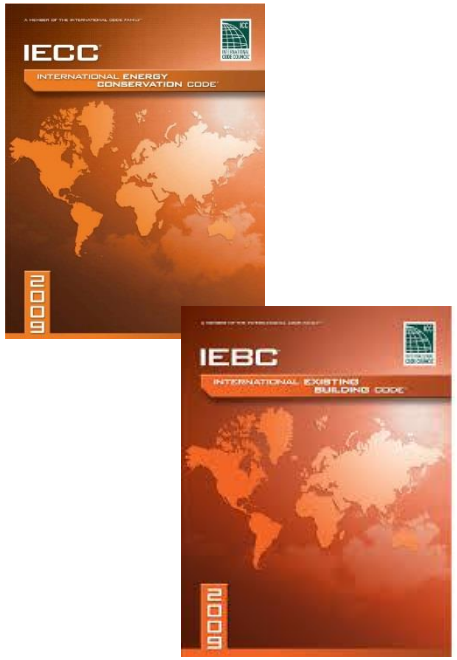
CONSORTIUM for BUILDING ENERGY INNOVATION

Improving Code Compliance

2015 Building Technologies Office Peer Review



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Project Summary

Timeline:

Start date: 5/1/14

Planned end date: 4/30/16

Key Milestones:

- ✓ Recruitment of Participating Municipalities (7/31/14)
- ✓ Development of Proof-of-Concept Compliance Guidance - Pennsylvania (9/30/14)
- ✓ Application and Revision of Guidance (12/31/14; 3/31/15)

Budget:

Total DOE $ to date: $250,000

Total future DOE $: $250,000

Target Market/Audience:

Building code officials, building owners, associated professionals

Key Partners CBEI,CBEI-Rutgers with:

Delaware Valley Regional Planning Commission (DVRPC)	International Code Council (ICC)
PA Partner Municipalities	Sustainability, Energy & High Performance Code Action Committee (SEPHCAC)
PA Assoc. of Building Code Officials (PABCO)	Building Codes Assistance Project (BCAP)
Pennsylvania Construction Codes Academy (PCCA)	New Buildings Institute (NBI)
PA Energy Code Collaborative	American Institute of Architects (AIA)

Project Goal:

Develop guidance for improved code compliance with change-of-occupancy provisions in International Energy Conservation Code (IECC) through proof-of-concept testing.

CBEI CONSORTIUM for BUILDING ENERGY INNOVATION

Vision:

By 2030, deep energy retrofits that reduce energy use by 50% in existing SMSCB, which are less than 250,000 sq ft

Mission:

Develop, demonstrate and deploy technology systems and market pathways that permit early progress (20-30% energy use reductions) in Small and Medium Sized Commercial Buildings

Our Goals:

- **Enable deep energy retrofits** in small to medium sized commercial buildings
- **Demonstrate energy efficient systems** tailored for SMSCBs in occupied buildings – living labs
- **Develop effective market pathways** for energy efficiency with utilities and other commercial stakeholders: brokers, finance, service providers.
- **Provide analytical tools** to link state and local policies with utility efficiency programs

CBEI Partners

Industry

Bayer MaterialScience

United Technologies Research Center

Economic Development Organizations

DVIRC

PIDC

Ben Franklin Technology PArtners

Universities

PENNSTATE 1855

NJIT

Penn University of Pennsylvania

Drexel University

Carnegie Mellon University

VirginiaTech Invent the Future

Purdue University

Morgan State University

Rutgers

Purpose and Objectives

Problem Statement: The application of the IECC to existing buildings and its relationship to the IEBC is not well understood by code officials. The IECC change-of-occupancy provision is hard to enforce in its current form because it is a performance requirement with no clear evaluation method other than costly modeling beyond the capabilities of most stakeholders.

Target Market and Audience: Building code officials, building owners/professionals

Impact of Project: This project delivers stakeholder vetted alternate change of occupancy compliance guidance, a test case for a code change proposal. The project is particularly important concerning SMSCB (small and medium sized commercial buildings) as they comprise most change of occupancy permits, but vary in terms of their abilities to meet the current compliance guidance cost-effectively.

Measuring achievement:

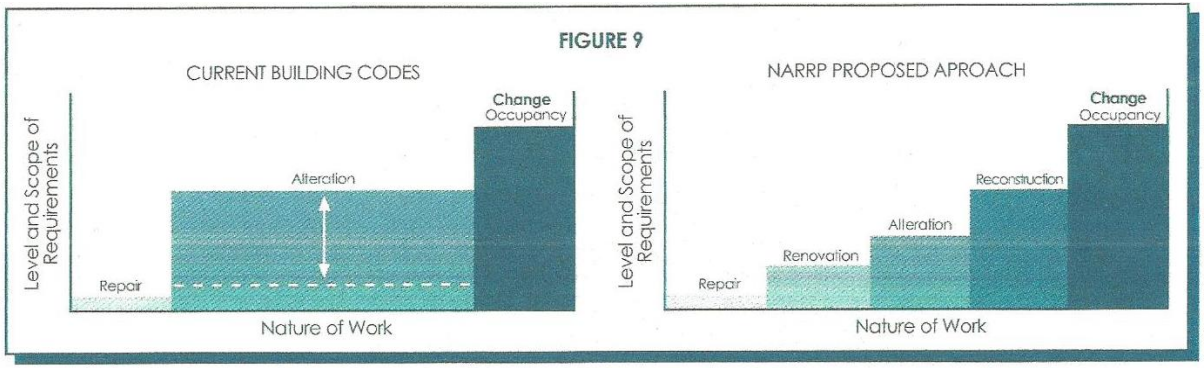
a. Near-term: outreach to stakeholders (partner municipalities, codes groups, allied organizations) on compliance guidance
b. Intermediate-term: code change submission to SEPHCAC (Jan 2016); adoption
c. Long-term: widespread adoption by jurisdictions, evidence of increased compliance

Approach

Approach to development of alternative compliance guidance:

1. Based on successful historical precedent utilizing a scaled approach – e.g., the Nationally Applicable Recommended Rehabilitation Provisions (NARRP), a recommended framework for addressing all types of work in every type of existing building (HUD, 1997) and the International Existing Building Code (IEBC) a comprehensive existing building code that establishes "minimum regulations for existing buildings using prescriptive and performance-related provisions (2012 3rd printing, ICC). These codes are founded on broad-based principles intended to encourage the use and reuse of existing buildings while requiring reasonable upgrades and improvements. Other examples include the NJ Rehabilitation Code and Massachusetts Article 22.

Predictability and Proportionality



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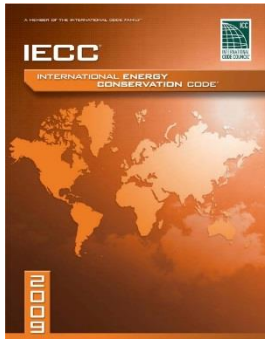
Approach

IECC 2009 101.4.4 (identical for IECC 2015 C505)



- Existing Guidance:

  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.

- Proposed Guidance:

  A change from one building type to another that increases end use energy intensity based on CBECS data, or other data to be defined, requires compliance with IECC requirements that address that end use.

- A change from one building type to another that does not increase end use energy intensity based on CBECS data, or other data to be defined, or that decreases it, does not trigger any specific IECC requirements.

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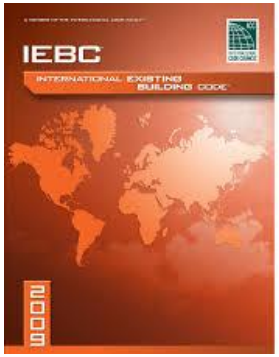
Approach – Impact Scale



IEBC Change of Occupancy

HAZARD CATEGORIES AND CLASSIFICATIONS: LIFE SAFETY AND EXITS

RELATIVE HAZARD	USE CLASSIFICATION
1 (Highest Hazard)	H
2	I-2, I-3
3	A, E, I-1, M, R-1, R-2
4	B, F-1, R-3, R-4, S-1
5 (Lowest Hazard)	F-2, S-2, U

Approach – Impact Scale based on Occupancies and HVAC End Use Intensity

Change of Occupancy Scale—Space Heating, Cooling, and Ventilation			
	CBECS Building Type	**EI Range** kBTU/sq.ft.	**IBC Occupancy Classification**
1.	Health Care (Inpatient)	133.5	I-2
2.	Food Service, Public Assembly,	75.6-89.9	A-1, A-2, A-3, A-4, A-5, B-Broadcasting Studios
3.	Education, Health Care (outpatient), Public Order and Safety, Office, Service, Food Sales, Retail (other than mall), Religious Worship	35.4-56.3	A-3-Courthouses or Religious Worship, B, E, I-3, M
4.	Lodging	24.2	I-1, R-1, R-2-Dormitory, R-4
5.	Warehouse and Storage	19.5	S-1, S-2

Table 1. Change of Occupancy Scale for Space Conditioning

Notes: 1. Energy intensity (EI) values are averages for the CBECS building types.

2. R-2 and R-3 residential units added as based on residential EI data.

Suggested Compliance Guidance:

A change of occupancy from one classification to another in a higher energy intensity classification (i.e., moving up on the scale of Table 1) the building or portion of the building changing occupancy shall comply with all applicable HVAC and envelope requirements of the IECC.

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Approach – Impact Scale based on Occupancies and Lighting End Use Intensity

Change of Occupancy Scale—Lighting			
	CBECS Building Type	**EI Range** kBTU/sq.ft.	**IBC Occupancy Classification**
1.	Health Care (Inpatient)	41.5	I-2
2.	Food Sales, Food Service, Retail (other than mall), Lodging, Office, Health Care (outpatient)	25.0-34.3	A-2, B, I-1, M, R-1, R-2-Dormitory, R-4
3.	Public Order and Safety, Service, Education, Warehouse and Storage	9.4-14.9	A-3-Courthouse, B-Service Transactions, E, I-3, S-1, S-2 R-2, R-3
4.	Public Assembly	7.8	A-1, A-3, A-4, A-5, B-Broadcasting Studios
5.	Religious Worship	4.6	A-3-Religious Worship

Table 2. Change of Occupancy Scale for Lighting

Notes: 1. Energy intensity (EI) values are averages for the CBECS building types.

2. R-2 and R-3 residential units added as based on residential EI data.

Suggested Compliance Guidance:

A change of occupancy from one classification to another in a higher energy intensity classification (i.e., moving up on the scale of Table 2) the building or portion of the building changing occupancy shall comply with all applicable lighting requirements of the IECC.

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Approach – Impact Scale based on Occupancies and Water Heating End Use Intensity

Change of Occupancy Scale—Water Heating			
	CBECS Building Type	**EI Range** kBTU/sq.ft.	**IBC Occupancy Classification**
1.	Food Service, Health Care (Inpatient)	52.9-56.1	A-2, I-2
2.	Lodging	31.6	I-1, R-1, R-2-Dormitory, R-4
3.	Public Order and Safety	16.4	A-3-Courthouse, I-3
4.	Education, Retail (other than mall)	6.6-6.9	E, M R-2, R-3
5.	All rest	0.9-3.8	A-1, A-3, A-4, A-5, B, S-1, S-2

Table 3. Change of Occupancy Scale for Water Heating

Notes: 1. Energy intensity (EI) values are averages for the CBECS building types.

2. R-2 and R-3 residential units added as based on residential EI data.

Suggested Compliance Guidance:

A change of occupancy from one classification to another in a higher energy intensity classification (i.e., moving up on the scale of Table 3) the building or portion of the building changing occupancy shall comply with all applicable water heating requirements of the IECC.

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Approach

Key Issues:

Conflict between building reuse and energy conservation, change-of-occupancy provision is hard to enforce in its current form, questionable practicality of envelope strategies in particular. Partial change of occupancies and historic buildings pose additional challenges.

Distinctive Characteristics:

Designing enforceable regulations requires striking a balance between the benefit (energy savings) and the costs of compliance and enforcement. This work suggests that the right balance will target larger buildings with more energy-intensive activities and will exempt smaller buildings with less energy-intensive activities and systems. (See table on Slide 14).

Project Example 1:

- B to R2: Change of use from county offices to five apartments on 2nd and 3rd floors. **This was the most frequent change of occupancy in this jurisdiction.**
- Proposed work: Not reported
- Estimated cost: $65,000
- Permit date: 7/12/12
- Climate Zone: 4A

Compliance Guidance:

Water Heating

Approach

Project Example 2:

- B or M to A2: Partial change from office or store to restaurant on first floor of a building with residential above.
- Proposed work: To be determined for specific project
- Estimated cost: Not provided
- Permit date: 5/22/14
- Climate Zone: 4A

Compliance Guidance:

Envelope, HVAC, Water Heating

Approach

Project Example 3:

- I1 to A2: Change of use from office/shelter to private club
- Proposed work: Interior alterations
- Estimated cost: $80,000
- Permit date: 7/14/11
- Exterior walls: Stone and plaster, not altered
- Climate Zone: 4A

Compliance Guidance:

Envelope, HVAC, Water Heating

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Progress and Accomplishments

Lessons Learned: The change-of-occupancy provision is not being enforced, not only because it is unclear but also due to decentralized political structures contributing to a code enforcement process that is *less uniform regionally and statewide,* and lack of interest/consequences (e.g., statewide audits focus on ADA compliance).

Accomplishments: Completed proof -of- concept and developed stakeholder vetted compliance guidance that will serve as a test case for change proposal based on pilot municipal and broader survey and interview work. Presented the proposed guidance at the DOE Energy Codes conference and took a straw vote on options. Secured an invitation to present at the June, 2015 SEPHCAC meeting. Sent an article containing project elements to the Journal of the American Planning Association for publication.

Market Impact: Change of Occupancy permits vary across jurisdictions from single digits to 40% of all existing building permits or greater, (based on data from PA only) of which some unknown percentage would trigger the proposed alternative compliance guidance. Based on data for DVRPC region, a number of policy options and energy regulating scenarios are depicted in Table 4 (next page).

Note: *CBECS microdata do not include buildings with floor areas of 1,000 ft^2 or less. CoStar data for DVRPC-PA region suggests that 3% of the commercial building stock has floor areas of 1,000 ft^2 or less.

Progress and Accomplishments

Market Impact, cont: The compliance guidance proposed is further modified by a policy objective of achieving the potential of a high rate of energy use reduction with a low, or optimal rate of regulatory burden. This approach is illustrated in the following Table 4, which supports the exemption of smaller buildings in specific categories. The guidance that follows illustrates two alternatives, the policy-optimized guidance (which has a low transactional burden but includes several exceptions) and a simplified guidance (which has a higher transactional burden but few exceptions).

Cohorts targeted	(% of Total Energy Use)	(% of Total Buildings)
All buildings >25k ft^2	67%	11%
All buildings >25k ft^2 & Offices, Labs, Food Sales, Food Service, Inpatient Healthcare, Nursing, Strip Mall, Enclosed Mall >10k ft^2	74%	15%
All buildings >25k ft^2 & Offices, Labs, Food Sales, Inpatient Healthcare, Nursing, Strip Mall, Enclosed Mall >10k ft^2 & All Food Service > 5k ft^2	75%	17%
All buildings >25k ft^2 & Offices, Labs, Food Sales, Inpatient Healthcare, Nursing, Strip Mall, Enclosed Mall >10k ft^2 & All Food Service	78%	21%
All buildings >10k ft^2	81%	27%
All buildings >10k ft^2 except Education, Public Assembly, Religious Worship, Nonrefrigerated warehouse <25k ft^2	77%	20%
Change	86%	33%
All buildings >5k ft^2	89%	47%
All buildings >1k ft^2*	100.00%	100.00%

Table 4: Illustrative Policy Scenarios
Note: *CBECS microdata do not include buildings with floor areas of 1,000 ft^2 or less. CoStar data for DVRPC-PA region suggests that 3% of the commercial building stock has floor areas of 1,000 ft^2 or less.

Project Integration and Collaboration

Project Integration: Input on an iterative basis from stakeholders and industry collaborators, including 3 pilot municipalities in PA. In each municipality and also for the DVRPC region as a whole, building inventories were constructed and analyzed for energy use and other characteristics and the proposed alternative compliance guidance was applied to sample projects with the assistance of building code officials and developers.

Partners, Subcontractors, and Collaborators: David Hattis, Building Technology Inc. (subcontractor); Mike DeWein, Leidos (CBEI advisor); ICC SEPHCAC (industry partner); PA partner municipalities with DVRPC; PABCO, PCCA, PECC (outreach partners); BCAP, AIA, NBI (collaborators)

Communications: NEEP Regional Building Energy Codes Leadership Group (September 2014); Pennsylvania Energy Code Collaborative (February 2015); DOE National Energy Codes Conference (March 2015); manuscript developed and submitted to peer reviewed journal

Next Steps and Future Plans

Next Steps and Future Plans:

1. In consultation with the ICC Sustainability, Energy & High Performance Building Code Action Committee (SEHPCAC), prepare change-of-occupancy code change recommendations for the IECC (in preparation for the code change currently scheduled for January , 2016). This includes updating recommendations based on newer CBECs or BPD energy statistics. We will also attend the June 2015 meeting to continue to solicit input and support from SEHPCAC to carry the proposal, as we did during the March DOE Energy Codes meeting in Nashville.

2. Develop an implementation strategy based on stakeholder feedback and best industry practice to include recommendations on policy implementation design, training needs and the sufficiency of available cost benefit data.

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REFERENCE SLIDES

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Project Budget

Project Budget: The scope and budget for this project were developed collaboratively with CBEI Directors and David Cohan, DOE.
Variances: None.
Cost to Date: $198,352
Additional Funding: None.

Budget History

CBEI BP3 (past) 2/1/2013 – 4/30/2014		CBEI BP4 (current) 5/1/2014 – 4/30/2015		CBEI BP5 (planned) 5/1/2015 – 4/30/2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
		$250,000	None	$250,000	None

CBEI – Consortium for Building Energy Innovation (formerly EEB Hub)
BP – Budget Period

Project Plan and Schedule