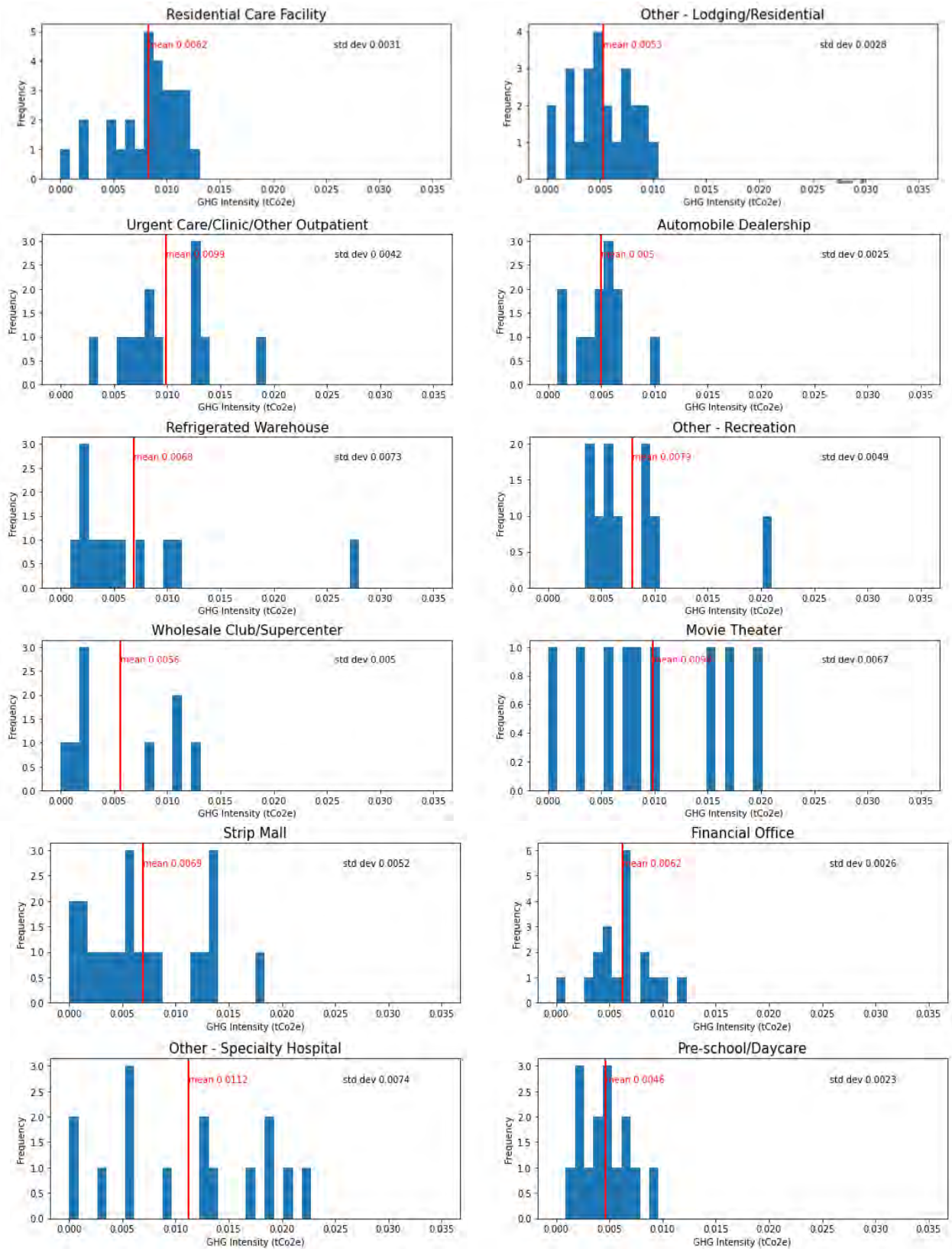
Figure 11. Distribution of GHGI for each ESPM Primary Property Type (cont.)
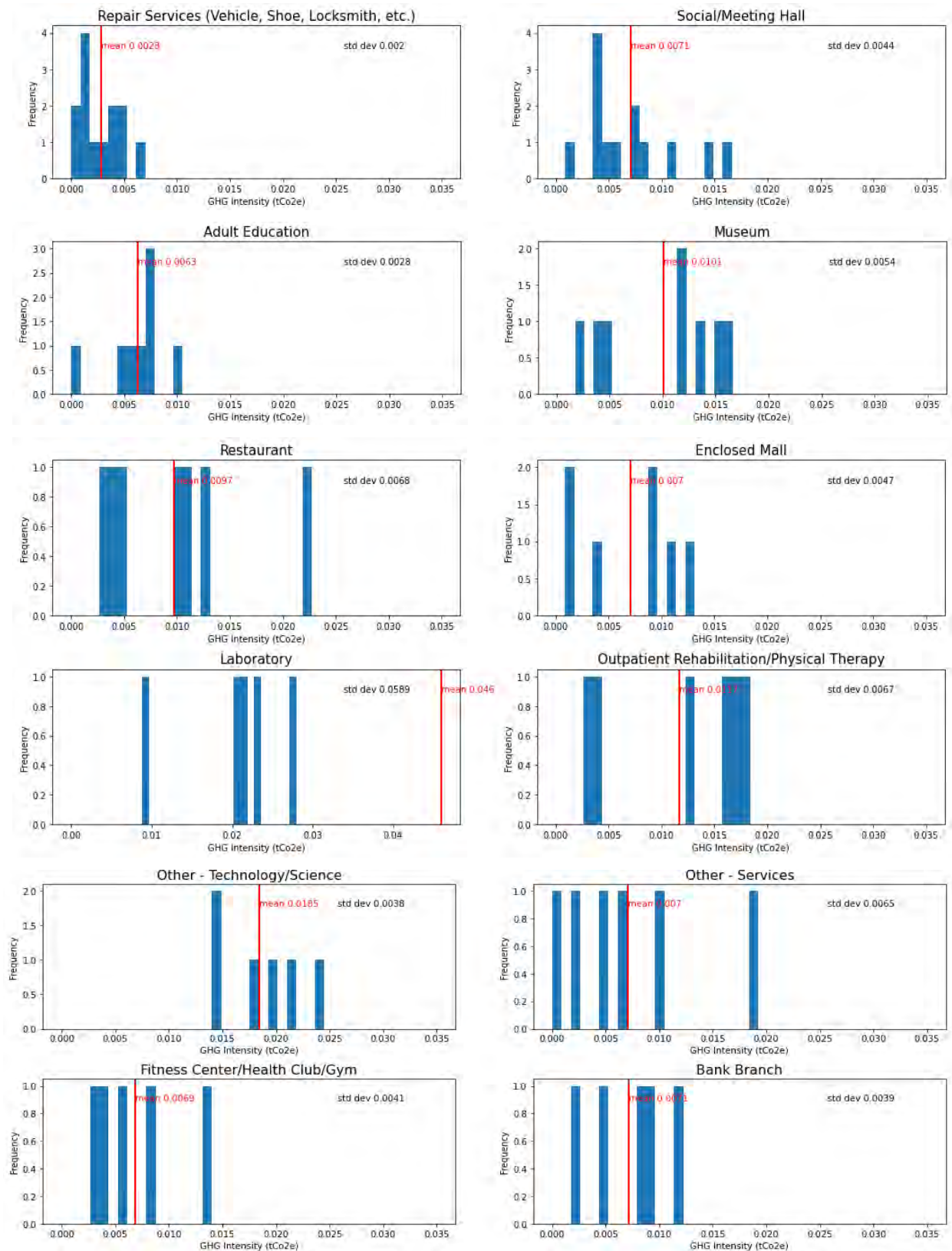
Figure 12. Distribution of GHGI for each ESPM Primary Property Type (cont.)
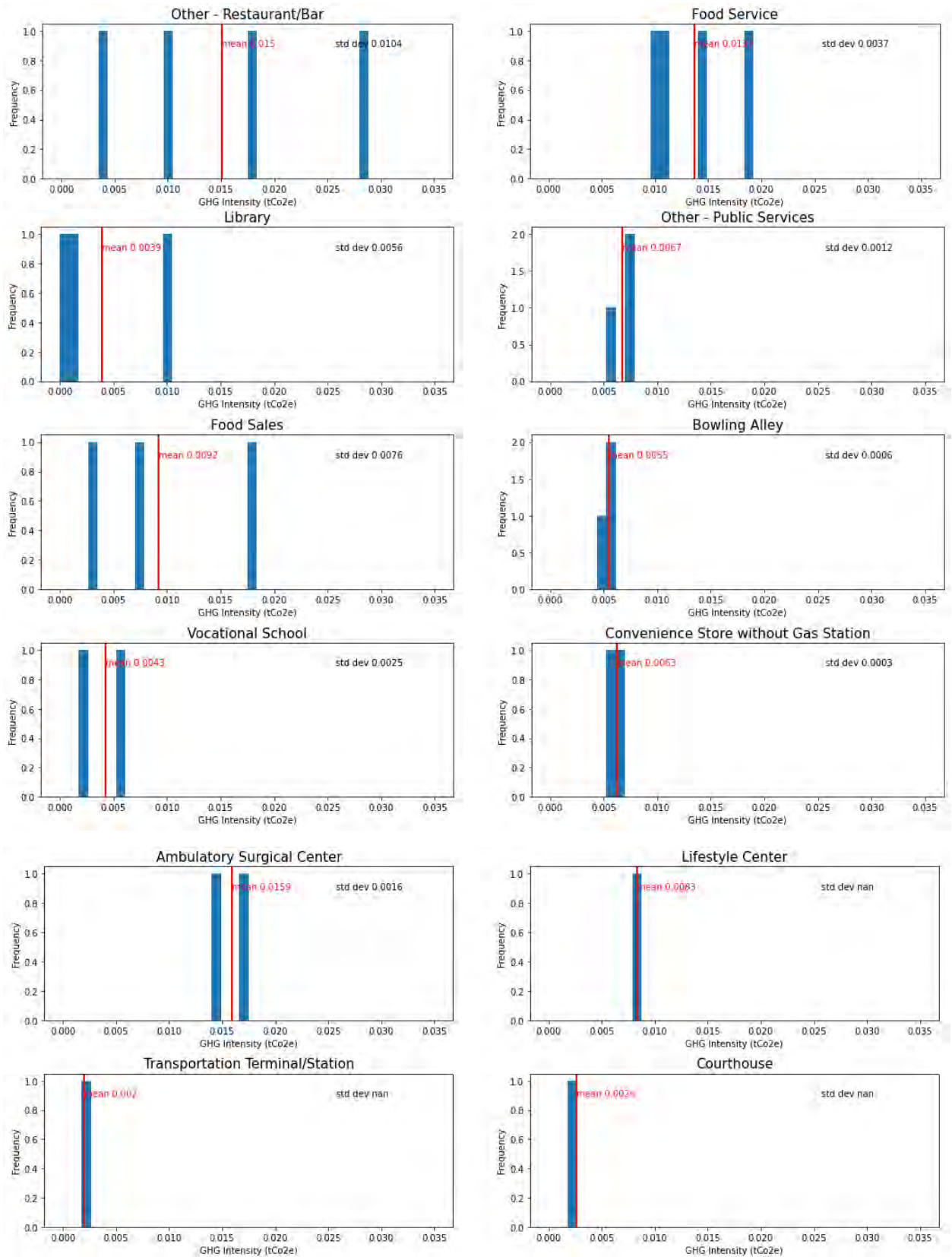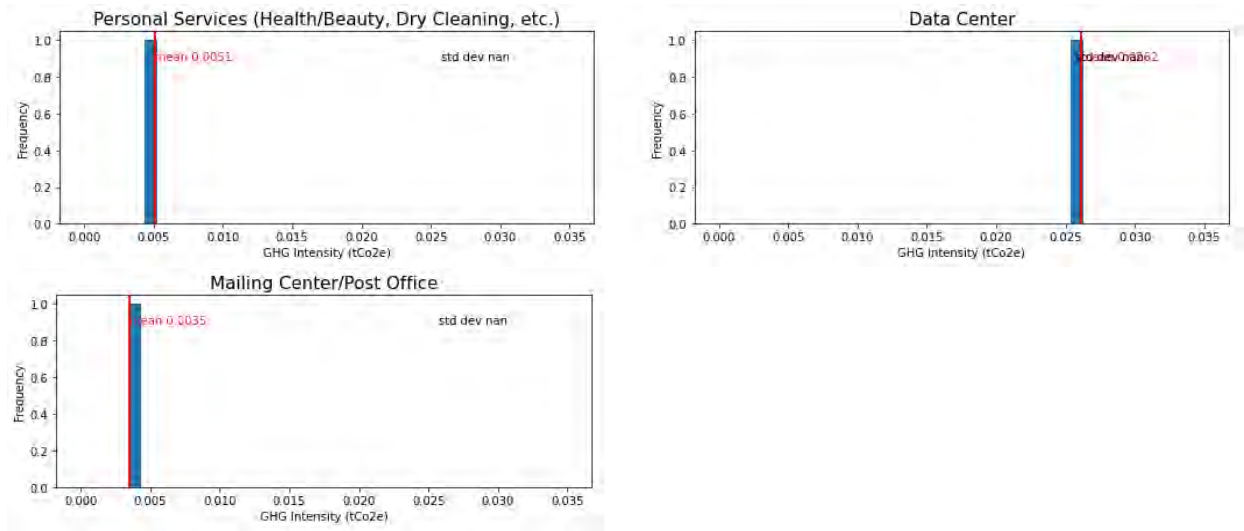
3.4 Comparing Building Code Group with ESPM Primary Use

In this section we analyze the impacts of converting from the Building Code categorization to the ESPM Primary Property Type category (which is described in Table 3 of this document). We illustrate this in the following twenty figures (Figures 9-28). For each of the ten GHGI limits listed in LL97, we include two sets of figures. These include:

1. Building Code
    a. The distribution of GHGI for all buildings in the group
    b. The ESPM Primary Property Types identified for buildings within the group

2. ESPM Primary Property Type
    a. The distribution of GHGI for all buildings in the group
    b. The ESPM Primary Property Types identified for buildings within the group

Viewing these figures shows how building Property Types shift between LL97's original Building Code assignment and the EPSM Primary Property Type grouping method.

Group 1 - GHG Limit = 0.01074 tCO$_2$e/ft^2

Figure 14. GHGI Limit 1 - Building Code

26
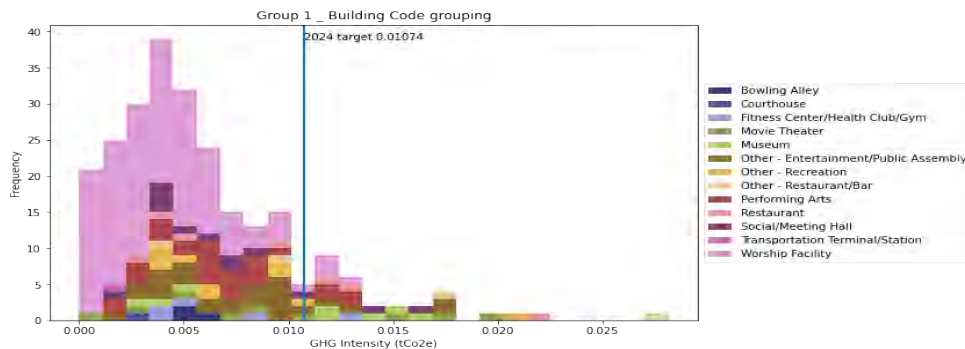
Figure 15. GHGI Limit 1 - ESPM Primary Use
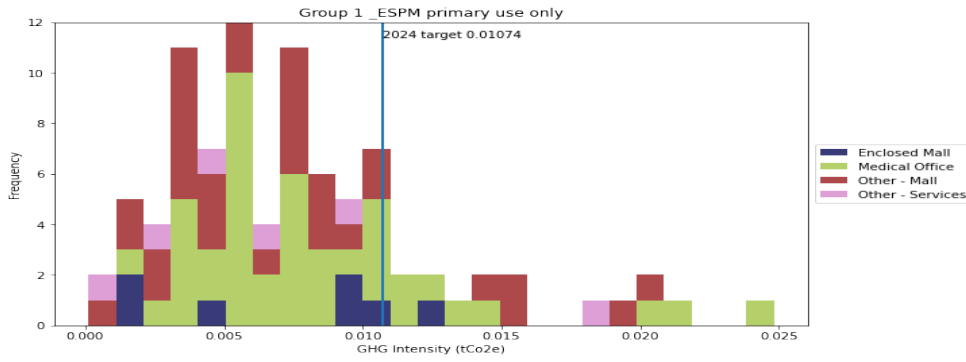
Group 2 - GHG Limit = 0.00846 tCO$_2$e/ft^2

Figure 16. GHGI Limit 2 - Building Code
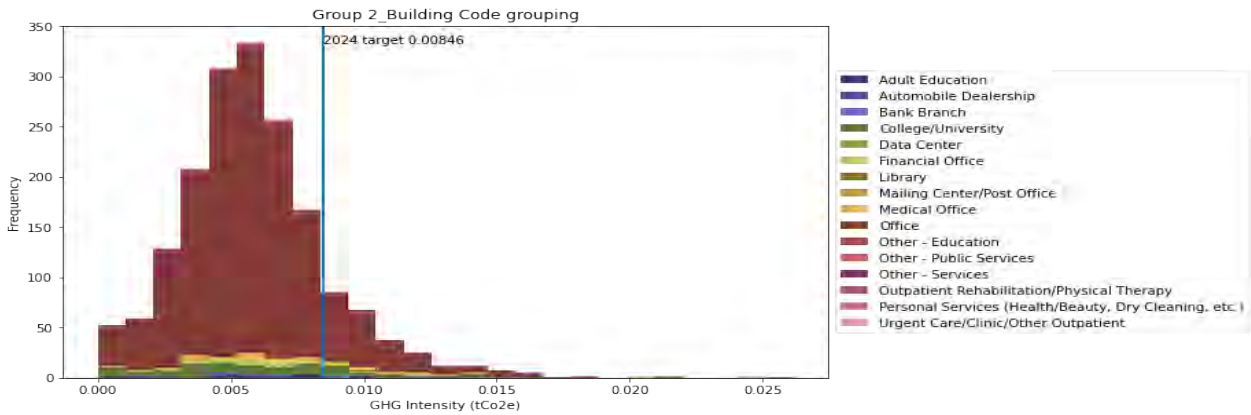
Figure 17. GHGI Limit 2 - ESPM Primary Use
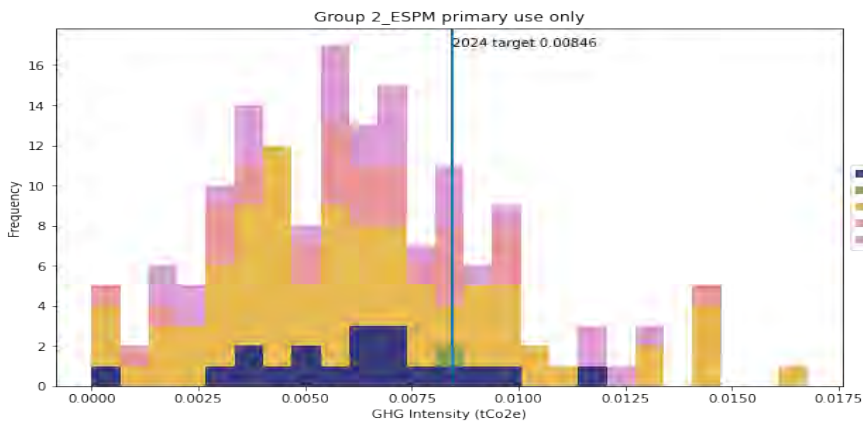
Group 3 - GHG Limit = 0.00758 tCO₂e/ft²

Figure 18. GHGI Limit 3 - Building Code
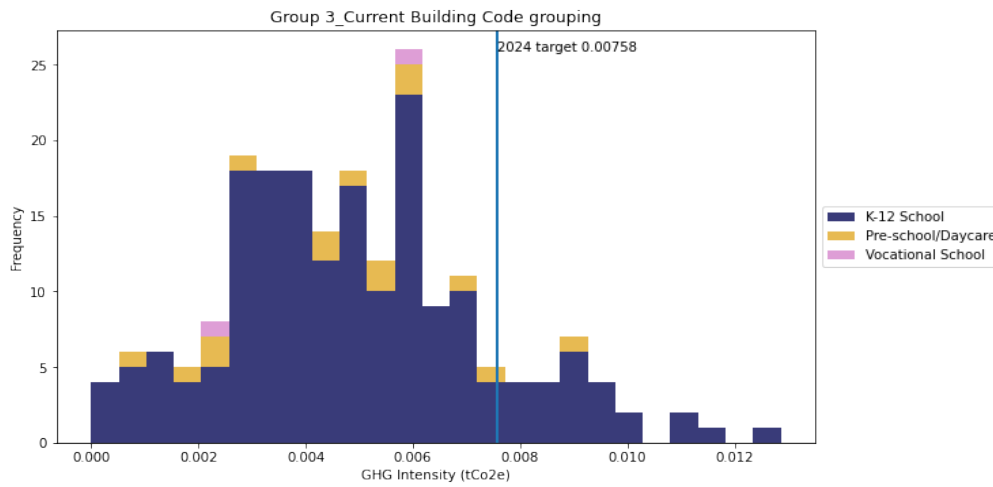
Figure 19. GHGI Limit 3 - ESPM Primary Use
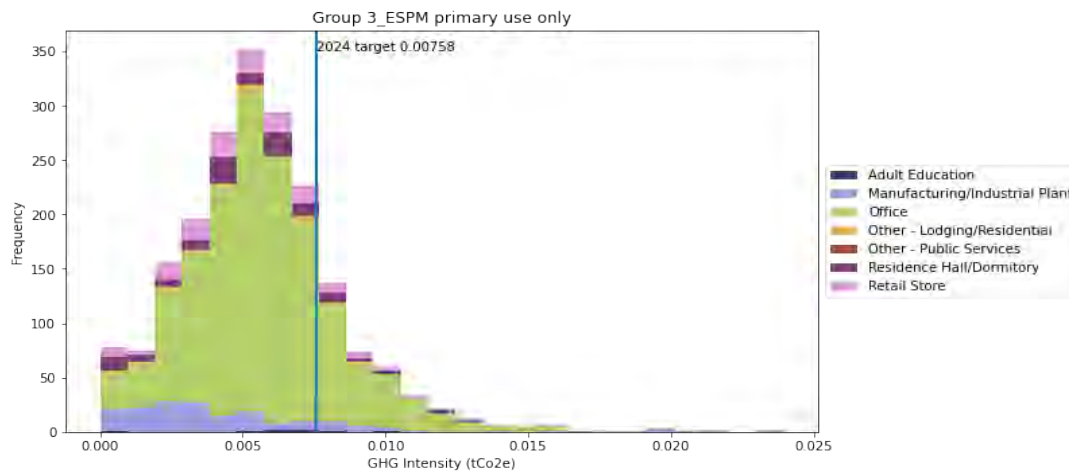
Group 4 - GHG Limit = 0.01138 tCO₂e/ft²
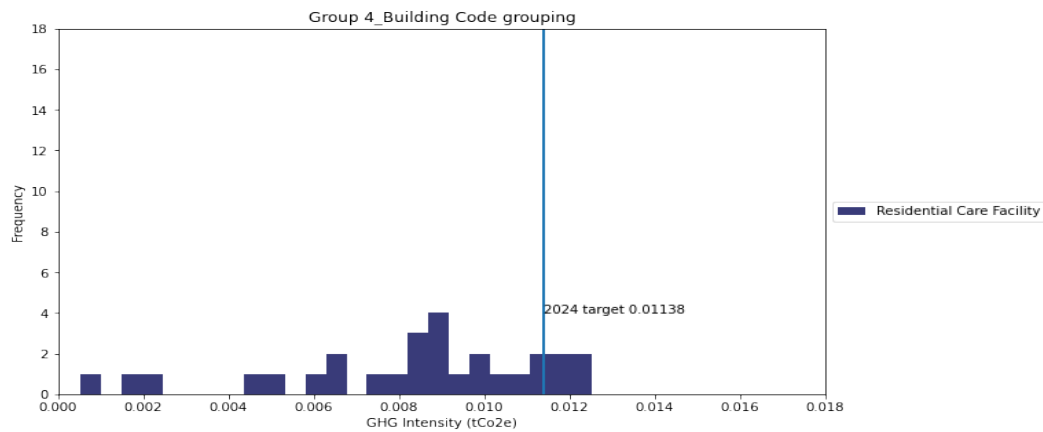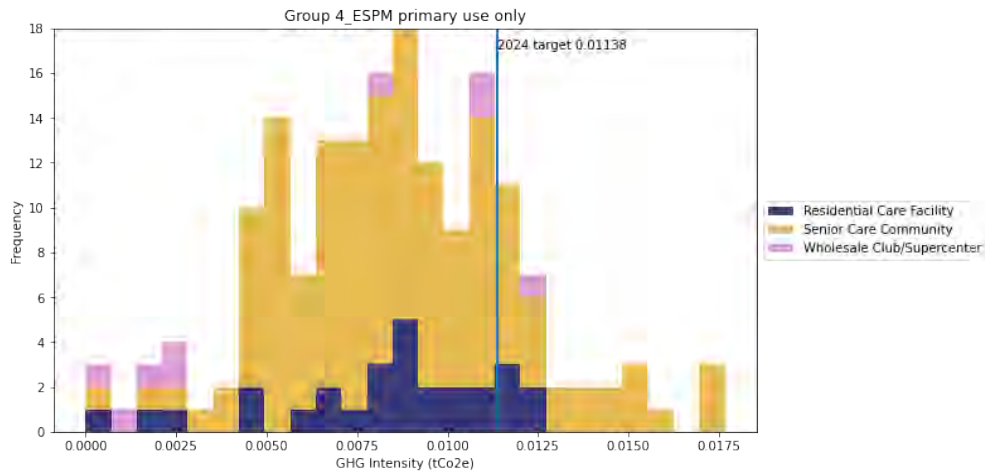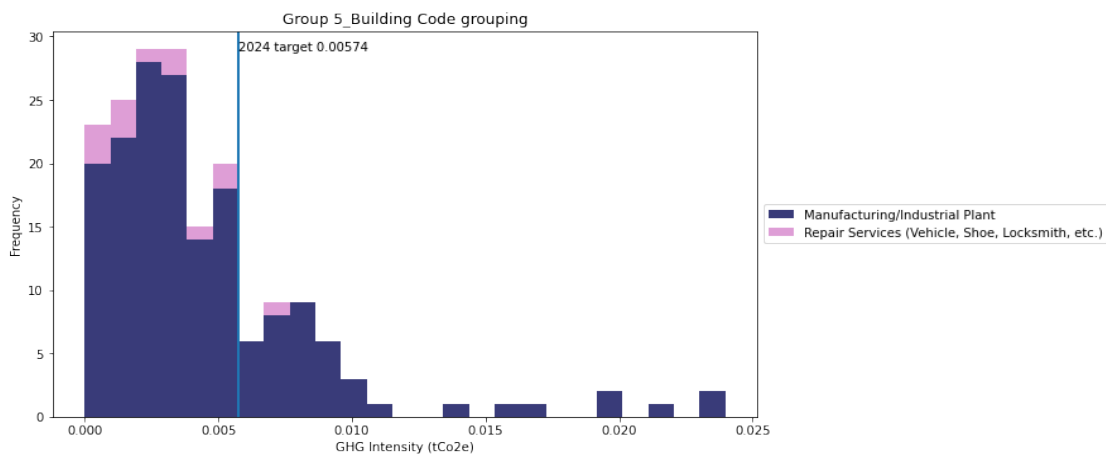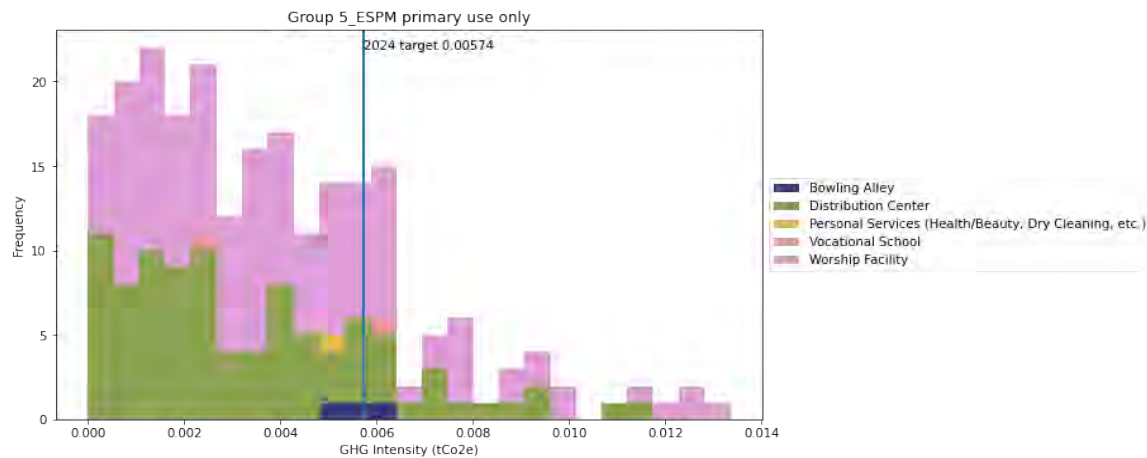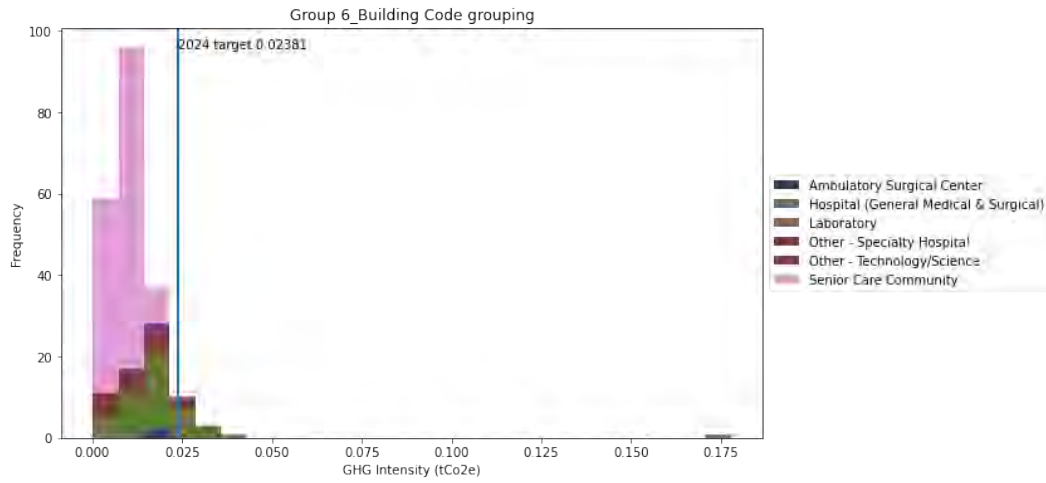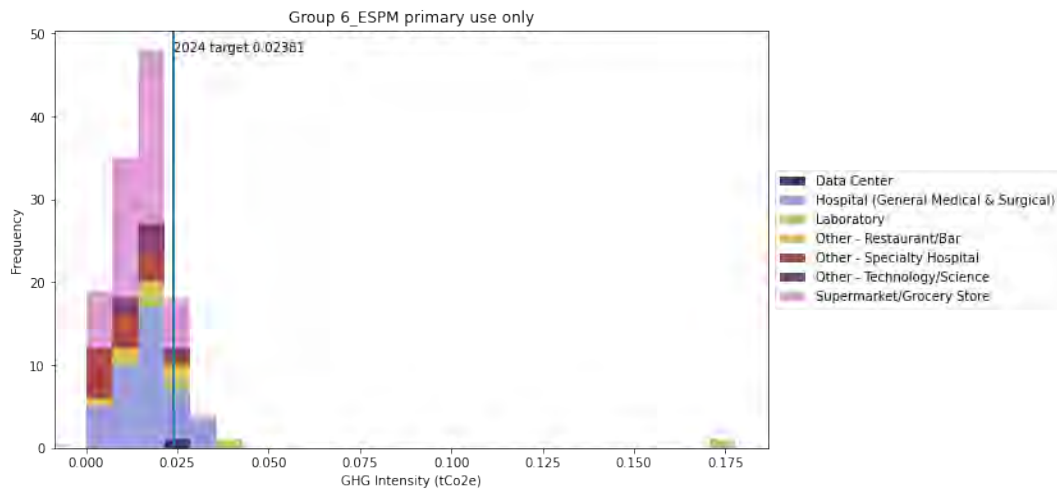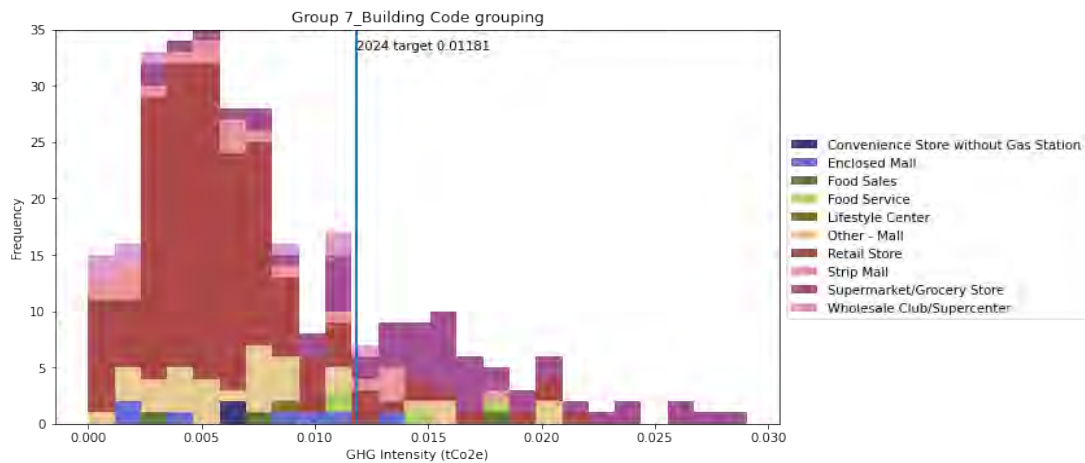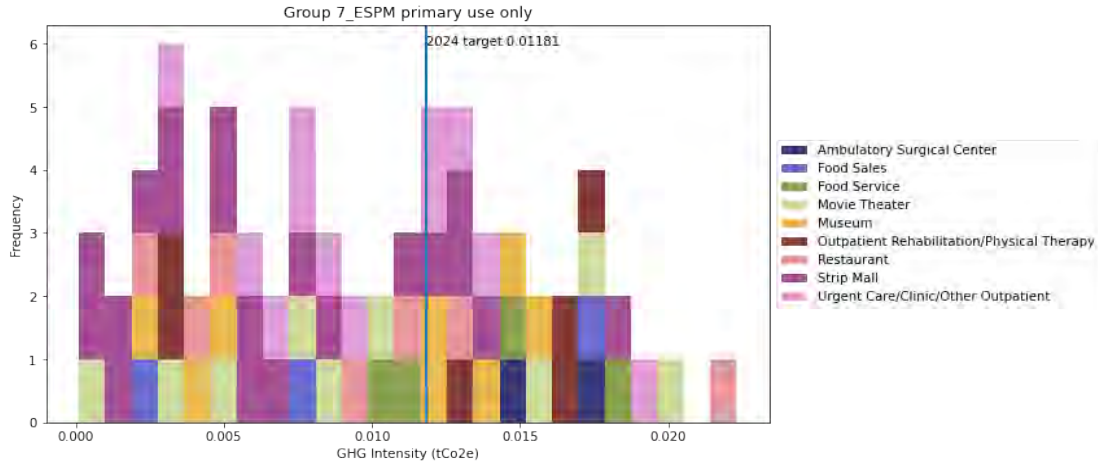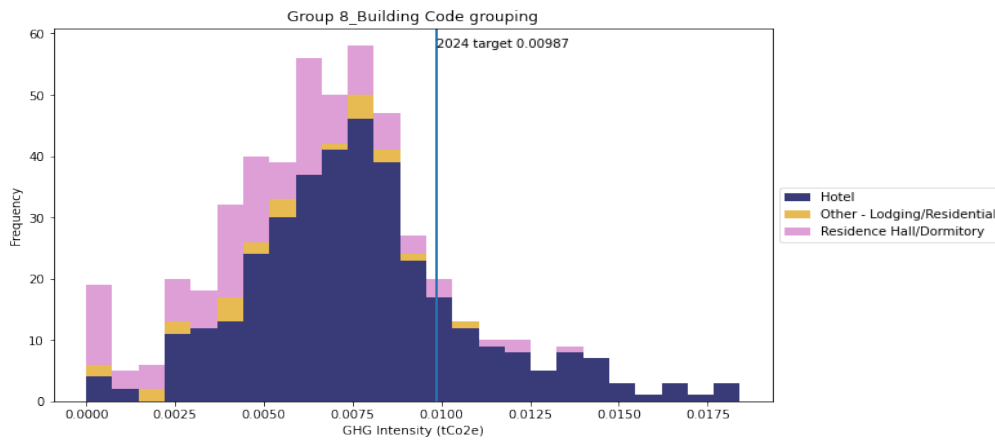
Figure 20. GHGI Limit 4 - Building Code

Figure 21. GHGI Limit 4 - ESPM Primary Use

Group 5 - GHG Limit = 0.00574 tCO$_2$e/ft^2

Figure 22. GHGI Limit 5 - Building Code

Figure 23. GHGI Limit 5 - ESPM Primary Use

Group 6 - GHG Limit = 0.02381 tCO$_2$e/ft^2

Figure 24. GHGI Limit 6 - Building Code

Figure 25. GHGI Limit 6 - ESPM Primary Use excluding outliers

Group 7 - GHG Limit = 0.01181 tCO$_2$e/ft^2

Figure 26. GHGI Limit 7 - Building Code

Figure 27. GHGI Limit 7 - ESPM Primary Use

Group 7_ESPM primary use only

Legend:
- Ambulatory Surgical Center
- Food Sales
- Food Service
- Movie Theater
- Museum
- Outpatient Rehabilitation/Physical Therapy
- Restaurant
- Strip Mall
- Urgent Care/Clinic/Other Outpatient

Group 8 - GHG Limit = 0.00987 tCO$_2$e/ft^2

Figure 28. GHGI Limit 8 - Building Code

Group 8_Building Code grouping

Legend:
- Hotel
- Other - Lodging/Residential
- Residence Hall/Dormitory

Figure 29. GHGI Limit 8 - ESPM Primary Use

Group 8_ESPM primary use only

Legend:
- Bank Branch
- College/University
- Fitness Center/Health Club/Gym
- Hotel
- Other - Entertainment/Public Assembly
- Other - Recreation
- Refrigerated Warehouse
- Social/Meeting Hall
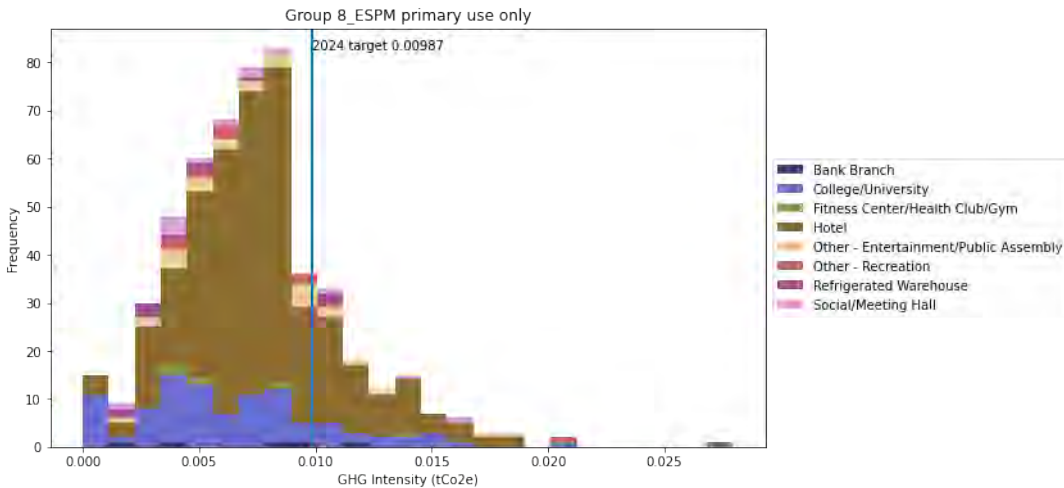
Group 9 - GHG Limit = 0.00675 tCO$_2$e/ft^2
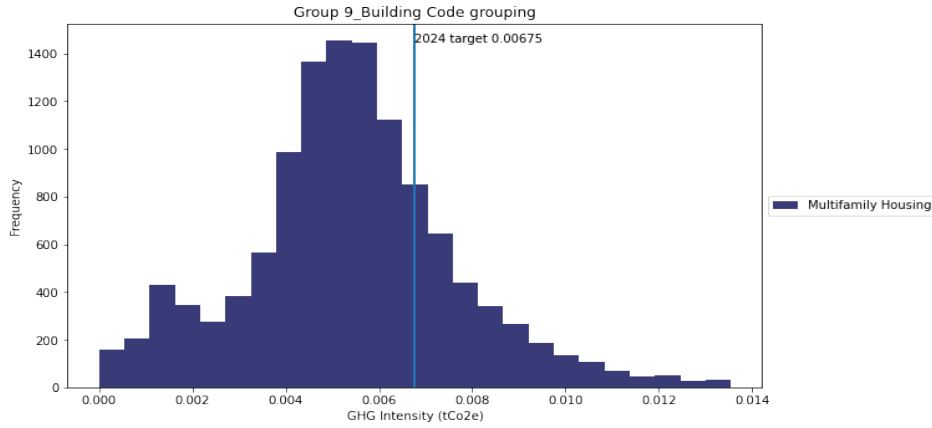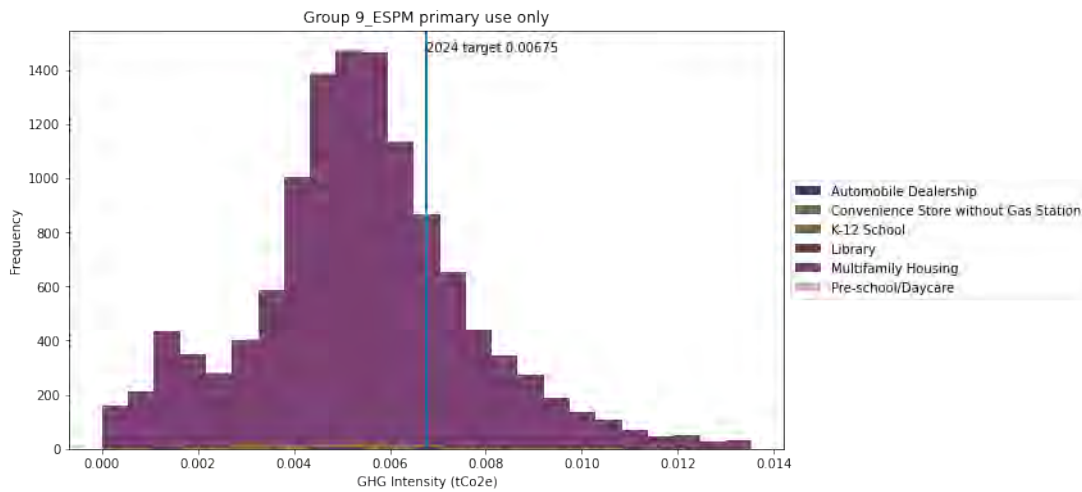
Figure 30. GHGI Limit 9 - Building Code

Figure 31. GHGI Limit 9 - ESPM Primary Use

Group 10 - GHG Limit = 0.00426 tCO$_2$e/ft^2

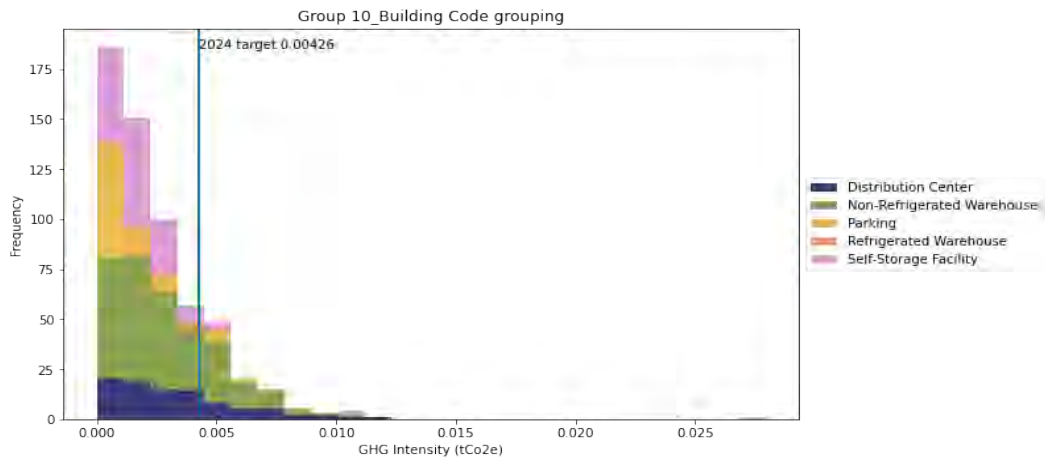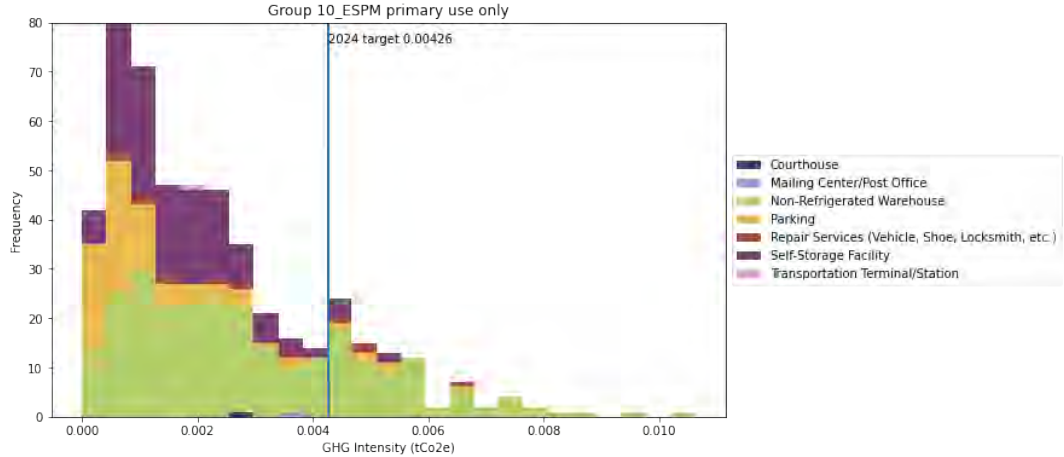*Figure 32. GHGI Limit 10 - Building Code*

Figure 33. GHGI Limit 10 - ESPM Primary Use

4. Acknowledgements

The New York City Department of Buildings gratefully acknowledges the following individuals who contributed to the development of the report on *Converting Emissions Limits in New York City's Local Law 97 to Energy Star Property Types for 2024 to 2029.*

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