CONSORTIUM for BUILDING ENERGY INNOVATION

REPORT

Title: Improving Code Compliance Phase 2 – Implementation Tools, Training and Stakeholder Development

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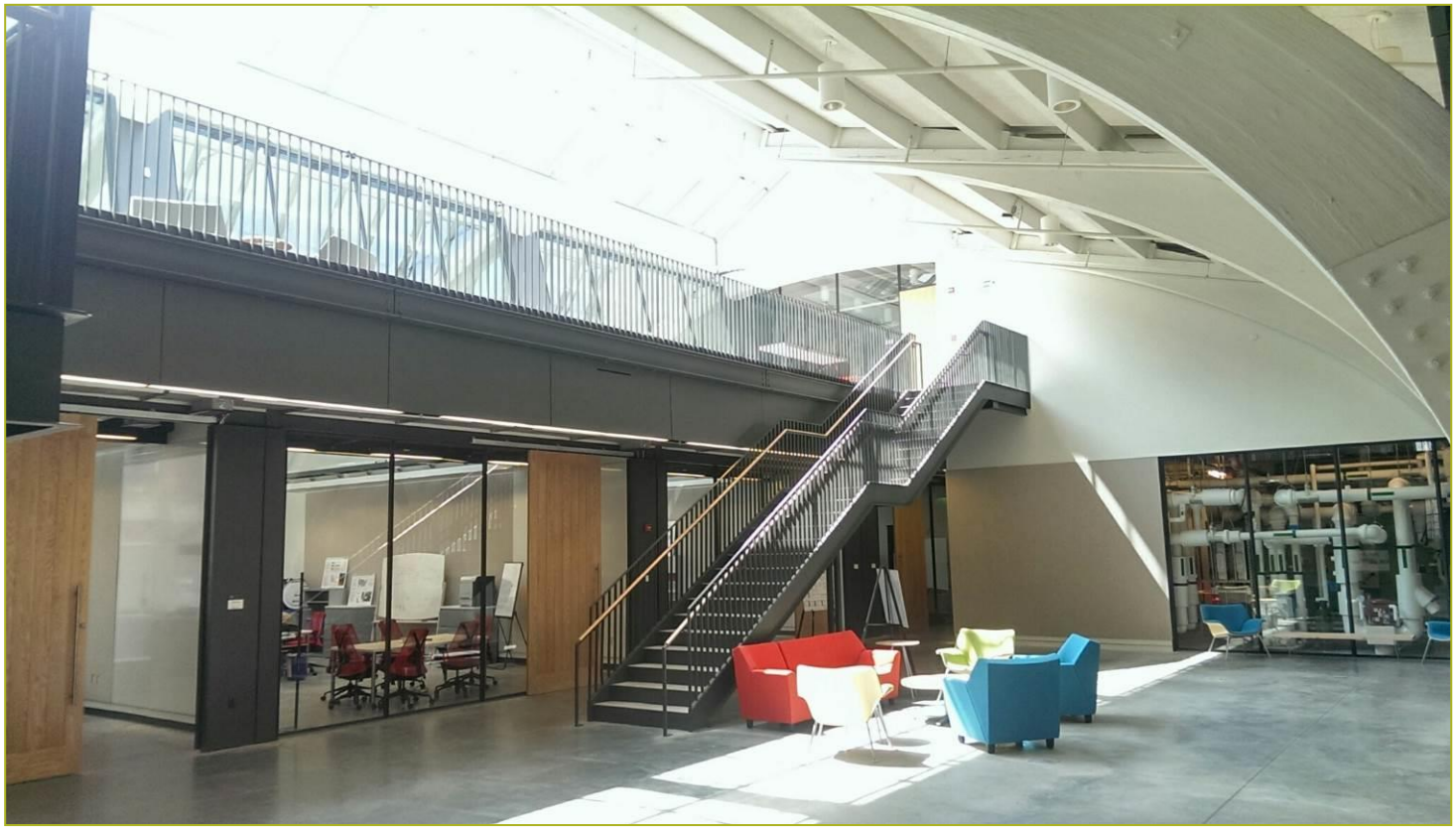

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Report Abstract

The objective of this project was to prepare a change of occupancy code change for the IECC (Section C505) and lay the groundwork for its eventual implementation. This objective has been accomplished in developing and submitting a code change proposal (CE 292-16) for consideration at the ICC Committee Action Hearings, testifying on this proposal at the Committee Hearings, and establishing the basis for its passage at the forthcoming ICC Public Hearings (Kansas City, October 2016). The code change, reason statement and implementation guidance have been refined in an iterative manner with stakeholders throughout the project timeline. Additional successes of this project include the very robust manner in which the proposed code has been socialized and gained acceptance, and the present consideration of its adoption by the jurisdiction of Washington, D.C.

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Footnotes now display for Table C505.3.1 and C505.3.2.

CE292-16

IECC: , C505.1, C505.2 (New), C505.2.1 (New), C505.2.2 (New), C505.3 (New), C505.3.1 (New), C505.3.2 (New), C505.3.3 (New).

Proponent : Jennifer Senick, Rutgers University, Center for Green Building, representing Rutgers University, Center for Green Building (jsenick@rutgers.edu)

2015 International Energy Conservation Code

Revise as follows:

C505.1 General. Spaces undergoing a change in occupancy ~~that would result in an increase in demand for either fossil fuel~~ from a F,H or ~~electrical energy~~ U occupancy to any other occupancy classification shall comply with this code. ~~Where the use in~~ Other spaces undergoing a ~~space changes from one use in Table C405.4.2(1) or C405.4.2(2) to another use in Table C405.4.2(1) or C405.4.2(2), the installed lighting wattage~~ change of occupancy shall comply with Sections C505.2 and C505.3. *Alterations* made concurrently with the change of occupancy shall be in accordance with Section ~~C405.4~~ C503.

Add new text as follows:

C505.2 Loads. Lighting loads and ventialtion shall comply with Sections C505.2.1 and C505.2.2.

C505.2.1 Lighting Wattage. Where the use in a space changes from one use in Table C405.4.2(1) or C405.4.2(2) to another use in Table C405.4.2(1) or C405.4.2(2), the installed lighting wattage shall comply with Section C405.4.

C505.2.2 Ventilation. Where the use in a space changes from one use to another as listed in Table 403.3.1.1 of the *International Mechanical Code* (IMC) the ventilation rate provided shall be as specified for the new occupancy in the IMC.

C505.3 Energy Intensities. Where a change of occupancy or use is made to an existing building that results in an increase in energy intensity classification as specified in Table C505.3.1, C505.3.2 or 505.3.3, the building or portion thereof shall comply with Sections C505.3.1 through C505.3.3 respectively that are applicable to the new occupancy and use. Where changes in occupancy and use are made to portions of an existing building only those portions of the building shall comply with Sections C505.3.1 through C505.3.3 as specified herein.

Exceptions:

1. Where it is demonstrated by analysis *approved* by the *code official* that the change will not increase usage of fossil fuel or electrical energy.
2. Where the occupancy or use change is less than 5,000 square feet in area.

C505.3.1 Space Heating, Cooling and Ventilation.
Where the change of occupancy or use results in an increase in energy intensity classification as specified in Table C505.3.1, the building or space undergoing the change shall comply with Section C402 and C403 applicable to the new occupancy and use. Where a change of occupancy or use is made to a whole building that exceeds the maximum fenestration area

allowed by Section C402.4.1, the building shall comply with Section C402.1.5

Exception:
Where the change of occupancy or use is made to a portion of the building, the new occupancy is exempt from Section C402.4.1 provided that there is not an increase in fenestration.

TABLE C505.3.1
Space Heating, Cooling and Ventilation.

Energy Intensity Classification	IBC Occupancy Classifcation and Use
1. High	A-2, B-Laboratories, I-2
2. Medium	A-1, A-3[a], A-4, B[b], E, I-1, I-3, M, R-4
3. Low	A-3-Places of Religious Worship, R-1, R-2, S-1, S-2

a. Excluding places of religious worship.
b. Excluding laboratories.

C505.3.2 Lighting Where the change of occupancy or use results in an increase in energy intensity classifcation as specified in Table C505.3.2, the building or space undergoing the change shall comply with Section C405 applicable to the new occupancy and use except for Section C405.5.

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TABLE C505.3.2
Lighting

Energy Intensity Classification	IBC Occupancy Classifcation and Use
1. High	A-2, B-Laboratories, I-2, M-Food Sales
2. Medium	A-3-Courtrooms, B[c], I-1, I-3, M[b], R-1, R-2, R-4, S-1, S-2
3. Low	A-1, A-3[a], A-4, E

a. Excluding courtrooms.
b. Excluding food sales.
c. Excluding laboratories.

C505.3.3 Service Water Heating. Where the change of occupancy or use results in an increase in energy intensity classification as specified in Table C505.3.3, the building or space undergoing the change shall comply with Section C404 applicable to the new occupancy and use.

TABLE C505.3.3
Service Water Heating

Energy Intensity Classification	IBC Occupancy Classifcation and Use
1. High	A-2, I-1, I-2, R-1, R-4
2. Low	All other occupancies and uses

Reason: The IECC 2015 change of occupancy requirement states (C505.1):

"Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code."

Field research and surveys of building officials demonstrate that this requirement is not widely enforced. Once reason for this is that while it is a clear performance requirement, there is no simple compliance evaluation method other than energy modeling, which is beyond the capabilities of most change of occupancy permit applicants. Another is that there is an inconsistency between the IECC Commentary on this requirement, which interprets energy demand as peak energy demand, and the intent of the IECC, **C101.3 Intent**: "This code shall regulate the design and construction of buildings for the use and **conservation** of energy over the life of each building" (emphasis added). Peak energy demand does not necessarily correlate with energy use. In our experience, building officials often require energy efficiency equipment upgrades, such as lighting or HVAC, in change of occupancy.

This proposal advances intensity per square foot as the metric for energy demand and the trigger for code compliance. Historic energy intensity per square foot is recorded for commercial buildings in the Commercial Buildings Energy Consumption Survey (CBECS) and the Building Performance Database (BPD), for residential buildings in the Residential Energy Consumption Survey (RECS), and for industrial buildings in the Manufacturers Energy Consumption Survey (MECS). These databases make it possible to rank building occupancies in the order of their energy intensities. Note that the ranking of occupancies to trigger specific code requirements has been a feature of the IEBC since its first edition (see IEBC 2015 Section 1012, Change of Occupancy Classification, Tables 1012.4, 1012.5 and 1012.6), and thus is familiar to building code officials.

Energy intensity data is further broken down by various end uses, as suggested by current enforcement practices: space conditioning, lighting, and water heating, which makes it possible to trigger code compliance of specific sections of the IECC by an increase in intensity for the use regulated by those sections. Only an increase in energy intensities in all three of the end uses triggers full compliance with the code.

There are ventilation requirements in the IMC and lighting wattage requirements in the IECC that are triggered by occupancy changes that do not correspond exactly to the energy intensity order of occupancies. The requirements are preserved by Section 505.2 of the proposed code change respectively.

There are two exceptions that apply to all three end uses:

C505.3 Exception 1 allows the applicant to demonstrate by analysis that the specific change will not increase energy intensity.

C505.3 Exception 2 provides an area limitation as a consideration of fairness to smaller applicants.

Three exceptions apply to specific end uses:

C505.3.1 Exceptions 1 and 2 address specific fenestration requirements.

C505.3.2 Exceptions excludes exterior lighting.

A matrix has been developed for each end use that displays a scale fo 2-3 groups in descending order from high to low energy intensities, measured in annual kBTU/ft2 (Tables 1-3). Within these scales are grouped CBECS building types and the corresponding International Building Code (IBC) occupancy classifications. Data sources for this analysis included primarily U.S. Department of Energy's CBECS 2003 and 2012 (aspects), BPD 2015, and RECS 2009. It w as decided to include F, H and U occupancies in the code change proposal. An analysis of the 2010 Manufacturing Energy Consumption Survey (MECS) show ed that many industries in these occupancy classifications could be classified in the low energy intensity categories, some w ere higher. How ever, since F, H and U buildings are not designed primarily for occupant comfort and safety, it w as decided that a change from F, H and U to any other occupancy should comply w ithe code.

Table 1. Change of Occupancy Scale - Space Heating, Cooling, and Ventilation

	CBECS Building Type	EI Range kBTU/sq.ft.	IBC Occupancy Classification
1. High	Health Care (Inpatient), Food Service, Laboratories	Above 75	A-2, B-Laboratories, I-2
2. Medium	Public Assembly, Education, Public Order and Safety, Office, Service, Health Care (Outpatient), Retail, Residential Care/Assisted Living	34-75	A-1, A-3, A-4, B, E, I-1, I-3, M, R-4
3. Low	Religious Worship, Lodging, Apartments, Warehouse and Storage	0-33	A-3-Places of Religious Worship, R-1, R-2, S-1, S-2

Table 2. Change of Occupancy Scale - Lighting

	CBECS Building Type	EI Range kBTU/sq.ft.	IBC Classification
1. High	Health Care (Inpatient), Food Sales, Food Service, Laboratories	Above 31	A-2, B-Laboratories,I-2, M-Food Sales
2. Medium	Retail, Lodging, Office, Health Care (outpatient), Public Order and Safety, Service, Lodging, Apartments, Residential	13-31	A-3-Courtrooms, B, I-1, I-3, M, R-1, R-2, R-4, S-1, S-2

	Care/Assisted Living,Warehouse and Storage		
3. Low	Public Assembly, Religious Worship, Education	0-12	A-1, A-3, A-4, E

Table 3. Change of Occupancy Scale - Water Heating

	CBECS Building Type	EI Range kBTU/sq.ft.	IBC Occupancy Classification
1. High	Food Service, Health Care (Inpatient),Lodging,Residential Care/Assisted Living	Above 15	A-2, I-1, I-2, R-1, R-4
2. Low	All the rest	0-15	All the rest

The concept for this code change proposal was presented at the 2015 DOE Energy Code Conference in Nashville and at two annual codes conferences organized by NEEP. It has benefited from extensive reveiw and feedback from numerous building officials in multiple states, other stakeholders participating in SEHPCAC and from technical reviewers at CBEI.

This code change has been developed withe support from the Consortium for Building Energy Innovation (CBEI), a project of the U.S. Department of Energy.

Cost Impact: Will not increase the cost of construction
The current code requirement triggers full compliance with the code when there is an increase in energy demand. The proposed code change offers the metric of energy intensity per square foot per year for measuring energy demand by occupancy. It applies this metric separately to three energy end uses: space conditioning, lighting, and water heating. Therefore, compliance with the code is triggered only for the end uses for which energy intensity is increased.

In most cases, the proposed change triggers partial code compliance, and only rarely will it trigger full code compliance.

CE292-16 : C505.1-SENICK12379

Implementation Strategy and Dissemination

Rutgers approach to its change of occupancy code change proposal to the ICC (CE 292-16 referring to IECC Section C505.1) entailed a great emphasis on outreach and research activities focused on how best to implement it. The team solicited implementation advice to help inform eventual implementation, employing this information strategically to better position the proposed code change during the adoption process. Results of our implementation strategy and dissemination activities are reflected in the final code change proposal, reason statement and cost statement submitted to the ICC (January), as amended in consultation with ICC staff for added technical/format clarity (February), and guided our approach to testimony at the ICC Committee Action Hearing for the commercial energy code (April). Throughout the project, the team market-tested through near constant iteration with a broad set of stakeholders various implementation approaches to the code change. Within BP5, we made formal presentations of this work at the NEEP Leadership Meeting (October 28), DOE National Energy Codes Conference in Tucson (March 21-24) and at the American Planning Association National Conference (April 2-5), and testified as proponent and in support at the ICC Committee Action Hearings in Louisville, Kentucky, Track 2 (April 22-27). While the proposed code change did not pass (the Committee voted 7-5 against), much encouragement was offered by members of the Committee and other stakeholders to bring a revised version to the floor of the upcoming Public Hearings in Kansas City (October 2016). Notably, several major jurisdictions are in favor of this proposal including Seattle and NYC (who voted in favor of it via their representation on the CECDC (Commercial Energy Code Development Committee) and also Washington, D.C., considering its adoption now (without waiting for the outcome of IECC 2018). Additionally, a consultant (and ex ICC staffer), representing the Illinois State Energy Office and Illinois building code officials, testified strongly in favor of our proposed code change and has offered to continue to help with its passage. The proposed code change also garnered industry support with testimony in favor from the Edison Electric Institute, while NAHB (National Association of Home Builders) and BOMA (Building Owners and Managers Association) maintained a neutral position on it.

<u>Stakeholder Informed Implementation Strategies for the Code Change</u>

The BP5 project built on stakeholder outreach/feedback including field research, interviews, questionnaires and several formal presentations in BP4, adding to these interactions with: building code officials; consulting energy and building code organizations; professional organizations; industry participants; and with the ICC (Sustainability, Energy & High Performance Building Code Action Committee, (SEHPCAC), Whole Code Committee and the Commercial Energy Code Development Committee (CECDC)). Additionally, we made numerous formal presentations and gained stakeholder feedback in these venues (Table 1). The submitted code change proposal reflects advice proffered by these participants and especially SEHPCAC members, with whom we worked for a period of many months in BP5 (Figure 1). In many cases, we employed a method known as snowball sampling, requesting ICC committee participants to introduce us or refer us to their peers in various jurisdictions, organizations, companies and ICC chapters in order to expand dissemination of this work. As a result of this process, we gained broad support for the proposal, which was reflected at the ICC Committee

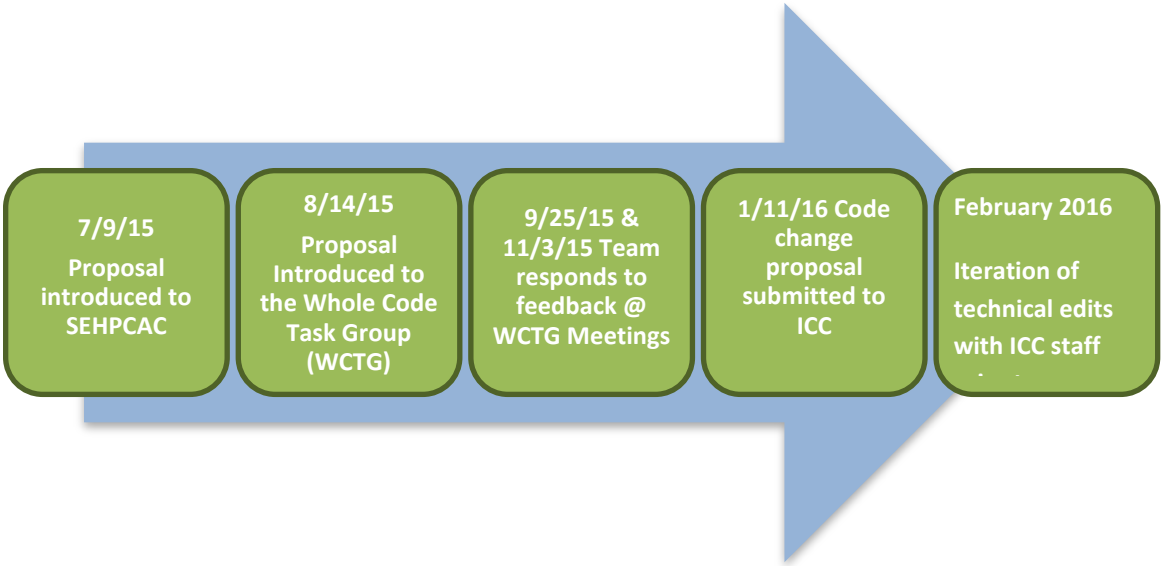
Action Hearings where some of these stakeholders testified in support of the proposal and others voted in favor of it. Examples of changes that have resulted from these interactions and which would impact eventual implementation of the proposed code change include the following:

- Inclusion of multi-family uses in the EUI tables of the proposed change of occupancy provisions, with appropriate reference language to RECS (Residential Energy Consumption Survey).
- Inclusion of manufacturing uses in the EUI tables of the proposed change of occupancy provisions AND inclusion of a requirement that all F, H, and U uses (industrial, high hazard, and agricultural) must fully comply with the code.
- Reduction of threshold for exempting small projects from 10,000SF to 5,000SF.
- Elimination of repetition of exceptions for analysis and 5,000SF, and elimination of exterior lighting exception.

Table 1: Stakeholder Activities in BP5 (n = 450)

	Code officials/ consultants	Energy organizations	Code organizations	Professional associations/ Industry
	Formal presentations: n ~ 350			
Proposal submission review	Denver, CO; Department of Consumer and Regulatory Affairs; Ellicot City, MD; Fairfax County, VA; Fort Worth, TX; Howard County, MD.; Idaho Circuit Rider Program; Lower Merion, PA; NJDCA; NYC Department of Buildings, Oklahoma Dept. of Commerce; Scottsdale, AZ; Seattle Dept of Planning and Development; Upper Merion, PA; Virginia State Fire Marshal's Office; Parker, CO; Washington, DC; West Chester, PA; Arliington, VA Survey respondents = 43 See also ICC Chapters n= 61	Edison Electric Institute; Energy and Resource Solutions; Florida Solar Center; Institute for Market Transformation (IMT); National Association of State Energy Associations (NASEO); New Buildings Institute (NBI); Northeast Energy Efficiency Partnerships (NEEP); Pacific Northwest National Laboratory (PNNL); Southeast Energy Efficiency Alliance (SEEA); Southwest Energy Efficiency Project (SEEP); Underwriters Laboratory, Urban Green Council, GSA n=13	Building Codes Assistance Project (BCAP); Energy Efficient Codes Coalition (EECC); Institute for Building Technology, and Safety (IBTS); NW Energy Codes Group; PA Construction Codes Academy; Pennsylvania Association of Building Code Officials (PABCO) ICC Government Affairs Sustainability, Energy & High Performance Building Code Action Committee (SEHPCAC) Whole Code Task Group Commercial Energy Code Development Committee (CECDC) NY Chapter Colorado Chapter Virginia Chapter n=12	AIA; American Architectural Manufacturer Association (AAMA); Associated General Contractors of America (AGC); Building Owners and Managers Association (BOMA); Carrier; Covestro (formerly, Bayer Material Science); DuPont; Leidos; K Hovnanian; National Assoc. of Home Builders (NAHB); National Electrical Manufacturers Assoc.(NEMA); National Fire Sprinkler Assoc.; National Institute of Building Sciences (NIBS); National Multifamily Housing Council; Plastic Pipe and Fittings Assoc.; RCI Inc. UTRC, Austin Energy. ERS n=19

Figure 1. Timeline of Interaction with ICC prior to Action Committee Hearings



Other Dissemination: Among other formal presentations, the code change was presented in a mock hearing format at the DOE National Energy Codes Conference 2016 in March in Tucson, Arizona (Senick, Hattis) and at the American Planning Association National Conference in April 2016 in Phoenix, Arizona (Andrews, Senick, Hattis). At these venues, we continued to seek input on recommendations regarding eventual implementation of the code change proposal. The Journal of the American Planning Association's (JAPA) Special Issue on Historic Preservation and Planning (impact factor: 1.556[1]) published an article by the team that covers this topic, *Energy-efficient re-use of existing commercial buildings* (DOI: 10.1080/01944363.2015.1134275)

Other Implementation Activities

1. Training Needs

Proper training of and collaboration with code officials is the key to success for building code enforcement, assisting also in their abilities to provide clear compliance guidance to applicants. Building code officials rightly view their jobs as protecting the public, so any provision that deviates from strict application of the building code or does not have a clear cut relation to public safety (i.e., the energy code) must be carefully articulated to the code official community. Adoption of Massachusetts Article 34, the New Jersey Rehabilitation Subcode, and the Maryland Rehabilitation Code (based on the *Nationally Applicable Recommended Rehabilitation Provisions*) offer some guidance with respect to

[1] http://www.journal-database.com/journal/journal-of-the-american-planning-association.html

effective outreach and training. In these cases an innovative approach to the regulation of existing buildings became effective through an aggressive and broad-based training program.

Over the course of this project, we have researched cities and states that already use the IECC for existing commercial buildings, especially those that could be considered progressive in their adoption of building codes. A number of organizations track code adoption (e.g., the ICC, BCAP-ACEEE, IMT). In many cases, we found overlap between these jurisdictions and those already represented in our stakeholder outreach above. Even in relatively advanced jurisdictions, we heard that there is an on-going need for training on the energy code[2]. Energy literacy, in particular, was deemed lacking.

In existing IECC training modules (by the ICC and other organizations), C505.1 appears as one sentence (without the commentary). We recommend that the more detailed, prescriptive guidance we have proposed in our code change should appear in lieu, should our code change be adopted. Even if it is not adopted at this time, the energy literacy components on which it is based –e.g., relative EIs of different occupancy classifications- are appropriate for inclusion in training materials, with linkage to their IEBC origins. Historic data on energy use can be used as a guide to compliance and building code officials trained in the use of databases (CBECS, DOE High Performing Buildings database, etc.) to infer energy use values. These inferred values may then be applied locally to identify enforcement priorities. Most energy used in most buildings is for space conditioning, a trend that has accelerated since the introduction of efficient LED lighting technology. Enforcement efforts could concentrate on space-conditioning energy end use, through application of an end-use matrix (to be drawn from CBECs) and training/guidance for complying with the current requirement.

Additionally, testimony and committee member comments at the ICC Louisville hearings suggest that there is extensive misunderstanding of issues surrounding the regulation of existing buildings. There is confusion about the relationship between alterations and change of occupancy (one code official testified that “if you don’t touch it you don’t have to do anything in an occupancy change”), and the change of occupancy approach in the IEBC. A training program targeted at addressing this issue would be very useful in advancing energy efficiency in existing buildings.

The overall goal of the training is to help local code officials influence the largest possible fraction of energy use with the narrowest possible targeting of enforcement efforts.

2. Cost-benefit Analyses

It was decided in the original scoping of this project, in consultation with DOE point of contact David Cohan, that an extensive CBA (cost benefit analysis) was not called for, not affordable (within the context of the CBEI project) and probably not particularly useful to the objective of the project. Indeed,

[2] Daniel Hamilton, San Francisco Bay Area Regional Energy Network and Judy Roberson, Benningfield Group, Inc. ACEEE Summer Study on Energy Efficiency in Buildings. “Regional Efforts to Capture Energy Savings through Enhanced Energy Code Compliance. 2014.

our proposed code change does not increase *compliance* (applicant) costs; for some projects, it lowers it substantially.

From our code change submission: "The current code requirement triggers full compliance with the code when there is an increase in energy demand. The proposed code change offers the metric of energy intensity per square foot per year for measuring energy demand by occupancy. It applies the metric separately to three energy end uses: space conditioning, lighting, and water heating. Therefore, compliance with the code is triggered only for the end uses for which energy intensity is increased. In most cases, the proposed change triggers partial code compliance, and only rarely will it trigger full code compliance. "

We earlier proposed an implementation strategy of applying the change of occupancy provisions to the 20% of buildings that use the most energy (exempting the other, smaller projects) to optimize *enforcement* costs. This analysis was presented in our prior G/NG; our corresponding recommendation had been to exempt projects under 10,000SF, which at the time gained broad support (BP4). Since then, a number of stakeholders, mainly code officials and some energy organizations, have felt strongly that the exemption should be 5,000SF. This is the exemption threshold in the code change proposal version that we submitted to the ICC.

We also encountered stakeholders who expressed concern that the proposed code change could *increase* compliance costs. The logic here may appear as counterintuitive. Because the current change of occupancy provision is vague, and acknowledged by some to be imperfectly enforced, a tightening of the current provision could be viewed as adding costs to individuals and organizations that are accustomed to non-compliance!

At the ICC Committee Action Hearings, absolutely no objection was raised to the 5,000SF exemption threshold and the approach of using increased Energy Intensity as the trigger for compliance also found no objection and received several nods and points of agreement. One person giving testimony against our proposal argued that an abandoned building not changing occupancies or changing occupancies from a prior low EI to a use also with a low EI would not have to comply with the change of occupancy provision and therefore would not have to make energy efficiency investments. While he may be correct that no EI trigger would result in an obligation to comply with the code, he is incorrect that no energy efficiency investments would result. The project still would have to comply with other aspects of the code – e.g., requirements for alterations. As noted above, there is great confusion among practitioners about the various requirements for existing buildings including between change of occupancy and alterations. We believe our proposal would help to address this problem also, resulting in significant benefits in terms of energy conservation and decreases in both compliance and enforcement costs.