EEB HUB Energy Efficient Buildings Hub

REPORT

Gaps in the Application of the Energy Code in Existing Commercial Building Modifications in the EEB Hub Region

June 2013

This report was prepared by the Building Codes Assistance Project at the Alliance to Save Energy and United Technologies Research Center. Any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the EEB Hub or the U.S. DOE.

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EXECUTIVE SUMMARY

Building energy codes and standards are essential tools to ensuring that new buildings meet minimum levels of performance with respect to energy consumption. They are also applied when existing buildings are modified, although only to the areas impacted (subject to exemptions under certain conditions). But there is evidence that buildings – both existing and new – are not achieving the code-mandated energy performance when they are built or renovated due to lack of full compliance with code requirements. Many factors contribute to this shortfall, and this report identifies those that are relevant to existing commercial buildings based on analysis of practices in the greater Philadelphia region (which the EEB Hub defines as five counties in New Jersey and five counties in Pennsylvania) (**Figure 1**). This report identifies the underlying causes of slippage. Leveraging research performed by the Building Codes Assistance Project (BCAP) for the Commonwealth of Pennsylvania in 2012, we identify ways in which the code application and enforcement processes can be improved to ensure that existing buildings reach their energy savings potential when intervention opportunities arise. We also conducted interviews and surveys of stakeholders in the region, reviews of municipal building department web sites in the region, and an analysis of New Jersey and Pennsylvania building code regulations.

Figure 1: Map of the EEB Hub Region

The purpose of this study is to:

1. Provide detailed documentation and analysis of the existing building renovation process in order to characterize and quantify "code slippage" (the gap between energy savings potential and the savings actually achieved). The goal will be to identify unique strengths and weaknesses of the region's energy

code[1] adoption & implementation infrastructure, and policies with regard to existing commercial buildings.

2. Recommend actions that stakeholders in the building industry and local jurisdictions can take to improve the implementation of the energy code and ensure greater compliance.
3. Evaluate potential methodologies to estimate the impact that the proper application of the energy code can have on the energy saving potential of existing mid-size commercial buildings in the region.

INTRODUCTION

IMPORTANCE OF ENERGY CODES

The operation of residential and commercial buildings (space heating, cooling, ventilating, lighting, domestic hot water heating, running appliances and various electrical devices, etc.) accounts for over 43 percent of the total energy consumption and 76 percent of electricity use in the United States. Estimates show that on average, 30 percent of the energy consumed by commercial buildings is wasted. Some of this waste, such as the unnecessary usage of lighting and mechanical systems when a building is unoccupied, can be limited through better building management. However, much of the wasted energy is a result of inefficient building systems and equipment. One of the most effective ways to combat the wasted energy that leads to poor building performance is through the application of energy codes, which establish a minimum level of performance for new buildings and for alterations to existing buildings. The application of building energy codes and standards to existing buildings also progressively improves the energy efficiency of such buildings as they undergo modifications throughout their life cycle, because new systems installed in existing buildings are generally required to meet the energy code in effect at the time of installation. Codes do not address plug load equipment (efficiency regulated primarily by federal appliance standards) or occupant behavior.

The total U.S. building stock is approximately 275 billion square feet, and every year approximately 5 billion square feet of residential and commercial floor space is renovated in the United States. By the year 2035 it is estimated that renovated buildings will represent nearly 38 percent of the entire U.S. building stock, and approximately 75 percent of the building stock will be either new (built between now and 2035) or renovated.[1] With such opportunity to raise the compliance standard for so many buildings, it is important to ensure that codes are properly applied so that existing buildings meet their performance potential.

Commercial buildings are an important piece of the energy consumption picture. There are more than 81 billion square feet of existing commercial floor space in the United States, and approximately 74 percent of the commercial building stock was built before 1989.[2] In the EEB Hub region, approximately 77 percent of the mid-size commercial buildings (not including high-rise multi-family buildings) were constructed prior to 1990.[3] Based on the age of the building stock, many were constructed when there were no energy code requirements or the energy codes were substantially weaker than current ones. Therefore, energy consumption of buildings could certainly be much lower if these buildings met more current energy codes and standards in the region.

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[1] For the sake of simplicity, the term “code” is used to refer broadly to adopted building regulations; including the IECC, ASHRAE Standard 90.1.

There is evidence that building codes are not resulting in the energy savings they are intended to produce. For example, compliance pilot studies conducted by DOE have shown that compliance with the energy code is very inconsistent nationwide. In this project our interest lies in the application of energy codes during building modifications. We believe there are opportunities to improve the application of codes so that the full benefits that are intended are actually realized. Though energy codes are designed to meet certain levels of performance, many factors throughout the process often contribute to code slippage. While code development and adoption are the necessary first steps of the energy codes process, they alone do not guarantee compliance. The other issues that play an important role in ensuring compliance and preventing code slippage is proper application and enforcement of the energy code. To ensure that energy codes accomplish their potential to reduce energy use and save money; there must be a level of understanding and collaboration among stakeholders in the building industry, and local governments must design and carry out effective energy code implementation strategies.

METHODOLOGY

Although this report devotes some attention to the general subject of codes and building modifications, it focuses on the situation present in the Hub region, which allows us to examine specific details and the variability that exists among municipalities, among stakeholders and between the two states of Pennsylvania and New Jersey. We also have access to the Hub's network of contacts with stakeholders in the region to help streamline data collection.

A note on terminology: Existing buildings can be changed in a number of ways during their lifetimes. In the most general sense we refer to these simply as "modifications." Modifications encompass a variety of activities, including renovations, repairs, alterations, additions, and change of use. These terms have specific meanings that are defined within the codes and standards, so to avoid confusion we will generally refer to modifications unless a specific meaning is intended.

This project consists of a number of different elements that have led to the generation of recommendations and conclusions. First, a preliminary report was assembled to present preliminary research and to outline the goals, state hypotheses, and explain our approach to the project. In the second phase of the project, a survey was developed and circulated to relevant stakeholders, and phone interviews were conducted with stakeholders who work directly in the application of the energy code. Utilizing the EEB Hub's local connections, interviewees were chosen from a collection of regional stakeholders that represented each of the relevant groups (architecture, construction, engineering, enforcement, developers/owners). The feedback received from the interviews was analyzed – along with additional research – to identify gaps and opportunities in the code application process. Though only a limited number of formal interviews were conducted; the insights from the interviews and survey results supported the secondary research and provided a basis to further engage stakeholders.

Feedback for the interviews was also used to gain an understanding of the building modification process from the perspective of those parties directly involved. By documenting the roles and responsibilities of each group throughout the process, it was possible to map out the process and identify when gaps and opportunities arise and which stakeholders may be best suited to address them.

The information collected and the analysis performed in this report will be presented to stakeholders as part of several workshop sessions. These sessions are designed to initiate further discussion on the perceived gaps and opportunities, and to identify resources and strategies to take actionable steps in addressing the gaps.

ORGANIZATION OF THE REPORT

Following this introduction, the report is arranged in the following sections:

Building Modifications and Energy Codes explains the framework under which building energy codes are developed and how modifications to existing buildings are treated under the codes. The requirements pertaining to alterations are examined for both the ASHRAE 90.1 standard and the International Energy Conservation Code, the two nationally recognized protocols adopted by states. This section concludes with a discussion of the adoption of energy codes by both Pennsylvania and New Jersey and how these two states address building modifications.

Overview of the EEB Hub Region (pgs. 7-15) summarizes the current state of the regional existing commercial building market. It also describes the demographics of the municipalities in the region and the different approaches they use to implement the building code. Through research and interviews, regional market barriers to the application of the energy code are identified.

Implementation of the Energy Code (pgs. 15-22) includes a step-by-step account of the building modification process and identifies the role of each key stakeholder group. Gaps and opportunities for the energy code to be integrated more effectively are identified. Interviews with local stakeholders help to provide a detailed perspective of the existing commercial building renovation process.

Enforcement of the Energy Code (pgs. 22-23) describes the status of code enforcement in the region, and identifies some of the common barriers that are present in code enforcement. In-depth interviews provide a look into the enforcement process and the efforts of several jurisdictions in the region. Combined with the feedback from stakeholders in the building industry, barriers and best practices in code implementation are identified.

Potential Savings from Energy Codes (pgs. 23-31) discusses the methodologies currently used to determine lost energy savings due to noncompliance with the building energy code. The specific challenges to applying these methodologies to existing buildings are identified.

Gaps & Opportunities (pgs. 31-34) lists the gaps and challenges that were discovered through our interviews with stakeholders, and provides recommendations to address these gaps.

Policy Opportunities and Above Code Programs (pgs. 34-38) explores the possibility of leveraging policy to achieve the compliance with energy code requirements on a broader range of existing building construction projects. It also summarizes several programs which incentivize energy efficiency and push for energy efficiency requirements beyond that of the codes.

Conclusion (pgs. 38-39) summarizes conditions in the region, our findings, and explains the next phase of our work.

OVERVIEW OF THE EEB HUB REGION

This section provides a description of the region in terms of the commercial building stock, the characteristics of its municipalities, and the different approaches used to implement the building energy code.

Building codes are ultimately administered at the municipal level, triggered largely by the requirement to obtain a building permit for various construction activities. Therefore it's important to understand the characteristics of municipalities in the region. There is a broad spectrum in terms of population growth; population density;

commercial development activity; industrial, commercial and residential land use; socioeconomics; governance models, age of building stock, etc. Some municipalities have more resources to implement codes and more mature administrative processes in place than others. There may be different compliance climates depending on location. Interviews for this project attempted to capture information from a representative sample of the different types of municipalities.

EXISTING BUILDING MARKET

Current economic conditions have made alterations and the reuse of existing buildings much more attractive than in the past. Renovations to existing buildings account for the majority of building activity in the region. For example, in the five-county New Jersey portion of the Hub region, 67% of all permitted construction value in 2012 was for renovation work. In many of the New Jersey municipalities, renovations constitute more than 90% of all permitted construction activity. To put these figures into perspective, in 1996 47% of the estimated construction costs authorized by permits in the entire state of New Jersey were attributed to existing building modifications, and this percentage was higher than in most states at that time.[4]

Estimates show that on average, 30 percent of the energy consumed by commercial buildings is wasted. Some of this waste, such as the unnecessary usage of lighting and mechanical systems when the building is unoccupied, can be limited through better building management. However, much of the wasted energy is a result of inefficient building systems and equipment. One effective way to combat the wasted energy that leads to poor building performance is through the application of energy codes.

The age distribution of the mid-size commercial building stock in the region (**Figure 2**) suggests that there is an opportunity to accomplish significant energy savings through energy retrofits and the application of the current energy code to the buildings constructed before 1990. This case for energy retrofits is further supported by the fact that the average energy expenditures in the EEB Hub region are 29 percent higher than the national average. Though age and energy efficiency are not necessarily directly correlated, age provides a point of reference with which to compare the effectiveness of energy code requirements.

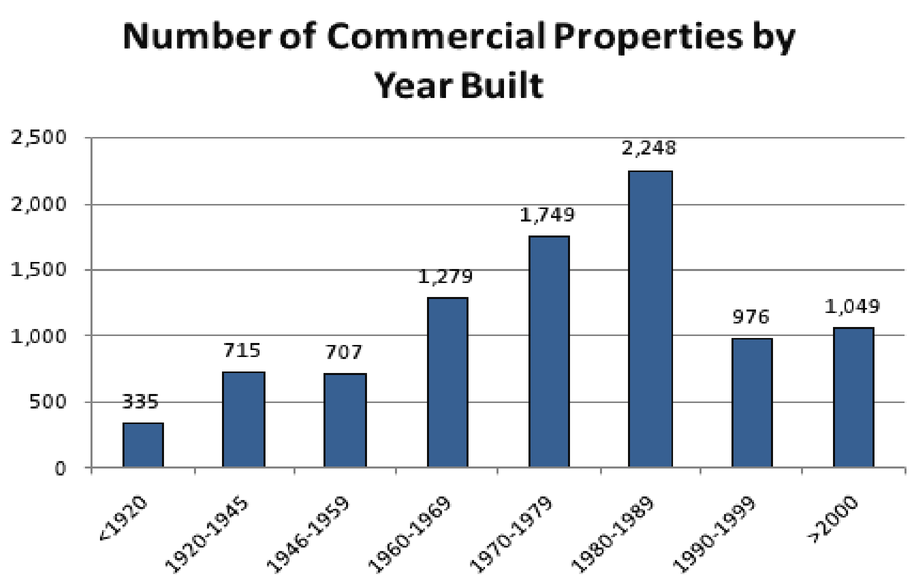

Figure 2: Number of Commercial Properties in the EEB Hub Region by Year Built (Source: CoStar)

Certain municipalities in the region have older building stocks than others, suggesting that they may have greater opportunities for energy efficiency gains as long as modifications are in full compliance with the energy code. Since our source of information on when buildings were constructed (CoStar) only goes down to the county level, we looked at population growth patterns at the municipal level as a proxy for the average age of the building stock. For example, in Montgomery County, Pennsylvania, the following boroughs had a population pre-1930 that was greater than or equal to their population in 2010: Bridgeport, Conshohocken, Jenkintown, Narberth, Norristown, and West Conshohocken. Consequently, the age of the building stock in these municipalities tends to be quite old, and therefore unlikely to possess many of the energy efficiency characteristics required by today's codes. In contrast, Montgomery Township's population in 1990 was only 49% of its 2010 population (i.e., population doubled in 20 years), suggesting that its building stock has many relatively new structures that would have been constructed in accordance with energy code requirements. **Figure 3** shows how municipalities in the region are distributed relative to one another in terms of building stock age. Based on this information, New Jersey appears to have an older building stock than Pennsylvania. The differences among municipalities in terms of the age of the building stock suggests that building departments need to account for the differing requirements that would be encountered between a stock of older buildings versus a stock of newer buildings.

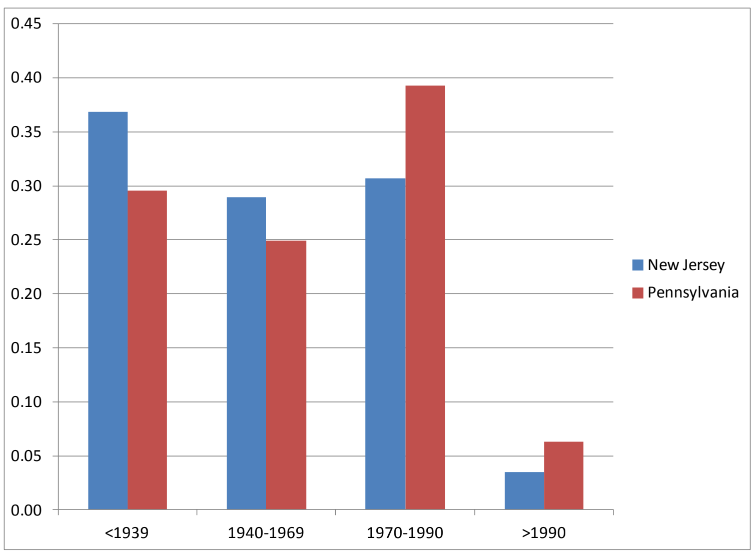

Figure 3: Fraction of Municipalities According to Average Age of Building Stock (source: analysis of DVRPC data on population trends)

Another factor to consider when examining the commercial building stock is the type of buildings that are represented in the region. The larger towns and cities in the EEB Hub region grew off an industrial base, which is apparent in the distribution of property types (**Figure 4**). However, it is important to note that there is an inverse relationship between energy consumption and the number of properties. Searching for correlations between building type, energy consumption, and building age could prove to be very useful in identifying areas with a high potential for energy savings.

Type	Energy Consumption	No. of Properties
Flex- Industrial	45	4,762
Office	93	2,249
Retail	99.5	1,738
Hospitality	100	159
Healthcare	188	150
Average	**91**	

Figure 3: Annual Energy Consumption by Property Type in the EEB Hub Region (Source: Buildings Energy Data Book, U.S. Department of Energy)

MULTIFAMILY

Multi-family structures are not represented in the figures above. Multi-family buildings of more than three stories are treated as commercial buildings under ASHRAE 90.1 and the IECC and are consequently subject to the requirements of commercial codes. For the City of Philadelphia, approximately 68 percent of building stock is residential and 32 percent of the residential building stock is comprised of apartments and condos, which likely fall under the requirements of ASHRAE 90.1.[5] The Philadelphia Housing Authority is the nation's fourth largest public housing authority, owning more than 14,000 affordable housing units and serving nearly 80,000 residents of Philadelphia. The public housing segment represents a significant opportunity to make an impact on a large scale because it represents a numerous properties under one owner.

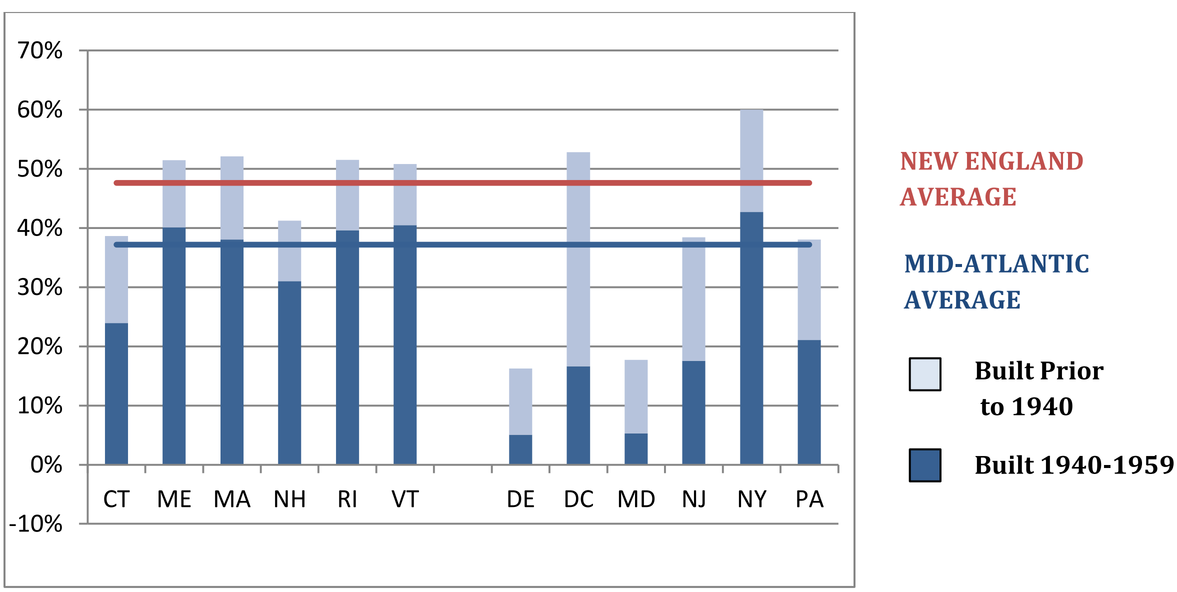

Figure 4: Percentage of small multifamily rental stock more than 50 years old. (Source: HR&A, U.S. Census Bureau)

The diversity of the multifamily market introduces challenges that are less common in other commercial building types. Diversity in ownership is one issue discussed later in this report; smaller owners typically have more volatile cash flows and less access to capital which makes it difficult to make energy related investments. Another issue is the diversity of the building stock itself. There are many variations in the configurations, construction, and building systems in the multifamily building stock that require specialized solutions. This diversity supports the need for more coordination and integrated design in the application of the energy code.

OVERVIEW OF BUILDING ENERGY CODE

The main focus of this report is to methodically examine the process used by design professionals, contractors, builders, municipal building departments and others in complying with and enforcing building energy codes for alterations and renovations. To set the stage and provide some context, however, this section first offers the reader an overview of the codes themselves – for example, the types of alterations exempt from code requirements and other aspects unique to existing buildings. Consequently, this section briefly explains the Federal government's role in establishing national energy standards for buildings, identifies those aspects of the International Energy Conservation Code (IECC) and American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Standard 90.1 relevant to alterations, and discusses their relationship to one another.

Also in this section, we review the codes adopted at the state level in the Hub region, including the Pennsylvania Uniform Construction Code (UCC) and Energy Code, and the New Jersey UCC, Energy Subcode, and Rehabilitation Subcode. In addition, we describe the state regulations on code implementation, and the qualifications, training, certification and recertification requirements for code officials in each state. These state codes, subcodes, and regulations define the environment that municipalities in the Hub region operate under when administering building energy codes. Despite the common framework that exists in each state, municipalities still take different approaches to administration depending on various factors. The variation at the municipal level is discussed later in the report.

NATIONAL ENERGY STANDARDS AND STATE ADOPTION

Energy codes and standards are a relatively recent phenomenon in the history of building codes, fire codes, plumbing codes and associated standards in the United States, some of which date back to the 1600s. It was not until 1992 that the Energy Policy Act (EPAct) mandated all states review and consider adopting the national model energy standard, which at that time was ASHRAE Standard 90.1-1989 for commercial buildings. Those states that chose to adopt the standard and incorporate it into their building codes did so at various times after 1992. New Jersey, for example, adopted it in 1995; however, Pennsylvania did not do so until 2004. Since 1992, ASHRAE has revised Standard 90.1 five times, with 90.1-2010 being the most current version, although New Jersey and Pennsylvania codes both refer to 90.1-2007. To put this in perspective, buildings still operating under the requirements of ASHRAE 90.1-1989 are estimated to consume 45 percent more energy than those complying with ASHRAE 90.1-2010.[6] Alterations, renovations, and remodels, however, were not addressed in the original energy codes. These activities have only been covered by the IECC since 2000 and by ASHRAE 90.1 since 1999.

While there is no federally-mandated minimum standard for energy efficiency in private residential or commercial buildings, the IECC and ASHRAE 90.1 are updated every three years under a consensus-based process to establish baselines for residential and commercial development respectively. Though recognized as the residential model energy code, the IECC also addresses commercial buildings and makes reference to the ASHRAE 90.1 standard as an alternative compliance path. Although the IECC and ASHRAE 90.1 are not identical, they have similar requirements that produce comparable results in terms of energy efficiency. Consequently, if a state adopts the IECC, then by default the option to use ASHRAE 90.1 is also available (e.g., IECC 2009 refers to 90.1-2007). (If a state specifies ASHRAE 90.1 in its code, however, the IECC is not used as an alternative.)

States that want to ensure construction within their boundaries meets national minimum standards will adopt the national model codes. The responsibility for adopting energy codes is generally left to state governments. Municipalities are then required to either enact an ordinance adopting the state code or they may defer implementation to the state.

Under the American Recovery and Reinvestment Act (ARRA), Section 410(a), states are required to develop and implement a plan, including training and enforcement provisions, to achieve at least 90 percent compliance with the national model energy code (2009 IECC or greater) by 2017. In response, some states have undertaken compliance studies to determine current compliance rates. However, the end of ARRA funding has made it challenging to progress these efforts.

> **GAP: With the end of Recovery Act funding and due to a shortage of funding in general, there is: 1) reduced staff size; 2) less energy code training being offered; and 3) difficulty in hiring 3rd party energy code inspectors.**
>
> **Opportunity:** State and local governments may need to be creative in their fund-raising and the pursuit of funding opportunities. Though the statewide funds of ARRA are no longer available, municipalities can still seek smaller scale funding opportunities to assist in their compliance efforts.

HOW ASHRAE STANDARD 90.1 ADDRESSES MODIFICATIONS

ASHRAE 90.1 requires alterations of existing buildings to comply with specific provisions for the following:

- envelope alterations (Section 5),
- alterations to heating, ventilating, and air conditioning (Section 6),
- service water heating alterations (Section 7),
- lighting alterations (Section 9), and
- alterations to other building service equipment or systems (Section 10).

Under 90.1, "alteration" is defined as "*a replacement or addition to a building or its systems and equipment*." Routine maintenance, repair, and service, and changes in the building's use classification or category are not considered alterations.

However, a variety of alterations are defined that do not require compliance. Exceptions from the requirements, for example, are made for alterations to designated historical buildings. Further, "*where one or more components of an existing building are being replaced, the annual energy consumption of the comprehensive design shall not be* *more than the annual energy consumption of a substantially identical design, using the same energy types,"* subject to verification by a design professional. Additional exceptions are identified below for specific classes of alterations.

ENVELOPE ALTERATIONS

Alterations to the building envelope must comply with the requirements for insulation, air leakage, and fenestration applicable to those specific portions of the building that are being altered.

Exceptions are made for the following scenarios:

- Installation of storm windows over existing glazing, replacement of glazing in existing sash and frame, and replacement of existing fenestration as long as the area replaced does not exceed 25% of the total fenestration area and the U-factor and SHGC are no worse than before the replacement.
- Wall, floor and roof cavities that are already insulated to full depth with insulation having an R-value of at least 3 per inch, when the existing structure has no framing cavities and no new cavities are created, and when a roof membrane is replaced and the roof sheathing or roof insulation is not exposed.
- The replacement of an existing door separating conditioned space from the exterior, which does not require a vestibule or revolving door to be added.

ALTERATIONS TO HEATING, VENTILATING, AND AIR CONDITIONING IN EXISTING BUILDINGS

- New HVAC equipment as a direct replacement of existing HVAC equipment must comply with the specific minimum efficiency requirements applicable to that equipment
- New cooling systems installed to serve previously uncooled spaces must comply with requirements according to the compliance path option
- Alterations to existing cooling systems must not decrease economizer capability unless the system complies with the prescriptive requirements for economizers
- New and replacement ductwork must comply with insulation and duct sealing requirements
- New and replacement piping must comply with insulation requirements
-

Exceptions are made for:

- HVAC equipment that is being modified or repaired but not replaced, as long as the modifications and/or repairs will not result in an increase in the annual energy consumption of the equipment using the same energy type
- Cases where a replacement or alteration of equipment requires extensive revisions to other systems, equipment or elements of a building and such replaced or altered equipment is a like-for-like replacement
- Refrigerant change or relocation of existing equipment
- HVAC ducts and pipes where there is insufficient space or access to meet the requirements

SERVICE WATER HEATING ALTERATIONS TO EXISTING BUILDINGS

Building service water heating equipment installed as a direct replacement for existing building service water heating equipment must comply with the requirements applicable to the equipment being replaced. New and replacement piping must comply with the requirements for service hot-water piping insulation. Exceptions are made for situations where there is insufficient space or access to meet the requirements.

LIGHTING ALTERATIONS

The replacement of lighting systems in any building space shall comply with the lighting power density requirements applicable to that space. New lighting systems must comply with the applicable lighting power density requirements. Any new control devices that are direct replacements of existing control devices must conform to certain specific requirements for lighting controls.

Exceptions are made for lighting alterations that replace less than 50% of the luminaires in a space provided that the alterations do not increase the installed interior lighting power.

Potential Issues: In general, the exceptions specified in 90.1 provide relief from those requirements that would necessitate a large expense in order to comply. A certain degree of judgment, however, is involved in determining whether an exception applies to an alteration. If complying with a requirement is deemed inconvenient or expensive by a contractor or designer, the exceptions can be broadly interpreted to avoid the requirement. It is then up to the inspector to catch any improperly identified exceptions.

HOW THE IECC ADDRESSES MODIFICATIONS

In the IECC, modifications of existing buildings are classified as additions, alterations, renovations, or repairs. Alterations are any construction or renovation to an existing structure other than repair or addition that requires a permit. They also include a change in a mechanical system that involves an extension, addition or change to the arrangement, type or purpose of the original installation that requires a permit. Repairs are defined as the reconstruction or renewal of any part of an existing building.

Under Section 101.4.3, **"**additions, alterations, renovations or repairs to an existing building, building system or portion thereof shall conform to the provisions of this code as they relate to new construction *without requiring the unaltered portion(s) of the existing building or building system to comply with this code*. Additions, alterations, renovations or repairs shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this code if the addition alone complies or if the existing building and addition comply with this code as a single building."

Like ASHRAE 90.1, the IECC defines a number of exceptions that do not require compliance provided the energy use of the building is not increased:

- Storm windows installed over existing fenestration.
- Glass-only replacements in an existing sash and frame.
- Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.
- Construction where the existing roof, wall or floor cavity is not exposed.

- Reroofing for roofs where neither the sheathing nor the insulation is exposed. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.
- Replacement of existing doors that separate *conditioned space* from the exterior shall not require the installation of a vestibule or revolving door, provided, however, that an existing vestibule that separates a *conditioned space* from the exterior shall not be removed,
- Alterations that replace less than 50 percent of the luminaires in a space provided that such alterations do not increase the installed interior lighting power.
- Alterations that replace only the bulb and ballast within the existing luminaires in a space provided that the *alteration* does not increase the installed interior lighting power.

As mentioned earlier, the IECC references ASHRAE 90.1 as an alternative compliance path, so the requirements for alterations described in the prior section also would apply under the IECC if ASHRAE 90.1 was chosen.

Potential Issues:

In 2003 the ICC originally published the International Existing Building Code (IEBC), which sets requirements for building modification work. Since then it has been updated on the triennial cycle, with the IEBC 2012 serving as the latest version. Portions of the IEBC are included in Chapter 34 of the International Building Code (IBC); however, during the 2012 cycle of review, the ICC Board approved the deletion of Chapter 34 in favor of a reference to the IEBC. While this ruling may serve to guide users toward using the IEBC, it could serve as a barrier by making existing building requirements less accessible, especially in jurisdictions that do not adopt the IEBC.

The IEBC specifically addresses existing buildings, but the other ICC codes are written with new construction as the primary focus. These activities can be very different from one another and addressing them collectively can cause confusion about the scope and the applicability of different energy code provisions. Both the IBC and the IEBC reference the IECC for energy related issues; however, additions, alterations, renovations, and repairs are separated and treated differently. This can result in a lack of clarity with regard to when and how certain provisions should be applied to existing buildings. This uncertainty can often act as a deterrent to owners and developers who are considering upgrading or redeveloping a building.

As applied to existing buildings, the IECC specifies that:

"…this code shall not be used to require the removal, alteration or abandonment of, nor prevent the continued use and maintenance of, an existing building or building system lawfully in existence at the time of adoption of this code."[7]

Understandably, this definition is meant to ensure that the energy code does not become an undue burden that discourages rehabilitation projects; however, the lack clarity regarding the code's application in existing buildings represents a missed opportunity.

PENNSYLVANIA'S UNIFORM CONSTRUCTION CODE

Pennsylvania regulates building construction activities through the Pennsylvania Uniform Construction Code (UCC), under which a variety of codes are adopted, including the Energy Code. As of December 31, 2009, Pennsylvania's statewide mandatory Energy Code is based on the 2009 IECC with reference to ASHRAE Standard 90.1-2007.[8] The initial version of the Uniform Construction Code (UCC) went into effect in April of 2004. Following its adoption, 92% of Pennsylvania municipalities opted to take on the responsibility of enforcing the UCC, which includes the energy code. Thus, the majority of municipalities have only begun enforcing an energy code since April 2004.

The UCC legislation has been altered 11 times since it was first passed.[9] In 2008, Act 106 amended the UCC by establishing the Review and Advisory Council (RAC). The 19 member council, appointed by the Governor from various construction industry trades and professions, as well as local government, is charged with making recommendations to the Governor, the General Assembly, and the Department of Labor & Industry (L&I) regarding proposed changes to the UCC and triennial updates to the model codes published by ICC.[10]

Under Section 403.45(e) of the UCC, a construction code official is required to conduct a final inspection of the completed construction work and file a final inspection report, which indicates, among other things, that energy conservation requirements under 401.7(10) are met.

CERTIFICATION, TRAINING, AND ENFORCEMENT RESPONSIBILITIES OF CODE OFFICIALS

Pennsylvania defines two certification categories for code officials specifically related to enforcement of the energy code: Energy Inspector and Energy Plans Examiner. Certification in each category requires passing a specific test. Municipalities are not required, however, to have staff certified in either of these disciplines to carry out inspections.

Energy Inspectors are responsible for the following:

> (i) Ensures that the building envelope, mechanical systems, electrical power and lighting systems and building service systems and equipment comply with the approved construction documents and the Uniform Construction Code.
>
> (ii) Duties include verifying that building envelope and components meet minimum requirements for installation of materials and that building envelope penetrations are caulked, sealed and weather-stripped, determining compliance of moisture control methods, installation of and types of mechanical equipment and efficiencies, heating, ventilation and air conditioning (HVAC) equipment, ducts and piping, insulation and sealing, lighting installation and lighting controls for building interiors and exteriors, permanently wired poly-phase motors and their efficiencies, piping insulation, circulation pump controls, heat traps, point-of-use controls and pool cover installations.

Energy Plans Examiners are responsible for the following:

> (i) Ensures that the design criteria specified for a building are correct and in accordance with the Uniform Construction Code and that alterations, additions and change of use or occupancy are in compliance with the Uniform Construction Code.

(ii) Duties include determining compliance of the design conditions specified, conditioned or unconditioned spaces, R-values for roof/ceiling, floor and wall assemblies and insulation placement, insulation of materials for the building envelope and its components, moisture control methods such as caulking, sealing and weather-stripping, duct and dipping insulation and sealing criteria, thermostats for each heating and cooling system, electrical metering, lighting installation and controls, piping insulation, circulation pump controls, heat wraps, shower heads and pool cover installations.

Given the existence of these two categories of certification and associated responsibility related to energy code compliance in Pennsylvania, we examined data on the current population of individuals holding certifications under the UCC. On a statewide basis, there are 592 certified Energy Inspectors and 385 certified Energy Plans Examiners for the 2,562 municipalities in the state. To put this into perspective, the following table (**Figure 5**) shows how these numbers compare to other certifications:

CERTIFICATION CATEGORY	# of certified individuals
Residential Building Inspector	1071
Residential Electrical Inspector	715
Residential Mechanical Inspector	699
Residential Plumbing Inspector	747
Residential Energy Inspector	542
Building Inspector	959
Fire Inspector	539
Electrical Inspector	543
Mechanical Inspector	718
Plumbing Inspector	826
Energy Inspector	592
Accessibility Inspector/Plans Examiner	891
Building Plans Examiner	616
Electrical Plans Examiner	280
Mechanical Plans Examiner	366
Plumbing Plans Examiner	394
Energy Plans Examiner	385
Building Code Official	1386
Elevator Inspector	148
Passenger Ropeway Inspector	19

Figure 5: Pennsylvania Code Official Certifications

It is difficult to discern from the data alone whether these numbers are adequate to address the needs of municipalities. Clearly, other categories have fewer certifications than the energy certifications, suggesting that the energy certifications are not disproportionately underrepresented. Given that the number of municipalities is much greater than the number of certified individuals in any category, it would appear that the number of inspectors and examiner is insufficient. However, some code officials serve multiple jurisdictions, such as inspectors employed by the state who serve towns that have opted out of building code enforcement responsibilities, and inspectors at third-party agencies, who also serve multiple municipalities. On the other hand, an unknown proportion of those with certifications are not employed in an official capacity to enforce state building codes. Some individuals hold a certification as a professional credential only, while others may maintain their certifications with the idea that they may want to become a building code official at some point in the future (e.g., upon retirement from current position). Further study is necessary to say whether or not the workforce is large enough.

Focusing on the EEB Hub region in Pennsylvania, we find it has approximately 191 certified Energy Inspectors and 129 certified Energy Plans Examiners (these numbers are qualified because they are based on self-reported addresses, and it's possible some individuals reside or have an office outside of the Hub region while still conducting inspection work within the region). The proportion of inspectors and examiners in the Hub region (~32%) is very close to the proportion of the state's population living in the region (34%), suggesting that the region has its "fair share" of code officials certified for energy inspections.

A cursory examination of employment advertisements indicates energy code knowledge and certification are specified as a job requirement. Although there were few positions open at the time this report was prepared, the following excerpt from an ad posted by a relatively small community in Bucks County stated the following:

High school diploma and two years building inspection experience required along with a valid Drivers License. Prefer at least two years of undergraduate course work from an accredited college in a related discipline. PA Uniform Construction Code (UCC)/Building Code Official certification is mandatory, along with UCC commercial certifications in the following categories; Building Inspector; Mechanical Inspector; Plumbing Inspector; ***Energy Inspector****; Accessibility Inspector/Plans Examiner; Building Plans Examiner; Mechanical Plans Examiner, Plumbing Plans Examiner;* ***Energy Plans Examiner****. Additional certifications and PA municipal government building inspection experience preferred. (emphasis added)*

On one hand, the experience and education threshold for this job is relatively low, while on the other commercial certifications for Energy Inspector and Energy Plans Examiner are apparently mandatory. It's encouraging to see an example where energy code knowledge and compliance are addressed, although it's unknown whether the "perfect" applicant was found who accepts the position.

Under the Pennsylvania UCC, certifications are valid for three years from the date of issuance. To be recertified, a code official must complete 15 hours of continuing education for each certification category. Training is available through the Pennsylvania Construction Codes Academy (http://www.paconstructioncodesacademy.org/), which offers two courses on energy codes: a one day course on the 2009 International Energy Conservation Code – Energy Code Compliance for Commercial Buildings, and a two-day (12 continuing education credit hours) course on International Energy Conservation Code Essentials, to help prepare attendees to take the tests for Commercial Energy Inspector and Commercial Energy Plans Examiner certification.

GAP: Many of the current local building officials find the energy code certification expensive, time-consuming, and difficult to pass, especially for long tenured staff.

Opportunity: Municipalities could partner with local colleges and/or technical schools to establish building technology and energy code compliance and certification courses. Organizations like the Building Performance Institute have already established their certification courses in community colleges and other institutions. By following a similar path, municipalities could attract younger members of the workforce.

Potential Issues:

In 2011, the General Assembly passed Act 1, which significantly altered the process to update the commonwealth's construction codes. Rather than "opt-out" of code provisions that are inappropriate in Pennsylvania, the RAC is now required to "opt-in" to all provisions—a much larger undertaking. In 2012, the RAC decided against updating to the 2012 IECC and proposed a six year code adoption cycle. This decision presents a major barrier to reducing the energy consumption of buildings.

The adequacy of the workforce to effectively address energy code compliance is in question, and the result from using of third party inspection agencies is not well understood.

NEW JERSEY'S UNIFORM CONSTRUCTION CODE

The New Jersey Uniform Construction Code is divided into subcodes (model codes and standards) that are adopted individually by the Commissioner of Community Affairs. The Rehabilitation Subcode governs all work related to residential and commercial building modifications. It references portions of the Energy Subcode, which in New Jersey currently is based on ASHRAE 90.1-2007 for commercial building projects.

Rehabilitation Subcode – Requirements for Energy Efficiency

With respect to existing building modifications, in 1998 New Jersey adopted the Rehabilitation Subcode (N.J.A.C. 5:23-6), which sets specific requirements for existing buildings, and contains all of the technical requirements that apply to a rehabilitation project. Rehabilitation projects are defined according to six categories: repair, renovation, alteration, reconstruction, change of use, and additions (**Figure 6**).

Class of modification	**Definition**	**Clarifications**
Repair	The restoration of materials, systems and/or components that are worn, deteriorated or broken using materials or components identical to or closely similar to the existing.	Repairs do not trigger the energy code. However, the addition to, alteration or relocation of mechanical system components such as ductwork is not repair work but is classified as either renovation, alteration, or reconstruction, as

		appropriate
Change of use	A change from one use to another use in a building or tenancy or portion thereof	If in the process of changing a building's use, if any work not required under the change-of-use provisions of the sub-code is to be performed, then this work must comply with the applicable requirements for repair, renovation, alteration, and reconstruction.
Additions	Essentially new construction attached to an existing building, treated as such for energy code compliance.	
Alteration	The rearrangement of any space by: • constructing walls or partitions or by a changing ceiling height, • adding or eliminating any door or window, • extending or rearranging any system, • installing any additional equipment or fixtures • any work reducing the loadbearing capacity of or imposing additional loads on a primary structural component	
Renovation	Removing and replacing or covering of existing interior or exterior finish, trim, doors, windows, or other materials with new materials that serve the same purpose and do not change the configuration of space.	Also includes the replacement of equipment or fixtures.
Reconstruction	Any project that requires the work area to be vacated while work is underway and a new certificate of occupancy is required before it can be reoccupied.	May include repair, renovation, alteration or any combination, but excludes projects with only floor finish replacement, painting, or wallpapering, or replacement of equipment and furnishings.

Figure 6: Definitions of Modifications Addressed by the NJ Rehabilitation Subcode

Alteration, renovation, and reconstruction are treated similarly under the subcode. All must comply with a specific set of energy code requirements (found in the version of ASHRAE 90.1 currently in effect) concerning changes to the building thermal envelope, new or replacement fenestration, new or replacement ducts, and total replacement of a building lighting system or newly installed building lighting systems:

- If the work exposes roof decking/sheathing or the framing of any wall, floor, ceiling, or roof assembly that is part of the building thermal envelope, any accessible voids in insulation shall be filled with insulation that meets the R-values of the commercial energy code. If space constraints prohibit the installation of required insulation, only insulation that fills the cavities of the framed assembly shall be installed.

- When windows, skylights or doors are newly installed or replaced the U-factor shall not exceed the U-factors of the commercial energy code.

- Newly installed or replaced ducts shall be installed with insulation meeting the R-values of Section 6.4.4.1.2 of the commercial energy code.

- The total replacement of a building lighting system or a newly installed building lighting system shall meet the following sections of the commercial energy code: Section 9.4.1 (controls) and Sections 9.5 and 9.6 (lighting power densities). A lighting system is "a group of luminaires circuited or controlled to perform a specific function."

In addition to the above requirements, materials and methods must conform to the following sections of the commercial energy code (**Figure 7**):

Category	**Section**	**Description**
Air Leakage	5.4.3.1 5.4.3.2 5.4.3.3	Building envelope sealing Air leakage for fenestration and doors Loading dock weather seals
Product information and Installation Requirements for Insulation	5.8.1.1 5.8.1.2 5.8.1.3 5.8.1.4 5.8.1.5 5.8.1.7 5.8.1.8	Labeling of building envelope insulation Compliance with mfr's requirements Loose-fill insulation limitation Baffles Substantial contact Insulation protection Location of roof insulation
Product Information and Installation Requirements for Fenestration and Doors	5.8.2	Rating and labeling of fenestration products
Mandatory HVAC Provisions	6.4.1	Equipment efficiencies, verification and labeling requirements

	6.4.2 6.4.4.1.1 6.4.4.2.1	Load calculations Insulation installation according to accepted industry norms and protection Duct sealing
Service Water Heating	7.4.2	Water heating equipment efficiency
Lighting	9.4.3	Exit sign maximum wattage
Electric Motors	10.4.1	Minimal nominal efficiency for general purpose motors

Figure 7: New Jersey Rehabilitation Code References to Energy Code

An obvious question is: Does the Rehabilitation Subcode produce results different from what ASHRAE 90.1 would create with respect to energy conservation? The Rehabilitation Subcode obviously points to the Energy Subcode (ASHRAE 90.1), so in the end probably not. In theory, the Rehabilitation Subcode eliminates some potential ambiguity that could result if the Energy Subcode was used directly. It points only to those requirements that are pertinent, so there is no need to evaluate the exemptions provided in ASHRAE 90.1 for alterations. On the other hand, a person unfamiliar with ASHRAE 90.1 must expend a fair amount of effort to connect the dots on energy requirements using the section references provided in the Rehabilitation Subcode.

CERTIFICATION, TRAINING, AND ENFORCEMENT RESPONSIBILITIES OF CODE OFFICIALS

In New Jersey, in accordance with N.J.A.C. 5:23-5, code officials must satisfy licensing requirements with documentation of sufficient experience, acceptable test results, educational background and other supporting information. Technical licenses are available for Building Inspector, Electrical Inspector, Fire Protection Inspector and Plumbing Inspector, with additional designations under each for specialization in high-rise and hazardous structures, industrial and commercial structures, and residential and small commercial structures (the latter only applicable to Building Inspectors). Administrative licenses include Construction Official, who serves as chief administrator of an enforcing agency, Building Code Official, Electrical Subcode Official, Fire Protection Subcode Official, and Plumbing Subcode Official. Specific educational requirements related to energy code knowledge are only designated for plumbing inspector license for industrial and commercial structures (N.J.A.C. 5:23-5.20(k).5). Other licenses do not have similar requirements.

Licenses are renewed every three years, subject to completion of the appropriate amount of continuing education credits (CEUs, where 1 CEU equals 10 contact hours). These range from 1.5 CEUs for an inspector license only to 2.5 CEUs for a combination of inspector, subcode official, and construction official licenses.

Training classes in building code compliance are offered by the Center for Government Services at Rutgers University, which assists the Bureau of Code Services in the New Jersey Department of Community Affairs in delivering continuing education material. The most recent guide to available courses (Spring 2013) has 325 seminar offerings. Of these, none deals specifically with energy code compliance issues for commercial construction (IECC for residential is covered), though a few plumbing and mechanical classes touch on energy. An overview course on the Rehabilitation Subcode and a more in-depth course on the Rehabilitation Subcode for building and fire protection inspectors are offered, but energy aspects are not among the material highlighted in the course descriptions. Based on this review, there appears to be a gap in energy code education within the state at the moment. It's worth noting, however, that on behalf of the New Jersey Department of Community Affairs, Rutgers Center for Government Services issued a request for proposals for the 2013 educational program (dated August 10, 2012) that specifically mentioned "Energy Efficiency Requirements for both Rehab and New Construction" among the categories of interest for course material.

New Jersey community colleges also offer training courses for licensing of code officials. These courses cover building code officials, electrical code officials, fire code officials, and plumbing code officials.

The New Jersey UCC, at N.J.A.C. 5:23-3.4, establishes the responsibilities for enforcement of the commercial energy code (ASHRAE 90.1). As indicated in the table below (**Figure 8**), plan review and inspection responsibilities are assigned to different code officials.

Energy Subcode Chapter	**Section/Title**	**Responsibility**	
		Plan Review	Inspection
4	Administration and Enforcement	Building/Plumbing/Electrical (as applicable)	Building/Plumbing/Electrical (as applicable)
5	Building Envelope	Building	Building
6	Heating, Ventilating, and Air Conditioning	Building/Plumbing/Electrical (as applicable) except as below	Building/Plumbing/Electrical (as applicable) except as below
	6.4.4.1.1-6.4.4.1.2	Building	Building
	6.4.4.1.3	Plumbing	Plumbing
	6.4.4.2	Building	Building
7	Service Water Heating	Plumbing/Electrical (as applicable)	Plumbing/Electrical (as applicable)
8	Power	Electrical (as applicable)	Electrical (as applicable)
9	Lighting	Electrical	Electrical

10	Other Equipment	Electrical	Electrical
11	Energy Cost Budget Method	Building/Plumbing/Electrical (as applicable)	Building/Plumbing/Electrical (as applicable)

Figure 8: Plan Review and Inspection Responsibilities under the NJ UCC

As shown, compliance with the Energy Subcode is monitored by three subcode officials, with different, and sometimes overlapping, responsibilities. It is assumed that this arrangement also applies under the Rehabilitation Subcode when it comes to energy code requirements.

COMPLIANCE TOOLS AND RESOURCES

Federal Compliance Tool: COMcheck

The Department of Energy Building Energy Codes Program makes the COMcheck compliance tool available as a means to demonstrate that a project meets all prescriptive requirements of ASHRAE 90.1 or the IECC. COMcheck addresses alteration projects as well as new construction, although there are some constraints when applied on alterations, as explained in the text below from the technical support document for version 3.9.1:

> In COM*check*, under new construction projects, and in the 90.1 and IECC editions, assembly tradeoffs are considered using a whole building energy cost methodology. This methodology requires the whole building to be specified. **For alteration projects**, 90.1 and the IECC only require "altered" assemblies to be shown to comply. Given only partial representation of the building, the whole building energy cost methodology cannot be used directly. A workaround to this constraint is possible by requiring that all unaltered assemblies also be specified but not factored into the tradeoff determination. That is, unaltered assemblies could be considered as satisfying the minimum whole building requirements but no more than that and no benefits (i.e., tradeoffs) would accrue to be applied toward the altered assemblies. However, it was felt that most commercial alteration projects involve a very limited number of assemblies being altered such that requiring a user to add all the unaltered assemblies would be too onerous to justify the limited benefit. Alternatively, a user can take advantage of the tradeoff methodology by simply specifying the project as a new construction type. Based on these constraints and options, COM*check* alteration projects show compliance by the prescriptive compliance method. A project is deemed to comply with the energy code when all altered assemblies either satisfy the prescriptive requirements or are shown to be exempt from compliance for one of the allowed exemption criteria in the code.
>
> http://www.energycodes.gov/sites/default/files/documents/BECP_Technical%20Support%20Document%20for%20Version%20391%20of%20the%20COMcheck%20Software_Sept2012_v00.pdf

COMcheck is an approved compliance tool in Pennsylvania and New Jersey. Pennsylvania actually requires it, although it's unclear whether this is the case for activities conducted under the Rehabilitation Subcode.

State Compliance Tools

There are no state-wide compliance tools analogous to COMcheck developed uniquely for either Pennsylvania or New Jersey. New Jersey has a standard application for plan reviews used throughout the state, although in current form it doesn't suffice as a compliance tool for energy code requirements. Although the New Jersey Application for Plan Review Instructions (http://www.state.nj.us/dca/divisions/codes/forms/pdf_bcpr/pr_app_guide.pdf) identifies the energy subcode as part of the UCC, the document contains no further reference to energy code compliance. For example, the checklist for plan submission does not reflect submission of COMcheck or any other documentation. Assignment of responsibility for different parts of the energy code to different inspectors could lead to confusion.

New Jersey uses standard forms state-wide for building permit applications (UCC Construction Permit Application – UCC F100; see http://www.state.nj.us/dca/divisions/codes/forms/pdf_ucc_stdforms/ucc_f100_cpa.pdf). This form is also used for rehabilitation work (repairs, alterations, renovations, reconstruction) in addition to new construction.

According to the NJ UCC, no energy calculations are required for rehabilitation projects. These are only applicable to new buildings or additions to existing buildings. COMcheck compliance software is therefore also not a requirement for rehabilitation work, despite the fact that COMcheck was designed by DOE to be used for such projects.

> NJAC 5:23-2.15(f)1.vi. Energy calculations: Calculations showing compliance with the energy subcode shall be submitted for all new buildings and additions to existing buildings. As provided in (f)1.vii below, these calculations shall be signed and sealed by the design professional, with the exception of calculations for class III structures which may be submitted by the mechanical contractor.
>
> (2) For all other buildings, compliance may be shown with the COMcheck compliance software or equivalent, submission of the compliance forms found in the COMcheck user's manual or the ASHRAE 90.1 user's manual for the edition of ASHRAE adopted under the energy subcode. The COMcheck user's manual and software are available from the U.S. Department of Energy at www.energycodes.gov. The ASHRAE 90.1 user's manual is available from the American Society of Heating, Refrigerating and Air-conditioning Engineers Inc. at www.ashrae.org.
>
> (A) To document compliance using COMcheck, users shall meet or exceed the ASHRAE/2007. Please see Bulletin 11-1 for further guidance.

Pennsylvania requires the use of COMcheck, although this requirement is not reflected in the instructions and other information maintained by many of the municipalities that were looked at. A uniform statewide permit application form is not required or available; each municipality has its own form, although the state building code regulations provide certain specifications for what these forms must include.

> **GAP: Information on energy code enforcement resources and procedures is not made as accessible by municipalities as information on other building codes.**
>
> **Opportunity:** Municipalities typically possess information on compliance (for both new construction and renovations) and tools like COMcheck, which can be made more visible and accessible to relevant parties. The promotion of these resources on municipal websites could serve to raise awareness, better inform the building community, and reduce inquiries for the staff.

Review of Municipal Building Department Web Sites

To augment the information obtained from interviews and surveys, municipal web sites were examined for their content with regard to code enforcement and compliance. Although in-person exchanges between building departments and applicants for building permits are the norm, the modern day reliance on electronic forms of communication would suggest that a municipality's web site is a relevant indicator of how the energy code requirements are treated.

The web sites of 14 municipalities in the region were closely examined – eight from Pennsylvania (excluding Philadelphia) and six from New Jersey. The municipalities were selected for this analysis based on population and amount of commercial and multi-family residential development (in terms of land area occupied), the focus being on larger municipalities with more commercial development. One might expect such municipalities to have more mature systems in place to address commercial building code compliance. A range of median household incomes and spread of locations among the 10 counties in the Hub region were also captured.

The web sites display a primary emphasis on life-safety codes, which is not unexpected given the existence of fire codes, building codes, plumbing and electric codes for much of the 20^{th} century. However, very few references to energy code requirements were identified. Listed below are questions that were considered during the review and a summary of what was found.

- What references to energy code requirements are made?

  In only 3 of the 14 municipalities was any reference made to energy codes. In one Pennsylvania township, IECC 2009 was included in the list of applicable codes, while in another the IECC (no year specified) was included. In one New Jersey township, IECC 2006 is referenced, even though the state currently follows ASHRAE 90.1-2007. For the New Jersey municipalities that were reviewed, none of them referred to the Rehabilitation Subcode and its applicability to alterations, renovations, and reconstruction. In general, other applicable codes were listed. The absence of references to the energy codes in these lists implies they are of secondary importance, or perhaps are not regularly applied or strongly enforced.

- What submittals are required to satisfy energy code requirements?

  Two of the Pennsylvania municipalities require certain documentation to be submitted in accordance with the energy code. One of these stated that all plan submissions must include energy calculations, specifications and details based on the IECC and using COMcheck software as applicable. The commercial plan submission checklist also requires signed and sealed energy plans and COMcheck energy calculations. The other town was a little less specific, but stated that applications for commercial work must include plans prepared by an architect and be complete with "electrical, plumbing, HVAC and <u>energy</u> calculations." A full review is also required before submitting a building permit application, which is to include "building, electric, mechanical, plumbing, <u>energy</u>, fire and accessibility." In general, all municipalities require an applicant for a building permit to submit plans signed and sealed by a design professional, so the information necessary to assess energy code compliance may in fact be available in many cases. However, whether this assessment takes place and is documented is unclear. Given that the Pennsylvania energy code requires COMcheck, municipalities would be well served by reinforcing this requirement.

- What external links are provided on the web site to codes and code compliance resources (e.g., state UCC, ICC, ASHRAE, COMcheck, or other)?

In general, the reviewed municipalities provide few links to external web sites with information on building energy codes. Certainly, there is a presumption by building owners and others that design professionals engaged in the construction of commercial buildings would be well versed in the applicable code requirements. However, in alterations of medium size commercial buildings, which may be smaller projects focused on only one or a few aspects of a building, an in-depth understanding of current code requirements may be less prevalent. The review of 14 municipal web sites found three links to the ICC web site (one of which was no longer functional), two links to the NJ UCC, and one link to the DOE web site where COMcheck software can be downloaded. One of the New Jersey municipalities provided a link to an information packet by the Tri-County Construction Code Association, which unfortunately contained outdated information on building code requirements.

- Do inspection checklists address energy code compliance?

Inspection checklists offered by many municipalities only refer to insulation inspection, if there is any mention of energy code inspection requirements at all. Less than half of the reviewed municipal web sites mentioned insulation on their checklists. One town identified the need for pre-slab inspection for insulation level (unheated slab R-4.5 and heated slab R-6.5) and for thermal break to top of slab, but no other requirements for insulation inspection. Other than insulation, no other inspection requirements pertinent to energy code compliance are specified in the checklists that were found. According to Bulletin No. 11-1 issued by the New Jersey Department of Community Affairs Division of Codes and Standards (April 2011), commercial building inspections under the energy code include, but are not limited to, verifying that: (1) the insulation specified on the plans is the insulation installed, (2) the lighting fixtures and associated controls specified on the plans are installed, and (3) the mechanical systems, associated controls and associated insulation specified on the plans are installed.

The paltry attention to energy codes on many municipal web sites gives the impression that their applicability to building alterations is likely to be neglected or loosely enforced in many localities. Setting clear expectations is a low-cost way for a municipality to improve compliance. One simple step taken by the City of Philadelphia Department of Licenses and Inspections is to provide a list of top 10 permit application deficiencies. The number one item on this list is energy conservation:

1. *New construction, additions, and alterations must comply with the building envelope, mechanical, and electrical power/ lighting provisions of 2009 International Energy Conservation Code (IECC). A Certificate of Design identifying compliance path and supporting documentation are required for all applicable permit applications.*

This sends a clear message to all applicants that energy code compliance is a must. Philadelphia also stands out for its Energy Conservation Certificate of Design for Commercial Construction, which is a form that must be completed for all building alterations. On this form, the design professional is required to attest to the following statement:

I certify, that in my professional opinion and in accordance with the accepted standards of my profession, the proposed building design represented in the building plans, specifications, and other calculations submitted with the permit application will achieve compliance with the provisions of the ICC Energy Conservation Code.

In addition, with respect to inspections, the design professional must also certify as follows:

> *The undersigned certifies that he/she is aware of his/her obligation to perform periodic inspections of the building construction to insure compliance with the requirements of the International Code Council International Energy Conservation Code and that he/she will perform said inspections.*

Furthermore, the owner is also required to certify the following statement:

"I understand that periodic inspections must be made during the construction of this project to insure compliance with the International Code Council International Energy Conservation Code. These inspections shall be made by a licensed design professional or the building contractor of this project. A Certificate of Summary Comparison of Pennsylvania and New Jersey Energy Code Requirements."

SUMMARY COMPARISON OF PENNSYLVANIA AND NEW JERSEY ENERGY CODE REQUIREMENTS

Based on the material presented in this section, it is apparent there are similarities as well as some important differences between the approach to building energy codes and building alterations taken by the two states. The following table (**Figure 9**) compares some of the key aspects.

Element	Pennsylvania	New Jersey
Energy code for modifications	ASHRAE 90.1-2007	NJ Rehabilitation Subcode (referencing portions of ASHRAE 90.1-2007)
State administrative body	Department of Labor and Industry	Department of Community Affairs, Division of Codes and Standards
Energy code adoption cycle	Currently 3 years, but 6-year cycle under consideration. Adoption requires 2/3 majority of RAC	NJ Rehab Subcode updated yearly; NJ Energy Subcode reviewed every 3 years
Composition of municipal building departments	No specific requirement; each municipality must have a designated building code official	Construction Official Building Subcode Official Electrical Subcode Official Plumbing Subcode Official Fire Subcode Official

		(an individual may assume more than one role)
Does state set certification requirements?	Yes	Yes
Standard statewide building permit application form	No – varies according to municipality	Yes
Enforcement		
Third-party inspection agencies allowed?	Yes	Yes
Municipalities can defer to state for code admin and enforcement	Yes	Yes
Standard compliance tools	COMcheck acceptable but requirement depends on jurisdiction	COMcheck not required for rehabilitation work
Element	**Pennsylvania**	**New Jersey**
Code officials and inspectors qualifications		
Energy-specific certifications or licensing	Energy Inspector Energy Plan Examiner	None
Recertification frequency	3 years	3 years
How much continuing education is required for recertification?	15 contact hours	15 – 25 contact hours
Training/education providers	Pennsylvania Construction Codes Academy	Rutgers Center for Government Services; community colleges

Figure 9: Comparison of Pennsylvania and New Jersey Building Energy Code Implementation

ENFORCEMENT OF THE ENERGY CODE

In Pennsylvania, the Department of Labor and Industry (L&I) has the authority to adopt and regulate building energy codes through the regulatory process. However, L&I is not responsible for enforcing the code on a large portion of the state's building stock. As of January, 2011, 2,396 (94.5 percent) of 2,563 municipalities have elected to administer and enforce the state's 2009 Uniform Construction Code (UCC) locally.[11] In the Hub region, only one municipality out of 238 opted out. Code enforcement is carried out by the municipalities' own employees or contracted certified third party agencies, except where the municipality has opted out of UCC enforcement responsibilities or lacks the services of an "Accessibility Inspector/Plans Examiner."[12] Currently many local inspection departments still exist that do not yet enforce the energy code sufficiently to achieve compliance with the UCC. In a 2009 assessment on the implementation of the UCC, it was stated that the UCC "imposed various new requirements and fees in areas where there were no preexisting building codes" prior to the Pennsylvania Construction Code Act (Act 45 of 1999) which took effect in July 8, 2004.[13] The report also found that about 60 percent of the surveyed municipalities (1,423 municipalities) retain a building code official that is an employee of a third-party agency; 25 percent where the building code official is a municipal employee; followed by 10 percent being a council of government[2] employee; and 5 percent as "other".[14] Many challenges in enforcing the code also apply to existing commercial building renovations and addition.

Observations shared with BCAP in the Commonwealth of Pennsylvania suggest that the energy code is not commonly enforced for commercial alterations and additions. One interviewee who participated in BCAP's Pennsylvania Gap Analysis study expressed that commercial alterations, in their experience, were often code compliant, while several others echoed each other in that alterations are not on a code officials' radar. One obvious reason the enforcement of the energy code on commercial alterations may be neglected is the fact the UCC exempts alterations to existing residential buildings from permitting and meeting code requirements.

New Jersey enforces the state Uniform Construction Code based on the 2009 IECC and ASHRAE/IESNA 90.1-2007 with amendments. The New Jersey Department of Community Affairs (DCA), Division of Codes and Standards enforces the code through licensed code officials. The code officials must be licensed by the Licensing Section of the Bureau of Code Services, Division of Codes and Standards. Much like Pennsylvania, jurisdictions with the construction code enforcement agency enforce the code, but jurisdictions without a construction code agency utilize enforcement by the Department of Community Affairs. Of the 138 municipalities in the Hub region, nine have chosen to rely on DCA to enforce building codes.[3] The Department of Community Affairs also oversees enforcement of state buildings.

EXISTING COMMERCIAL BUILDINGS ENFORCEMENT PROCESS

In an effort to identify issues related specifically to energy code enforcement in existing building projects, BCAP conducted interviews with code enforcement officials. The criteria for choosing building departments to engage was heavily shaped by connections made through the Energy Efficient Buildings Hub (EEB Hub) in Philadelphia, and the responsiveness of the local building departments. The initial goal was to capture a subsection of municipalities

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[2] For UCC enforcement purposes, municipalities may choose to create an intergovernmental agreement to form a regional body called councils of government (COG). They aid municipalities with the administration and enforcement of the UCC.

[3] See http://www.nj.gov/dca/divisions/codes/offices/localcode.html

in the EEB Hub region whose characteristics could be applied on a broader scale. Unfortunately, finding code officials that were readily available to speak with us proved to be a challenge. This underscores the shortage of resources and staff that was identified in our research. In total, representatives from three different jurisdictions were interviewed.

In detailing the enforcement processes of these three jurisdictions, this section aims to provide gaps and identify opportunities that may benefit these departments in the enforcement the building energy code. There generally few differences between the building plan review and inspection processes of new construction and existing buildings. The enforcement process for each of the jurisdictions is represented in **Figures 10, 11, 12** below.

CITY OF PHILADELPHIA, PA

For the typical project, the applicant (usually a contractor, architect, or engineer) will submit required materials – including permit application and buildings plans (typically requiring a stamp by a licensed design or engineer professional) – to the building department along with any other required application documents or requirements. The list of requirements differs from jurisdiction to jurisdiction. In Philadelphia, depending on the project, the applicant may have to receive pre-requisite approvals from various departments before submitting required materials for a permit. Upon receiving these materials, the clerk records the permit request in the department's tracking software. From this point, the department sets a goal of completing review.

Building plans, fire suppression, and mechanical system are reviewed for compliance, either by comparing them to COMcheck or IECC prescriptive code requirements. In Philadelphia, plumbing and electrical reviews are done either by a separate department or by third party agencies; the city currently has 10 electrical inspectors, whom owners can choose for their projects. Using third party agencies is an ongoing, convoluted issue for different reasons, including a lack of funding and inconsistency within the permit process.

GAP: Improper integration of third party enforcement agencies can lead to inconsistencies.

Opportunity: Guidelines established by municipalities could guide greater coordination between third party agencies and local jurisdictions during the review and inspection phases.

Third party agencies can be very useful for jurisdictions with limited resources. However, their involvement can take on many forms. A comprehensive third party program takes on all of the enforcement duties for a jurisdiction, but often times the third party agencies are only responsible for certain enforcement activities. One of the issues that can lead to inconsistencies is when tasks such as plan review and inspection are conducted by different agencies with no coordination between the two.

Upon approval, construction on a project can begin. At the completion of construction, the completed project is reviewed again, inspected, and compliance is confirmed through the use of a checklist—Philadelphia has its own checklist which includes energy code provisions. The inspection results are recorded in the city's database software.

GAP: The permit information available for existing buildings is inconsistent because different building departments may use different systems to store documentation. This leads to inefficiencies and redundancy, particularly in existing building projects.

Opportunity: A state mandate calling for a building permit documentation system to be used across jurisdictions, would help local building departments and building industry professionals could to better utilize the vast amount of information that is available.

An improved documentation system would help local building department to work more efficiently. It would also provide the design and construction community with the information needed to apply the energy code more effectively in existing buildings. One example of a successful use of technology was in the city of Gillette, WY. By instituting a comprehensive internet based software solution for plan review, they were able to improve efficiency dramatically. [15]

Depending on the results, the permit clerk calculates the permit fees, contacts the applicant, and informs them of the permit status. For projects that show noncompliance, the reviewer or permit clerk contacts the applicant to request resubmittal, clarification, or more information. From here the designer and/or engineer corrects sheets with identified problems and submits for re-review of those issues. For projects that show compliance for all but a few items, a temporary occupancy permit can get issued.

According to inspectors in Philadelphia, the most common energy code violations by design and construction professionals occur in the electrical portion, control devices, and in water conservation. In existing building projects, electricians are hired for a particular portion of the project, and it is not uncommon for energy code requirements to go unfulfilled.

Judging by the broad spectrum of quality in the plans that are submitted, it seems that there is a lack of clarity for energy code requirements. Regardless of the reason; whether it be a lack of knowledge, insufficient education, or issues with the code content, it presents a barrier for proper code application. Building plan reviewers in Philadelphia constantly receive building plans and permit applications that do not meet and/or address the energy code requirements. Another challenge for the proper application and enforcement of the energy code is limited staff and resources within the department. This is an issue that was present in each of the jurisdictions interviewed. Compared to smaller jurisdictions, Philadelphia has many more multi-disciplinary and certified employees who are knowledgeable and capable of carrying out every aspect of the review and inspection. But given the volume of permit applications, they still find themselves shorthanded. The department receives about 300 permits a day, which inevitably require plan reviewers to focus more on the basic safety code requirements, than the energy code.

NEW HANOVER TOWNSHIP, PA

New Hanover Township's existing commercial plan review process is similar to that of Philadelphia's. One main difference is that the same department reviews all of the submittal materials during the building plan review. Because the township building department is smaller than Philadelphia's, they do not have the staff capacity to combine the steps of construction, re-occupancy, and issuing permit to speed up the process. Another difference is that COMcheck is used exclusively to review energy code compliance. New Hanover also does not have any pre-requisite approval requirements.

GAP: COMcheck exists as a "deemed to comply" tool which needs to be reviewed and approved by a code official, but the results are often accepted without considerable review.

Opportunity: Code officials could benefit from enhanced training for tools like COMcheck to help them better understand the limitations of the software, and resources that help them to identify common errors. By actively seeking out federal funding opportunities; states, municipalities and advocacy groups could potentially support these training programs.

WEST WINDSOR TOWNSHIP, NJ

In West Windsor, New Jersey, the procedures for commercial plan review and inspection are similar to those of the above two jurisdictions. However, New Jersey's Rehabilitation Subcode[4] under the UCC for existing buildings, requires reviewers and inspectors to review a greater variety of building elements. The UCC specifically defines the technical requirements for each Subcode, and similar to Philadelphia, also requires pre-requisite approvals by an appropriate department before an initial request for activity can take place. A significant difference and best practice that can be applied to other jurisdictions, is that the West Windsor department verifies what has been previously approved for the submitted project and checks what code provisions were checked before. Once they check, the building plans and other submittal materials go to reviewers from all major Subcodes and they all review and analyze everything that has been submitted. This requires additional resources, but it encourages reviewers to consider the building as a whole instead of allowing them to focus exclusively on one aspect of the building. Reviewers have 20 days to act on the application upon the submittal of a complete application. Another difference in New Jersey is the additional construction inspections that may be required by other arms of municipal government. This activity depends on the project scope and location, but it is a best practice to ensure the project is code compliant in all aspects.

[4] The Rehabilitation Subcode is the first comprehensive set of code requirements for existing buildings which covers areas of building, electrical, fire protection, plumbing, and elevator. To learn more about the New Jersey Subcode: http://www.state.nj.us/dca/divisions/codes/offices/rehabbackground.html

Building Plan Review and Inspection Process: Existing Building Modifications

Energy Code Requirements, City of Philadelphia, Pennsylvania

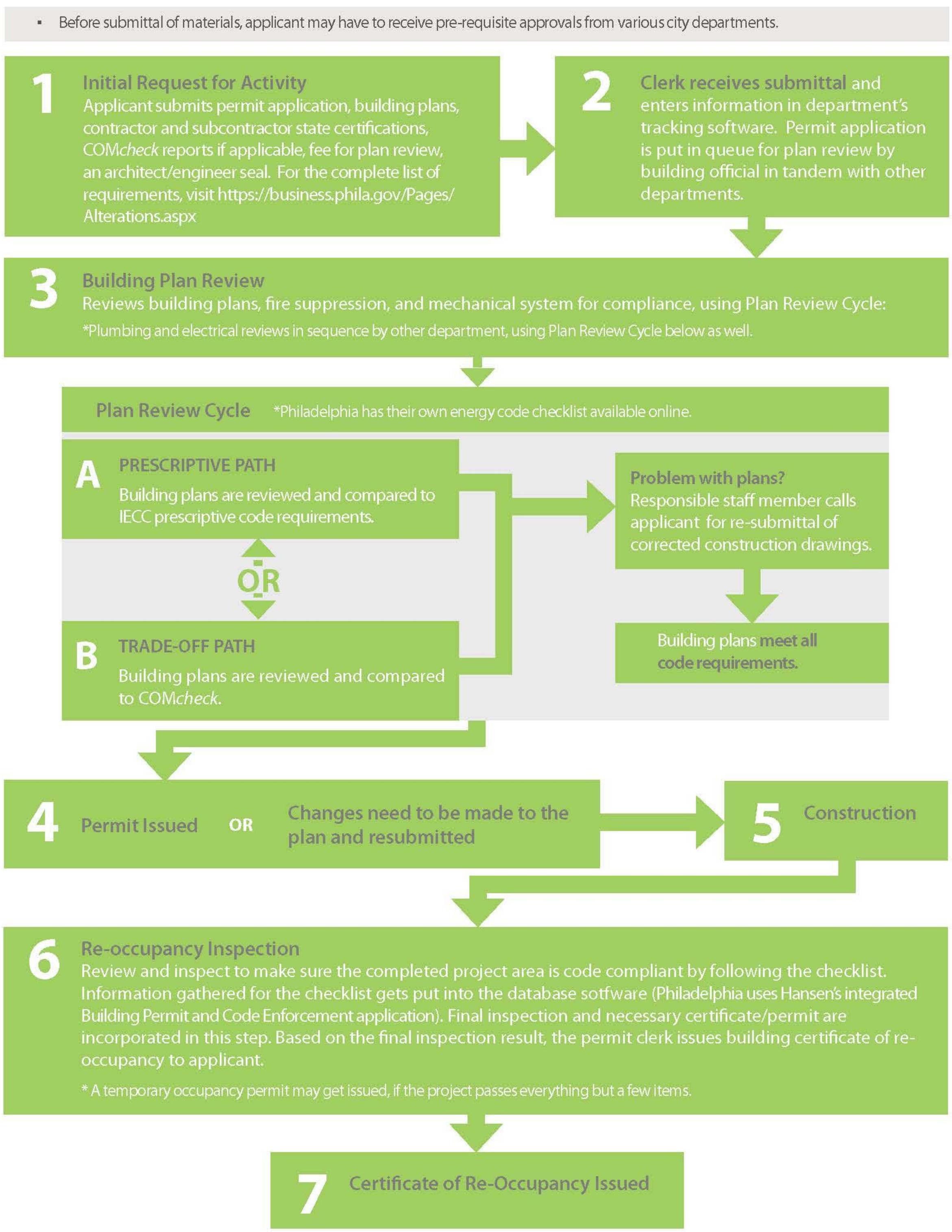

Figure 10: Building Plan Review & Inspection Process: Existing Buildings - City of Philadelphia, PA

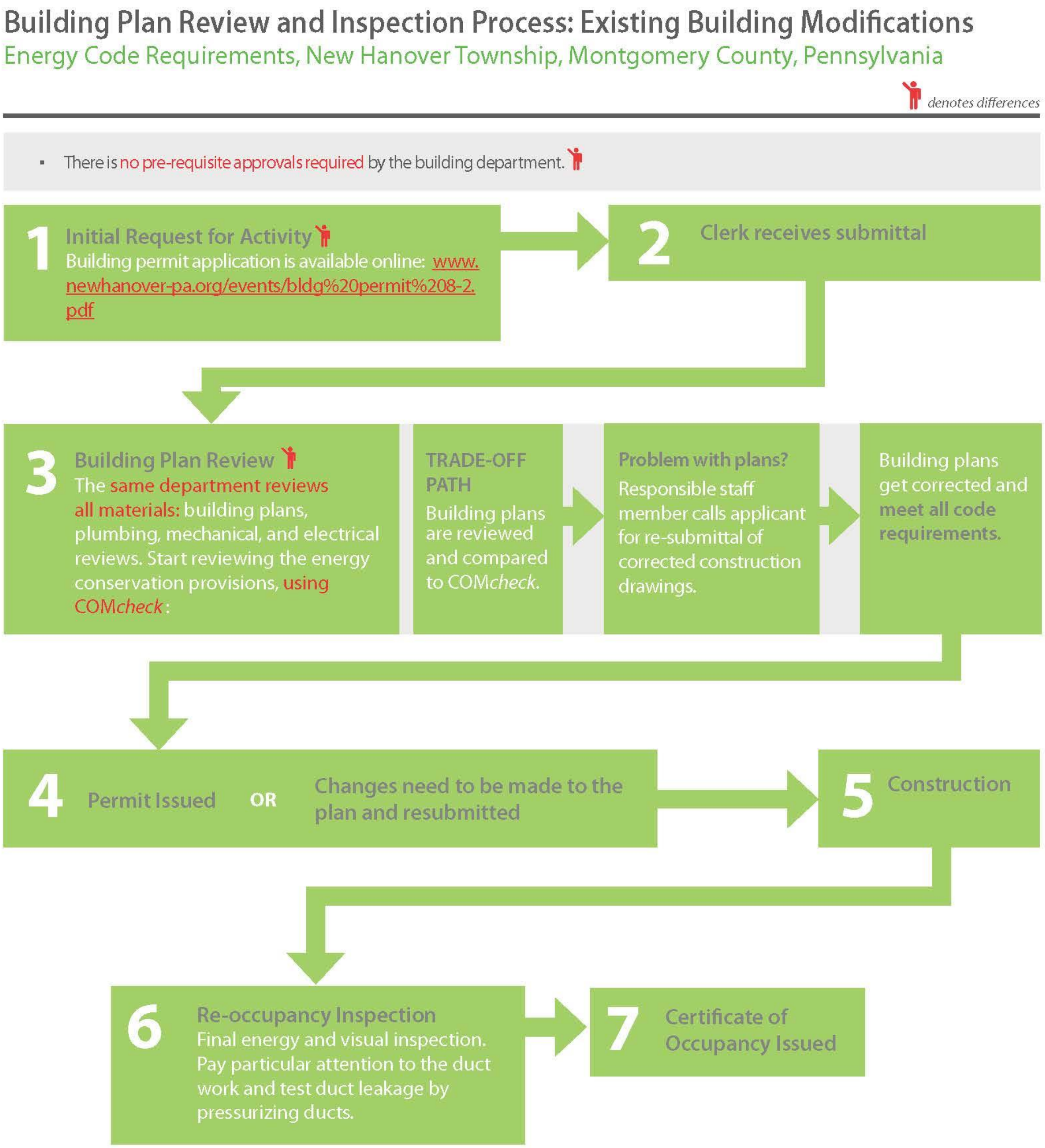

Figure 11: Building Plan Review & Inspection Process: Existing Buildings - New Hanover Township, PA

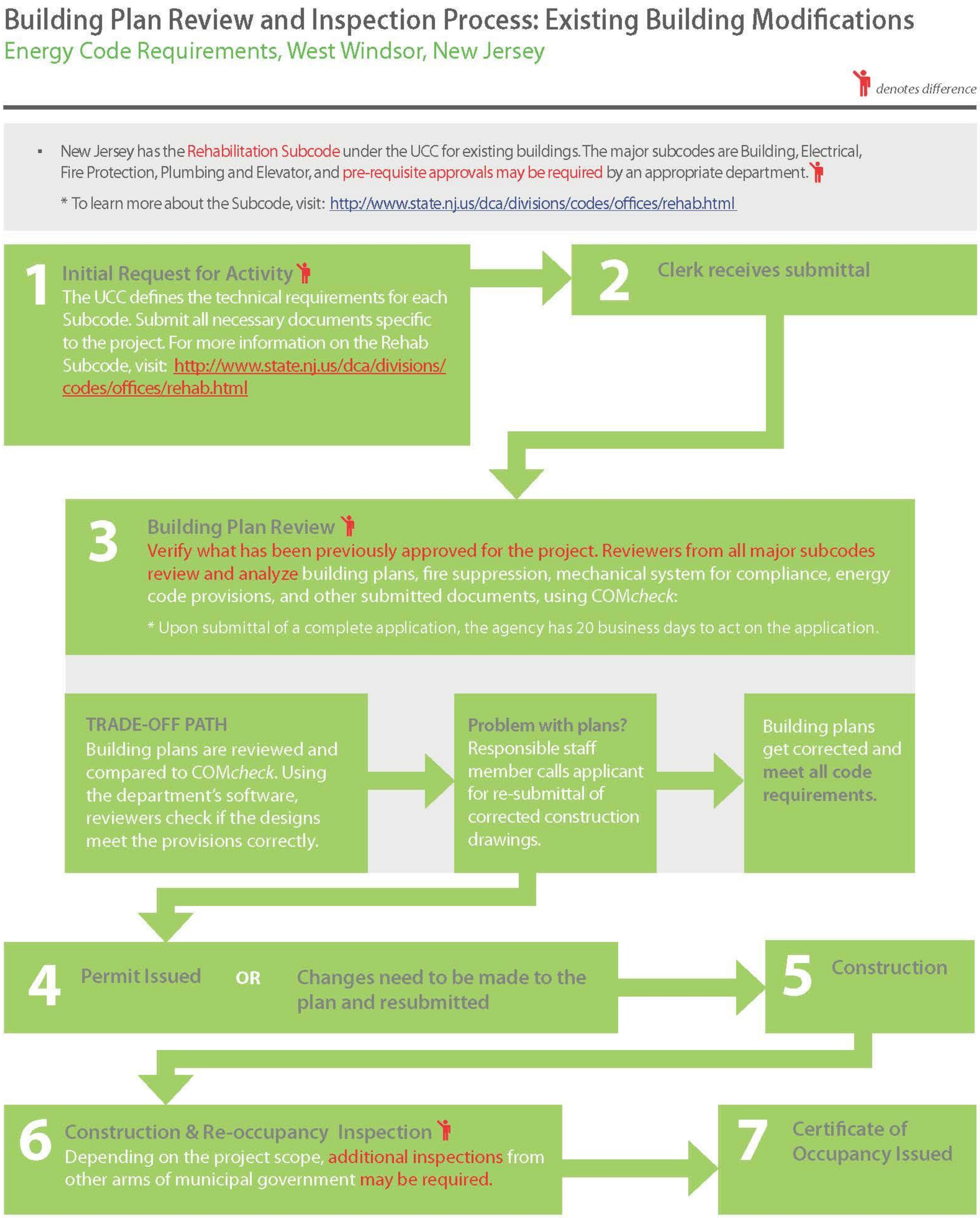

Figure 12: Building Plan Review & Inspection Process: Existing Buildings - West Windsor, NJ

IMPLEMENTATION OF THE ENERGY CODE

Often the focus of code compliance falls on building departments and the officials charged with enforcing the code. However, the actual application of the code occurs well before the enforcement officials get involved. To thoroughly address the application of the energy code in existing commercial buildings, one must understand every step of the process from the time that an owner decides to pursue a renovation project until the construction work is completed and the building is once again operable. By analyzing the role of every stakeholder group involved and learning about their specific processes and incentive systems, one can identify gaps in the process as well as previously unforeseen opportunities.

THE CODE IMPLEMENTATION PROCESS

One overarching theme that was present among each of the stakeholder groups interviewed was that the process for applying the energy code in existing buildings was the same as the process for new construction. Additions, alterations, renovations and repairs are all subject to energy code requirements, but the IECC does not differentiate between them or take into account the specific conditions that can arise from each activity. Instead, activities that are subject to the code are treated in the same manner as new construction. The code should provide language to differentiate or further explain existing building requirements from new construction.

GAP: Processes in a modification/renovation project are often very complex, but stakeholders typically approach energy code application in existing building modifications with the same process that they use for new construction projects.

Opportunity: Altering the language in the IECC would help to address existing buildings more thoroughly and better reflect the issues faced in the renovation process.

- Two separate proposals were made to the 2015 IECC submitted (by the Sustainable Energy High Performance Code Action Committee and the Northwest Energy Codes Group) with the goal of:

1. Clarifying the requirements for additions, alterations, renovations and repairs; and
2. Creating a separate section for existing buildings that can be expanded in the future

As defined in this report the phases of the renovation process are defined as follows:

- **Pre-Design –** includes the initiation of the project and decisions made that impact the scope of work and the parties that will be involved.
- **Design Development** – includes the architectural design process and the design of the building system. Designs must meet all applicable code requirements.
- **Permitting** – this is when code officials are typically first introduced to a project. Building plans are submitted and reviewed by enforcement officials to ensure that code requirements are being met. COMcheck is used as a tool to show compliance with the energy code, but it must be thoroughly reviewed before being accepted.

- **Construction** – the permit approved plans are taken and used to begin construction. At this point code requirements addressed in the plan must be executed properly in the field.
- **Final Inspections** – Projects are inspected to ensure that the construction was executed properly and meets the code provisions that were addressed in the plans.

The figure below (**Figure 13**) is a flowchart showing the steps involved in the renovation process and the groups involved.

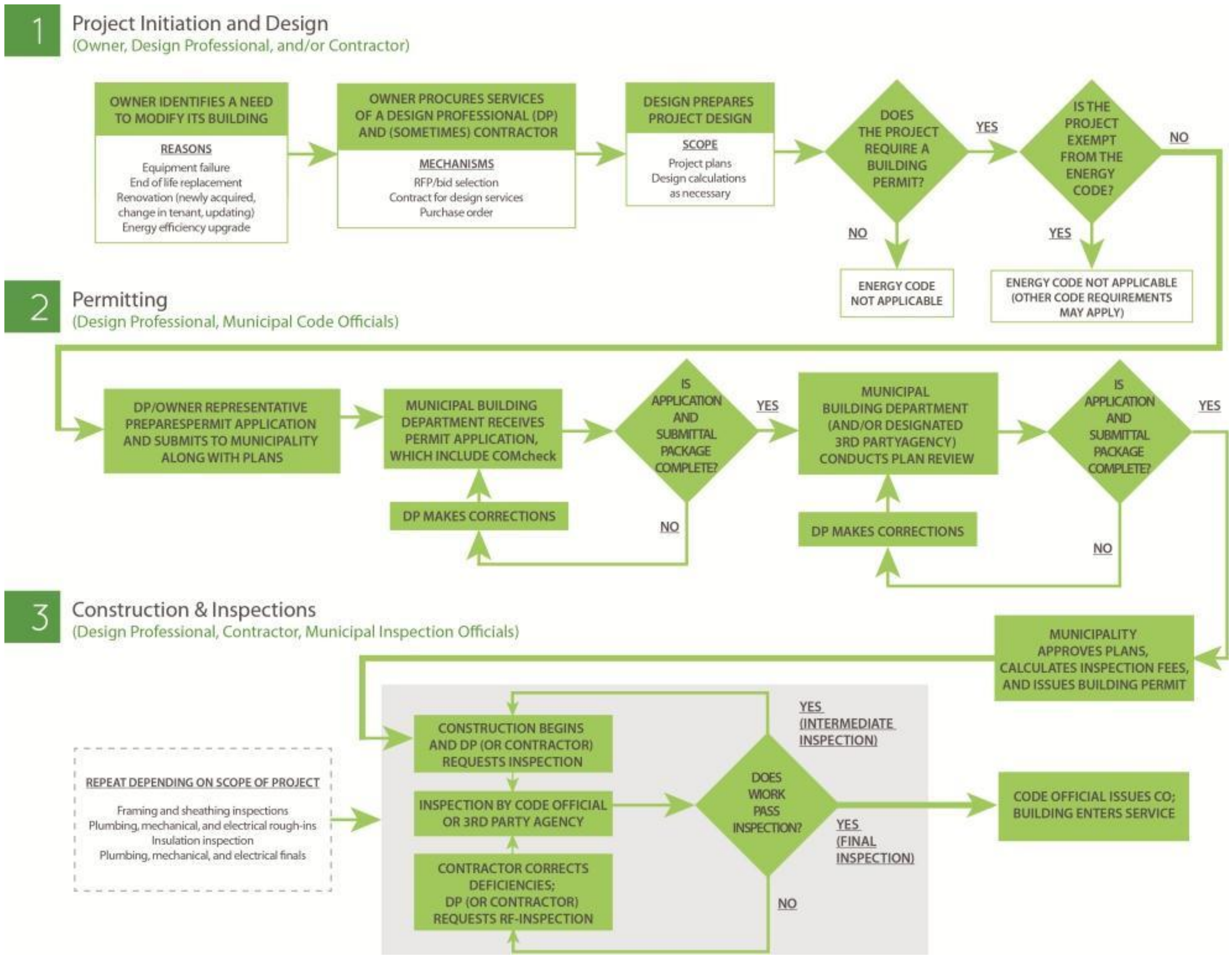

Figure 13: Building renovation flow chart

GAP: There are breaks in communications throughout the design and construction of existing building projects, and the most qualified stakeholders are not always involved at the appropriate times.

Opportunity: A reorganization of the design and construction process would facilitate interaction between the appropriate stakeholders at the appropriate stages of the process. Owners are in a position to demand this type of process.

- Architects should coordinate with engineers earlier in the design process to analyze the energy impact of specific design decisions.
- Engineers can best explain the impact of certain building systems and should be included more frequently in design meetings with owners.
- Earlier interaction with enforcement officials and contractors can help to identify potential code issues in the design process.
- Contractors need more insight on the energy code decisions that are made to help them be more informed when interacting with inspectors and other enforcement officials. Their on-site activities expose them to existing conditions that could inform design decisions.

STAKEHOLDER ROLES

The interview process provided information on the roles, responsibilities, and motivation for different stakeholder groups. Below are some of the insights gathered from our interactions and a graphic (**Figure 14**) summarizing stakeholder responsibilities at different phases of the process.

OWNER/REAL ESTATE INVESTMENT TRUST (REIT)/PROPERTY MANAGERS/DEVELOPER

Though this group of stakeholders does not directly impact the application of the energy code in existing commercial buildings, they are the most influential. They are ultimately responsible for making the decision to modify an existing building. Their influence over the design and construction process puts them in the position to have a major impact on the application of code. However, they are neither trained nor motivated to get involved in the details of code application. Based on our conversations with owners in the region, they assume that the design and construction team comply with all applicable code requirements. Based on compliance studies that have been conducted in many states, we know that 100% compliance is not as common as owners may perceive.

> ***Our interviews showed that owners' approach to energy efficiency improvements and the energy code differed based on numerous factors such as:***
>
> - ***Resources of owner***
> - ***Split incentive***
> - ***Intended holding period***
> - ***Inadequate appraisal of energy efficiency***

The decision to renovate a property could be made for numerous reasons, including: aesthetics, maintenance, building performance improvements, marketing purposes, etc. Based on the interviews of owners in the region, asset repositioning and increasing the market value by improving building capability were the biggest reasons that led many of them to perform modifications on properties.

While the motivation to make energy efficiency improvements heavily depends on finances, tenant demand plays a significant role in realizing savings and making owners move closer towards a more energy efficient market. Owners interact with tenants with the goal of understanding what they value; if tenants want it, the owner will try their best to provide it. As one owner puts it, [owners] "try to make as many quantifiable changes that will attract more tenants and save money."

GAP: Energy codes are often overlooked as a cost efficient energy saving strategy.

Opportunity: Outreach and educational material developed by code advocacy groups would help owners understand the costs and energy savings benefits of complying with the energy code. As disclosure policies spread and tools like DOE's Building Performance Database (https://bpd.lbl.gov) grow, access to information will be available for advocacy groups to present the financial benefits of performing different building upgrades and modifications.

Energy retrofits are very effective, but they are not always financially viable options; particularly for smaller building owners. The goal is to encourage owners to perform existing building upgrades by helping them understand that significant savings benefits are possible by simply complying with the energy code.

Owners' role is crucial because s/he is essentially the final decision maker for incorporating energy efficiency on a property, but it should be noted that their decision is also intricately affected by the other stakeholders' behavior at the same time, including that of the tenants. Market demand for energy efficiency is especially important for the small and medium commercial properties in the Hub region; savings from energy efficiency are often not significant enough for smaller tenants and companies to absorb the initial costs and achieve a timely payback.

GAP: Energy code issues are neglected because they are not directly aligned with stakeholder incentives.

Opportunity: Outreach and educational material from advocacy groups can educate owners and commercial tenants on the implications of noncompliance with the energy code and encourage them to demand compliance from the building industry professionals that they work with.

Owners are understandably focused on the financial factors in a modification project; factors which are often dictated by the demands of their tenants. In order to meet the demands of their clients; architects, engineers, and contractors are also motivated to place a good deal of emphasis on the issues that have direct implications on the cost of a project. If energy efficiency is not a client's primary concern when performing a modification, this can lead to a lack of attention being paid to energy code issues. Gaps in the enforcement of the energy code in existing building projects can perpetuate negligence of code requirements because of lack of consequences for noncompliance.

ARCHITECTS

Architects are hired by the owner to develop the renovation designs and oversee the construction done by the contractor (also acts as the builder in the case of design/build contracts). Some clients come with specific objectives, but often the architect's role is to present clients with potential design opportunities for projects. The architects are responsible with ensuring that the design meets the required codes and standards. The architects coordinate with contractors, engineers, and consultants throughout the design process to determine the impact of design decisions. They are also expected to inform the owner about necessary code requirements and provisions for the renovation. Some architects are proactive in thoroughly analyzing appropriate code requirements, including the energy code, how the project meets each requirement, and with explaining what they mean to their clients.

GAP: The building energy code is not implemented as effectively as possible because it is not considered early enough in the process.

Opportunity: Energy code analysis can be conducted earlier in the design process by architects and engineers.

- Utilizing tools like energy models, Building Information Modeling, and COMcheck in the early design stages can help architects and engineers incorporate energy saving strategies and reduce costs when making adjustments throughout the process. These tools can also help owners to better understand the potential savings impact of designs.
- Engaging enforcement officials during the design process can give the design team a greater understanding of the potential energy code requirements that may need to be considered.

Frequently, some architects encounter resistance from clients. This is a result of the incentive structure; owners are concerned with the financial implications of design decisions and they do not commonly perceive code issues as a factor. Architects work directly for owners and their continued success is contingent on their ability to comply with an owner's request; so when an owner is dismissive toward energy code or energy efficiency issues, it can be difficult for an architect to pursue it further. Overall, the architects interviewed in the course of this research expressed that being proactive helped in the successful implementation of energy related design strategies; one architectural firm even performed energy analyses early in the design process on a regular basis.

ENGINEERS/CONSULTANTS

Mechanical and electrical engineers work primarily with the architect though they occasionally interact with the owner as well. Their responsibility is to develop the technical plans and drawings and perform analyses of the relevant building systems.

According to our conversations with engineers, they typically do not get involved in the building modification process until the architect has made significant progress on the design. Considering the services provided by the engineers and the technical skills that they possess, more interaction with the architect in the early stages of design would likely lead more efficient design solutions and more effective energy code integration. Some engineers are specialists in the field of energy efficiency and design with the intent of making systems perform beyond the code requirements. Another barrier to energy efficiency and energy code application is the engineer's limited access to the owner; architects have a direct relationship with owners, but engineers are often better suited to explain the benefits of complying with certain energy code requirements.

Often operating as project consultants, lighting designers can also play an important role in achieving energy efficiency through the application of the energy code. Lighting serves as one of the most effective ways of reducing energy in a building, and conversations we've had with lighting designers suggest that the majority of lighting replacements trigger code requirements. Lighting designers are typically hired by an architect, but in existing building modifications they often work directly for the owner. This direct access to the owner allows them to educate the owner on the benefits of specific designs; this kind of relationship with owners would greatly help engineers.

CONTRACTOR/REMODELER

The contractor works with the architect, engineers, and consultants during the construction phase to ensure that their designs are being constructed as planned and meet the most recent energy codes and standards.

The contractor has little to no involvement with the energy code decisions early on in the process. Contractors usually have general knowledge about the energy code and its application but the expectation is that energy code issues are addressed in the construction drawings by architects and engineers. One recommendation brought forward during the interview process was a desire for contractors to have a greater involvement in the design process. Communication between the design and the construction team is crucial in any project, but existing building modification projects require more extensive preparation and investigation from contractors.

Another task that contractors may be responsible for is the hiring of third party code enforcement agencies when applicable. In the EEB Hub region, third party code enforcement agencies are sometime used to support the efforts of local municipal building departments.

MUNICIPAL BUILDING CODE OFFICIALS

Local building officials are typically employees of municipalities at local building departments where they enforce the provisions of the building codes that are adopted at the local and state level. The range of resources and personnel available in different municipalities varies greatly. Code officials, plan reviewers and inspectors in New Jersey and Pennsylvania must be licensed or certified and complete continuing education credits. In Pennsylvania, recertification is required every three years, and must be preceded by 15 credit hours of continuing education. Energy inspector is one of the certification categories in Pennsylvania, and individuals seeking this certification must pass the commercial energy inspector examination.

Unlike Pennsylvania, licensing and certification requirements in New Jersey do not specifically address the energy code. But, that is not to say that the energy code is enforced less rigorously. Energy code-related issues are reviewed along with all the other documents submitted during the plan review and are checked by reviewers from four specialized fields—building, electrical, plumbing, and fire. In some jurisdictions, reviewers must be licensed with at least seven years of field experience and maintain their license(s) and code knowledge through available trainings and resources, such as those offered by the ICC.

THIRD PARTY CODE AGENCIES

The size, resources, and even the responsibilities for local building departments can vary greatly across municipalities. These agencies provide Uniform Construction Code (UCC) service and must be certified by the Department of Labor and Industry in Pennsylvania. The size, resources, and even the responsibilities for local building departments can vary greatly across municipalities. Use of third-party agencies is permitted provided they are certified in accordance with regulations. Such agencies are used widely within the state, and make sense especially for small municipalities that lack financial resources to operate a fully staffed building department. According to the latest list on the web site maintained by the Department of Labor and Industry, 174 third party inspection agencies conduct business in the state, though they may not be authorized to legally enforce all aspects of the UCC and services may be limited to certain counties and types of construction (commercial or residential).

Figure 14: Stakeholder responsibilities during the renovation process

ENERGY SAVINGS POTENTIAL

ESTIMATING LOST ENERGY SAVINGS

Code slippage is predicated on the idea that there is a gap between the projected energy savings for a building and the savings that are actually achieved. Compliance studies recently performed in the northeastern U.S. suggest a significant proportion of commercial buildings do not fully meet building energy code requirements. An energy code compliance study completed for Rhode Island looking at new commercial construction found approximately 70% compliance. Determined according to the DOE/PNNL methodology, this indicates that on average buildings perform 30% worse than the code requires, or in other words using 30% more energy than fully compliant buildings.[5]

A study in New Hampshire looked at both new construction and renovations.[6] For plan reviews, renovation projects were found to be non-compliant at a significantly higher frequency than new construction. The percentage of non-compliance for building thermal envelope, lighting/electrical, and mechanical systems on plan reviews for renovations was about twice that of new construction, at over 30% non-compliance. The same pattern was true for non-compliance detected from on-site inspections.

Code officials in New Hampshire were also asked how often they conducted plan reviews for different building systems on commercial building projects. For new commercial buildings, plan reviews were "always" done 55% of the time for the building thermal envelope, 40% of the time for lighting/electrical, and 45% of the time for mechanical systems. Lower percentages (about 5 percentage points less) were observed for commercial renovation projects.

In new construction lost energy savings can be directly connected to energy code compliance; proper application of the code should yield the projected energy savings based on the prevalent energy code. In existing buildings this same logic is applied to modifications that call for energy code compliance. However, to truly understand the potential for energy savings in existing buildings, it is also important to consider buildings that were designed to comply with older versions of the energy code, but are now underperforming due to outdated systems.

Calculations performed for new construction focus on lost energy savings due to improper or incomplete energy code application, but in existing buildings the lost energy savings due to inaction is very important. The potential savings from bringing outdated building systems up to compliance with the prevalent energy code could serve to motivate owners to perform building upgrades. Small to medium sized properties and property owners in particular can be a major factor in capturing these savings. Significant energy and cost savings from the replacement of outdated and poor performing systems could mean that the issues of scale and payback prove to be less prohibitive.

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[5] DNV KEMA. 2012. Draft Final Report Rhode Island Energy Code Compliance Baseline Study. Prepared for State of Rhode Island Office of the Building Commissioner and National Grid. http://www.rieermc.ri.gov/documents/evaluationstudies/2012/RI%20Code%20Compliance%20Baseline%20Study%20%20Final%20Report%20-%20July%2023%202012.pdf

[6] GDS Associates. 2012. New Hampshire Energy Code Compliance Roadmap, Volume 2. Prepared for the New Hampshire Office of Energy and Planning. http://www.nhenergycode.com/live/code_docs/roadmap/2012-04-20%20NH%20Building%20Energy%20Code%20Compliance%20Roadmap%20Report_Volume%201.pdf

The following list calls attention to some of the most prominent challenges and explains why they may be even more difficult to overcome in existing buildings.[7]

- **Data collection –** Estimating energy savings across a broad collection of buildings is difficult because energy use data can be difficult to collect. One reason is that this information is not publicly available in most instances. One would need to get the information through voluntary disclosure. Another reason is that energy data is not always collected. Even when energy use data is available, different stakeholders may possess the data dependent on the situation.
- **Establishing a baseline –** naturally the most logical basis for any comparison of energy code related savings is compliance. One study performed by DOE developed protocols by which compliance could be measured on a state by state basis. The problem is that the methods available for determining compliance face certain limitations. Existing buildings face the same difficulties in establishing a compliance baseline; however, it is further complicated by the varying ages of buildings. Unlike new construction, which can compare the savings related to noncompliance with the prevalent building energy code, the potential savings associated with modifications to existing buildings would be based off of a building's compliance with whichever building energy code (if any) was required at the time it was constructed or most recently modified. This makes the task of estimating lost energy savings a much more complicated endeavor.
- **Scope of work –** in new construction, compliance with the energy code is expected for all aspects of a building, which allows us to correlate compliance with energy savings. In existing buildings, the nature and scope of a modification determine which provisions of the energy code are required. Therefore the energy saving implications of achieving 100% compliance can be completely different in an existing building than they would be in new construction. It also makes the evaluation of compliance a much more difficult process; one would need to first need to determine which code provisions are applicable in a given project and then evaluate whether the modification work is compliant with those provisions. The myriad of code scenarios that can arise in different modification projects make it impossible to associate a fixed energy savings value with a compliance level. Again, this is an issue that makes it very difficult to estimate energy savings on a broad scale, and would require a much more detailed approach than those that have been established for new construction.

EXISTING METHODOLOGIES[8]

Numerous studies have shown that code slippage can be attributed in great part to low compliance with the building energy code. Estimating lost energy savings resulting from noncompliance with the building energy code has proven to be a challenging task. Recent efforts; from organizations like BCAP, the Institute for Market Transformation (IMT), and Cadmus, have presented effective tools and approaches for the estimation of savings. According to IMT, "The projected national savings from bringing just a year's worth of new residential and

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[7] See Institute for Market Transformation. *Assessment of Energy Efficiency Achievable from Improved Compliance with U.S. Building Energy Codes*. (2013) or ACEEE. *Building Energy Code Advancement through Utility Support and Engagement. (2012)* for more information on compliance evaluation and savings calculations for new construction.

[8] See The Cadmus Group, Inc. *Attributing Building Energy Code Savings to Energy Efficiency Programs*. (2013) or Vermont Energy Investment Corporation. *New York Energy Code Compliance Study. (2012)* for more information on the methodologies presented here.

commercial construction in the U.S. up to full compliance is 2.8-8.5 trillion Btu annually, or $63-$189 million in annual energy cost savings."[16] However, these methodologies face limitations that are yet to be fully resolved; and these challenges are amplified when considering existing buildings.

BCAP ENERGY CODE SAVINGS ESTIMATOR[17]

Overview

BCAP Energy Code Savings Estimator (Code Savings Estimator) is a tool to estimate national or state-level savings of energy, utility cost, and carbon emissions savings through full-compliance of a selected version of energy codes. Originally called the Energy Code Calculator, the Code Savings Estimator was first developed by BCAP and the Alliance to Save Energy (ASE) in an effort to show the overall savings energy code implementation can have on the nation or a given state. In 2012, BCAP developed the latest version to estimate such savings at a state-level through the adoption and implementation of updated residential and commercial energy codes. The tool provides estimates for a variety of scenarios dictated by the user. The Code Savings Estimator compares the desired target code scenario to the "business-as-usual" baseline scenario, which can be either the Annual Energy Outlook (AEO) reference published by the U.S. Energy Information Administration or current practice.

Advantages

- Can calculate state-specific estimates, though it is not considered as accurate a reference case as that of national estimates; this is due to the fact that AEO projects energy on the national scale.
- Easy to use and delivers results very quickly.

Disadvantages

- Does not address the issues related to estimating savings for existing buildings.
- AEO projects national energy use, so it is impossible to calculate region-specific estimates with this approach.

1. Analyze the data calculated by the selected baseline and code scenario.

ENERGY MODELING

Overview

The modeling approach compares "the modeled energy use of an as-built building to modeled use of the same configuration building [as] if it were built to exactly meet the code (reference building)."[18] This approach directly determines the energy impacts of the compliance level, estimates compliance and gross saving, and permits other analyses to be conducted. To create an accurate model, representative of an as-built and of a reference building, this approach requires multiple site visits, which can be difficult, time-consuming, and expensive to accomplish. It is also crucial to acquire an appropriate sample size to provide desired accuracy, typically from about 50 to a few hundred, and "at least two model runs are required for each sample buildings."[19]

> **GAP: The lack of professionals qualified to perform energy modeling and analysis can lead to poorly executed models and inconsistent results**
>
> **Opportunity:** Architects, engineers, and other stakeholders should invest in training of the use of energy analysis tools.

The importance of these skills should be promoted to institutions of higher education and programs that offer professional degrees in architecture and engineering. Courses could also be established at vocational institutions to engage younger members of the workforce.

Advantages

- Estimated compliance and gross savings are considered to be accurate on an individual building basis.
- Less prohibitive than an evaluation of prescriptive code compliance because there is no need to access all building components.
- It is flexible enough to accommodate other analyses, such as sensitivity analysis and comparison of compliance of plans and buildings as-built.
  - This provides the potential to estimate the impact of modifications to existing buildings
- Can help to identify inefficiencies for the interactive effects of multiple building components

Disadvantages

- It can be time-consuming because multiple site visits are required and a virtual model must be built.
- Energy model results tend to overestimate energy usage when compared to actual utility data, which leads to overestimates on code related savings potential. However, though the absolute savings estimate is high, the "compliance margin" (the difference between the baseline and modeled energy use) is fairly accurate because the energy usage for both the as-built and reference models would be overestimated.[20]
- The ability to scale up this approach may be limited because the energy modeling component requires specially trained professionals.
- It can be very expensive because the desired sample size for accuracy requires from about 50 to a few hundred buildings.
- Results are extrapolated to the population of buildings which affects accuracy.

BILLING DATA ANALYSIS

Overview

The other direct empirical approach is the billing data analysis. This approach uses "actual energy bills from buildings built under the new code and compares the results to buildings constructed prior to the new code."[21] This data can be acquired either through energy disclosure policies, by offering financial incentives, or voluntarily. Two analyses are required: Analysis on energy efficiency of buildings built under the prior (or existing code) and analysis on energy efficiency of buildings under the new code.

Advantages

- Actual energy consumption data is an accurate portrayal of energy consumption.
- Several thousand buildings can be analyzed for a modest level of effort.
- It does not require site visits to the buildings that are being analyzed.
- Utility bill can provide some insight into the impact that building modifications have on energy usage.

Disadvantages

- Acquiring the customer energy consumption data may become an obstacle and may take a long time to acquire it. Owners may be reluctant to share data for various reasons that range from lack of trust to lack of understanding the benefits in capturing value from big data, benchmarking, and to privacy concerns.

- There may be some errors from mischaracterizing buildings because it is impossible to know with certainty under which code new buildings were constructed.
- Data may also differ dependent on how it is acquired; for example, owners who volunteer to share their buildings' energy billing data are likely to have higher performing buildings. Conversely, those who disclose their buildings' energy data due to incentives may have buildings that function more poorly than the average building population.

PROPOSED METHODOLOGY

This section seeks to identify best practices from existing methodologies and make recommendations on how lost energy savings in existing commercial buildings can be estimated effectively across the EEB Hub region. To gain a more comprehensive understanding of the potential savings, the impact of noncompliance and the impact of inaction will both be explored.

COLLECT DATA

The process of collecting the applicable data from the entire existing commercial building stock in the region is practically unfeasible. For a methodology of estimating lost energy savings to be useful there must be enough information collected to make assumptions about the building stock, but the diversity of code implications in existing building modifications makes it difficult to make these assumptions. Understanding what data is needed and how to collect it is an important first step.

GAP: It is very difficult to obtain current and accurate information on the existing building stock; such as: the age of building systems & components,

Opportunity: The state should require more detailed permit documentation and a revised system for storing the building permit data. This could serve as a source for determining the volume of renovations and what types of projects are being commissioned.

Requiring plan reviewers and inspectors to detail a building's compliance with specific energy code provisions would make this valuable information more accessible. It would also assist in evaluating the rate of compliance for existing building modifications.

INFORMATION	SOURCES	CHALLENGES
BUILDING AGES	Census Tax records CBECS Real estate information databases (CoStar, McGraw Hill, etc.)	May be difficult to find this information at smaller scales, like the state, city, or municipal level
BUILDING SIZES	Census Tax records CBECS Real estate information databases (CoStar, McGraw Hill, etc.)	Same as above
BUILDING TYPES	Census CBECS Real estate information databases (CoStar, McGraw Hill, etc.)	Same as above
BUILDING COMPONENTS & SYSTEMS	CBECS EReal estate information databases (CoStar, McGraw Hill, etc.)	Same as above
LIFE SPAN OF RELEVANT BUILDING SYSTEMS	Product research Expert feedback	
PERFORMANCE DATA	Energy modeling Utility bills	Energy modeling is requires specialized labor, and without a disclosure policy utility bill information is not available to the public.
DATA OF LAST MODIFICATION	Local building departments Real estate information databases (CoStar, McGraw Hill, etc.)	Sources would not account for work done without permits
TYPES OF MODIFICATIONS PERFORMED AND THEIR SCALE (FLOOR AREA)	Local building departments Real estate information databases (CoStar, McGraw Hill, etc.)	Interactions with local building departments have shown that there is no consistent method of collecting and storing this information
HISTORY OF CODE ADOPTION IN THE REGION	Building department websites OCEAN website www.energycodesocean.org	

LOST SAVINGS DUE TO NON-COMPLIANCE

To establish a point of comparison by which to estimate lost energy savings in existing buildings numerous baselines must be used to accommodate for buildings of different ages. Each of the previously adopted versions of the energy code would serve as baselines for comparison. For buildings constructed before the adoption of an energy code or standard, assumptions about the building components and systems would need to be made to estimate performance. The concept below focuses on the performance of buildings that have undergone renovations that should be compliant with an adopted version of the energy code.

The logical first step is to establishing the baseline is to organize the building stock data, identify the buildings that have undergone modifications, and associate them with the version of the energy code that they should theoretically be compliant with. The next step would be to use compliance levels to determine lost energy savings; however, the process is more in depth for existing buildings than it is for new construction.

Since existing building modifications can vary so much in scope and scale, one cannot directly associate compliance level with energy savings. Therefore, it is necessary to determine the prevalence of different types of building modifications in the region, and determine which energy code provisions are commonly required in those modifications. This information provides perspective on the existing building modification and renovation market. From here, estimates can be made to associate energy savings with different code provisions and building systems. One example of linking the compliance of building systems to energy savings **(Figure 6)** is in a report commissioned by the New York State Energy Research and Development Authority (NYSERDA)[22]. This report conducted a compliance study based on the DOE/BECP protocol and assessed the lost energy savings of specific building systems in new construction.[23]

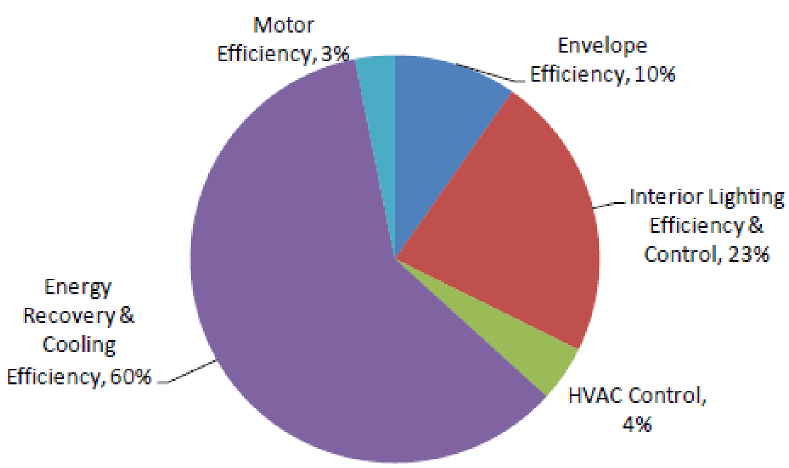

Figure 6 – Commercial Lost Savings by Building System (source: Vermont Energy Investment Corporation. *New York Energy Code Compliance Study*. Jan. 2012).

This methodology addresses the issue of diverse project scopes when evaluating the potential energy savings associated with existing building modifications. When applied to the appropriate baseline and combined with information about the renovation market, estimates can be made on the lost energy savings due to energy code compliance in existing building modifications.

Many of the challenges explained earlier with regard to the collection of data and appropriate evaluation of compliance are still present, but the purpose of this approach was to present one way to potentially think about the issues unique to existing building modification projects.

LOST SAVINGS DUE TO INACTION

In addition to lost energy savings due to non-compliance with the energy code, one must also account for the energy that is lost as a result of building components beyond their useful life cycle and are due for an upgrade that would bring them in compliance with the latest adopted energy code. Issues of non-compliance are best addressed by architects, engineers, contractors, and code officials; but performing upgrades to buildings is the responsibility of the building owner and is influenced greatly by the market factors discussed earlier.

The proposed approach is similar to the approach to estimate lost energy savings due to non-compliance, except that instead of collecting data on the volume and types of renovations, data must be collected to determine the age of building systems and components addressed in the energy code. This information would then be analyzed to determine how much of the existing building stock is still utilizing building systems and components that are beyond their useful life. Information on the life expectancy of building components can be determined by speaking with experienced professionals or through several sources such as the Chartered Institution of Building Services Engineers (CIBSE). The out of date systems should then be categorized into different groups based on type and age in order to establish baselines. Once the baselines are established, lost energy savings can be determined by calculating the difference in energy consumption that would occur if the baselines were replaced with systems and/or components that complied with the current adopted code requirements.

Identifying Retrofit Candidates

A good example of criteria to identify retrofit candidates is in Econsult's report for the EEB Hub, *The Market for Commercial Property Energy Retrofits in the Philadelphia Region*. Econsult selected 6 major property-level metrics to determine whether an individual building would benefit from an energy retrofit:

- **Age Index**: Older buildings are more likely candidates for improvements.
- **Property Type Index**: Different property types have different levels of energy consumption.
- **Enclosure Index**: Shorter buildings are more cost-effective candidates for improved energy efficiency via improvements to their envelope or enclosure.
- **Materials Index**: Buildings with masonry exteriors, rather than steel and/or glass, are more likely to have gaps in their envelope and hence benefit from improvements to their exterior.
- **Internal Load Index**: Buildings in which daylight is unable to penetrate to interior spaces use greater amounts of synthetic light, which increases their energy consumption.
- **Owner-Concentration Index**: Multiple buildings which are owned by a single entity are easier to retrofit for the practical reason that it is logistically and legally easier to deal with one owner rather than several.

In the report, 47 percent of the commercial and industrial space in the Philadelphia area is identified as potential candidates for energy retrofits. This covers 4,201 buildings with 154 million square feet of space, the retrofit of which is estimated to generate $618 million in local spending and support 23,500 jobs.[24]

GAPS & OPPORTUNITIES

BCAP has identified the gaps and barriers related to code compliance in different states through its Compliance Planning Assistance (CPA) program. The CPA efforts identified the need for increased outreach from state and local governments to assist in promoting the adoption of energy codes, a need for more training, and recommended that states raise awareness of the most current energy code requirements among code officials, builders, and designers. The CPA program provides a very useful foundation with which to examine the unique issues that affect the application of building energy codes in existing buildings found in the Hub region. For this project, we expanded the focus to examine the code application process and interactions between stakeholders to identify gaps and opportunities. The following summarizes the gaps and opportunities that were identified from our conversations with stakeholders in the region.

PROCESS GAPS

GAP: There are breaks in communications throughout the design and construction of existing building projects, and the most qualified stakeholders are not always involved at the appropriate times.

Opportunity: A reorganization of the design and construction process would facilitate interaction between the appropriate stakeholders at the appropriate stages of the process. Owners are in a position to demand this type of process.

- Architects should coordinate with engineers earlier in the design process to analyze the energy impact of specific design decisions.
- Engineers can best explain the impact of certain building systems and should be included more frequently in design meetings with owners.
- Earlier interaction with enforcement officials and contractors can help to identify potential code issues in the design process.
- Contractors need more insight on the energy code decisions that are made to help them be more informed when interacting with inspectors and other enforcement officials. Their on-site activities expose them to existing conditions that could inform design decisions.

GAP: The building energy code is not implemented as effectively as possible because it is not considered early enough in the process.

Opportunity: Energy code analysis can be conducted earlier in the design process by architects and engineers.

- Utilizing tools like energy models, Building Information Modeling, and COMcheck in the early design stages can help architects and engineers incorporate energy saving strategies and reduce costs when making adjustments throughout the process. These tools can also help owners to better understand the potential savings impact of designs.
- Engaging enforcement officials during the design process can give the design team a greater understanding of the potential energy code requirements that may need to be considered.

GAP: Processes in a modification/renovation project are often very complex, but stakeholders typically approach energy code application in existing building modifications with the same process that they use for new construction projects.

Opportunity: Altering the language in the IECC would help to address existing buildings more thoroughly and better reflect the issues faced in the renovation process.

- Two separate proposals were made to the 2015 IECC submitted (by the Sustainable Energy High Performance Code Action Committee and the Northwest Energy Codes Group) with the goal of:

    3. Clarifying the requirements for additions, alterations, renovations and repairs; and

    4. Creating a separate section for existing buildings that can be expanded in the future

MARKET GAPS

GAP: Energy code issues are neglected because they are not directly aligned with stakeholder incentives.

Opportunity: Outreach and educational material from advocacy groups can educate owners and commercial tenants on the implications of noncompliance with the energy code and encourage them to demand compliance from the building industry professionals that they work with.

Owners are understandably focused on the financial factors in a modification project; factors which are often dictated by the demands of their tenants. In order to meet the demands of their clients; architects, engineers, and contractors are also motivated to place a good deal of emphasis on the issues that have direct implications on the cost of a project. If energy efficiency is not a client's primary concern wen performing a modification, this can lead to a lack of attention being paid to energy code issues. Gaps in the enforcement of the energy code in existing building projects can perpetuate negligence of code requirements because of lack of consequences for noncompliance.

GAP: Energy codes are often overlooked as a cost efficient energy saving strategy.

Opportunity: Outreach and educational material developed by code advocacy groups would help owners understand the costs and energy savings benefits of complying with the energy code. As disclosure policies spread and tools like DOE's Building Performance Database (https://bpd.lbl.gov) grow, access to information will be available for advocacy groups to present the financial benefits of performing different building upgrades and modifications.

Energy retrofits are very effective, but they are not always financially viable options; particularly for smaller building owners. The goal is to encourage owners to perform existing building upgrades by helping them understand that significant savings benefits are possible by simply complying with the energy code.

ENFORCEMENT GAPS

GAP: Many local building departments lack the staff and resources to effectively perform all of the code enforcement duties

Opportunity: *See the recommendations for the following four gaps*

GAP: COMcheck exists as a "deemed to comply" tool which needs to be reviewed and approved by a code official, but the results are often accepted without considerable review.

Opportunity: Code officials could benefit from enhanced training for tools like COMcheck to help them better understand the limitations of the software, and resources that help them to identify common errors. By actively seeking out federal funding opportunities; states, municipalities and advocacy groups could potentially support these training programs.

GAP: Many of the current local building officials find the energy code certification expensive, time-consuming, and difficult to pass, especially for long tenured staff.

Opportunity: Municipalities could partner with local colleges and/or technical schools to establish building technology and energy code compliance and certification courses. Organizations like the Building Performance Institute have already established their certification courses in community colleges and other institutions. By following a similar path, municipalities could attract younger members of the workforce.

GAP: The permit information available for existing buildings is inconsistent because different building departments may use different systems to store documentation. This leads to inefficiencies and redundancy, particularly in existing building projects.

Opportunity: A state mandate calling for a building permit documentation system to be used across jurisdictions, would help local building departments and building industry professionals could to better utilize the vast amount of information that is available.

An improved documentation system would help local building department to work more efficiently. It would also provide the design and construction community with the information needed to apply the energy code more effectively in existing buildings. One example of a successful use of technology was in the city of Gillette, WY. By instituting a comprehensive internet based software solution for plan review, they were able to improve efficiency dramatically. [25]

GAP: Improper integration of third party enforcement agencies can lead to inconsistencies.

Opportunity: Guidelines established by municipalities could guide greater coordination between third party agencies and local jurisdictions during the review and inspection phases.

Third party agencies can be very useful for jurisdictions with limited resources. However, their involvement can take on many forms. A comprehensive third party program takes on all of the enforcement duties for a jurisdiction, but often times the third party agencies are only responsible for certain enforcement activities. One of the issues that can lead to inconsistencies is when tasks such as plan review and inspection are conducted by different agencies with no coordination between the two.

GAP: Information on energy code enforcement resources and procedures is not made as accessible by municipalities as information on other building codes.

Opportunity: Municipalities typically possess information on compliance (for both new construction and renovations) and tools like COMcheck, which can be made more visible and accessible to relevant parties. The promotion of these resources on municipal websites could serve to raise awareness, better inform the building community, and reduce inquiries for the staff.

GAP: With the end of Recovery Act funding and due to a shortage of funding in general, there is: 1) reduced staff size; 2) less energy code training being offered; and 3) difficulty in hiring 3rd party energy code inspectors.

Opportunity: State and local governments may need to be creative in their fund-raising and the pursuit of funding opportunities. Though the statewide funds of ARRA are no longer available, municipalities can still seek smaller scale funding opportunities to assist in their compliance efforts.

MEASURING IMPACT

GAP: It is very difficult to obtain current and accurate information on the existing building stock; such as: the age of building systems & components,

Opportunity: The state should require more detailed permit documentation and a revised system for storing the building permit data. This could serve as a source for determining the volume of renovations and what types of projects are being commissioned.

Requiring plan reviewers and inspectors to detail a building's compliance with specific energy code provisions would make this valuable information more accessible. It would also assist in evaluating the rate of compliance for existing building modifications.

GAP: The use of COMcheck and the prescriptive compliance path can lead to over optimization of certain building parts and higher energy costs than anticipated.

Opportunity: The building performance path for code compliance offers the best opportunity to accurately measure energy usage. Understanding that this is not always a feasible option, a thorough analysis of existing conditions should be conducted, and perhaps supplemented with basic energy models, to ensure that the most effective components are selected when pursuing the prescriptive compliance path.

GAP: The lack of professionals qualified to perform energy modeling and analysis can lead to poorly executed models and inconsistent results

Opportunity: Architects, engineers, and other stakeholders should invest in training of the use of energy analysis tools.

The importance of these skills should be promoted to institutions of higher education and programs that offer professional degrees in architecture and engineering. Courses could also be established at vocational institutions to engage younger members of the workforce.

POLICY OPPORTUNITIES AND ABOVE CODE PROGRAMS

OPPORTUNITIES IN POLICY

Federal, state, and local policies offer the opportunity to improve the performance of the existing building stock through various avenues. Though the enforcement of the energy code occurs almost entirely at the local level, state governments should (and in some cases have) set the example for municipalities by adopting a more stringent energy code or standard for state buildings. This would allow state governments to provide insight on the application of the code and facilitate the adoption of more stringent energy codes for local municipalities.

Policy and regulation can also play an important role in the market adoption of energy efficiency measures for existing buildings. One approach is through the introduction of policy that incentivizes market players with energy efficiency benchmarks or that requires disclosure of energy performance. In New York City, mandatory energy disclosure and benchmarking laws have generated demand for energy retrofits.[26] The Philadelphia disclosure ordinance, modeled after New York City, should produce similar results. However, one issue to consider is how the demand from tenants and owners to improve building energy performance can help to increase compliance and address code slippage. Energy use disclosure and benchmarking make building performance a market factor and creates incentives for owners and building industry professionals to deliver the expected energy savings. The building energy code is one way to achieve those savings.

Figure 7 shows how codes can contribute to the potential energy savings of buildings and how the efforts of Program Administrators (PA's) can play a role in delivering those savings through expanded market actions (policy, incentives, etc.).

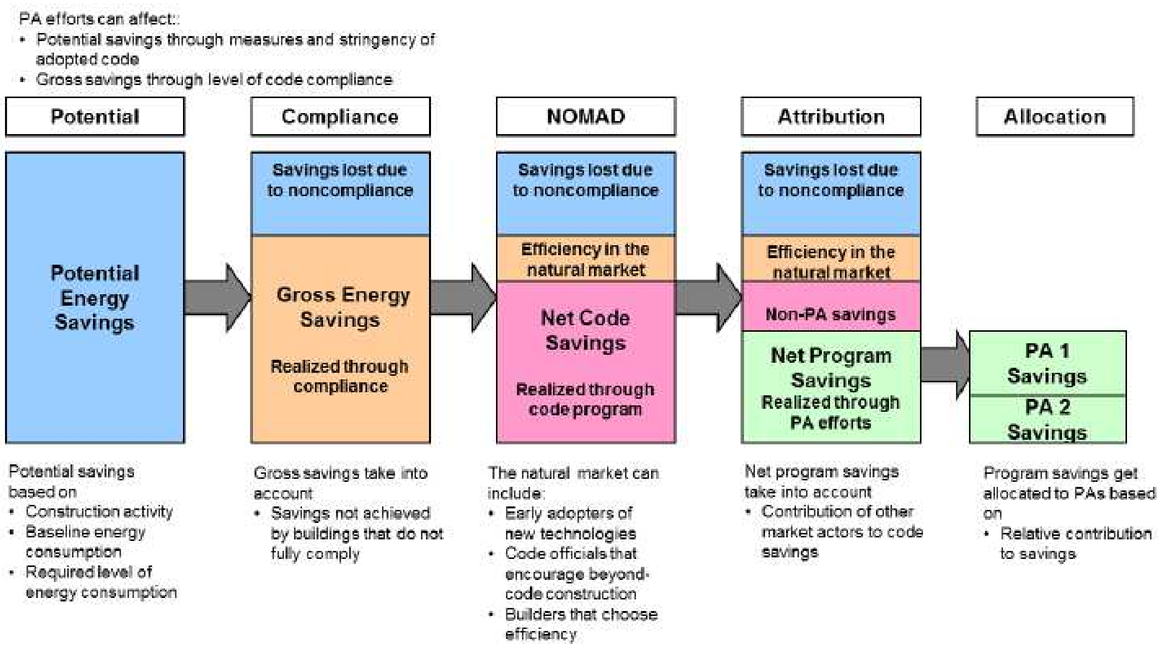

Figure 7 - General Model of Energy Code Evaluation and Attribution to Utilities / PAs (source: The Cadmus Group, Inc. *Attributing Building Energy Code Savings to EE Programs*. Feb. 2013)

Below are some of the policies and incentive programs that are available in the EEB Hub region.

ENERGY CONSERVATION BILL

The Philadelphia City Council unanimously passed Bill No. 120428 "Energy Conservation" on June 21, 2012. This bill requires commercial building owners and operators of commercial buildings with an indoor floor space of 50,000 square feet or greater to report energy and water usage data and provide benchmarking. According to the bill, "Portfolio Manager, or any successor system thereto, developed by the United States Environmental Protection Agency, to track and assess the energy and water use of a building" will be used for benchmarking.[27]

Impact on the energy code: Although, benchmarking does not directly address the building energy code, making building performance public knowledge, can act as an incentive for owners to update their properties. Access to knowledge should lead to more informed tenants and likely drive the demand for higher performing buildings. The disclosure and benchmarking of energy usage motivates property managers and owners to ensure that their properties remain competitive in the regional market. The focus on building energy performance makes it very likely that these modification projects will trigger energy code requirements.

ENERGYWORKS INCENTIVE PROGRAM

The EnergyWorks Incentive Program is a comprehensive energy solutions program for home, commercial, and industrial building owners supported through the Department of Energy's Better Buildings Program. EnergyWorks has experts that help owners find ways to reduce their buildings' energy use and provide low interest loans to help them pay for the improvements. EnergyWorks incentive program provides below-market financing for three types of building energy efficiency projects: limited energy retrofits (such as the replacement of a single piece of equipment or system), extensive whole building energy retrofits, and energy efficient gut rehab of existing buildings. EnergyWorks provides an energy analysis on systems and usage and makes recommendations for the most cost effective ways to cut costs and increase the building's value.

Impact on the Energy Code: This incentive program provides some interesting opportunities for the application of the energy code on an existing building. The access to below market financing is a motivating factor for owners to perform upgrades to their buildings, and the three project types are very likely to include actions that trigger the energy code. The option of replacing a single piece of equipment or system immediately requires compliance with the energy code, while the other two options present opportunities for the energy code to be considered a part of a holistic design approach. However, the challenge of ensuring that the energy code is properly applied and enforced is still present.

NEW JERSEY'S CLEAN ENERGY PROGRAM: PAY FOR PERFORMANCE

New Jersey's Clean Energy Program includes incentives that directly link to the savings of the existing building project. The Pay for Performance program provides partners to perform technical services under contract with the owner. The partners perform an energy audit; develop an energy reduction plan, a financial plan, and a construction schedule for the project. The Pay for Performance program is eligible to any existing commercial, industrial, or institutional buildings with a peak demand over 100kW for any of the preceding twelve months. It is also eligible to multifamily housing; however they are not required to meet the 100kW prerequisite. The energy reduction plan has to show the capability to reduce the energy consumption of the building by fifteen percent or more to be considered eligible.

Impact on the Energy Code: This incentive program is particularly interesting because it includes aspects of a disclosure policy and ties it to financial incentives. Binding the performance of the building to financial incentives creates a more direct impact for owners and consequently places a higher focus on the proper application of the energy code. This feature also provides the data necessary to compare energy savings projections with actual energy savings, and brings the issue of code slippage to the forefront. However, one of the challenges of applying this program directly to the performance of the energy code is that the 15% savings requirement doesn't necessarily mean that energy code requirements will be addressed.

ABOVE CODE PROGRAMS

The establishment of the energy code and energy efficiency policies in buildings has laid the groundwork for above code programs that strive for even greater performance from buildings. The following highlights examples that are raising the ceiling and expanding beyond the requirements of the IECC.

STRETCH ENERGY CODE

The 'Stretch' Code is an enhanced version of the 2009 IECC that was adopted in Massachusetts in July of 2009. With greater emphasis on performance testing and prescriptive requirements, it was designed to be approximately 20 percent more efficient than the IECC. It divides commercial buildings by size and type. Buildings less than 5,000 sq. ft., "specialty buildings" less than 40,000 sq. ft. (supermarkets, warehouses, and laboratories), and renovations are exempt. Buildings larger than 100,000 sq. ft. and "specialty buildings" larger than 40,000 sq. ft. must exhibit a 20 percent reduction in energy use from ASHRAE 90.1-2007 using approved energy modeling. Buildings between 5,000 and 100,000 sq. ft. can meet the same performance requirements or a prescriptive code based on a codified version of New Buildings Institute's (NBI) Core Performance Guide, which includes more stringent building envelope and HVAC equipment requirements than the 2009 IECC and new requirements for commissioning, air barriers and lighting controls. Additions must meet the same performance requirements, whereas renovations will require a less stringent HERS rating (80 or 85 for homes 2,000 sq. ft. and larger or smaller, respectively). Both can also comply with Energy Star for Homes prescriptive requirements, plus meet or exceed 2009 IECC insulation requirements.

INTERNATIONAL GREEN CONSTRUCTION CODE

The International Code Council's (ICC's) International Green Construction code (IgCC) is an overlay code, meaning that it requires to be used with all the other ICC codes. The IgCC is the first model code to include sustainability measures for the entire construction project. The code contains provisions for site development and land use, energy efficiency, water conservation, material resource conservation and efficiency, indoor environmental quality and comfort, commissioning and operations and maintenance, and existing buildings. The energy efficiency provisions use the commercial IECC provisions as a basis, and then improve on them by generally increasing the efficiency of the IECC by 10%. Designed to be used as a regulatory framework for both new and existing buildings, the IgCC establishes minimum green requirements for buildings and complementing voluntary rating systems, which may extend beyond baseline of the IgCC. The IgCC is adaptable by offering flexibility in establishing several levels of compliance, starting with the core provisions of the code, and then moving forward to "jurisdictional requirement" options that can be customized to fit the needs of a local community.

ASHRAE STANDARD 189.1

ASHRAE published Standard 189.1, *Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings*, on January 22, 2010. The standard is intended to be adopted into local codes as an alternate compliance option to the IgCC and/or as a resource for local jurisdictions for starting a local green building program. The energy efficiency goal of Standard 189.1 is to provide significant energy reduction over that in Standard 90.1-2007. The U.S. Department of Energy (DOE) estimated that applying the minimum set of prescriptive recommendations in the Standard 189.1 would result in weighted average site energy savings of 27 percent when compared to Standard 90.1-2007.

LEED FOR EXISTING BUILDINGS

The first LEED Rating System (LEED-NC) was launched in 2000 and was specifically designed for the construction of new buildings. LEED is administered by a third party organization, the Green Building Certification Institute (GBCI) instead it is administered by the Green Building Certification Institute. LEED-EB was piloted in January, 2002, with official launch in November, 2004. The USGBC launched LEED-EB to address the ongoing operations, maintenance and upgrades of existing buildings. LEED-EB was expanded to include Operation and Maintenance Standards in January, 2008.

Buildings applying for certification are compared with a theoretical baseline building defined by a LEED methodology or the more stringent of either ASHRAE/ANSI/EISNA codes or local codes. LEED for Existing Buildings: O&M compares a singular project to other existing buildings using the EPA Portfolio Manager benchmarking tool.

ENERGY STAR[28]

ENERGY STAR's Portfolio Manager is a widely used program to help buildings across all 50 states track and rate their energy consumption. As of December 2012, the program acquired over 260,000 buildings across the nation, representing over 28 billion square feet (nearly 40 percent of the commercial market).

The program also helps to evaluate if energy design intent translates into efficient building operation, energy savings and pollution prevention over time. According to the Fifteen O&M Reports for Energy-Efficient Buildings, building owners can save five to twenty percent annually on their energy bills by implementing O&M best practices. Like LEED, Energy Star is voluntary except in jurisdictions which have mandated it for energy disclosure.

CONCLUSION

Building energy codes are a cost-effective tool to reduce energy consumption. Despite ongoing energy code improvements, however, and widespread adoption of new codes among the states many of our buildings fall short of the efficiency levels the codes are designed to produce. We refer to this phenomenon as slippage. Many factors contribute to this underperformance, including: political barriers; insufficient technical expertise, awareness, and knowledge about the energy code; and not enough personnel to address energy code compliance. BCAP’s Compliance Planning Assistance (CPA) program has helped to identify these issues and recommend tactics and strategies for states to address these issues and improve their compliance rates. However, one aspect of the codes not often addressed is their misapplication or under-application to existing buildings. Particularly for those buildings in which the ownership or landlord-tenant structure tends to inhibit investments in energy efficiency, the building energy codes are the safety net that ensures a basic level of performance.

Based on the age and energy consumption of the commercial building stock in the United States, existing commercial buildings represent an obvious opportunity for large energy savings. Ensuring that the energy code is properly applied to all renovation projects (not just energy retrofits) could result in significant progress toward reducing the energy impact of the building stock. Though some of the challenges that face the application of energy codes in existing buildings are common to those identified in the BCAP’s CPA efforts, one of the goals of this project moving forward is to clearly identify those issues unique to existing buildings in the EEB Hub region.

Code enforcement has frequently been identified as an area for improvement with regard to energy code compliance. However, many of the relevant decisions that impact compliance and building performance are made before enforcement officials are involved. With this in mind, the goal was to detail the process that these local stakeholders went through when presented with an existing building modification project, and identify opportunities to throughout the process. We defined the code application process as everything that occurs in a renovation project from the moment an owner decides to pursue a renovation, until the building has passed inspections and is once again operable.

Through secondary research and the engagement of stakeholders who are active in the regional building market, we were able to identify a series of gaps and provide recommendations on closing those gaps. The interviews we conducted focused on speaking with the stakeholders directly involved in the application of the building energy code. The most common issues we encountered were:

- Little differentiation in the implementation and enforcement of energy codes for new construction and existing buildings
- a need for greater interaction between certain stakeholders in different phases of the process
- a lack of incentives for proper energy code application
- a shortage of qualified professionals

This report presents our findings after speaking with a selection of representatives from different stakeholder groups. The results are not meant to definitively characterize the region, but many of our findings were in line with research previously conducted by BCAP. Moving forward we will continue to engage a broad group of regional stakeholders and present our findings to them with the intent of gathering feedback and using it to develop tools and resources to address the issue of code slippage in existing buildings.

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