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Massachusetts Electric and Gas Program Administrators

Commercial Building Department Document Review (Final Report)

April 27, 2016

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CADMUS

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Part of the Special and Cross-Cutting Evaluation Program Area

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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

1.1 OVERVIEW

Building energy codes undoubtedly play a significant role in transforming the building energy efficiency market and construction practices, aiming to raise the entire market to desired efficiency levels. However, achieving their full potential impact varies and depends on how well the energy code is enforced. Energy code enforcement starts with thorough and proper documentation to prove that the design parameters and characteristics meet energy code requirements.

The Massachusetts energy code requires that applicants file some form of documentation at the local building department during the building permit process. Typically, building departments are required to archive the final permit documents submitted by the applicant. These records serve as public documents and are meant to track historical modifications to the building and add transparency to the permitting process. However, sometimes these documents get misplaced or filed in separate locations making it hard or impossible for the building department staff to locate them.

Given the constantly-evolving nature of code cycles, and various energy codes enforced in different jurisdictions (stretch code versus IECC), there is uncertainty in how sufficiently energy code requirements are documented, and therefore reviewed by plan checkers per site. In order to bring more clarity to this issue, the Massachusetts Program Administrators and the EEAC Consultants sponsored this study as part of the evaluation of the Massachusetts Code Compliance Support Initiative (CCSI). The study focused on determining current levels of energy code documentation and identifying factors that may influence documentation levels. The sponsors contracted with the Tetra Tech cross-cutting evaluation team to conduct a limited scope of data collection to assess the level of documentation associated with energy code compliance for a sample of new construction commercial facilities located in the Commonwealth of Massachusetts. Cadmus, who led this effort for the cross-cutting team, visited the building departments in six jurisdictions and requested data to determine the type of documentation being filed to show compliance with the Massachusetts energy code for commercial buildings.

1.2 METHODOLOGY

Cadmus conducted a technical desk review to assess the available level of documentation, which was focused on answering these general research objectives:

- For what percentage of buildings was documentation filed to demonstrate compliance with high-impact energy code requirements?
- When present, what was the format of the filed documentation?
- How does documentation vary by energy code?
- How does documentation vary by municipality?

More specifically, Cadmus attempted to answer these researchable questions:

- Was COMcheck documentation present? If so, what type of compliance certification (lighting, envelope, and HVAC) was included? How did the data in COMcheck compare with the relevant energy code's specific requirements?
- For LEED-certified buildings:
  - Was an energy modeling report submitted?
  - Did this report show how the design case compares to the baseline case in terms of their annual energy consumption?
  - What baseline was used?
  - Did the energy modeling report document certain building parameters and characteristics? If so, what type of data points were used?[1]
- For buildings that took the prescriptive path to code compliance, did the parameters and characteristics specified in the drawings and construction details meet relevant energy code requirements? Was a prescriptive code compliance checklist filed?

1.3 OVERALL RESULTS

Overall, within the small number of jurisdictions for which Cadmus collected data, available energy code compliance documentation varied site by site, and jurisdiction by jurisdiction and was limited and incomplete. Based on our limited sample, the buildings in Boston proved to have the most thorough level of documentation overall, with 56 percent of the buildings having COMchecks for the envelope, lighting, and HVAC measures. However, given the small sample size, especially in jurisdictions other than Boston, it is hard to draw a definitive conclusion and extrapolate to all of the new construction within each jurisdiction's territory, or across the Commonwealth.

Figure 1 shows the percentage of sites with at least some documentation present for building envelope, lighting, and HVAC measure categories by jurisdiction. Cadmus differentiated LEED-certified buildings that exceed the code by demonstrating better overall energy performance, as opposed to measure-level compliance, because of different documentation requirements. For instance, there were 9 buildings in Boston – of the 9 buildings, 56 percent of the buildings (5 of the 9) had energy code documentation related to envelope, lighting, and HVAC, and, 44 percent of the buildings were LEED-certified. There was also some overlap – 3 out of the 5 buildings that had envelope, lighting, and HVAC documentation were also LEED certified. Some sampled projects in other jurisdictions had no available compliance documentation for certain measure types or included no LEED-certified buildings. Note that we also only looked at one project in Quincy. However, the documentation provided did not include information besides the address.

Figure 1. Percentage of Sites with Some Energy Code Documentation by Jurisdiction and Measure Category

[1] Applicants submit LEED certification and its related documents such as energy modeling reports majorly under two scenarios: 1) The performance-based path is taken to comply with the energy code (as opposed to prescriptive path), and 2) Used as a verification/documentation method to show compliance with the stretch code that requires buildings to exceed IECC 2009 or ASHRAE 90.1 2007 by 20% when it comes to annual energy consumption (meaning show 20% less consumption).

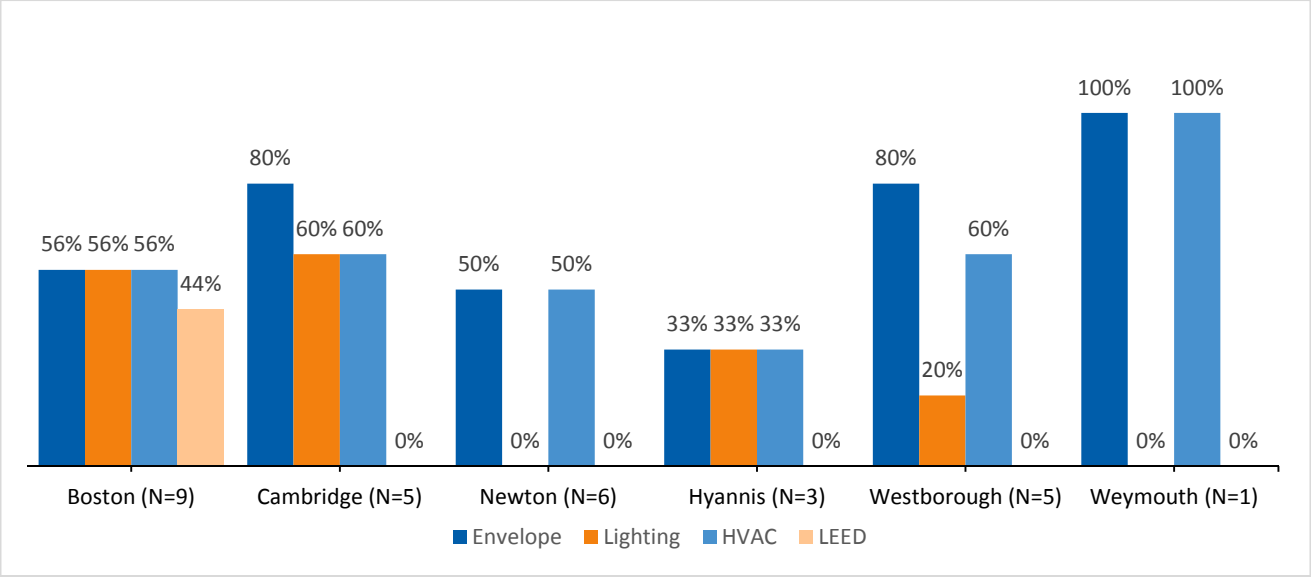
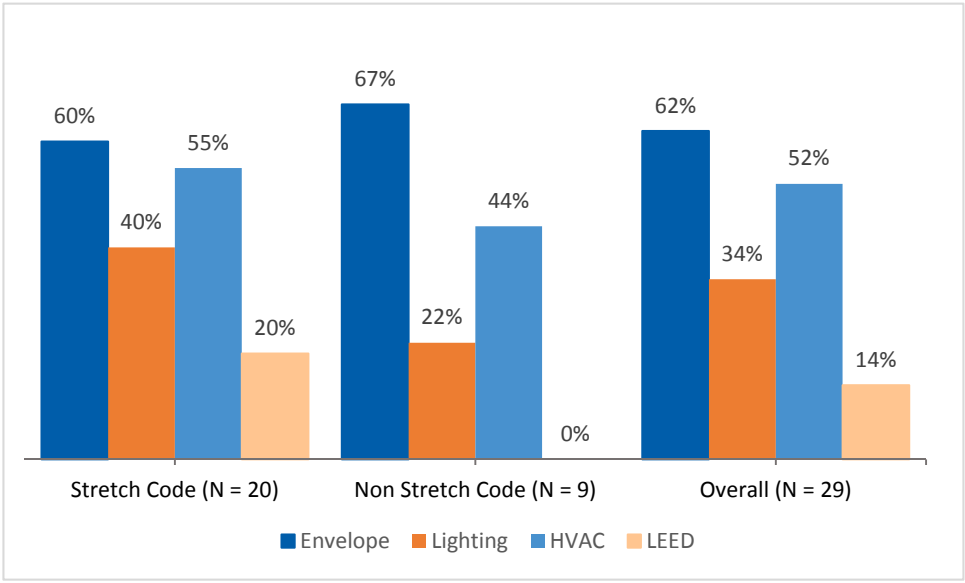


Figure 2 shows the level of documentation by stretch code jurisdictions, non-stretch code jurisdictions, and the overall level of documentation for all projects.

Figure 2. Percentage of Projects by Stretch and Non Stretch Code, and Overall Jurisdictions that had at least some level of Documentation per Measure



The data in Figure 2 indicates: 20 projects were under the stretch code (Boston, Cambridge, and Newton); of those 20, 60% had at least some envelope documentation, 40% had at least some lighting documentation, 55% had at least some HVAC documentation, and 20% were LEED certified.

1.4 CONCLUSIONS AND RECOMMENDATIONS

While the sample of data reviewed during this evaluation is relatively small and not statistically representative, several key themes emerged during the documentation analysis and the interviews with code officials. See Section 6 for more detail on the findings supporting these conclusions and recommendations.

Cadmus has identified the following conclusions based on this review.

- Findings indicate that energy documentation is incomplete, sparse, and inconsistent even in the jurisdictions that allowed us to look at their available documents. Compliance documentation varied between jurisdictions, and between the energy code compliance categories reviewed.
- Reviewing data points from architectural drawings and specification books is complex and time consuming compared to reviewing COMcheck submittals. COMcheck allowed for a quick and thorough quality assurance check compared to other methods.
- In the absence of COMcheck submittals, prescriptive compliance checklists can be a viable alternative to document compliance with the energy code and to facilitate the plan review and inspection process.
- The energy code trainings focus on energy code requirements, but there is insufficient emphasis on the administrative level and how critical it is to sufficiently document the energy code requirements as part of the permitting process.
- Code officials do not consistently view the importance of energy code requirements, and several do not consistently apply focus to those aspects of plan review and inspection.

Based on Cadmus' review of energy code documentation and *ad hoc* discussions with energy code officials, while collecting data at building departments, to obtain their insights and views on code enforcement and compliance, Cadmus offers the following recommendations for ways the CCSI can support improving energy code documentation and enforcement of the energy code:

- Educate building departments about the need to require energy code documentation consistently for every commercial project to support compliance.
- Inform building departments about the benefits of using COMcheck to capture where certain building parameters and characteristic stand relative to code and to clarify the applicable code, and encourage them to require COMcheck reports.
- Through training and other mechanisms, advise building departments to require applicants to submit a prescriptive compliance checklist to document energy code compliance if COMcheck reports are not submitted.
- Focus on providing adequate documentation of energy code compliance in future CCSI trainings.
- Raise awareness of the importance of energy code enforcement with code officials and building departments and increase the priority of enforcing the energy code.

2. DATA COLLECTION

Cadmus visited building departments in six jurisdictions across Massachusetts and made a data request to view the documentation related to energy code compliance submitted for newly constructed commercial facilities built in various municipalities. These jurisdictions were the cities of Boston, Cambridge, Newton, the village of Hyannis, and the towns of Westborough and Weymouth.

Cadmus coordinated with each building department and requested access to available energy code documentation for commercial facilities permitted within the last two years. This documentation includes architectural, mechanical, and electrical/lighting drawings; energy-code related certifications such as COMcheck; and prescriptive compliance checklists or energy modeling reports for LEED-certified buildings.

Because the energy-related documentation was in different formats, Cadmus printed or took photos of hard copies of permit documents or saved electronic formats to a CD or to a computer via USB port. Cadmus selected a sample of building projects from each of the six jurisdictions, for a total of 29 projects. Table 1 lists the jurisdictions, number of projects reviewed in each, and the format of the collected data. The number of buildings sampled by jurisdiction ranged from one to nine, with an average of five buildings per jurisdiction.

Table 1. Sampled Jurisdictions, Number of Reviewed Projects, and Format of Collected Data

Plan Review Jurisdiction	Reviewed Buildings	Format of Collected Data
City of Boston	9	Photocopy of permit documentation including COMcheck and documents related to LEED-certification and energy modeling reports
City of Cambridge	5	Photos of COMcheck and architectural and mechanical drawings
City of Newton	6	PDF files including permit forms, COMcheck and architectural, mechanical and electrical drawings
Village of Hyannis	3	PDF files including permit forms, COMcheck and architectural, mechanical and electrical drawings
Town of Westborough	5	Photos of COMcheck and architectural and mechanical drawings
Town of Weymouth	1	Photos of COMcheck and architectural and mechanical drawings
Total	**29**	

2.1 SAMPLE OF JURISDICTIONS

Cadmus tailored a scope to match the time and budgetary constraints of the project and to optimize the available project resources. Therefore, it is important to note that when it comes to sampling, this study serves more as a case study and it is not based on a sampling frame that is statistically robust due to too few sample points. However, this case study provides valuable data points and observations which can create a foundation for and/or justify

allocation of resources to future studies as it reveals significant gaps and inconsistencies when it comes to energy code documentation.

Cadmus found that many jurisdictions in Massachusetts include vast residential areas with little or no commercial new construction activity in the last two years. Given the limitation on the total number of building department site visits to be conducted and to optimize the project resources, Cadmus focused on recruiting building departments that had sizable commercial construction activity.

However, Cadmus succeeded in conducting site visits only at building departments that could facilitate the data request by having staff available to research and/or publicly accessible documents. Cadmus approached six more jurisdictions that were not able to process our data request for several reasons, including being understaffed, having archived the building permit records offsite, not being able to make copies of electronic files accessible only to building department staff, or simply not having any new ground up commercial buildings permitted in the last two years.

Given the few sample points, Cadmus cannot state definitively that this case study is not subject to some selection bias, which may overstate availability of documentation due to the selection of jurisdictions with information available at our request. We also cannot provide evidence or make any conclusions on the state of documentation in other jurisdictions for which we do not have data. While this study could only show an upward bias, meaning that the jurisdictions that had documents available for review might also employ better practices in terms of energy code documentation and enforcement, what we eventually found is that energy documentation is incomplete, sparse and inconsistent even in the jurisdictions that allowed us to look at their available documents.

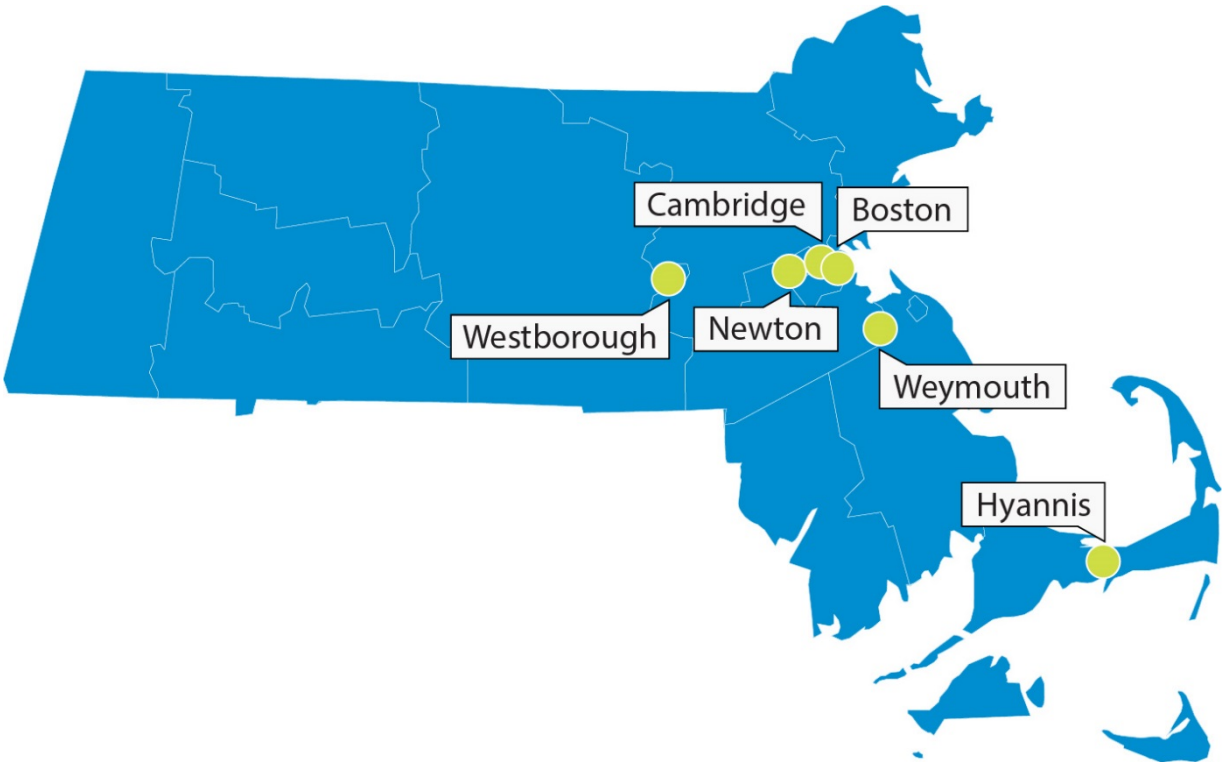
Table 2 presents the relevant energy code at each of the six jurisdictions. Of these, three had adopted stretch code and three enforced 2012 IECC.

Table 2. Relevant Energy Code at Each Jurisdiction

Plan Review Jurisdiction	Relevant Energy Code
City of Boston	Stretch Code
City of Cambridge	Stretch Code
City of Newton	Stretch Code
Village of Hyannis	2012 IECC
Town of Westborough	2012 IECC
Town of Weymouth	2012 IECC

Figure 3 displays the distribution of the municipalities in the technical review.

Figure 3. Building Departments Visited



Three of the jurisdictions visited (Boston, Cambridge, and Newton) adopted and implemented stretch code at various points in time, so there was a mix of buildings permitted under stretch code, 2009 IECC, and 2012 IECC in the review. For example, of the nine sampled buildings from Boston (a stretch code city), two were permitted under the 2009 IECC because they preceded the application of the stretch code.

In total, Cadmus reviewed the documentation for 29 buildings. Some of the building departments Cadmus visited or contacted via phone were unable to provide the documentation for any of their buildings. Because some sampled buildings were in the initial stages of the application process and did not appear to have been completed, Cadmus excluded them from its technical review.

3. SUMMARY OF CODE REQUIREMENTS

In planning this study, Cadmus prioritized the high-impact energy-related requirements that would, in theory, require documentation at building departments to prove compliance with the energy code and that would have a significant impact on the overall energy consumption of the building. Cadmus used these requirements to assess the level of enforcement of the energy code.

This section details Cadmus' assessment of the level of documentation for these high-impact code requirements:

- Lighting: Lighting power density
- Envelope: U-value of exterior surfaces such as roof, exterior wall, and floor including glazing performance (U-value and SHGC)
- HVAC: Heating and cooling system types and efficiency rating.

Massachusetts adopted 2012 IECC and ASHRAE 90.1-2010 as energy codes on July 9, 2013. However, it phased in adoption over an extended concurrency (grace) period, so these codes became the sole effective baseline on July 1, 2014. The standard "non-stretch" energy provisions of the code are based on the 2012 IECC as of July 1, 2014.

However, certain jurisdictions enforce a stretch code, which is based on amendments to the 2009 IECC (and ASHRAE 90.1-2007 for large commercial buildings) until the stretch code is updated, rather than the 2012 IECC.

3.1 STRETCH CODE REQUIREMENTS

Table 3 presents the requirements to comply with the commercial building stretch code.

Table 3. Compliance with Commercial Stretch Code

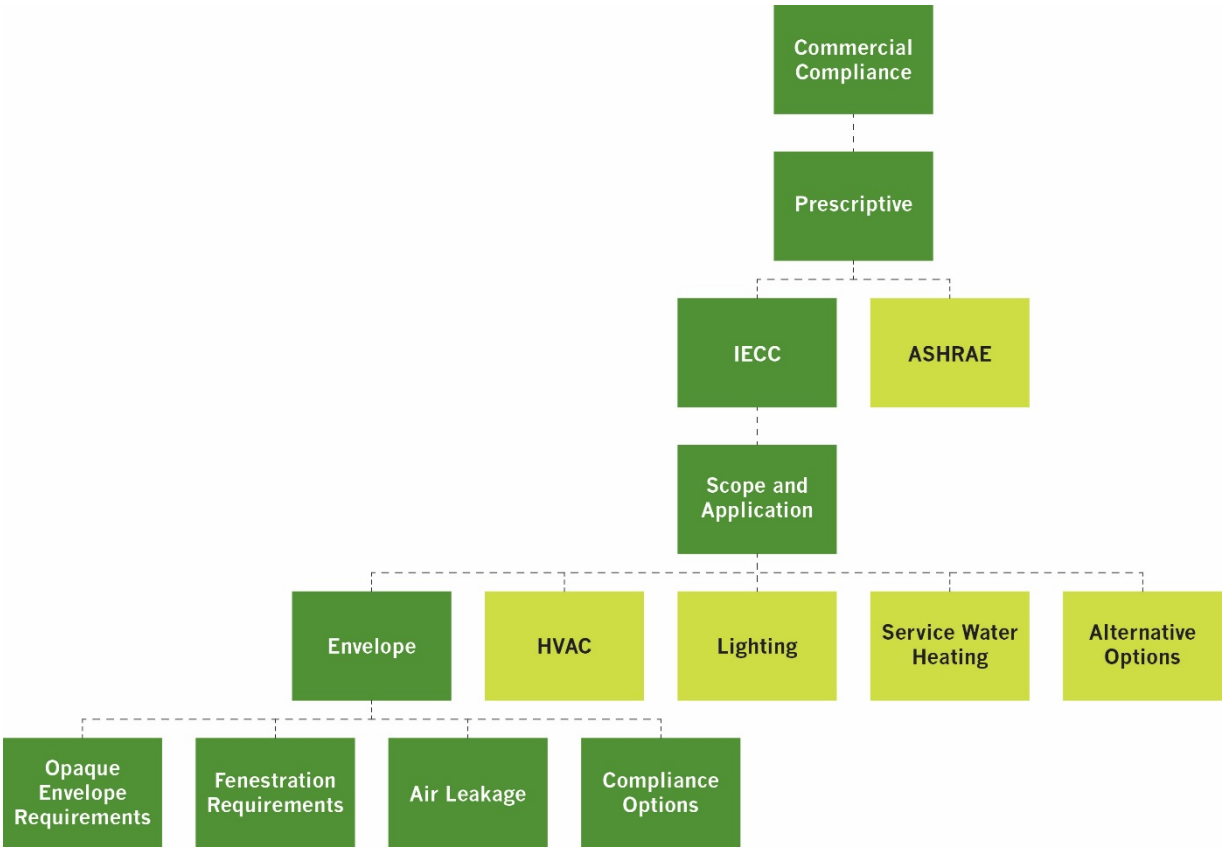
Building Size and Category	Stretch Code Requirement		Base Code
New Construction (0–4,999 sq. ft.)	Not Subject to Stretch Code		2012 IECC plus MA amendments
New Construction (5,000–100,000 sq. ft.)	20% above 90.1-2007	Or, Section 501.1.4 Prescriptive Path	Not available
New Construction (above 100,000 sq. ft.)	20% above 90.1-2007	Not available	Not available
Supermarket, Labs Warehouse (<40,000 sq. ft.)	Not Subject to Stretch Code		2012 IECC plus MA amendments
Supermarket, Labs Warehouse (>39,999 sq. ft.)	20% above 90.1-2007	Not available	Not available
Additions (>30% new floor area added to buildings >100,000 sq.	20% above 90.1-2007	Not available	Not available

Building Size and Category	Stretch Code Requirement	Base Code
ft.)		
Alterations and Repairs	Not Subject to Stretch Code	2012 IECC plus MA

3.2 2012 IECC CODE REQUIREMENTS

Figure 4 shows the several paths to comply with commercial energy code and the measure categories within its scope.

Figure 4. Commercial Energy Code Compliance Paths



Energy code requires applicants to take one of the three available paths towards compliance, including:

1. IECC 2012 & Massachusetts Amendments
   a. Prescriptive Checklists
   b. Software Based Compliance; COMcheck

Additional Efficiency Package Options

Per code section C406.1, buildings following the prescriptive path shall also comply with at least one of the following:

- Efficient HVAC Performance – Minimum Efficiency Requirements for Mechanical Equipment – Tables C406.2 (1-7)
- Efficient Lighting Systems – Reduced LPD per Table C406.3
- On-Site Renewable Energy Systems – Provide for 1.75 Btu or 0.50 Watts per ft2 of Conditioned Floor Area
- For on-site use of biomass fuel, provided not less than 65 percent of the energy used within the building for space and service water heating using sealed combustion mechanical equipment rated at a minimum of 85 AFUE. The biomass shall meet the eligible fuel and emission criteria under M.C.L. c. 25A. § 11 F (Massachusetts renewable energy portfolio standard)

2. ASHRAE 90.1 2010 Compliance
   a. Building Performance Methodology: “Energy Cost Budget Method” (Section11)
3. C102.1.1
   a. Compliance with a code official approved “above code” program/performance protocol

3.2.1 2012 IECC versus ASHRAE 90.1 2010

Below is the list of the major differences between 2012 IECC and ASHRAE 90.1 2010:

2012 IECC

- Limit of 30 percent window-to-wall ratio without daylighting requirements
- More stringent fenestration U-factor requirements
- Allows up to 5 percent skylight area with daylighting controls
- Continuous air barrier requirements
- Requires 50 percent daylight in spaces with large roof areas

ASHRAE 90.1 2010

- 40 percent window-to-wall ratio with no daylighting requirements
- Continuous air barrier requirements
- Requires 50 percent daylight in spaces with large roof areas
- Allows building envelope trade-offs using ENVSTD[2] approach.

[2] ENVSTD (for ENVelope STanDard) is a computer program developed to simplify compliance with the envelope system performance path.

3.3 2009 IECC CODE REQUIREMENTS

The 2009 IECC requirements are very similar to the 2012 IECC requirements that are detailed above.[3] The 2009 IECC requires that buildings meet a series of envelope, HVAC, lighting, and service water heating requirements using either a prescriptive path or a performance path. However, the 2009 IECC requirements are generally less stringent compared to 2012 IECC requirements. The energy code documentation requirements are quite similar for both versions of the IECC.

[3] For more information, see: https://www.energycodes.gov/sites/default/files/documents/Comparison_2009to2012_IECC.pdf

4. FINDINGS

In this section, Cadmus presents the findings of its review of the documents filed at building departments.

4.1 LEVEL OF ENERGY CODE DOCUMENTATION

For each jurisdiction, and for the overall sample of buildings, Cadmus conducted a technical review of the level of available energy code documentation. Cadmus' primary finding was that the documentation varied building by building and was largely inconsistent and incomplete at the jurisdiction level and overall. Table 4 shows the percentage of documentation for envelope, lighting, and HVAC for each plan review jurisdiction and for the sample overall. For instance, of the 9 buildings in Boston, 56% had at least some envelope documentation, 56% had at least some lighting documentation, and 56% had at least some HVAC documentation. Three out of four LEED certified buildings in Boston (75%) had documentation on specifications related to the energy code. Likewise for the other cities, and the overall calculation takes all buildings into account.

Cadmus made a binary assessment (yes or no) for each measure (envelope, lighting, and HVAC) if any documentation was present at all. The binary assessment indicates what proportion of the code requirements for which any documentation was available. For instance, under the Envelope category, there are four subcategories (each with different levels of documentation) and, assuming documentation was available on three of the four subcategories, the project would receive a score of 75%. In the HVAC category, there are five subcategories (again, each with different levels of documentation). Table 4 thus gives a general overview of the level of documentation present. Note that it is an upper bound of the documentation present, as it was, essentially, rounded up.

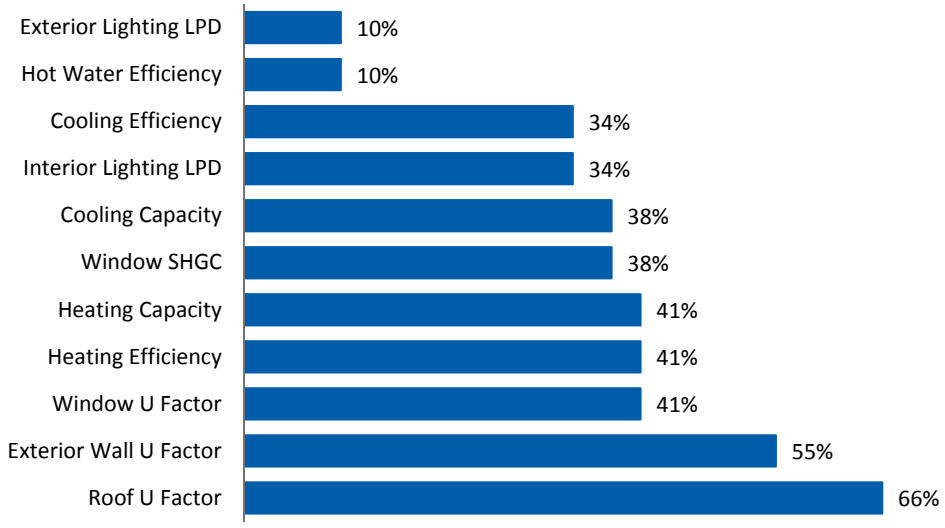
The appendix shows the level of documentation present for each building.

Table 4. Overview of Energy Code Documentation at the Project Level

Relevant Code	Jurisdiction	Envelope	Lighting	HVAC	LEED	Number
Stretch Code	Boston	56%	56%	56%	75%	9 (five non LEED certified and four LEED certified buildings
	Cambridge	80%	60%	60%	-	5
	Newton	50%	0%	50%	-	6
Stretch Code Overall		**60%**	**40%**	**55%**	**75%**	**20**
IECC 2012	Hyannis	33%	33%	33%	-	3
	Westborough	80%	20%	60%	-	5
	Weymouth	100%	0%	100%	-	1
IECC 2012 Overall		**67%**	**22%**	**44%**		**9**
Total Overall		**62%**	**34%**	**52%**	**10.5%**	**29**

Figure 5 further disaggregates the level of documentation present. For every subcategory in each measure (envelope, lighting, and HVAC) in all jurisdictions (all sites), Figure 5 gives the percentage of as-designed values documented. The percent documentation present for as-designed parameters in all measures in all jurisdictions is 37 percent. This metric gives an indication of the overall level of documentation available for all sites (N = 29).

Figure 5. Total Percent Documentation Present by Measure Category



4.2 COMPARISON TO CODE

For each jurisdiction, building, and the overall sample, Cadmus compared the documented envelope, lighting, and HVAC information to the relevant prescriptive or budgeted code per COMcheck to assess if these buildings' parameters and characteristics were at code, below code, or above code. These characteristics are shown in Table 5 through Table 7. It is important to note that each building varied in how energy code compliance was presented, and the available data were inconsistent. Each jurisdiction in Tables 5 through 7 also gives a count of each type of documentation present—roof U factor code, roof U factor design, wall U factor code, etc. Cadmus also gives a total count and the total percentage of each measure (code and design, where applicable) at the bottom of Tables 5 through 7. This gives a more detailed account of the level of documentation (as opposed to level of some documentation present such as in Table 5).

Also, note for Tables 5 through 7 the color-coding used for the cells. Light gray means that the value was not available (except in the case of building type) and is also indicated as N/A; light blue means that the design was at code; light green means that the design was above code (that is, more efficient than required by the code); light orange means that the design was below code (less efficient than required by the code); white means the cell entry is indicative of the code-dictated value (baseline value).

Cadmus presented these data across all jurisdictions combined because there were not enough data points in each jurisdiction to come up with a meaningful conclusion. However, it is important to note that the intention of this subsection is not to serve as a code compliance study and portray how well code is met. These tables show how various building types did or did not meet code for major code-related parameters, and are merely illustrative of the results the limited number of sample points and type of documentation Cadmus found during this case study research. It is likely that buildings with better energy code documentation tend to meet or exceed code. Therefore, these findings cannot be applied to the overall state population of jurisdictions and buildings when it comes to the overall level of compliance with code.

4.2.1 Envelope

Table 5 shows the comparison of the as-designed and code parameters for envelopes in each jurisdiction (where data were available).

As noted above, light grey shading indicates data was not available; light blue indicates the design just meets the code; light green indicates the design is more efficient than required by code; and light orange indicates the design does not meet the code. These are also displayed in Figure 6 through Figure 8.

Table 5. Comparison of the Code and As-designed Values for Envelope Measures

Building	Type	Roof U Factor		Exterior Wall U Factor		Window U Factor		Window SHGC	
		Code	Design	Code	Design	Code	Design	Code	Design
Boston									
1	Mixed Use - High Rise MF, Garage & Retail	0.048	0.039	0.064	0.057	0.35	0.29	0.4	0.3
2 (LEED)	Mixed Use - High Rise MF, Garage & Retail	0.063	0.048	0.2	0.064	0.45	0.43	0.4	0.3
3	N/A	0.063	N/A	0.2	N/A	0.45	N/A	0.4	N/A
4 (LEED)	Mixed Use - High Rise MF, Garage & Retail	0.063	N/A	0.2	N/A	0.45	N/A	0.4	N/A
5	Mixed Use - High Rise MF & Retail	0.063	N/A	0.2	N/A	0.45	N/A	0.4	N/A
6	Mixed Use - High Rise MF & Retail	0.048	N/A	0.064	N/A	0.35	N/A	0.4	N/A
7	Mixed Use - High Rise MF, Garage, Retail, & Restaurant	0.027	0.017	0.08	0.039	0.45	0.32	0.4	0.4
		0.35	0.35	0.051	0.045	0.35	0.31	0.4	0.25
8 (LEED)	Religious Building	0.048	0.048	0.064	0.064	0.45	0.45	0.4	0.4
9 (LEED)	Office & Retail	0.048	0.048	0.064	0.064	0.45	0.45	0.4	0.4
Count		**5**	**5**	**5**	**5**	**5**	**5**	**5**	
Cambridge									
10	Mixed Use - High Rise MF & Retail	0.048	0.048	0.064	0.062	0.550	0.430	0.4	0.320
11	N/A	N/A	0.148	N/A	0.044	N/A	0.148	0.4	N/A
12	University	N/A	0.056	N/A	N/A	N/A	N/A	0.4	N/A
13	Office	0.048	0.027	0.064	0.061	0.350	0.280	0.4	0.320
14	University	N/A	0.039	N/A	N/A	N/A	N/A	0.4	N/A
Count		**2**	**5**	**2**	**3**	**2**	**3**	**2**	
Newton									
15	University Lab (Major Renovation)	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
16	Retail	N/A	0.028	N/A	0.028	N/A	N/A	0.4	N/A
17	Retail	N/A	0.028	N/A	0.028	N/A	N/A	0.4	N/A
18	Mixed Use	N/A	0.038	N/A	0.038	N/A	N/A	0.4	N/A
19	Office	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
20	Grocery Store	N/A	N/A	N/A	0.048	N/A	N/A	0.4	N/A
Count		**0**	**3**	**0**	**4**	**0**	**0**	**0**	

Building	Type	Roof U Factor		Exterior Wall U Factor		Window U Factor		Window SHGC	
		Code	Design	Code	Design	Code	Design	Code	Design
Hyannis									
21	Golf Club	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
22	Restaurant	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
23	N/A	N/A	0.020	N/A	N/A	N/A	N/A	0.4	N/A
Count		**0**	**1**	**0**	**0**	**0**	**0**	**0**	
Westborough									
24	Mixed Use - High Rise MF, & Retail	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
25	Clubhouse	0.027	0.027	0.064	0.062	0.35	0.3	0.4	0.18
26	Multifamily	0.027	0.027	0.062	0.051	0.35	0.3	0.4	0.18
27	N/A	N/A	0.033	N/A	N/A	N/A	N/A	0.4	N/A
28	Clubhouse	0.027	0.027	0.064	0.062	0.45	0.33	0.4	0.35
Count		**3**	**4**	**3**	**3**	**3**	**3**	**3**	
Weymouth									
29	Multifamily	0.027	0.021	0.051	0.062	0.35	0.32	0.4	0.27
Count		**1**	**1**	**1**	**1**	**1**	**1**	**1**	
Total Count		**11**	**19**	**11**	**16**	**11**	**12**	**11**	
Total % of Sites with Valid Data		**38%**	**66%**	**38%**	**55%**	**38%**	**41%**	**38%**	
Building	**Type**	**Roof U Factor**		**Exterior Wall U Factor**		**Window U Factor**		**Window SHGC**	
		Code	**Design**	**Code**	**Design**	**Code**	**Design**	**Code**	**Design**
Boston									
1	Mixed Use - High Rise MF, Garage & Retail	0.048	0.039	0.064	0.057	0.35	0.29	0.4	0.3
2	Mixed Use - High Rise MF, Garage & Retail	0.063	0.048	0.2	0.064	0.45	0.43	0.4	0.3
3	N/A	0.063	N/A	0.2	N/A	0.45	N/A	0.4	N/A
4	Mixed Use - High Rise MF, Garage & Retail	0.063	N/A	0.2	N/A	0.45	N/A	0.4	N/A
5	Mixed Use - High Rise MF & Retail	0.063	N/A	0.2	N/A	0.45	N/A	0.4	N/A
6	Mixed Use - High Rise MF & Retail	0.048	N/A	0.064	N/A	0.35	N/A	0.4	N/A
7	Mixed Use - High Rise MF, Garage, Retail, & Restaurant	0.027	0.017	0.08	0.039	0.45	0.32	0.4	0.4
		0.35	0.35	0.051	0.045	0.35	0.31	0.4	0.25
8	Religious Building	0.048	0.048	0.064	0.064	0.45	0.45	0.4	0.4
9	Office & Retail	0.048	0.048	0.064	0.064	0.45	0.45	0.4	0.4

Building	Type	Roof U Factor		Exterior Wall U Factor		Window U Factor		Window SHGC	
		Code	Design	Code	Design	Code	Design	Code	Design
Count		5	5	5	5	5	5	5	
Cambridge									
10	Mixed Use - High Rise MF & Retail	0.048	0.048	0.064	0.062	0.550	0.430	0.4	0.320
11	N/A	N/A	0.148	N/A	0.044	N/A	0.148	0.4	N/A
12	University	N/A	0.056	N/A	N/A	N/A	N/A	0.4	N/A
13	Office	0.048	0.027	0.064	0.061	0.350	0.280	0.4	0.320
14	University	N/A	0.039	N/A	N/A	N/A	N/A	0.4	N/A
Count		2	5	2	3	2	3	2	
Newton									
15	University Lab (Major Renovation)	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
16	Retail	N/A	0.028	N/A	0.028	N/A	N/A	0.4	N/A
17	Retail	N/A	0.028	N/A	0.028	N/A	N/A	0.4	N/A
18	Mixed Use	N/A	0.038	N/A	0.038	N/A	N/A	0.4	N/A
19	Office	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
20	Grocery Store	N/A	N/A	N/A	0.048	N/A	N/A	0.4	N/A
Count		0	3	0	4	0	0	0	
Hyannis									
21	Golf Club	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
22	Restaurant	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
23	N/A	N/A	0.020	N/A	N/A	N/A	N/A	0.4	N/A
Count		0	1	0	0	0	0	0	
Westborough									
24	Mixed Use - High Rise MF, & Retail	N/A	N/A	N/A	N/A	N/A	N/A	0.4	N/A
25	Clubhouse	0.027	0.027	0.064	0.062	0.35	0.3	0.4	0.18
26	Multifamily	0.027	0.027	0.062	0.051	0.35	0.3	0.4	0.18
27	N/A	N/A	0.033	N/A	N/A	N/A	N/A	0.4	N/A
28	Clubhouse	0.027	0.027	0.064	0.062	0.45	0.33	0.4	0.35
Count		3	4	3	3	3	3	3	
Weymouth									
29	Multifamily	0.027	0.021	0.051	0.062	0.35	0.32	0.4	0.27
Count		1	1	1	1	1	1	1	
Total Count		11	19	11	16	11	12	11	
Total Percentage of Sites with Valid Data		38%	66%	38%	55%	38%	41%	38%	

4.2.2 Lighting

The IECC commercial building code regulates the intensity of installed lighting in commercial spaces by placing limits on the lighting power density (LPD), which is the total wattage of lighting installed per square foot of the illuminated area.

Table 6 shows the comparison of the designed interior and exterior lighting power density and the applicable code for each building in each jurisdiction.

Table 6. Comparison of the Code and Designed Values for Lighting Measures

		Interior Lighting LPD		Exterior Lighting LPD	
Building	Type	Code	Design	Code	Design
Boston					
1	Mixed Use - High Rise MF, Garage & Retail	N/A	N/A	N/A	N/A
2	Mixed Use - High Rise MF, Garage & Retail	1.05	1	N/A	N/A
3	N/A	0.45	0.37	N/A	N/A
4	Mixed Use - High Rise MF, Garage & Retail	N/A	N/A	N/A	N/A
5	Mixed Use - High Rise MF & Retail	N/A	N/A	N/A	N/A
6	Mixed Use - High Rise MF & Retail	N/A	N/A	N/A	N/A
7	Mixed Use - High Rise MF, Garage, Retail, & Restaurant	0.81	0.61	N/A	N/A
8	Religious Building	1.9	1.9	N/A	N/A
9	Office	1.1	1.1	N/A	N/A
	Retail	1.7	1.7	N/A	N/A
Count		**5**	**5**	**0**	**0**
Cambridge					
10	Mixed Use - High Rise MF & Retail	1.1 (Office), 0.6 (Corridors), 1.7 (Retail), 1.5 (Mech/Elec)	1.1 (Office), 0.6 (Corridors), 1.7 (Retail), 1.5 (Mech/Elec)	N/A	N/A
11	N/A	1.2	0.75	0.15	0.13
12	University	N/A	N/A	N/A	N/A
13	Office	1	0.77	N/A	N/A
14	University	N/A	N/A	N/A	N/A
Count		**3**	**3**	**2**	**2**
Newton					
15	University Lab (Major Renovation)	N/A	N/A	N/A	N/A
16	Retail	N/A	N/A	N/A	N/A
17	Retail	N/A	N/A	N/A	N/A
18	Mixed Use	N/A	N/A	N/A	N/A
19	Office	N/A	N/A	N/A	N/A
20	Grocery Store	N/A	N/A	N/A	N/A
Count		**0**	**0**	**0**	**0**

Building	Type	Interior Lighting LPD		Exterior Lighting LPD	
		Code	Design	Code	Design
Hyannis					
21	Golf Club	1.15	0.85	0.09	0.02
22	Restaurant	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	N/A	N/A
Count		**1**	**1**	**1**	**1**
Westborough					
24	Mixed Use - High Rise MF, & Retail	N/A	N/A	N/A	N/A
25	Clubhouse	0.9	0.54	N/A	N/A
26	Multifamily	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	N/A	N/A
28	Clubhouse	N/A	N/A	N/A	N/A
Count		**1**	**1**	**0**	**0**
Weymouth					
29	High Rise MF	N/A	N/A	N/A	N/A
Count		**0**	**0**	**0**	**0**
Total Count		**10**	**10**	**3**	**3**
Total Percentage		**34%**	**34%**	**10%**	**10%**

4.2.3 HVAC

Table 7 shows the heating and cooling capacities for the different buildings and compares code and the designed values of the heating efficiency, cooling efficiency, and hot water heater efficiency.

Table 7. Comparison of the Code and Designed Values for HVAC Measures

Building	Type	Heating Capacity [kBtu/h]	Cooling Capacity [kBtu/h]	Heating Efficiency		Cooling Efficiency		Hot Water Heater Efficiency	
		Design	Design	Code	Design	Code	Design	Code	Design
Boston									
1	Mixed Use - High Rise MF, Garage & Retail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Mixed Use - High Rise MF, Garage & Retail	14,700 (Total)	N/A	80%	87%	N/A	N/A	80%	91%
3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Mixed Use - High Rise MF, Garage	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

		Heating Capacity [kBtu/h]	Cooling Capacity [kBtu/h]	Heating Efficiency		Cooling Efficiency		Hot Water Heater Efficiency	
Building	Type	Design	Design	Code	Design	Code	Design	Code	Design
	& Retail								
5	Mixed Use - High Rise MF & Retail	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Mixed Use - High Rise MF & Retail	79.75	31.375	80%	96%	13 SEER	16 SEER	N/A	N/A
7	Mixed Use - High Rise MF, Garage, Retail, & Restaurant	27.20	20.422	7.70 HSPF	10.30 HSPF	13 SEER	16 SEER	67%	95%
8	Religious Building	N/A	N/A	80%	80%	10-12 EER	13 SEER, 10.8 EER	N/A	N/A
9	Office & Retail	N/A	N/A	80%	80%	10-12 EER	14 SEER, 10.8 EER	N/A	N/A
Count		3	2	5	5	4	4	2	2
Cambridge									
10	Mixed Use - High Rise MF & Retail	2622.985	7590.42	80%	80%	10 EER	9.48 EER	N/A	98%
11	N/A	121	111	N/A	N/A	N/A	N/A	N/A	N/A
12	University	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	Office	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	University	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Count		2	2	1	1	1	1	0	1
Newton									
15	University Lab (Major Renovation)	17.9	19.3	N/A	N/A	N/A	N/A	N/A	N/A
16	Retail	245	125.45	80%	80%	N/A	N/A	N/A	N/A
17	Retail	220	132.6	80%	80%	N/A	N/A	N/A	N/A
18	Mixed Use	91.75	83.69	80%	70%	11 EER	13.15 EER	N/A	N/A
19	Office	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20	Grocery Store	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Count		4	4	0	3	0	1	0	0
Hyannis									
21	Golf Club	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22	Restaurant	33	60	N/A	95%	13 SEER	13 SEER	N/A	N/A

		Heating Capacity [kBtu/h]	Cooling Capacity [kBtu/h]	Heating Efficiency		Cooling Efficiency		Hot Water Heater Efficiency	
Building	Type	Design	Design	Code	Design	Code	Design	Code	Design
23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Count		1	1	0	1	0	1	0	0
Westborough									
24	Mixed Use - High Rise MF, & Retail	49	N/A	80%	67%	13 SEER	15.4 SEER	N/A	N/A
25	Clubhouse	64	38	80%	95%	13 SEER	14.8 SEER	N/A	N/A
26	Multifamily	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
28	Clubhouse	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Count		2	1	1	2	1	2	0	0
Weymouth									
29	High Rise MF	N/A	21	N/A	N/A	13 SEER	10 SEER	N/A	N/A
Count		0	1	0	0	0	1	0	0
Total Count		12	11	7	12	6	10	2	3
Total Percentage		41%	38%	24%	41%	21%	34%	7%	10%

4.3 OVERALL

Figure 6 through Figure 12 show the differences of the as designed envelope U factors (roof, wall, and window), interior lighting power density, and the heating and cooling efficiencies relative to the code. To allow us to compare the design to the code requirements, the code had to be identified with the design. However, we found that this information was missing in many cases. For instance, the designed roof U factor was found in 19 buildings that submitted COMcheck or detailed energy modeling report, but only 12 buildings identified the code that applied to the building. In those cases, we attempted to determine the applicable code by the application submittal date, if available, and fill in the missing values.

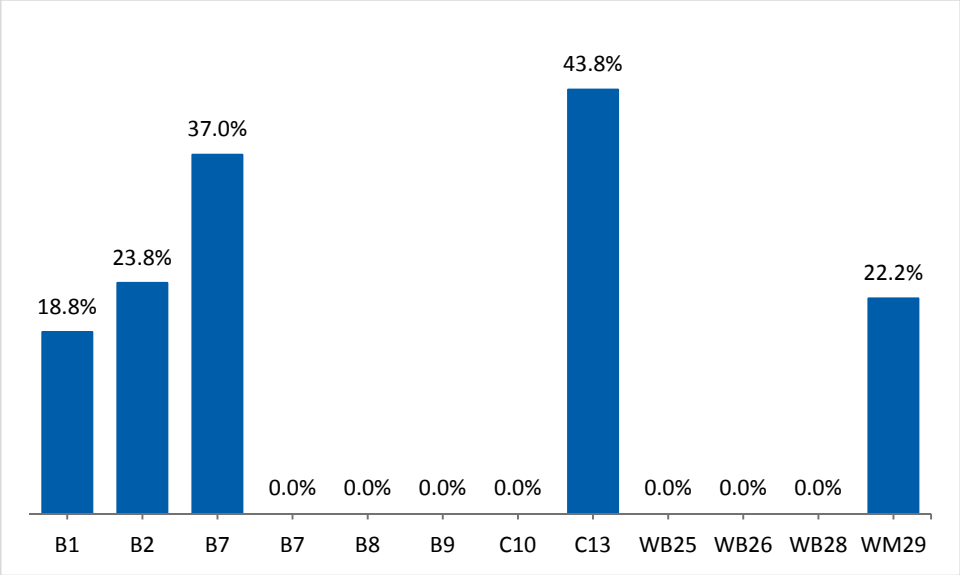
Note that the buildings in Figure 6 through Figure 12 are given the same number throughout. That is, building 1 in Figure 6 is also building 1 in Table 5. Cadmus added identifiers in order to quickly identify the jurisdictions. These are B = Boston, C = Cambridge, N = Newton, H = Hyannis, WB = Westborough, and WM = Weymouth. Also, note that B9 is for one site, but there were two compliance documents for the same address so they are shown as two points on the graphs.

For each requirement, we calculated the percentage values shown by taking the difference between the design value and the code requirement and dividing by the code requirement. Positive values indicate the design was more efficient that required by the code. In the case of U-factors, values smaller than required by the code are more efficient.

4.3.1 Roof

Figure 6 shows the relative percentage of the designed roof U factor compared to code. Note that of the 12 buildings where the code could be compared to the design (we had the design values of 19 roofs), 5 were above code and the remainder just met the code.

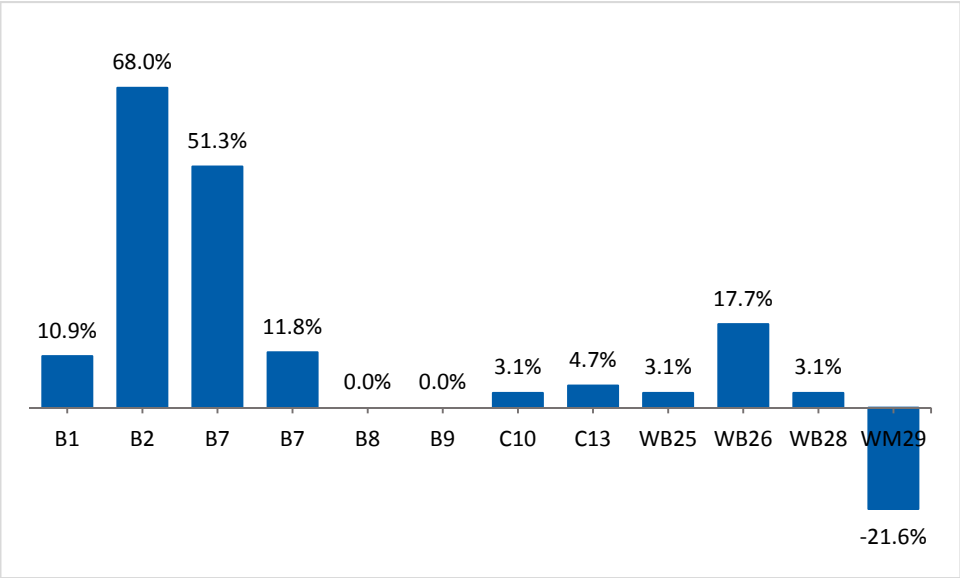
Figure 6. Percentage at, Above, or Below Roof U Factor Code in All Jurisdictions N = 12



4.3.2 Exterior wall

Figure 7 shows the relative percentage of the designed exterior wall U factor compared to code. Cadmus determined that exterior wall design U factors for nine buildings were above code, two were at code, and one was below code. We had the design values for 12 projects.

Figure 7. Percentage at, Above, or Below Exterior Wall U Factor Code in All Jurisdictions, N = 12



4.3.3 Window

Figure 8 shows the relative percentage of the designed window U factor compared to code. Note that Cadmus found that the design values for ten buildings were better than required by the code for this measure and two just met the code. We had the design values for 12 windows.

Figure 8. Percentage at, Above, or Below Window U Factor Code in All Jurisdictions, N = 12

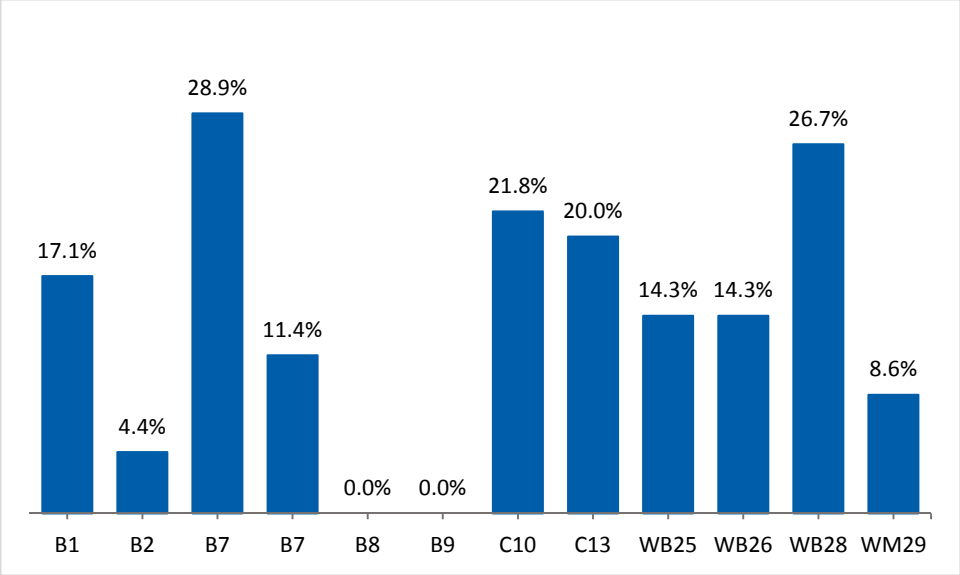
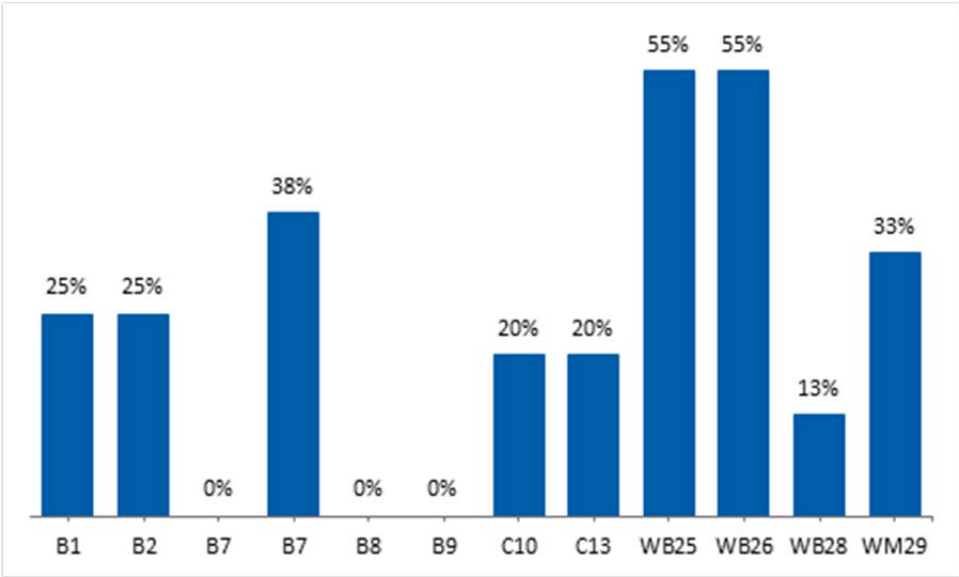


Figure 9 shows the relative percentage of the designed window SHGC compared to code. Nine of the designs were better than code, three were at code, and none were below code.

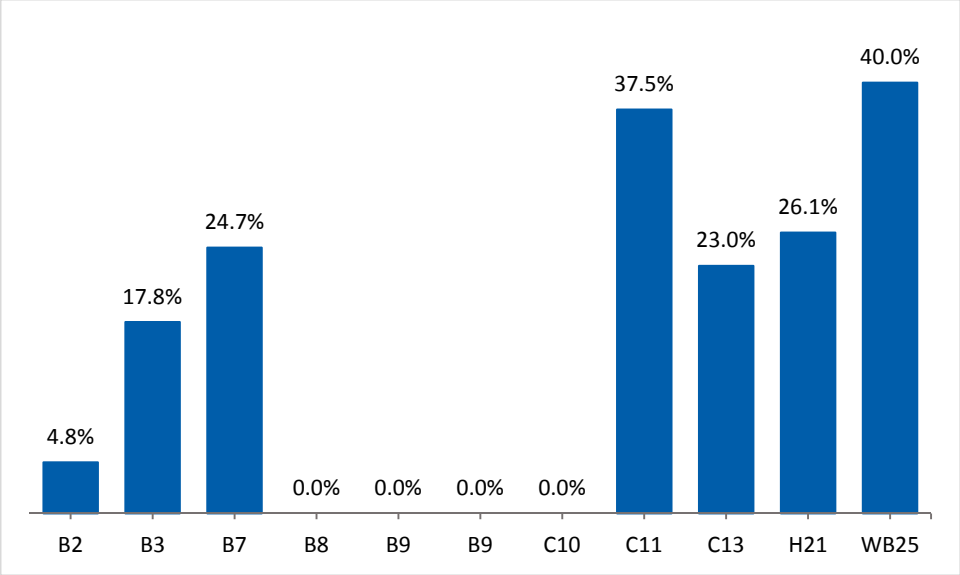
Figure 9. Percentage at, Above, or Below Window SHGC Code in All Jurisdictions, N = 12



4.3.4 Lighting

Figure 10 shows the percentage at, above, or below interior LPD code for all jurisdictions. Cadmus did not present exterior LPD because there were not enough buildings with that information. Note that seven buildings are above code and four just met the code. LPD data was available for 11 buildings – with seven above (better than) code and four at code.

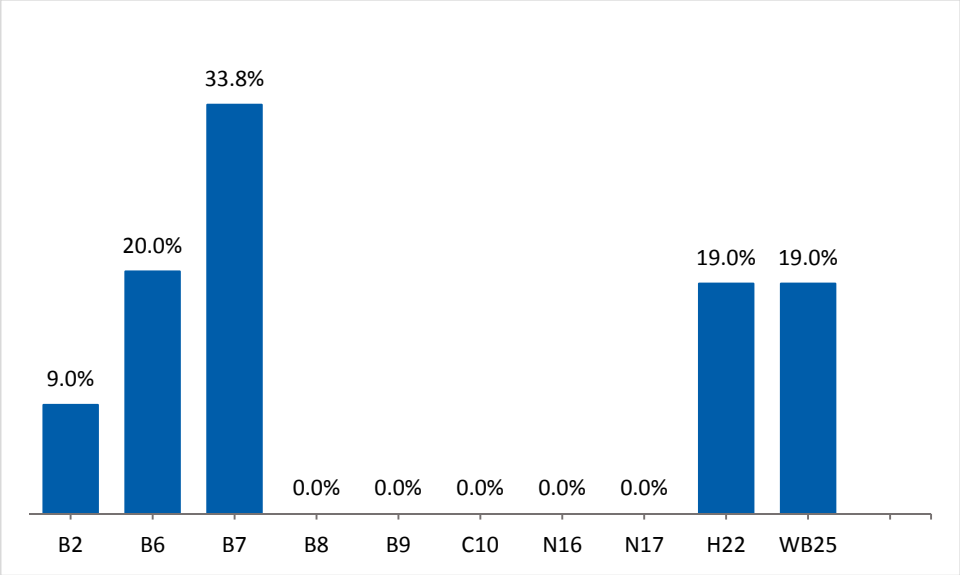
Figure 10. Percentage at, Above, or Below Interior LPD Code in all Jurisdictions, N = 11



4.3.5 Heating efficiency

Figure 11 shows the heating efficiency for all jurisdictions compared to the applicable code. For this code requirement, values larger than the code requirement are better than code. Note that five buildings are above code and six just met code.

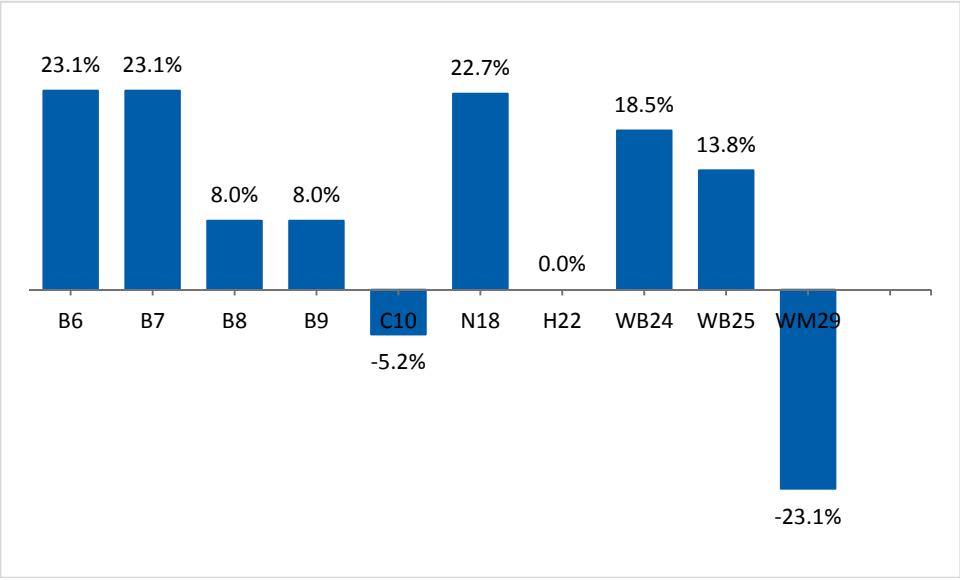
Figure 11. Percentage at, Above, or Below Heating Efficiency Code in All Jurisdictions, N = 11



4.3.6 Cooling efficiency

Figure 12 shows the cooling efficiency for all jurisdictions compared to the applicable code. As for heating efficiency, values above the code requirement indicate the equipment was better than the code required. Note that seven buildings were above code, one building was at code, and three buildings were below code.

Figure 12. Percentage at, Above, or Below Cooling Efficiency Code in All Jurisdictions, N = 11



5. CONCLUSIONS AND RECOMMENDATIONS

Overall, we found that code compliance documentation available was very limited, varied building by building, and was largely inconsistent and incomplete at the jurisdiction level and overall. Based on our limited sample, the buildings in Boston had the most thorough level of documentation overall, with 56 percent of the buildings having COMchecks for the envelope, lighting, and HVAC measures. However, the sample size is too small, especially in jurisdictions other than Boston, to draw a definitive conclusion and extrapolate to all of the new construction within each jurisdiction's territory.

Although documentation was available for a high percentage of buildings in Cambridge (specifically for the envelope), documentation was not very complete in many cases (see Table 8 for an overall picture and Table 5 through Table 7 for specific points.

Newton, Hyannis, Westborough, and Weymouth also had sparse documentation. Based on Table 4 (a measure of some level of documentation), 50 percent of projects at Newton (three out of six projects) had at least some level of envelope documentation, 0 percent had lighting information, and 50 percent had at least some level of HVAC information. Moreover, 33 percent of projects at Hyannis (one out of three projects) had at least some level of envelope, lighting, and HVAC documentation. In Westborough (five projects), 80 percent had at least some level of envelope documentation, 20 percent had at least some level of lighting documentation, and 60 percent had at least some level of HVAC documentation. In Weymouth (only one project), there was only envelope and lighting information available.

However, this does not tell the entire story. Table 8 summarizes the information given at the bottom of Tables 5–7. Table 9 gives a more detailed look at documentation present for each of the measures.

Table 8. Total Percent Documentation for All Measures in All Jurisdictions

Measure	Overall Percent Documentation
Roof U Factor	66%
Exterior Wall U Factor	55%
Window U Factor	41%
Window SHGC	38%
Interior Lighting LPD	34%
Exterior Lighting LPD	10%
Heating Capacity	41%
Cooling Capacity	38%
Heating Efficiency	41%
Cooling Efficiency	34%
Hot Water Efficiency	10%

The average amount of design documentation present for any measure was 37 percent. This metric is not perfect (e.g., not all measures are necessarily comparable), but it does give an idea as to the level of documentation present across all measures in all jurisdictions.

The parameters associated with all energy code measures were documented infrequently and inconsistently. As a result, it was not possible to determine the overall degree of code compliance with confidence both in terms of design specifications and as-built parameters, especially since we did not collect primary as-built parameters in actual buildings after construction was completed. However, the information presented in this study could be used to help inform code officials of the importance of requiring documentation as an important step towards enforcing the code and issuing a building permit. It is reasonable to assume that compliance with these measures would increase if code officials conducted a more thorough plan review of the energy code documented compliance and required such documentation to be filed on a more consistent basis.

Finally, it is important to note the scope of this project and how it is limited by the data. The data gathered was not meant to be representative of Massachusetts and was too sparse to be able to draw any statistically valid conclusions. The data do not provide conclusive evidence about commercial code compliance documentation by jurisdiction size, building type, or which code is enforced by a jurisdiction.

However, we can conclude, based on the jurisdictions we visited, that commercial code compliance data is typically not very complete and sometimes does not even identify what code applied. If this is reflective of the entire state, then there will be issues with providing adequate energy code documentation about commercial buildings in Massachusetts and conducting future reviews of code compliance based on jurisdiction documentation. It is unknown why the data is so sparse, but anecdotally (based on discussions with several plan reviewers and building inspectors) the biggest challenge is dedicating enough resources to the energy aspects of the building code. Typically, code officials prioritize non-energy code related requirements such as life safety and structural requirements over energy code requirements.

Additionally, we cannot say that overall compliance was high when energy code documentation was present. However, where we could compare, there were frequent incidences of parameters exceeding code. We expect this in stretch code jurisdictions as projects had to exceed the 2009 or ASHRAE 90.1 2007 baselines by 20% in order to meet the stretch code.

Finding: COMcheck provides a method for plan checkers to review whether as-designed building parameters and characteristics meet the energy code requirements. Trying to extract each data point from the architectural, mechanical, and electrical drawings and specification books instead can prove to be very time consuming. For example, calculating LPD using the architectural and lighting plans and fixture schedules can take a large amount of time. When a COMcheck lighting certification is submitted, on the other hand, a plan reviewer can go over the as-designed LPD values for each commercial space versus code and perform a quick quality assurance check by reviewing the drawings and fixture schedules. For instance, there were 11 total projects that had COMchecks (five in Boston, two in Cambridge, one in Hyannis, two in Westborough, and one in Weymouth), and this type of documentation usually gave the most information and was the least time consuming for us to find the data we needed.

Cadmus' recommendation: The Massachusetts program administrators should explore ways to work with municipalities to increase the submittals of COMcheck outputs to verify code compliance as a way to increase consistency and reduce the burden on code officials.

One option would be to emphasize the usefulness of COMcheck in CCSI code official training and how it can make it easier to enforce the code.

Finding: In the absence of COMcheck submittals, prescriptive compliance checklists can be a viable alternative to document compliance with the energy code and to facilitate the plan review and inspection process.

Cadmus' recommendation: The Massachusetts program administrators also should consider ways to work with municipalities to help them institute requirements for a prescriptive compliance checklist if COMcheck output is not provided. This also could be included in CCSI code official training.

Finding: The results of this study could be considered in conjunction with the results of the ongoing assessments of the energy code trainings. While the energy code trainings focus on energy code requirements, there is less emphasis on the administrative level and how critical it is to sufficiently document the energy code requirements as part of the permitting process.

Cadmus' recommendation: The future CCSI trainings should focus on best practices in terms of providing adequate and transparent documentation of energy code compliance for commercial buildings.

Finding: While visiting building departments and conversing with code officials about energy code enforcement mechanisms, Cadmus observed that code officials have various views on the importance of energy code requirements. Several building code officials stated that they do not necessarily agree with periodic updates of the energy code and that they find the effort required to learn the code in each new code cycle to be counterproductive. Some clearly stated that they do not believe in the importance of energy code requirements and enforcement. Therefore, their focus on the energy code aspect of plan review and physical inspection is not consistent or sufficient. Some said that they simply trust the commercial general contractors and designers, as they are typically more knowledgeable of the code compared to the general contractors working within the residential sector.

Cadmus' recommendation: The CCSI should consider working with DPS/BBRS to find methods that may enable increased energy code enforcement during code officials' compliance review and inspection. Examples of these methods might include encouraging attendance at energy code technical support events (both CCSI as well as other regional and national events), a greater emphasis on providing handout materials to attendees at training events and at building departments, and alerting CCSI training attendees as to where compliance documentation failures are occurring. Increased emphasis on communicating the importance of compliance in training opportunities should help raise awareness of the importance of energy code enforcement and increase the priority placed on enforcing the energy code.

APPENDIX A: PROJECT DOCUMENTATION SUMMARY BY BUILDING

Table 9 is an expansion of Table 4. Table 9 shows the level of at least some documentation present, whether or not a project was LEED certified, and relevant building information if it was available. Note the letter before each number, which corresponds to the building jurisdiction: B = Boston, C = Cambridge, N = Newton, H = Hyannis, WB = Westborough, and WM = Weymouth.

Table 9. Project Documentation Summary by Building

Building	Type of Building	Square Footage	Project Valuation	Energy Code	COMcheck or LEED Documentation			LEED Certified
					Envelope	Lighting	HVAC	
B1	Mixed Use - High Rise MF, Garage & Retail	28,736	$14,000,000	2009 IECC	YES	NO	NO	--
B2	Mixed Use - High Rise MF, Garage & Retail	1,000,000	$9,447,585	ASHRAE 90.1-2007	YES	YES	YES	YES - No Information on Cert. Level
B3	N/A	16,660	N/A	ASHRAE 90.1-2007	NO	YES	NO	--
B4	Mixed Use - High Rise MF, Garage & Retail	416,951	$91,361,750	ASHRAE 90.1-2007	NO	NO	NO	Gold (Certification in Progress)
B5	Mixed Use - High Rise MF & Retail	N/A	$10,000,000	ASHRAE 90.1-2007	NO	NO	NO	--
B6	Mixed Use - High Rise MF & Retail	N/A	$1,750,000	2009 IECC	NO	NO	YES	--
B7	Mixed Use - High Rise MF, Garage, Retail, & Restaurant	44,993	$9,000,000	2009 IECC	YES	YES	YES	--
B8	Religious Building	6,000	$4,591,335	ASHRAE 90.1-2007	YES	YES	YES	YES - No Information on Cert. Level
B9	Office & Retail	22,000	$5,312,129	ASHRAE 90.1-2007	YES	YES	YES	YES - No Information on Cert. Level
C10	Mixed Use - High Rise MF & Retail	67,716	N/A	ASHRAE 90.1-2007	YES	YES	YES	--
C11	N/A	N/A	N/A	ASHRAE 90.1-2007	YES	YES	YES	--
C12	University	N/A	N/A	N/A	YES	NO	NO	--
C13	Office	67,774	N/A	2009 IECC	YES	YES	YES	--
C14	University	N/A	N/A	N/A	NO	NO	NO	--
N15	University Lab (Major Renovation)	1,254	$455,365	N/A	NO	NO	NO	--
N16	Retail	19,625	N/A	N/A	YES	NO	YES	--
N17	Retail	9,695	N/A	N/A	NO	NO	YES	--
N18	Mixed Use	7,140	N/A	N/A	YES	NO	YES	--
N19	Office	3,250	N/A	N/A	NO	NO	NO	--

Building	Type of Building	Square Footage	Project Valuation	Energy Code	COMcheck or LEED Documentation			LEED Certified
					Envelope	Lighting	HVAC	
N20	Grocery Store	1,853	N/A	ASHRAE 90.1-2007	YES	NO	NO	--
H21	Golf Club	15,961	$2,500,000	2009 IECC	NO	YES	NO	--
H22	Restaurant	2,156	$430,000	ASHRAE 90.1-2007	NO	NO	YES	--
H23	N/A	N/A	N/A	2009 IECC	YES	NO	NO	--
WB24	Mixed Use - High Rise MF, & Retail	29,267	N/A	N/A	NO	NO	YES	--
WB25	Clubhouse	6,048	N/A	2009 IECC and 2012 IECC	YES	YES	YES	--
WB26	Multifamily	74,117	N/A	2009 IECC	YES	NO	NO	--
WB27	N/A	N/A	N/A	N/A	YES	NO	NO	--
WB28	Clubhouse	5,884	N/A	N/A	YES	NO	NO	--
WM29	Multifamily	18,512	N/A	ASHRAE 90.1-2007	YES	NO	YES	--
% YES / LEED Certified					**62%**	**34%**	**52%**	**14%**