Advanced Energy Codes Impact Evaluation Interim Report: First Delphi Process Results

Final

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Executive Summary

This report presents findings from the first Delphi Process completed as part of the impact evaluation of the Energy Conservation Construction Code of New York State ("Energy Code") component of the New York State Research and Development Authority (NYSERDA) Advanced Energy Codes and Standards program ("the Program"). The Energy Code component provides training and technical assistance to code enforcement officials and the broader design and construction marketplace; develops technical tools to support code enforcement and compliance; conducts technical studies and research; and initiates pilots and provides implementation assistance. The results of the First Delphi set a baseline for compliance with the Energy Code. A Second Delphi Process, with expected completion in 2018, will estimate the change in Energy Code compliance and will attribute the portion of code compliance change to NYSERDA's codes activities.

ES.1 Project Objectives and Scope

The primary goal of the impact evaluation is to attribute energy savings to the Program's Energy Code component. Impact evaluation activities will estimate statewide Energy Code compliance before and after implementing the Energy Code component, including, but not limited to, training and technical assistance. The difference in compliance levels will be used to estimate energy savings due to the Energy Code component.

To evaluate the Energy Code component's effectiveness and estimate associated savings, the evaluation team conducted a Delphi process, engaging Energy Code experts to estimate compliance levels within the residential and commercial sectors. A Delphi process is a structured method to converge expert opinion from a series of interviews on a particular subject. The Delphi process consisted of three rounds of in-depth, one-on-one interviews with the Delphi participants ("experts").

ES.2 First Delphi Results

Of the twenty-one experts interviewed during the Delphi process, seventeen have expertise in commercial building projects and fourteen have expertise in residential building projects. The overall weighted estimate of Energy Code compliance in New York State is 74% for commercial new construction and 77% for residential new construction. This result suggests that 74% of the Energy Code requirements are met by the average new commercial building and 77% of the Energy Code requirements are met by the average new residential building. The coefficients of variation (CVs) show the variability in results among the experts with experience in commercial and residential new construction.

Table 1-1. Energy Code New Construction Compliance Estimates from First Delphi Process

Energy Code	Weighted Average Compliance	Weighted CV
Commercial	74%	13%
Residential	77%	11%

ES.3 Recommendations to Improve Compliance

Overall recommendations – The Delphi experts made the following overall observations and recommendations to improve compliance with the Energy Code:

- **Leverage third-party compliance support**. Many Delphi experts recommended leveraging third-party energy professionals to support code enforcement offices.
- **Target building operations**. Many experts recommended strategies targeting post-occupancy operations and maintenance to improve building performance.

Commercial code focus areas –Commercial expert response and rationale analysis identified the following focus areas for improving commercial compliance and awareness:

- **Air sealing and the building envelope –** Many experts identified a general lack of understanding of the building science behind air barriers and sealing requirements. The enforcement of the continuous air barrier was identified as an explicit opportunity for targeted training.
- **Daylighting –** Many experts observed lack of awareness among the design and construction community regarding what is required to comply with the Energy Code daylighting requirements. Targeted training on daylight zones and their applicability across a variety of building types would help improve awareness, compliance, and enforcement of this requirement.
- **Commissioning –** Many experts felt that review of commissioning activities is not adequately performed by the code enforcement community. The new 2014 Energy Code[1] requires more rigorous commercial building commissioning, and while many experts felt that these are an improvement over the 2010 Energy Code, they remain concerned that a lack of effective enforcement will result in these requirements going largely ignored.

Residential code focus areas –Residential expert response and rationale analysis identified the following focus areas for improving residential compliance and awareness:

- **Documentation on plans and in electrical panels** – Many experts identified a lack of sufficient documentation on residential construction projects to verify compliance.
- **Mechanical equipment sizing –**Experts indicated that they rarely see evidence of mechanical sizing (Manual J) calculations; while the calculations may be performed, lack of documentation makes them difficult to verify.
- **Air sealing and envelope insulation.** Air sealing and the proper insulation installation were consistently identified as one of the biggest challenges for residential construction. Delphi experts observed that in most residential building, the amount of insulation provided meets the Energy Code, but installation techniques frequently do not meet manufacturers' requirements.

[1] In November 2014, the New York State Building Code Council voted to adopt an update to the commercial Energy Code, effective January 1, 2015. The updated code is based on the 2012 International Energy Conservation Code (IECC-2012) and includes a supplement specific to New York State.

1 Introduction

This report presents the findings from the first Delphi Process completed as part of the impact evaluation of the Energy Conservation Construction Code of New York State (Energy Code) component of the New York State Research and Development Authority (NYSERDA) Advanced Energy Codes and Standards program ("the Program"). Program Overview

The Program aims to reduce energy use by a) increasing compliance with the Energy Code and b) contributing to the appliance and equipment standards (Standards) development. The Energy Code component includes conducting sector-based compliance assessments to measure progress towards an American Recovery and Reinvestment Act (ARRA) mandated compliance goal and associated energy savings.

The Program plans to achieve its goals through the following activities:

- Training and other support services to building enforcement, design, and construction markets
- Developing a stretch Energy Code available to municipalities for voluntary, local adoption that is more efficient than state-minimum code
- Advancing standards for additional equipment categories not covered by federal standards to capture savings in New York

The Program's quantified energy savings goals are to:

- Achieve 90% Energy Code compliance statewide (meet ARRA funding requirements)
- Achieve 631 GWh of cumulative annual electricity savings, 4,921,000 MMBtu cumulative annual fossil fuel savings, and 129 MW of cumulative demand reduction

The energy code component provides training and technical assistance to code enforcement officials and the broader design and construction marketplace; develops technical tools to support code enforcement and compliance; conducts technical studies and research; and initiates pilots and provides implementation assistance. Effective January 1, 2015, New York State adopted the 2012 International Energy Conservation Code (IECC-2012)/ASHRAE 90.1-2010, with a state-specific supplement, for its Commercial Energy Code provisions. On March 9, 2016, New York State adopted the IECC-2015 in its entirety (residential and commercial provisions), as well as ASHRAE 90.1-2013, as Energy Code, with a state-specific supplement of minimal amendments. This update will be effective October 3, 2016.

The NYSERDA Technology and Market Development (T&MD) Operating Plan established considerable energy saving goals for the Program, approximately 80% of the energy savings, fossil fuel savings, and demand reduction for the overall T&MD Operating Plan. This report is specifically focused on activities completed to support the impact evaluation of the Energy Code component of the Program.

NYSERDA seeks to close the gap between the actual compliance rate and the ideal rate (100%) to realize Energy Code energy savings. The program's primary audience consists of the design, construction, and enforcement markets, including: builders, architects, engineers, code enforcement officers, and energy professionals including HERS raters and others functioning in a third-party capacity.

Energy Code education among the Program's target markets is a key impediment to code compliance. NYSERDA seeks to address this barrier through training, technical resources and studies on the Energy Code and its practical application. Energy Code training is one primary Program activity and thus the predominant focus of the evaluation; other Program activities will be assessed, as applicable, during later Delphi Panel work. NYSERDA contracted with training contractors to develop and deliver a portfolio of classroom training courses on the updates to the Energy Code and has dedicated $4 million to support

training. The trainings are targeted to four distinct audiences: code enforcement officials, design professionals, construction trades, and energy and other professionals. Moreover, several trainings are tailored to audiences that work primarily with commercial or residential buildings.

1.1 Purpose and Scope of the Evaluation

The primary goal of the impact evaluation is to assess the energy savings of NYSERDA T&MD-sponsored Energy Code trainings. The impact evaluation activities will estimate the level of Energy Code compliance before and after the trainings and other Energy Code support activities[2]. The difference in compliance levels will be used to estimate the related energy savings due to T&MD-sponsored Energy Code activities.

The research questions targeted by this effort are as follows:

1. What is the level of compliance after Program implementation?
2. Has NYSERDA reached its goal of 90% compliance by 2017?
3. What are the energy savings associated with increased compliance?

The evaluation team first reviewed the NYSERDA energy savings model used to project savings from Energy Code activities, discussing any revisions identified with NYSERDA. In 2015, the team conducted the first of two Delphi processes with a group of experts with commercial and residential experience in New York State (NYS) to gather information on specific building practices in NYS. The evaluation team analyzed the building practice results to establish a baseline Energy Code compliance level (First Delphi), and will estimate through a second Delphi process how this level changes over time relative to NYSERDA Energy Code activities funded by T&MD. The evaluation team will estimate compliance rates in NYS for two time periods:

1. Code compliance before T&MD-sponsored trainings (≈2014–2015) – This compliance rate, covered in this report, sets a baseline for Energy Code compliance in 2014. This baseline will enable measurement of future impacts from the Energy Code activities sponsored by NYSERDA though T&MD funding.
2. Compliance after T&MD-sponsored trainings (≈2017–2018) – This compliance rate will be developed through the second Delphi process and will reflect the impact of the T&MD-sponsored Energy Code component planned for 2015–2017. The evaluation team anticipates that the second Delphi will be completed in 2018 for 2017 code compliance levels.

The anticipated increase in compliance will be used in the NYSERDA energy model to compute the gross energy savings from T&MD-sponsored Energy Code activities. The second Delphi process will include attribution questions to identify the portion of the anticipated increase that is due to NYSERDA's T&MD efforts and the portion due to technology progress and normal market adoption.

1.1.1 Scope of this Report

The primary scope of this report is to present the results of the First Delphi Process, estimating Energy Code compliance in New York State prior to NYSERDA's T&MD code training and support activities.

[2] Energy Code activities, like stretch codes or the hotline, may not receive individual process evaluations like training, but can be assessed through the second Delphi Panel as determined to be substantial in impacting code compliance.

1.2 Report Organization

The remainder of this report is organized as follows:

- Section 2 provides an overview of the methodology for the Delphi process.
- Section 3 presents analysis and results.
- Section 4 contains conclusions and next steps.

2 Methodology

2.1 Delphi Process Overview

To evaluate the effectiveness of NYSERDA's energy code component of the Program and estimate associated savings, the evaluation team conducted a Delphi process, engaging energy code experts to estimate compliance with the Energy Code levels within the residential and commercial sectors. A Delphi process is a structured method to achieve a convergence of opinion regarding a particular subject from a series of interviews with experts. The Delphi process consisted of three rounds of in-depth, one-on-one interviews with the Delphi participants ("experts"). In this case, it proceeded as described in the following sections.

2.1.1 Expert Recruitment

The evaluation team recruited a pool of experts that have direct experience with commercial and residential building practices in New York State, both upstate and downstate. This group contained code enforcement officials; members of statewide energy code development committees; leading engineers and architects; and building efficiency consultants. Overall, 21 experts were recruited for the study; the distribution of experts is shown in tables 2-1, 2-2, and 2-3.

Table 2-1. Delphi Experts by Years of Experience

New York Energy Code Experience	Number of Recruited Experts
< 5 years	0
5 to 10 years	6
10 to 15 years	7
15 to 20 years	2
>20 years	6

Table 2-2. Delphi Experts by Occupation[3]

Delphi Expert Occupation	Experts Recruited
Code official/building department	6
NYS/local code development	4
Architect/engineer	6
Construction/builders association	4
Energy/code consulting	8
Industry group/other	0

[3] Several of the Delphi experts fulfill multiple occupations due to their involvement in code development, consulting, and other code-related activities.

Table 2-3. Delphi Expert Code and Geographic Expertise

Energy Code Expertise	Geographic Expertise	Number of Experts
Commercial	Downstate	4
	Upstate	1
	Both Downstate and Upstate	2
Residential	Downstate	2
	Upstate	2
	Both Downstate and Upstate	0
Both Commercial and Residential	Downstate	2
	Upstate	4
	Both Downstate and Upstate	4
Total Experts		**21**

2.1.2 First Delphi Process: Round One

The first round of the Delphi process consisted of a mix of structured (closed-ended) questions and open-ended questions. The structured questions sought to solicit experts' responses and knowledge about specific building practices required by the Energy Code, while the open-ended questions focused on the reasoning behind the responses and the primary contributing factors to improving or hindering compliance with the Energy Code. The interviews initially focused on new construction projects and then asked expert perspectives regarding the differences in practices for renovations.

After the initial round of interviews, the evaluation team prepared a data summary containing both quantitative and qualitative results, customized for each expert. This data summary was designed to show each expert how their individual responses compared to the overall Delphi expert averages, and the popular justifications provided for each question. This material was presented to the experts in written and graphical form, leveraging boxplots to display the dispersion of results across the expert pool.

2.1.3 First Delphi Process: Round Two

During the second round of the Delphi process, the evaluation team distributed the customized data summaries to the experts and conducted follow-up interviews where the experts were given an opportunity to revise their initial responses and to provide additional rationale for doing or not doing so. During this second round the evaluation team also analyzed the open-ended responses from Round 1 and presented the primary themes for the experts to rank on Likert Scales[4] in the following areas:

- Differences between new construction and renovation projects
- Primary influences (positive and negative) on energy code compliance
- General recommendations for improving compliance

Similar to the first round, the evaluation team revised the customized data summary with quantitative and qualitative results for redistribution to the Delphi experts' consideration in round three.

[4] A Likert Scale is a commonly used rating scale in questionnaires that asks respondents to specify their level of agreement or disagreement on a symmetric scale for a series of statements.

2.1.4 First Delphi Process: Round Three

A third round of the Delphi was conducted to provide the experts an opportunity to make any final revisions based on the results of the second round. For each expert, the evaluation team focused on the specific building practices that were identified as the poorest performers, asking experts for additional rationale and any measure-specific recommendations to improve compliance.

2.1.5 Limitations of the Study

With any self-selection study there is an expectation that the pool of experts may have conflicts of interest or other biases inherent in their responses. It is possible that individual experts may indicate artificially high or low compliance with specific building practices to emphasize the utility of the services they provide. This is especially likely for experts who specialize in a subset of the Energy Code requirements. For example, a provider of building envelope air sealing products and/or studies could indicate low air sealing and insulation compliance to focus more attention in this area. Conversely, code enforcement officials could indicate high compliance throughout the code requirements to signify that they are performing their jobs effectively.

While bias most likely remains in the results, it is difficult to quantify and the evaluation team took the following actions to mitigate this bias. The evaluators set recruitment targets across a variety of criteria, including geographic expertise, commercial vs. residential code experience, overall years of experience, and job function. Throughout recruitment, the evaluation team tracked progress against these criteria and made efforts to meet as many of these targets as possible. The design of the Delphi process encourages convergence of expert opinion by sharing responses from the previous round with the full expert pool. Consistent with the theory and purpose of Delphi panels, while experts are able to defend their initial responses, sharing the broader set of opinions resulted in some convergence of opinion; experts were able to observe differing perspectives and rationales and had the flexibility to adjust their original responses to reflect their estimate of the market condition.

2.2 Energy Code Compliance Assessment Methodology

The following sections explain the methodology used to develop the overall energy code compliance estimates for the 2010 Energy Conservation Construction Code of New York State (Energy Code).

2.2.6 Defining Compliance

While compliance with the Energy Code is required by law, there is no prescribed assessment method that NYS must use to determine compliance and address buildings that may fail to meet certain Energy Code requirements. Most often, compliance studies focus on individual building performance, either rating a building overall as passing or failing the energy code (the "pass/fail method") or deriving a percentage of the code requirements that are met by the building (the "percent compliance method"). While in theory all buildings should be 100% compliant, in practice nearly all buildings fail to meet at least one energy code provision.

For the Delphi process, the evaluation team assessed compliance based on the percentage of buildings that meet each individual code requirement. This approach is similar to the percent compliance method in that it recognizes that compliance levels vary across different energy code provisions. The individual expert responses were then aggregated by energy impact as explained below.

2.2.7 Aggregating Expert Estimates for New Construction Compliance

The evaluators aggregated the results of the First Delphi Process to develop overall estimates of energy code compliance for commercial and residential new construction in accordance with the 2010 Energy Code, which is roughly equivalent to the 2009 International Energy Conservation Code (IECC 2009) and incorporates some state-specific amendments. While the Energy Code offers both prescriptive and performance compliance options, the Delphi Process evaluated compliance on a prescriptive basis due to the following reasons:

- The majority of design teams choose the prescriptive path for compliance.
- Buildings that elect to comply with the performance path must still meet many of the code requirements (termed "mandatory" in the code language) on a prescriptive basis.
- It is difficult for code officials and researchers to assess compliance with the performance-based approach.[5]

The aggregation of compliance scores was accomplished in a two-step process: 1) weighting of individual energy code provisions by relative energy impact and 2) aggregating compliance scores based on estimates of upstate and downstate construction volumes.

Weighting of individual energy code provisions – The evaluation team leveraged existing energy code compliance methodologies, as well as prior studies conducted by the team, to weight each building practice by its relative energy impact. These weights are based on the compliance method developed by the Department of Energy (DOE) with the Pacific Northwest National Laboratory (PNNL) and modified to reflect the experience of the evaluation team. The distribution of weighting across the three primary energy code categories – building envelope, mechanical systems, and electrical systems – is shown in Table 2-4. It is important to note that while all code components were included in the weighting, scores were not assessed for provisions where an expert was not knowledgeable or otherwise unable to provide their perspective.

Table 2-4. Distribution of Question Weights by Energy Code Category

Code Category	Commercial	Residential
Documentation	0%	5%
Envelope	39%	62%
HVAC	39%	22%
Lighting	23%	11%

Aggregating compliance score – The evaluation team used the individual building practice weights to estimate a weighted compliance score for each Delphi expert. These scores represent the percent of the energy code requirements that are compliant for the average building based on each expert's opinion. These individual expert scores were then aggregated based on estimates of upstate and downstate construction volumes as shown in Table 2-5. During recruitment, the team identified each expert's experience by geography (upstate, downstate, or both). The evaluation team used the commercial and residential construction estimate data from the NYSERDA Energy Model to weight the experts accordingly.

[5] Assessing compliance with the performance-based approach requires that the assessors (code officials, researchers, etc.) have access to the full performance model inputs, modeling results, a working knowledge of the modeling software, and the time to review the model in entirety. It is rare that an assessor will have all of the necessary data and time to review compliance in this manner.

Table 2-5. NYSERDA Energy Code Model New Construction Volume Estimates[6]

Construction Volume	Commercial	Residential
Upstate	37.50%	45.73%
Downstate	62.50%	54.27%

The approach used to calculate the overall compliance score was adapted from the California Evaluation Framework methodology for stratified sample design.[7] The overall compliance score (c) was calculated based on the following formula:

$$c = \frac{\sum_{i=1}^{n} w_i y_i}{\sum_{i=1}^{n} w_i}$$

where,

w_i = Stratum expert weight

y_i = Expert compliance score

2.2.8 Assessing Compliance for Renovation Projects

For renovation projects, the Delphi interviews focused on identifying the primary differences in renovations compared to new construction for both commercial and residential projects. In the first round of the Delphi process, experts were asked as a series of open-ended questions to solicit general expert opinions. In the second round, experts were asked to assess the thematic differences on a Likert Scale (Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, Strongly Disagree). In addition, experts were asked to indicate the magnitude of the difference in compliance between renovation and new construction for both commercial and residential projects. This approach yielded a compliance estimate for renovations expressed as an approximate percentage better or worse than new construction. This estimate was confirmed in the third Delphi round, and experts were asked to provide additional rationale for their agreement or disagreement with the earlier results.

[6] Commercial data from Cost-Effectiveness of ASHRAE Standard 90.1-2010 for the State of New York, prepared by Pacific Northwest National Laboratory, dated November 20. Residential data from Table 7.5 in PNNL study titled Cost-Effectiveness Analysis of the 2009 and 2012 IECC Residential Provisions - Technical Support Document, dated April 2013

[7] TecMarket Works, et. al. The California Evaluation Framework. Project Number: K2033910. Prepared for the California Public Utilities Commission and the Project Advisory Group. June 2004.

3 Estimates of Energy Code Compliance

This section contains the results from the First Delphi process. The energy code compliance estimates for commercial and residential new construction are presented first, followed by code compliance estimates for renovation projects. Following this discussion, this section examines the compliance results by expert category and then presents recommendations from the Delphi experts to improve compliance with the energy code throughout the state.

3.1 Energy Code Compliance for New Construction

This section provides results and discussion for the Delphi expert estimates of compliance for commercial and residential new construction in New York. Of the 21 experts interviewed during the Delphi process, 17 had expertise in commercial building projects and 14 had expertise in residential building projects. The overall weighted estimate of energy code compliance for commercial new construction in New York is 74%, and for residential new construction it is 77%. From the previously discussed compliance definition, this result suggests that 74% of the energy code requirements are met by the average new commercial building and 77% of the energy code requirements are met by the average new residential building.

Table 3-1 shows the weighted Delphi expert new construction compliance estimates for the commercial and residential energy codes. The coefficients of variation (CVs) show the variability in results among the experts with experience in commercial and residential new construction.

Table 3-1. Energy Code New Construction Compliance Estimates from First Delphi Process

Energy Code	Weighted Average Compliance	Weighted CV
Commercial	74%	13%
Residential	77%	11%

3.2 Renovation Compliance Estimates

While the primary focus of the Delphi interviews was on new construction practices, experts were asked for their perspectives on the magnitude of the differences between renovations and new construction. For both commercial and residential energy codes, the average response for the experts was that renovations were slightly worse (6% to 15% worse) than new construction.

The important takeaways for renovations are not in the specific range of compliance, but rather that none of the experts interviewed for either residential or commercial projects felt that compliance for renovations exceeded new construction. While a few experts felt that compliance was similar, the majority of experts indicated that compliance was either slightly or significantly worse for renovations.[8] This suggests a gap in awareness of how the energy code applies to renovation projects. The following are the primary justifications provided for this gap:

- **Confusion over code applicability** – Many experts routinely observed confusion and ambiguity regarding when and how the Energy Code applies to renovations. This was observed for both commercial and residential projects. While the applicability to renovations and major

[8] It is important to note that renovation projects can range in size and complexity from equipment replacements and upgrades to full-scale renovations. The applicability of the code to renovations is consistent with the energy code definition of covering provisions of the code as they relate to new construction, with the exceptions indicated in the code.

alteration projects is explained in the code, there was a general lack of awareness regarding what components of projects need to meet current code requirements in a given renovation.

- **Less enforcement on renovation projects** – Delphi experts felt that there is less code enforcement attention overall on renovation projects compared to new construction. This was observed within the code enforcement community, as well as with design and engineering professionals. While this was observed for both commercial and residential projects, this was identified as a larger issue on the residential side, where in many cases, there is one single person responsible for the entire renovation from design through implementation. In addition, many experts observed a tendency for renovation contractors to be smaller and less professional than new construction contractors, which can in turn lead to less focus on the energy code requirements.
- **Poor air sealing** – Multiple Delphi experts observed either a lack of understanding of the renovation envelope and air sealing requirements or poor implementation of air sealing on renovation projects. A deeper examination of renovation projects could provide additional insight into the specific nature of the compliance challenges that these projects present.
- **Landlord/tenant barrier –** The landlord/tenant barrier was referenced by Delphi experts as affecting the attention placed on renovation projects. The party responsible for the renovation may not be paying the same party that is paying the utility bills or using the space and may be less focused on ensuring that the renovations meet code requirements.

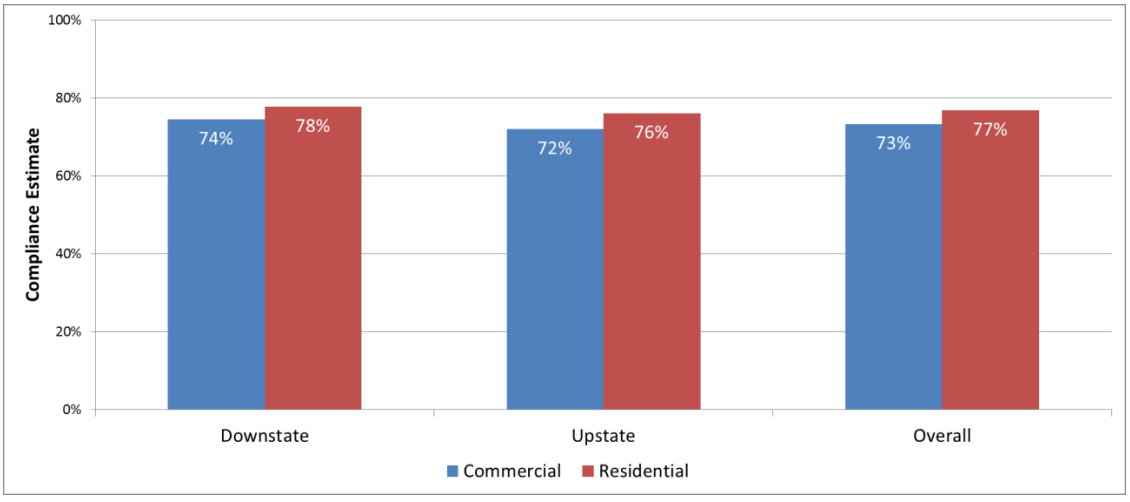
3.3 Compliance Estimate Stratifications

Analysis of the compliance scores within the context of their expertise provides some additional insight into the new construction compliance estimates. Note that the data presented in this section consists of average compliance estimates for the Delphi experts that are not weighted by construction volumes.

3.3.1 Compliance by New York State Geography

Figure 3-1 shows the overall new construction compliance estimates segmented by geography. Downstate territory includes New York City and the surrounding areas, and Upstate includes the rest of the state. While the average compliance results did not vary too much across the state, the Delphi experts with experience in the downstate area generally estimated compliance to be slightly higher than those with experience upstate. This may be due to the widespread enforcement effort across New York City or local New York City code provisions, and is worthy of further examination during the second Delphi process.

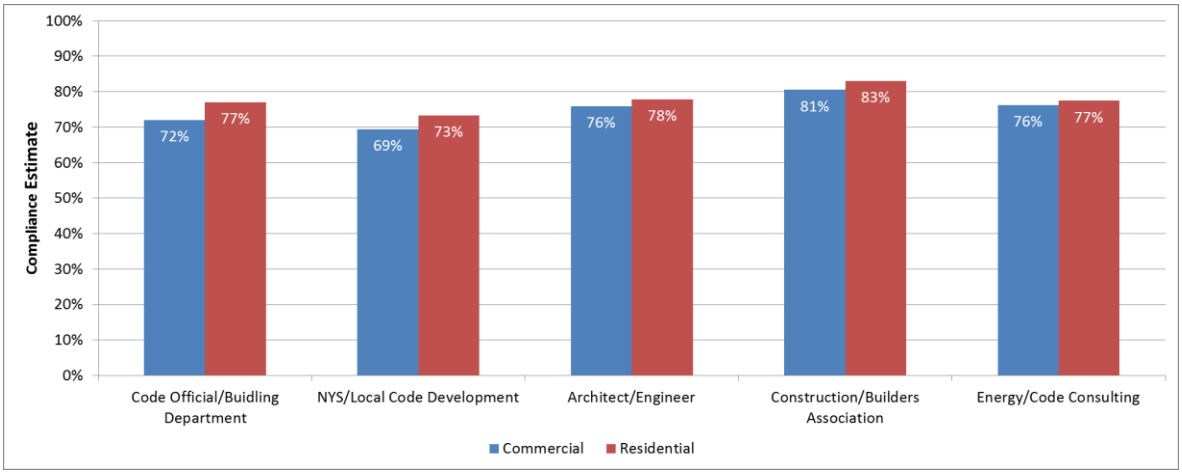
Figure 3-1. New Construction Compliance by New York State Geography



3.3.2 Compliance by Expert Occupation

Figure 3-2 shows the overall new construction compliance estimates for the Delphi experts segmented by expert occupation and aggregated as described in Section 2.2.7. There was some consistency across commercial and residential results; experts involved in code development on average had the lowest estimates, while experts from the construction trades had the highest. This is likely reflective of these experts' perspectives and justifications for their respective roles in the process. Code development experts typically advocate for improved code provisions, training, and support, while construction experts may perceive that noncompliance would be reflective of their installation deficiencies.

Figure 3-2. New Construction Compliance by Expert Occupation



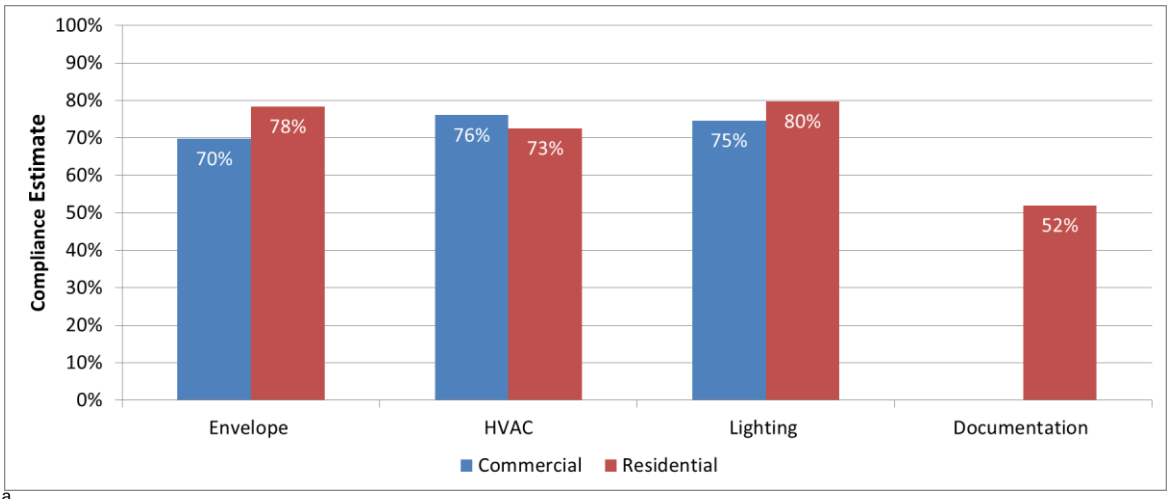
3.3.3 Compliance by Code Category

Figure 3-3 presents new construction compliance estimates by energy code category, enabling the following observations:

- Envelope and lighting compliance were assessed as higher for residential projects. This is likely due to code officials having more familiarity with common residential envelope materials and installation methods and a much simpler residential lighting code.
- For HVAC components of the energy code, commercial compliance was slightly higher residential compliance. Commercial buildings are often more complex and are more likely to have registered engineers and design professionals engaged throughout the design, construction, and inspection of these systems.
- Note that documentation was only assessed for the residential energy code.[9]

[9] The Delphi interviews did not ask explicitly about documentation for commercial projects, as it is commonly supplied during building design and development. The residential code explicitly requires that documentation of each home's building envelope and key mechanical features be displayed on or near the electrical panel.

Figure 3-3. New Construction Compliance by Code Category[a]



[a] Documentation was only assessed for the residential energy code.

3.4 Commercial Code Focus Areas

The average estimates for each commercial new construction provision addressed in the Delphi are presented in Table 3-2. Analysis of these provisions can provide insights into the primary components of the Energy Code to target for future support activities. The averages presented in **Error! Reference source not found.** are unweighted average responses for the commercial code Delphi experts.

Table 3-2. Average Delphi Expert Estimates for Commercial New Construction

Compliance	Code Requirement Description	Code Category
46%	Continuous air barrier: Air barrier documented and/or installed to be continuous throughout envelope	Envelope
55%	Continuous air barrier installation quality: Air Barrier installed well with no gaps and all openings sealed continuously	Envelope
58%	Daylighting controls: Day-lit spaces have separate controls from general lighting controls or are automatically controlled with daylight sensors	Lighting
59%	Demand controlled ventilation (DCV): DCV provided in all spaces > 500 sq ft with average occupancy > 40 persons/1000 sq ft	HVAC
61%	Commissioning systems: HVAC system completion, including air and hydronic system balancing; maintenance manuals provided to facility staff for all HVAC equipment	HVAC
62%	Thermal bridging: Continuous insulation in use for commercial projects to mitigate thermal bridging	Envelope
67%	Economizers: Economizers provided for cooling systems >= 54,000 Btu/h, capable of providing 100% outdoor air	HVAC
69%	Lighting power density (LPD): Meets space-specific LPD requirements	Lighting
72%	Envelope insulation installation quality: Envelope insulation is installed per manufacturer's requirements	Envelope
74%	Distribution systems: Ductwork and piping meet required insulation levels	HVAC
79%	Energy (heat) recovery ventilation (ERV): ERV provided for all fans > 5,000 cfm and > 70% outside air supply	HVAC
79%	Variable frequency drives (VFDs): VFDs installed where required on pumps and fans (required on all individual variable air volume (VAV) fans with >10 hp motors)	HVAC

Compliance	Code Requirement Description	Code Category
79%	Envelope insulation: Meets envelope insulation requirements	Envelope
81%	Interior lighting controls: Manual and automatic lighting controls installed and functioning properly	Lighting
83%	Windows and doors: Windows and doors meet u-factor requirements	Envelope
84%	Mechanical controls: Mechanical controls provided – programmable thermostat to provide heating and cooling to each zone, with capability for automatic setback and 7-day scheduling	HVAC
90%	Exterior lighting control: Exterior lighting controlled by either motion sensor or time clock	Lighting
94%	Equipment efficiency: Installed equipment meets efficiency requirements	HVAC

The evaluation team synthesized the average compliance estimates presented in **Error! Reference source not found.**, combined with the qualitative comments by the Delphi experts throughout the interview rounds, to prioritize the following focus areas to improve compliance with the commercial Energy Code:

- **Air sealing and the building envelope** – The Delphi experts identified a lack of compliance with the continuous air barrier and envelope insulation requirements of the code. A continuous air barrier is required that connects all components of the building envelope, sealing any joints and penetrations in the envelope. Insulation is required throughout the envelope, with an increasing focus on continuous insulation to prevent thermal bridging through the envelope. Delphi experts identified that there is an overall lack of understanding of the building science behind these requirements, knowledge gaps within the construction industry regarding how to meet these standards, and uncertainty as well as a lack of training within the code enforcement community regarding how to inspect and assess compliance. The enforcement of the continuous air barrier was identified as an explicit opportunity for targeted training. Additionally, third-party inspections from certified air barrier professionals could help alleviate the burden on code officials and improve overall compliance with these requirements.
- **Daylighting** – Daylighting is an area of increasing attention and complexity within the Energy Code. Commercial Delphi experts felt that daylighting provisions are still considered new to the code and that there is a lack of awareness among the design and construction community regarding what is required to comply with the code. Targeted training on the properties of daylight zones and their applicability across a variety of building types would help improve awareness, compliance, and enforcement of this requirement.
- **Commissioning –** The 2010 Energy Code contains limited commissioning requirements. However, the Delphi experts felt that review of commissioning activities is largely outside of the scope of code enforcement activities. The 2014 Energy Code requires more rigorous commissioning of commercial buildings, and while many of the experts felt that these are an improvement over the 2010 code, they remain concerned that a lack of an effective enforcement mechanism will result in these requirements going largely ignored.
- **Advanced mechanical controls** – Advanced mechanical controls, including demand controlled ventilation (DCV) and economizer requirements, were identified as areas for improvement for compliance with the Energy Code. Overall, the experts felt that the primary reason for compliance challenges in these areas was a lack of awareness regarding the code requirements and understanding of how to meet the code. For example, a few experts identified that many engineers and builders think that the installation of economizers is an advanced, better-than-code building practice, while the code actually requires economizers provided that the building meets specific cooling system size specifications.

- **Distribution systems** – The code requires that distribution systems are insulated and sealed properly based on where these systems are located in relation to the building envelope. Delphi experts noted that while insulation for ductwork and piping is often supplied, these systems are rarely sealed to the extent required by the code.
- **Lighting power density** – While the compliance estimate with the lighting power density requirement of the 2010 code was low at 69%, the Delphi experts for the most part felt that steady decrease in the cost of LEDs will improve compliance with this requirement in subsequent codes. A few experts with experience in New York City indicated that electrical drawings are still not required for many projects within the city, but they concurred that LEDs will likely mitigate the impact of this requirement.

3.5 Residential Code Focus Areas

The average estimates for each residential new construction provision addressed in the Delphi are presented in Table 3-3. Analysis of these provisions can provide insights into the primary components of the energy code to target for future support activities.

Table 3-3. Average Delphi Expert Estimates for Residential New Construction

Compliance	Code Requirement Description	Code Category
45%	Certificates in panel: Permanent certificates are posted on or in the electrical panel to document code compliance.	Documentation
49%	Equipment sizing: Heating and cooling equipment sized per Manual J or similar process	HVAC
51%	Air sealing: Building thermal envelope sealed to limit infiltration. All joints penetrations sealed, as well as windows, doors, attic access, etc.	Envelope
59%	Documentation: Projects supply enough detail on the construction documents for code official to assess compliance.	Documentation
61%	Envelope insulation installation quality: Envelope insulation is installed per manufacturer's requirements.	Envelope
64%	Recessed fixtures: Recessed fixtures in the building envelope are IC-rated and sealed with gasket or caulk to limit air leakage.	Envelope
69%	Distribution systems: Ductwork and piping insulated and sealed	HVAC
73%	Interior light fixtures: At least 50% of permanent fixtures have high efficacy lamps.	Lighting
79%	Vapor retarders: Vapor retarders provided in interior side of frame walls (zones 5 and 6 only)	Envelope
82%	NFRC stickers: Builders leave window and door certification (NFRC) stickers for inspection.	Envelope
87%	Individual unit metering: Individual dwelling units separately metered	Lighting
88%	Envelope insulation: Meets envelope insulation requirements	Envelope
93%	Windows and doors: Windows and doors meet u-factor requirements	Envelope
98%	Programmable thermostats: Programmable thermostats installed in each dwelling unit with capabilities for daily schedule control, automatic adjustment based on largest heating/cooling zone, and have temperature range from 55° to 85°F	HVAC

The evaluation team synthesized the compliance estimates presented in **Error! Reference source not found.**, combined with the qualitative comments by the Delphi experts throughout the interview rounds, to prioritize the following focus areas to improve compliance with the residential Energy Code:

- **Documentation on plans and in electrical panels** – Many Delphi experts identified a lack of sufficient documentation on residential construction projects to verify code compliance. This is

not necessarily reflective of the actual performance of residential construction against the code, but without complete and accurate documentation it is very difficult for code officials to assess whether a building is compliant or not. In many areas of the state, residential documentation contains building envelope requirements and very little, if any, documentation of mechanical and electrical systems. This challenge is really an enforcement issue; verifying documentation is not high on the punch list of code officials when reviewing plans and conducting site visits. If code officials actually enforced that adequate documentation is supplied and certificates are posted where required, it is likely that compliance would improve. Some jurisdictions, such as New York City, have increased their enforcement in these areas and as a result they have seen significant improvements in documentation provided for residential projects.

- **Mechanical equipment sizing –** The Delphi experts noted similar challenges for verifying mechanical equipment sizing for residential projects. The code requires that mechanical equipment for residential construction is sized in accordance with Manual J, a protocol developed by the Air Conditioning Contractors of America (ACCA) to calculate cooling loads to determine how much cooling a house actually needs. Delphi experts indicated that they rarely see evidence of Manual J calculations; the lack of documentation makes this requirement difficult to verify. Further, although it is the norm for commercial construction, engineers are not always hired for residential building; in many cases, it is the architect or the builder who conducts the equipment sizing using broad rules of thumb. This approach is not compliant with the Energy Code. Equipment sizing is also an enforcement issue in that if code officials were consistently asking for it and requiring documentation of the load calculations, the industry would move towards improving compliance.
- **Air sealing and envelope insulation** – Air sealing and the proper installation of insulation were consistently identified as one of the biggest challenges for residential construction. Delphi experts observed that in most residential buildings the amount of insulation provided meets the Energy Code but the installation techniques frequently do not meet manufacturers' requirements. These deficiencies, such as gaps and voids within wall cavities, and fiberglass batts compressed behind pipes and wires, can have significant impacts on the thermal performance of the building envelope. Many experts cited the increasing prevalence of blower door testing as one of the primary solutions to this challenge, and since the new version of the Energy Code requires blower door testing for all residential new construction, the evaluators anticipate an improvement in this provision during the Second Delphi process.
- **Distribution systems** – Distribution systems for residential construction were identified by the experts as often failing to meet code requirements. Consistent with their assessment of envelope insulation, experts contended that insulation levels are often met for duct and piping systems but they are rarely sealed to the extent required by the Energy Code.

3.6 Recommendations to Improve Energy Code Compliance

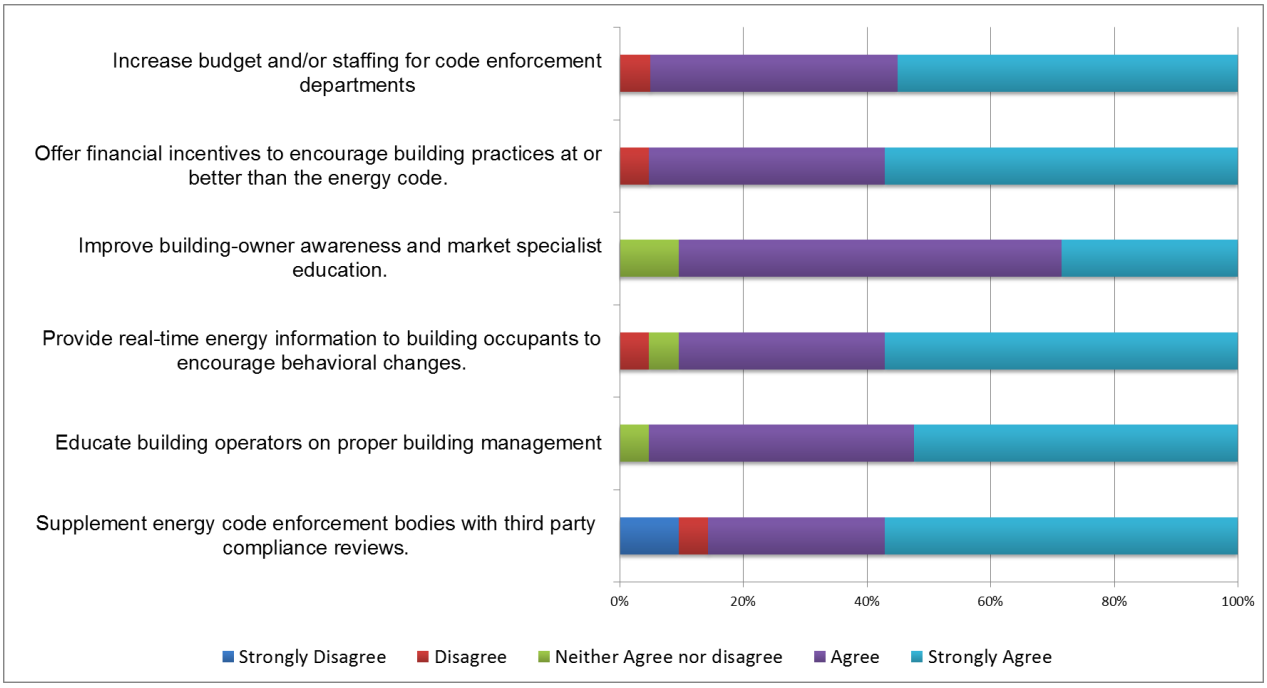
This section presents a summary of the Delphi expert responses throughout the three Delphi rounds to questions regarding recommendations to improve compliance with the energy code.

3.6.1 Overall Recommendations

Figure 3-4 presents the primary overall recommendations for improving energy code compliance in New York. While many of these recommendations would require additional funding, the overwhelming agreement across the Delphi experts suggests that many of these recommendations can improve code compliance and/or building energy performance. Highlights from Delphi interviews include:

- **Third-party compliance support** – Many Delphi experts recommended leveraging third-party support for compliance reviews in some capacity. It is important to note that while experts almost universally perceive building departments and code officials as understaffed to manage their existing review volume, the code enforcement community would likely push back against efforts that could be perceived as removing some of their authority. However, code officials are likely to support third-party compliance support if it is implemented as a service to the community targeting specific requirements that are difficult to assess or require specialized knowledge. For example, air sealing and leakage requirements, and mechanical specifications such as variable frequency drive (VFD) requirements, were identified as requirements that are difficult to understand and enforce. NYSERDA already offers some third party reviews to code officials to supplement plan reviews and field inspections; expansion of these services could help alleviate the burden on the code enforcement community while retaining their overall authority in certifying the buildings for occupancy.
- **Target building operations**. The evaluators focused interview questions on the Energy Code, which mandates many control functionalities but does not explicitly focus on building operation and performance. However, many experts identified strategies targeting post-occupancy operations and maintenance as primary recommendations to improve building energy efficiency. These recommendations ranged from increased education to building maintenance staff on their buildings' designs and operating protocols, to providing real-time energy information regarding building performance and systems to occupants to influence them to reduce their usage. This topic does not sit squarely within the Energy Code evaluated in this study, but the enhanced commissioning requirements in more recent codes place more of a focus on ensuring that buildings and their controls operated as they are designed and installed.

Figure 3-4. Overall Delphi Expert Recommendations



4 Conclusions and Next Steps

This report presents Delphi Expert estimates of compliance with the Energy Code in NYS prior to the implementation of NYSERDA's T&MD energy code activities. These estimates should be considered the pre-program baseline estimates; the Second Delphi Process, with targeted completion in 2018, will estimate compliance with the Energy Code in 2017. The delta between these code levels, combined with attribution information about the influence of NYSERDA's energy code activities compared to other influences such as technology advancement and normal market adoption, will estimate the impact of the energy code component of the NYSERDA Program.

4.1 Considerations for Second Delphi Process

The evaluators have identified the considerations below for the Second Delphi process to be completed in 2018. These considerations are informed by the evaluators' understanding of upcoming Energy Code changes and the analysis of the process and the results from the First Delphi interviews.

- **Capture code changes**. It is likely that new versions of both the commercial and residential energy codes will be implemented by the beginning of the Second Delphi process. It will be important to understand how building practices changed in light of the new code versions and how training and other NYSERDA influences affected these practices. Generally, when new energy code versions are adopted, compliance initially dips as design, building, and enforcement communities need to adjust to the new and more stringent requirements. As these communities become more familiar with the new and enhanced code provisions, compliance tends to increase throughout the implementation period; this pattern often repeats with each new code version adopted. Thus, it may be necessary for Delphi participants to explicitly reflect on the time periods immediately before and after code changes to provide their opinions on NYSERDA's role in increasing awareness and compliance with new or more stringent requirements.
- **Incorporate process evaluation findings**. A process evaluation is currently underway for NYSERDA's energy code training activities. The findings from this process evaluation should be reviewed and integrated into the interview guide for the Second Delphi process. This will be especially useful in drafting and analyzing attribution questions to assess the influence of NYSERDA programs on Energy Code compliance.
- **Expand Delphi second-round conversation**. The evaluators found great value in the iterative nature of the Delphi process, specifically in providing each expert with the results of the previous round, both numerically and qualitatively with comments. The team captured many insights through this process and recommends lengthening the second round interviews to present more of the experts' first round results and rationales and to gather additional details regarding the justifications the experts provide in response to these first round results. This would further improve the quality of data collected. The third round did result in some convergence of opinion and some targeted recommendations for improving compliance, but the primary convergence occurred between the first and second rounds of the Delphi process.