DRAFT Final Report
Rhode Island Energy Code Compliance Baseline Study

Prepared for:	State of Rhode Island Office of the Building Commissioner and National Grid
Submitted to:	National Grid
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1. Executive Summary

This Executive Summary provides a high level review of the results for the *Rhode Island Energy Code Compliance Baseline Study*. In this section, we state the study objectives, summarize the evaluation approach, and present key findings, conclusions and recommendations.

1.1 Overview of Objectives and Approach

The principal research objectives of the study are to:

1. Estimate statewide energy code compliance rate for commercial buildings;
2. Provide feedback on patterns of compliance and non-compliance; and
3. Identify opportunities for Rhode Island in the quest to achieve 90% compliance with energy codes.

The Study Team[1] developed the research approach in collaboration with the State of Rhode Island Office of the Building Commissioner and National Grid. The research plan was developed based on the experiences of the Study Team in other jurisdictions, discussions with National Grid, a review of the Pacific Northwest National Laboratory's (PNNL) *Measuring State Energy Code Compliance*[2] report prepared for the Department of Energy's (DOE's) Building Energy Codes Program (BECP) and the *Rhode Island Baseline Commercial Code Compliance Study* document[3] provided by National Grid.

A high level synopsis of the research approach is as follows:

- **Coordination with Code Compliance Stakeholders:** Collaborated with National Grid's Codes and Standards Program Manager and Evaluation Manager, the Residential New Construction Baseline Study Team, and the State of Rhode Island's Office of the Building Commissioner to understand how this research can most effectively support the Code Compliance stakeholders group, their goals, and their vision for attainment of those goals.

[1] DNV KEMA, ERS and APPRISE.

[2] U.S. Department of Energy. *Measuring State Energy Code Compliance*. Prepared by Pacific Northwest National Laboratory. March 2010.

[3] Rhode Island Baseline Commercial Code Compliance Study_v2.doc

- **Marketing of Research:** Developed and implemented a marketing plan to promote study participation with building officials.
- **In-Depth Interviews:** Conducted in-depth interviews with 31 Rhode Island building officials. Building official interviews focused on code officials' knowledge of commercial energy code, staffing and training practices, processes for determining energy code compliance and barriers to enforcing energy codes.
- **Sample Design:** Developed a sample (obtained from the F.W. Dodge Player Database) of commercial building projects constructed since 2008. The Study Team used the most recent four years of construction data to obtain a sample large enough to yield the targeted number of completes. The building size groups are consistent with BECP's recommended strata boundaries. The sample includes a census of buildings from each stratum except the small stratum. For the small stratum, a simple random sample of 45 projects from the 105 was chosen.

  As shown in Table 1-1, the Study Team exceeded the target of 30 buildings with an overall response rate of 35%. Even though the target goal was to obtain 30 completed site visits for newly constructed commercial buildings in Rhode Island, Table 1-1 shows the final sample contains 33 site visits. Targets for all building sizes were met or exceeded.

Table 1-1: Overview of Sample Design and Response Rates

Building Size Strata	# Projects (2008-2011)[a]	% Total Construction Area[a]	Target	Completed	Response Rate
Small (<=25k ft^2)	105	12%	9	11	28%
Medium (>25k ft^2 to 60k ft^2)	23	11%	9	9	39%
Large (>60k ft^2 to 250k ft^2)	27	35%	9	9	39%
X-Large (>250k ft^2 to 400,000 ft^2)	6	23%	2	3	50%
XX-Large (>400,000 ft^2)	2	19%	1	1	50%
Total	**163**	**100%**	**30**	**33**	**35%**

[a]Source: F.W. Dodge

- **Site Data Collection Methodology:** The Study Team developed tools and rigorous protocols and procedures to ensure high stratum-level response rates and high quality site data for the assessment of code compliance. Two custom tools were developed to facilitate site data collection and quality control thereof. The first is a data collection tool developed with Filemaker Pro and Filemaker Go for use with Apple iPad tablets. The

second is an Excel spreadsheet analysis tool used to compile site data and characterize individual project specifics as well as perform overall and sector based baseline analysis

- Senior Study Team experts administered classroom and field training to onsite staff. Site surveyors were responsible for recruiting sampled sites for participation in the study, obtaining and reviewing as-built plans, conducting site visits and performing quality control of information entered in the iPad database. Site data was submitted to senior staff within 24 hours of completing the site visit for additional quality control and verification.

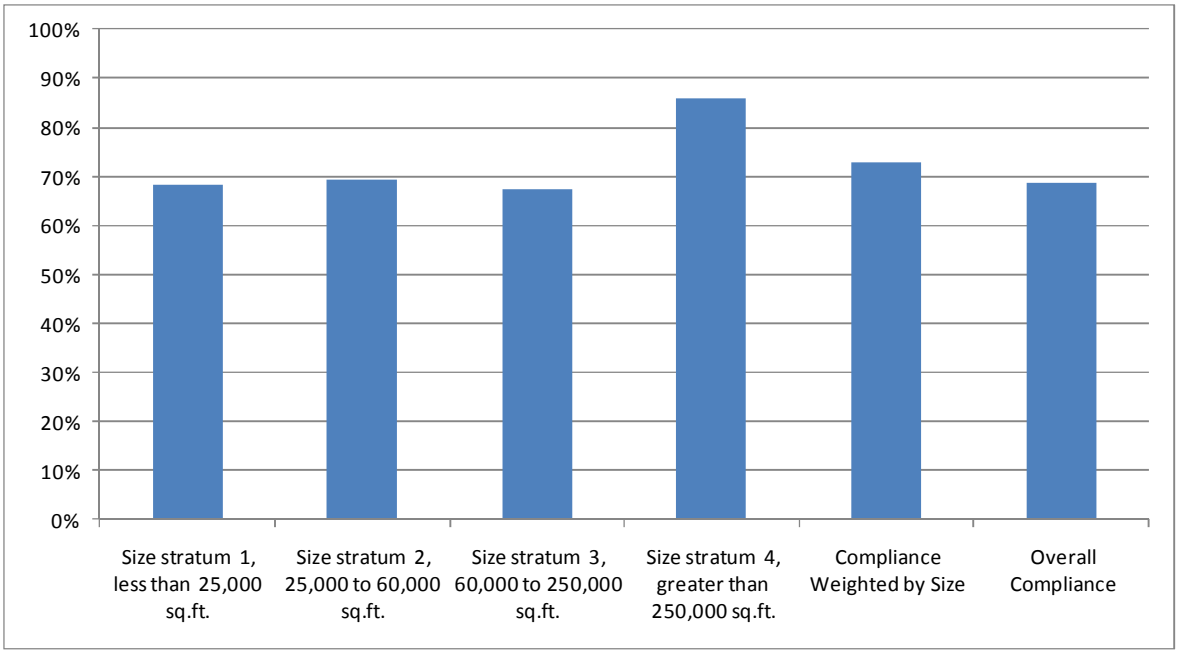
- **Estimation of Overall Baseline Condition and Code Compliance:** Estimated commercial code compliance rates to determine what trends in baseline methodologies and code compliance rates are evident and what opportunities they offer for programmatic activities to advance practices and improve energy efficiency. Examples of additional compliance rate breakdowns included in the report are: energy code category, building type, geography, individual code provisions, code version and new (advanced code provisions).

  To facilitate comparison with other states using the same methodology, and to allow the results to be utilized for ARRA funding reporting, the Study Team calculated the statewide estimate using the weighting methods and compliance score calculation developed by PNNL.

1.2 Key Findings and Conclusions

Figure 1-1 presents the unweighted and weighted overall state-wide compliance rates for Rhode Island commercial buildings. Overall state-wide compliance is estimated to be 70% (unweighted) utilizing the DOE/PNNL tiered impact methodology. **Weighted by building size, the overall compliance rate improves to 73%. This represents the preferred DOE/PNNL methodology for the code compliance requirements associated with Federal ARRA funding for state energy efficiency programs and projects.**

Figure 1-1: Rhode Island Statewide Compliance Rates



Analysis of commercial new construction in Rhode Island and feedback from building officials located throughout the state leads us to draw the following conclusions about commercial energy code compliance rates and practices. Conclusions first address findings on building and measure compliance and then address observed barriers to energy code compliance.

1. Overall code compliance for new construction in Rhode Island is estimated at approximately 70% compliance. However, it is important to consider several factors:

    a. This result does not mean that 70% of commercial buildings comply as we found no buildings fully in compliance;

    b. The overall number refers to the average provision compliance weighted by energy impacts as proposed by DOE/PNNL;

    c. It is more relevant to say that on average commercial buildings perform approximately 30% worse than the code requires, and, by extension, use 30% more energy than fully compliant buildings;

    d. Considering that efficiency programs strive for 15-20% performance improvement compared to code, this 30% gap is significant; and

e. A follow-up study that includes performance monitoring and the calculation of building energy use intensity (EUI) would better refine the performance gap and savings opportunity.

2. Lighting and lighting controls offer major opportunities for efficiency.

3. Mechanical system efficiency levels are at full compliance.

4. Code compliance is a shared responsibility.

5. While building officials and their staffs generally report satisfaction with the training process, their proficiency with the commercial energy code may be impeded by lack of direct experience with projects permitted under the current code, SBC-8-2010.

6. Interviews reveal that for many Rhode Island communities, residential renovations and residential new construction dominate the workload and experience of local code officials.

7. Because Rhode Island has a small population but a significant diversity of villages, towns, and cities, building officials need code education and compliance tools that match their level of exposure to new commercial construction.

8. Small commercial builders and contractors would benefit from targeted training on the commercial energy code, taking the educational burden off of building officials and inspectors.

9. Some building officials find it hard to keep up with the rapid introduction of new building materials on the market. There is an expressed need for regular education on the performance of new building materials.

10. Training on the commercial energy code and compliance tools such as COMcheck, positively affects enforcement practices.

11. Familiarity with the Green Building Act of 2010 is inconsistent across jurisdictions despite several trainings offered by the state.

12. Commercial architects, engineers, and to a degree contractors are better informed on the commercial energy code than their residential counterparts are on the residential energy code.

13. To verify commercial energy code compliance for HVAC and lighting systems, building officials rely heavily on engineers from the design team to report on whether or not compliance has been achieved.

14. Several building officials experience challenges in interpreting trade-off and performance approaches in energy code compliance documentation.

15. Code officials require additional staff resources in order to properly address the energy code and/or they need assistance from other sources in order to share the burden of energy code compliance.

1.3 Recommendations

Based on the extensive research of new construction sites and building officials operating in the Rhode Island marketplace, the Study Team offers the following list of recommendations for consideration.

1. Implement a comprehensive plan to provide energy code compliance assistance. Methods to accomplish this may include:

    a. Funding additional staff or energy experts to work with the State's Office of the Building Commissioner and local officials to augment building official knowledge and resources;

    b. Funding and staffing a team of third party experts to verify the compliance for complex HVAC systems, HVAC controls, and lighting power densities and controls; and

    c. Provide focused assistance for new provisions. Newly adopted code provisions are often misunderstood or ignored.

2. Continue "beyond code" new construction efforts. Program administrators, rather than developing code compliance strategies, should continue to focus on beyond code efforts such as those represented by the Rhode Island "Green Code."

3. For future energy code studies, we recommend interviewing a cross-section of market actors including building owners, architects, engineers, and contractors. The benefit of reporting a variety of perspectives is the development of a deeper understanding the entire new construction supply chain.

4. Continue commercial energy code trainings as they are reportedly well-received by building officials and their staff. When developing curriculum and hiring trainers, give special consideration to the size and complexity of buildings that building officials are likely to oversee in their jurisdictions.

5. Offer building officials curriculum that is not simply a recital of energy code provisions. In addition to teaching the content of the commercial energy code, provide the context of the code provisions.

6. Develop energy code training opportunities across market actor segments but particularly focus on small construction firms.

    a. Introduce commercial energy code circuit riders to visit building officials, contractors, builders, architects and engineers and focus on actual commercial building projects.

7. Facilitate trainings or seminars on new building materials to help keep building officials knowledgeable about the pros and cons of new products. It is admittedly difficult for the state to organize seminars on new products due to its need to remain neutral on products and services, but the state can do the following:

    a. Signal to local industry trade groups that code officials would like to be trained on new building products;

    b. Hire a building scientist to periodically offer training on envelope assemblies and building materials; and

    c. Based on research in Rhode Island and other states, the Study Team has developed a comprehensive training list for market actors.

2. Introduction

The Rhode Island Energy Code Compliance Baseline Study was undertaken to investigate energy code compliance. The Study Team collaborated with the State of Rhode Island Office of the Building Commissioner and National Grid to determine study goals and to develop a research plan.

This report provides the results for the Rhode Island Energy Code Compliance Baseline Study for the review of the commercial energy code compliance rate within the State of Rhode Island. In this section we provide a review of the evaluation study objectives, summarize the evaluation approach, and describe the organization of the remainder of the report.

2.1 Evaluation Objectives

The principal research objectives of the study are provided in Table 2-1.

Table 2-1: Research Objectives

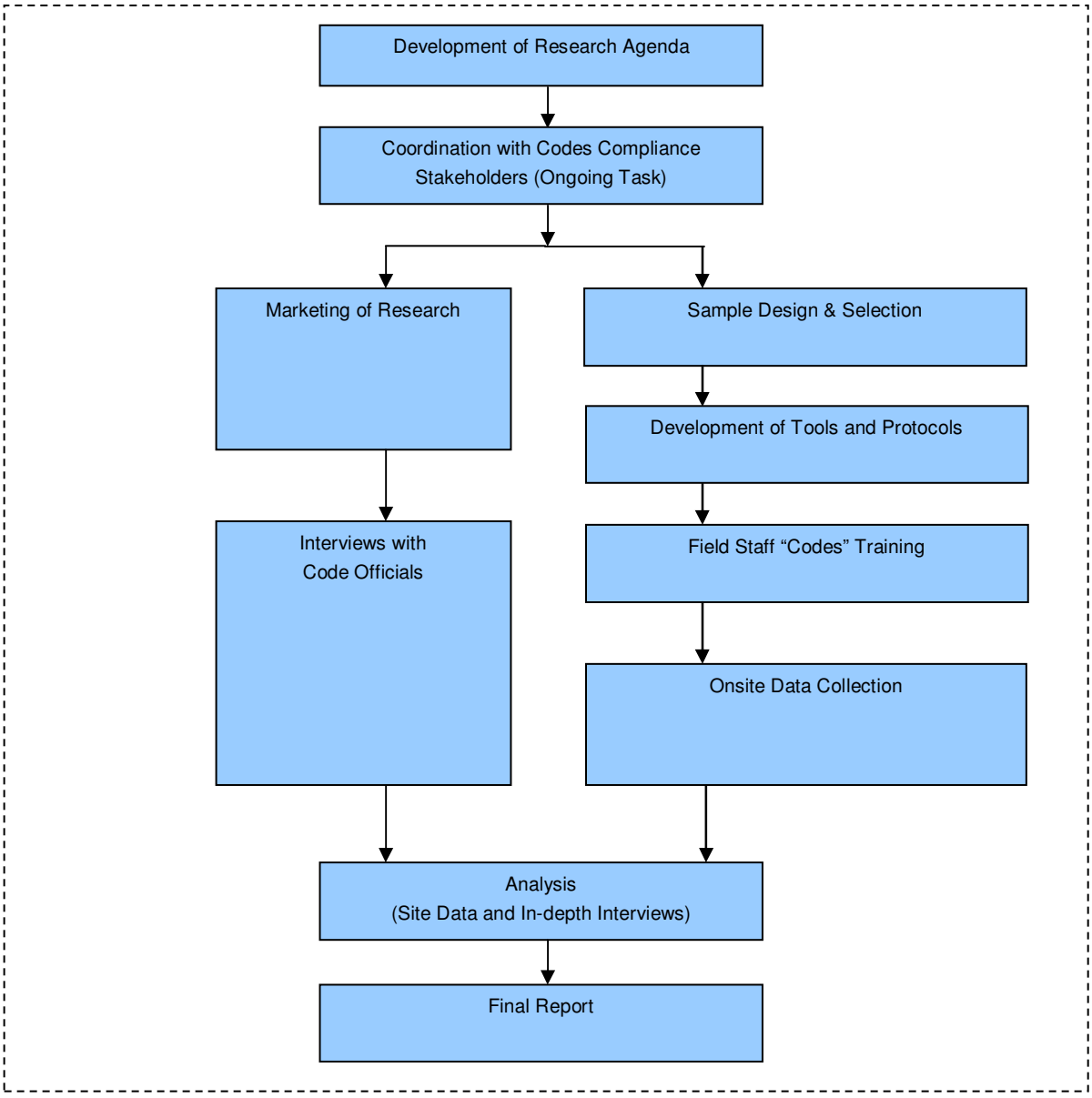
#	Primary Objectives
1	Estimate statewide energy code compliance rate for commercial buildings.
2	Provide feedback on patterns of compliance and non-compliance.
3	Identify opportunities for Rhode Island in the quest to achieve 90% compliance with energy codes.

2.2 Overview of Approach

The Study Team developed the research approach in collaboration with the State of Rhode Island Office of the Building Commissioner and National Grid.

Figure 2-1 outlines the research agenda for the Rhode Island Energy Code Compliance Baseline Study. Successful execution of this research required significant planning and stakeholder outreach efforts. A summary of the primary steps undertaken in this study follows the diagram.

Figure 2-1: Research Agenda



Development of Research Agenda

The development of the research agenda was based on 1) the experience of the Study Team in other jurisdictions; 2) discussions with National Grid; 3) review of PNNL's *Measuring State Energy Code Compliance*[4] report; and 4) the *Rhode Island Baseline Commercial Code Compliance Study* document[5] provided by National Grid. In particular, this study benefitted from the Study Team's recent comprehensive baseline commercial energy code compliance study in Massachusetts. The timing of the Rhode Island study allowed for the utilization of data collection instruments, protocols and training materials developed for the *Project 11 Code Compliance Baseline Study* developed for the State of Massachusetts.

Coordination with Code Compliance Stakeholders

A key driver of the research was to provide the National Grid's Codes and Standards Program Manager and Evaluation Manager, the Residential New Construction Baseline Study Team, and the State of Rhode Island Office of the Building Commissioner with information to assist with the delivery of current and new initiatives to support and enforce code compliance in Rhode Island.

Marketing of Research

Developed and implemented a marketing plan to promote study participation to building officials using electric announcements and a jurisdictional letter. The Study Team branded the study as an effort to learn about common construction practices in relation to the energy code. The marketing campaign communicated the potential benefits of such a program and it is believed that these efforts resulted in achievement of higher data collection response rates across the State of Rhode Island.

Building Code Official Interviews

The Study Team attempted to conduct interviews with building officials from each of Rhode Island's 39 municipal jurisdictions from a list provided by the State of Rhode Island Office of the Building Commissioner. The Study Team was able to complete interviews with building officials representing 31 of these jurisdictions.

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[4] U.S. Department of Energy. *Measuring State Energy Code Compliance*. Prepared by Pacific Northwest National Laboratory. March 2010.

[5] Rhode Island Baseline Commercial Code Compliance Study_v2.doc

The building code official interviews focused on gaining an understanding of code officials' knowledge of commercial energy code, staffing and training practices, processes for determining energy code compliance and barriers to enforcing energy codes in the State of Rhode Island.

Sample Design & Selection

The Department of Energy's (DOE's) Building Energy Codes Program (BECP) recommends a minimum sample size of 30 buildings for Rhode Island in estimating the statewide building code compliance rate for commercial new construction buildings within a tolerable margin of error when using an average of four years of construction starts data. The Study Team developed a sample plan of new construction buildings with a target of 30 completes. The sample was stratified by building size (square footage).

Development of Tools and Protocols

The Study Team developed several custom instruments and procedures to ensure thorough and accurate site data collection, including:

- A data collection tool developed with Filemaker Pro and Filemaker Go for use with Apple iPad tablets; and
- An Excel spreadsheet analysis tool utilized to compile site data and perform site level and overall analysis.

Field Staff "Codes" Training

Onsite staff from the Study Team participated in the training that was conducted for the Massachusetts Energy Code Compliance Baseline study in November 2011. This training was conducted in an effort to establish consistent data collection procedures and data accuracy. Classroom training included coverage of the data collection procedures associated with the iPad tool. Staff involved in site data collection received in-the-field training that included hands-on collection and iPad input of project data for building envelope, mechanical system and lighting system measures.

Onsite Data Collection

The onsite data collection undertaking consisted of visiting 33 building sites and using the tools developed during the Development of Tools and Protocols phase of the study to collect data to

assess code compliance. Tasks associated with this activity included recruiting sampled sites for participation in the study, obtaining and reviewing as-built plans, conducting site visits and performing quality control of information entered in iPad database.

Analysis and Reporting (Site Data and Interviews)

The Study Team analyzed the site data to determine the following:

- Overall rates of compliance
- Compliance by category:
    - Envelope
    - HVAC
    - Lighting Power Density (LPD)
    - Lighting controls (separate as compliance varies greatly from LPD compliance)
- Individual measures with high or low compliance rates
- Opportunities for training, technical assistance and financial incentives

The Study Team also analyzed qualitative findings from 31 interviews with building code officials. These interviews provided a solid foundation for understanding the market structure in regard to the existing energy code and related compliance and enforcement efforts. Furthermore, these interviews provided additional information to support the findings of the site data collection.

2.3 Organization of Report

The remainder of this report is organized as follows:

- **Section 3. Methodology.** This section presents the Study Team's approach to the following:
    - Coordination efforts with the Codes & Standards Team;
    - Marketing of research to increase study participation;
    - Building official interviews;
    - Sample design and weighting procedures;

- Site-level data collection; and
- Estimation of commercial code compliance rates.

- **Section 4. Baseline and Code Compliance Trends**. This section presents the results of analysis based on the evaluation of 33 project sites to determine estimates of the following:
  - Statewide energy code compliance rates;
  - Overall code compliance for different building size stratum;
  - Statewide code compliance weighted by building size;
  - Compliance by energy code categories (e.g., building envelope, lighting, HVAC);
  - Compliance by geographic region; and
  - Compliance rates for code provisions that represent opportunities for improvement through compliance support mechanisms.

- **Section 5. Building Official Interview Findings.** This section presents the results of 31 in-depth interviews conducted with Rhode Island building officials.

- **Section 6. Conclusions and Recommendations.** This section integrates the findings from the building official interviews and site visits. The Study Team provides recommendations for increasing levels of code compliance for consideration for the State of Rhode Island Office of the Building Commissioner and National Grid.

- **Appendices**
  - A. iPad Site Data Collection Instrument
  - B. Jurisdictional Letter
  - C. Building Code Official Interview Guide

3. Methodology

This section describes the process taken to develop the Code Compliance Baseline Study; the methodologies used to gather market data on new construction buildings; and to determine code compliance rates for commercial buildings in Rhode Island.

This section is organized as follows:

- **Coordination with Code Compliance Stakeholders:** Collaboration efforts between the Study Team, National Grid, the State of Rhode Island Office of the Building Commissioner, and other stakeholders.
- **Marketing of Research:** Discussion of marketing plan to promote study participation with building officials.
- **Building Code Official Interviews:** Overview of the interviews the Study Team conducted with Rhode Island building officials – includes description of the building officials interviewed, data collection process and survey instrument.
- **Sample Design:** Description of the rationale used to determine the sample design to conduct onsite visits.
- **Site Data Collection Methodology:** Approach implemented to collect site data and a description of the custom tool developed for baseline and code compliance analysis.
- **Estimation of Overall Baseline Condition and Code Compliance:** Process used for estimating commercial code compliance rates.

3.1 Coordination with Codes and Standards Stakeholders

A central purpose of this study is to inform the National Grid's Codes and Standards Program Manager and Evaluation Manager, the Residential New Construction Baseline Study Team, and the State of Rhode Island Office of the Building Commissioner of the energy code compliance rates for commercial new construction in Rhode Island. Close coordination between the Study Team and the stakeholders was needed to understand how this research could most effectively report compliance rates and support state initiatives. An initial meeting with the Study Team and key stakeholders was held at the Office of the State's Building Code Commissioner in Providence on February 7, 2012. Key discussion items included:

- History of commercial building energy codes and standards development;

- Overview of building officials' jurisdictions and duties; and
- Status and overview of commercial energy code training and compliance practices.

Potential study outcomes in developing study materials and tools, the Study Team requested information from project stakeholders in order to facilitate marketing efforts, data collection processes, informational letters on the study sent to building officials across the State, and the field data collection tool.

Although not part of the original study scope, the Study Team was requested to interview at least one building official from each of Rhode Island's 39 municipal jurisdictions. In preparation for this effort, an introductory letter was developed and emailed to the head official of each jurisdiction to encourage participation in the interview process.

After finalizing the building official interview guide on commercial code compliance and enforcement, the Study Team was asked to coordinate with the Residential New Construction Baseline Study Team who had been tasked with interviewing building officials about residential energy code enforcement and compliance. To avoid overburdening building officials, the Study Team integrated questions regarding residential enforcement and compliance into the commercial interview guide to learn about the residential new construction market.

3.2 Marketing of Research

The BECP stresses the importance of marketing code compliance studies to stakeholders in order to obtain the necessary data from a representative sample of buildings. For this study, it was felt that it was most important that the Study team inform and engage the building officials. The Study Team used two approaches for this:

1. **Electronic Announcements:** an email sent to all building officials informing them of the study activities.
2. **Jurisdictional Letter:** a written letter sent to building officials informing them of the study and encouraging participation.

Building upon experience from previous studies, the Study Team understood that proper branding of the study would be vital to its success. Instead of conveying the research as a code compliance study, the study team branded the study as an effort to learn about common construction practices in relation to the energy code.

It was also understood that any marketing materials or announcements would be needed to communicate the intent of the study and alleviate any concerns that the actors may have with this research. The primary message of the materials conveyed in the announcements was that the information collected through this study will be used to estimate a *statewide* energy code compliance rate for commercial buildings, identify opportunities for Rhode Island to help reach its statewide goal of a 90% compliance rate with the energy code, and provide feedback on general patterns practice, not specific to any individual jurisdictions.

The marketing campaign communicated the potential benefits of such a program and it is believed that these efforts resulted in achievement of higher data collection response rates across the State.

3.3 Building Code Official Interviews

This section discusses interviews the Study Team conducted with Rhode Island building code officials. A description of the building officials interviewed and a summary of the data collection process and survey instrument is provided.

Senior Massachusetts-based members of DNV KEMA's Sustainable Buildings and Communities (SBC) practice conducted 31 in-depth interviews via telephone with building officials, out of a census population of 39, to gain an understanding of compliance practices for the current commercial building energy code in Rhode Island. Some interviews were completed by other DNV KEMA staff under the direct supervision of the SBC team. DNV KEMA's SBC division provides green building consulting and sustainable building portfolio services. The interviewers used their professional familiarity with energy code compliance in commercial building design and operation to elicit important details and resolve inconsistencies in building officials' answers.

The 31 building code officials interviewed represented 8 cities and 23 towns in Rhode Island. These interviews were conducted by phone between May and June 2012 and averaged 51 minutes in length, with a range of 25 to 90 minutes.

Table 3-1 presents a summary of the key research topics covered in the building official interview guide. The interview guide contained both general questions (e.g., *"Are you more familiar with the 2009 IECC or ASHRAE 90.1 – 2007 standards?"* and *"How could the energy*

efficiency programs offered by National Grid improve compliance?") and questions broken out by commercial and residential[6] buildings (e.g., *"How many **commercial/residential** building permits were issued by your department?"* and *"Within the last two years, has anyone from your staff attended training on **commercial/residential** energy code compliance and enforcement?"*) All topics may not have been covered in each interview. The focus of each interview was guided by the experience and availability of the interviewees.

Table 3-1: Building Official Interview Guide Research Topics[7]

Key Research Topics	General Questions	Questions Addressing Commercial and Residential Categories Separately
General Information		
Job Responsibilities	X	
Number of Building Permits Issued		X
Staff Characteristics	X	
Energy Code Training		
Training on Energy Code Compliance and Enforcement		X
Training on 2012 IECC	X	
Training on Green Buildings Act	X	
Preference for Mode of Receiving Training	X	
Energy Code Compliance Practices		
Preference for 2009 IECC vs. ASHRAE 90.1 – 2007 Standards	X	
Educational/Professional Background Needed to Enforce Energy Code		X
Energy Code Documentation Reviewed		X
Process for Complying with Energy Code		X
Resources Used to Answer Energy Code Questions	X	
Perception of Design and Construction Team Familiarity with Energy Code		X

[6] The Residential New Construction Baseline Study Team will analyze and present residential code compliance results from the building code official interviews.

[7] The Residential New Construction Baseline Study Team will analyze and present residential code compliance results from the building code official interviews.

Key Research Topics	General Questions	Questions Addressing Commercial and Residential Categories Separately
Challenges to Enforcing Energy Code Requirements		X
Familiarity with National Grid Energy Efficiency Programs	X	
Awareness of American Recovery and Reinvestment Act	X	
Suggestions to Improve Energy Code Compliance	X	

3.4 Sample Design and Weighting Procedures

This section discusses the sample design and post-survey weighting.

3.4.1 Sample

3.4.1.1 Target Population

The target population for the Code Compliance Baseline Study was the commercial and industrial buildings constructed between 2008 and 2011 in the state of Rhode Island that fall under the commercial energy code.

3.4.1.2 Sample Frame

The sample frame was the Dodge Players Database for 2008-2011. This database is developed using information from the F.W. Dodge New Construction Reporting system. The Dodge Players Database is designed to furnish information on the market actors associated with individual new construction projects, including owners, architects, engineers, and other market actors.

The sample frame had 163 new construction projects in 2008-2011. Based on the frame, the estimated total new construction square footage was 8.6 million square feet. However, that estimate was adjusted as a result of screening and interviewing the sampled cases.

3.4.1.3 Sample Selection

The sample frame was stratified into five strata based on the square footage of a project:

- **Small:** Up to 25,000 ft^2
- **Medium:** Larger than 25,000 ft^2 and up to 60,000 ft^2
- **Large:** Larger than 60,000 ft^2 and up to 250,000 ft^2
- **X-Large:** Larger than 250,000 ft^2 and up to 400,000 ft^2
- **XX-Large:** Larger than 400,000 ft^2

Table 3-2 shows the number of projects, the total square footage, and the percent of total square footage for each stratum.

Table 3-2: New Construction Sample Stratification

Stratum	# Projects	Total Square Footage(in 1000 ft^2)	% Total Square Footage
Small	105	1,068	12%
Medium	23	906	11%
Large	27	3,033	35%
X-Large	6	1,942	23%
XX-Large	2	1,662	19%
Total	**163**	**8,611**	**100%**

Source: F.W. Dodge

The sample included a Census of buildings from each stratum except the small stratum. For this stratum, we selected a simple random sample of 45 projects from the 105 projects, as shown in Table 3-3.

Table 3-3: Sample Design - Number of Buildings Sampled by Stratum

Stratum	# Projects	Sample Size	# Target Completes
Small	105	45	9
Medium	23	23	9
Large	27	27	9
X-Large	6	6	2
XX-Large	2	2	1
Total	**163**	**103**	**30**

3.4.2 Data Collection

3.4.2.1 Field Visits

The Study Team completed 33 site visits with the sampled projects. Table 3-4 shows the sample disposition by stratum.

Table 3-4: Sample Disposition by Stratum

Disposition		Small		Medium		Large		X-Large		XX-Large	
		#	%	#	%	#	%	#	%	#	%
Complete	Complete	11	24%	9	39%	9	33%	3	50%	1	50%
Contacted	Refused	6	13%	4	17%	8	30%	2	33%	1	50%
	Quota Met	12	27%	4	17%	0	0%	0	0%	0	0%
	Could Not Schedule	11	24%	6	26%	6	22%	1	17%	0	0%
Excluded	Not Eligible	4	9%	0	0%	4	15%	0	0%	0	0%
	Duplicate	1	2%	0	0%	0	0%	0	0%	0	0%
TOTAL		45	100%	23	100%	27	100%	6	100%	2	100%

Table 3-5 shows the number of eligible sampled cases, the number of completed interviews, and the response rate by sample stratum. The overall survey response rate was 35%.

Table 3-5: Survey Response Rate by Stratum

Stratum	Eligible Sample Size	Number of Completes	Response Rate
Small	40	11	28%
Medium	23	9	39%
Large	23	9	39%
X-Large	6	3	50%
XX-Large	2	1	50%
Total	**94**	**33**	**35%**

3.4.2.2 Sample Eligibility Status

The estimated total square footage of eligible new construction projects based on information from the Dodge database was 8.6 million square feet. During the interviewing, some sampled cases were found to be ineligible. Based on the sample eligibility rates, we estimated that in

2008 through 2011, about 8.1 million square feet of new construction area fell under the commercial energy code.

3.4.3 Data Processing

3.4.3.1 Weights

The Department of Energy's (DOE's) Building Energy Codes Program (BECP) recommends that the average individual scores from the completed sites be weighted by building size strata according to the proportion of total square footage constructed in the population that each size stratum represents in order to derive an overall state compliance metric for commercial new construction buildings.

Table 3-6 shows the proportion weights developed for each stratum.

Table 3-6: Proportion Weights by Stratum

Stratum	Total Eligible Square Footage (in 1000 ft^2)	Stratum Proportion Weight
Small	963	0.12
Medium	906	0.11
Large	2,623	0.32
X-Large	1,942	0.24
XX-Large	1662	0.21
Total	**8,096**	**1.00**

In addition to stratum proportion weights, site-level weights are developed to be used in the subgroup analysis. The site level square footage weight (SFW) is based on two factors – the stratum factor and the square footage of each site.

The formula for the stratum factor (SF) is SF = Sum of Stratum Square Footage / Sum of Square Footage for Stratum Respondents.

The formula for the Square Footage Weight for each completed site is SFW = SF * Square Footage of the Site.

These weights are then normalized so that they add up to 33, the total number of completed sites by multiplying each weight by 33/8,096. The normalized (relative) weights reflect the

relative importance of each completed site, which is based on the total square footage each site represents in the population, in the estimation of compliance rates.

Table 3-7 presents information on the computation of site-level relative square footage weights.

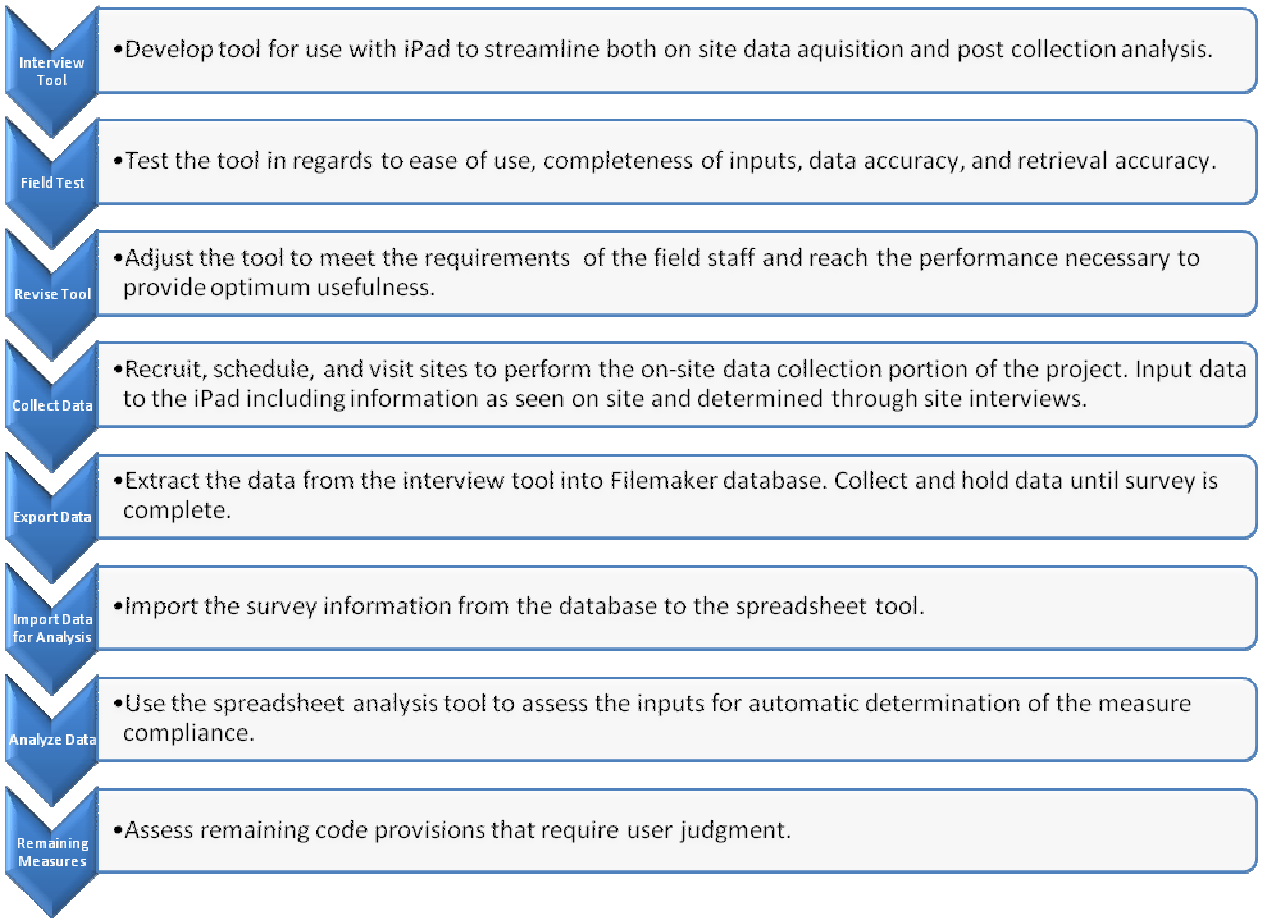
Table 3-7: Relative Square Footage Weights by Stratum

Stratum	Total Eligible Square Footage (in 1000 ft^2)	Total Respondent Square Footage (in 1000 ft^2)	SF	Average Weight	Average Relative Weight
Small	963	125	7.70	87.55	0.36
Medium	906	327	2.77	100.67	0.41
Large	2,623	957	2.74	291.44	1.19
X-Large	1,942	949	2.05	647.33	2.64
XX-Large	1662	1,068	1.56	1,662	6.77
Total	**8,096**	**3,426**	**2.36**	**245.33**	**1.00**

3.5 Site Data Collection Methodology

This section presents the methodology implemented to collect data regarding specific project sites in Rhode Island. It also describes the custom tool developed for baseline and code compliance analysis. Figure 3-1 illustrates the process employed to collect and verify the site data.

Figure 3-1: Site Data Collection Process



3.5.1 Data Collection Tool Development and Quality Control

In order to assure thorough and accurate site data collection, the Study Team developed two custom tools. The first is a data collection tool developed with Filemaker Pro and Filemaker Go for use with Apple iPad tablets. The second tool is an Excel spreadsheet analysis tool that is utilized to compile site data and characterize individual project specifics as well as perform overall and sector based baseline analysis.

- **Data Collection Tool** – ERS modified the data collection instrument utilized for the Massachusetts Code Baseline study for use as the basis the Rhode Island study. Modifications included coverage of the provisions of the Rhode Island amendments and adjustments for the climate zones utilized. In addition the instrument was developed to be fully consistent with the DOE/PNNL compliance methodology, utilizing weighted tiers based on predicted energy impacts. DNV KEMA and ERS worked together to develop

the iPad application that provides for a step-by-step data collection process that prompts the user for responses to each baseline measure and/or energy code requirement. Drop-down menus are utilized to facilitate accurate data collection, and comment fields for every measure assure the ability to fully describe site details.

- **Data Analysis Tool** – ERS senior engineers developed a spreadsheet tool that accepts uploaded data from the iPad Filemaker tool, populating a spreadsheet for each project surveyed. The tool automatically determines code compliance for any measures identifiable with a yes/no response, or a specific threshold value. For all compliance measures, the tool facilitates analysis of code compliance and performance levels relative to code provisions. Sorting functions allow compliance by measure, measure category, and overall. In addition the tool will be used to gauge compliance across various sectors as allowed by the sample.

Training was conducted with all staff associated with the study to ensure consistent data collection procedures and ensure high levels of data accuracy. Classroom training included coverage of all site survey questions as well as the data collection procedures associated with the iPad tool. In addition, all staff involved in site data collection received in-the-field training that included the hands-on collection, and iPad input of project data for building envelope, mechanical system, and lighting system measures.

Following the above training exercises, the entire survey instrument was reviewed with the trained staff covering all questions and concerns regarding possible obstacles to obtaining accurate information while on-site. Following this exercise, final modifications were made to the iPad tool and the associated spreadsheet tool.

In order to provide for on-going quality control, a follow-up debriefing session was conducted after the initial round of site visits. Staff discussed challenges presented by their initial visits/interviews with clarifications and recommended methodologies developed both peer-to-peer and by senior staff. Minor modifications were made to the data collection tool in response to staff feedback generated during this initial round of site data collection.

3.5.2 Site Data Collection Procedures

Utilizing the methodologies developed during the above described process, the project staff scheduled and conducted site surveys and interviews in a manner consistent with data collection best practices. The procedure is outlined as follows:

- **Site Scheduling** – In order to assure proper coordination, each Study Team member scheduled their own site visits. Working from their assigned projects from the sample, initial information regarding the status of the project (i.e. fully complete, under construction, design stage, etc.) was recorded. Upon identification of viable sites, the site visits were scheduled.
- **Obtaining Project Documentation** – At the time of initial site scheduling, the team member arranged for access to project documentation, including architectural/mechanical/electrical plans and project specifications including "sequence of operation" documents.
- **Assuring Valuable Data Collection** – Prior to visiting the site, team members requested that key personnel be available. This typically included project owners, design team members, and facility managers. In addition a facility tour with adequate time to perform project assessment and data collection was scheduled.
- **On-Site Interviews**–Although flexibility was maintained in order to accommodate project participants, each site visit began with discussion with a building representative on-site in order to gather as much project data as possible. These interviews assist in:
    - Obtaining key features of the project related to energy efficiency
    - Assuring access to as much of the project site as possible
    - Establishing safe and constructive procedures for the rest of the visit
- **Project Document Review** – Depending on the size and scope of the facility, as well as the results of the scheduling procedure, project documents were reviewed on-site in conjunction with the site survey, or were reviewed independent of the site work. Depending on the detail presented in the available documents the following project information was gathered and then verified through the facility tour:
    - Comprehensiveness of the documents in terms of energy code compliance issues
    - Adequacy of document details for facilitating compliance and instructing construction personnel
    - Required system testing and facility training procedures
    - Envelope details, including, but not limited to:
        - Air barriers and air sealing
        - Insulation levels and materials

- Thermal breaks
- Vapor retarders for cavity insulation
- Fenestration specifications
- Facility specific details such as loading docks, vestibules, etc.

o Mechanical system details:

- Model numbers and/or efficiency levels of equipment
- Thermostatic controls
- Fan and pump controls
- Heat recovery ventilation as applicable
- Duct and pipe insulation
- Control sequences

o Lighting system details:

- Lighting power density (LPD) of space types
- Manual controls
- Automatic timer and/or occupancy based controls
- Daylighting zones
- Exterior lighting efficacy requirements

- **Facility Tour** – A comprehensive facility tour was performed at each site in order to field verify the information collected from the design documents, and to collect additional data not available in the documents. For a small percentage of the sites, the Study Team was not provided access to design documents but was invited to tour the facility. For these sites, as much data as possible was collected through physical inspection. In all cases, the iPad data collection tool is fully completed with each measure addressed. "Not verifiable" (NV) and "not applicable" (NA) were utilized to avoid confusion as to possible missing data.

- **Data Submission** - To ensure that proper procedures were followed, site survey personnel uploaded completed data collection files within 24 hours of completing the site survey.

3.5.3 Data Upload and Analysis Procedure

The Study Team developed a data transfer protocol that is highly automated, yet allows for quality control at every step. The user interface allowed for the entry of comments and adjustments at any juncture, and every baseline measure was recorded or is referenced as "not applicable" or "not verifiable." The procedure the Study Team utilized is as follows:

- **Data Upload –** Upon assurance that collected data is complete and accurate; the individual facility data collected was uploaded from the Filemaker tool to the custom analysis spreadsheet tool.
- **Data Quality Assurance Review –** Following the upload of the data, project management reviewed the spreadsheet inputs for completeness and conflicts, referring all questions and concerns back to the project staff assigned to the site.
- ***Automatic* Code Compliance/Baseline Determination –** There are many code provisions that are prescriptive across all commercial building types and others that are prescriptive, but are segregated by building type and/or building size. For these provisions, upon uploading of the Filemaker data, the spreadsheet tool recorded the baseline information, the building type/size when appropriate, and made a code compliance determination automatically. This determination verifies that individual provisions are met. COMcheck and "Total Building Performance" methodologies allow for some tradeoffs within building envelope measures. The DOE/PNNL compliance methodology does not allow for trade-off determinations. However, our field assessments did not identify envelope assemblies that significantly outperform code provisions, allowing such trade-offs. Where we encountered assemblies that fell short of code requirements, they had not been offset by corresponding beyond code envelope practices.

  Determinations made in this fashion, include:

  - Air barriers and air sealing
  - Insulation levels
  - Fenestration performance
  - HVAC efficiency levels
  - VFD fan and pump controls

- Lighting controls

- ***Semi-Automatic* Code Compliance/Baseline Determination –** Other provisions do not lend themselves to automatic determinations and require user judgment. For these provisions the Filemaker data was uploaded to the spreadsheet in the same fashion, but dropdown menus prompted the user for inputs in order to make a final code provision determination. Provisions handled in this fashion include:
  - Daylighting zones
  - Control of complex HVAC systems
  - Economizing
  - Demand Control Ventilation
  - Prevention of simultaneous heating and cooling

- ***Calculated* Code Compliance/Baseline Determination –** In some cases, a calculation was needed to determine compliance with a specific provision. An obvious example is LPD which is the main avenue of lighting compliance. The steps followed are as follows:
  - Site surveyor determined if the project consisted of repeated lighting layouts with similar fixtures, as is common with commercial buildings, and determined a survey approach accordingly.
  - Site surveyor selected a minimum of two areas of the project that represented the variety of space types encountered, or in some cases, surveyed the entire facility.
  - The dimensions of each selected space were entered in the iPad tool.
  - The lighting fixture technologies were selected from drop-down menus.
  - The fixture quantity was recorded in the tool.
  - The tool assigned the appropriate fixture wattage from an extensive database of lamp/ballast combinations and calculated the LPD.
  - Upon uploading the Filemaker data to the spreadsheet tool, the LPD calculation was repeated and the result checked against the lighting power allowance (LPA) for the space or building area type.

- **Final Quality Control of Data Inputs** – Following the above procedures, the Study Team reviewed all finalized facility spreadsheets for consistency and completeness.

Incomplete data produced an automatic inquiry to the site surveyor who then reviewed the site data. In nearly all cases the result of such inquiries was the recognition that a portion of the baseline information was not verifiable due to the stage of project completion. All staff was instructed to record only baseline conditions that were verifiable without causing damage to the structure.

3.6 Estimation of Overall Baseline Conditions and Code Compliance

One of the advantages of spreadsheet tools is that they allow data to be viewed and analyzed in many differing ways. One of the goals of this project is to determine what trends in baseline methodologies and code compliance rates are evident and what opportunities they offer for programmatic activities to advance practices and improve energy efficiency.

3.6.1 Estimation of Overall Commercial Code Compliance Rates

Through the comparison of actual practice baseline conditions with energy code provisions the Study Team has constructed an analysis of the recent and current energy code compliance rates in Rhode Island. The purposes for doing this include:

- The establishment of an overall code compliance rate for commercial buildings for Rhode Island in accordance with the guidelines established for compliance with the American Recovery and Reinvestment Act (ARRA) for codes-related project activities at the state and local levels. These guidelines include the measurement of the compliance rate associated with the commercial energy code identified (IECC 2009/ASHRAE 90.1 2007) in the ARRA legislation. For projects permitted before IECC 2009 went into effect, code compliance was based on IECC 2006 with Rhode Island amendments.
- The identification of overall needs for increased energy code awareness and education.
- The identification of compliance categories and individual provisions that represent lower than average compliance rates associated with significant energy impacts.
- Identifying opportunities for Rhode Island efficiency programs to offer assistance and incentives in support of code compliance and advancing standard practice.

The process utilized to determine overall compliance rates meets or exceeds all of the requirements of the ARRA legislation and will assist Rhode Island officials in charting a course to reach the mandated goal of 90% energy code compliance by the year 2017.

The process the Study Team utilized is as follows:

1. Assess energy code compliance via interviews with market actors, a review of available construction documents, and site visits at a representative sample of 33recently constructed commercial buildings in Rhode Island.
2. Calculation of an average rate of compliance across each compliance category: envelope; HVAC; lighting; and procedural (design documents, operational testing, owner training, etc.). For some categories this consists of a compliance/non-compliance rating. For others, such as LPD achieved, the percentage of the differential to code is identified in addition to the pass/fail basis.
3. Calculation of the overall percentage of code provision compliance for the sample of facilities, utilizing the energy impact weighted "Tier" methodology established by the DOE for compliance with ARRA program guidelines.

ARRA Weighted "Tier" Methodology - The methodology recommended by the DOE for establishing code compliance rates utilizes a system that establishes a weighted value for each code provision. This methodology correctly recognizes that individual code provisions have different impacts. In order to assess the relative impacts with reasonable accuracy, the provisions are cataloged in three tiers: High, Medium, and Low Impact. A point system is utilized to compile the results with three points assigned to High, two to Medium, and one to Low Impact provisions. As such a High Impact provision contributes three times as much to the overall compliance percentage as does a Low Impact provision.

Enhanced Weighted "Tier" Methodology – As stated, the methodology utilized in this project complies with the ARRA guidelines but has been enhanced in several important ways:

- The DOE/PNNL methodology requires only yes/no determinations on code compliance. Because this project seeks to inform in regards to baseline practices, the actual level of efficiency is recorded in addition to compliance/non-compliance.
- The Study Team has identified a number of instances where the DOE/PNNL methodology does not correctly identify code provision impacts. These will be identified, although the overall compliance rate will reflect the DOE/PNNL methodology in order to be consistent with ARRA requirements and to allow comparisons with other states utilizing this methodology. Examples where we would recommend adjusted impact assessments include:

- Bi-level switching of lighting is assigned a higher impact value than is the ability to turn lights fully off manually or automatically. The relative impacts are likely the opposite.
- The DOE/PNNL methodology scores the impact of SHGC to be greater than the impact of fenestration air leakage. In our climate zone the impact of SHGC is quite minimal and is in fact negative on the south façade for many projects. On the other hand the impact of fenestration air leakage is likely greater.
- Lighting Power Density requirements are incorrectly assessed as "lighting installed per the approved lighting plan." The team understands from the interviews with code officials and design professionals that "approved lighting plans" are rarely checked for code compliance by code officials. As such we are calculating actual achieved LPDs and quantifying performance against code level Lighting Power Allowances (LPAs).
- For HVAC, the Study Team recorded what systems and controls have been installed, not simply attempting to assess, in the field, whether or not they are code compliant.

- Rhode Island has adopted several amendments to the base (IECC 2009) code. The Study Team assessed those amendments and included compliance information. There is no ARRA requirement that state specific amendments be met; only that the base IECC 2009 provisions be assessed. As such the amendments are not included in the overall compliance score.
- For projects permitted prior to the adoption of IECC 2009 we measured compliance in accordance with IECC 2006. This is consistent with ARRA requirements.

It is important to note the results of this calculated compliance rate does not represent the percentage of commercial buildings that fully comply with the energy code. Although informative there are notable limitations to a single statewide compliance estimate. For example, very few buildings fully comply with the energy code. In fact none of the buildings in our sample were fully compliant. Based on this research, it is clear that some code provisions are misunderstood by both market actors and code officials. Code officials are allowed some leeway in interpreting and applying code provisions, and ongoing code amendments and corrections impact construction projects to a varying degree. It is also clear that implementing an "international" energy code results in some provisions that are insignificant in some climate zones, and some provisions are not fully followed in Rhode Island for this reason.

In addition to providing the overall compliance rates, the Study Team established categories of compliance rates that will allow the sponsors to easily view the potential for improving standard practice, by measure as well as overall compliance. The impacts are weighted using the DOE/PNNL methodology. Additionally both above and below code performance were recorded by category, and with direction from the project sponsors, the data can be evaluated to further assess energy impacts and programmatic opportunities.

In addition, our analysis procedure facilitated making overall judgments regarding design and construction practices. The Study Team assessed the gaps between standard baseline practices, and code compliant/best practices. These determinations, along with other code related work sponsored by the Massachusetts and Rhode Island utilities, will allow program administrators and state authorities to target specific areas where education and implementation programs can best effect positive change in new construction practices.

4. Baseline and Code Compliance Trends

In this section, the Study Team presents the results of the analysis applied to the site collected "as-built" data for the estimation of overall code compliance rates and compliance rates by subcategories. The compliance results presented include:

1. An estimate of statewide overall energy code compliance rate for commercial buildings, utilizing the DOE/PNNL tiered energy impact procedures developed in support of ARRA funded energy efficiency programs.
2. An estimate of overall energy code compliance within each building size stratum identified for the project.
3. Disaggregated estimated compliance rates presented for informational purposes only, due to small sample sizes:
    - Estimates of compliance by energy code category: envelope; lighting; lighting controls; HVAC; and design documentation.
    - Estimates of compliance by commercial building type.
    - Estimates of compliance by geographic region. The regions include the Greater Providence region, and the remainder of the state.

4.1 Determining Code Compliance Rates

Determining new construction practices for completed buildings is not a trivial task. Many elements such as construction materials, equipment, and practices are no longer discoverable once the building is completed. Although design documents (plans and specifications) are often available for review, they may not represent the final "as-built" specifications, and it's not always certain that contractors follow all details as specified. For larger projects "as-built" plan sets are often produced, yet even those documents cannot be relied upon to fully represent actual construction practice.

The Study Team developed and executed a methodical approach in identifying construction practice, recording design document information and verifying design intent on site through a rigorous inspection process. Data that cannot be verified to a reasonable degree of certainty is not included in the final data analysis. Thus, absence of that data does not skew the results in any direction, as it does not contribute to either compliance or non-compliance, as each site is calculated for compliance only on verified data.

4.1.1 DOE/PNNL Compliance Methodology

The compliance rates presented were calculated utilizing the methodology developed by the DOE/PNNL ARRA Team for use in determining current compliance rates and for establishing a plan for participating states to reach 90% compliance with IECC 2009 by 2017. The methodology weights the impact of compliance with various provisions based on the predicted energy impacts of provision compliance/non-compliance. The weighting is applied in a tiered fashion utilizing three tiers. Tier 3 is weighted at three-times the energy impact of Tier 1, and twice the impact of Tier 2.

Although the methodology is valid, it is important to recognize some important factors in considering the results:

- The methodology assumes that several visits can be made to construction sites at key construction phases to verify provision compliance. Indeed this is the best practice code enforcement methodology. However, post-construction evaluation does not provide the same opportunities.
- It is assumed that code officials actually site verify the myriad of energy code provisions. The interviews with code officials that were conducted for this project make it clear that it is not possible for code officials to do so. Code officials have many other code responsibilities, and cannot allocate unlimited time to site and/or plan review. Our interviews with code officials suggest that many times they rely on the design professional statements of energy code compliance. This is not inappropriate, as code compliance, including energy provisions, is a responsibility of professional, registered architects and engineers, as well as licensed construction practitioners.
- It is also assumed that code officials would record non-compliance with individual provisions and that recorded information could be utilized to determine code compliance rates. As it is the code officials responsibility to enforce compliance it is counterintuitive that they would record non-compliance.
- The tiered system may or may not be accurate for any particular climate zone or building type. It generates an overall compliance value that is useful for ARRA program compliance. However, it is much more useful for program administrators to look at individual provisions and provision categories when assessing efficiency improvement opportunities.

- It tends to undervalue, or ignore, the importance of proper installation and proper commissioning. Both are code compliance issues, and both can have a much greater impact than the actual efficiency level of an installed piece of equipment.

In summary, the DOE/PNNL methodology is valid and useful for determining overall compliance rates. However, when looking to develop programmatic opportunities for advancing the efficiency levels of construction practices, it is important to disaggregate the information in order to identify specific areas to address.

4.2 Estimated Overall Energy Code Compliance

To facilitate comparison with other states using the same methodology, and to allow the results to be utilized for ARRA funding reporting, we calculated the statewide estimate using the proportion (P) weights and compliance score calculation developed by PNNL. These are provided as Equation 1 and Equation 2.

***Equation 1*: Calculation of P by size stratum**

$$P_i(size\ stratum) = (Total\ constructed\ building\ space\ for\ size\ stratum\ of\ building\ (ft^2))/(Total\ const$$

***Equation 2*: Calculation of average state compliance score, weighted by building size**

$$P_{small} \times \left(\frac{sum\ of\ building\ scores\ in\ small\ strata}{n_{small}}\right) + P_{medium} \times \left(\frac{sum\ of\ building\ scores\ in\ medium\ strata}{n_{medium}}\right) +$$
$$P_{large} \times \left(\frac{sum\ of\ building\ scores\ in\ large\ strata}{n_{large}}\right) + P_{Xlarge} \times \left(\frac{sum\ of\ building\ scores\ in\ X-large\ strata}{n_{Xlarge}}\right) +$$
$$P_{XXlarge} \times \left(\frac{sum\ of\ building\ scores\ in\ XX-large}{n_{XXlarge}}\right) = Average\ Compliance\ Score$$

where P_i = the small, medium, large, X-large, XX-large proportion weight

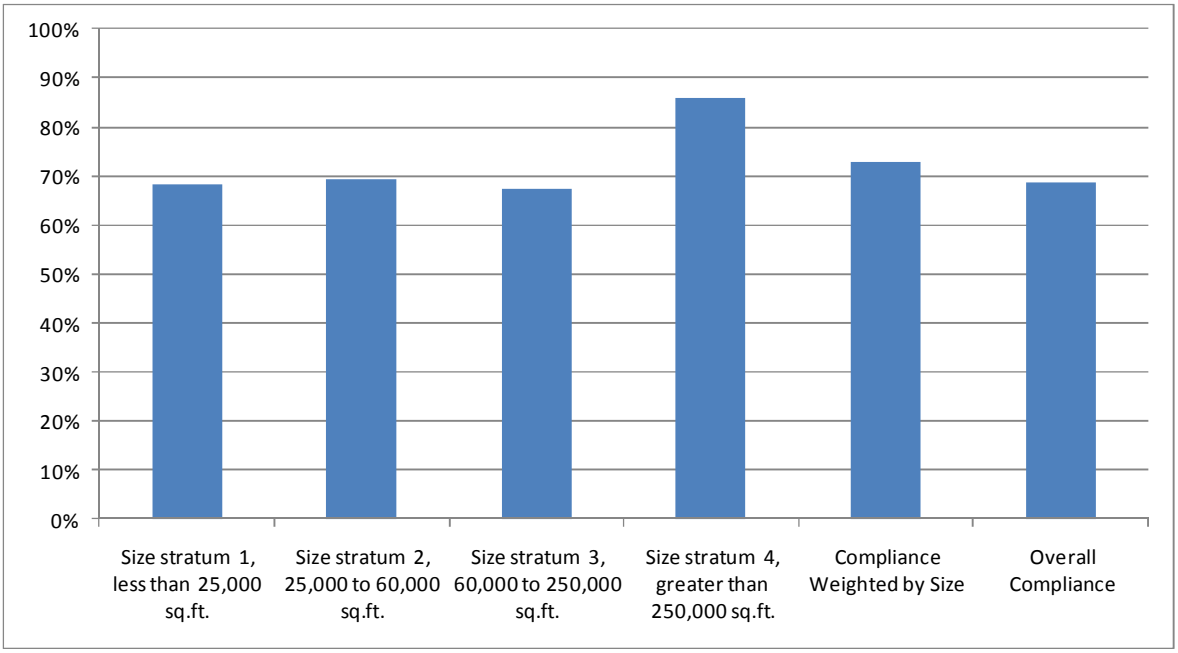
n_i = the number of samples evaluated within the respective size stratum

Figure 4-1 presents the unweighted and weighted overall state-wide compliance rates for Rhode Island commercial buildings. Overall state-wide compliance, weighted by building size is estimated to be 73% utilizing the DOE/PNNL tiered impact methodology. **The weighted calculation represents the preferred DOE/PNNL methodology for the code compliance requirements associated with Federal ARRA funding for state energy efficiency programs and projects.** Removing the size weighting reduces the compliance rate to just

below 70%. Given that only one building in the sample was within the largest stratum, it is appropriate to say that the estimated compliance rate is within the 70-73% range.

Our earlier study of Massachusetts buildings revealed a lower compliance rate for the smallest size stratum. This is not the case for Rhode Island, as the compliance rate was consistent across all building sizes, and any differences are viewed as insignificant given the sample size.

Figure 4-1: Statewide Rhode Island Compliance Rates

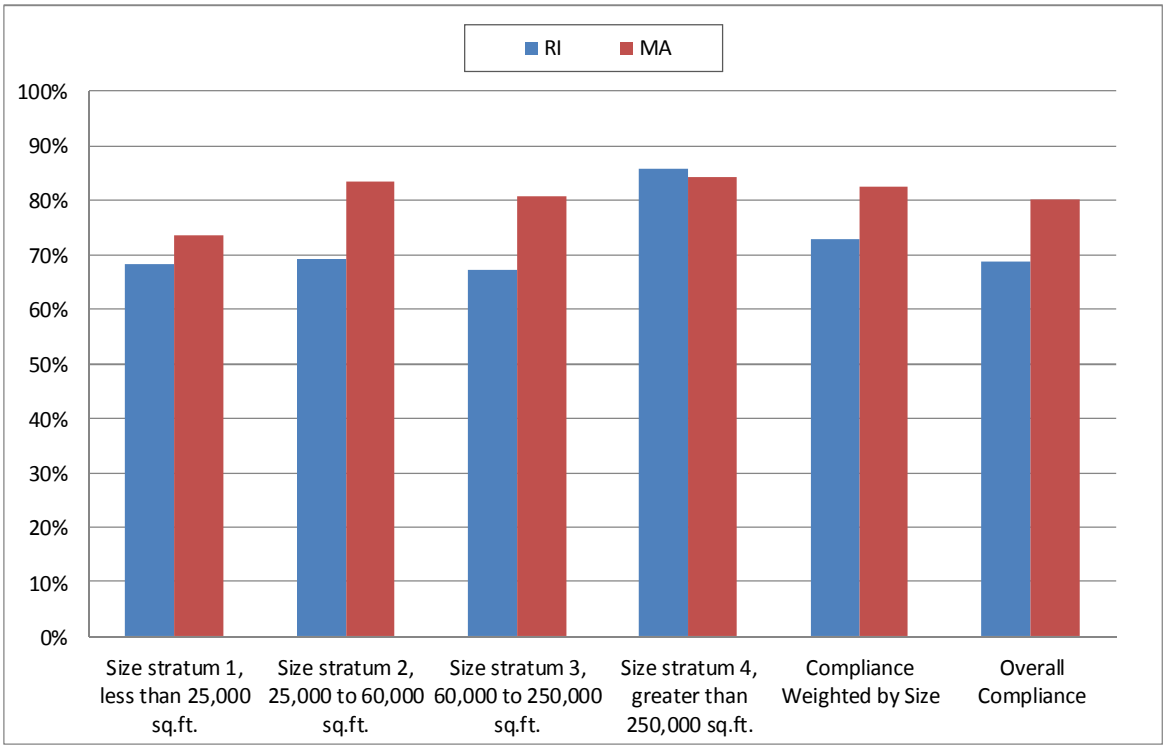


The lowest compliance rate calculated for individual projects was approximately 47%, with the highest being 88%. No evaluated projects achieved 100% code compliance.

4.2.1 Estimated Compliance Rates for Massachusetts and Rhode Island

Prior to completing this study of Rhode Island baseline and code compliance practices, the Study Team completed a similar study for recently constructed commercial buildings in Massachusetts. Figure 4-2 presents the comparative compliance rates for the four size strata as well as the overall estimated compliance rated weighted by building size.

Figure 4-2: Rhode Island and Massachusetts Statewide Compliance Rates



4.3 Estimated Compliance by Energy Code Category

We disaggregated the site data by code compliance category to help inform the sponsors regarding relative compliance improvement opportunities across the categories. Table 4-1 presents the estimated compliance by energy code categories: building envelope, mechanical systems (HVAC), lighting and lighting controls.

Table 4-1: Statewide Compliance Rates by Energy Code Category

Compliance Sector	Stratum			
	Size Stratum 1 <25,000 sq. ft.	Size Stratum 2 25,000 to 60,000 sq. ft.	Size Stratum 3 >60,000 to 250,000 sq. ft.	Size Stratum 4 >250,000 sq. ft.
Total Compliance	68%	69%	67%	86%
Documentation Compliance	65%	85%	51%	100%
Envelope Compliance	68%	65%	50%	41%
HVAC Compliance	7%	78%	76%	95%
Lighting Compliance	72%	75%	70%	67%
Lighting Controls Compliance	59%	72%	60%	75%
Count of Strata Table	17	6	9	1

We observe no dramatic variation except with the largest size stratum. However, that stratum is represented by only one facility. If that facility was included in stratum 3, the effect would be minimal. Lighting control provisions were observed to be at the lower end of compliance. This is significant as it is a category easily addressed by efficiency program administrators. It also raises questions about code enforcement, as the lighting control provisions are clearly defined in code documents and are easily checked on design documents as well as during field inspections.

4.4 Disaggregated Informational Estimated Compliance Rates

Once disaggregated, the sample is not large enough to supply significant statistical data. However, the estimates are presented to inform the study sponsors as to possible areas for educational and programmatic efforts to improve building performance and code compliance.

4.4.1 Estimated Compliance by Commercial Building Type

The Study Team disaggregated the data by building type in order to identify any discernible patterns. Table 4-2 presents the overall compliance rates by the identified building types in the sample. Although the results should be viewed with caution due to small sample sizes, it is

interesting to note the consistency in the compliance rates. Although the compliance rate for the warehouse and garage are lower than the norm, those building types were represented by only one building in the sample.

Table 4-2: Statewide Compliance Rates by Building Type

Building Type	Compliance	Site Count
Hotel	65%	2
Office Building	74%	2
Retail Store	69%	8
Warehouse	49%	1
Labs/Manufacturing/Industrial	64%	2
Garage	47%	1
Municipal	63%	5
Fitness/Sport	86%	1
Worship	72%	1
Education	76%	6
Hospital/Medical	77%	2
Multi-Family	88%	1
Residential Hall/Dormitory	65%	1

4.4.2 Estimated Compliance by Geographic Region

We also investigated whether there were differences in compliance rates based on the two regions identified in the Rhode Island Code; Greater Providence (Providence County) and the remainder of the state, and this data is presented in Table 4-3.

Table 4-3: Statewide Compliance Rates by Geographic Region

Geographic	Buildings Surveyed	Compliance Rates					
		Overall	Documentation	Envelope	HVAC	Lighting	Lighting Controls
Providence County	9	70%	65%	48%	82%	56%	59%
Outside Providence	24	68%	66%	67%	75%	78%	63%

The only significant differences observed in compliance rates is that compliance with envelope and lighting provisions is lower in the Greater Providence region. Both represent significant opportunities for program administrators as envelope and LPD compliance could readily be addressed through program code assistance efforts. However, it is interesting to note that only the “Performance Lighting” program path offered by National Grid addresses LPD as a savings metric, while the more often utilized prescriptive path simply supports efficient technologies. If

the Performance Lighting option was utilized more often, lighting code compliance would likely improve.

4.4.3 Estimated Compliance Rates for Selected Individual Code Provisions

The analysis process allows us to identify some code provisions and compliance rates that present particular opportunities for program administrators to explore for enhancing compliance and harvesting savings through educational and/or compliance support mechanisms. The opportunities and/or code provisions that were observed by the study team to offer program opportunities include:

- Lighting Power Density
- Lighting Controls
- Control of Daylit Zones
- Fan power limitations
- Insulation and sealing of HVAC ducts and pipes
- Insulation of service water heating pipes

4.5 Compliance by Code Version and Trends Over Time

Although the DOE/PNNL methodology applies only compliance related to IECC 2009, we adapted the procedure to allow for a similar calculation for projects constructed under IECC 2006. This was particularly important for the Rhode Island effort, as unlike the Massachusetts study, which included many current construction sites, the Rhode Island sample included only three buildings constructed under IECC 2009. For this reason the principal driver of the code compliance rates reported for Rhode Island is compliance with IECC 2006, and there is not enough data to report any trends in terms of compliance with the recently adopted IECC 2009.

4.6 Rhode Island Air Barrier Provision

Massachusetts and Rhode Island have both adopted an additional significant requirement for a “continuous air barrier.” This air barrier must connect all building envelope elements and must seal all envelope penetrations. The Rhode Island sample did not allow us to visit any construction sites where we were able to verify proper installation of air barriers. We did find that

they were typically specified on design documents, although it was often difficult to ascertain if proper material and techniques were specified when a single barrier was designed to perform both air barrier and vapor retarder functions. Without the ability to physically inspect installations, we do not feel that there is sufficient data to reach any conclusions as to compliance with the air barrier provisions.

4.7 General and Administrative Observations and Comments

Code Compliance – There are many general observations that support the conclusions and recommendations presented in this report. Some key observations include:

- Most code compliance efforts occur during the design phase, not during construction site visits as the DOE/PNNL methodology assumes. Designers represent that aspect of the new buildings and construction market that are most aware of the detailed code provisions and the associated technologies. In contrast, contractors and code officials have less knowledge and understanding of the technical code details. Design-side compliance is particularly true for larger facility projects which typically include detailed design documents with equipment specifications.
- In addition to the above point, code compliance for commercial buildings is performed primarily by the design team, rather than through code official enforcement. Code officials accept that design professionals build to code regulations. Many accept a signed Form 128 (“Project Certification”) as proof of energy code compliance.
- Although many code officials accept COMcheck as evidence of code compliance, the tool is often misunderstood since it does not represent proof of compliance, but is simply a calculation tool that accepts user inputs of code provision details. Data entry in COMcheck must be checked against the plans and specs in order to verify compliance.
- Overall code compliance is estimated to be approximately 70 - 73%.
    - This does not mean that 70% of buildings comply – as we found no buildings fully in compliance.
    - It refers to the average provision compliance weighted by energy impacts as proposed by DOE/PNNL.
    - It is more relevant to say that on average, commercial buildings perform approximately 30% worse (from an energy perspective) than the code requires.

  - Considering that efficiency programs often strive for 15-20% performance improvement compared to code, this represents a significant opportunity for improvement that can be, at least partially, addressed through programs.

- PAs should not focus a program effort solely on improving enforcement; rather, they should continue to focus on beyond code measures, using such efforts to also inform on better compliance on basic code requirements. Further, considering there is an average energy gap between observed levels of practice and fully code-compliant projects, we believe programs should seek the ability to utilize "standard practice" baselines and claim savings on projects for the delta from standard practice to code compliance plus the delta from code compliance to the installed project.
- Many design professionals, when made aware of new code provisions and/or technologies, tend to become increasingly interested in incorporating them in their projects. PAs should focus on these measures to gain traction and to achieve greater impacts.
- Code officials should be taught basic building science, HVAC principals, and the use of controls systems, rather than being taught to memorize code provisions. In the effort to just push towards memory of provisions, code officials tend to just focus on a few provisions that they have keyed into or grasped, neglecting consideration of many other requirements. A broader base of insights associated with a deeper understanding of energy use and concepts should enable a more energy-intensive set of focus areas.

Design Documentation – Amongst the collection of administrative requirements stated in the code, the code requires that project plans and specifications include enough detail to identify performance levels and to verify compliance with code provisions. In most cases the project documentation is adequate, but there are many cases where the documentation does not reflect the as-built condition or where information is missing. Some identified lack of plans data include:

- Window and door specifications are often missing model numbers and/or performance data. Nevertheless, as required, labeling on those installed products is generally left in place during the construction phase.
- Lighting fixture details are often missing or are incorrectly listed with nominal lamp wattage data, rather than the rated luminaire wattage, which is dictated by the lamp/ballast combination in fluorescent and HID luminaires.
- Incomplete data regarding HVAC model numbers, however field verification is typically obtainable and advisable as equipment substitution is common.

- Service water heating data is often missing from plans/specifications.

In addition to the code requirement for design documentation, a concurrent provision requires the labeling of many products. As stated, this information is typically clear and available for the main HVAC components, most insulation products, and fenestrations (temporary labels) enabling the code official to assess the efficiency levels of installed systems.

4.8 Building Envelope Observations and Comments

- Continuous Air Barriers – As previously discussed, this is not an IECC requirement, but is a code amendment in both Massachusetts and Rhode Island. Air barriers are very difficult to verify unless the construction project can be visited at the appropriate time. Although we attempted to visit construction sites, the Rhode Island sample did not offer the opportunity to field verify air barriers. However, we did review plans carefully and discussed the air barrier with building design teams and owners, gathering as much data as possible. We found that a continuous air barrier was typically specified, but that the design documents often lacked the detail to assure that the barrier would effectively connect all building components. It was also impossible for the field team to determine whether installation was in accordance with the design documents.
- Air Sealing – In nearly all cases, exposed penetrations of the envelope were observed to be or were seemingly properly sealed. As with air barriers, much air sealing is enclosed within envelope assemblies and difficult to field verify after construction is complete or past a certain point.
- Below Grade Insulation – For all projects reviewed, some below grade insulation was specified. However, because all of the projects in the sample were completed and back-filled, it was not possible to verify insulation levels.
- Above Grade Wall and Roof Insulation – For most projects, the above grade wall insulation levels were specified to meet code standards. Insulation levels were verified on design documents and field verified whenever possible. However, as with all envelope assemblies, field verification following construction completion is extremely difficult. Thickness of walls/roofs and interviews with building owners provide some insights, but not enough to draw definite conclusions. Fortunately, this is an area that is often checked by code officials according to our interviews. Code officials are generally most familiar with residential construction, and insulation materials and techniques are well within their areas of expertise.

4.9 Lighting System Observations and Comments

In contrast with envelope provisions, which are difficult to evaluate post-construction, we were able to assess lighting system compliance for all evaluated buildings. When full sets of design documents were available, our team of field evaluators calculated lighting power density levels from electrical/lighting plans, and then field verified that the lighting was installed as designed, noting any discrepancies. When there was a lack of available lighting plans, we measured spaces, recorded fixture types and counts, calculating and recording the result. The following observations relate to the site data collected regarding lighting measures:

- Lighting Power Density – In what represents a significant opportunity for efficiency programs, we often field calculated lighting power density levels higher than code allows for building areas or spaces type. The data sample is too small to form definitive conclusions by space type, but classrooms, in particular, were observed to have LPDs significantly higher than code allowances. This is surprising as Rhode Island has been active in high performance schools programs which encourage energy efficiency, and the efficiency programs in Rhode Island often engage school projects. However, it is worth noting that most efficiency program lighting models do not utilize LPD as a metric, and instead focus on lighting technologies. "Performance Lighting" is an LPD based model, but it is underutilized compared with prescriptive approaches.
- "Manual" Lighting Controls – In nearly all cases, the requirements for manual control for each controlled space are met. This may seem trivial, but prior to energy code adoption, it was common for commercial buildings to control lighting at circuit panels, resulting in lighting that was powered during all operating hours.
- Bi-Level and Automatic Controls – The requirement that many space types have bi-level manual and/or automatic controls installed is not complied with as often, and the code includes many exceptions for this provision. We found bi-level lighting controls to be installed in only 7% of the facilities. Occupancy sensors and/or timer controls were found in less than 50% of the facilities. The fact that we found occupancy sensors installed and functioning is a positive sign, as early versions of sensors experienced reliability and operational problems often leading to early retirement of the controls. Lighting controls, however clearly represent an opportunity for program assistance.
- Exterior Lighting Control – For exterior lighting, the provision that a timer or photocell control be installed was nearly always met.
- Daylighting Zone Controls – The separate control of daylit zones is a new provision introduced with IECC 2009. It requires that daylit zones within commercial buildings be

recognized and be controlled separately. We found in Massachusetts that the design community and code officials have not yet embraced the new requirements for separate control of daylit zones, as we found low compliance rates with this measure. This is likely the case in Rhode Island, but our sample included only three buildings that would have been required to comply with this provision. Daylight control represents a significant opportunity as, with the exception of retail space, modern commercial buildings are typically designed with 25-40% of their occupied areas receiving enough daylight to allow the electric lighting to be dimmed or turned off for a majority of the workday. School designers throughout the Northeast are recognizing this as they often control lighting close to classroom windows separate from the remaining lighting in the room.

4.10 HVAC System Observation and Comments

HVAC measures and requirements addressed through the energy code address a myriad of aspects of HVAC components, including specific primary equipment efficiencies (for unitary, boiler, furnace, chillers, and other equipment), size limitations for fans and pumps, speed control capabilities for fans and pumps, temperature and pressure control equipment, and distribution system insulation and sealing. Compliance was observed to be highly variable between these categories.

- System Rated Efficiency Levels – The majority (over 85%) of the equipment installed on site and specified in the drawings met or exceeded code requirements. The energy code adopted by Rhode Island is nearly identical to the code adopted throughout the Northeast. Manufacturers, their sales representatives, and distributors, do not normally stock or provide equipment that does not meet the minimum criteria to pass the code requirements. For this reason, HVAC equipment efficiency levels are complied with essentially by default.
- HVAC System Insulation Measures – Basic measures such as duct insulation and sealing and pipe insulation were observed to be in compliance less than equipment efficiency levels. Many of these requirements have been in place for multiple code versions, yet compliance is still relatively low.

5. Building Official Interview Findings

This section provides the findings of the in-depth interviews conducted with Rhode Island building code officials. Commercial compliance, with limited reference to residential compliance practices, is discussed herein, and findings on residential compliance are anticipated to be released at a later date.

The Study Team completed interviews with building officials during May and June of 2012. In total, 31 out of 39 jurisdictions participated in the interview process. The jurisdictions represent a range of city and town population sizes which the Study Team classified according to the following categories: Large (more than 40,000 residents); Medium (10,000 – 40,000 residents) and Small (less than 10,000 residents).

During the interview process, information was collected on the backgrounds and years of experience on the head building official and his or her inspectors. Table 5-1 presents a summary of the Rhode Island building code officials interviewed including interview census and completes, and characteristics of the officials' tenure and average staff size.

Based on our findings, building code officials interviewed have an average of 9.4 years experience. On the whole, those working in small jurisdictions have more experience (average = 12.4 years) compared to large (average = 3.1 years) and medium (average = 10.2 years) jurisdictions. In general, building code officials in large jurisdictions have noticeably more personnel (average staff = 15) than those in medium (average staff = 5.2) and small (average staff = 2.9) jurisdictions.

Table 5-1: Summary of Rhode Island Building Code Official Interviews

Size of Jurisdiction	Number of Interviews		Years of Experience		Average Size of Staff
	Census	Completed	Average	Range	
Large (>40,000 residents)	6	6	3.1 Years	From 1.5 to 6 years	15.0
Medium (10,000 to 40,000 residents)	23	17	10.2 Years	From 1 to 27 years	5.2
Small (<10,000 residents)	10	8	12.4 Years	From 1 to 34 years	2.9
Total	**39**	**31**	**9.4 years**	**From 1 to 34 years**	**6.6**

The Team's interview findings provide background on the commercial new construction market in Rhode Island including information on code compliance practices, perspectives on designers

and contractors who work on commercial construction, code training needs, and code enforcement challenges. The findings offer context for the energy code compliance ratings found in Section 4 of this report, and they give the Study Team an informed basis for its recommendations presented in Section 6. Building official interview responses are organized according to overarching themes, and these identified themes include the following:

1. **Energy Code General Compliance Practices.** This section summarizes the basic methods that building officials use to determine commercial code compliance, including documentation they require as well as the resources they use, and code officials' background and experience.
2. **Energy Code Enforcement Barriers.** This section focuses on the practice of enforcing the energy code and the challenges building officials face. Officials report a variety of barriers, primarily contractors' knowledge and education and insufficient information submitted to verify code compliance.
3. **Energy Code Knowledge and Training.** This section examines building officials' knowledge levels and current understanding of the commercial energy code, their assessment of market actors' knowledge and training as well as knowledge gaps and identified training needs. The rapid pace of change in regulations makes it difficult for builders to come up to speed on new codes, and as a result, building officials feel they must educate these builders. Additional training opportunities exist on the Green Buildings Act as more than half the building officials request more training.
4. **Energy Code Technical Challenges and Opportunities.** This section summarizes the ongoing technical challenges that building officials face when trying to enforce energy code compliance as well as opportunities. Building officials suggestions on how to improve commercial energy code compliance cluster around three major categories: education, code revisions, staff assistance.

5.1 Energy Code General Compliance Practices

This section presents the Study Team's key findings related to commercial energy code compliance practices.

Compared to residential building activity, relatively few commercial building permits have been issued in Rhode Island during the last several years, reflecting a low level of commercial activity and development. Although it is likely that residential construction permits often outnumber commercial permits, the low numbers of commercial construction

permits noted in this study are also reflective of the overall sluggish construction market that began with the 2008 recession. Fourteen out of the 31 jurisdictions participating in the interviews issued fewer than 20 commercial and fewer than 400 residential permits within the last year, including permits for renovations.

Of the jurisdictions interviewed, the range of commercial building permits issued within the last year is 0 to 4,000. Similarly, the range for residential building permits is 6 to 4,000. Five commercial respondents and six residential could not readily recall how many building permits had been issued by their offices with the last year.

Table 5-2 displays the numbers of commercial and residential construction permits issued within one year of the study, with each of the 31 jurisdictions interviewed assigned an ID number. The table is meant to show the significant variability in construction activity that we encountered in the study.

Table 5-2: Number of Commercial and Residential Building Permits Issued, Prior Year

KEMA ID for Towns and Cities Participating in Study	# of Commercial Building Permits Issued During Previous Year*	# of Residential Building Permits Issued During Previous Year*
594916	4,000	4,000
163848	1,320	1,980
182715	225	Don't know
158441	150	1,200
825384	100	180
437213	88	850
198571	26	32
488159	26	406
866734	25	250
679612	20	290
257178	20	80
213427	18	40
296453	12	400
174242	10	500
612925	10	1,500
585936	8	50
869648	6	494
673857	5	40
285883	5	15
194889	5	14
573214	4	50
717479	3	480
613262	2	115
719698	1	46
775189	0	103
392752	0	6
418696	Don’t know	Don't know
278689	Don’t know	Don't know
926914	Don't know	Don't know
267367	Don't know	Don't know
265618	Don't know	Don't know

* # of permits issued indicates total for new construction, retrofits and renovations

The most frequently mentioned documentation building officials require are COMcheck documentation and Form 128 Certification. Some building officials require only one or the other, and some require both. Table 5-3 displays the breakdown of compliance documentation typically requested by the 31 building officials interviewed for this study.

Table 5-3: Compliance Documentation Requested, by Officials Using Approach

Compliance Documentation Typically Requested for Commercial New Construction	Numbers of Officials Using Approach out of 31 Building Officials Interviewed
Prescriptive Approach	3
COMcheck Documentation	7
Form 128 Certification	7
Prescriptive Approach & COMcheck Documentation	1
COMcheck Documentation & Form 128 Certification	8
Prescriptive Approach & Form 128 Certification	2
No Standard Approach*	3

*Some building officials do not have standard documentation approaches for new commercial construction because commercial projects are rare in their jurisdictions.

Building officials report the time needed for plan review of commercial projects depends on two major factors: building size-complexity and thoroughness of plans and specifications. Reportedly, code officials spend on average 1 hour to 2.5 hours on plan review per project. Other issues affecting plan review time include: staff availability, the type of construction (e.g. steel vs. pre-fabrication), and extent of lighting power density calculations. One respondent says he looks at building envelope first because "if that's not built correctly, all the rest is pointless." As a second priority behind envelope, he reviews HVAC systems.

To verify commercial energy code during field inspections, respondents report devoting an average of 50 minutes (low range) to 2.75 hours (high range) for commercial projects. Similar to the plan review process, time allotted for field inspections for commercial energy code depends on the project/building size and/or complexity of systems. Again, staff availability is mentioned as a constraint on compliance efforts. Other factors mentioned include the stage of construction, a new building vs. an addition, and type of building (e.g. school, warehouse, etc.). Problems that increase the inspection time occur when building components do not comply with or match the plans. Improper installation of any materials and equipment (which require working with the installing contractor to correct) also slows down the field inspection process.

Building code officials use two primary resources to answer questions on energy code issues: the Rhode Island Building Commissioner's office and the state building code and codebooks including IECC companion guides. Most officials use at least two or more sources. In addition to using the Rhode Island Commercial Code itself, 15 officials say they call or email the Commissioner's office. Some officials use the Internet to research code issues,

including websites such as www.energycode.gov, or energy.gov, and others reach out to industry peers for information. .

Sixteen of 31 respondents report that there are provisions in the building code that take precedence over the energy code. The most frequently mentioned are structural integrity, health and safety, and egress. This line of questioning was meant to gauge the perceived importance of the energy code compared to other code provisions. Six mentioned that they don't pick and choose but enforce all codes equally while 17 interpreted the question to mean which code takes precedence when specific provisions overlap or contradict each other within a building itself.

During plan reviews for commercial buildings, some building officials focus primarily on envelope measures while others also check efficiencies of mechanical and lighting systems. Almost one third of respondents use plan reviews to check air barriers, R-values of insulation, U-values of fenestration, and sealing of envelope penetrations. Another third of respondents are also reviewing lighting and HVAC systems for energy code compliance. The rest of the respondents mentioned that either they see too few commercial projects to describe a typical plan review or their answers were general (i.e. they look for "minimum code compliance with the IECC"). Table 5-4 below captures interview comments regarding the types of information building officials look for during plan reviews for energy code compliance. Clearly, the answers provided depend on the construction types (new, renovation, retrofit), size, and complexity of typical construction projects within an officials' jurisdiction. Repeated comments have been grouped together for ease of reading.

Table 5-4: **Commercial Energy Code Compliance Items Uncovered During Plan Review**

Commercial Energy Code Compliance Items Covered During Plan Review
Responses focused solely on envelope compliance (9)
• R-values on exterior walls • Fenestration glazing and U-value • Windows and heat loss • Insulation and windows • Insulation levels • Air leakage • A COMcheck report showing that building meets prescriptive measures for insulation in the walls, floor, and ceiling • Code compliance for windows, garage doors, openings, envelope penetrations, air barriers and insulation

Commercial Energy Code Compliance Items Covered During Plan Review
• Looks for code compliance breakdown by architect (will specifically check requirements for fenestration) • General code compliance with specific windows, the envelope, R-values, U-values, air sealing, the specifications that spell out what is being installed • Insulation values, equipment utilized, glass areas (U values)
Responses focused on envelope and mechanical and/or lighting compliance (10)
• R-values, U-values, lighting and duct insulation • Looks at the building envelope first because "if that's not built correctly, all the rest is pointless." Secondly, HVAC. • Efficiencies, lighting power density, insulation for envelope. They look at everything. • Full compliance. Lighting is very important, energy controls, insulation and SEER ratings. • Primarily looks at insulation, windows, plumbing, mechanical and ductwork. He also looks at whether the plans are stamped. • Looks at air barriers and the R-values of insulation for building envelope compliance, and lighting power densities for electrical compliance. • Looks at the heating system, verifies ductwork, checks fenestration, the number of windows and the U-factor of windows, looks at the basement for how insulated it is and whether it's a conditioned space, checks the lights to ensure that they are the proper type and won't allow leakage (for recessed lighting), and looks to see that fireplaces have gasketed doors. • The respondent says that his guys are level-handed regarding the energy code. They look equally at all items required for energy code compliance. • Looks at the building envelope, since the winds are brutal in his area, interior lighting and insulation on ductwork and venting for HVAC. • The foundation, insulation of the slab, walls and ceiling, mechanical systems
Other Responses (6)
• Looking that Form 128 is signed and that plan cover sheets list codes complied with. • Mechanical system specs • "It all depends on the project. You have to balance it out, and know what, in particular, you can put on a plan. You also need a field inspection." • It could be just reviewing the COMcheck, or it could be looking at plans, equipment, damper location. • Don't know. He has to rely on the engineer and wouldn't know where to begin. • If it's a large project, he looks at mechanical. Roof top units, for instance, can't be changed on the fly. He looks at what is going to be installed. Also requires that calculations are stamped by engineers to certify their work.

Building officials are divided about the educational and professional backgrounds needed to comprehensively enforce the energy code. Among 27 code officials answering, about half said they think professional backgrounds in engineering, architecture, construction or contracting are most important while several mentioned on-the-job training and education. The three most frequently mentioned are: mechanical/electrical engineering, code education and understanding, and contractor/construction professional experience. Three code officials representing Rhode Island cities said ICC certification is 'required' or 'very important' to successfully enforce the commercial energy code.

More than half the building code officials (14 of 27) previously worked as contractors and say these prior positions provided their experience with the energy code. For these officials, the average tenure as a contractor was 30 years, and ranged from 22 to 40 years. In addition, eight officials report serving as building officials in another city or town prior to obtaining their current position.

5.2 Energy Code Implementation Barriers

This section presents key findings related to barriers to energy code implementation that were identified during the interview process.

Contractor knowledge and education is the most frequently cited barrier to building officials' ability to enforce the energy code. Twenty of 31 officials cite no limitations to their ability to enforce the energy code, but 11 acknowledge impediments to code enforcement with over half citing lack of contractor knowledge. An official who stated the following: "they have no licensing program and no requirements for continuing education" may have been referring primarily to residential, not commercial, contractors. Five code officials say that staff constraints are a barrier.

Few building officials receive plans, specifications, and calculations in enough detail to verify commercial energy code compliance. The majority of respondents have to request further clarifications and information from design teams or builders. An official relayed that he provides the design team or builder with a checklist of his information needs, which greatly facilitates his information gathering process.

There is no "typical" missing energy compliance information as it varies by project. However, building officials do report some common items missing from their projects' design documentation or field reports. These include:

- Specifications for heating and cooling systems, ductwork, and U-values on windows.
- Substitutions for the originally specified insulation and/or windows are not reported.
- Detailed wall sections are not provided including thickness of insulation.
- Equipment cut sheets with model numbers and energy ratings are not submitted.
- Details on lighting fixtures and/or COMcheck reports.
- The design professional's calculations or COMcheck reports.
- Lack of information provided and improper interpretation of the code when using COMcheck software.

Compliance problems encountered during plan review center around four commercial building systems: building envelope, specialized insulation/sealing, lighting and HVAC. Table 5-5 displays these results based on building officials' interview replies.

Table 5-5: Compliance Problems Encountered During Plan Review, by Building System

Commercial Building Systems	Compliance Problems Encountered During Plan Review or Inspection by Building Officials	Explanation of Compliance Problems
Building Envelope	Lack of Air Barrier	Air barrier not included in wall or roof assemblies
	Lack of Continuity of Air Barrier	Penetrations of the air barrier not sealed. Air barrier not continuous through joints and assemblies.
	Envelope Insulation Levels	Not enough insulation planned for building. Insulation R value too low.
	Installation of Insulation	Subcontractors cut or drill through insulation to run piping and electrical wiring. Lack of continuity of insulation. Sloppy installation.
	Envelope Sealing Around Fenestration	Contractors overlook sealing around windows.
	Envelope Sealing at Building Joints and Seams	Contractors overlook sealing joints and seams.
	Fenestration	Improper U values
Specialized Insulation/Sealing	Piping Insulation	Piping insulation not installed or R-value not high enough. Pipe fitters and plumbers have trouble with insulation around hangers.
	Duct Insulation	Insulation is not installed.
	Duct Sealing	Some contractors use duct tape to seal ducts instead of sealant or foil-faced adhesives. Sometimes ducts are insulated but not sealed.
Lighting	Installed Interior Lighting Power	Lighting power densities (LPDs) are beyond code maximums, or they are not calculated. Fixture substitutions that create a non-compliant installation.
	Lighting Controls	Missing lighting controls
Hi LHVAC	HVAC Equipment	Incorrect sizing of HVAC equipment. Equipment substitutions that don't meet code.
	HVAC System Controls	[No explanations were provided by respondents why HVAC system controls do not meet the commercial energy code.]

5.3 Commercial Energy Code Knowledge and Training

This section presents key findings related to commercial energy code knowledge and training.

Building officials say they must educate many residential and some commercial contractors and subcontractors on new code energy provisions. The rapid pace in change of regulations makes it hard for builders to get up to speed on new codes. (Even though this study does not address residential construction, some of the smaller contractors and builders referenced by building officials also work on small commercial establishments. Building officials must teach the smaller players the energy code on those projects as well.)

All building officials interviewed indicate that they and/or their staff members have attended trainings on the Rhode Island's commercial energy code. Some indicated that they had attended multiple trainings on the commercial energy code. Twenty-seven out of 31 respondents feel that training has been sufficient on commercial energy codes. Additionally, 20 out of the 31 respondents report that trainings have changed how they enforce the commercial energy code or raised their awareness of what to look for during their plan reviews and field inspections.

Two building officials expressed strongly divergent views on amount and sufficiency of commercial energy code training. An official stated, "Training on energy codes is few and far between. The codes seem to change often and are complex. Training should be offered more often to staff." Another stated that, "The state has provided plenty of training on the energy code - all of which has been extremely informative. Plus, there are seminars offered that cover certain topics like new types of insulation or building materials."

Interview results indicate that building officials are generally satisfied with the amount and frequency of training and that they apply their training to improve their commercial energy code enforcement practices. However, they express a desire for follow-up sessions to review new products and building materials. Because new building products and materials enter the market on a regular basis, not all of these can be covered during training sessions. Lack of knowledge about these products can make it difficult to determine envelope compliance using REScheck/COMcheck software.

Most building officials interviewed are familiar with the Green Buildings Act (GBA), but more than half say they need more training on it. Twenty of 31 building officials are "a little" or "somewhat" familiar with the GBA (13 and 7 respondents, respectively) but more than half say they need more training

- **According to respondents, at least two training sessions have been offered on the Green Buildings Act.** Eight building officials indicate that there are GBA projects within

their jurisdictions. All but one of these projects followed LEED certification (the remaining one followed NE-CHPS).

- **The presence of GBA projects within a jurisdiction does not appear to correlate with a sense of familiarity with the Act.** Among eight jurisdictions with GBA projects, five respondents state that they have "a little familiarity," and two report they are "very familiar" with the GBA. By contrast, some officials report feeling sufficiently trained on the Green Buildings Act even with no GBA projects starting or ongoing in their jurisdictions.

When asked about their preferences for receiving training in the classroom, demonstrations in the field, or via webinar/online training, the strongest preference is for classroom teaching. More than half of respondents also prefer in-the-field demonstrations. Building officials are least open to online training as only 3 respondents expressed interest in online training. As an official stated about the benefits of classroom learning, "the classroom allows for interacting with other building officials from around the state, and hearing their questions and answers regarding the energy code." The Study Team spoke to a building official who says that what is taught in the classroom is "only good for the trip home. Classes taught in the field would lead to better retention. Ideally, I would like to see a code expert sent out to walk around and oversee things with each building official."

Additional trainings need to be balanced with what is considered a necessity by building officials. One building official noted that while more training is good, it is only meaningful if the content is relevant to building officials needs.

If available and offered, nearly all respondents would attend training on the 2012 IECC. The most typical comment was that training is mandatory while one respondent would attend "only when and if the state adopts the new code" and another says, "I would attend any training offered on any building codes."

Among the commercial design and building community, knowledge of the Rhode Island commercial energy code continues to evolve. In their own words, building officials say that "generally speaking" design teams and contractors know the commercial energy code, and that, "architects and engineers are more familiar with the code than contractors." One official complained that with every plan review "there's always something missing" and several officials repeated the fact that they still have to teach building professionals the minimum code requirements.

When asked how to improve the energy efficiency programs in Rhode Island, the primary suggestion is to improve outreach and advertising. Most respondents interviewed (26 of 31) are familiar with National Grid's energy efficiency programs while three are "somewhat" or "a little familiar."

5.4 Energy Code Technical Challenges and Opportunities

This section presents key findings related to energy code technical challenges and opportunities, including respondents' views on improving energy code.

Areas that pose challenges to building officials, in terms of determining compliance, are listed in Table 5-6**.** Responses are categorized by building envelope, HVAC and lighting, and overall compliance challenges. Primarily direct quotes or slightly modified quotes have been captured to most accurately convey the nuanced answers received on this topic.

Table 5-6: Energy Code Provisions Building Officials Find Difficult to Assess

Energy Code Provisions That Building Officials Find Difficult to Assess
Building Envelope
• Insulation values of exterior walls, especially when attributing an R-value to concrete mass-wall construction. "Some project teams will build out their walls to reach the required R-value if they're off the value by less than 1 which can make it difficult to figure out compliance with the COMcheck methodology." • Air sealing the envelope and ensuring compliance. • "It's difficult to figure out compliance in existing buildings when there is a rehab. For example, the code doesn't give an R-value for insulation, it just says to fill the cavities. What should they be filled with and to what R-value?"*

Energy Code Provisions That Building Officials Find Difficult to Assess

HVAC & Lighting

- One building official relies heavily on engineers for electrical and HVAC compliance.
- High efficiency lighting – it would be easier if the code simply specified what kinds of light fixtures can get put in, rather than require LPD calculations.
- Lighting power density. He has to rely on an engineer (doesn't know where to begin).
- It can be difficult and complex to determine whether HVAC systems meet energy code specifications and whether all the lighting meets code. One building code official typically relies on an engineer's report, along with a prescriptive checklist, to determine compliance.
- Determining compliance for heating and electrical systems requires an engineer to provide a report. The complexity of the systems means that the building official must rely on engineers and his mechanical inspectors to determine compliance.
- Determining whether mechanical systems meet the energy code. This is caused by lack of background knowledge on the complexity of the mechanical systems. It is easier for someone with more training/background in mechanical systems to determine compliance. The interviewee usually relies on separate in-house mechanical inspector to determine compliance.
- Lighting and heating systems, both due to what is involved in the calculations. For lighting, the difficulty is in knowing what was installed for bulbs/lights.
- For heating, the difficulties are in gathering information about the installation, the areas served by the system and whether the system serves multiple units.

Overall Compliance Challenges

- There is difficulty when a project uses a performance based approach or when there is energy modeling. It's hard to determine compliance because something may not meet the prescriptive code, but when it's blended with the performance of other items, the building may still meet code.

- Heat loss calculations. This is an area they don't normally deal with on a regular basis. They are not engineers.

- Trade-off based compliance. The building official prefers performance based compliance. "If the system is used properly, that's fine. Twice, however, the same outfit used COMcheck and there were inaccuracies on insulation for slab thickness."

- Requirements for steel buildings and calculating solar heat coefficients. For steel buildings, there is thermal transmission at studs and columns. This requires a thermal break. He doesn't understand what to look for. For solar heat, the calculations and documentation are hard to understand.

*Although this report focuses on commercial new construction, the study team included this comment to provide helpful information to study sponsors.

Building officials' suggestions on how to improve commercial energy code compliance cluster around three major categories: education, code revisions, and staff assistance. A fourth category, "other" captures any other comments. Again, quotes are provided to convey nuances in their responses. Table 5-7 displays the quotes gathered by the Study Team.

Table 5-7: Building Officials' Suggestions How to Improve Energy Code Compliance

Building Official Suggestions' to Improve Energy Code Compliance
Education
• More education regarding the specific uses and characteristics of new energy efficient materials should be provided to builders, with warnings if use of the products might have unintended effects.
• "The more education, the better, particularly with three year cycles. "Architects, contractors and code officials barely get used to the last code before a new one comes out…nobody can memorize the codebook."
• Better job educating contractors and design professionals.
• More education/training for builders. "There should be a state award for 'green builders' who consistently use and demonstrate awareness of the updated energy codes."
• Offer classes to contractors and designers as well as building officials, as "they are always looking for training and additional code classes."
• Education "is the biggest thing that could be done for the code community." Outside of the code community, commercial and residential architects are most in need of education. "They are the primary designers of the buildings and need to be educated so they can review what their consulting staff is doing." Engineers also need additional education regarding the energy code, with a focus on mechanical and electrical engineers.
• Provide more education to builders.
• Informing the public, especially contractors. "This turns building inspectors into teachers. There's not enough information available, and the builders/owners won't buy or read the code book because it takes too much time."
• Provide education to HVAC and plumbing contractors. "They need to get into their heads what they should be doing (e.g., not using lead soldering on potable water piping)."
• Sufficient training for new adoptions/amendments to the energy code.
Code Revisions
• Commercial code should be at least as stringent as the residential code.
• Change code methodology from prescriptive to performance based. "Just increasing the requirement of one thing isn't going to make sure that it is quality related. Time and time again, the insulation is shabby. It has voids and holes, and I say to myself, 'why does this happen over and over again.' I am sick of being the training officer for these big insulation companies. They should all be licensed so they can put in insulation properly. The whole industry suffers because the guys doing insulation don't do a very good job. That is why

Building Official Suggestions' to Improve Energy Code Compliance
we need an objective method." • Possibly, more prescriptive measures could be added for commercial compliance (although respondent understands this is all a work in progress). • Stop changing the code so often. The respondent wondered whether they're reaching the point of diminishing returns. ("At what point have we done too much?").
Staff Assistance
• National Grid sends a representative onsite to handle some of the energy code compliance inspections which would "take some of the burden off us and make it easier to enforce the code." • Having a couple of dedicated energy inspectors working throughout the whole state to lighten the building officials' burden and let them focus on the rest of the building code. • More time for in-depth review of plans and field inspections (greater budget).
Other
• Show that the codes are making a difference if you want people to comply because every time energy efficiency increases, so do costs. "The more we seem to improve insulation, heating systems and windows, the more it seems to cost in other areas, like indoor air quality. The respondent sees mold problems all the time from heavily insulated basements." • Equipment that doesn't meet energy code requirements should not be for sale. • National Grid should be more assertive in their promotion of energy conservation. Water recycling should be required, as should be making use of consumer waste in some way.

6. Conclusions and Recommendations

This section integrates the findings from the document review and site visits at 33 newly constructed commercial buildings in Rhode Island and interviews with 31 building officials. The Study Team's conclusions and recommendations recognize the cooperative nature of code compliance. They are not narrowly focused on improving enforcement, but are focused on improving the understanding of code provisions and providing additional code assistance across both the market actor and building official communities.

6.1 Conclusions

Analysis of the thirty-three commercial new construction sites in Rhode Island, the geography and demographics of the state, and the thirty-one interviews with building officials, lead us to draw the following conclusions about commercial energy code compliance rates and practices in the state.

Rhode Island's demographics coupled with its relatively small general population pose interesting challenges in terms of delivering the appropriate amount of education and tools to the building officials and inspectors. The smaller towns, such as New Shoreham, Little Compton, and Foster range in population from just over one thousand in New Shoreham to slightly over 4,600 in Foster, according to the 2010 U.S. census. These areas are heavily residential and/or cater to tourist and part-time residents.

By contrast, Rhode Island is also home to commercial and industrial towns that experience much more commercial activity, such as East Providence or Woonsocket, but still maintain a relatively small population (under 50,000), and there are a handful of larger cities that have seen ongoing commercial new construction and renovations despite a recessionary economy. The range of commercial building permits issued within the last 12 months underscores this variation – from 0 in one small town to over 4,000 in city of Providence.

The diversity of demographics means that building officials are overseeing potentially widely disparate commercial projects ranging from something as technically complex as a new university laboratory to the remodeling of a stand-alone convenience store. Consequently, exposure to the commercial energy code and its compliance mechanisms varies widely across this small state.

Conclusions first address findings on building and measure compliance and then address observations on commercial energy code compliance in Rhode Island.

1. **Overall code compliance for new construction in Rhode Island is estimated at approximately 70% (unweighted) compliance.** However, it is important to consider several factors:

    a. This result does not mean that 70% of commercial buildings comply as we found no buildings fully in compliance.

    b. The overall number refers to the average provision compliance weighted by energy impacts as proposed by DOE/PNNL.

    c. It is more relevant to say that on average commercial buildings perform approximately 30% worse than the code requires, and, by extension, use 30% more energy than fully compliant buildings.

    d. Considering that efficiency programs strive for 15-20% performance improvement compared to code, this 30% gap is significant.

    e. A follow-up study that includes performance monitoring and the calculation of building energy use intensity (EUI) would better refine the performance gap and savings opportunity.

2. **Lighting and lighting controls offer major opportunities for efficiency.** Despite the ease of calculating LPD values, the calculation is often not completed, or incorrect values are utilized. COMcheck is the most popular methodology for calculating LPD and checking against code lighting power average (LPA). However, COMcheck relies on user inputs. Incorrect fixture wattage is often entered into the tool, and building or space area is often improperly entered. Including auxiliary spaces, such as basements and mezzanines, in calculations often leads to artificially low reported LPDs. The lighting control provisions have become more complicated and assistance is needed. In addition, many electrical contractors ignore lighting control specifications as they fear call-backs to adjust controls that were never properly commissioned.

3. **Mechanical system efficiency levels are at full compliance.** Because manufacturers and distributors only stock code compliant equipment, compliance with efficiency levels occurs by default. At this point, code compliant HVAC equipment is generally the lowest efficiency level available in the local marketplace. However, installation practices are not fully code compliant (For example, proper duct sealing is not always carried out even when high efficiency HVAC units are installed). Design teams and construction managers need assistance to understand these practices. Design professionals are

charged with the responsibility of monitoring the construction process, but there is a large degree of variability in this area, providing an opportunity to close the gap between as-designed and as-built compliance and performance.

4. **Code compliance is a shared responsibility.** Our interviews with code officials reveal that design and construction professionals share the responsibility of code compliance with building officials. In fact, the regulations surrounding code implementation state that design professionals and licensed construction trades people share code compliance responsibility with code officials. It has never been assumed by the developers of codes that officials (building inspectors) would carry full responsibility for energy code compliance. Rather, it is intended that design professionals will understand and design to code and that they will oversee the construction of their code compliant designs, ensuring that the design intent is adhered to. Especially for the commercial sector, code officials' primary duties associated with the energy code are to work with the design/construction communities assisting them in understanding and complying with code provisions.

5. **While building officials and their staffs generally report satisfaction with the training process, their proficiency with the commercial energy code may be impeded by lack of direct experience with projects permitted under the current code, SBC-8-2010.** Given the recent slowdown of the construction industry due recession and the residential demography of many Rhode Island towns, the study team posits that lack of experience with commercial new construction and commercial construction in general, poses a barrier to mastering the commercial energy code.

6. **Interviews reveal that for many Rhode Island communities, residential renovations and residential new construction dominate the workload and experience of local code officials.** Although some Rhode Island towns are predominantly residential in nature, the impact of the economic recession beginning in 2008 no doubt contributes to the reduction of commercial construction in many areas. Consequently, some building officials and their inspectors have had limited exposure to new construction and compliance processes under the SBC-8-2010 commercial energy code.

7. **Because Rhode Island has a small population but a significant diversity of villages, towns, and cities, building officials need code education and compliance tools that match their level of exposure to new commercial construction.** Given that some jurisdictions may see no new commercial construction for years at a time and that others see hundreds and thousands of commercial projects per year (including

renovations and retrofits), building official training must take into account the wide experience gap among building officials. Some will need training that mirrors residential compliance processes while others will need more sophisticated tools and methods for determining commercial compliance.

8. **Small commercial builders and contractors would benefit from targeted training on the commercial energy code, taking the educational burden off of building officials and inspectors.** In jurisdictions where they oversee many more residential than commercial projects, building officials report that a great deal of their time is spent educating contractors on the provisions of the energy code. While we feel this is primarily the case for residential contractors, we believe that the same contractors also take on small commercial jobs and likely fail to meet the commercial energy code just as they fail to meet the residential energy code.

9. **Some building officials find it hard to keep up with the rapid introduction of new building materials on the market. There is an expressed need for regular education on the performance of new building materials**. As minimum energy codes increase in stringency, the proper assembly of the building envelope, for both commercial and residential construction, becomes increasingly important. New building materials including insulating foams, vapor barriers, air barriers, structural insulated panels, etc. are regularly introduced to the marketplace and their performance alters the envelope's air infiltration rate, dew point, ability to shed moisture, and thermal resistance. Understanding the performance and durability of new building products is an important part of determining envelope compliance.

10. **Training on the commercial energy code and compliance tools such as COMcheck, positively affects enforcement practices.** Building officials report that, due to training, they are more effective at plan reviews, inspections, and utilizing COMcheck as a documentation tool. One building official from a small city also noted that mandatory energy code training "has made energy code enforcement more of a priority than in previous years". That is, the training demonstrates state's commitment to commercial energy code enforcement and officials are paying closer attention to energy code compliance as a result.

11. **Familiarity with the Green Building Act of 2010 is inconsistent across jurisdictions despite several trainings offered by the state.** The study team expected to see greater familiarity with the Green Building Act (GBA) requirements in jurisdictions where public buildings are currently under construction (i.e. those having to comply with the

GBA). However, there appears to be no correlation between presence of a GBA project and familiarity with the Green Buildings Act on the part of building officials. Because the GBA is so new and new construction of public buildings is somewhat uncommon, it is anticipated that building officials will become more familiar with the Act once more projects are designed and built in or near their jurisdictions.

12. **Commercial architects, engineers, and to a degree contractors are better informed on the commercial energy code than their residential counterparts are on the residential energy code.** Commercial design teams also provide better energy code compliance documentation, although building officials communicate that there is still room for improvement in commercial compliance documentation practices.

13. **To verify commercial energy code compliance for HVAC and lighting systems, building officials rely heavily on engineers from the design team to report on whether or not compliance has been achieved.** Engineers are often asked for reports, calculations, and project certifications (i.e. stamped affidavits) to document compliance with lighting power densities, lighting controls, HVAC equipment efficiencies, and HVAC controls that meet code.

14. **Several building officials experience challenges in interpreting trade-off and performance approaches in energy code compliance documentation.** Because the two methods are not prescriptive, equipment efficiencies or insulation R-values may be installed even though they are below code. Energy modeling and trade-off approaches look at the efficiency of the whole building or discrete building systems, respectively. Further training or technical assistance for interpreting these approaches may be warranted.

15. **Code officials require additional staff resources in order to properly address the energy code and/or they need assistance from other sources in order to share the burden of energy code compliance.** This conclusion is drawn from building official comments that low staffing levels can impede their ability to enforce the commercial energy code.

6.2 Recommendations

Based on the extensive research of new construction sites and building officials operating in the Rhode Island marketplace, the Study Team offers the following list of recommendations for consideration.

1. **Implement a comprehensive plan to provide energy code compliance assistance.** A comprehensive plan for providing third-party energy code assistance would ease the burden on code officials and would help to integrate code compliance and programmatic efficiency efforts. Because there are unrealized savings to be harvested, the assistance effort could potentially be funded through existing efficiency program administrators who would coordinate their efforts with the State. Such a plan should focus on assigning energy efficiency practitioners to assist design teams and code officials in interpreting code provisions and identifying equipment and techniques utilized to meet those provisions. Methods to accomplish this may include:

    a. **Funding additional staff or energy experts to work with local officials and the State's Office of the Building Commissioner to augment building official knowledge and resources.** It is recommended that staff with strong engineering and energy modeling background complement the Office of the Building Commissioner staff or energy efficiency program administrator staff to answer questions on energy code and compliance processes.

    b. **Funding and staffing a team of third party experts to verify the compliance for complex HVAC systems, HVAC controls, and lighting power densities and controls.** The team would supplement building official plan and specification review and provide independent engineering assessments for energy code compliance. Third party experts would also be able to review and assess energy models and question modeling assumptions and techniques. Their assessments would provide much needed feedback for design engineers who are rarely, if ever, challenged on their modeling approaches.

    c. **Provide focused assistance for new provisions.** Newly adopted code provisions are often misunderstood or ignored. With each code introduction, program administrators should assess the new provisions and develop an approach for technical assistance that combines code compliance with the promotion of above code measures. Again, savings should be harvested referencing actual standard practice**.**

2. **Continue "beyond code" new construction efforts.** Program administrators, rather than developing code compliance strategies, should continue to focus on beyond code efforts such as those represented by the Rhode Island "Green Code." In addition, as they engage on code compliance issues, it is recommended that they always promote a beyond code measure(s) as the preferred alternative. As they expand these efforts, code

compliance improvement becomes a supplemental benefit, rather than the sole focus, and the total savings associated with the project will be the total of the delta from standard practice to code compliance in addition to the delta from code compliance to the actual installed premium measures.

3. **For future energy code studies, we recommend interviewing a cross-section of market actors including building owners, architects, engineers, and contractors. The benefit of reporting a variety of perspectives is the development of a deeper understanding the entire new construction supply chain.** It further eliminates the bias of one group, in this case the building officials, in terms of self-reporting their performance.

4. **Continue commercial energy code trainings as they are reportedly well-received by building officials and their staff. When developing curriculum and hiring trainers, give special consideration to the size and complexity of buildings that building officials are likely to oversee in their jurisdictions.** If possible, offer separate trainings tailored to small commercial projects versus complicated commercial / institutional / industrial building types that are controlled by building management systems. This provides officials the opportunity to train on the building sizes they are most likely to encounter in their jurisdictions.

5. **Offer building officials curriculum that is not simply a recital of energy code provisions. In addition to teaching the content of the commercial energy code, provide the context of the code provisions.** That is, offer curriculum that gives background, theories, and calculations that allow building officials and inspectors to learn context and methodologies in addition to the code rules. It is also suggested that the state adopt alternative training approaches such as code compliance charrettes that walk the participants through sets of rough plans and help them make code compliance decisions as they go.

6. **Develop energy code training opportunities across market actor segments but particularly focus on small construction firms.** During the course of the interviews, respondents expressed frustrations with some architects, engineers, and contractors but expressed most concern about small commercial and residential contractors and builders due to their lack of knowledge of energy code and necessary compliance documentation. To implement this recommendation, we recommend further consultation with building officials who can advise on the size and types of firms (e.g., insulation installers, builders etc.) to be targeted for code trainings.

a. **Introduce commercial energy code circuit riders to visit building officials, contractors, builders, architects and engineers and focus on actual commercial building projects.** The circuit riders would visit individual jurisdictions to review current projects and answer questions for code officials and inspectors. Additional meetings would be held with small contractors, builders etc. to review their current projects and answer code questions. This approach has previously been adopted in other states for design professionals and received a positive response.

7. **Facilitate trainings or seminars on new building materials to help keep building officials knowledgeable about the pros and cons of new products.** It is admittedly difficult for the state to organize seminars on new products due to its need to remain neutral on products and services, but the state can do the following:

    a. Signal to local industry trade groups that code officials would like to be trained on new building products;

    b. Hire a building scientist to periodically offer training on envelope assemblies and building materials;

    c. Based on research in Rhode Island and other states, the Study Team has developed a comprehensive training list for market actors; and

    d. Table 6-1 displays this information. Training topics are prioritized according to perceived needs where '1' is the highest priority, '2' is medium and '3' is lowest priority. Not applicable, or 'N/A' is used where certain training would be inappropriate.

Table 6-1: Key Training Topics for Market Actors*

Key Training Topics	Design Community	Contractors & Sub-contractors	Building Officials
2012 IECC and ASHRAE 90.1-2010 for commercial buildings	1	1	1
Identify and explain the changes between 2009 IECC and 2012 IECC and why changes occurred.	1	1	1
Utilization of COMcheck software for lighting, HVAC, and envelope compliance. Include supplemental data and inspections needed to verify COMcheck reports.	1	3	1
Training on improved energy code inspection processes for lighting and lighting controls	2	3	1
Daylighting – identifying areas where separate switching is required. Importance of daylight system calibration and commissioning.	1	1	1
New building materials and products - their properties and performance. Note: this type of training could be organized by 3rd parties rather than the state.	3	3	1
Building science: the movement of air and moisture through building assemblies with focus on detailing and envelope materials such as insulation, air barriers, vapor retarders	1	1	1
Basic HVAC systems including control strategies and ASHRAE guidelines for system sizing	1	2	1
Air sealing for multi-family applications	1	1	2
How to achieve continuous insulation in attics, roofs, walls, and slabs for multi-family construction and similar building types	1	1	2
Connecting and sealing air barriers across joints and seams for multiple commercial building types	1	1	1
Basic training on energy modeling software (such as eQuest and Energy Plus)	1	N/A	N/A
Advanced training on difficult- to-model building systems (such as eQuest and Energy Plus)	1	N/A	N/A

***Key to Training Priority: Highest = 1, Medium = 2, Lowest = 3. N/A = Not Applicable.**

A. iPad Site Data Collection Instrument

Final Site Data Collection Instrument

Rhode Island Commercial Building Data Collection

2012 Commercial Baseline Study

Note: Each iPad to be uploaded with:

- An electronic version of this survey instrument
- A copy of IECC 2009
- A copy of a system/equipment identification guide

Building ID:___ Climate Zone: _____

Date:_____ Name of Evaluator(s): _____

Building Contact: Name:_____ Phone:_____ Email:_____

Building Name & Address:_____

Conditioned Floor Area:_____ ft^2

State:_____ County:_____

Building Use: ☐ Office Building ☐ Retail Store ☐ Warehouse ☐ K-12 School ☐ Hotel

☐ Restaurant ☐ Grocery Store ☐ Banking/Financial Institute ☐ Residential Hall/Dormitory

☐ Other _____

Building Ownership: ☐ State-owned ☐ Local government-owned ☐ National account/Franchise

☐ Speculative ☐ Private ☐ Other _____

Instructional Note: Do not assume that items specified in the plans are necessarily installed in the building as specified. In general, "as built" drawings are more reliable than design drawings, but measures should be field verified as much as possible, and not based solely on the available documents.

Instructional Note: N/A may be used to describe "not available" "not accessible" or "not applicable." When selecting N/A; always enter a comment as to why you were unable to obtain the data. Where possible use the dropdown menu for N/A comments.

2009 IECC Section #	Plan Review	Y	N	N/A	Comments/Assumptions
103.2	Plans available: Envelope HVAC Electrical Service Water Heating				
103.2	Plans, & specifications contain enough detail for determining Energy Performance: Envelope HVAC Electrical Service Water Heating				
	Documents available for this study: Design Plans "As Built" Plans Specifications Sequence of Operations (typically included in the Specifications documents)				

Acceptance Documentation

Instructional Note: The following is to be determined in a discussion with the building owner or facility manager. Please add comments.

2009 IECC Section #	Plan Review	Y	N	N/A	Comments/Assumptions
103.7	Did the building owner receive documentation that all HVAC, lighting control and power distribution systems were tested and that the designated building code official witnessed such tests?				
103.7	Did the building owner receive operations and maintenance manuals for the above systems?				

Additional Comments/Assumptions Regarding Plans Review: *Each section of the survey is followed by an additional comments opportunity – there will be a text box on the iPad for them.*

Envelope

Instructional Note: Utilize a combination of plans review and field inspection to determine installed conditions. For example, if the plans show a 5 ½"cavity wall with 2" of rigid foam, ½" sheetrock and a 1" façade; but the actual wall thickness totals less than 9"; the wall was not built to spec. When in doubt, add comments. Do not guess!

2009 IECC Section #	Air Barrier	Detailed on Plans			Installed?			Comments/ Assumptions
		Y	N	N/A	Y	N	N/A	
502.4.3 RI Amendment	Is there a continuous air barrier installed?	☐	☐	☐	☐	☐	☐	
	Does the air barrier connect all of the following: Foundation; Walls; Windows; Roof; Envelope Penetrations?	☐	☐	☐	☐	☐	☐	Record specs and/or describe the air barrier material:
502.4.9	Are doors and other access openings leading to shafts, chutes, stairwells, and elevator lobbies connected to the air barrier or equipped with weatherseals	☐	☐	☐	☐	☐	☐	

2009 IECC Section #	Footing / Foundation Inspection	Verified Value	Installed?			Comments/ Assumptions
			Y	N	N/A	
502.2.4	Below-grade wall insulation R-value. Interior to foundation ☐ Exterior to foundation ☐	R- 5 - 30				
502.2.6	Slab edge insulation R-value.	R- 5-30 Radiant Floor				
502.2.6	Slab edge insulation depth below grade	0-6 ft				
303.2.1	Exterior insulation protected against physical and UV damage (trowel/spay-on or rigid covering)					

503.2.7	Piping, ducts and plenum are insulated and sealed when installed in or under a slab.	R- 1-11				

2009 IECC Section #	Wall & Floor Systems	Verified Value	Y	N	N/A	Comments/ Assumptions
502.3.2	Fenestration Labels Present? Performance Levels on Plans?		☐			
502.4.1, 502.4.2	Doors - air leakage	0.2 – 1.2 cfm/ ft^2				
502.4.1, 502.4.2	Windows - air leakage.	0.2 – 1.2 cfm/ ft^2				
502.3.2	Windows including fixed glazing	U factor 0.3 – 1.5 SHGC 0.1 – 0.6 VLT 0.1 – 0.9				Record temporary label information when present: Record ID numbers from glass and glazing spacer: Record window make and model # when available: If none of the above are available, describe windows

502.3.2	Doors Glazing Only	U factor 0.3-2.0 SHGC 0.1 – 0.6				Record temporary label information when present: Record any ID numbers from unit: Record make and model # when available: If none of the above are available, describe doors
502.4.7	Vestibule at main entrance? Revolving Door? Self-Closing Door?					
502.2.3	Wall assembly 1 Above-grade wall insulation R-value. • If more than 1 wall assembly type, record area: 100 – 500,000 ft^2	R- 5-60 **Structure type** Mass Metal Steel Wood				
502.2.3	Wall assembly 2 Above-grade wall insulation R-value. • Record area: 100 – 500,000 ft^2	R- 5-60 **Structure type** Mass Metal Steel Wood				
303.2	If observable; is above-grade wall insulation properly installed?	Voids Compressed behind wires/pipes				Other installation issues:

Envelope Cont.

2009 IECC Section #	Wall & Floor Systems	Verified Value	Y	N	N/A	Comments/Assumptions
	Wall Assembly Metal and Wood framing – continuous rigid insulation for thermal break	R- 5-30				
502.2.5	Floor assembly 1; R-value. • If more than 1 floor assembly type, record area: 100 – 500,000 ft^2	R- 5-60 **Structure type** Mass Steel Wood				
502.2.5	Floor assembly 2; R-value. • Record area: 100 – 500,000 ft^2	R- 5-60 **Structure type** Mass Steel Wood				
303.2	Floor insulation properly installed?					Describe any installation issues:
303.1.1, 303.1.1.1	If observable, is insulation labeled with R-value or is there an insulation certificate providing R-value and other relevant data.					

Additional Comments/Assumptions:

2009 IECC Section #	Roof Systems	Verified Value		Y	N	N/A	Comments/ Assumptions
	Describe roof, including color	Flat Pitched Stone Membrane Metal Shingled Black/Dark White	☐ ☐ ☐				
502.4.1, 502.4.2	Are roof penetrations air/water sealed?						
502.2.1	Is there insulation installed on top of a suspended ceiling. If so, is that insulation intended for sound only?						
502.2.1	Roof 1 Roof insulation R-value. (Do not include any insulation installed on top of a suspended ceiling.) • If more than 1 roof assembly, record area 100 – 500,000 ft^2	R- 5-100 Above deck Attic					
	Roof 2 Roof insulation R-value. (Do not include any insulation installed on top of a suspended ceiling.) • Record area 100 – 500,000 ft^2	R- 5-100 Above deck Attic					
	If metal frame – is there continuous rigid insulation for thermal break	R Value 5 -40					
	Are thermal spacer blocks installed between metal rafters and metal roofing?						
502.3.2	Skylights	U factor 0.3 – 1.5 SHGC 0.1 – 0.6					Describe:

Additional Comments/Assumptions:

Mechanical Systems

2009 IECC Section #	Mechanical - HVAC	Verified Value	Y	N	N/A	Comments/Assumptions
503.2.3	1) HVAC equipment. Type: Small to Medium Unitary Packaged Terminal AC & Heat Pumps Warm Air Furnace Boilers (Circle 1 Oil or Gas) Condensing Units Chillers Manufacturer:_____ Model Number:_____ Capacity Output BTUH:_____ kW:_____ Tons:_____ HP:_____ Efficiency:_____ 2) HVAC equipment. Type: Small to Medium Unitary Packaged Terminal AC & Heat Pumps Warm Air Furnace Boilers (Circle 1 Oil or Gas) Condensing Units Chillers Manufacturer:_____ Model Number:_____ Capacity Output BTUH: 1,000 – 500,000 kW: 0.5 - 100 Tons: 0.5 - 100 HP: 1-100 Efficiency: 50-98					
503.2.4.1	Heating and cooling to each zone is controlled by an electronic thermostat with setback/ set forward control. (local stats or EMS)					
503.2.4.1.1	Heat pump controls prevent supplemental electric resistance heat from coming on when not needed. (Model #)					Make & model # of system/controls
503.2.7 RI Amendment	HVAC ducts and plenums insulated?	R-1-12				
503.2.8	HVAC piping insulated? Wall thickness of insulation?	0.25 - 3 in.				

503.2.7.1	Are ducts and plenums sealed? Mastic Tape			☐		If sealed with tape: Standard duct tape: ☐ Listed/Labeled tape: ☐
503.3.1, 503.4.1	Air economizers installed					
503.4.5	Zone controls can limit simultaneous heating and cooling and sequence heating and cooling to each zone.					Record any control system details available:

Mechanical Systems Cont.

2009 IECC Section #	Mechanical - HVAC	Verified Value	Y	N	N/A	Comments/Assumptions
503.2.9.1	Air outlets and zone terminal devices have means for air balancing.					
503.2.9.2	Do HVAC hydronic heating and cooling coils have means to balance flow?					
503.2.9.2	Do HVAC hydronic heating and cooling coils incorporate pressure test connections?					
503.2.10.1	If an HVAC system has a combined fan horsepower >5; do the plans/specs include a calculation for maximum allowable horsepower per CFM (see IECC section 503.2.10.1					
503.2.11	Efficiency level of Service water heating equipment	**50-98%**				
504.5	Insulation for piping for recirculating and non-recirculating service hot-water systems insulated.	**0.25 – 3”**				☐ Rigid Foam ☐ Flexible Foam ☐ Fiberglass

Additional Comments/Assumptions:

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Complex HVAC Systems

	Mechanical - HVAC - Complex	Verified Value	Y	N	N/A	Comments/ Assumptions
503.2.5.1	Is demand control ventilation installed					If installed, Describe the area it serves:
503.4.2	VAV fan motors ≥10 hp controlled VFD or Vane Axial Fan  Vane Axial Fan	VSD Vane axial fan				
503.4.3.4	Pumping systems >10 hp for chiller and boiler systems > 300,000 Btu/h; temperature reset based on load					
503.4.3.3.3	Two-position automatic valve interlocked to shut off water flow when hydronic heat pump with pumping system >10 hp is off.					
503.4.4	Heat rejection Fan systems with motors ≥7.5 hp controlled by VFD.					
503.2.6	Energy recovery *(ERV or HRV)* on systems ≥ 5,000 cfm and 70% outside supply air.					
503.4.6	Condenser heat recovery system for preheating of service hot water in 24/7 facilities with loads >6 MMBtu *(Hospital, etc.)*					

Additional Comments/Assumptions:

Lighting/Electrical

2009 IECC Section #	Lighting Controls	Y	N	N/A	Comments/Assumptions
505.2.2.2	Buildings >5,000 ft^2. Automatic lighting control to shut off all non-emergency building lighting after hours (timer or occupancy)				
505.2.1	Each enclosed space includes at least a manual light switch				
505.2.2.1	Bi-Level switching in offices				
	Are any daylit zones controlled separately? (manual or auto)				
505.2.3	Verify separate lighting control devices for specific uses installed Occupancy/Vacancy Sensors Timers Daylight dimming				
505.4	LED or self-illuminating exit signs				
505.2.4	Automatic lighting controls for exterior lighting installed. Photocell Astronomical timer				
505.6.1	Exterior lighting over 100 W is fluorescent, HID or LED				

Additional Comments/Assumptions:

Lighting Cont.

2009 IECC Section #	Lighting Power Density Allowance	Y	N	N/A	Comments/ Assumptions
	Collect LPD data for the entire building or 2 representative spaces **Space Type** _____ Length 10 – 1,000 Width 10 - 1000 Fixture: 2L4'T8 30-90 Watts 3L4'T8 30-120 Watts 4L4'T8 30-120 Watts 2 U T8 30-90 Watts 8' T8 60-200 Watts CFL 5-200 Watts Inc. 60-300 Socket rated Watts HIF 100-400 Watts HID 30-1,500 Watts Other 1-1,000 Watts **Area 2** **Space Type** ____ **Values As above**_____ Length _____ Width _____ Fixture: 2L4'T8 _____Watts 3L4'T8 _____Watts 4L4'T8 _____Watts 2 U T8 _____Watts 8' T8 _____Watts CFL _____Watts Inc. _____ Socket rated Watts HIF _____Watts HID _____Watts Other _____Watts				Describe Fixtures

Additional Comments/Assumptions:

Other

2009 IECC Section #	Other	Complies			Comments/Assumptions
		Y	N	N/A	
502.4.6	Weather seals installed on all loading dock cargo doors				
504.7.1	Pool heaters are equipped with on/off switch and no continuous burning pilot light.				
504.7.3	Pool covers are provided for heated pools and pools heated to >90˚F have a cover ≥R-12.				
504.7.2	Time switches are installed on all pool heaters and pumps.				

Additional Comments/Assumptions:

B. Jurisdictional Letter

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Administration
DIVISION OF CAPITAL PROJECTS AND PROPERTY MANAGEMENT
BUILDING CODE STANDARDS COMMITTEE
One Capitol Hill
Providence, RI 02908-5859
(401)-222-1129 FAX 222-2599

<<Date>>

<< Name of Building Official>>
<<Municipality of Building Official>>

Dear <<Name of Building Official>>,

Buildings account for roughly 40 percent of the nation's energy consumption, and enhancing their efficiency will lead to a stronger economy, greater energy security, and a cleaner environment. With this in mind, the State of Rhode Island Office of the Building Commissioner and National Grid are asking local jurisdictions to participate in a statewide study to assess baseline construction practices in relation to building energy codes. This letter is meant to familiarize you with the study and to solicit your support for this important activity.

The study is part of a major effort to support and improve vital efficiency measures that will help address energy and environmental challenges here in Rhode Island. **The objectives of the study are to estimate a statewide energy code compliance rate for commercial buildings, provide feedback on patterns of compliance and non-compliance, and identify opportunities for Rhode Island to help reach its statewide goal of a 90% compliance rate with the energy code.** To achieve this, the study team will conduct on-site observations at randomly selected buildings and conduct a brief interview with the building officials involved in the design and construction of those buildings. It is our intention to better understand the real-world challenges of implementing the energy code and determining code compliance. Further, learning about real-world challenges can lead to improvements in the codes, increased educational and support activities, and support for code enforcement efforts.

The study began in February 2012 and is continuing for six months. In total, we will visit a randomly generated sample of approximately 30 commercial building projects constructed in the last 4 years. The State of Rhode Island Office of the Building Commissioner and National Grid have hired the firms, KEMA Inc. and ERS, Inc., to conduct the study. They will be referring to the U.S. Department of Energy's Building Energy Codes Program (BECP) survey protocol for guidance on this type of study. BECP protocols are available at: www.energycodes.gov/arra/compliance_evaluation.stm.

What to Expect:

Building Departments Level of Work: There will be minimal disruption to building departments' staff. For background on building energy code practices, department staff may be asked to participate in a standardized 30 minute phone interview.

If a commercial building in your jurisdiction was selected for a site visit, field research staff from KEMA or ERS will contact you to set up a date and time to speak with you and conduct the 30 minute phone interview. At that time, the field researcher will ask you about 1 or 2 specific commercial projects in your jurisdiction. The project(s) will have been selected at random, and questions will relate to energy code activities for the specific commercial project.

During the Building Department Interview. If scheduled for an interview, the field researcher will perform the following tasks:

- Conduct a short, standardized interview on your plan review, inspection and permitting processes
- Answer questions you may have about the energy code baseline study
- Review with you the data collection methods for the commercial projects
- Seek to collect energy-related information on the specific project(s) from plans, specifications, or related project documentation that may be available

In the Field. When visiting commercial projects in your jurisdiction, the field researcher will collect information on the building's energy-relevant features. He or she will also look to get copies of any available as-built drawings and design plans from the building owners or design teams.

Information gathered during the site visits from individual buildings and jurisdictions will not be made public and the identity of Building Departments and individuals and buildings interviewed will not be disclosed.

Thank you very much for your consideration. On behalf of the State of Rhode Island Office of the Building Commissioner and National Grid, we look forward to collaborating in the pursuit of energy savings. If you have any questions or concerns, please don't hesitate to contact me, Wendy Todd of National Grid or Jim Leahy of KEMA.

With kind regards,

John P. Leyden, CBO
State Building Code Commissioner

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C. Building Official Interview Guide

RHODE ISLAND COMMERCIAL AND RESIDENTIAL ENERGY CODE COMPLIANCE BASELINE STUDY

INTERVIEW GUIDE FOR BUILDING CODE OFFICIALS

Contact Name: _____

Municipality: _____

County: _____

Telephone: _____

E-Mail Address: _____

Interview Date: _____ Interview Time: _____ (Duration in Minutes)

[NOTES TO INTERVIEWER]

Discussions with building code officials will provide a solid foundation for understanding the compliance practices in regard to the existing building energy code. The objectives of the interviews are to collect the following information:

- Code officials' knowledge of commercial and residential building energy code and high performance green building standards for public buildings.
- Commercial and residential energy code compliance staffing and training practices.
- Process for determining commercial and residential energy code compliance.
- Barriers to enforcing commercial and residential energy codes.

The interviewee should have received an introductory letter summarizing the Commercial Energy Code Study and an email from John Leyden encouraging participation in the study.

If respondents have questions about study, they can contact Wendy Todd of National Grid at wendy.todd@us.ngrid.com or 781-907-2232; or John Leyden, State Building Code Commissioner at John.Leyden@doa.ri.gov or 401-222-3529.

LEAD-IN:

Hi, my name is _____ and I work for DNV KEMA Energy and Sustainability, an energy consulting firm. We have been hired by National Grid and the State of Rhode Island Office of the Building Commissioner to conduct research on energy code compliance in new commercial and residential building construction.

This study is part of a major effort to support and improve vital efficiency measures that will help address energy and environmental challenges in Rhode Island. The objectives of the study are to understand current design and construction practices, the energy code compliance process, and the future energy savings potential from recently constructed buildings. I would like to talk with you to find out more about your experience with the energy code.

In appreciation of your time and feedback in completing the interview, we would like to offer a $50 donation to the charity of your choice.

The conversation should take approximately 45 minutes. Your responses are confidential and the report will not include the names or jurisdictions of the individuals we interview.

Roles and Responsibilities

I would like to start by asking you a few questions about your job.

RR1. What is your job title?

RR2. How long have you held this position?

RR3. What are your primary job responsibilities?

RR3a. [If not indicated in RR3] Do your job responsibilities involve residential, commercial and/or industrial buildings?

☐ Residential buildings
☐ Commercial buildings
☐ Industrial buildings

[NOTE TO INTERVIEWER: When conducting rest of survey, only ask **residential questions** if RR3/RR3a indicates building official involved with residential buildings; only ask **commercial questions** if RR3/RR3a indicates building official involved with commercial and/or industrial buildings]

RR4. Have previous positions provided you experience with the energy code?

☐ Yes
☐ No

RR4a. [If RR4=Yes] Please describe this experience.
[Probe: Name of position, Length of time in role, Description of role pertaining to the energy code]

RR5. During the previous year, how many commercial and residential building permits were issued by your department? [Include total number of permits for retrofit, renovations and new construction]

RR5a. Commercial:

RR5b. Residential:

Staff Energy Code Compliance Processes and Training

In this section, I would like to ask you some questions about your office and training.

SECC1. How many staff work in your office?

SECC2. [If SECC1>1] What is the average number of years of experience of your staff?

SECC3. Within the last two years, has anyone from your staff attended training on commercial and/or residential energy code compliance and enforcement?

SECC3_com. Commercial
☐ Yes
☐ No

SECC3_res. Residential
☐ Yes
☐ No

SECC3a. [IF SECC3_com and/or SECC3_res = YES] Who conducted the training?

SECC3a_com. [IF SECC3_com = YES] Commercial

SECC3a_res. [IF SECC3_res = YES] Residential

SECC3b. [IF SECC3_com and/or SECC3_res = YES] What was reviewed during the training?

SECC3b_com. [IF SECC3_com = YES] Commercial

SECC3b_res. [IF SECC3_res = YES] Residential

SECC3c. [IF SECC3_com and/or SECC3_res = YES] In what ways, if any, has this training changed your process of energy code enforcement?

SECC3c_com. [IF SECC3_com = YES] Commercial

SECC3c_res. [IF SECC3_res = YES] Residential

SECC3d. [IF SECC3_com and/or SECC3_res = YES] Do you feel that this training has been sufficient so you can understand and enforce all sections of the energy code?

☐ Yes
☐ No

SECC3e. [If response to SECC3d indicated] Why do you say that?

SECC4. How would you prefer to receive training?
[Read responses and check all that apply]

☐ Webinar / Online
☐ Classroom
☐ In the field
☐ Other (Please describe: _____)

SECC5. If offered, do you anticipate attending training on 2012 IECC?

☐ Yes
☐ No

SECC6. How familiar are you with the Green Buildings Act that went into effect in October 2010? [Read responses and check one]

☐ Not familiar
☐ A little familiar
☐ Somewhat familiar
☐ Very familiar

SECC6a. [IF SECC6 = YES] Have any projects within your jurisdiction had to follow the requirements of the Green Buildings Act?

☐ Yes
☐ No

SECC6b. [If response to SECC6a = YES] What project(s) followed the Green Building Act requirements?

SECC6c. [If response to SECC6a = YES] Which code or rating system did the project follow - the IGCC, LEED, Green Globes or Northeast CHPS?
[Only ask Northeast CHPS if project is a school]

☐ IGCC
☐ LEED
☐ Green Globes
☐ Northeast CHPS (if project is a school)

SECC6d. [If SECC6=YES] Have you have received sufficient training to enforce the Green Buildings Act and its provisions?

☐ Yes
☐ No

SECC6e. [If response to SECC6d indicated] Why do you say that?

Energy Code Compliance Practices

I want to find out more about energy code practices for commercial and residential buildings in your jurisdiction. According to our records, <name of project/owner> has recently constructed a new building in <city/town>. As we continue our conversation, when applicable, please provide examples of your experiences with the construction of this building.

ECCP1. Are you more familiar with the 2009 IECC or ASHRAE 90.1 - 2007 standards?

☐2009 IECC
☐ASHRAE 90.1 - 2007

ECCP1a. [If response to ECCP1 indicated] Why is that?

ECCP2. Which parts of the energy code are most difficult in determining compliance?

ECCP2_com. Commercial

ECCP2a_com. Why is that?

ECCP2_res. Residential

ECCP2a_res. Why is that?

ECCP3. What types of educational or professional backgrounds are needed to comprehensively enforce the energy code?

ECCP3_com. Commercial

ECCP3_com. Residential

ECCP4. Who conducts **plan reviews** for energy code compliance?
[Read responses and check all that apply]

☐ Not done
☐ Interviewee (if single person code office)
☐ In-house staff
☐ 3rd party entities (Please describe: _____)
☐ Other jurisdictions or government agencies (Please describe: _____)
☐ Other (Please describe: _____)

ECCP5. Who conducts **field inspections** for energy code compliance?
[Read responses and check all that apply]

☐ Not done
☐ Interviewee (if single person code office)
☐ In-house staff
☐ 3rd party entities (Please describe: _____)
☐ Other jurisdictions or government agencies (Please describe: _____)
☐ Other (Please describe: _____)

ECCP6. What documentation and/or calculations do you require from applicants to demonstrate energy code compliance?

[Probe: If mention COMcheck reports, ask which type of report:

– e.g., Envelope; interior lighting; exterior lighting; HVAC?)]

[Probe: If mention RESCheck reports ask, which type of report:

– e.g., Envelope; HVAC?)]

[Probe: Project certifications?]

ECCP6_com. Commercial?

ECCP6_res. Residential?

ECCP6a. [Ask if **project certification** is mentioned in ECCP6] If you require project certification to demonstrate commercial and/or residential energy code compliance, are the project certifications specific to the energy code or do they address all code provisions?

☐ Certifications specific to the energy code
☐ Certifications address all code provisions

ECCP6b. What percentage of buildings use the following methods to demonstrate energy code compliance?

If examples of methods to demonstrate energy code compliance needed:

- Prescriptive is a checklist.
- RESCheck and COMCheck are considered trade-off methods.
- Performance is submission of an energy model showing code building performance versus proposed building performance.

ECCP6b_com. Commercial Buildings

Prescriptive: %

Trade-off: %

Performance: %

Percentage should total 100%

ECCP6b_res. Residential Buildings

Prescriptive: %

Trade-off: %

Performance: %

Percentage should total 100%

ECCP7. [If ECCP4 does not equal "Not Done"] Please provide an estimate of the range of time devoted to **plan review** for energy codes per project.

ECCP7_com. Commercial

[Enter ranges:] Low Range: _____mins/hours; High Range: _____mins/hours

ECCP7_res. Residential

[Enter ranges:] Low Range: _____mins/hours; High Range: _____mins/hours

ECCP7a. In regard to the energy code, what are you specifically looking for in your plan reviews?

ECCP7a_com. [If response to ECCP7_com] Commercial projects:

ECCP7a_res. [If response to ECCP7_res] Residential projects:

ECCP7b. [If range in ECCP7_com or ECCP7_res>0 hours] For projects, what affects the number of hours devoted to **plan review** for energy codes?
[Probe: Building size, building type and complexity, staff, resources]

ECCP7b_com. [If response to ECCP7_com] Commercial projects:

ECCP7b_res. [If response to ECCP7_res] Residential projects:

ECCP8. [If ECCP5 does not equal "Not Done"] Please provide an estimate of the range of time devoted to **field inspections** for energy codes? If energy field inspections are performed in conjunction with inspections for other code provisions, please estimate the time for the energy-related field inspections only.

ECCP8_com. Commercial

[Enter ranges:] Low Range: _____mins/hours; High Range: _____mins/hours

ECCP8_res. Residential

[Enter ranges:] Low Range: _____mins/hours; High Range: _____mins/hours

ECCP8a. [If range in ECCP8_com or ECCP8_res >0 hours] For projects, what affects the number of hours devoted to **field inspections** for energy codes?
[Probe: Building size, building type and complexity, staff, resources]

ECCP8a_com. [If response to ECCP8_com] Commercial

ECCP8a_res. [If response to ECCP8_res] Residential

ECCP9. Are there other provisions of the code that generally take precedence over the energy code?

☐ Yes
☐ No

ECCP9a. [If ECCP9=Yes] What provisions take precedence over the energy code?

ECCP9b. [If ECCP9=Yes] How much time is spent reviewing other code provisions versus the energy code?

ECCP10. What resources do you use to help answer questions on energy code issues?

ECCP11. Do you feel that the design and construction teams who work in your jurisdiction are familiar with the energy code – including recent updates in 2010?

ECCP11_com.

☐ Yes
☐ No

ECCP11a._com. Why do you say that?

ECCP11._res.

☐ Yes
☐ No

ECCP11a._res. Why do you say that?

ECCP12. What system does your department use to maintain permitting data?
[Read responses and check all that apply]

☐ Paper
☐ Electronic
☐ Other (Please describe: _____)

ECCP13. Are there any limitations that impede your ability to enforce the energy code?

☐ Yes
☐ No

ECCP13a. [If ECCP13=Yes] What limitations impede your ability to enforce the energy code?

[Do not read list; Check all that apply]

☐ Lack of time
☐ Lack of staff
☐ Lack of money
☐ Lack of education or training
☐ Lack of data provided with the plans
☐ Lack of building access
☐ Lack of equipment
☐ Other (Please describe: _____)

ECCP13b. [If response to ECCP13a indicated] What kind of assistance might help get around these impediments?

ECCP14. What percent of the time is all information submitted adequate to determine energy code compliance?

ECCP14_com. Commercial Buildings: %

ECCP14_res. Residential Buildings: %

ECCP15. [IF ECCP14_com or ECCP14_res not 100%] What information is typically missing from plans, specifications and/or actual construction that prevents you from determining compliance?

ECCP15_com. [IF ECCP14_com not 100%] Commercial Buildings:

ECCP15_res. [IF ECCP14_res not 100%] Residential Buildings:

ECCP16. Do you find there are **plan review** and/or **field inspection** items that are typically not compliant with the energy code?

☐Yes
☐No

ECCP16a_com. [If ECCP16=Yes] Which of the following plan review and/or inspection items do you generally find do not comply with the energy code?

[Read responses and check all that apply]

☐ Lack of air barrier
☐ Lack of continuity of air barrier (through different assemblies, joints, etc.)
☐ Envelope insulation levels
☐ Envelope sealing around fenestration
☐ Envelope sealing at building joints and seams
☐ Installation of insulation
☐ Fenestration
☐ Duct insulation
☐ Duct sealing
☐ Piping insulation
☐ Installed interior lighting power
☐ Installed exterior lighting power
☐ Lighting controls
☐ HVAC equipment
☐ HVAC system controls

☐ Other (Please describe: _____)

ECCP16b_com. [If ECCP16=Yes] Why do these items not comply with the energy code?

ECCP16a._ res. [If ECCP16=Yes] Which of the following plan review and/or inspection items do you generally find do not comply with the energy code?

[Read responses and check all that apply]

- ☐ Lack of air barrier
- ☐ Lack of continuity of air barrier (through different assemblies, joints, etc.)
- ☐ Envelope insulation levels
- ☐ Envelope sealing around fenestration
- ☐ Envelope sealing at building joints and seams
- ☐ Installation of insulation
- ☐ Fenestration
- ☐ Duct insulation
- ☐ Duct sealing
- ☐ Piping insulation
- ☐ HVAC equipment
- ☐ Other (Please describe: _____)

ECCP16b_res. [If ECCP16=Yes] Why do these items not comply with the energy code?

ECCP17. Are you familiar with National Grid's energy efficiency programs that offer technical assistance and financial incentives to customers in Rhode Island?

- ☐ Yes
- ☐ No

ECCP17a. [If ECCP17=Yes] How could the energy efficiency programs offered by National Grid improve compliance?

Closing Comments

CC1. Are you aware of the American Recovery and Reinvestment Act's provisions about energy code compliance and your state's response to it?

☐ Yes
☐ No

CC1a. [IF CC1 = Yes] Has the American Recovery and Reinvestment Act provisions changed the energy code compliance process in your jurisdiction?

☐ Yes
☐ No

CC1b. [IF CC1a = Yes] How has it changed the energy code compliance process in your jurisdiction?

CC2. Do you have any other input regarding energy code compliance in regard to new construction, major renovations and additions in commercial and residential buildings or suggestions on how to improve code compliance?

Those are all the questions I wanted to ask. Thank you for your time and participation.