Code to Zero Initiative Market Evaluation Report: Baseline Estimates and Progress Toward Goals

Deliverable 3 – Appendices

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NYSERDA Contract # 104542 June 2020

NYSERDA Record of Revision

Code to Zero Initiative Market Evaluation Report
Code to Zero Initiative Market Evaluation Report: Baseline Estimates and Progress Toward Goals Deliverable 3 – Appendices June 2020

Revision Date	Description of Changes	Revision on Page(s)
June 2020	Original Issue	Original Issue

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Appendix A. New York State Energy Code Delphi Panel

This appendix presents the findings from the Delphi Panel completed as part of the evaluation of New York State Energy Research and Development Authority's (NYSERDA's) Code to Zero Initiative. The Delphi Panel process uses the judgement of a group of experts to develop estimates and compile informed opinions about a research topic. The Panel comprised 12 experts (panelists) in building energy codes and code compliance working across New York State (NYS).

Through the Delphi process, panelists accomplished the following primary goals of the task:

- Establish baseline compliance metrics with the 2016 Energy Conservation Construction Code of New York State (ECCCNYS)
- Estimate the rate of adoption of more stringent local energy codes, such as NYStretch Energy Code–2020 (NYStretch)
- Provide insight into energy code enforcement practices
- Discuss the use of new technologies and building practices

Delphi Panel Process Overview

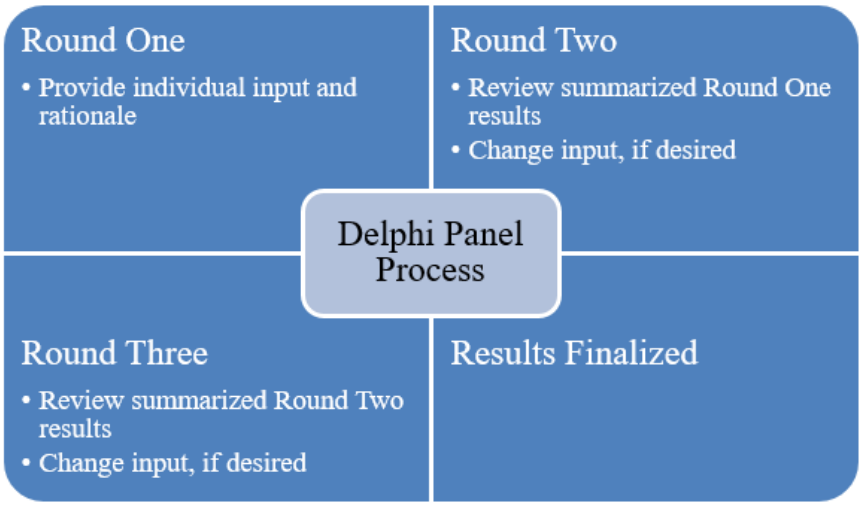
The Delphi Panel process combines the opinions of a group of experts through an interactive, iterative process. The Delphi method, first developed by the RAND corporation in the 1950s, is widely used to develop informed opinions from a group of experts. Using this method, experts anonymously reply to a survey or questionnaire, results are aggregated, and feedback of the group response is shared with the experts. Experts are encouraged to consider the insight from other experts and refine estimates, as needed. The process repeats, with the goal being a reduction in the range of responses or, in some cases, a consensus.

The survey used for the Code to Zero Initiative evaluation asked panelists to provide feedback based on their own experiences with the energy code in NYS building construction markets and as experts in their fields. For this evaluation, panelists completed three rounds of questionnaires, shown in Figure 1. To begin, the Market Evaluation Team asked panelists to review background material on the Code to Zero Initiative, information on the adoption of the ECCCNYS and NYStretch, and information related to energy code compliance and enforcement in NYS. Once familiar with the intent of the study, panelists completed the first round of the survey that included questions on energy code compliance and enforcement, the adoption of more stringent local energy codes, and the use of new building technologies.

The Market Evaluation Team anonymized and aggregated the estimates and rationales panelists provided in the first round of the survey and returned them to the group for a second round of input. During the second round, Panelists reviewed their own response alongside the responses of their peers and adjusted or revised their answers based on the results, if desired. The process was repeated, and the third and final round of the survey provided experts one additional opportunity to adjust their input or offer commentary.

Figure 1. Delphi Panel Process

Source: Delphi Panel Surveys by Market Evaluation Team.



The Team designed the survey instrument to collect qualitative and quantitative data. Since the group of experts included various occupations, not all questions were applicable to each panelist. This document summarizes the qualitative data to provide insight into the NYS energy code market. For quantitative data, the average and range of the panelists' estimates are reported because the estimates did not converge.

Expert Recruitment and Participation

The Market Evaluation Team began the Delphi Panel recruitment process by generating a candidate list that included individuals known for their experience and expertise in energy codes and the NYS building construction market. In total, 52 experts were invited to participate to reach the Team's target of 10 to 12 panelists. Recruitment occurred in two major phases; the second phase was only necessary because some individuals who agreed to participate opted out once the survey was distributed. Additionally, recruiting builders and contractors proved especially challenging; while two builders were ultimately recruited, neither completed all three rounds.

The final Delphi Panel comprised a diverse group of experts within the community of building code experts in NYS, including code enforcement officers, design professionals, energy professionals, construction industry experts, and individuals involved with state or local code development. Ten of the 12 panelists had expertise with both the residential and commercial energy codes, and the remaining two had either residential or commercial expertise only. Table 1 shows the distribution of experts by occupation; several panelists selected more than one title for their current occupation, noting that it can vary depending on the nature of the work or the role held on a specific project. Most frequently, architects or engineers also serve as energy or code consultants or third-party energy professionals.

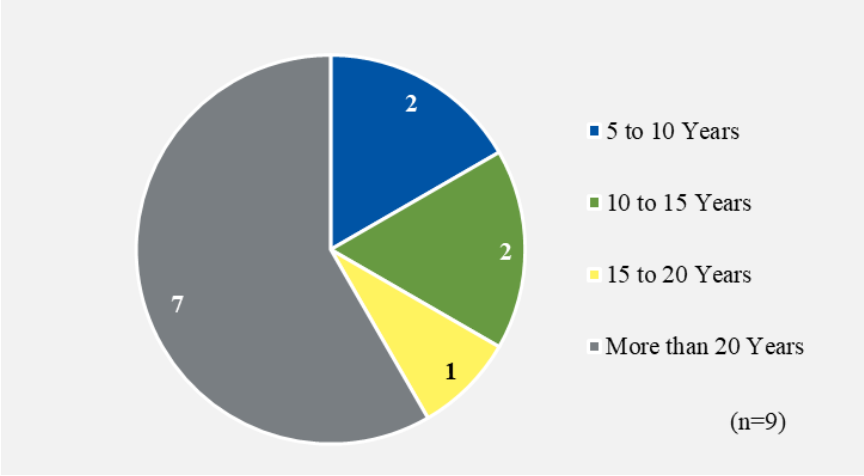
Table 1. Delphi Panelists by Occupation

Delphi Panelist Occupation	Number of Experts Recruited
Design professional (architect or engineer)	4
Energy or code consultant	4
Third-party energy professional	4
Code enforcement officer	2
Construction industry	2
State or local code development	1

Figure 2 shows the distribution of experts by years of experience with the ECCCNYS; more than one-half of the experts have been using or applying the ECCCNYS for over 20 years.

Figure 2. Delphi Panelists by Years of Experience with the ECCCNYS

Source: Delphi Panel Surveys by Market Evaluation Team.



Finally, Table 2 shows the distribution of panelists by regional expertise. The regions represent the 10 economic regions defined by the New York State Department of Labor. The panelists provided good coverage of the state. As with their occupations, several panelists indicated their expertise spans multiple geographic regions; two panelists noted they have statewide expertise.

Table 2. Delphi Panelists by Regional Expertise

Region	Number of Experts
Western New York	3
Finger Lakes	3
Southern Tier	2
Central New York	2
North Country	2
Mohawk Valley	3
Capital District	7
Hudson Valley	2
New York City	4
Long Island	2

Self-Selection Bias

Since participation on the panel is voluntary, one limitation of the Delphi Panel process is the possibility of self-selection bias. One method for mitigating self-selection bias is to avoid a predominance of one or a few respondent types; as such, the Market Evaluation Team strategically recruited panelists to ensure that they represented a variety of occupations and regional expertise. Evident discrepancies in responses due to occupation or other influences are noted.

Delphi Panel Findings

The following sections detail the results of the three rounds of surveys administered to Delphi Panel experts in each of the following topic areas: energy code compliance, energy code enforcement, stretch energy code adoption, and advanced technologies.

Energy Code Compliance

New York's current statewide energy code took effect on October 3, 2016. The 2016 ECCCNYS is based on the 2015 International Energy Conservation Code (IECC) and ASHRAE 90.1-2013 and is supplemented by the *2016 Supplement to the New York State Energy Conservation Construction Code.*[1] An update to the ECCCNYS took effect in May 12, 2020 and is based on the 2018 IECC and ASHRAE 90.1-2016. The updated code, the 2020 ECCCNYS, took effect immediately with no transition period.

In considering the 2016 ECCCNYS, a main goal of the Delphi panel process was to establish a baseline for energy code compliance in the current market. Panelists also provided insight into the challenges the market faces when complying with commercial and residential energy codes, support services needed to overcome these challenges, and the anticipated impact of an energy code update on compliance rates. The following sections report Delphi Panel results by market type, either commercial or residential.

Compliance in the Commercial Building Market

The survey asked Delphi Panel experts with commercial building expertise to estimate the percentage of new construction permitted using the following compliance methods:

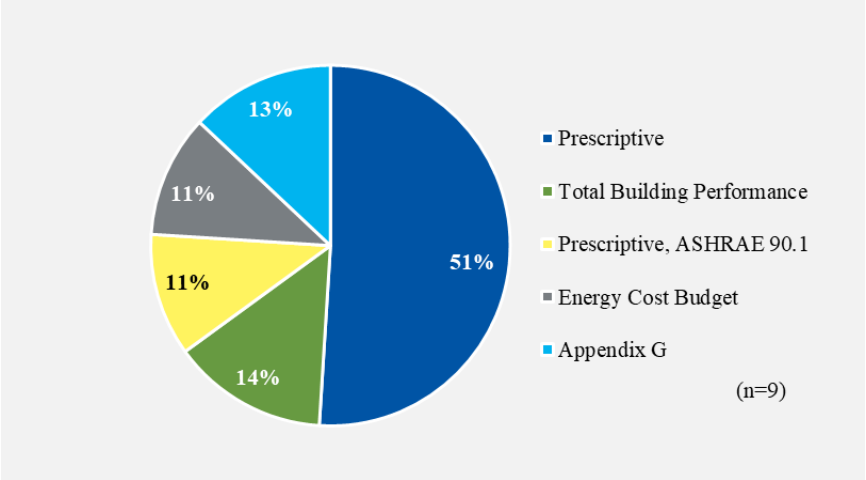
- Prescriptive
- Total Building Performance (C407)
- Prescriptive compliance option of ASHRAE 90.1
- Energy Cost Budget, Chapter 11, ASHRAE 90.1
- Appendix G, ASHRAE 90.1
- Others, as specified by the panelists

Figure 3 shows the average percentage of new construction permitted using each compliance option. Panelists estimated that nearly two-thirds (62%) of all new commercial buildings are permitted using a prescriptive compliance option.

[1] The 2016 Supplement to the New York State Energy Conservation Construction Code is available on the Department of State, Division of Building Standards and Codes' website at https://www.dos.ny.gov/DCEA/CodeUpdate.html.

Figure 3. Commercial New Construction Compliance Paths

Source: Delphi Panel Surveys by Market Evaluation Team.



These estimates varied widely by panelist, with several panelists noting that the estimates provided were indicative of the projects they are typically involved with rather than all projects within their jurisdictions. The two code enforcement officers, individuals with perhaps the greatest knowledge of the compliance methods used in their jurisdictions, also provided broadly different responses. One code enforcement officer with experience in the Hudson Valley region reported that 100% of all new construction is permitted using the prescriptive compliance path of the IECC, adding, "I don't recall ever getting any plans using any of the ASHRAE 90.1 methods." In contrast, the other code enforcement officer with experience in the Finger Lakes region estimated just 40% of all new commercial construction is permitted using the prescriptive compliance path of the IECC, while 45% is permitted using the Total Building Performance compliance option of the IECC, and the remaining 15% is permitted using various ASHRAE 90.1 compliance options.

Panelists provided the following commentary when describing compliance methods related to their project work:

- "The estimates [are] based on personal project experience. Our firm provides energy modeling for energy code compliance so we may have more projects using the [Energy Cost Budget] compliance path than typical projects. Additionally, our work is predominantly in NYC where C407 is not a viable path. Also, we have found that under the current code, Appendix G is simply more stringent than Chapter 11 thus Energy

Cost Budget compliance models are used for energy code compliance for all our projects."

- "The majority of high rise new commercial construction originates in NYC, regulated by the ASHRAE-90.1 Energy Cost Budget method, due to the high percentage of glazing."
- "More applications are exceeding the 30% WWR [window-to-wall ratio] (or 40% for ASHRAE), and as a result, are turning to energy modeling for compliance. Economizers continue to be a game-changing requirement that cause applicants to switch from an IECC base code to ASHRAE, based on the whole building cap prescribed in the IECC."

One panelist stated that compliance is determined strictly on the design professionals' affidavits:

- "For commercial building compliance, many Code Enforcement Officials rely heavily on the following statement on the plans, as required by New York State, to determine compliance: "When plans or specifications bear the seal and signature of a registered design professional, such registered design professional shall also include a written statement that to the best of his or her knowledge, belief and professional judgment, such plans or specifications are in compliance with the Energy Code" - C103.2.2."

The panelists' average estimate of the percentage of commercial new construction that demonstrates compliance using COM*check* was 56%.

Commercial Compliance Rate

In the first survey round, the Market Evaluation Team asked panelists to estimate the overall commercial compliance rate, as well as compliance rate by system (building envelope, mechanical, and electrical power and lighting) and component for both new construction and additions and alterations.[2] In rounds two and three, panelists reviewed and responded to input from the group and recorded changes to their estimates, if applicable. For this study, the *overall compliance rate* is the average percentage of requirements that are in compliance for the entire building, while the *compliance rate* for building systems is the average percentage of requirements that are in compliance. All panelists agreed with these definitions of compliance.

[2] For this study, alterations and additions were considered one category because existing building requirements generally apply evenly to both.

Overall Commercial Compliance Rate

To determine the overall commercial compliance, the Market Evaluation Team aggregated the panelists' compliance estimates in two ways.

- First, the Team calculated an average compliance rate using the final, third-round estimates provided by each panelist, determined as 84% for commercial new construction and 72% for commercial alterations and additions.
- Second, the Team calculated the overall compliance rate by weighting each panelists' individual system estimates by relative energy impact in accordance with the distribution of weightings used in the 2015 ERS Delphi Panel study.[3] The energy impact weights were based on the Score + Store compliance tool developed by the U.S. Department of Energy with the Pacific Northwest National Laboratory, which assigned a weighted value to energy code provisions based on their energy impact, and modified by ERS based on research and experience. The Market Evaluation Team reviewed the Score + Store tool, past and current compliance methodologies, and significant changes to the 2015 IECC, and concluded that the weights developed and used by ERS in the *Advanced Energy Codes Impact Evaluation Interim Report: First Delphi Process Results* report are still accurate.

Table 3 shows the weight applied to each commercial system.

Table 3. Commercial Distribution of Weights by System

System	Weight
Building Envelope	39%
Mechanical Systems	39%
Electrical Power and Lighting Systems	23%

Using this method, the Team determined the current overall compliance rates as 83% for commercial new construction and 70% for alterations and additions. For reporting purposes, the Market Evaluation Team will use these weighted compliance rates as the baseline.

[3] ERS' *Advanced Energy Codes Impact Evaluation Interim Report: First Delphi Process Results* report is available on NYSERDA's website at: https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/Program-Evaluation/2016ContractorReports/2016-advanced-energy-codes.pdf.

Commercial Compliance Rate by System

Panelists estimated the compliance rate for each major building system. For new construction, panelists identified the building envelope as having the highest rate of compliance (85%). For alterations and additions, the mechanical system compliance rate was highest (72%). Table 4 shows the average compliance estimate by system; for both new construction and additions and alterations, the range was minimal.

Table 4. Commercial Compliance Rate by System

System	New Construction	Additions and Alterations
Building Envelope	85%	68%
Mechanical Systems	79%	69%
Electrical Power and Lighting Systems	80%	72%

Commercial Compliance Rate by Component

Finally, the Market Evaluation Team asked panelists to estimate the compliance rate for select building components, identified as either having a significant impact on building energy use (determined through research and based on the Market Evaluation Team's experience with energy code studies) or as being a newer code requirement. Table 5 shows the unweighted average of the panelists' compliance rates for each building component in new construction and additions and alterations.

Table 5. Commercial Compliance Rate by Component

Code Requirement	Description	New Construction Compliance Estimate	Additions and Alterations Compliance Estimate
Continuous air barrier	Air barrier meets the code requirements for materials, assembly, or testing	70%	62%
Continuous air barrier installation quality	Air barrier is installed well with no gaps and all openings are sealed continuously	66%	57%
Thermal bridging	Continuous insulation is used for commercial projects to mitigate thermal bridging	66%	49%
Envelope insulation	Meets envelope insulation requirements	86%	78%
Envelope insulation installation quality	Envelope insulation is installed per manufacturer requirements	67%	65%
Fenestration (windows, skylights, and doors)	Windows and doors meet U-factor and solar heat gain coefficient requirements	88%	79%
Vertical fenestration (windows and doors)	The vertical fenestration area is less than 30% of the gross above-grade wall area or up to 40% with automatic daylighting controls (window to wall ratio)	71%	75%
Demand controlled ventilation (DCV)	Demand controlled ventilation is provided in all spaces larger than 500 square feet with an average occupant load of 25 people per 1,000 square feet	69%	58%

Code Requirement	Description	New Construction Compliance Estimate	Additions and Alterations Compliance Estimate
Mechanical commissioning	HVAC system completion was accomplished, including air and hydronic system balancing and functional performance testing; documentation and reporting requirements are met	66%	53%
Economizers	Economizers are provided where required, meet the design requirements for capacity, and have appropriate controls	85%	72%
Distribution systems	Ductwork and piping meet required insulation levels	85%	83%
Energy recovery ventilation	Energy recovery ventilation is provided for fan systems that exceed values specified in the code; exhaust air recovery efficiency is ≥50%	58%	62%
Variable air volume systems	Variable air volume fan motors ≥10 horsepower are driven by variable speed drive, have a vane-axial fan with variable pitch blades, or have controls or devices to limit fan motor demand	88%	80%
Mechanical controls	Mechanical controls are provided (via a programmable thermostat to provide heating and cooling to each zone, with capability for automatic setback and shutdown)	92%	79%
Equipment efficiency	Installed equipment meets efficiency requirements	95%	94%
Equipment sizing	Equipment meets sizing requirements	80%	64%

Code Requirement	Description	New Construction Compliance Estimate	Additions and Alterations Compliance Estimate
Multiple HVAC systems	Multiple zone HVAC systems have supply air temperature reset controls and limit simultaneous heating and cooling to each zone	90%	78%
Daylighting controls	Daylit spaces have separate controls from general lighting controls or are automatically controlled with daylight sensors	80%	63%
Lighting power density	Meets space-specific lighting power density requirements	91%	80%
Interior lighting controls	Manual and automatic lighting controls are installed and functioning properly	86%	80%
Exterior building lighting power	Exterior lighting does not exceed the exterior lighting power allowance	89%	77%
Exterior lighting controls	Exterior lighting is controlled by either motion sensor or time clock	91%	84%
Additional efficiency package options	Projects meet the additional efficiency requirements of C406	62%	33%[a]

[a] The additional efficiency package options apply to alterations only (not additions).

Two panelists provided closing thoughts on component compliance:

- "Equipment efficiency continues to retain high compliance because federal mandates dictate equipment meet a certain level of performance. Therefore, all new equipment on the market seemingly complies with the energy code by default. The only issues with efficiency lie in buildings that utilize older equipment and have failed to replace them. Envelope thermal bridging and insulation installation on site (lack of contractor knowledge or compliance with the architect's thermal boundary detailing) continues to be an issue. There is a gap between contractor and energy code knowledge." (Design professional)

- "My responses are taken from considerable real-time plan review and site inspection work over the last three to four years in NYS. I am surprised to see numbers that represent higher compliance levels than mine in other responses. Also, the energy code is often not even considered for existing building projects; at least 50% of the time, I do not even see the designer's NYS-required "sign-off" for energy code compliance." (Energy code consultant)

Impact of Code Updates on Compliance Rates

The Market Evaluation Team asked panelists to estimate how a code update (moving from one version of the energy code to another) impacts the overall commercial building compliance rate, if at all. For example, there would be a 10% decrease if the compliance rate went from 90% to 80%, or a 7% increase if the compliance rate went from 73% to 80%. On average, panelists estimated that compliance would decrease by 9% at the beginning of a new code cycle (estimates ranged from a 5% decrease to a 15% decrease), and provided the rationale for their responses:

- "This depends greatly on the significance of the code changes. For standard code updates on a three-year cycle, code changes would impact compliance rates initially by approximately 5% in year one, then the compliance decrease should fade after year one." [5% decrease]
- "I honestly don't think we know what the impact is, nor can we tell with the occasional code compliance evaluation studies we conduct. We need real time [quality control] over code companies statewide, not just large communities that have more construction or are more sophisticated, to better understand this." [10% decrease]

- "Without enforcement, notice of the changes, and training about the new requirements, and an understanding of how to effectively comply, then simply changing the rules reduces compliance until folks learn the new rules. Some professionals (and code officials) never know the rules or learn the new rules. So their designs only get worse relative to code over time." [10% decrease]
- "With an increase in stringency, the code gets harder to meet and will result in stakeholders not being able to meet the requirements and build what they want. Consequently, this tempts them to figure out how to get around [the requirements]." [10% decrease]

Challenges to Commercial Energy Code Compliance

Panelists identified challenges the commercial building market must overcome when complying with energy codes. These challenges most commonly included:

- Cost of implementing the energy code requirements
- Complexity of the energy code requirements
- Lack of understanding of energy code requirements
- Inconsistent energy code enforcement
- Perception that energy codes are not as critical as life/safety codes (e.g., fire, structural, electrical, and accessibility)

Additional specific responses included inconsistency in energy modeling protocols and limited capability of the typical code enforcement officer to navigate the complex code requirements.

The experts agreed that the challenges are more pronounced in geographic regions with fewer commercial projects, resources, or building department staff. Specific anecdotes included these:

- "I work in mostly one geographic area, but I would surmise the smaller, less populated areas suffer on commercial compliance. I believe it is due to the lack of exposure and experience."
- "Larger offices tend to have greater expertise understanding the requirements of the complex commercial code."
- "Well-funded cities and municipalities generally have greater compliance rates since, in general, they have improved oversight and are likely to have adequate staff and access to outside resources."

One panelist noted challenges that are specific to larger cities:

- "In dense urban environments like New York City, where there are zero lot lines, and potentially only space for a seismic gap between adjacent buildings as a building code requirement, there is often little room for exterior continuous insulation as is sometimes incorrectly specified on drawings. There must be a way to remedy exterior wall insulation requirements for buildings by compensating on the interior."

Experts agreed that compliance differs by building type, offering the following specific examples:

- "In multifamily buildings, it is also difficult to regulate high efficacy lamp requirements for dwelling units, as users can easily swap out lamps with less efficient lamps."
- "Air barrier details are good for very complex buildings or those in programs [such as] ABAA [Air Barrier Association of America]. This is not [the case] in simpler buildings. Likewise, dealing with thermal sheets is better in more complex buildings. Commissioning is almost nonexistent regardless the building type."
- "Multifamily commercial compliance is lower than general commercial because the continuous insulation requirement is hard to meet. Also, many designers don't understand that they cannot use the NYCECC [New York City Energy Conservation Code] for multifamily commercial with more than 30% WWR."[4]
- "Larger, more complex building designs require more engineering expertise from the code officials."
- "Obviously, dependent on occupancy, building systems will vary. For example, residential high-rise buildings have very different space conditioning and ventilation requirements than most any other commercial occupancy. Electrical power requirements are also quite different, calling for a generally much greater power load. Industrial buildings become a challenge to the applicant, simply due to the fact of quantifying when and how to expend waste heat in industrial occupancies."

Factors Driving Commercial Energy Code Compliance

Factors identified by the panelists as driving the commercial market to comply with energy codes include energy costs; local and statewide laws and regulations; increased awareness of building energy consumption; green building programs and requirements; fear of liability because of non-

[4] In this scenario, the project would demonstrate compliance using Chapter 11 Energy Cost Budget of ASHRAE 90.1.

compliance, at both the individual and jurisdiction level; energy code enforcement; and the professional ethics and knowledge of the design community. One panelist elaborated:

- "Generally, the commercial market is higher served by the professional design community. Architects and Engineers are more directly involved in design as well as oversight. This makes for a huge difference in rate of compliance."

Panelists identified the following activities, practices, or types of support as having the greatest impact on increasing commercial building energy code compliance:

- Training and education for industry professionals
- Technical assistance for industry professionals
- Training for building operators and owners
- Education for building occupants
- Incentives that cover increased first cost
- Compliance tools for plan review and site inspection
- Public demand for energy efficient buildings

A design professional panelist also offered:

- "[The] manufacturing industry and code officials need to work together more closely to resolve technological issues and increase enforcement of compliance. Products that are energy code compliant could develop a certification system, making it easier for design professionals to specify efficient materials and equipment, and increasing enforcement on a whole."

Commercial panelists estimated, on average, that a training program aimed at educating all sectors of the building industry could increase the overall compliance rate of commercial buildings by 15% (estimates ranged from 5% to 25%). Respondents provided the following commentary on training programs and their impact on commercial compliance:

- "Understanding is the first step, and a large step, since without the reasons why a requirement is in code, it may be overlooked or disregarded. Budgetary constraints may ultimately control the outcome." (Design professional)
- "Not sure of percentage improvement, but I would assume that education and training would have a significant impact on compliance improvement." (Third party energy professional)

- "I believe that training increases an inspector's compliance rate for the energy code by at least 15-25%." (Code enforcement officer)
- "15% compliance increase if training is provided to contractors." (Design professional)
- "I think hands-on training with individual jurisdictions conducted statewide under a NYSERDA project is worthwhile. I also believe that incentivizing plan review and site inspection third-party agencies statewide would be an investment that can bring measurable results. Training on the energy code by chapter and verse is almost worthless; we've been doing it for decades, and it isn't advancing the actual enforcement levels very much." (Design professional/energy code consultant)
- "Without enforcement, there is little incentive to pay attention to compliance. Only those that care about compliance will take the training and I would guess [they] were already making an effort to comply. I would estimate that training may influence a small group to start considering compliance or help those that were trying to be a little better. My estimate would be that training would improve compliance by about 5%." (Design professional/NYS or local code development/energy code consultant)
- "Once someone is educated in any field, they will apply what they have learned, which is why it is critical that the code is taught correctly and opinions are not injected into the [training] program." (Code official)
- "I feel hands-on technical assistance is more valuable for CEOs." (Energy code consultant)

Commercial Compliance and the Building Process

The survey asked experts to identify at which phase of a commercial new construction project energy code compliance is most significantly impacted: planning and design, permitting and plan review, construction, or inspection. Panelists ranked each phase from 1 to 4, where 1 meant the phase had the greatest impact on compliance and 4 meant the least impact, and provided a rationale for why they provided the ranking. While responses were varied, experts most commonly indicated that compliance is most significantly impacted at the design phase for commercial construction and least impacted at the inspection phase.

The following section presents selected commentary and rationale for the rankings provided to each phase:

- Planning Phase:
  - "Design professionals are surprisingly not up to speed on [the] latest requirements, yet code officials are too dependent on designers to do an in-depth plan review." (Ranking: 1, greatest impact)
  - "This is still critical but is only as accurate as to how the drawings are followed during construction." (Ranking: 3)

- Permitting and Plan Review Phase:
  - "The plan review is the most important, this identifies to the designer and the contractor that systems may need to be upgraded to meet code." (Ranking: 1, greatest impact)
  - "The low amount of overall time for energy code plan review and low technical understanding by code officials can have a huge impact." (Ranking: 2)
  - "Without enforcement, there is no reason to comply." (Ranking: 1, greatest impact)

- Construction Phase:
  - "All the added costs to the construction of the building and the extra time it takes to […] comply slows down the construction of the building." (Ranking: 1, greatest impact)
  - "This is important, but if the contractor is following the code approved drawings, then it would comply." (Ranking: 3)
  - "Contractor education in installing materials and equipment wisely, according to specifications, is critical." (Ranking: 1, greatest impact)
  - "Increasingly lower level of education and training of construction staff results in weaker detailing of code requirements." (Ranking: 4, least impact)
  - Changes during construction are often for cost savings. Compliance review during this stage is most helpful to owners to quantify the impact of design changes during construction, but they have to want to know that they still comply." (Ranking: 4, least impact)

- Inspection Phase:
  - "If the inspector is inspecting to the code approved drawings, this is not as important." (Ranking: 4, least impact)
  - "Most errors are corrected at this stage and contractors learn firsthand through an enforced penalty." (Ranking: 2)
  - "Code officials are often not educated to understand many complex commercial systems and are relying too much on the initial design." (Ranking: 3)

Finally, the survey asked panelists to determine whether commercial energy code compliance should be considered apart from compliance with other building codes or integrated into compliance with other building codes. The majority of experts (5 out of 8) who provided a response said energy code compliance should be considered separately from other building codes. These respondents said:

- "Building codes have to do with life safety and the energy code has nothing to do with that, only with saving money and using less energy. The [two] things have nothing at all in common with each other." (Code enforcement officer)
- "I think the commercial compliance arena needs more assistance [than other building codes] from performance professionals, such as commissioning agents, air barrier specialists, etc., to take the plan review and site inspection processes to the next level." (Third-party energy professional)
- "Other codes are typically about life safety within a given building. Energy code compliance is about impact on society as a whole." (Design professional)
- "Unfortunately, commercial building energy code compliance is too complex to be integrated with the other building codes." (Third-party energy professional)
- "In commercial construction, due to the complexities of the energy code requirements, it would be more effective to keep compliance separate from general building code compliance." (Third-party energy professional)

Respondents (one code official, one energy code consultant, and one design professional) who felt the energy code should not be treated separately provided the following rationales for integrating commercial energy code compliance into compliance with other building codes:

- "One cannot determine compliance separately because other aspects of the codes are not stand alone, they are incorporated and intertwined. One could not separate the codes

from each other and expect that compliance would be achieved in any greater capacity." (Code enforcement officer)

- "I have found a huge overlap in building materials, systems, and assemblies with New York City's IECC based energy code, and New York City's Construction Codes. There are often local, overriding conflicts that may exempt energy code. Therefore, there needs to be more integration at the buildings department level and enhanced education amongst energy code plan examiners and construction code plan examiners." (Design professional)

Compliance in the Residential Building Market

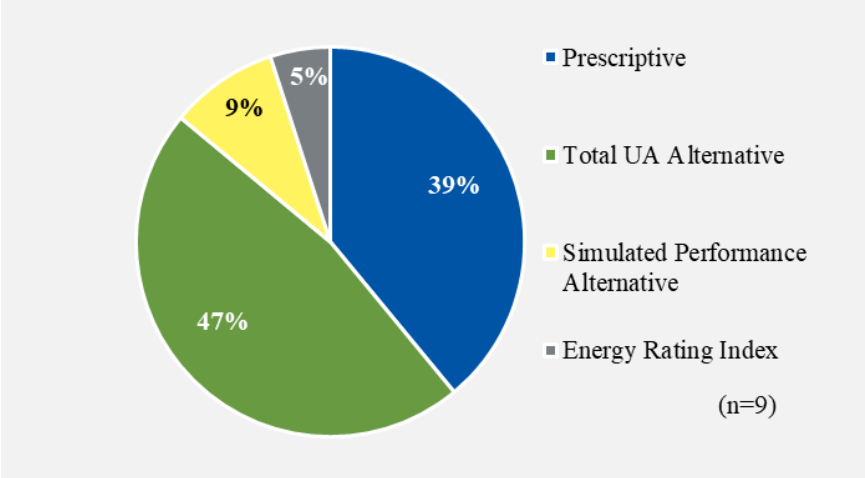
The surveys also asked Delphi Panel experts with residential building expertise to estimate the percentage of new construction permitted using the following compliance methods:

- Prescriptive
- Total UA Alternative (R402.1.5)
- Simulated Performance Alternative (R405)
- Energy Rating Index (ERI) Compliance Alternative (R406)
- Others, as specified by the panelists

Figure 4 shows the average percentage of new construction permitted using each residential compliance option. Panelists estimated that 86% of all new construction is permitted using a prescriptive compliance option, most commonly the Total UA Alternative (generally complied with using RES*check*), and just 14% is permitted using a performance option. Energy code consultants and third-party energy professionals estimated a higher use of the ERI compliance option than other occupations did.

Figure 4. Residential New Construction Compliance Paths

Source: Delphi Panel Surveys by Market Evaluation Team.



As was the case with commercial building compliance, the two code enforcement officers reported different compliance paths most commonly used in their jurisdictions. The code enforcement officer with experience in the Hudson Valley region estimated prescriptive compliance was the most common approach: he said 80% of all new construction is permitted using the prescriptive compliance path of the IECC and the remaining 20% is permitted using the Simulated Performance Alternative. This is consistent with the estimate the code enforcement officer provided for commercial building compliance.

The code enforcement officer with experience in the Finger Lakes region reported a wider range of options used for residential buildings, estimating 48% of all new residential construction is permitted using prescriptive compliance, 45% using the Simulated Performance Alternative, and the remaining 7% using either the UA Trade Off (5%) or the ERI (2%) approach. This variation is also consistent with the estimates provided by this code enforcement officer for commercial building compliance.

The panelists' average estimate of the percentage of residential new construction that demonstrates compliance using RES*check* was 68%.

Residential Compliance Rate

In the first survey round, the Market Evaluation Team asked panelists to estimate the overall residential compliance rate, compliance rate by system or energy code category (documentation, building envelope, mechanical, and electrical power and lighting), and compliance rate by

component for single-family new construction, low-rise residential new construction, and additions and alterations. Panelists reviewed and responded to input from the group and recorded changes to their estimates, if applicable, in rounds two and three of the survey.

Overall Residential Compliance Rate

For overall residential compliance, the Team aggregated the panelists' compliance estimates in the same manner as aggregated for commercial estimates. First, the Team calculated average overall compliance rates using the final, third-round estimates provided by each panelist:

- Overall compliance rate for residential single-family new construction was 71%
- Overall compliance rate for low-rise residential new construction was 73%
- Overall compliance rate for residential alterations and additions was 67%

The Market Evaluation Team then calculated the weighted overall compliance rate for single-family new construction and single-family alterations and additions by weighting each of the panelists' individual system or energy code category estimates by energy impact. The Team used the distribution of weighting from the 2015 ERS Delphi Panel study for residential compliance as well. Table 6 shows the weight applied to each system.

Table 6. Residential Distribution of Weights by System or Category

System or Category	Weight
Documentation	5%
Building Envelope	62%
Mechanical Systems	22%
Electrical Power and Lighting Systems	11%

Using this method, the current, weighted overall compliance rate was 77% for residential single-family new construction and 71% for residential single-family alterations and additions. For reporting purposes, the Market Evaluation Team used these weighted compliance rates as the baseline.

Residential Compliance Rate by System

Panelists estimated the compliance rate for each major building system or energy code category. For single-family new construction and additions and alterations, panelists identified the building

envelope as having the highest rate of compliance (80% and 77%, respectively). Table 7 shows the average compliance estimates by system or energy code category.

Table 7. Residential Compliance Rate by System or Category

System or Category	New Construction	Additions and Alterations
Documentation	59%	55%
Building Envelope	80%	77%
Mechanical Systems	69%	61%
Electrical Power and Lighting Systems	79%	63%

Residential Compliance Rate by Component

Finally, the Market Evaluation Team asked panelists to estimate the compliance rate for select building components, identified as either having a significant impact on building energy use or as being a newer code requirement. Table 8 shows the average of the panelists' compliance rates for each building component in single-family new construction and additions and alterations.

Table 8. Residential Compliance Rate by Component

Code Requirement	Description	New Construction Compliance Estimate	Additions and Alterations Compliance Estimate
Certificates in panel	Permanent certificates are posted on or in the electrical panel to document code compliance	63%	25%
Documentation	Projects construction documents supply enough detail for code official to assess compliance, including details of air and duct sealing and the mechanical system design	58%	41%
Air sealing	Building thermal envelope is sealed to limit infiltration, and all joints and penetrations are sealed, as well as windows, doors, attic access, and other pertinent areas	61%	44%
Air barrier and insulation installation	Components of the thermal envelope were installed per Table R402.4.1.1, inspected per that same table, and tested with a blower door test.	67%	49%
Air leakage rate	Air leakage rate does not exceed 3 ACH(50)	79%	44%
Rooms containing fuel burning appliances	Appliance and combustion air opening is located outside the building thermal envelope or enclosed in a room; combustion closets are insulated to levels not less than the basement wall R-value requirements in Table R402.1.2; and closet is air sealed and door fully gasketed	60%	44%
Tenant separation walls	There are fire separations between dwelling units in two-family dwellings and townhouses insulated to R-10 or greater and walls are air sealed	70%	55%

Code Requirement	Description	New Construction Compliance Estimate	Additions and Alterations Compliance Estimate
Envelope insulation (general)	The building meets or exceeds required envelope insulation levels, including for the roof, above-grade wall, slab, foundation, and floor	86%	79%
Envelope insulation (specific)	Ceiling	88%	70%
	Above-grade wall	87%	76%
	Basement	79%	64%
	Floor/slab	79%	64%
Insulation installation quality	Envelope insulation is installed per manufacturer's requirements and Table R402.4.1.1	69%	66%
Percentage of projects with various grade insulation installation qualities	Grade I – Minor Defects	45%	48%
	Grade II – Moderate Defects	35%	32%
	Grade III – Substantial Defects	14%	14%
Recessed lighting	Recessed fixtures in the building envelope are IC-rated and sealed with gasket or caulk to limit air leakage	64%	58%
Vapor retarders	Vapor retarders provided on interior side of frame walls (climate zones 5 and 6 only)	94%	94%
Windows and doors	Windows and doors meet U-factor requirements	94%	93%
National Fenestration Rating Council stickers	Builders leave window and door certification (National Fenestration Rating Council) stickers for inspection	78%	74%
Equipment sizing	Heating and cooling equipment is sized per Manual J or similar process	65%	58%

Code Requirement	Description	New Construction Compliance Estimate	Additions and Alterations Compliance Estimate
Distribution systems	Ductwork and piping is insulated and sealed	74%	71%
Duct insulation	Supply and return ducts in the attic are a minimum of R-8 (where ≥3-inch diameter) and R-6 (where <3-inch diameter)	90%	88%
Duct testing	Ducts located in unconditioned spaces were tested for air leakage; total duct leakage does not exceed 4 cfm per 100 square feet of conditioned floor area	62%	61%
Hot water pipe insulation	R-3 insulation on hot water pipe is over 3/4-inch where applicable	80%	79%
Programmable thermostats	Programmable thermostats are installed in each dwelling unit with capabilities for daily schedule control, automatic adjustment based on largest heating/cooling zone, and have a temperature range from 55°F to 85°F	96%	96%
Interior light fixtures	At least 75% of permanent fixtures have high-efficacy lamps	79%	82%
Individual unit lighting metering	Individual dwelling units are separately metered	94%	91%

Impact of Code Updates on Compliance Rates

As with commercial, panelists estimated how a code update (moving from one version of the energy code to another) impacts the overall residential building compliance rate, if at all. On average, panelists estimated that residential compliance would decrease by 9% at the beginning of a new code cycle (estimates ranged from a 5% decrease to a 15% decrease), and provided the same types of rationale as they did for their commercial estimates. One design professional also said, "There is a learning curve for new code updates that takes some time. Training programs and webinars should be provided for free to design professionals and contractors. New York City offers very expensive courses (through Urban Green Council), which could instead be provided as online presentations." [5% decrease]

Challenges to Residential Energy Code Compliance

Panelists with residential expertise identified common challenges the residential market must overcome when complying with energy codes, some of which were also listed as primary challenges for the commercial building market, such as these:

- Cost of implementing the energy code requirements
- Lack of understanding of energy code requirements
- Inconsistent energy code enforcement

However, panelists also identified the following challenges with residential energy code compliance that are not applicable, or are applicable to a lesser degree, in the commercial market:

- Home builder resistance to change in construction practices
- Homeowners completing construction without energy code knowledge
- Limited funding for architectural services or non-involvement of design professionals
- Lack of understanding and submittal of documentation requirements

Panelists also identified the following specific challenges:

- "There will need to be more rigorous documentation and procedures in line for air leakage testing. There must be standards for documentation provided. Residential lighting must become more stringent, as the code requirements in my opinion, are relaxed."
- "Mechanical contractors are reluctant to right-size equipment and they [do not complete] duct leakage testing."

Residential panelists did not mention the complexity of the energy code or that it is not considered a health and safety code like commercial respondents. Residential experts also noted to a lesser degree than commercial experts that compliance challenges differ by geographic region. Experts that did note a difference in compliance challenges across jurisdictions most commonly said the building departments in larger jurisdictions are more capable of energy code enforcement than smaller jurisdictions. One third-party energy professional added, "Counties aggregating many towns, villages, or cities seem to do the best [with compliance]." Another third-party energy professional said the "energy code is often better supported when grouped with the Planning/Zoning Department." Panelists agreed that compliance tends to be greater in more affluent regions of the state.

Factors Driving Residential Energy Code Compliance

While the factors identified by the experts as driving the commercial market to comply with energy codes included such things as local and statewide regulations and green building programs, panelists said the key to driving compliance with the residential energy code is to appeal to the homeowner.

Panelists identified the following activities, practices, or types of support as having the greatest impact on increasing residential building energy code compliance:

- Training and education for industry professionals
- Use of third-party energy professionals in compliance verification
- Mandatory performance testing
- Educating homeowners on the benefits of code compliance
- Educating contractors on the business benefits of code compliance
- Rebates or other incentives for homeowners

Residential experts estimated, on average, that a training program aimed at educating all sectors of the building industry could increase the overall compliance rate of residential buildings by 13% (estimates ranged from 10 to 30%). This average is slightly lower than was estimated for

commercial compliance enhancement. Respondents provided the following commentary on training programs and their impact on residential compliance:

- "Training programs can be much more effective (10% to 30% or more) if the presenter will indicate the reasons why a code change has been implemented [and] share the science behind the change." (Design professional)
- "I think that training, as long as it is to the builders also, could maybe bring it up by 15%." (Code enforcement officer)
- "Training in specific areas, such as mechanical systems and clarifications of testing requirements, may increase compliance 10-15%. It is these areas where enforcement is weaker - if the knowledge is there, enforcement will follow." (Energy code consultant/third-party energy professional)
- "This is a difficult question to answer. The impact could be dramatic but is in large part dependent upon the trainee's ability to carry out the information learned within his/her available budget, and supervisory approval to increase his/her oversight and enforcement of said requirements." (Design professional)
- "Ten percent if [training is provided to] stakeholders and higher if direct assistance were given to all jurisdictions." (Energy code consultant)
- "At least 10% - more if we include QA." (Third-party energy professional)
- "If it is applied, and to the correct market sector, it can help. However, we continue to focus on the code enforcement infrastructure segment and need to think outside that box. We need to get to […] homeowners, designers, program managers, and product manufacturers and distributors. We need to increase the impact and influence of the energy code on the standard architectural specifications, require product listing and code consideration, promote builder programs that raise the bar for that sector via recognition programs, require energy code training for AIA certification and not just assign CEUs, etc." (Design professional/energy code consultant)

Residential Compliance and the Building Process

As with commercial buildings, the survey asked experts to identify at which phase of a residential new construction project energy code compliance is most significantly impacted: planning and design, permitting and plan review, construction, or inspection. Panelists ranked each phase from 1 to 4, where 1 meant the phase had the greatest impact on compliance and 4 meant the least impact, and provided a rationale for why they provided the ranking. Responses for residential

compliance were opposite to those reported for commercial compliance. Residential experts said compliance is most significantly impacted at the inspection phase for residential construction (rather than planning and design phase reported for commercial) and least impacted at the planning and design phase (rather than the inspection phase).

The following presents select commentary and rationale for the rankings provided to each phase:

- Planning Phase:
  - "The designs are usually based on a builder or owner's desires and design documents are generally less sophisticated than commercial." (Ranking: 4, least impact)
  - "Residential applications typically follow standard envelope details, equipment specifications, and design standards that are repetitive, and so these details must be thoroughly reviewed." (Ranking: 2)
  - "Architects and subcontractors never talk to each other." (Ranking: 2)

- Permitting and Plan Review Phase:
  - "There isn't much to looking to see if it complies on the plans." (Ranking: 4, least impact)
  - "Plan review is where most items are caught and flushed out. If not, it causes problems when inspecting." (Ranking: 1, greatest impact)
  - "While this is ranked last in comparison, the examiner still is in a position to educate the design professional on code requirements. It is then up to the design professional to communicate with the contractors. Therefore, this is an indirect way of enforcement, compared to the other three variables." (Ranking: 4, least impact)
  - "It is important the [code enforcement officer] requires full documentation prior to issuing a permit rather than allowing some things (e.g., Manual J) to be submitted prior to [Certificate of Occupancy]." (Ranking: 3)

- Construction Phase:
  - "[Subcontractors] will do what is on plans." (Ranking: 4, least impact)
  - "Contractor education in installing materials and equipment wisely, according to specifications, is critical." (Ranking: 1, greatest impact)
  - "This is the last chance to get [compliance] right." (Ranking: 2)

- Inspection Phase:
  - "In residential, if it is not forced [through inspection], there is no compliance." (Ranking: 1, greatest impact)
  - "If concise, comprehensive plan review is not assured, site inspection is often superfluous." (Ranking: 3)

The surveys also asked panelists to indicate whether they thought residential energy code compliance should be considered apart from compliance with other building codes or integrated into compliance with other building codes. Unlike commercial Panelists who said the energy code should be considered apart from other building codes, two-thirds of the experts (6 out of 9) who provided a response said energy code compliance should be integrated into compliance with other building codes. One code enforcement officer, one individual in the construction industry, and one third-party energy professional said compliance should be considered separately; the third-party energy professional said, "Many view the building codes as safety items but not so much with the energy codes. Many of the new energy codes are above the technical savvy of the CEO."

The experts who thought the energy code should be integrated provided the following justifications:

- "The residential code is mostly a standalone document. Certain provisions of the IECC are intertwined with other parts of the IRC [International Residential Code]. It would be more difficult to enforce a standalone IECC." (Code enforcement officer)
- "Residential code compliance is simpler than commercial and should be integrated with the other codes." (Third-party energy professional)
- "Similar to commercial code compliance, I have found a huge overlap in building materials, systems, and assemblies with New York City's IECC-based energy code and New York City's Construction Codes. There are often local, overriding conflicts that may exempt energy code. Therefore, there needs to be more integration at the building department level and enhanced education amongst energy code plan examiners and construction code plan examiners." (Design professional)
- "Integration of energy features along with other building code features would increase the likelihood of increased compliance with energy features, since the energy component would not be seen as an additional task." (Design professional)

A third-party energy professional offered the following about energy code enforcement in general:

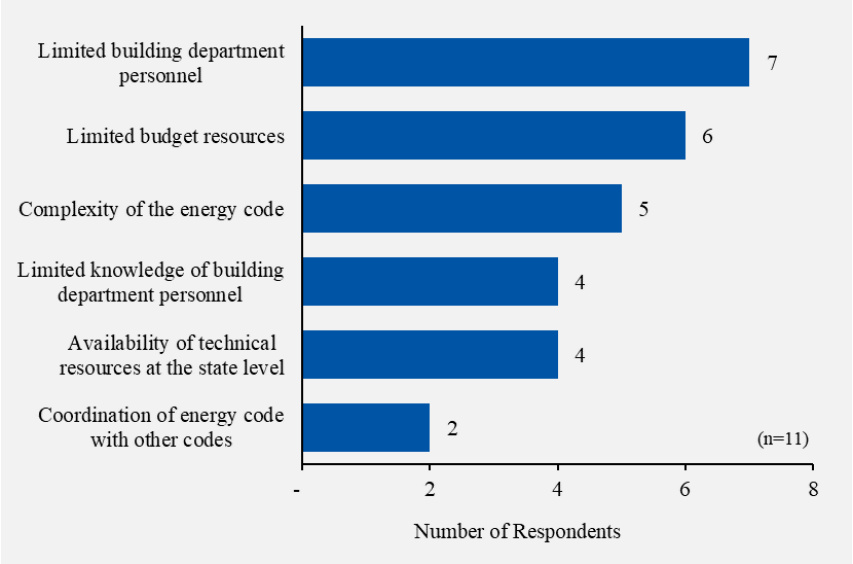
- "After over 30 years in the energy code business in NYS and many other states, I don't believe the code enforcement infrastructure will ever be able provide high levels of energy code compliance."

Energy Code Enforcement

The Delphi Panel process gathered information on commercial and residential energy code enforcement practices and challenges across NYS. The survey asked panelists to select the three most significant challenges facing energy code enforcement from a list the Market Evaluation Team provided, with the option of providing additional challenges if needed.[5] Figure 5 shows the number of panelists who selected each option as one of the top three challenges in Round One. Limited building department personnel and limited budget resources were the two most common responses.

Figure 5. Challenges Facing Energy Code Enforcement

Source: Delphi Panel Surveys by Market Evaluation Team.



In Round Two, Panelists responded to the results of Round One, with the opportunity to add any challenges facing the enforcement community not previously identified, comment on the order of

[5] Challenges to energy code enforcement presented to the panelists were selected based on previous code compliance studies, both in NYS and other states.

response, or provide additional observations about the data. While the results were not surprising to the panelists, a few provided the following additional commentary:

- "I agree, limited resources primarily in the area of staff to conduct proper review and inspections."
- "I agree with the three main issues. I expected coordination of the energy code with other building codes to be higher up, as NYC still manages to find overlaps and/or conflicts with its construction codes and energy codes."
- "Complexity of the energy code should be number one. Code compliance trade-offs and compliance options make determining code compliance more difficult."
- "These seem right. Our local compliance varies from town to town though, so lack of QA and or verification should be at the top of the list."

Alternative Energy Code Enforcement Structures

Typical enforcement structures vary by state and local jurisdictions and are often reliant on available resources. Key components of enforcement structures include the approaches used to conduct plan review and on-site inspections. There is a growing interest in alternative enforcement structures, defined in this study as new, innovative, or otherwise atypical methods or structures for enforcing the energy code. Examples of alternative code enforcement structures include county-level energy code enforcement, shared services, quality assurance platforms for plan reviews and inspections, third-party services, and other enforcement techniques outside of traditionally provided plan review and inspection practice.

Panelists estimated, on average, that 8% of jurisdictions throughout the NYS are currently using an alternative energy code enforcement structure. Table 9 shows jurisdictions known to the panelists as using an alternative energy code enforcement structure.

Table 9. Jurisdictions Known to Panelists with Alternative Energy Code Enforcement Structures

Jurisdiction	Alternative Code Enforcement Structure
City of New York	Building Energy Code Inspection Unit is part of Sustainability Enforcement
City of Syracuse	Employs third-party plan review for commercial energy code compliance

Important features of alternative code enforcement structures, according to the panelists, include saving the building department time and money, improving efficiency and quality of services, increasing compliance, providing greater enforcement and compliance consistency between towns, and increasing the knowledge of contractors and building owners. Panelists said jurisdictions typically share the following concerns when deciding to employ an alternative enforcement structure:

- How will the alternative enforcement structure impact the building department's budget?
- Will the alternative enforcement structure save the jurisdiction money or will it incur additional costs?
- Are incentives available to offset the cost of additional staff, third-party personnel, or required equipment or software?
- Will additional costs be passed on to owners or developers?
- Will building departments lose staff, funding, or other resources if an alternative enforcement mechanism is employed?
- Will the building department lose authority or oversight when bringing in third-party personnel or other alternative enforcement mechanisms?
- How will third-party QA/QC be integrated into the regular oversight by NYS-Department of State?
- What forms of technical assistance and training opportunities are available to support the alternative enforcement structure employed?
- Are qualified, experienced third-party personnel available in the jurisdiction?
- How will the jurisdictions be supported in verifying certifications or credentials of third parties?
- Will enforcement be consistent if a third party is used?
- Will reports be made available to the building department in a timely manner?
- Will the alternative enforcement structure improve overall compliance with the energy code?

Panelists expressed the need for training on the benefits of third parties and a database of qualified third parties maintained by an official agency. Additionally, panelists said it will be important to code officials to maintain authority regardless of the enforcement alternative used.

Stretch Energy Code Adoption in New York State

NYSERDA's latest voluntary, locally adoptable stretch energy code is the NYStretch Energy Code–2020, which is approximately 19% more efficient than the residential provisions of the 2018 IECC and roughly 7% more efficient than the commercial provisions of ASHRAE 90.1-2016. The stretch energy code will also be more efficient than the 2020 ECCCNYS, effective in May 2020.

The Market Evaluation Team designed the Delphi Panel survey to gain insight into the current environment in NYS for the adoption of stretch energy codes, including NYStretch. For this evaluation, a stretch code is defined as a voluntary, locally adopted code or compliance option that offers municipalities a more energy-efficient alternative to the state base code, or the ECCCNYS in New York.

To begin, panelists identified jurisdictions in NYS that have adopted a local energy code more stringent than the current ECCCNYS, shown in Table 10.[6] This list of jurisdictions is not intended to be exhaustive. Several other towns or counties not listed below require Leadership in Energy and Environmental Design (LEED) certification for city-owned or county building capital projects.

[6] Rather than focusing strictly on stretch energy codes in NYS, this first report gathered information from the Delphi Panel on more stringent local energy codes that may not be referred to as a stretch code.

Table 10. Jurisdictions Known to Panelists with More Stringent Local Energy Codes

Jurisdiction
City of Ithaca
City of New York
Town of Babylon
Town of Bedford
Town of Brookhaven
Town of Clarkstown
Town of Clarksville
Town of Greenburgh
Town of Hempstead
Town of Ithaca
Town of New Paltz
Town of Red Hook
Town of Riverhead
Town of Smithtown
Town of Southampton
Town of Yorktown

The jurisdictions known to panelists as having a more stringent local energy code represent nearly 2% of towns (14 of 932) and 3% of cities (2 of 62) in NYS; eighteen percent (11 of 62) of the State's counties have at least one city or town with an energy code more stringent than the ECCCNYS.[7]

Naturally Occurring Market Adoption Rate of Stretch Codes

To establish a baseline forecast of the naturally occurring market adoption rate of stretch codes, panelists estimated the likely adoption rate by NYS jurisdictions from 2019 to 2030. The survey asked panelists to consider the NYS market only and to provide estimates that represent current

[7] The number of towns (932), cities (62), and counties (62) in NYS is listed in the Local Government Handbook: https://www.dos.ny.gov/lg/publications/Local_Government_Handbook.pdf.

market factors; that is, panelists were to assume that no market intervention by NYSERDA or any other entity takes place.

Table 11 shows the panelists' estimates of the percentage of the total NYS jurisdictions adopting an energy-related stretch code by 2030 for each of the three rounds of the Delphi Panel process. Panelists reviewed commentary from one another and modified their responses, if desired, in each round.

Table 11. All Rounds: Stretch Energy Code Naturally Occurring Market Adoption Rate

Year	Percentage of Jurisdictions Adopting, Round One	Percentage of Jurisdictions Adopting, Round Two	Percentage of Jurisdictions Adopting, Round Three
2019	5%	3%	3%
2020	7%	4%	3%
2021	10%	7%	7%
2022	16%	9%	9%
2023	19%	12%	12%
2024	23%	14%	14%
2025	27%	17%	17%
2026	29%	18%	18%
2027	30%	18%	19%
2028	31%	20%	20%
2029	33%	21%	22%
2030	38%	25%	26%

Table 12 shows two ranges of estimates: the final average of all panelists' responses and the final average of panelists' responses with outliers removed.[8] The majority of panelists said the Round Three estimates with outliers removed were the best prediction of naturally occurring market adoption.

[8] Responses outside 1.5 times the interquartile range were identified as outliers and removed. The number of panelist estimates outside of this range varied for each year estimated; in 2019, 2020, and 2030, no responses were considered outliers.

Table 12. Final Estimates: Stretch Energy Code Naturally Occurring Market Adoption Rate

Year	Percentage of Jurisdictions Adopting, All Responses Considered	Percentage of Jurisdictions Adopting, Outliers Excluded
2019	3%	3%
2020	3%	3%
2021	7%	3%
2022	9%	5%
2023	12%	7%
2024	14%	8%
2025	17%	8%
2026	18%	11%
2027	19%	12%
2028	20%	14%
2029	22%	16%
2030	26%	26%

Throughout the process, panelists provided commentary to support their estimates or in response to comments from their peers and the average estimates. The following are examples of this commentary:

- "[Stretch code adoption] is not likely to happen without incentives. […] We need to work with the third parties that will actually do the work under Passive House, or HERS [Home Energy Rating System], our PHIUS+ [Passive House Institute US] to assure better compliance and have an alternate way of collecting compliance results. This has the potential to provide the best model for overall energy code compliance. [We also need] registries for energy code professionals and incentives for third-party certifiers."
- "I believe the adoption of stretch codes in NYS will depend on a quality training program together with in-field technical assistance. Modest incentives to get things started would probably help as well."
- "I changed my percentages above, because as we head into 2020 and await the next energy code to come out this year, I believe change will be very gradual for adoption in the beginning. Between 2020 and 2030, I do believe adoption will ramp up as many

policy documents adopt 2030 as the year for high energy performance and passive house level design."

- "I believe there will be a slow ascent to more stringent energy code adoption by jurisdictions if NYSERDA does not intervene."
- "Adoption will start out slowly at first but after 4-5 years it will become more of the norm and will increase. Look at Massachusetts, for example."
- "This will not happen without NYSERDA intervention, in my opinion. Should consider the stretch code be included as a requirement for Clean Energy Communities or the Climate Smart Communities Certification."

Stretch Energy Code Adoption Considerations

To better understand the motivation for and factors driving stretch energy code adoption throughout NYS, the survey asked panelists to identify reasons some jurisdictions have adopted more stringent local energy codes while others have not. Table 13 lists the five primary motivations and reservations, as identified by the panelists, influencing jurisdictions that are considering the adoption of a stretch energy code or more stringent local energy code.

Table 13. Stretch Energy Code Adoption Motivations and Reservations

Motivations for Stretch Code Adoption
To meet statewide targets and climate change goals, particularly those related to a reduction in greenhouse gas emissions
To gain distinction from other jurisdictions
To be eligible for incentives for meeting above code requirements
To appeal to the community and attract businesses and people
To counter high electric and gas rates
Reasons Jurisdictions Have Not Adopted a Stretch
Shortfalls in state legislation recognizing energy code benefits
Additional costs to developer may encourage building in a nearby town
Lack of financial incentives in general, specifically for building owners
Pushback from the communities, builders, developers, code officials; lack of demand by consumers
Perceived increase in costs

Most panelists noted there are no unique issues jurisdictions must face when implementing and enforcing a more stringent local energy code or stretch code that they are not already facing with typical energy code implementation and enforcement. One panelist noted building departments have a "current lack of ability, manpower, and understanding when enforcing current code standards" and expected such issues to carry over to stretch code enforcement as well.

To encourage and support stretch code adoption, panelists most commonly suggested providing rebates, grants, or other incentives to adopting jurisdictions. Additional suggestions included these:

- Providing training and education targeted at code officials, building professionals, and the community
- Offering technical support to building professionals and enforcement support to code officials
- Assisting with the integration of third parties into the code compliance process
- Advertising the benefits of the stretch code

Two panelists also recommended a stronger relationship between state code officials and local building departments. One of these panelists said: "State code officials should visit local city councils, visit local building departments to engage with its upper management staff, and attend code hearings to provide their perspective on the benefits of code adoption."

One-Cycle and Stretch to Zero Energy Codes

A One-Cycle stretch code is a stretch energy code that is essentially one code cycle ahead of the statewide energy code. That is, the One-Cycle stretch code incorporates elements of the newest national model energy code that the state has yet to adopt. In contrast, a Stretch to Zero energy code goes beyond one cycle of the national model energy code and instead includes provisions that will help a building achieve net zero energy. This means the energy used is about the same as the energy generated by a building. Stretch to Zero energy codes often include requirements or options for renewable technologies, unregulated systems, district (vs. building) energy systems, and zoning requirements not yet covered by the national model energy code or One-Cycle stretch code.

The survey asked panelists to identify the benefits, if any, for jurisdictions to adopt a One-Cycle stretch code rather than a Stretch to Zero energy code. Again, panelists identified lower cost as

the greatest benefit to adopting a One-Cycle stretch code. The following summarizes additional input provided by the panelists:

- "A One-Cycle stretch code allows the industry to slowly grow accustomed to newer code requirements and enables a smoother transition into the next code cycle."
- "A One-Cycle stretch code is more technically achievable based on current design and construction standards."
- "A One-Cycle stretch code is better suited for jurisdictions who receive little to no incentives."
- "Stretch to Zero codes will require investments in technologies that may not be financially viable yet or have properly trained professionals capable of installing them."
- "Stretch to Zero codes may burden local code enforcement officers who already struggle to enforce the energy code."

All of the panelists, with the exception of one code enforcement officer respondent, agreed that having the option of a One-Cycle stretch code will encourage more jurisdictions to adopt a stretch code, particularly if jurisdictions are made aware of the successful adoption of a One-Cycle stretch code in a nearby jurisdiction. One panelist also noted, "One-Cycle stretch codes will allow design professionals, manufacturers, consumers, and utility providers to see the benefits of stringent code adoption."

Advanced Technologies

Another goal of the Delphi Panel process was to identify new or advanced strategies or technologies not yet incorporated into the current ECCCNYS or NYStretch. Table 14 shows the advanced technologies or emerging strategies panelists recommend for consideration in future code-cycle updates.

Table 14. Advanced or Emerging Technologies

Technologies in Residential and Commercial Buildings
Advanced commercial occupancy controls integrating mechanical and lighting systems
Advanced residential controls integrating mechanical systems and the building envelope
Advanced shading strategies such as building orientation, overhangs, and deciduous tree placement
Advanced solar photovoltaic panel technology
Battery storage systems

Technologies in Residential and Commercial Buildings
Cogeneration
Domestic hot water heat pumps (renewable energy)
Energy (thermal, batteries, flywheels) storage
Graywater recycling systems
High-efficiency transformers
Homeowner operating guides for homes
Knowing, marketing, and requiring as-built energy usage
Networked lighting
Ozone laundry
Passive house design (PHIUS/PHI) for residential and commercial buildings
Phase change material for thermal energy storage
Residential commissioning
Thermal interfaces between walls, windows, balconies, parapets, structural penetrations, etc.
Vacuum insulation systems
Variable refrigerant flow heat pump systems

Throughout the Delphi process, panelists also identified advanced technologies that have been newly codified but are not yet widely implemented. These include commercial air barrier testing, high-efficiency electric and geothermal heating and hot water systems, water source heat pump systems, and combination HVAC and hot water technologies.

Panelists identified challenges to the implementation of new technologies or strategies in the current market; most commonly, panelists noted the cost of the new technology (including up-front cost, maintenance cost, and payback period) to be the greatest hinderance to implementation. The panelists also identified the following implementation barriers:

- Uncertainty of the cost-effectiveness of new and advanced technologies
- Limited knowledge of code officials to review, inspect, and enforce new and advanced technologies
- Limited knowledge of and experience with new and advanced technologies by manufacturers, contractors, and equipment suppliers
- Lack of training for code officials and building professionals focused on new and advanced technologies

- Complexity of current energy code compliance calculations and lack of impact of new and advanced technologies on future calculations
- Limited space available to implement new and advanced technologies in commercial buildings, particularly if the technology must be installed on the roof

Although not explicitly asked to identify ways to overcome the challenges facing advanced technology implementation, several panelists offered these suggestions:

- Introduce a new technology as an option prior to making it mandatory
- Conversely, make each new technology mandatory
- Offer incentives that reduce cost
- Provide targeted training on the new technology
- Engage manufacturers in promoting new technologies
- Assess cost-effectiveness and provide clear data on expected return on investment

Definitions Provided to Delphi Panelists

Advanced building technologies and strategies. For the purpose of this evaluation, this will include new or emerging advances in technology, equipment, software, building practices, energy management strategies, innovative design and construction practices, and other similar advanced building concepts, not currently included in the Energy Conservation Construction Code of New York State (ECCCNYS) or stretch code.

Alternative code enforcement structure. New, innovative, or otherwise atypical methods or structures for enforcing the energy code. Examples of alternative code enforcement structures include county-level energy code enforcement, shared services, quality assurance platforms for plan reviews and inspections, third-party services, and other enforcement techniques outside of traditionally provided plan review and inspection practice.

Base energy code. The base energy code is the minimum state energy code. In New York, the base code is the ECCCNYS.

Commercial buildings. All buildings that are not included in the definition of "Residential building" in the IECC.

Compliance rate. For systems, the average percentage of requirements that are in compliance. *Overall compliance rate* is the average percentage of requirements that are in compliance for the entire building.

Compliance using RES*check* and COM*check*. RES*check* and COM*check* are online tools to demonstrate compliance with the prescriptive compliance options of the IECC and ASHRAE 90.1. RES*check* and COM*check* allow trade-offs within individual building components (envelope, HVAC, lighting) but do not permit trade-offs across different building components.

Low-rise Residential. A building, other than a hotel/motel that is Occupancy Group: R-2, multi-family, with three stories or less; R-3, single family; or U-building, located on a residential site.

National model codes. The International Energy Conservation Code (IECC) and ASHRAE Standard 90.1 are the two most widely used energy codes and are referred to as national model codes.

One-Cycle stretch code. National model energy codes are developed on a three-year cycle. Typically, by the time New York enacts the ECCCNYS, the next version of the national model energy code has been developed. A One-Cycle stretch code would include elements of the next version of the energy code and, therefore, when adopted, would be one code cycle ahead of the ECCCNYS.

Performance energy code compliance. Method of complying with the commercial energy code by using the Energy Cost Budget Method (Chapter 11) of ASHRAE Standard 90.1, Appendix G of ASHRAE Standard 90.1, or Section C407 Total Building Performance of the IECC. Method of complying with the residential energy code using the Simulated Performance Alternative (Section R405) or the Energy Rating Index Compliance Alternative (Section R406) of the IECC.

Prescriptive energy code compliance. Method of complying with the energy code by meeting the prescriptive and mandatory envelope, mechanical, service water heating, and lighting requirements, as well as an efficiency option in Section C406 of the IECC for commercial buildings.

Residential buildings. Residential buildings include detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height, above grade plane.

Stretch code. A stretch code is a voluntary, locally adopted code or compliance option that offers municipalities a more energy-efficient alternative to the state base code.

Stretch to Zero code. A Stretch to Zero code refers to an energy code that would go beyond a One-Cycle stretch code such that a building's energy use would be near or the same as the energy

it generates. It may also address unregulated systems (e.g., plug load, data centers), renewable technologies, district (vs. building) energy systems, and zoning requirements.

Appendix B. Representative Jurisdiction In-Depth Interviews

This appendix presents findings from the Market Evaluation Team's in-depth interviews with jurisdiction representatives, completed as part of the Code to Zero Initiative evaluation. The Team collected one-on-one feedback and insights from professionals (code enforcement officers, architects, and building contractors) who work across the state with the NYS energy code, as well as their responses to findings from the Delphi Panel.

In-depth interview respondents replied to questions addressing several primary goals of the task:

- Establish baseline compliance metrics with the 2016 ECCCNYS
- Estimate the rate of adoption of more stringent local energy codes, such as NYStretch
- Provide insight into energy code enforcement practices
- Discuss the use of new technologies and building practices

In-Depth Interview Methodology

The Market Evaluation Team combined the opinions from a group of experts, obtained through interactive, one-on-one phone interviews. Respondents provided information parallel to that of the Delphi Panel, including insights into current levels of code compliance, differences in new construction and retrofit practices, primary influences of and barriers to compliance, and recommendations for increasing energy code compliance within these jurisdictions. Respondents based their feedback on their own experiences with the NYS energy code market and as experts in their respective fields. As not all respondents worked with all aspects of the code, the Team adjusted each interview to only ask questions relevant to each respondent.

Expert Recruitment and Participation

To ensure geographical, socioeconomic, and building density diversity, the Team interviewed professionals who work with the energy code in an urban jurisdiction (New York City), a suburban jurisdiction, and a rural jurisdiction. For anonymity purposes, the suburban and rural jurisdictions are not identified in this report.

The Market Evaluation Team selected jurisdictions based on an analysis of new square footage in New York's urban, suburban, and rural counties since 2006. The Team mapped counties to a census-defined, core-based statistical area by urban, suburban, and rural categories, then assessed

the new square footage over time for each statistical area. As expected, the area that included New York City consistently had the highest new construction rates for the commercial and residential sectors. The Market Evaluation Team filtered out New York City to determine which suburban and rural counties consistently experienced the greatest amount of new construction between 2006 and 2017; from this list, the Team selected jurisdictions for participation.

The Market Evaluation Team created a potential sample list of experts for each of the three jurisdictions selected and set a target of interviewing three individuals in each jurisdiction. The Team developed the sample by researching local energy code experts and building professionals with experience in each jurisdiction, contacting building departments and design professional firms, and speaking with code officials and other experts for recommendations. As shown in Table 15, the Team completed the target interviews for the suburban and rural jurisdictions. However, due to the coronavirus pandemic, the Team could only complete two New York City interviews.[9] In the fall of 2020, the Team plans to re-interview this same set of experts, and will ensure sufficient representation among New York City respondents.

Table 15. Jurisdictional Interview Respondents by Region

Municipality Type	Number of Experts
Urban	2
Suburban	3
Rural	4

The Market Evaluation Team attempted to recruit experts across a range of occupations within each jurisdiction, including code officials, architects, builders, and energy professionals. Due to budget issues, the Mayor's office in the suburban region would not permit us to interview the code official. In future outreach efforts, the Team can consider shifting focus to a nearby town or other jurisdiction to capture feedback from a suburban code official. Table 16 shows respondent types from each region. Respondents had an average of 17 years of experience working with the ECCCNYS (ranging from 12 to 30 years of experience).

[9] Individuals who had agreed to participate in the study were no longer available during the interview period due to the pandemic, and attempts to reschedule with these individuals or re-recruit other experts proved unsuccessful due to closed public offices and stay-at-home orders.

Table 16. Jurisdictional Interview Respondent Types

Municipality Type	Code Officials	Construction Industry	Design Professionals
Urban	0	1	1
Suburban	0	2	1
Rural	2	2	0

Self-Selection Bias

As interview participation was voluntary, the in-depth interview process faced possible self-selection bias. One method for mitigating self-selection bias is to avoid a predominance of one or a few respondent types. As such, the Team attempted to recruit respondents who represented a variety of occupations and regional expertise; as discussed, this led to successfully recruiting respondents from three municipality types and three occupations.

In general, views on the energy code varied between the jurisdictions selected for this study, and the results and commentary presented in the following sections highlight this variance. New York City respondents, for example, were largely in support of energy codes and other energy efficiency policies and regulations. The suburban and rural respondents, however, generally viewed the energy code as an "unfunded mandate" and often spoke of the difficulties in achieving compliance with the energy code with few or only part-time code inspectors while also meeting the needs of the low-income population in their area.

In-Depth Interview Findings

The following sections detail the interview results related to energy code compliance, energy code enforcement, stretch energy code adoption, and advanced technologies.

Energy Code Compliance

New York State's energy code at the time of the interviews was the 2016 ECCCNYS, which took effect on October 3, 2016. The 2016 ECCCNYS was based on the 2015 IECC and ASHRAE 90.1-2013 and modified by the 2016 *Supplement to the New York State Energy Conservation Construction Code*. On May 12, 2020, the 2020-ECCCNYS took effect and is based on the 2018 IECC and ASHRAE 90.1-2016.

Through the in-depth interviews, the Market Evaluation Team primarily sought to achieve two main goals: compare local experiences to the baseline compliance estimate, as determined

through the Delphi Panel, and gather insights into challenges faced by each jurisdiction when complying with the residential and commercial energy codes. The Market Evaluation Team also gathered feedback on the impact of energy code updates on compliance and on activities that might increase code compliance in each jurisdiction. The respondents' experience with demonstrating or enforcing compliance varied, and not all respondents worked in both the residential and commercial sectors. As such, the Team only asked respondents questions applicable to their occupation and experience.

Compliance in the Commercial Building Market

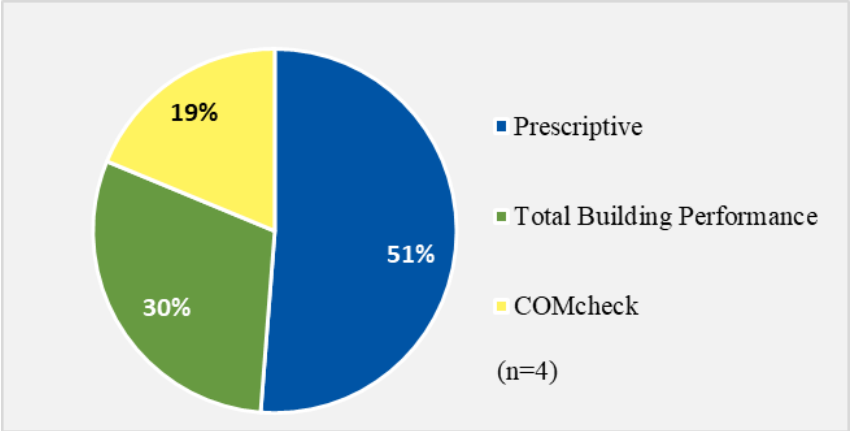
The Market Evaluation Team asked interview respondents with commercial building expertise to estimate the percentage of new construction permitted (either in their jurisdiction or their project work) using the following compliance methods:

- Prescriptive
- Prescriptive compliance option of ASHRAE 90.1
- Total Building Performance (C407)
- Energy Cost Budget, Chapter 11, ASHRAE 90.1
- Appendix G, ASHRAE 90.1
- Others, as specified by the respondents

Figure 6 shows that respondents estimated that 51% of commercial new construction buildings were permitted using the prescriptive compliance option and another 30% are using COM*check*, a deemed to comply software.

Figure 6. Commercial New Construction Compliance Paths

Source: Jurisdiction Interviews by Market Evaluation Team.



Respondents noted that additions and alterations are permitted using the same compliance paths as for new construction. In future interviews, the Team will provide respondents with a handout or another visual aid to better present these questions, as the technical details proved difficult to grasp over the phone.

The Market Evaluation Team also asked interviewees to estimate the percentage of new construction that demonstrates compliance with COM*check*. Of four respondents, two said 100% (one from a rural community and one from New York City), one said 75% (from a suburban community), and one said 0% (from a rural community).

Commercial Compliance Rate—New Construction

To address overall compliance estimates for commercial new construction, the Team asked the five respondents with experience in the commercial sector if they agreed with the Delphi Panel unweighted estimate of 84% overall compliance.[10] Responses varied:

- One rural respondent said the estimate should be a bit higher (closer to 90%)
- One rural and one suburban respondent said the estimate should be slightly lower
- One New York City respondent said the overall compliance rate might be closer to 70% at the state level, but agreed with the Delphi Panel estimate for their own jurisdiction; another New York City respondent and one rural respondent agreed that the estimated percentage was close to their own observations

Those who provided context suggested a variety of reasons why they agreed or disagreed with the Delphi Panel estimate. One rural respondent who agreed with the Delphi Panel estimate explained that compliance would be higher, but some developers who build and manage low-income multifamily properties choose not to comply with the energy code because they experience less project oversight from code enforcement officers, and thus feel less regulatory pressure to comply. These developers, the respondent explained, bring down the efforts of more responsible developers and affect compliance overall.

One rural code official said the "80% range [is] a fair estimate," explaining that commercial construction is held to a higher standard than residential construction within their jurisdiction, and is more widely enforced. A New York City respondent considered compliance to be slightly

[10] The Team presented the average, unweighted response from the Delphi Panel to interview respondents for comparison. The weighted compliance rate is 83%.

higher than that estimated by the Delphi Panel because of their jurisdiction's access to resources and other compliance tools, such as duct and envelope testing equipment, that have made it easier to ensure as-built compliance.

The Market Evaluation Team asked interview respondents to consider the Delphi Panel study findings regarding the highest and lowest compliance rate in commercial new construction for the three main energy code categories (building envelope, mechanical systems, and electrical power and lighting systems). The Delphi Panel estimated building envelope compliance as the highest (85%), followed by electrical power and lighting systems (80%) and mechanical systems (79%).[11] Interview respondents generally agreed with the Delphi Panel study findings.

Respondents who agreed with these estimates said the detail required for building envelope components in commercial documentation and the rigor of building envelope inspections led to greater compliance than with the other systems:

- "I would say envelope is going to be, in reality, hitting its benchmark more often, since the documentation is usually just a check mark for mechanical and lighting systems in COM*check*. There is more rigor on envelope." (New York City respondent)
- "The building envelope was always built to code because there were so many inspections along the way." (Rural respondent)

A suburban respondent, however, disagreed that building envelope achieved the highest compliance levels, saying, "Envelope is harder to comply with, and the actual installation may not meet design." He also said lighting and mechanical systems had slightly higher compliance rates than that estimated by the Delphi Panel.

Commercial Compliance Rate—Additions and Alterations

To estimate overall compliance for commercial additions and alterations, the Team asked respondents if they agreed with the Delphi Panel study's unweighted estimate of 72% overall compliance.[12] Two respondents agreed (one from New York City, one suburban), another two

[11] The compliance estimated by the Delphi Panel study showed only small differences between the main categories (ranging from 79% to 85%).

[12] The Team presented the average, unweighted response from the Delphi Panel to interview respondents for comparison. The weighted compliance rate for additions and alterations is 70%.

said actual compliance is higher (both rural respondents), and one rural respondent said actual compliance is lower (closer to 60%).

As with new construction, the Market Evaluation Team asked interview respondents to consider the Delphi Panel commercial additions and alterations study findings regarding high and low compliance with the three main energy code categories (building envelope, mechanical systems, and electrical power and lighting systems). The Delphi Panel estimated building electrical power and lighting system compliance as the highest (72%), followed by mechanical systems (69%) and building envelope (68%).[13] Interviewees generally agreed with these estimates and provided some insight:

- A New York City respondent noted that the lower compliance rate estimated for the building envelope makes sense because of the complexity associated with updating existing components in additions or alterations. She explained that increasing insulation levels within existing walls is especially difficult.
- Another New York City respondent, who often works as a third-party inspector, noted that companies like theirs often make sure the building envelope complies. She said that, for mechanical and electrical systems, showing compliance is often just "checking a box," and that more complex documentation and more rigorous inspections are necessary to demonstrate compliance with building enclosures (and that extra rigor would improve overall compliance in this category).
- One rural respondent agreed that compliance was highest for electrical systems, but that mechanical systems had lower compliance rates than that of the building envelope.

Overall, respondents did not report a significant difference in compliance rates for additions and alterations in comparison to new construction projects. One respondent said, "It's brand new; whether it is completely brand new or [we're] putting it off to the side, it's got to be compliant." However, a few reported that code compliance for additions and alterations is more complex than for new construction, depending on building characteristics, and that it is often easier to comply with new construction.

[13] Compliance estimated by the Delphi Panel showed only small differences between the main categories (ranging from 68% to 72%).

Challenges to Commercial Energy Code Compliance

Four interview respondents identified one or more challenges to commercial energy code compliance within their jurisdiction:

- Unlicensed contractors
- Contractors who willfully do not comply with the energy code
- The speed at which the energy code changes (leaving insufficient time to master code requirements before the next code cycle takes effect)
- Mastering technical details, such as thermal bridging details or brick shelf angles
- Lack of education and understanding of why energy code updates are important, particularly for contractors

One suburban builder noted specifically that some contractors do not understand why a task they have completed for decades no longer meets code; once they understand that compliance offers actual benefits, represents best practice, and has been based on new understandings and available technologies, they become more willing to comply.

Another respondent explained that individuals in the rural jurisdiction who provide addition and alteration work are rarely licensed and do not always know the details of the energy code: "That code book is 2.5 to 3 inches thick, and it's expensive… not everyone is crazy enough like I was to buy a $400 book."

When asked what activities or types of support would have the greatest impact on increasing commercial building energy code compliance, three respondents offered one or more suggestions:

- Ensure that prices are affordable for materials needed to comply with updated codes or offer incentives to offset the cost
- Use special inspections (a respondent noted that New York City previously had a special enforcement team inspecting parapet insulation, which ensured that contractors followed the building plans)

- Offer targeted education:
  - Training opportunities focused on energy code requirements that have changed and what this requires of the different stakeholders and parties involved
  - Education for design teams on how to more effectively communicate the importance of code compliance and energy efficiency to developers
  - Education for community leaders (such as mayors and commissioners of building departments) on the community benefits offered by adopting a stretch code

Factors Driving Commercial Energy Code Compliance

The Market Evaluation Team asked interview respondents what factors drive compliance with the commercial energy code in their jurisdictions. Respondents most commonly said code enforcement has the biggest impact on compliance. A respondent from the rural jurisdiction emphatically noted that it is *not* strong design professionals driving compliance. He said, instead, that the driving force in his area comes from customers. The local Wal-Mart, he explained, recently updated its lighting system because the corporate office understood the cost savings associated with increased efficiency. He noted that "Some people are doing the math [for potential cost savings] and making upgrades if they see the benefits." A New York City respondent said code compliance is also driven by the importance of maintaining professional integrity.

Impact of Code Updates on Compliance Rates

The Market Evaluation Team asked interviewees to assess the impacts of an energy code update (moving from one version of an energy code to the next) on compliance rates in NYS. The Team presented the Delphi Panel study's estimate of 9% as the expected drop in compliance within the first year of implementing a new energy code, and the respondents agreed that the Delphi Panel estimate sounded reasonable. One noted that the drop would only last for the first project or two, and once they had worked through the process a couple of times, compliance would return to its usual level.

A rural respondent said that, while the decrease is reasonable, the change in compliance is based on the code changes themselves; when the 2010 code was released, he noted, the drop in compliance was noticeably large (perhaps as much as 20%) due to the extensive nature of the code changes. He observed that code changes in more recent iterations were less extensive, which made them easier to follow and obtain compliance.

Compliance in the Residential Building Market

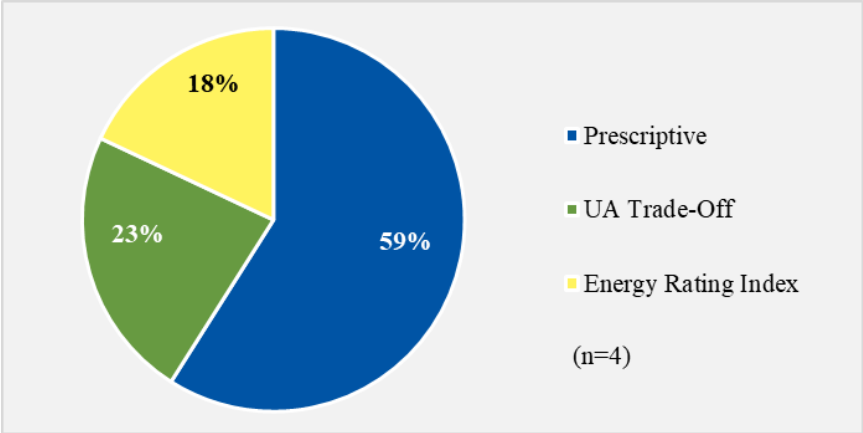
The Market Evaluation Team asked the four interviewees with residential building expertise to estimate the percentage of new construction permitted using several compliance methods:

- Prescriptive
- Total UA Alternative (R402.1.5)
- Simulated Performance Alternative (R405)
- ERI Compliance Alternative (R406)
- Others, as specified by the interviewees

Figure 7 shows that interviewees estimated 82% of projects are permitted using a prescriptive compliance option and less than 20% of projects are using a performance alternative. This estimate is consistent with the Delphi Panel estimate that 86% of residential new construction is permitted using a prescriptive compliance option.

Figure 7. Residential New Construction Compliance Paths

Source: Jurisdiction Interviews by Market Evaluation Team.



Two rural respondents who provided estimates said the prescriptive path is exclusively used in their jurisdiction to demonstrate compliance. A suburban respondent said their jurisdiction exclusively uses RES*check*. The final respondent (from New York City) noted a split of prescriptive and ERI compliance for most projects, with a small percentage using UA Trade-Off.

For additions and alterations, only one respondent provided a different response than those given for new construction; a New York City respondent stated that, for new residential construction, her organization uses ERI and prescriptive pathways to demonstrate compliance about 90% of the

time, but for additions and alterations, they use the UA Trade-Off for about half the projects and the ERI for the other half.

The Market Evaluation Team also asked respondents to estimate the percentage of new construction projects using RES*check* to demonstrate compliance: three of four said they use RES*check* to demonstrate compliance for all projects, while the fourth uses RES*check* for 50% of projects. This percentage is higher than the estimated use of the Total UA Alternative in Figure 7, likely because jurisdictions are also using RES*check* as a prescriptive checklist.

Residential Compliance Rate

When asked about residential single-family new construction, respondents considered the Delphi Panel study's unweighted estimate of 71% overall compliance as too low.[14] One code official from the rural jurisdiction noted that, in his opinion, residential code compliance is easier to achieve than commercial code compliance and the estimate should be at least as high as commercial (84%). A respondent from the suburban jurisdiction who also indicated that the estimate is low said he could only reference his own experience building in the residential sector and could not comment on the building practices of others. Another suburban respondent, however, noted that the energy code for residential projects is "loosely regulated" and compliance might be that low if the requirements are thoroughly considered.

The Market Evaluation Team then asked interview respondents to consider Delphi Panel study findings regarding which main categories of the residential energy code (building envelope, mechanical systems, electrical power and lighting, and documentation) had the highest and lowest compliance rate in single-family new construction. The Delphi Panel estimated building envelope compliance as the highest (80%), followed by compliance for electrical power and lighting

[14] The Team presented the average, unweighted response from the Delphi Panel to interview respondents for comparison. The weighted compliance rate for single-family residential new construction is 77%, approximately 6% higher than the unweighted estimate.

systems (79%), mechanical systems (69%), and documentation (59%). Interview respondents generally agreed with the Delphi Panel study findings, offering feedback:

- One suburban respondent considered that lighting compliance is likely lower, saying there are "still a lot of incandescent bulbs out there," and that he has never seen a code inspector care about verifying lighting.
- Alternatively, a rural respondent said he considered lighting as generally easiest to comply with, and agreed that mechanical systems are often more complex and likely have lower compliance.
- Another suburban respondent agreed that the building envelope reaches compliance more frequently than the mechanical systems, given the additional "fine print" associated with mechanical systems that makes compliance harder to achieve.

The Team also asked interview respondents to consider overall compliance for low-rise residential (low-rise multifamily) projects; only two respondents had experience with such projects.[15] One rural respondent explained that low-rise residential developers in his area make little to no effort to comply with the code, and he found the Delphi Panel study estimate of 73% too high. The other respondent receives grant money for her New York City low-rise multifamily projects and said compliance is heavily regulated as a result.

The Team asked the four interview respondents who worked on residential addition and alteration projects to consider the unweighted Delphi Panel study estimate of 67% overall compliance.[16] One respondent (a rural code official) said that compliance should be the same for additions and alterations as for new construction, since everything is inspected. The other three respondents

[15] Low-rise residential buildings are defined as a building, other than a hotel/motel, that is Occupancy Group: R-2 multi-family, with three stories or less; R-3, single family; or U-building, located on a residential site.

[16] The Team presented the average, unweighted response from the Delphi Panel to interview respondents for comparison. The weighted compliance rate for additions and alterations is 71%, approximately 4% higher than the unweighted estimate.

said the estimate is reasonable and that they generally agreed that compliance is lower for these projects than for new home construction, providing commentary:

- One rural code official said he is often more lenient with additions and alterations than with new construction, resulting in lower compliance for measures not prioritized during plan review and inspection.
- Another rural code official said addition and alteration projects likely achieve lower compliance because air leakage testing is not required in their jurisdiction.
- A New York City building company respondent explained that compliance is more challenging for alteration projects because the scope of the energy code does not clearly define the requirements: "From a codes perspective, you switch to the alterations section and you're not even sure which requirements from new construction apply. There is a lot of interpretation in alterations. Compliance is more difficult, and then the definition of compliance is hard… From defining what you have to do to completing it, everything is more difficult with an alteration." The same respondent noted, however, that these issues are not as prevalent for additions as they are for alterations, as code language regarding addition projects is more straightforward.
- A rural code official said his area has many antiquated systems in homes receiving additions or alterations, affecting the ease and affordability of achieving full compliance.
- Conversely, a rural builder found the Delphi Panel study estimate a little low, emphasizing that, "Whether new or building on to something, you definitely try to comply with everything. You have to because it is inspected."

Interview respondents also considered the residential code requirements that the Delphi Panel study gave low compliance rates (such as for mechanical equipment sizing, duct testing, air sealing, recessed lighting, documentation requirements, and fuel-burning appliance room requirements) or high compliance rates (such as programmable thermostats, vapor retarders, window/door U-factors, and duct insulation).

Respondents provided observations about measures the Delphi Panel estimated to have low compliance rates:

- One rural code official said that achieving required U-factors on fenestration poses a large challenge that affects compliance. He agreed that compliance is low for air

sealing, and added that compliance is likely low for rigid foam insulation and blown-in insulation as well.

- Another rural code official agreed that mechanical sizing is the most difficult, which might lower compliance. He also said his area has many manufactured homes that were manufactured elsewhere, so building standards are difficult to control.[17]
- Another rural community respondent said the Panel had a reasonable assessment of the requirements with the highest compliance difficulty.

Respondents provided observations about measures the Delphi Panel estimated to have the highest compliance rates:

- A rural community respondent said many of the items identified by the Delphi Panel as having high compliance rates, such as programmable thermostats and windows and doors, are compliant upon purchase from the manufacturer, and that a builder would have to seek out noncompliant products for these measures.
- Another rural community respondent agreed about thermostats and other prefabricated measures, but considered compliance with duct insulation as more of a challenge.
- A suburban community respondent said programmable thermostats and windows and doors have consistently high compliance rates because manufacturers and distributors generally carry whatever is required to comply with code.

Challenges to Residential Energy Code Compliance

When asked, interviewees identify several challenges to residential energy code compliance within their jurisdiction:

- Lack of educated contractors
- High prices for code compliant materials (such as windows and doors)
- Meeting blower door test requirements
- Finding time and money to learn new techniques to keep current with code changes
- Increased building costs

One contractor working in the rural jurisdiction said his area has a large low-income population and, for certain types of equipment, manufacturers increase prices beyond affordability out of

[17] Though not regulated by state code, manufactured homes fall under federal regulations, which should be enforced at manufacturing plants.

greed, pricing them beyond what local residents can afford. Another rural code enforcement officer said that, during inspections, he often encounters older, non-compliant windows and doors purchased at auction by contractors because of their affordability.

To pass blower door tests, which had been an issue for his company a few times, a suburban respondent said they learned approaches to pass the test, but learning those lessons took time and money, and might pose barriers for others—particularly for smaller builders.

Respondents had several suggestions for activities or types of support that would have the greatest impact on increasing residential building energy code compliance:

- Increase training for code officials:
  - "Code officials getting trained and passing it on."
  - "Education. Synchronizing how building officials view the energy code… as connected with life and safety."
  - "A lot of small towns, those inspectors are only part time. How do you get them into a classroom when they are busy and only have so much time to spend on the job?"
- Provide training targeted to builders and architects: "I would like programs for builders to learn and [get] an incentive for [going to training events]."
- Provide financial incentives for builders and homeowners: "Economy-wise, pricing is what is taking out the energy-efficient stuff [from projects]. Materials and equipment are not affordable."
- Garner state support for smaller towns: "The state is pushing a lot of cost mandates to town- and county-level government—[the towns] are trying to make ends meet without taxes going up. Where does the money come from?"

Factors Driving Residential Energy Code Compliance

The Team asked three interview respondents who are familiar with the residential energy code what factors drive compliance with the residential energy code. As with commercial compliance, respondents most commonly emphasized that enforcement drives residential compliance, but had additional feedback:

- A suburban builder explained that when achieving a higher efficiency level was voluntary, few customers chose to spend more to achieve those higher levels. He noted that many homebuyers like the idea of meeting a certification standard (such as ENERGY STAR), but it often costs a few thousand extra dollars to "achieve that

sticker." While people are interested in the benefits offered by higher standards, their overall behavior is motivated by cost.

- A building company respondent from the suburban jurisdiction said customers drive code compliance, particularly for owner-occupied projects. He said developers may not care about code as much, but customer demand drives overall builder compliance, as does the company's desire to appeal to customer preferences.

Impact of Code Updates on Compliance Rates

The Market Evaluation Team asked interviewees to assess the impact of a new energy code on residential compliance rates in NYS. The Team provided respondents with the Delphi Panel study estimate of a 9% expected drop in compliance within the first year of a new energy code's implementation. Three of four respondents with residential energy code experience agreed that the Panel estimate sounded a little low, with the final respondent saying the Panel estimate sounded about right.

The three who considering the estimate low explained why the Panel study underestimated the drop in compliance. One respondent from a suburban community said that overall state numbers are affected by smaller communities, which would experience a more significant drop. He noted that smaller communities in the state still do not know how to comply with or enforce a new code that was adopted two years ago.

A rural area respondent agreed, noting that whenever the energy code is updated, it costs him (as a code official) several hundred dollars for a new set of books. He said contractors and engineers do not purchase a copy and, if they did, the code is not written for small town contractors to understand. In smaller communities, he noted, many contractors are just "any guy with a hammer and a truck," and that "the more complex the code gets, the fewer the number of people who understand it."

Energy Code Enforcement

Through the in-depth interview process, the Market Evaluation Team also gathered information on energy code enforcement practices and challenges in respondents' jurisdictions. Respondents discussed how codes are enforced within each jurisdiction, any alternative code enforcement structures, and the types of jurisdictional support needed to improve energy code enforcement.

Energy Code Enforcement Practices

Interview respondents described how the energy code is enforced within their jurisdictions. Most said their projects undergo thorough plan reviews and site inspections (eight of nine), with the final respondent, a builder from the rural jurisdiction, saying a code official has never required a plan review or inspection for any of his projects.

A rural code enforcement officer explained that while he always requires RES*check* or COM*check*, he generally relies on the plan review and the site checks; a New York City respondent from an architect firm agreed: "COM*check*… does not tell much more about how the building will perform. It may be a checklist, but all the data you have to put in is what percent[age] of walls are what R-value, how many windows you have…. you can show that in the drawings."

Inspection practices vary by jurisdiction as well as within each jurisdiction. New York City respondents described inspections as being thorough, provided by trained and knowledgeable professionals, and occurring regularly throughout the project. A builder from the suburban jurisdiction noted that, for large projects, site inspections require more time from inspectors than they can afford to ensure that all details are in compliance, and the inspectors often do not catch all the issues (such as ensuring that all exterior walls are properly sealed). Instead, his jurisdiction more often relies on builder-provided test results (such as air leakage test results) because it takes much less time for inspectors to review documentation than to conduct inspections. Another suburban builder respondent noted that enforcement varies by inspector, where some inspectors are professional engineers who pay close attention to all aspects of the energy code, while others are part-time construction workers who are less interested in the details.

Challenges to Energy Code Enforcement

Respondents shared what they considered the most significant challenges facing residential and commercial energy code enforcement. Responses generally fell into three categories:

- Staffing limitations:
  - "The biggest thing is that municipalities can't hire 15 inspectors to just walk around and inspect every single item. It is too much."
  - "The bigger challenge is with part-time inspectors. They just don't have the support or resources that people in the city have."

- Financial limitations:
  - "People financially just don't want to spend the money."
  - "It would be a giant expense to everyone. Trying to inspect every single house would be a huge problem. It's costly [to do the inspections] and people don't want inspections."

- Lack of education:
  - "… [the biggest challenge is that] special inspectors aren't trained or don't care, [or don't have the] education and interest."
  - "People don't think it's important. There is not enough education."
  - "A lot of our homebuilders think things are too complicated, so they revert back to their old methods. [The challenge is] trying to convince some of these builders who have been doing this for a while that there is a better way."

Overall, respondents think the energy code proves challenging to enforce and that the quality of energy code enforcement generally relies on the enforcement office having sufficient time for the building code's energy-related aspects and having enough education and experience with energy code requirements to operate effectively.

Alternative Energy Code Enforcement Structures

Eight of nine respondents said they do not use alternative energy code enforcement strategies in their jurisdiction. The final respondent, a suburban interviewee, said the city and neighboring communities sometimes outsource certain aspects of enforcement to third-party professionals; this includes occasionally hiring architecture or engineering firms to assist with the permit review process. The review is beneficial, he explained, because it is conducted by someone who knows what documentation the jurisdiction requires. He also noted that, during construction, a building envelope consultant inspects and verifies that the construction company followed the building plans correctly.

One suburban respondent stated that, while they have not seen remote inspections in practice, the possibility is interesting because this would allow code officials to provide timely inspections more efficiently (and may prove useful in situations like the current coronavirus pandemic, where site visits are prohibited in many states).

Another respondent (from New York City) is interested in the possibilities offered by outcome-based compliance tools (such as a utility bill enforcement aspect, where, for example, if a

building does not reach the efficiency level outlined in the plan, the construction company would have to return to fix identified issues). The respondent said this would be a great way to enforce the plans being followed correctly, but that it might be complicated to identify such issues after construction.

Jurisdictional Viewpoint on Alternative Enforcement Structures

Three respondents discussed which factors are most appealing to their jurisdictions when considering an alternative code enforcement structure:

- A respondent from the rural jurisdiction noted that staff capacity is important, so an enforcement structure that relieves or consolidates code enforcement officer responsibilities would be ideal.
- Another rural code enforcement officer would be interested in simplified code enforcement using online tools or other digital resources. This respondent also discussed the importance of having a network of knowledgeable resources, expressing interest in county-level enforcement or some other form of resource sharing. Due to staffing limitations, he does not have other code enforcement staff in his office to discuss issues with, and instead relies on relationships with code officials from nearby jurisdictions to confirm decisions and code interpretations. He explained that these relationships prove key in smaller towns, where it can take four or five days to receive a second opinions from the state.
- A suburban community respondent said most upstate New York economies are not doing as well as city economies, making it difficult to meet enforcement needs in such areas. He said there are too few financial resources available for upgrading or changing the current methods of enforcement, and recognized an opportunity for county-level enforcement, which would allow for hiring full-time experts (a luxury that not all towns can afford) and would increase specialization with the energy code. The respondent noted that Washington County has a county-level building department, largely because the county is so rural that little applicable activity occurs, and said that such a model might benefit rural areas in general.

Stretch Energy Code Adoption in New York State

NYStretch is a voluntary, locally adoptable stretch energy code and is approximately 19% more efficient than residential provisions of the 2018 IECC and roughly 7% more efficient than the

commercial provisions of ASHRAE 90.1-2016. NYStretch is also more efficient than the 2020 ECCCNYS (effective May 2020).

Naturally Occurring Market Adoption Rate of Stretch Codes

To establish a baseline forecast of the naturally occurring market adoption rate of stretch codes, the Delphi Panel respondents estimated the likely adoption rate by NYS jurisdictions from 2019 to 2030. For the survey, panelists considered the NYS market only and provided estimates that represent current market factors, assuming that no market intervention takes place.

The Market Evaluation Team asked respondents to consider the Delphi Panel study finding, which suggested that, by 2030, 26% of jurisdictions would voluntarily adopt a stretch code (without support or encouragement from the state, NYSERDA, or other entities). While some considered their region uninterested (particularly in the rural jurisdiction), most agreed that, for the state overall, the Panel study estimate provides an accurate assessment. Two respondents, one from a rural area and one from a suburban community, said the estimate is a little high without an incentive to encourage adoption.

Stretch Energy Code Adoption Challenges

In discussing stretch code adoption, particularly why jurisdictions have not adopted and might not be interested in adopting a stretch code, respondents discussed challenges with implementing or enforcing more stringent local energy codes. Respondents from a rural community said there is no political interest for such changes in their area: “Adopting new legislation is a non-starter; there is no political appetite. I personally don’t think a more stringent energy code is beneficial to the people we’re trying to help… the term ‘unfunded mandate’ is used a lot.”

Rural jurisdiction respondents said residents and builders in their area are intimidated by the idea of more regulation around meeting the energy code, and said residents would be more likely to buy a modular home than to build a new single-family home, just to avoid the extra costs associated with meeting the energy code.

Another respondent (from a suburban community) said the main issue their jurisdiction faces is a lack of knowledge, including how to address cost issues. This respondent noted that some areas (such as Ithaca) have taken innovative approaches to reduce greenhouse gas emissions in new

buildings,[18] and had the impression that incentives are available to help make such actions feasible (three respondents—two rural and one suburban—brought up Ithaca as an example community that is implementing more stringent code). The respondent noted that, as codes have become more stringent, he needs to go beyond his currently practices and is intrigued how other jurisdictions surpass current minimum requirements.

Stretch Energy Code Support for Interested Communities

When asked what support would be most helpful for jurisdictions that are interested in adopting a stretch code, respondents generally agreed that two key issues would need to be addressed: education and incentives:

- "Many of the engineers aren't aware of some of the trade-offs or alternatives."
- "Training about how to apply the code. It would be nice to understand the relationship between envelope and air tightness so you can right-size your mechanical systems."
- "For a design professional, [we need] resources showing 'how'—the details of what would be required to comply with a stricter code. Figuring out how to sell it to a client that this is the right thing to do."
- "The approach of getting [jurisdictions] to mandate [a stretch code] is not going to work. If they want jurisdictions to do it, give homeowners an incentive. That will drive change."

Advanced Technologies

Another goal of the in-depth interviews was to evaluate the presence of new or advanced strategies or technologies in the respondents' jurisdictions that are not yet incorporated into the current ECCCNYS or NYStretch.

When asked to identify new or emerging technologies, four respondents identified at least one measure they had seen implemented within their jurisdictions or had observed elsewhere and would like to see included in future energy codes:

- Passive house modeling (passive house planning package modeling)
- Heat pump water heaters

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[18] See information on the Ithaca Energy Code Supplement online: http://www.ithacagreenbuilding.com/

- Geothermal heat pumps
- Intelligent thermostats and other remote energy-controlling devices (particularly for second homes)
- Advanced framing technologies
- Triple-paned windows and other high insulation levels for fenestration
- Solar panel arrays (and the necessary structural updates to accommodate them)
- Walkability or access to public transportation

Others said that, although their jurisdictions are not currently implementing new or innovative technologies, they are interested in learning of new techniques, as long as education about implementation is included.

Respondents also identified several challenges in implementing new and emerging technologies or advanced building strategies in their jurisdictions:

- Resistance to change:
  - "Builders are not wanting to change their ways."
  - "Resistance to change—[natural] gas furnaces are cheap, easy to get, and people know how to use them."

- Resistance to mandated technologies that raise new construction costs in low-income areas and create general affordability issues:
  - "Big companies make a lot of money, but then [there are] these people [local residents] who have their properties that have to listen to them and are not being compensated properly. Wealth isn't being spread."
  - "The issue is affordability and education."

- Issues of overall costs:
  - "It is a big price jump between double- and triple-paned windows."
  - "Financially, incentives would help."
  - "Just cost; cost is the big thing."

- Lack of demand from customers:
  - "There is no demand from residents in the community."
  - "Clients don't understand the value."

- Lack of skilled installers:
  - "It is just finding skilled installers who really know the technology."
  - "[For heat pump water heaters] it is hard to find contractors to do the work."

A respondent from the rural jurisdiction noted that staff capacity is the most important factor when determining if a new or innovative strategy can be implemented.

Another respondent noted that, for more rural communities like his own, regulation (such as a more stringent code) or advances in technology would have to be introduced to the community through the community, and suggested involving the local utility or another recognizable local institution to accomplish such: "It would help if the utilities walked in and introduced themselves and the program; it could get them (residents) on board without forcing people. Just say, 'Hey, we've got a program going on that will help disperse this a little bit into the area, and I know the economics are a little slower, but we can help you with that.' I think you'd get a better response from that than the county or the whole state saying, 'you have to do this.'"

Definitions Provided to Interviewees

Compliance rate. The average percentage of requirements that are in compliance.

NYStretch Energy Code– 2020. NYSERDA's latest voluntary, locally adoptable stretch energy code, which is approximately 19% more efficient than the residential provisions of the 2018 IECC and 7% more efficient than commercial provisions of ASHRAE 90.1-2016.

Overall compliance rate. The average percentage of requirements that are in compliance for the entire building.