CITY ENERGY

A JOINT PROJECT of **NRDC + IMT**

DECEMBER 2018

ASSESSMENT METHODOLOGY FOR CODE COMPLIANCE IN MEDIUM TO LARGE CITIES

ABOUT CITY ENERGY PROJECT AND THE CITY ENERGY PROJECT RESOURCE LIBRARY

A joint initiative of the Institute for Market Transformation and the Natural Resources Defense Council, the City Energy Project supported bold yet practical ways to deploy energy efficiency at the city level to boost local economies, reduce pollution, and create healthier, more prosperous communities nationwide.

The project partnered with 20 local governments across the U.S. from 2013–2018 to design locally appropriate energy efficiency policies and programs. Building upon the past successes and innovation of cities, the City Energy Project established best-in-class practices for energy efficiency to be customized and replicated nationwide. Models and recommendations have been distilled into the City Energy Project Resource Library. This curated set of resources contains the necessary blueprints for a city government to craft and implement customized solutions to productively manage energy efficiency initiatives across commercial, multifamily, and public buildings in its jurisdiction.

For more information on the participating cities and counties in the City Energy Project, and to search the City Energy Project Resource Library, visit cityenergyproject.org.

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INTRODUCTION

From 2006 to 2012, national model energy codes increased energy savings potential by nearly 30 percent. However, these savings are only realized when a building is designed and constructed to meet the provisions of the adopted energy code. Building energy codes are legal requirements—adopted at the state and local levels—for the design and construction of buildings. They establish the minimum level of energy efficiency for new residential and commercial buildings and for alterations and additions to those buildings. They improve efficiency by mandating performance through careful construction and proper systems design.[1]

Ensuring compliance with building energy codes is a simple, ready-made way for cities to realize energy and carbon savings without the passage of any new policies. In fact, according to a fact sheet produced by the Institute for Market Transformation (IMT) in partnership with 16 other leading energy efficiency organizations, every dollar spent on energy code enforcement yields $6 in energy savings: A 600 percent return on investment.[2]

Enforcement of energy codes is almost always done by building permit office staff at the local (city or county) level who typically review plans to ensure they are compliant and then conduct field inspections to verify that the plans are followed during construction. Compliance, and non-compliance, consists of many parts and factors in the construction of a building. Enforcement issues can be a result of several factors, including department budget, priorities, training, and accountability. Design and construction professionals are most likely to comply when given adequate education and training; similarly, city building department staff are most likely to spot non-compliance when they have adequate tools, training, and accountability for reviewing plans for compliance and sufficiently inspecting construction.

For a city government that wants to determine whether opportunities exist to capture additional energy and carbon savings through better energy code compliance, assessing the compliance process can be extremely difficult. To overcome this, the City Energy Project—a joint initiative of the Institute for Market Transformation and the Natural Resource Defense Council—has developed this public methodology that enables any city to identify areas for improvement and assess the potential energy and carbon savings associated with increased compliance.

HOW A CITY CAN ASSESS ENERGY CODE COMPLIANCE

The City Energy Project Assessment Methodology for Energy Code Compliance in Medium to Large Cities (CEP Assessment Methodology) is a plug-and-play methodology designed for cities to evaluate the process of building practices through the lens of code compliance. This peer-reviewed methodology focuses on qualitative evaluation by conducting interviews, evaluating processes, and collecting limited data on building systems to uncover potential areas of low compliance and provide actionable feedback.

Using this assessment methodology allows a city to acquire the information needed to drive improvements in its code compliance and enforcement efforts. Benefits of conducting an assessment include:

- Allows staff to directly participate and learn from the process of evaluation
- Identifies current issues with energy code compliance practices
- Determines a compliance score that provides the city with a benchmark that can be used to measure progress.
- Provides a plan with solutions to improve compliance and realize energy savings
- Estimates how non-compliance effects energy consumption in a jurisdiction.

The City Energy Project began conducting citywide compliance assessments in 2013. First drafted in 2014, the CEP Assessment Methodology reflects lessons learned from cities participating in

the project. Compliance scores achieved in the CEP cities have ranged from 64 percent to 92 percent (shown below in Figure 1. Compliance Scores in CEP Cities), with four cities actively finalizing evaluations and new scores undergoing analysis.

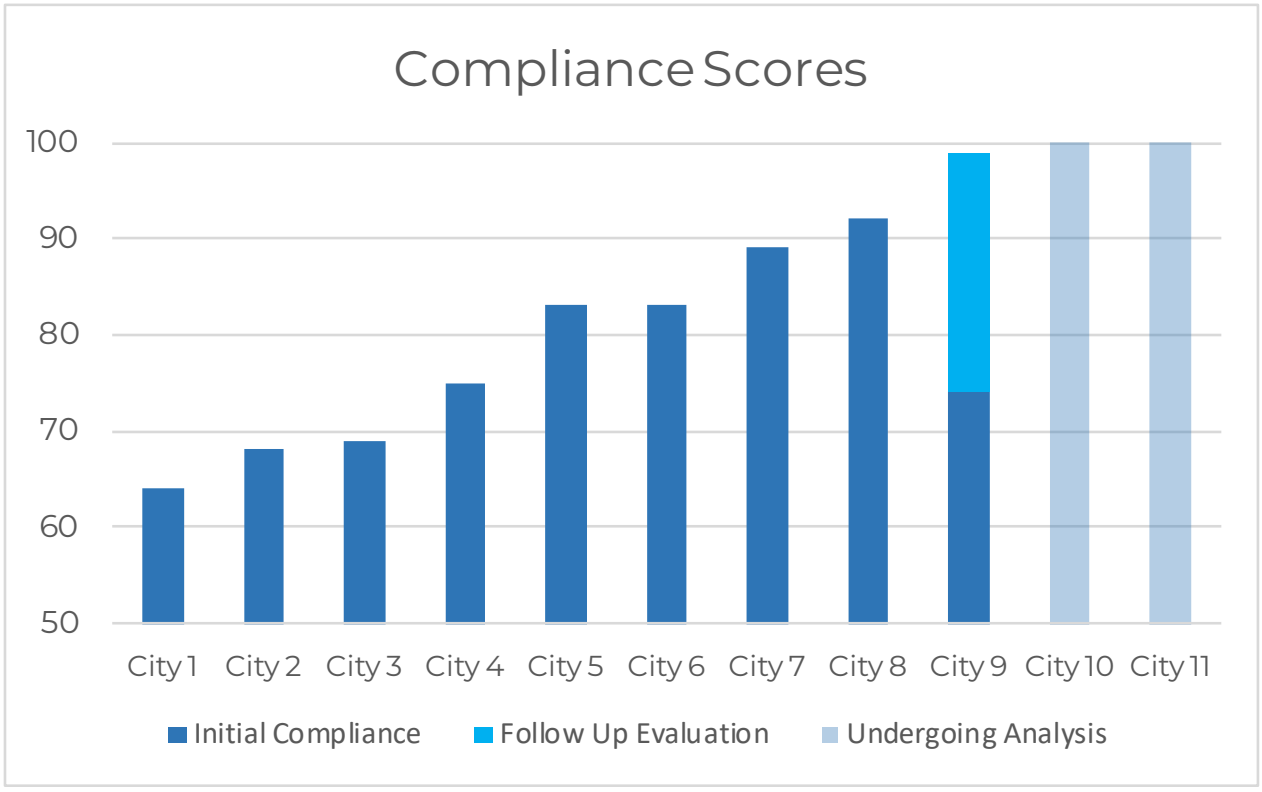
BENEFITS OF IMPROVED CODE COMPLIANCE

Low compliance rates mean energy savings associated with code compliance are lost and households and businesses incur unnecessary costs for heating and cooling buildings. Residents may spend an additional $300 per year on their energy bills.[3] That is significant to a household's budget, and is impactful when extrapolated to a city: for example, in a city with 4,000 annual single-family housing starts, that translates to an additional $1.2 million that homeowners and renters would pay for utility bills if compliance rates are low. This figure increases exponentially when new commercial and multifamily buildings are considered. In fact, a recent IMT CEP Compliance Assessment found that in one Mid-Atlantic city, high-rise multifamily buildings were using $0.50 additional per square foot in energy costs due to non-compliance. That adds up to over $1.5 million in unnecessary annual energy costs for buildings permitted citywide in 2014 alone. The compliance assessment also found that commercial office buildings were paying an additional $0.25 per square foot in energy costs due to non-compliance with the code, which is nearly $3 million for buildings permitted citywide in 2014.

In addition to the energy-related cost savings associated with code compliance, energy codes provide additional significant benefits[4,5] including:

- Increasing durability of the building envelope
- Improving indoor air quality
- Improving fires safety
- Protecting from extreme temperatures and storms
- Preventing potential moisture, mold, and rot problems
- Reducing water use via hot water piping insulation
- Increasing the comfort and safety of the building's occupants

Figure 1. Compliance Scores in CEP Cities



STATEWIDE CODE COMPLIANCE ASSESSMENTS

Historically[6], compliance assessment studies have been done at the state and regional level and have focused on residential and commercial construction individually.

The U.S. Department of Energy's (DOE) Building Energy Codes Program developed an evaluation protocol[7] for determining residential energy code compliance rates. The final data collection and analysis methodology was released in 2018 and provides national guidance for evaluating compliance rates at the state level. This protocol was based on methodologies used in past energy code compliance studies, including the ***Iowa Residential Energy Code Plan Review and Field Inspection Training***[8] and the ***Indiana Commercial Energy Code Baseline Study***[9] conducted by Britt/Makela Group. The DOE protocol has been used as a basis for subsequent commercial energy code compliance assessments, including studies in Georgia, Illinois, Iowa New York, Utah, and the Northwest U.S. More recently, residential compliance studies were conducted in Alabama, Georgia, Kentucky, Maryland, North Carolina, Pennsylvania, Texas, and West Virginia and a multi-state study was completed in Idaho, Montana, Oregon, and Washington.

The DOE residential building assessment methodology has evolved to collect data on systems instead of whole buildings, calculating potential energy savings due to non-compliance, and the residential checklists have been updated to reflect collection of data on components DOE quantitatively determined as having the largest direct impact on energy use.

The commercial building methodology is under development through an ongoing field study. A preliminary collection methodology has been developed and an analysis methodology is undergoing development as the field study delivers data on commercial buildings across two climate zones. Field studies in Minnesota and Illinois are using the DOE protocol as a basis for energy code compliance assessments. The commercial field study is anticipated to be completed in early 2020.

While these studies provide valuable information on state and regional trends, they don't meet the needs of cities for several reasons:

- Cities that participate in the evaluations typically receive little to no feedback on the findings or what actions could be taken to correct compliance issues.
- Statewide compliance studies data collection teams, particularly those following U.S. Department of Energy protocols, often have limited interaction with the jurisdictions.
- The statewide sample will include only a small number of buildings from any one jurisdiction.
- The analysis focuses on statewide trends.
- City and state governments may have different goals on how to use the data that come out of an assessment.

Perhaps most important, from a practical perspective, is that statistically valid studies are quite expensive. The CEP Assessment methodology provides valuable information that can be acted on with or without a formal compliance study. The CEP Assessment Methodology looks specifically for barriers and solutions to compliance by focusing on process and directly involving staff to provide an interactive learning opportunity.

AN OVERVIEW OF THE CEP ASSESSMENT METHODOLOGY

FOUR-PHASE PROTOCOL

The CEP Assessment Methodology provides a four-phase protocol to comprehensibly assess a city's energy code compliance and enforcement practices and develop a compliance improvement plan. Briefly described below, the phases are more fully detailed in the respective sections of the document.

- **Phase 1: Conduct Interviews.** Identify and speak with key stakeholders in the local building department and design and construction communities.
- **Phase 2: Review Building Department Processes.** Review processes and tools in place for submissions, corrections, inspections and document storage.
- **Phase 3: Collect Data Sample.** Select from Limited, Standard or Statistical and customize based on 2–3 years of city permit data:
  - Review initial submittals of construction plans to the building department.
  - Review plans that been deemed "Approved" for construction.
  - Conduct on-site inspection of buildings under construction.
- **Phase 4: Analysis and Report.** Analyze findings, develop a compliance improvement plan, and provide an overall compliance score.

The methodology includes both qualitative and quantitative aspects. For the qualitative component, interviews with building department staff and an assessment of plan review and inspection processes help reveal challenges to effective energy code compliance, and options to address those challenges through education or operational changes within the city. For the quantitative analysis, key information is collected on a variety of code requirements, from insulation levels in walls to specifications for heating, ventilation, and cooling (HVAC) equipment. The combination of these components allows for a more holistic view of the jurisdiction implementation to provide tailored compliance recommendations.

To increase flexibility and use by the cities, the CEP Assessment Methodology includes scoping options which impact time and cost of the assessment to the jurisdiction. These scoping options are discussed below in Scoping Decisions and Scoping Modifications.

CEP ASSESSMENT METHODOLOGY TIME FRAME

The CEP Assessment Methodology is designed for a six- to 18-month period depending on the sampling set used, as illustrated in Table 1. CEP Assessment Time Frame. The length of Phase 3: Collect Data Sample may vary depending on the construction timing available to meet the defined sample.

Table 1. CEP Assessment Time Frame

Month:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Limited Sample	1	2	3	3	4	4												
Standard Sample	1	2	3	3	3	3	4	4	4									
Statistical Sample	1	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4

Legend:
PHASE 1 PHASE 2 PHASE 3 PHASE 4

SCOPING DECISIONS AND MODIFICATIONS

Data collection in Phase 3 of the CEP Assessment Methodology can be varied in the following dimensions, depending on how expansive the city wishes to make its scope, the volume of building permits and construction trends, and how much time and budget available to invest in the evaluation:

- Level of building department staff involvement
- Data collection sample size
- Inclusion of energy modeling

Level of Staff Involvement
The CEP Assessment Methodology requires each city to determine the appropriate level of staff involvement based on staff knowledge of the energy code, time available, and interest in education opportunities available through participation in the assessment.

There are several goals for the inclusion of staff in the CEP Assessment Methodology:

- Provide hands on education and training for building department staff through direct participation in the evaluation
- Allow for a more nuanced understanding of internal processes and procedures
- Promote internal problem solving and troubleshooting to allow for best practices to emerge

There are three options for level of staff involvement:

- Staff/Third-Party Team Approach
- Self-Evaluation
- Third-Party Evaluation

Table 2. Staff Time for Assessment, Standard and Limited Sample Size provides an estimate of staff time involved in an assessment, considering variables of staff or third party collecting the data. Even when a third party is used, there will be a minimum amount of support time needed from city staff to make appropriate introductions, gather plans, and schedule inspections. If staff collect data, the amount of time outlined below is in addition to a day of training on the methodology.

DATA COLLECTION SAMPLE SIZE

The CEP Assessment Methodology requires each city to determine an appropriate sample based on its building stock, construction starts, and goals associated with undertaking the data collection phase of the assessment. The sample is distributed across systems and building type, including new construction as well as additions and alterations of both commercial and residential structures. There are several goals for the sampling strategy of the CEP Assessment Methodology:

- Ensure that cities collect sufficient information on energy code compliance without over-burdening plan review and field inspection staff.
- Design the sample set so that it is reasonably representative of the energy impacts of the mix of projects that occur within cities.

Design the sample set to address the goals of the assessment and interests in either frequency of occurrence or high energy users.

There are three recommended base samples:

- Limited: 15 commercial building systems, and 10 residential buildings.
- Standard: 35 commercial additions/tenant build-outs or alterations, 20 new commercial new buildings, and 30 residential buildings.
- Statistical: Determined based on analysis of city building stock, permit data and a working group or Delphi panel.

Inclusion of Energy Modeling

Depending on the interests of the city, the methodology can be implemented with or without energy modeling. The modeling portion of the methodology is intended to help a city estimate the amount of energy savings that are lost due to none compliance with the code. This number can prove valuable to conversations with utility programs around funding energy code compliance and advancement work, and in looking at long term strategies to reach carbon reduction goals. With or without this estimate, the methodology will still provide targeted areas and recommendations for improvement. A city should evaluate its priorities and budget for the assessment to determine if a calculation of lost energy savings is appropriate for inclusion in their assement.

Table 2. Staff Time for Assessment, Standard and Limited Sample Size

	Staff Collect Data		Third Party Collects Data	
	Standard Sample:	Limited Sample:	Standard sample:	Limited Sample:
Phase 1	15		3-4	
Phase 2	25		1-2	
Phase 3				
Plan Review	120	70	8	4
Inspection	100	50	12	4
Phase 4	—	—	—	—
Total	**260**	**160**	**26**	**12**

CEP EVALUATION BUDGET

Where the city uses an outside consultant, the budget should include both the costs for the contract, as well as building department staff time, which may vary depending on the sample size selected. The cost for an outside consultant thus may vary from $20,000 to $120,000, a range which includes conducting qualitative reviews, completing plan review and inspections, evaluating the results, energy modeling (on the upper end), and providing a report of findings and recommendations.

A proposed budget for a follow-up assessment again considers the soft cost of contracting with a third party to oversee the evaluation process, complete plan review and inspections, evaluate the results, review and assess progress in modifying procedures based on the recommendations of the initial qualitative analysis, and provide a report. The estimated cost per evaluation for the third party for the follow-up assessment is $20,000 to $30,000 per city. Cities may want to determine a long-term funding plan for implementing the initial evaluation, long-term evaluation, and compliance enhancement strategies, based on the evaluation results.

IMPLEMENTING THE COMPLIANCE ASSESSMENT

The CEP Assessment Methodology focuses on understanding the process in place in a jurisdiction to begin to evaluate energy code compliance. This methodology combines a qualitative assessment with a small data collection sample to compare qualitative data points to what is occurring in practice.

The qualitative evaluation is initiated by the third-party evaluator to provide an objective viewpoint assessment. Questionnaires (Appendix A. CEP Qualitative Assessment Tools) are used in interviews with building department staff and local designers and contractors in addition to onsite observations by the third party on how the enforcement process is working. The third-party evaluator will then work on collecting basic information on the plan review and field inspection processes. This data is collected on checklists (referred to as Data Collection Forms). Once complete, the third-party evaluator will review the findings of both the qualitative and quantitative assessment and develop a compliance plan with solutions to improve compliance and realize energy savings.

Level of Staff Involvement/Third-Party Support

In preparing to conduct a compliance assessment, jurisdictions will need to make decisions on the level of staff involvement and the role staff play in data collection, as well as the use of outside consultants.

The CEP Assessment Methodology encourages collaboration with building department staff starting in the data collection process. This provides an opportunity for staff to identify solutions to compliance issues, and to gain further education on the energy code and how it affects energy consumption in their jurisdiction. The CEP Assessment Methodology recommends using an outside consultant to interview staff and assess processes, train staff in data collection, provide oversight and quality assurance, and provide the final analysis and compliance improvement recommendations. This approach has the potential to reduce the costs of data collection while providing hands-on education for the building department staff.

A jurisdiction has several different options for conducting an energy code compliance assessment including:

- Third-Party/Staff Team Evaluation
- Staff Self-Evaluation
- Third-Party Evaluation

Each approach uses a slightly different strategy for conducting the assessment with varying advantages and disadvantages, as discussed on the following pages. In practice, many cities have preferred to have an outside consultant conduct the entire assessment, due to time and resource constraints.

Third-Party and Staff Team Evaluation (Recommended)

The CEP Assessment Methodology recommends a Third-Party and Staff Team model. Under this model the third party would conduct Phases 1 and 2 interviews and process evaluation, then provide initial oversight and training to the building department during the data collection phase. The in-house staff then collects data from the building plans and on-site inspections. During the data collection phase, the third party monitors the evaluation process and provides assistance when needed while the building department staff receives training on the evaluation process and the energy code. Finally, the third-party completes Phase 4, conducting analysis and developing a compliance improvement plan. The Third-Party and Staff Team Approach is recommended as an alternative to pure third party evaluation as it can reduce the cost of that evaluation by using the consultant in more targeted ways. The Third-Party Staff Team evaluation has the advantages of both the third party and self-evaluation assessment strategies, while minimizing the disadvantages associated with each.

Advantages

The third party can provide oversight into the evaluation process and reduce the bias typically associated with self-evaluation. Additionally, the overall cost is significantly less for the Third-Party and Staff Team approach, as opposed to costs for pure third-party evaluation. Evaluators have direct access to the building plans and construction projects, which enables

them to collect compliance data as the project progresses, reducing the number of assumptions that typically enter the collection process. Compliance issues and problems can be identified and reported immediately. Staff will increase their knowledge on the energy code over time as they evaluate their own work. The third party can be used to validate compliance barriers that may exist outside of the building department and even engage city leadership on developing solutions.

Disadvantages

The cost of a Third-Party and Staff Team evaluation is greater than self-evaluation by the building department, as a qualified third-party will need to be contracted to assist with the evaluation. This cost, however, is significantly less than a full third-party review. There may also be some residual bias since plan review and inspection will be performed by in-house staff, although the third-party oversight should reduce that problem.

Self-Evaluation

Self-evaluation, sometimes considered "first-party" evaluation, involves in-house plan review and inspection staff performing an energy code compliance assessment on their department. Self-evaluation can lead to biased results. For example, those conducting the evaluation may not accurately report compliance issues due to lack of training, or to protect the jurisdiction or staff member involved in the plan review or inspection of a project. As such, self-evaluation should not be used as a formal evaluation process. However, because the evaluator has direct access to building plans and the construction site, the quantity of "real" data collected can be significantly greater than third-party evaluation. The self-evaluation process allows plan review and inspection staff to collect on-site data as the building is being constructed versus visiting the site just once during the evaluation process.

Advantages

A self-evaluation can be conducted in-house with a minimal budget, as evaluators (plan review and inspection staff) have direct access to the building plans and construction projects.

Disadvantages

Self-evaluation can lead to subjective, biased results that may not accurately reflect issues within a jurisdiction. A common problem is the evaluator may not have training or experience in evaluating energy code compliance and therefore may lack the expertise necessary to determine compliance with the energy code—this can lead to inaccurate results.

A self-assessment may also make it difficult to address energy code compliance challenges that are caused by policies outside of the building department. For example, if the city council has set a policy to fast-track development to the detriment of energy code compliance, it may be difficult for building department staff to bring attention to such a policy. Finally, there may be reluctance on the part of code officials to expose low compliance rates which might reflect badly on the department.

Third-Party Evaluation

Third-party evaluation involves the use of an independent evaluator with no conflict of interest with the city, designers, or builders assessed as part of the project. Third-party evaluations eliminate bias in the evaluation process and produce objective results. The evaluator or evaluation team conducts the evaluation over a period of days, weeks, or months based on the depth of the evaluation. Evaluators complete all data both qualitative and quantitative data and evaluate and summarize the data prior to reporting to the city.

Advantages

The advantage of third-party evaluation is that it minimizes potential bias in producing an objective evaluation of the building department's processes. This type of evaluation also typically involves companies with expertise in the assessment of energy code compliance and requires less commitment by building department staff.

Disadvantages

Third-party evaluations can be expensive. Due to time and budget constraints for a typical third-party evaluation, most data must be collected from the construction site during one on-site visit per project. Although information is collected from the building plans, it is difficult to determine from the on-site visit if all measures comply with the energy code, or only those that are observed during the site visit under typical time constraints. Assumptions must then be made based on "typical construction practice" in the region to complete the data collection process. In addition, neither industry professionals nor code officials are included in the process, and much of the information gathered may not be effectively communicated between the third party and code officials.

Minimum Building Department Staff Responsibilities

Regardless of the approach selected, building department staff should anticipate at least a minimum level of participation to ensure successful completion of the evaluation. Staff need to provide a predetermined number of sets of commercial and residential building plans representing the defined sample. Additionally, building department staff need to arrange all site visits, and if possible accompany a third-party evaluator onto each project site.

PHASE 1: CONDUCT INTERVIEWS

To gain a full view of the compliance issues in a building construction process in a city, there are multiple stakeholders that need to be interviewed. Primary interviews are focused on building department plan review and inspections staff, designers, and general contractors or construction managers. Additional interviews may be conducted with other city staff, developers, consultants, third-party plan review and inspection companies, and specialty contractors (plumbing, mechanical, electrical) as identified as important by the city or through the primary interviews. Appendix A. provides sample interview questions to ask during a code compliance assessment.

BUILDING DEPARTMENT STAFF

Representative plan review and field inspection staff are interviewed to determine their perceived knowledge of the energy code and to determine what problems and issues they are having with the code. A minimum of two plan reviews, two inspectors and one supervisor should be interviewed. The evaluator may also consider interviewing the Chief Building Official.

The gap in knowledge will be the difference between the perceived knowledge and how well plan review and inspections are performed. An assessment is done on the types of training that staff have attended and reference books that they may use for assisting on the job. Questions are asked concerning the issues and problems that the design and construction communities are having with the energy code.

DESIGNERS

A sample of local architects and engineers are interviewed to determine their perceived knowledge of the energy code and to determine what problems and issues they are having with the code. To find participants, the evaluator should ask around the building department as well as reach out to local chapters of the American Institute of Architects, ASHRAE, and U.S. Green Building Council.

The gap in knowledge will be the difference between the perceived knowledge and the code compliance issues found in permit submissions. Questions are asked concerning the issues and problems that occur when interacting with the building department, and what type and quality of continuing education is pursued by design professionals related to the energy code.

GENERAL CONTRACTORS/CONSTRUCTION MANAGERS

A sample of general contractors or construction managers are interviewed to determine their perceived knowledge of the energy code and to determine what problems and issues they are having with the code. To find participants, the evaluator should ask around the building department as well as reach out to local chapters of Associated General Contractors, International Code Council, and National Association of Home Builders.

The gap in knowledge will be the difference between the perceived knowledge and the code compliance issues found in the field. Questions are asked concerning the issues and problems that occur when interacting with the building department, and what type and quality of continuing education is pursued by builders and contractors related to the energy code.

PHASE 2: REVIEW AND ASSESS PROCESS

To understand how the building department operates, the evaluator will review the process that a plan submittal takes from first contact through to final inspection and document storage. This information will be supplemented based on the interviews from both internal and external parties to look for efficiencies and best practices that could be adopted by the department. Internal processes can impact the ability to access accurate information about a project, which can lead to energy code compliance issues. This evaluation will assess the process used for both new construction and additions and alterations.

DOCUMENT SUBMITTAL AND PLAN REVIEW

Evaluators will begin by reviewing the initial documentation submitted for permit application. This stage of the evaluation is high level, looking at the type and completeness of the documentation submitted to complete a full energy code review, including:

- ✔ Wall, ceiling and floor details/wall sections
- ✔ Window and door schedules
- ✔ COMcheck or REScheck report(s)
- ✔ Mechanical schedules
- ✔ Lighting schedules

The evaluator will document the type and level of completeness of submittal documentation to perform an energy code review. Issues to be identified may include a lack of clarity regarding what information needs to be submitted and in what format, or receiving a project without all the required energy code documentation.

CORRECTIONS AND CODE DEFICIENCIES

During this stage, evaluators will review plans that have been reviewed by the building department staff, but not approved for permit. The evaluator will use the Data Collection Form to record information from the plans and documentation for a select building system and determine if the building system complies with the energy code. Code violations will be recorded on the Data Collection Form with the action taken by the plan reviewer to correct the violation. For example, if window U-factors identified on the plans are less efficient than what is called for in the code, the action taken by the plan reviewer would be that a correction notice was sent to the designer to correct the issue with an additional comment on the form once the code violation has been corrected.

ON-SITE INSPECTIONS

The field inspection process will be assessed to determine what tools are currently being used in terms of checklists, computers, etc., to guide the field inspection for the energy code. The third-party evaluator will accompany the field inspector through a typical energy inspection at each stage of construction to assess the inspection process for energy to determine what is reviewed and how. Projects will be selected that represent both new buildings and additions and alterations.

Issues to be identified may include a lack of clarity regarding what documentation needs to be on site for inspection compliance, inability to review approved plans before an inspection (especially for performance path projects), or lack of follow through on energy code violations.

DOCUMENT STORAGE AND RETRIEVAL

The department's document storage and retrieval process will be assessed as well. This includes evaluating the process of paper or digital storage of plans, and relative ease of retrieval for an inspector or other party to review after permit. Issues to be identified may include the storage of plans in such a way that it becomes difficult to retrieve the energy code documentation for inspection, reporting, or other needs.

PHASE 3: COLLECT DATA SAMPLE

The data collection phase applies a "building systems" approach. Data is collected on each of the three systems which comprise a building—envelope (roof, walls, and foundation), lighting, and mechanical/plumbing—as those systems are accessible. Data is collected from building plans for a building that will be at a stage in the construction process that reveals the system to be inspected during the time frame of the assessment. For example, if the mechanical system is going to be inspected, the ducts should not be covered with sheetrock at the time of inspection. Using a systems approach allows greater access to data in a shorter amount of time from several buildings compared to the whole-building approach, which requires multiple visits to a single building over the construction period to collect data on all systems from one building.

DEFINE THE DATA COLLECTION SAMPLE SET

To begin, the city should evaluate its capacity in terms of time and budget to support the assessment and selected the appropriate base sample. The sample is divided into two distinct groups of buildings, residential and commercial, based on the definition of each building type in the energy code:

- Residential buildings: low-rise (three stories or less) projects that include one-, two-, and multifamily homes. Fewer residential than commercial samples are proposed to reflect the typical proportion of residential and commercial buildings in a medium-to-large city.
- Commercial buildings: include multifamily residential buildings that are four stories and higher. Since cities tend to have a high percentage of large commercial buildings, including multifamily buildings taller than three stories, these building types are more highly represented than single-family residential structures.

There are three base samples. The advantages and disadvantages of each are laid out below:

Limited Sample

15 commercial building systems, and 10 residential buildings, shown in Table 3. Limited Sample.

Advantages

The advantage of the limited sample is that it allows for a cost and time effective process evaluation of the energy code enforcement in a city. The limited sample is good for cities that are interested in understanding a basic level of compliance and are interested in taking compliance improvement recommendations seriously.

Disadvantages

The limited sample is small. The number of building systems selected in this sample is not intended to be statistically valid. The size of this sample may not give a full view of the construction activity in a city.

Table 3. Limited Sample

BUILDING SYSTEM	SAMPLE SIZE			
COMMERCIAL NEW CONSTRUCTION				
ENVELOPE	2 PRESCRIPTIVE	2 COMCHECK	1 PERFORMANCE	TOTAL # OF ENVELOPE SYSTEMS: **5**
LIGHTING	2 RETAIL	2 OFFICE	1 OTHER BUILDING TYPES	TOTAL # OF LIGHTING SYSTEMS: **5**
HVAC/SERVICE WATER	2 SINGLE ZONE SYSTEMS		3 COMPLEX SYSTEMS	TOTAL # OF HVAC SYSTEMS: **5**
				TOTAL # OF SYSTEM SAMPLES: **15**
RESIDENTIAL NEW CONSTRUCTION				
ENVELOPE	2-3 SINGLE FAMILY		2-3 MULTIFAMILY	TOTAL # OF ENVELOPE SYSTEMS: **5**
LIGHTING	2-3 SINGLE FAMILY		2-3 MULTIFAMILY	TOTAL # OF LIGHTING SYSTEMS: **5**
HVAC/SERVICE WATER	2-3 SINGLE FAMILY		2-3 MULTIFAMILY	TOTAL # OF HVAC SYSTEMS: **5**
				TOTAL # OF SYSTEM SAMPLES: **15**

Standard Sample (Recommended)

35 commercial additions/tenant build-outs or alterations, 20 new commercial buildings, and 30 residential buildings, shown in Table 4.

Advantages

The advantage of the standard sample is that it takes into account a broader range of construction activity, focusing also on tenant fit outs and alterations, which account for a lot of the construction in medium to large cities. It is more comprehensive than the limited sample, and strikes the balance of time and cost compared to a true statistical sample.

The standard sample is good for cities who may have a dedicated energy plan review and inspection system in place and who have completed a basic assessment previously. The standard sample is also beneficial for cities looking to complete an energy modeling analysis, as it will provide more data points for a broader swath of construction.

Disadvantages

The time and cost will be greater than the limited sample. The number of building systems selected in this sample is not intended to be statistically valid.

Table 4. Standard Sample (Recommended)

BUILDING SYSTEM	**SAMPLE SIZE**			
COMMERCIAL ADDITIONS/TENANT BUILD-OUTS/ALTERATIONS				
ENVELOPE	3 PRESCRIPTIVE	2 COMCHECK		TOTAL # OF ENVELOPE SYSTEMS: **5**
LIGHTING	5 RETAIL	5 OFFICE	5 OTHER BUILDING TYPES	TOTAL # OF LIGHTING SYSTEMS: **15**
HVAC/SERVICE WATER	5 SINGLE ZONE SYSTEMS		5 COMPLEX SYSTEMS	TOTAL # OF HVAC SYSTEMS: **10**
				TOTAL # OF SYSTEM SAMPLES: **35**
COMMERCIAL NEW CONSTRUCTION				
ENVELOPE	2 PRESCRIPTIVE	2 COMCHECK	1 PERFORMANCE	TOTAL # OF ENVELOPE SYSTEMS: **5**
LIGHTING	5 RETAIL	5 OFFICE	5 OTHER BUILDING TYPES	TOTAL # OF LIGHTING SYSTEMS: **10**
HVAC/SERVICE WATER	2 SINGLE ZONE SYSTEMS		3 COMPLEX SYSTEMS	TOTAL # OF HVAC SYSTEMS: **5**
				TOTAL # OF SYSTEM SAMPLES: **20**
RESIDENTIAL NEW CONSTRUCTION				
ENVELOPE	5 PRESCRIPTIVE	5 RESCHECK/PERFORMANCE		TOTAL # OF ENVELOPE SYSTEMS: **10**
LIGHTING	10 LIGHTING SYSTEMS			TOTAL # OF LIGHTING SYSTEMS: **10**
HVAC/SERVICE WATER	10 HVAC SYSTEMS/SERVICE WATER			TOTAL # OF HVAC SYSTEMS: **10**
				TOTAL # OF SYSTEM SAMPLES: **30**

Statistical Sample

Determined based on analysis of city building stock, permit data and a working group or Delphi panel.

Advantages

The statistical sample is most likely to give a report that can be used to estimate energy (and potentially) carbon savings for a city. The statistical sample is recommended for cities that are serious about meeting climate goals and need to obtain verifiable data to understand the impact that buildings will have on meeting those goals.

Disadvantages

Completing a statistically valid sample is time consuming. There will be increased time upfront analyzing the city building stock and determining the sample itself, and the added time and cost in gathering and analyzing plan review and inspections data required for the assessment report.

Two to three years of permit data should be collected and evaluated to appropriately distribute the sample across building types, new construction vs. alteration projects, and potentially geography in the city. This data will be used to customize the sample to meet the goals of the city undertaking the assessment. Samples can be further customized based on interest in frequency of occurrence and/or focus on largest users of energy. It is recommended that frequency of occurrence take precedence over large energy users unless the city has appropriate benchmarking data to understand the energy use target.

Other factors go into determining the building sample as well. The CEP Assessment Methodology recommends the following be taken into account when developing the jurisdiction sample for limited and standard[9] sample sets:

- **Unique building types.** It is recommended that projects that are unique to the jurisdiction (only one building of its type will be built) should be avoided when selecting the sample. If pursuing the limited sample, it is critical to avoid unique buildings. Cities pursing the standard sample may opt to include one unique building.
- **Additions and alteration projects.** If alterations are selected for the sample they should be complex enough to elicit interest given the scope of the evaluation. Since renovation rather than new building construction is more common in cities, the recommended standard sample for alterations is comparatively high. Cities using the limited sample are recommended to focus on new construction only. Evaluation of new construction projects will involve full systems instead of partial, and the lessons learned can be translated to smaller renovation projects.
- **Above-Code Programs.** It is recommended that the projects selected not be participants in an above-code program such as LEED or ENERGY STAR. Due to the proliferation of these programs, this may not be feasible, or may not produce an accurate sample, in some areas. Cities should take into account the percentage of construction that pursue above code programs and tailor their sample to reflect the same level of participation where possible.

COLLECT PLAN REVIEW DATA

The quantitative evaluation process will review for code compliance in the documentation submitted and approved plans for permit. Data will be collected on the City Energy Project Data Collection Forms and values will contribute to the overall estimated compliance rate. If using energy modeling, data will also be used to construct the appropriate models for analysis.

The evaluator will assess the same project plans that were reviewed for completeness on submittal and held for deficiency comments after they were approved. Selected projects will be in a stage of construction that will allow a system to be inspected in the field. For example, if a project is selected for review of the lighting system, it will be important that the building be in a stage of construction where the system components are installed in the field.

If conducting the assessment with a disengaged sample (see Scoping Modifications below) the plans reviewed may be from different buildings to fulfill the initial and approved plan review samples.

If staff is collecting data rather than the third-party evaluators, a third party should perform a mid-point assessment when 50 percent of the plan review samples are complete to provide feedback to the jurisdiction on the findings to date.

Plan Review Methodology

The CEP Assessment Methodology uses a basic plan review process for determining compliance with the energy code. The evaluation follows a process common for plan review of energy code submittals:

- ✓ Verify that compliance documentation is complete and accurate. This includes prescriptive compliance submittals, COMcheck or REScheck documentation, or performance approach submittals.
- ✓ Verify that compliance documentation matches the building plans.
- ✓ Verify that the information is contained in the building plans,

specifications, and supporting documentation to show compliance with the energy code.

There are three types of energy code compliance options for a construction project:

- ✔ Prescriptive
- ✔ Envelope Trade-off (for example, COMcheck or REScheck)
- ✔ Performance

Each of the options available to demonstrate compliance requires a slightly different approach when reviewing submittal documents.

Prescriptive Compliance

The Data Collection Forms can be used to document compliance using the prescriptive approach. ASHRAE also provides forms for documenting compliance for the prescriptive requirements for commercial buildings. If no code compliance form is present with the building plans, the plans and specifications must be assessed to determine if compliance with the energy code is achieved. The Data Collection Forms, can be used to guide the plan reviewer through verifying compliance with the code using the steps below:

- **Building envelope:** Use the minimum prescriptive R-values for insulation and maximum fenestration U-factors from the energy code to populate the minimum code requirements on the Data Collection Form. Review the plans to determine both the proposed insulation R-values for each assembly and window U-factors, and determine if the proposed value meets or exceeds the minimum requirements. All deficiencies should be recorded on the Data Collection Form and be listed as part of a correction notice. In addition, verify that the plans and specifications reflect the requirements for the building envelope that are not related to insulation and fenestration. Record all information on the Data Collection Form and identify the deficiencies.
- **Mechanical and Service Water Heating:** Verify that the proposed HVAC and service water heating (SWH) systems comply with the provisions of the energy code. Record all deficiencies on the Data Collection Form.
- **Building lighting system:** Verify that the lighting power density proposed in the building is less than or equal to the allowed lighting power density. Also verify that the lighting controls and other non-lighting power related lighting features comply with the energy code. Record all deficiencies on the Data Collection Form.

COMcheck and REScheck Compliance

DOE COMcheck and REScheck software provides forms for documenting compliance with the energy code. If a project complies with the COMcheck or REScheck compliance approach, the levels of efficiency for different measures can be used from the COMcheck or REScheck form to complete the Data Collection Form. When completing the Data Collection Form, use the proposed values in the COMcheck or REScheck documentation to populate the minimum code requirements for the building envelope, HVAC, SWH, and lighting requirements. Use either the COMcheck or REScheck printout or energy code to verify that the plans and specifications provide the information needed to verify compliance with the code.

Performance Compliance

The energy codes require documentation that provides a summary of the building input file and associated output file when using the performance approach. Documentation from the software varies, but the steps used to evaluate COMcheck documentation can be used to complete the Data Collection Form. As with the COMcheck documentation, the minimum code requirements are the proposed values in the software.

COLLECT INSPECTION DATA

The on-site data collection portion of Phase 3 will assess code compliance for components of the systems evaluated prior. The field inspector will perform the on-site data collection during each inspection performed (e.g., foundation, framing, rough-in of mechanical, etc.). The goal is to determine if the installed energy features meet the minimum energy code requirements listed on the Data Collection Forms used for the plan review portion of the CEP evaluation.

The field inspector will record all findings when the job site is first visited for each inspection. An installation will either comply or not comply with the code. The action taken shall be recorded on the Data Collection Form for all features that do not comply with the code. For example, if the foundation insulation is found to be non-compliant with the energy code, the action recorded would be that a correction notice was given to the contractor to correct the violation. Any additional actions for the violation should be recorded on the Data Collection Forms until the feature is compliant.

If staff is collecting data in Phase 3 rather than the third-party evaluators, the third party should perform a mid-point assessment when 50 percent of the field inspection samples are complete to provide feedback to the jurisdiction on the findings to date.

SCOPING MODIFICATIONS

The CEP Assessment Methodology allows for flexibility in the implementation of Phase 3. The process outlined above is considered to be the standard implementation of the methodology. Cities needs vary, and the following options are considered to be acceptable for implementation, and will yield results that are equally beneficial to the implementing city:

Disengaged Sample

The jurisdiction may choose to modify and complete plan review and inspections samples simultaneously and across different buildings.

Issue: Data collection at three construction stages (initial submittal, final plan review, and construction) of a building system necessitates a long time span. If time is an issue for a jurisdiction, or the jurisdiction has different needs, the samples can be disengaged. This approach will reduce the time frame of the evaluation, though it will eliminate the opportunity to compare findings across stages of construction.

Solution: Conduct plan review discretely from inspection phase.

Data Collection Reversal

The jurisdiction may choose to modify and complete the plan review and inspections in reverse order.

Issue: Constructions starts are variable, and targeting the correct buildings in a large sample may prove to be difficult if not impossible for structuring site visits on projects that have undergone plan review already. This may increase time and travel required to fulfill the sample.

Solution: Conduct the assessment by reversing the inspections and plan review phases. The building department should still target buildings at the correct stage of construction to fulfill the sample, but this shift will ensure that no extra time is spent reviewing plans of a project that might not be available or at the correct stage of construction for inspection.

DATA COLLECTION TOOLS

Phase 3 of the CEP Assessment Methodology builds on data collected using forms based the DOE Data Collection Forms. The City Energy Project Codes Methodology Assessment Data Collection forms are available by visiting the City Energy Project Resource Library.

The residential data collection forms provided are based on the DOE Data Collection Sheets for the 2009 and 2012 International Energy Conservation Code (IECC) released in 2015; the commercial data collection forms are based on the compliance checklists developed for the 2009 and 2012 IECC released in 2015. The DOE forms have been modified to collect both plan review and field data, as well as to calculate the data collection phase piece of the compliance score.

The Data Collection Forms are intended for use by evaluators to gather the appropriate information on energy code compliance. These forms generally reflect the energy code provisions that can be reviewed either during the plan review process or in the field and include instructions for proper use and recording results.

The Data Collection Forms collect a variety of information that is crucial to determining whether a building complies with the code. They list the code section number, as well as the building component being inspected, along with a column for the value proposed in the building plans and the observed value of the component installed in the field. This information can be used to inform the magnitude of the compliance issue, and modeling cumulative energy savings due to non-compliance. For example, if the minimum code requirement was R-20 + R-5 wall insulation and all the insulation installed was R-19, installing slightly more efficient insulation would solve the problem at a minimal cost. However, if the installed insulation is R-13, a change in framing to “2x6” and additional insulation may be needed, resulting in a greater cost.

Based on the data collected from the plan reviews and field inspections, compliance for each component is determined from the compliance options listed in the Data Collection Form. Columns to record assumptions and observations are also included in the forms and can help inform the evaluation results. For example, a project may show continuous insulation for an exterior concrete wall with insulation installed between metal furring strips. The installation would not comply with the code, but the issue could be solved for future projects through training and education. The Data Collection Forms also include areas where the evaluator can record the actions necessary to correct any errors observed in the plan review and field inspection.

No matter which method of plan review and inspection is implemented, all data must be gathered before moving to Phase 4.

PHASE 4: FINAL REVIEW OF DATA

Both qualitative and quantitative assessments are important, and work in tandem to comprehensively identify the issues facing the jurisdiction. For example, a qualitative assessment may reveal that insulation inspections are not being conducted because of budget cuts and too few staff. A quantitative assessment may identify that insulation R-values are non-compliant in many installations. Developing a solution that requires the inspector to verify that the installed insulation R-value matches the energy code documentation will not solve the compliance problem if there is no insulation inspection. Effective solutions must be tailored to address the specific barriers faced by the city.

Data and information will be analyzed to determine the informal rate of compliance, potential energy savings due to non-compliance, issues found during the collection process and other helpful feedback. There are several components to the final review and reporting.

QUALITATIVE ANALYSIS

Findings from the interviews and the checklists should be discussed in terms of frequency and impact. Based on findings, consider addressing the following areas:

- Program Staffing
- Use of Third Parties
- Plan Submittals
- Documentation
- Plan Acceptance
- Additions, Alterations, and Repairs Guidance
- Electronic Data Storage and Retrieval
- Site-Built Windows
- Lighting Controls
- Overall Training and Education
- Integration of Energy Code Plan Review and Inspection

COMPLIANCE SCORE

The overall compliance score for a city is based on several factors, both qualitative and quantitative, discovered through the assessment. The evaluator should weigh each phase of the assessment and grade the city on information gained from interviews, process evaluation and data collection equally. The data collection portion of the score can be calculated directly in the Data Collection Forms. The compliance score provides a measurable point of comparison for a city, but it does not provide an indication of energy savings lost (increased energy spent) due to non-compliance.

It is important to note that the compliance score is not intended to act as an energy code compliance rate nor is it intended to supersede compliance methodologies recommended by the U.S. Department of Energy. Compliance information collected through this methodology can feed into larger statewide compliance studies.

CUMULATIVE INCREASED ENERGY USE DUE TO NON-COMPLIANCE

Calculating the cumulative increased energy use due to non-compliance provides the jurisdiction with the localized cost of non-compliance, based on energy rates, building types (e.g. residential, commercial-retail, commercial-office, etc.), and construction trends.

Construction permit data is needed to calculate cumulative energy impacts. For example, in a CEP Assessment that was limited to commercial buildings, the project team used the jurisdiction's construction permit data which showed the square footage of construction for each of the building types in the evaluation. Energy lost per square foot of building area was estimated based on cumulative energy lost per occupancy and the floor area of the prototype buildings used in the EnergyPlus analysis.

Commercial

Cumulative 20-year potential energy savings for fully compliant commercial buildings can be modeled using DOE'S building prototypes to calculate the differences in energy use for compliant and non-compliant buildings, based on findings from Phase 3—field inspection. Using industry standard modeling techniques, the project team can modify the ASHRAE 90.1 based prototypes to reflect the jurisdiction's base code, and local building practices, such as typical glazing area. The models are then again modified to reflect evaluation findings to allow for comparison between code and assessment evaluation findings. Finally, an estimate for energy use is calculated assuming all buildings under construction had similar compliance issues as were documented in Phase 3. Energy lost can be determined for the total floor area under construction for each occupancy type.

Residential

Cumulative, 20-year potential energy savings for fully compliant residential buildings can be calculated using Energy Plus,

REMDesign, REMRate, or similar software in which energy use for a building is calculated. Like the analysis described for commercial buildings, findings from Phase 3 are applied to a standard home which reflects typical residential construction in the jurisdiction. An estimate for energy use is calculated assuming all residences under construction had similar compliance issues as were documented in Phase 3. Energy lost can be determined for the total residential floor area under construction on an annual basis. The annual energy lost is then extrapolated out 20 years to estimate the cumulative energy savings lost for the current floor area under construction.

COMPLIANCE IMPROVEMENT PLAN

This information will be used to determine an internal course of action to mitigate the compliance issues in concert with the results of the qualitative analysis mitigate the compliance issues identified through quantitative and qualitative analysis. A recommendation should be included for each point addressed in Phase 4: Qualitative Analysis. For more information on how to establish an energy code compliance plan, see the City Energy Projec resource, Establishing a Plan to Achieve Energy Code Compliance in Cities.

ONGOING QUALITY ASSURANCE

Cities maximize the benefits of undertaking the CEP Assessment Methodology when they undertake periodic quantitative assessments, beginning one year after the completion of the initial assessment and then every two to three years thereafter. The results of the initial qualitative assessment should be reviewed as part of the ongoing evaluation to assess progress in implementing procedural changes. Additionally, an ongoing quantitative assessment will provide continued feedback to the city.

Cities should consider using third parties to provide this sort of continuous improvement, but those third parties could be either outside consultants or a plan review or inspection staff member who has participated in the evaluation process.

Where the city conducts periodic quantitative assessments, the CEP Assessment Methodology recommends using 50 percent of the sample size from Table 2. Staff Time for Assessment, Standard and Limited Sample Size based on the building system types and types of projects.

RESOURCES

- ASHRAE, Standard 90.1–2013 User's Manual, available at http://www.techstreet.com/ashrae?ashrae_auth_token=
- The Institute for Market Transformation and Natural Resources Defense Council, "City Energy Project Data Collection Forms," updated in November 2017, available at www.cityenergyproject.org/resources
- The Institute for Market Transformation and Natural Resources Defense Council, "Establishing a Plan to Achieve Energy Code Compliance in Cities," available at http://www.imt.org/resources/detail/establishing-a-plan-to-achieve-energy-code-compliance-in-cities
- International Code Council, 2009 International Energy Conservation Code and ASNI/ASHRAE/IENSNA Standard 90.1– 2007 Energy Standard for Buildings Except Low-Rise Residential Buildings, available at http://shop.iccsafe.org/codes/2009-international-codes/2009-international-energy-conservation-code-1.html
- International Code Council, 2012 International Energy Conservation Code and ASNI/ASHRAE/IENSNA Standard 90.1–2010 Energy Standard for Buildings Except Low-Rise Residential Buildings, available at http://shop.iccsafe.org/codes/2012-international-codes/2012-international-energy-conservation-code.html
- International Code Council, 2009 IECC Code and Commentary, available at http://shop.iccsafe.org/catalogsearch/result/?order=relevance&dir=desc&q=IECC+Commentary
- International Code Council, 2012 IECC Code and Commentary, available at http://shop.iccsafe.org/catalogsearch/result/?order=relevance&dir=desc&q=IECC+Commentary
- Indiana Department of Commerce, Energy and Recycling Division, "Indiana Commercial Energy Code Baseline Study," March 21, 2005, available at https://www.energycodes.gov/sites/default/files/documents/bp_indiana_commercial_energy_code_baseline_study.pdf
- U.S. Department of Energy, "Achieving the 30% Goal: Energy and Cost Savings Analysis of ASHRAE Standard 90.1–2010," May 2011, available at https://www.energycodes.gov/sites/default/files/documents/BECP_Energy_Cost_Savings_STD2010_May2011_v00.pdf
- U.S. Department of Energy Building Energy Codes Program, Compliance Evaluation Checklists, available at https://www.energycodes.gov/compliance/evaluation/checklists

APPENDIX A: CEP QUALITATIVE ASSESSMENT TOOLS

Building Department Interview

- Agency _____
- Jurisdiction served _____
- Name of person completing survey _____
- Title of person completing survey _____
- Email address _____
- Telephone number _____
- Surveyor _____
- Date _____

	QUESTION	RESPONSE
1	**NUMBER OF COMMERCIAL BUILDING PERMITS ISSUED PER YEAR**	
2	**HOW IS YOUR JURISDICTION FUNDED? (CHECK ALL THAT APPLY)**	○ Permitting Revenue ○ Jurisdictional Budget ○ Funding from the State ○ Other
3	**DOES EVERYONE IN YOUR DEPARTMENT HAVE ACCESS TO A COPY OF THE ENERGY CODE?**	
4	**HOW OFTEN DO YOU REFER TO ANY ENERGY CODE?**	
5	**HOW OFTEN DO YOU REFER TO THE OTHER BUILDING CODES?**	
6	**WHO CONDUCTS ENERGY CODE PLAN REVIEWS? (CHECK ANY THAT APPLY)**	○ In-house staff ○ Third-party entities ○ Other jurisdictions or government agencies ○ Not done ○ Other
7	**WHO CONDUCTS FIELD INSPECTIONS FOR ENERGY CODE COMPLIANCE? (CHECK ANY THAT APPLY)**	○ In-house staff ○ Third-party entities ○ Other jurisdictions or government agencies ○ Not done ○ Other
8	**WHAT LEVEL OF EDUCATION AND TRAINING DO YOU AND/OR YOUR AGENCY STAFF RECEIVE SPECIFICALLY FOR RESIDENTIAL ENERGY CODES?**	○ *High*—Professional certification by ICC or similar credentials. Receives annual training on the energy code. ○ *Medium*—Receives periodic training on the energy code. ○ *Low*—Receives on-the-job training on the energy code but seldom receives formal training ○ *None*—Energy codes training is never provided

	QUESTION	RESPONSE
9	**WHAT LEVEL OF EDUCATION AND TRAINING DO YOU AND/OR YOUR AGENCY STAFF RECEIVE SPECIFICALLY FOR COMMERCIAL ENERGY CODES?**	○ *High*—Professional certification by ICC or similar credentials. Receives annual training on the energy code. ○ *Medium*—Receives periodic training on the energy code. ○ *Low*—Receives on-the-job training on the energy code but seldom receives formal training. ○ *None*—Energy codes training is never provided.
10	**IF TRAINING IS RECEIVED, HOW IS IT DELIVERED? (CHECK ALL THAT APPLY)**	○ Classroom ○ In the field ○ Webinar/Online ○ Other
11	**HOW WOULD YOU PREFER TO RECEIVE YOUR TRAINING?**	
12	**IF TRAINING IS RECEIVED, DO YOU FEEL THE TRAINING IS WORTHWHILE AND YOU LEARNED WHAT YOU NEEDED TO LEARN?**	
13	**IS THERE ANY SPECIFIC TRAINING YOU WOULD WANT TO RECEIVE THAT WOULD BENEFIT YOU IN YOUR JOB?**	
14	**WHAT METHODS ARE USED AS A BASIS FOR DOCUMENTING ENERGY CODE COMPLIANCE IN COMMERCIAL BUILDINGS AND IN WHAT PERCENTAGES?** NOTE: INCLUDE COMCHECK SUBMISSIONS FOR TRADE-OFF PERCENTAGE**.**	Prescriptive Trade-off Performance
15	**HOW MUCH TIME (IN HOURS) IS DEVOTED TO THE AVERAGE PLAN REVIEW FOR RESIDENTIAL ENERGY CODES?**	
16	**HOW MUCH TIME (IN HOURS) IS DEVOTED TO THE AVERAGE PLAN REVIEW FOR COMMERCIAL ENERGY CODES?**	
17	**HOW MUCH TIME (IN HOURS) IS DEVOTED TO THE AVERAGE FIELD INSPECTION FOR RESIDENTIAL ENERGY CODES?**	
18	**HOW MUCH TIME (IN HOURS) IS DEVOTED TO THE AVERAGE FIELD INSPECTION FOR COMMERCIAL ENERGY CODES?**	
19	**WHAT MAJOR ISSUES IMPEDE YOUR ABILITY TO ENFORCE THE ENERGY CODE FOR RESIDENTIAL BUILDINGS?**	
20	**WHAT SUGGESTIONS WOULD YOU GIVE TO IMPROVE THE ENFORCEMENT OF THE ENERGY CODES FOR RESIDENTIAL BUILDINGS?**	
21	**WHAT MAJOR ISSUES IMPEDE YOUR ABILITY TO ENFORCE THE ENERGY CODE FOR COMMERCIAL BUILDINGS?**	
22	**WHAT SUGGESTIONS WOULD YOU GIVE TO IMPROVE THE ENFORCEMENT OF THE ENERGY CODES FOR COMMERCIAL BUILDINGS?**	
23	**DESCRIBE YOUR PROCESS FOR REVIEWING PLANS FOR ENERGY CODE COMPLIANCE.**	
24	**DESCRIBE YOUR PROCESS FOR REVIEWING ENERGY FEATURES IN THE FIELD FOR COMPLIANCE WITH THE ENERGY CODE.**	
25	**HOW WOULD YOU IMPROVE THIS PROCESS?**	

Designer/Contractor Interview

- Company _____
- Name of person completing survey _____
- Title of person completing survey _____
- Email address _____
- Telephone number _____
- Surveyor _____
- Date _____

	QUESTION	RESPONSE
1	**NUMBER OF RESIDENTIAL AND COMMERCIAL BUILDING PROJECTS COMPLETED EACH YEAR?**	
2	**HOW OFTEN DO YOU REFER TO ANY ENERGY CODE?**	
3	**HOW OFTEN DO YOU REFER TO THE OTHER BUILDING CODES?**	
4	**WHOM DO YOU RELY ON FOR ENERGY CODE EXPERTISE?**	○ In-house Staff ○ Consultants ○ Building Department ○ Not done ○ Other
5	**WHAT LEVEL OF EDUCATION & TRAINING DO YOU AND/OR YOUR STAFF/ COLLEAGUES RECEIVE SPECIFICALLY FOR ENERGY CODES?**	○ *High*—Professional certification by ICC, AIA or similar credentials. Annual training on the energy code. ○ *Medium*—Receives periodic training on the energy code. ○ *Low*—Receives on-the-job training on the energy code but seldom receives formal training. ○ *None*—Energy codes training is never provided.
6	**IF TRAINING IS RECEIVED, HOW IS IT DELIVERED? CHECK ALL THAT APPLY**	○ Classroom ○ In the field ○ Webinar/Online ○ Other
7	**HOW WOULD YOU PREFER TO RECEIVE YOUR TRAINING?**	
8	**IF TRAINING IS RECEIVED, DO YOU FEEL THE TRAINING IS WORTHWHILE AND YOU LEARNED WHAT YOU NEEDED TO LEARN?**	
9	**IS THERE ANY SPECIFIC TRAINING YOU WOULD WANT TO RECEIVE THAT WOULD BENEFIT YOU IN YOUR JOB?**	
10	**WHAT METHODS ARE USED AS A BASIS FOR DOCUMENTING ENERGY CODE COMPLIANCE IN COMMERCIAL BUILDINGS AND IN WHAT PERCENTAGES? NOTE: INCLUDE COMCHECK SUBMISSIONS FOR TRADE-OFF PERCENTAGE.**	Prescriptive Trade-off Performance
11	**WHAT MAJOR ISSUES IMPEDE YOUR ABILITY TO APPLY THE ENERGY CODE TO YOUR PROJECTS?**	
12	**WHAT SUGGESTIONS WOULD YOU GIVE TO IMPROVE THE ENFORCEMENT OF THE ENERGY CODES BY THE BUILDING DEPARTMENT?**	
13	**DESCRIBE THE BUILDING DEPARTMENT PROCESS FOR REVIEWING PLANS FOR ENERGY CODE COMPLIANCE.**	

14	**HOW WOULD YOU IMPROVE THIS PROCESS?**	
15	**WHO DO YOU BELIEVE IS ULTIMATELY RESPONSIBLE FOR ENERGY CODE COMPLIANCE IN BUILDING PERMIT DOCUMENTS (PLANS, SPECS, ETC)?**	
16	**DESCRIBE THE BUILDING DEPARTMENT PROCESS FOR REVIEWING ENERGY FEATURES IN THE FIELD FOR COMPLIANCE WITH THE ENERGY CODE.**	
17	**HOW WOULD YOU IMPROVE THIS PROCESS?**	
18	**WHO DO YOU BELIEVE IS ULTIMATELY RESPONSIBLE FOR ENERGY CODE COMPLIANCE IN THE FIELD?**	

APPENDIX B: REVISIONS TO THE CEP ASSESSMENT METHODOLOGY

The 2017 and 2018 releases of the CEP Assessment Methodology are intended to provide clarity and offer updates to increase the value of compliance assessment to the jurisdiction. Technical revisions in 2017 include:

- The CEP data collection forms have been updated for the 2015 IECC.
- The CEP residential data collection forms have been updated to gather data on actuals values, in addition to pass-fail notations. For example, if the code requires R-19 insulation and R-13 observed, in addition to marking "does not comply", the value 13 is recorded.
- A minimum sample size is defined as 15 commercial systems and 10 residential buildings.
- Cumulative energy savings lost due to non-compliance is calculated, modeled in EnergyPlus using DOE prototype buildings for commercial buildings and REMRate/REMDesign Energy Plus or software program with similar capability to calculate energy use—modified for findings in the field, Phase 3, and extrapolated for 20 years based on construction data.
- An option to disengage the sample. Ideally the projects reviewed in plan intake, plan review and in the field will all be the same projects. Regardless of sample size, this tends to draw out the time needed to complete the assessment. Samples may now be taken to fulfill the plan and a specific project does not need to be followed from beginning to end.

Technical revisions in 2018 include:

- Three potential samples are identified.
- Additional guidance is provided around selecting the sample.
- An option to reverse the plan review and inspection phases is included.
- Phases have been re-arranged to emphasize process evaluation.
- Interviews of designers and contractors are now included, along with an interview tool.
- Additional guidance is provided around building department process evaluation.

APPENDIX C: SAMPLE COMPLIANCE ASSESSMENT REPORT

BACKGROUND

The purpose of this study was to evaluate the city's energy code enforcement practices, determine an overall compliance score and provide suggestions for improvement. This was accomplished by interviewing key stakeholders in the design and construction industry as well as building department staff, evaluating permitting and inspections processes and performing energy plan reviews and conducting inspections on a limited number of buildings. The compliance score is based on the results of interviews, process evaluation and the data collected compared to the energy code that the city has adopted and is currently enforcing.

Note that the data collection phase of this study was based on a stripped down process that looked at only eight projects.

QUALITATIVE FINDINGS

Qualitative information was collected and used to better understand the city's overall process and potential for increased compliance with the energy code. A brief survey was conducted at the beginning of the site visit and additional questions and observations were made throughout the visit. Qualitative information collected is summarized in Table 1. Qualitative Findings.

Table 1. Qualitative Findings

AREA EVALUATED	DESCRIPTION OF FINDINGS
NUMBER OF COMMERCIAL BUILDING PERMITS ISSUED PER YEAR	Approximately 15,000 to 20,000.
NUMBER OF PLAN REVIEW STAFF	Approximately 20. The building department is set up as a "one-stop shop." Once the plans are submitted, all reviews are completed simultaneously. The plan review staff is also responsible for review of the fire code.
DIVISION OF DISCIPLINES FOR PLAN REVIEW	Separate plan reviews are conducted for each discipline (e.g. structural, mechanical, electrical, and plumbing). Each discipline reviews energy as part of its review.
NUMBER OF INSPECTION STAFF	25 to 30 staff members
DIVISION OF DISCIPLINES FOR INSPECTION	Inspection staff is divided into separate disciplines similar to plan review. Staff is divided into mechanical, plumbing, electrical and structural inspections. Energy is reviewed in the field applicable to each inspection. There are no combination inspectors.
DOCUMENTATION TYPE	The majority of documentation submitted is for the performance approach with fewer projects using the prescriptive compliance approach.
TIME DEVOTED TO ENERGY REVIEW DURING PLAN REVIEW	Time is dependent on complexity of project, with more complex projects taking longer time. Times range from 15 minutes to one hour or more.
TIME DEVOTED TO ENERGY REVIEW DURING FIELD INSPECTION	Time is dependent on complexity of project, with more complex projects taking longer time. Times range from 15 minutes to one hour or more.
GREATEST PLAN REVIEW ISSUE (ENERGY)	Moisture related issues are the biggest issues faced by the city. Moisture impacts energy for the building envelope. Termites are another issue that the jurisdiction must overcome. Termites pose a potential problem for the installation of foam insulation at- or below- grade.
GREATEST NEED	Training on the energy code was the greatest need cited by the Building Official. Specifically, targeted training is needed for building department staff and industry.
CODE INTERPRETATIONS	All formal interpretations are made at the state level, but the building official has the ultimate authority for code interpretations.
POTENTIAL FOR INCREASING EFFICIENCY OF CODE AT THE LOCAL LEVEL	It is possible for the city to adopt a more stringent or stretch code but this would need to be approved at the state level.

OTHER OBSERVATIONS	The city has informally designated one inspection staff member as their "energy code person." This staff member serves on the state advisory committee for the energy code and is looked upon as the in-house resource for the energy code. One inspector/plan reviewer was assigned to assist in the site visits for this study. The staff person was new to the department. The inspector was very knowledgeable about codes and mechanical and plumbing codes in general. He had a working knowledge of the energy code. The division manager was responsive to new ideas for the department (e.g. the adoption of a stretch code). He had a working knowledge of the energy code and had performed energy modeling simulations in his architectural practice prior to his position with the city. He is going to be responsible for setting up electronic plan storage for the building department and was very receptive to ideas concerning consistent nomenclature and filing, which was found to be an issue in other compliance studies when it came to locating energy code compliance documentation for the project.

REVIEW PROCESS

The city's building department was asked to provide nine commercial building projects to complete the compliance study. The buildings represented typical commercial projects being built within the city and were to be at a stage in the construction process where a portion of the efficiency features used for energy code compliance could be evaluated. At the time of the study, only eight building projects fitting the criteria were available. The building type and floor area of each project are listed in Table 2.

Buildings were evaluated following the data collection protocol as described in the U.S. Department of Energy (DOE) document, "Measuring State Energy Code Compliance (Compliance Protocol)." Additionally, DOE's 2009 International Energy Conservation Code (IECC) Commercial Data Collection checklist was modified to reflect the city's energy code and was used for on-site data collection for both the plan review and field inspection phases of the project.

PLAN REVIEW

The goal of the plan review portion of the compliance study was to determine if the building plans submitted were in compliance with the city's energy code. The data collection checklist described above was used as a guide throughout the review process and whenever feasible, the energy code documentation was used to complete the form. In instances when energy code documentation was not available, it was assumed that the building used the prescriptive approach to comply with the energy code and was therefore compared against the prescriptive requirements. Energy code compliance documentation was then evaluated for each of the projects using either a performance approach or a prescriptive approach.

FIELD INSPECTION

Following the completion of the plan review portion of the compliance study, four building projects were selected for field inspections, including:

- Auto Dealership
- Bakery/Restaurant
- High-rise Residential
- Lodging/Hotel/Motel

The remaining four projects were not visited for various reasons: two of the projects were at framing stage and did not have energy features installed, another project was complete but the building could not be accessed, and the final project consisted of a tenant improvement with minimal modifications that were impacted by the energy code.

Table 2. Building Type and Floor Area (Sq. Ft.)

BUILDING TYPE	FLOOR AREA (SQUARE FEET)
Other (Bakery/Restaurant)	4,576
Restaurant/Dining/Fast Food	5,967
Healthcare Center	6,531
Retail/Mercantile	8,568
Retail/Mercantile	15,532
Other (Auto Dealership)	53,648
Lodging/Hotel/Motel	104,885
High-Rise Residential	369,500

Two additional buildings were visited that were not part of the plan review: a medical classroom building and a performing arts building. Information collected from these additional buildings during the field inspections was accounted for in the findings and considered when developing recommendations.

To determine the level of compliance of each building the data collection checklist was used to gather information on the individual efficiency features of the building. For energy code features that had either not been installed or were installed and inaccessible, the "Non-Observable" option was selected. For example, lighting systems were typically deemed "Non-Observable" as the buildings were not at a stage where the final lighting systems had been installed.

FINDINGS

Plan Review Process

Project types in the city range from multi-building hotel complexes with large central cooling plants, to performing arts buildings that use district cooling for space conditioning, to small strip mall shopping centers. The variety of project types requires those reviewing the plans for compliance with the energy code to be well versed in requirements for several different system types and configurations. The plan review staff is subdivided into mechanical, electrical, plumbing, and architectural/structural disciplines with each group reviewing the energy provisions that pertain to their area of expertise. The time spent reviewing for energy code compliance is dependent on the size and complexity of the project.

Documentation

Energy modeling software was commonly used for determining commercial energy code compliance for complete projects (e.g. plans are submitted for architectural, mechanical, water heating and lighting review). The software provides a summary of the levels of efficiency for each of the building's systems and pass/fail documentation of the various features found in the buildings. It also allows users to demonstrate compliance with envelope requirements using the prescriptive method.

All performance-based software documentation (including COMcheck) requires training to understand which parameters are important and which parameters will not affect the energy use of the building. There were some instances where the terms used in the energy modeling software were different from what is used in the energy code. For example, the lighting documentation uses the term "control points" to help document lighting controls in the space. For a person unfamiliar with the documentation, linking the documentation back to the building plans could be difficult.

Plan Review

Conducting a plan review on each of the eight commercial buildings provided insight into compliance issues associated with documentation, fenestration, HVAC load calculations and lighting controls. The findings for the plan reviews are included in the following tables: Table 3. Building envelope; Table 4. Mechanical; Table 5. Lighting; and Table 6. Documentation.

Table 3. Building Envelope Plan Review and Inspection

BUILDING ENVELOPE	
PLAN REVIEW	
Information on Building Plans / Assembly R-values	Often there was not sufficient information shown on the building plans to determine if an assembly complied with the energy code. For example, roof insulation thickness was shown on the plans but a minimum R-value was not indicated. Wall insulation R-value was also not routinely identified on the plans. One project called out an R-29.7 for a wall system (metal stud wall) in the performance documentation which was not represented on the building plans.
Information on Building Plans / Fenestration Efficiency	Often there was not sufficient information shown on the building plans to determine if an assembly complied with the energy code, including information on SHGC and glazing U-factor. For example, the calculations indicated a fenestration U-factor of 0.27 but this information was not included on the plans.
Cool Roof/ Roof Absorptance	Building plans did not typically include maximum roof absorptance for roof systems or cool roof membranes. Cool roof membranes were routinely viewed on-site when available. It is assumed that the membranes meet the intent of the code.
INSPECTION	
Windows	NFRC 100 and 200 certificates were not present for site-built windows to demonstrate the rated U-factor and SHGC for the product
Wall Insulation	When the performance compliance documentation was available, the insulation on the plans matched what was shown on the compliance documentation.
Air Sealing	Air sealing requirements were called out on the plans for two projects. Evidence of air sealing was found onsite for projects that were at the air sealing/insulation stage.
Insulation Installation	Insulation installation quality was good for the type of insulation viewed on site.

Table 4. Mechanical

MECHANICAL	
PLAN REVIEW	
Testing & Balance	Testing and balancing requirements were present on plans.
HVAC Efficiency	High efficiency equipment was documented routinely in performance documentation. The efficiencies of the systems shown on the plans were consistent with what was included in the performance documentation.
INSPECTION	
Ducts Insulation	Duct insulation R-values were code compliant on site.
Duct Sealing	Duct sealing was compliant for the ducts that were viewed on site.
Piping Insulation	Piping for HVAC systems were insulated to meet the code requirements for all systems viewed on site.
HVAC Controls	HVAC controls that were viewed on site met the intent of the energy code requirements.

Table 5. Lighting

LIGHTING	
PLAN REVIEW	
Fixture Wattages	The fixture wattage shown in the performance documentation was not accurate for type of bulb/fixture shown on the plans for one project. However, the proposed lighting on the plans for the building was less than what was shown in the lighting compliance documentation so the building was still in compliance.
Lighting Controls	General lighting controls complied with the code for all projects. Lighting controls for day lit spaces was routinely not accounted for in the lighting projects. Daylighting controls were called out on one project with high glass area.
Automatic Lighting Shut-off	Automatic lighting shut-off was called out on at least one project. Occupancy sensors were used to meet the requirement on another project. Information was insufficient on other projects to determine if automatic lighting shut-off was included.
Task Lighting Controls	Task lighting was routinely controlled separately where required by code.
INSPECTION	
High-Efficacy Lighting	High-efficacy lighting was installed in dwelling units for the high-rise multifamily project per the energy code.

Table 6. Documentation

DOCUMENTATION	
PLAN REVIEW	
HVAC Load Calculations	HVAC load calculations or signed summary sheet were not available for review on all applicable projects and it was unclear if they were submitted with the plans (Section 503.2.1).
Compliance Form A	It is unclear if Compliance Form A is being submitted for projects that are complying prescriptively or for alterations and renovations. Two projects reviewed were alterations and no documentation was present during the review of the plans.

COMPLIANCE SCORES

The overall compliance score is 67. This score combines work across the three phases of the assessment, each explained for the city below.

Interview compliance scores take into account the interviewees working knowledge of the code, perception of the building permitting and construction process, and compares those to the processes evaluated and results of the data collection phase. The overall compliance scores for interviews is 64. The score was lower for building department staff due to the wide range of energy code knowledge, and contractors due to the unfavorable perception of inspections that matched with inspection issues found in the data collection phase.

Process compliance scores take into account the consistency and ease of each process for permitting, inspections and document storage. Notes on each are presented in the table below that contributed to the score in each section.

Data collection compliance scores were compiled using the DOE Store and Score methodology. Compliance was determined by using both the information found in the field that was observable and, when not observable, the information collected from the building plans. Overall, the compliance score was highest for the medical center, which was an alteration. Very little was changed on the overall building other than lighting. Compliance was found to be lowest for the restaurant. There were no calculations with the building plans so prescriptive compliance was assumed, potentially resulting in a lower compliance score. The overall compliance score for data collection is 65. However, the compliance score may have been higher had the energy code documentation been present with the plans.

Table 7. Compliance Scores

COMPLIANCE SCORES			
PHASE 1	**INTERVIEW 1**	**INTERVIEW 2**	**INTERVIEW 3**
Designers	85	72	70
Building Department Staff	75	50	62
Contractors	60	60	45
PHASE 2	**SCORE**	**CONTRIBUTING FACTORS**	
Intake	85	• No standard checklists • High-level of consistency • Rate of submission of all documentation for energy review at intake is low	
Plan Review	40	• Conflict between reviewers on critical items • Level of knowledge of reviewers has broad range • No standard checklists • Reviewers share copies of energy code books	
Inspection	71	• Level of knowledge of inspectors has broad range • No standard checklists • Limited time devoted to energy code issues in field	
Document Storage	100	• All documents stored electronically • Easy to retrieve and review	
PHASE 3	**FLOOR AREA (SQUARE FEET)**	**COMPLIANCE SCORE**	**BUILDING TYPE**
Building 1	8,568	83	Retail/Mercantile
Building 2	6,531	100	Healthcare Center
Building 3	5,967	50	Restaurant/Dining/Fast Food
Building 4	53,648	71	Other (Auto Dealership)
Building 5	4,576	57	Other (Bakery/Restaurant)
Building 6	369,500	58	High-rise Residential Building
Building 7	104,885	81	Lodging Hotel/Motel
Building 8	15,532	75	Retail/Mercantile

Table 8. Compliance Scores Recommendations

COMPLIANCE SCORES RECOMMENDATIONS	
RECOMMENDATIONS	
Energy Code Plan Submittals	It is not clear that all of the documentation is being submitted during plan review that is required by the city's energy code. A checklist can be developed for use by the city that provides a list of specific items to be submitted for permit. The city should specify what needs to be included on the plans as well as clearly communicate submittal requirements on its website.
Energy Modeling Software Plan Review Guide	A plan review guide should be developed for use to better understand the energy modeling software reports. A similar guide was developed for the COMcheck reports and is very effective in walking the plan reviewer step-by-step through what to review on the plans.
Overall Training and Education	Energy code training and education is critical for implementation of the energy code. Training for plan review and inspection staff on various energy code issues will increase both the knowledge of the energy code and the energy code compliance rate. Given the types of projects reviewed, suggested training should include sessions on complex mechanical systems. The training should be divided into the following topics: • Scope and application • Architectural • Mechanical/plumbing • Lighting Field inspection training should also be deployed to ensure that the higher efficiency features called out on the building plans are being installed in the field.
Site-Built Windows	NFRC certificates for site-built windows should be required for all installations. Installing fenestration that does not meet the energy code requirements can significantly impact the cooling load of the building. Installing non-compliant fenestration can also result in improperly sized heating and cooling systems in the building if used in the HVAC requirements to size equipment as required by the energy code. The requirements for NFRC certificates can be phased in over time to ensure that the fenestration providers have the time to supply the rated products. This would include training and education for the building, design and enforcement industry. Product information showing window U-factors and SHGC values for all proposed window products should be required at plan review. NFRC certificates should be required at time of inspection for all site built products prior to the installation of the product.
Lighting Controls	Education should be provided to plan review and inspection staff on meeting the lighting controls requirements in the energy code, including specific education on the sections relating to controls for daylight zones and non-daylight zones. The Northwest Energy Efficiency Alliance has developed training specifically for lighting designers and control suppliers that focuses on compliance with the lighting control requirements. Training should also be provided to plan review and inspection staff.
Develop and Implement a Stretch Code	The development of a stretch code that would increase the efficiency of the city's current commercial code is recommended. Stretch code elements could come from ASHRAE 90.1-2013, the 2015 IECC and the IgCC. Given the complexity of the projects built in the city, the plan review and inspection staff has the expertise to enforce a more advanced code. A proposed stretch code would need to go through state approval but would be worth the investment.

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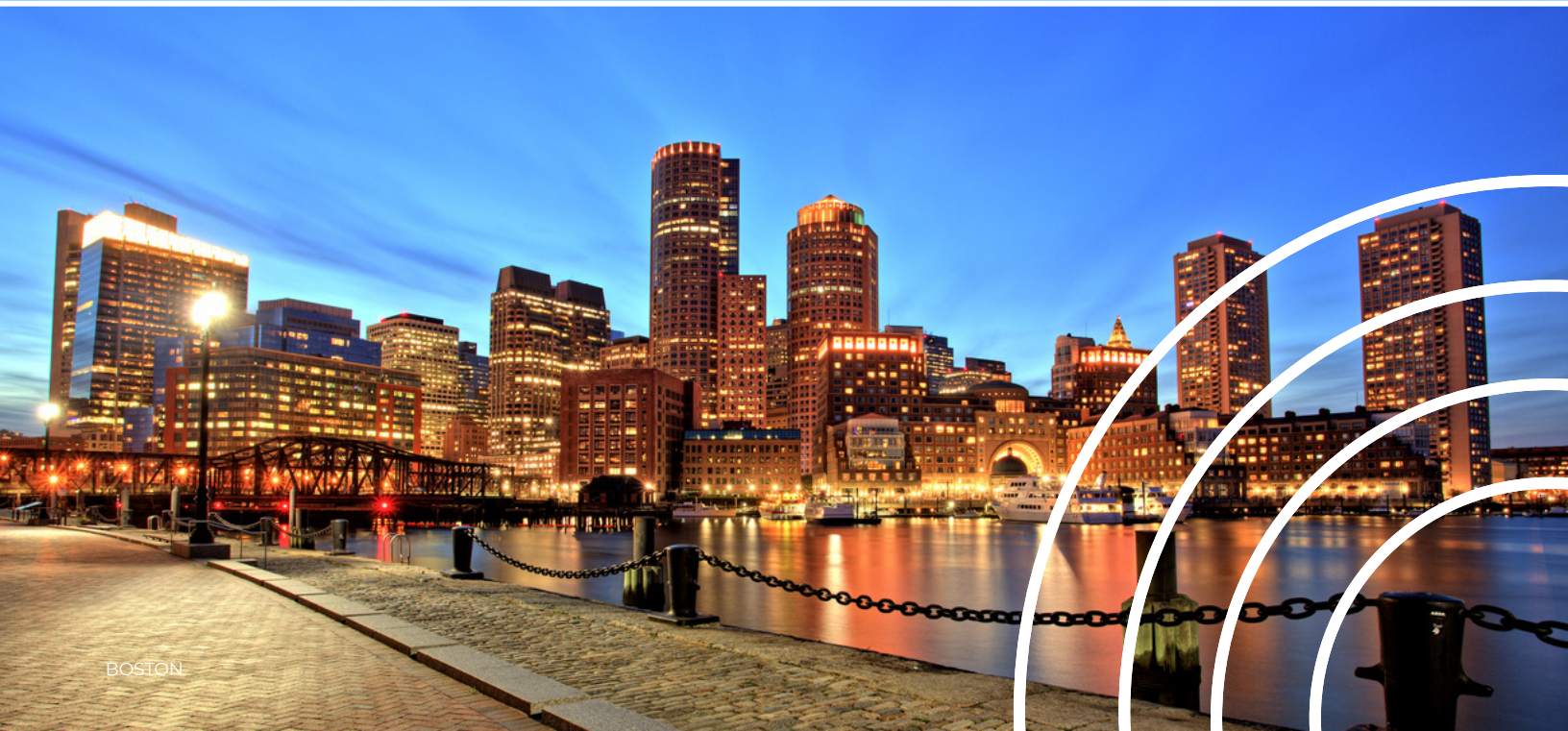

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