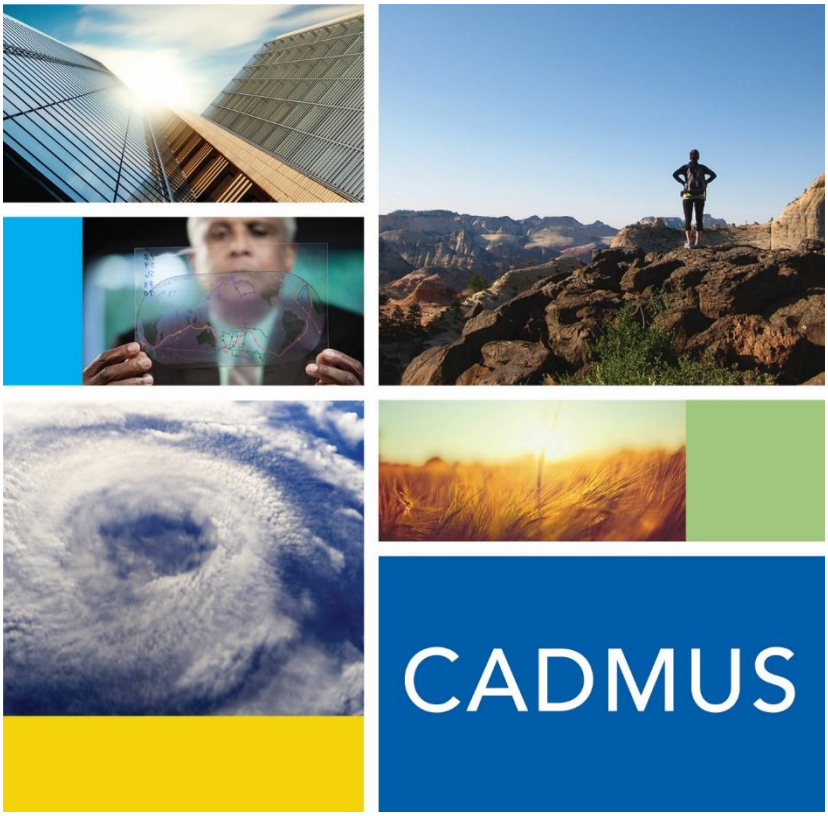


Impact Evaluation Report for the Illinois Building Energy Codes Education and Technical Assistance Program

June 1, 2017

Illinois Department of Commerce
And Economic Opportunity

The Cadmus Group, Inc.

An Employee-Owned Company • www.cadmusgroup.com

This page left blank.

Prepared by:
Jeremy Eckstein
Dan Groshans
Allen Lee
Taliesin Namkai-Meche
Jerica Stacey

The Cadmus Group, Inc.

This page left blank.

CADMUS

Table of Contents

Executive Summary

The Department of Commerce and Economic Opportunity's (DCEO's) Building Energy Codes Education and Technical Assistance Program (the "program") has supported the adoption, implementation, compliance, and enforcement of the Illinois Energy Conservation Code (IECC[1],[2]) for several years. The DCEO hired ADM Associates and Cadmus to evaluate the program.

As shown in Figure ES-1, the program has been providing support for the IECC for a number of years. For this evaluation, we focused on the program's activities for Program Year Two (which began in June 2012) through Program Year Five (which ended in May 2016). Due to a lengthy impasse over the state budget, the program effectively ended after EPY8/GPY5. As requested by the DCEO, we estimated the program impact for the 2014, 2015, and 2016 calendar years and also for EPY7/GPY4, EPY8/GPY5, and EPY9/GPY6.

Figure ES-1. Effective Code and Program Years (PY)

<table>
<tr><td colspan="4">2012</td><td colspan="4">2013</td><td colspan="4">2014</td><td colspan="4">2015</td><td colspan="4">2016</td><td colspan="4">2017</td></tr>
<tr><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td></tr>
<tr><td colspan="4">2009 IECC</td><td colspan="8">2012 IECC in effect</td><td colspan="12">2015 IECC in effect</td></tr>
<tr><td colspan="4">90.1 2007</td><td colspan="8">ASHRAE 90.1 2010 in effect</td><td colspan="12">ASHRAE 90.1 2013 in effect</td></tr>
<tr><td colspan="2">EPY4</td><td colspan="4">EPY5/GPY2</td><td colspan="4">EPY6/GPY3</td><td colspan="4">EPY7/GPY4</td><td colspan="4">EPY8/GPY5</td><td colspan="4">EPY9/GPY6</td><td colspan="2">EPY10</td></tr>
</table>

Note: Each program year begins on June 1 and ends on May 31.

The primary objective of the evaluation is to estimate the impact the program has had on energy savings within the state of Illinois. In order to quantify expected program savings, the DCEO developed methods to estimate the total potential savings (of moving from the 2009 IECC to the 2012 IECC) and the savings due to the program when it provided two calculation methodologies—one for residential construction and one for commercial construction. For this evaluation, the DCEO recommended that we use energy consumption models developed by the Pacific Northwest National Laboratory (PNNL) to quantify the energy impact. We agreed that the PNNL models provide the best available estimates of code impact and we relied on them for our energy estimates. These models produced estimated savings for both the residential and commercial sectors based on the estimated compliance levels provided by the experts.

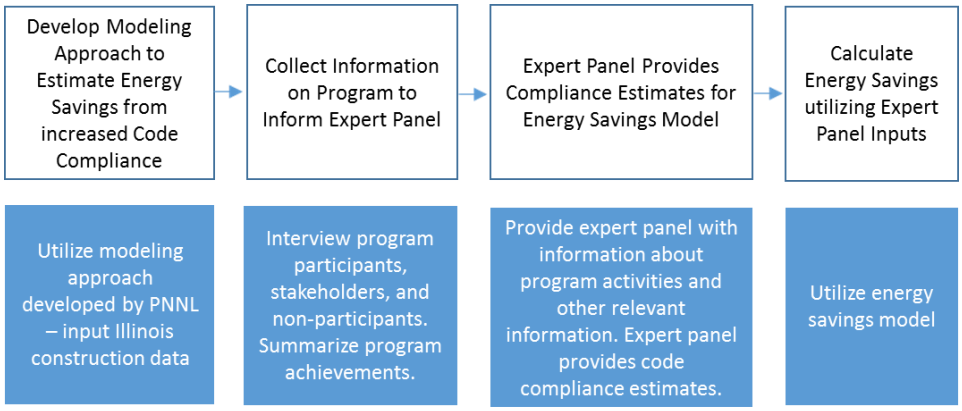
Cadmus' approach, summarized in Figure ES-2 eliminates the need for field studies, but still requires estimates of code compliance. We decided to use an expert panel in which independent experts could review the available data and then estimate the difference in the level of compliance due to the program. In addition to developing the energy models, we also conducted research to inform the

[1] The Illinois Energy Conservation Code is based on the International Energy Conservation Code with Illinois-specific amendments.

[2] Under the Illinois Energy Conservation Code (and the International Energy Conservation Code) for commercial buildings, builders have the option to comply with the IECC commercial code or ASHRAE 90.1.

experts about program activities, other compliance studies, the experience of program participants, and the contrasting experience of nonparticipants.

Figure ES-2. Analysis Approach



Program Activities

The program was designed to increase compliance with new Illinois energy codes. The program worked with jurisdictional code officials to support them to enforce the new codes, and also worked with industry professionals, including contractors, Home Energy Rating System (HERS) raters, and designers to help them to comply with the codes.

To facilitate code enforcement and code compliance, the program made a range of services available statewide, free of charge, to individuals and jurisdictions that work within investor-owned utility (IOU) service areas or who do a majority of their work within IOU territories. We summarized the program activities in Table ES-1 based on DCEO's annual Energy Conservation Technical Assistance Updates.

Table ES-1. Overview of Key Program Activities 2012 – 2015

Program Activity	2012	2013	2014	2015	Total
Trainings/workshops held	73	42	61	38	**214**
Individuals trained	1,633	1,755	1,276	878	**5,542**
Technical Assistance/Code Interpretations	302	412	476	526	**1,716**
Outreach Speaking Engagements	47	56	23	46	**172**

Participant Feedback

To create a record of how the program affected code compliance and enforcement, Cadmus conducted in-depth interviews with 25 individuals (12 code officials, 13 building professionals) who had attended one or more residential or commercial energy code classroom training sessions sponsored by DCEO as part of the program.

The primary goals of these interviews were to determine whether and how the skills and knowledge obtained from the training sessions are being applied in the field by training participants, as well as to assess the impact the training and technical assistance offered by the program has had on compliance with the 2012 IECC throughout the state. Cadmus provided the expert panel with a summary of the

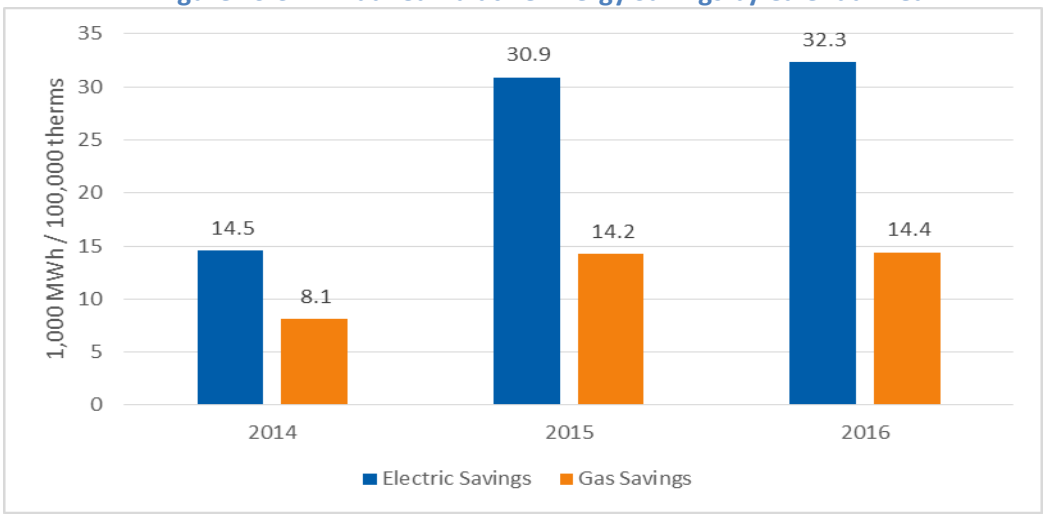
interviews in order to allow the panel to estimate how much the program affected commercial and residential code compliance in Illinois. Findings from these interviews include the following:

- When asked—separately—about the impact of the program on specific new residential and commercial code provisions in 2012 IECC:
    - Code officials told us that they received new information, began enforcing these provisions, and changed plan review and inspection processes
    - Building professionals told us that they received new information and that they changed their work to better comply with these provisions
- Both code officials and building professionals described ways in which the training helped them find and correct compliance issues (with insulation, infiltration/sealing, lighting controls, etc.) that they might have missed prior to the training.
- Most of the code officials and building professionals we interviewed identified the technical support services provided by DCEO when asked where they would first look for information about energy code interpretations and for answers to code-related questions.

Energy Impact of the Program

As illustrated in Figure ES-3, we estimated the cumulative energy savings from the program in Illinois to be 32,300 MWh and 1,440,000 therms for 2014 through 2016. Savings shown for each year are cumulative (2015 includes the savings from 2014 construction activity and 2015 construction activity, and 2016 includes savings from construction activity in all three years). The incremental savings from 2015 to 2016 are modest because the 2015 IECC adopted in 2016 in Illinois resulted in smaller overall energy savings.

Figure ES-3. Annual Cumulative Energy Savings by Calendar Year



Cadmus estimated savings for the commercial and residential sectors separately. As illustrated in the graphs below (see Figure ES-4 and Figure ES-5), most of the energy savings for the program came from commercial construction.

Figure ES-4. Cumulative Electric Savings by Sector and Calendar Year

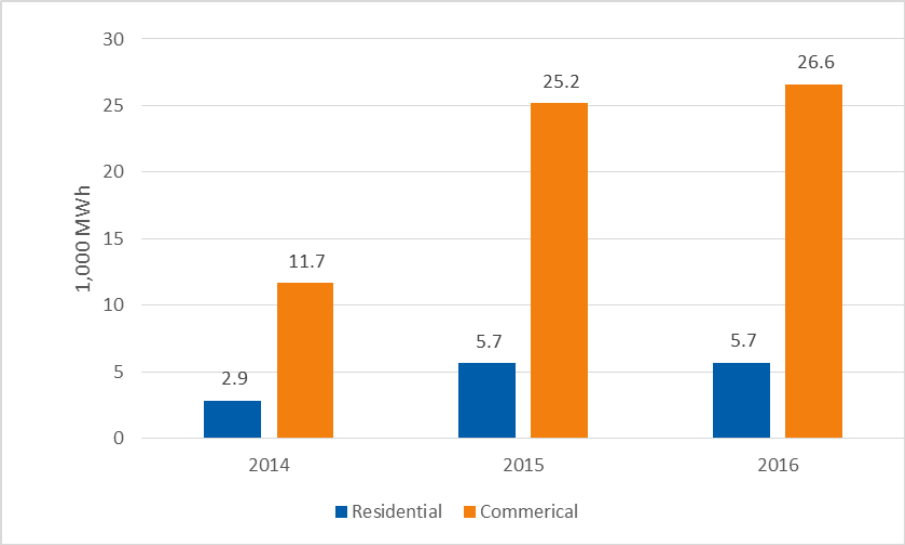
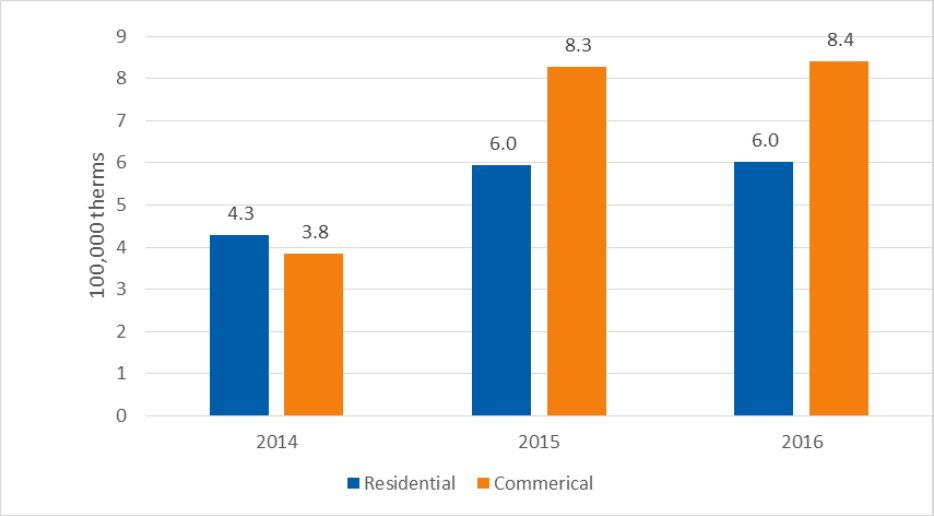


Figure ES-5. Cumulative Gas Savings by Sector and Calendar Year



In Table ES-2, we summarize the incremental savings for EPY8/GPY5 by sector and fuel. The estimated statewide energy savings attributable to the program were allocated to individual utilities through a two-step process. In the first step, total energy savings were attributed to the electric and gas utilities. Then the savings were allocated to the individual utilities.

For the electric savings, U.S. Energy Information Agency data were referenced to estimate the portion of electric impacts that accrued to the electric utilities that funded the program operations. According to 2015 data on utility retail sales, in Illinois, 78.03% of electricity was sold by ComEd and Ameren Illinois.[3] Total program-attributable electric energy savings were multiplied by 78.03% to calculate the total claimable electric energy savings, ensuring that energy impacts are not inappropriately associated with

[3] https://www.eia.gov/electricity/sales_revenue_price/xls/table10.xlsx

ComEd or Ameren Illinois customers. Table ES-2 shows the resulting utility savings of 9,568,241 kWh as the share of electric savings attributed to ComEd and Ameren Illinois.

For the gas savings, American Gas Association data were referenced to estimate the portion of natural gas impacts that accrued to the natural gas utilities that funded the program operations. According to 2015 data on natural gas utility sales volume in Illinois, 94.97% of statewide residential, commercial, and industrial gas sales volume was associated with Nicor, North Shore Gas, Peoples Gas, and Ameren Illinois.[4] Total program-attributable natural gas energy savings were multiplied by 94.97% to calculate the total claimable natural gas energy savings, ensuring that energy impacts are not inappropriately associated with Nicor, North Shore Gas, Peoples gas, or Ameren Illinois customers. Table ES-2 shows the resulting utility savings of 414,828 therms as the share of natural gas sold by Nicor, North Shore Gas, Peoples Gas, and Ameren Illinois.

Table ES-2. Summary of EPY8/GPY5 Savings

EPY8/GPY5 Savings	Electric Savings (kWh)			Gas Savings (Therms)		
	Statewide Savings	Utility Share	Utility Savings	Statewide Savings	Utility Share	Utility Savings
Residential	1,826,998	78.03%	1,425,607	110,877	94.97%	105,300
Commercial	10,435,262	78.03%	8,142,635	325,922	94.97%	309,528
Total	**12,262,260**	**78.03%**	**9,568,241**	**436,799**	**94.97%**	**414,828**

In the second step, the total claimable electric energy savings were allocated to ComEd and Ameren Illinois in proportion to the financial contribution of each electric utility to program operations for EPY8/GPY5. Table ES-3 summarizes the share of financial contribution and program savings for each electric utility.

Table ES-3. Share of Financial Contribution and Program Savings by Electric Utility

Electric Utility	Share of Financial Contribution	EPY8/GPY5 Savings (kWh)
Ameren	27.62%	2,642,748
Comed	72.38%	6,925,493
Total	**100.00%**	**9,568,241**

The same approach was used for natural gas utilities: the total claimable natural gas energy savings were allocated to Nicor, North Shore Gas, Peoples Gas, and Ameren Illinois in proportion to the financial contribution of each natural gas utility to program operations for EPY8/GPY5. Table ES-4 summarizes the share of financial contribution and program savings for each natural gas utility.

[4] https://www.aga.org/sites/default/files/2015_fields.xls

Table ES-4. Share of Financial Contribution and Program Savings by Gas Utility

Gas Utility	Share of Financial Contribution	EPY8/GPY5 Savings (Therms)
Ameren	15.52%	64,375
Nicor	54.48%	226,018
North Shore	5.70%	23,629
Peoples	24.30%	100,806
Total	**100.00%**	**414,828**

Conclusions and Recommendations

Code officials and industry professionals that participated in DCEO's program, as well as code officials that did not participate, found that the program had a strong influence on the extent to which residential and commercial buildings comply with Illinois' energy codes. Enhanced code compliance in Illinois since 2014, which our study's expert panel attributed to the program, has resulted in significant energy savings over the three calendar years and three program years that we analyzed. Based on our modeling approach, available new construction data, and expert panel estimates, we calculated cumulative energy savings attributable to the program to be 32,300 MWh and 1,440,000 therms for 2014 through 2016 and 28,400 MWh and 1,180,000 therms for PY4 though PY6. Cadmus did not have any information on the cost of implementing the program, and were therefore unable to estimate the cost effectiveness of the program.

> **Recommendation:** We recommend that the Illinois utilities continue to fund a code compliance program in Illinois in order to achieve enhanced energy savings from Illinois energy codes in the future, assuming that the program is cost effective.

While the program achieved significant cumulative energy savings by increasing residential and commercial code compliance rates in Illinois, incremental savings after the adoption of the 2015 IECC were more modest than for previous years because overall energy savings from that code versus the 2012 IECC are lower than when Illinois moved from the 2009 IECC to the 2012 IECC. We observed this trend for both commercial and residential codes.

> **Recommendation:** Cadmus recommends that the Illinois utilities identify the provisions of the 2015 IECC that result in the highest levels of energy savings, and target code compliance and code enforcement training on those provisions in order to maximize the impact of the program.

Introduction

Objectives

The Department of Commerce and Economic Opportunity's (DCEO's) Building Energy Codes Education and Technical Assistance Program (the "program") has supported the adoption, implementation, compliance, and enforcement of the Illinois Energy Conservation Code (IECC[5],[6]) for several years. The DCEO hired ADM Associates and Cadmus to evaluate the program. For simplicity, we refer to the evaluation team as Cadmus for the remainder of this document.

During the time period being evaluated, the program was supported by Energy Efficiency Portfolio Standard Funds which were collected through surcharges on electric and gas utility bills. These funds were collected from customers of the following utilities: Commonwealth Edison, Ameren Illinois, Nicor Gas, Peoples Gas, and North Shore Gas. This program was offered in the same utilities' service areas.

As a result of recent legislation, after January 1, 2018, the Department of Commerce & Economic Opportunity will no longer administer Energy Efficiency Portfolio Standard Funds (EEPS), which support Illinois Energy Now Programs for the public sector, low income customers, and market transformation. After that time, each electric and gas utility will be responsible for offering their own public sector, low income, and market transformation programs in their service territories.

As shown in Figure 1, the program has been providing support for the IECC for a number of years. For this evaluation, we focused on the program's activities for Program Year Two (which began in June 2012) through Program Year Five (which ended in May 2016). Due to a lengthy impasse over the state budget, the program effectively ended after EPY8/GPY5. As requested by the DCEO, we estimated the program impact for the 2014, 2015, and 2016 calendar years and also for program years 4, 5, and 6.

Figure 1. Effective Code and Program Years (PY)

<table>
<tr><td colspan="4">2012</td><td colspan="4">2013</td><td colspan="4">2014</td><td colspan="4">2015</td><td colspan="4">2016</td><td colspan="4">2017</td></tr>
<tr><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td></tr>
<tr><td colspan="4">2009 IECC</td><td colspan="12">2012 IECC in effect</td><td colspan="8">2015 IECC in effect</td></tr>
<tr><td colspan="4">90.1 2007</td><td colspan="12">ASHRAE 90.1 2010 in effect</td><td colspan="8">ASHRAE 90.1 2013 in effect</td></tr>
<tr><td colspan="2">EPY4</td><td colspan="4">EPY5/GPY2</td><td colspan="4">EPY6/GPY3</td><td colspan="4">EPY7/GPY4</td><td colspan="4">EPY8/GPY5</td><td colspan="4">EPY9/GPY6</td><td colspan="2">EPY10</td></tr>
</table>

Note: Each program year begins on June 1 and ends on May 31.

The primary objective of the evaluation is to estimate the impact the program has had on energy savings within the state of Illinois. In order to quantify expected program savings, the DCEO developed methods to estimate the total potential savings (of moving from the 2009 IECC to the 2012 IECC) and the savings due to the program when it provided two calculation methodologies—one for residential construction

[5] The Illinois Energy Conservation Code is based on the International Energy Conservation Code with Illinois-specific amendments.

[6] Under the Illinois Energy Conservation Code (and the International Energy Conservation Code) for commercial buildings, builders have the option to comply with the IECC commercial code or ASHRAE 90.1.

and one for commercial construction—that were included as Exhibits 6.1 and 6.2 in Docket 13-0499 of the Illinois Commerce Commission. These two exhibits are included in Appendix A to this report.

In terms of energy savings, the DCEO exhibits document the assumption that the program gradually shifts a portion of newly constructed buildings from a non-compliant condition (modeled as 2009 IECC) to a compliant condition (modeled as 2012 IECC). The DCEO assumed that there would be some level of compliance in the absence of the program and that the program impact would be in addition to this. Specifically, the DCEO assumed for both residential and commercial construction that an additional 5% of new buildings would be compliant as a result of the program in the first year after the 2012 IECC took effect, 10% in the second year, and 15% in the third year.

For this evaluation, the DCEO recommended that we use energy consumption models developed by the Pacific Northwest National Laboratory (PNNL) to quantify the energy impact. As described below, we relied on the PNNL models for our energy estimates.

Research Approach and Activities

Cadmus recognizes that it is challenging to determine the impact of energy code support programs. A rigorous analysis must determine the level of compliance (and energy consumption) in the absence of the program, determine the level of compliance (and energy consumption) in the presence of the program, and must also show that the change in code compliance is due to the program activities.

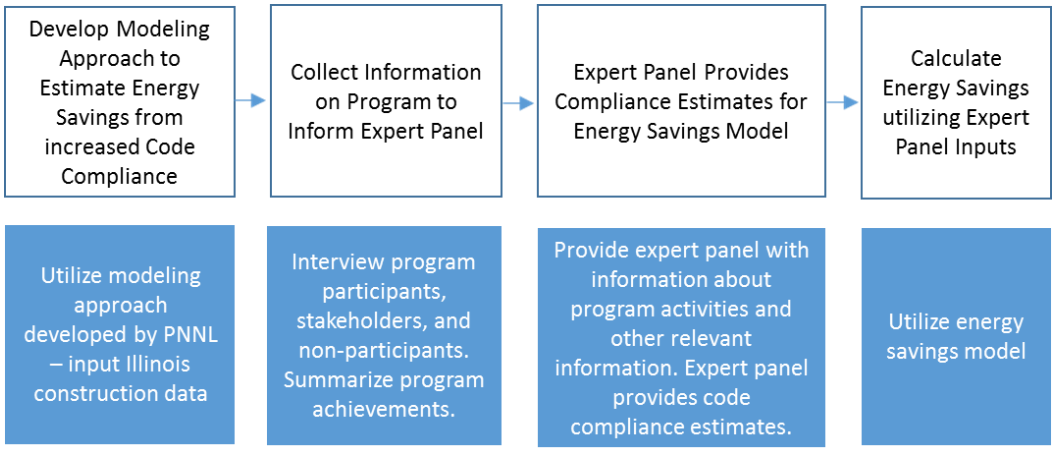
Cadmus has evaluated code compliance and energy savings associated with energy codes; these studies typically require extensive visits to newly constructed buildings and development of energy simulation models. For code support programs, rigorous studies typically evaluate compliance twice: the first field study establishes a baseline and the second determines whether compliance has changed from the baseline level. However, these approaches were not suitable to the resources available and timeline required by the DCEO.

Cadmus was able to rely on the PNNL analyses to provide energy consumption data for any level of compliance that was provided as input to the models. This approach eliminates the need for field studies, but still requires estimates of code compliance. We decided to use an expert panel in which independent experts could review the available data and then estimate the difference in the level of compliance due to the program.

Cadmus' evaluation included two components necessary to implement the expert-based approach. One of these was research to inform the experts about program activities, other compliance studies, the experience of program participants, and the contrasting experience of nonparticipants. The other component consisted of development of energy models that incorporated actual construction activity data in the PNNL energy consumption models. These models produced estimated savings for both the residential and commercial sectors based on the estimated compliance levels provided by the experts.

Figure 2 illustrates Cadmus' process of estimating the program energy savings

Figure 2. Analysis Approach



Program Activities

Program Design

The program was designed to increase compliance with new Illinois energy codes. The program worked with jurisdictional code officials to support them to enforce the new codes, and also worked with industry professionals, including contractors, Home Energy Rating System (HERS) raters, and designers to help them to comply with the codes. The program implementer, Darren Meyers of International Energy Conservation Consultants, LLC (IECC_LLC), estimated that 25 percent of residential compliance is determined during plan review and the remaining 75 percent is determined in the field by code officials or home performance contractors, including third-party HERS raters and Duct and Envelope Tightness (DET) verifiers.[7] In residential compliance, less responsibility for compliance is placed on the design firm and more is placed on enforcement of the energy code by building departments and third party professionals.

As such, the program frequently targeted training to third parties or the use of third party services. By doing so, the program educated code officials on the use of third parties and helped build trust in third party professionals, both of which have aided in sharing the burden of energy code enforcement.

The program also addressed the initial perception, held, according to the program implementer, by many jurisdictions, that the adoption of statewide energy codes represented an "unfunded mandate." The program implementer expressed that a key result of providing industry stakeholders with resources to comply with the energy code has been a wider general acceptance of the code.

To facilitate code enforcement and code compliance, the program made a range of services available statewide, free of charge, to individuals and jurisdictions that work within investor-owned utility (IOU) service areas or who do a majority of their work within IOU territories. Energy code support services provided under the program included:

- Energy code training and education services
- Technical assistance services
- Outreach speaking engagements
- Resource development

Program Activities

During the EPY5/GPY2 through EPY8/GPY5—the program years included in this evaluation—and as noted above, DCEO partnered with Darren Meyers of IECC_LLC to provide energy code support under Illinois Energy Now. The program has operated under several names, including the Building Industry Training and Education (BITE) Program and the Building Energy Codes Education and Technical

[7] This estimate, according to the program implementer, used to be that 10 percent of compliance was determined at plan review and 90 percent in the field by code officials. However, with new documentation requirements (such as Manual J, D, and S submittals) and the introduction of third party professionals into the code requirements (to perform blower door tests, for example), the estimate has changed.

Assistance (BECETA) Program. For simplicity, Cadmus will refer to the DCEO energy code support program as "the program" throughout this document.

Energy Code Training and Education Services

To support compliance with and enforcement of the Illinois energy code and applicable state laws, the program provided comprehensive training and education services to code officials and building industry professionals. Training was conducted in a variety of formats, most commonly as half- or full-day sessions. However, the program also offered customized training to accommodate certain parts of the industry, such as providing breakfasts for construction crews during short morning trainings, and hosted "awareness crossovers," or events aimed at providing education to realtors and appraisers. Additionally, Registered Energy Professional (REP) training was offered by the program in the City of Chicago. REP is a special designation that Chicago uses for licensed architects and engineers who, once they have completed training, can self/pre-certify that construction documents meet the provisions of the code.

From 2012 to 2015 the program offered the following training courses:

- Illinois Energy Conservation Code (Residential and Commercial, including Standard 90.1)
- Trust but Verify: Understanding Energy Modeling Submissions
- REM/*Rate* Software: Developing & Reviewing Performance-Based Submittals for Code Compliance
- Residential HVAC Load Calculations
- Game On! Commercial Energy Modeling for Code Compliance
- Inside the Game! Modeling to Code with OpenStudio 1.5.0

Additionally, the program provided extensive training for the City of Chicago to help it bring its energy code enforcement into compliance with state law.

Technical Assistance

In addition to trainings, the program supported energy code compliance and enforcement by providing technical assistance to code officials and building industry professionals. IECC_LLC answered written and verbal energy code inquiries, including those submitted to the DCEO website, the City of Chicago energy codes email address, the DCEO energy code hotline. The program operated under the assumption that having one point of contact and one consistent answer was critical to establishing and maintaining credibility of the code and in supporting statewide energy code enforcement.

The program also provided in-field technical assistance through a "circuit rider" position. The circuit rider provided in-person consultations to jurisdictions, builders, contractors, architects, design firms, and other industry professionals seeking advice on energy code compliance and enforcement issues.

Technical assistance inquiries were analyzed by the implementer and the results were used to develop a comprehensive list of frequently asked questions (FAQs), providing the industry with yet another avenue for obtaining code information.

Program implementers shared that one of the main indicators that the program was having some effect was the uptake in technical assistance following each training session. Program implementers explained that two to three weeks after training, including presentations given at conferences and trade association meetings, an increase in call volume and e-mails occurs. This indicated that training attendees were thinking more critically about energy code provisions and their application.

Code Interpretations

The program aimed to improve consistency in enforcement by providing clear, consistent code interpretations and offering technical assistance. As explained by the program implementer, "Uniformity is the key to improving enforcement." The program successfully provided uniform code interpretations to both code officials and building professionals. Additionally, since jurisdictions were often constrained by budgets and manpower, the technical assistance provided to designers and other building professionals helped jurisdictions focus on enforcement. Designers could seek code interpretations from the program implementers rather than waiting for the local building department to respond to an inquiry. This not only improved consistency in how the code was applied, but improved relationships between building professionals and their building departments.

Outreach Speaking Engagements

To understand all aspects of the building industry and to help bring awareness to the energy code, the program scheduled speaking engagements throughout the state. These included presentations and talks given to trade associations and code enforcement organizations, keynote presentations included as part of industry conferences, workshops provided to IOUs, and other strategic consulting sessions.

Summary of Program Activities for 2012 – 2015

Each year, DCEO publishes an Energy Conservation Technical Assistance Update document detailing the activities of the program for the year. Table 1 provides an overview of the main program activities summarized in the update documents by program year.

Table 1. Overview of Key Program Activities 2012 – 2015

Program Activity	2012	2013	2014	2015	Total
Trainings/workshops held	73	42	61	38	**214**
Individuals trained	1,633	1,755	1,276	878	**5,542**
Interpretations provided	302	412	476	526	**1,716**
Outreach Speaking Engagements	47	56	23	46	**172**

Modeling Approach to Estimate Energy Savings

Analysis Approach

As recommended by DCEO, Cadmus applied methods developed by PNNL to model the energy savings that result from increases in energy code compliance. A 2014 PNNL paper[8] describe these methods in detail. Additionally, we drew on residential and commercial models that PNNL has made available at www.energycodes.gov/resource-center/utility-savings-estimators. The PNNL models follow the methodology described in the 2014 PNNL paper and use and make public additional data that PNNL has not published elsewhere. Cadmus followed the PNNL approach because PNNL provides the most up-to-date data on building energy consumption under various energy codes and because PNNL developed a robust methodology specifically to provide a quantitative analysis of the impact of increased energy code compliance.

Approach and Model Flow

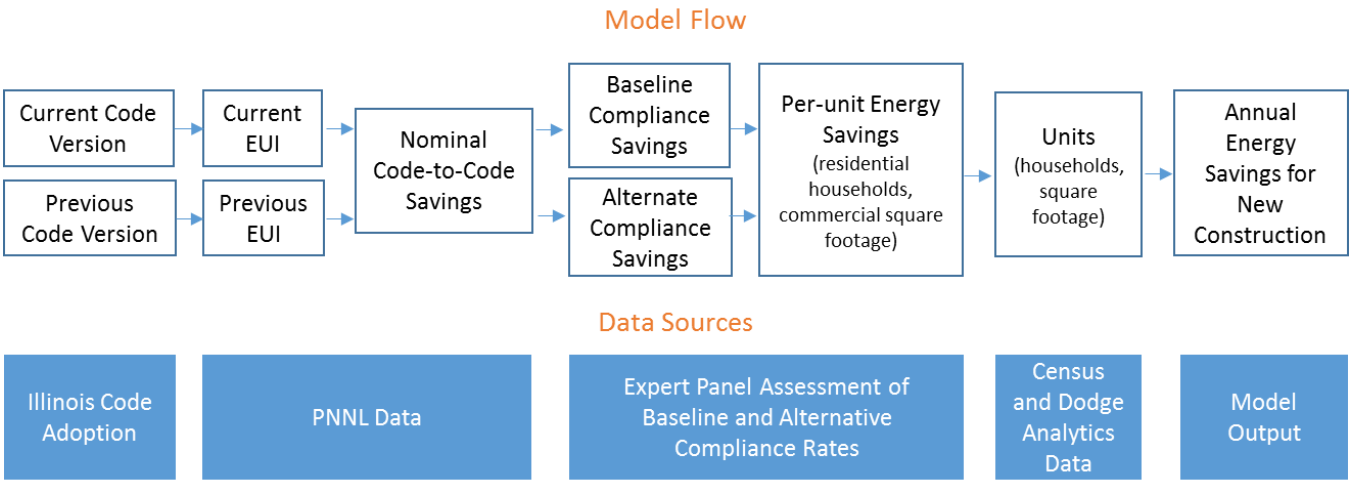
The PNNL modeling approach depends on calculating the per unit (households for residential construction and square footage for commercial construction) energy savings under baseline and alternative code compliance scenarios. The baseline scenario is the assumed compliance rate without the program and the alternative scenario is the assumed or known compliance rate with program support. The evaluated program savings are the difference between the baseline and alternative per unit savings, multiplied by the applicable new construction stock in each year. Using this method we estimate the cumulative savings for the evaluation period, both by program and calendar year.

Our model, which follows the PNNL approach, takes into account both the changes in energy use intensity (EUI) resulting from switching from one code version to the next, and the assumed levels of code compliance with and without the program to calculate energy savings. Figure 3, which was adapted from a PNNL presentation,[9] describes the modeling approach.

[8] Building Energy Codes Program: National Benefits Assessment, 1992-2040, Livingston OV et al, Pacific National Laboratory, March 2014, PNNL-22610 Rev 1.

[9] https://www.energycodes.gov/training-courses/becp-utility-estimator-tool-demonstration-webinar (last accessed March 19, 2017)

Figure 3. Model Flow and Data Sources



Energy Use Intensities

Our model utilizes EUIs estimated by PNNL for fully code-compliant buildings for each code version. PNNL provided EUIs per household for the residential sector and per building square footage for the commercial sector. We use these fully code-compliant EUIs as the basis for our savings calculation. Baseline savings are the difference between EUIs for the current code version and EUIs of the immediately preceding code version. PNNL refers to this approach as utilizing a "rolling baseline"[10].

Using PNNL's approach, we estimated energy savings by utilizing the PNNL-produced EUIs broken out by end use and fuel type, as described in Table 2. PPNL produced EUIs for each of Illinois' two climate zones. Because the PNNL analyses did not provide EUIs for the IECC 2015 (adopted in Illinois in 2016) and ASHRAE 2013 (adopted in Illinois in 2016) code versions, we estimated EUIs for these codes by adjusting the preceding codes' EUIs by the overall code-to-code savings estimated by PNNL in papers published in 2015[11] and 2014[12]. We weighted the adjustment by energy consumption in each of PNNL's defined end uses.

[10] Impacts of Model Building Energy Codes, Athalye RA et al, Pacific Northwest National Laboratory, October 2016, PNNL-25611 Rev 1

[11] 205 IECC: Energy Savings Analysis, Mendon VV et al, Pacific Northwest National Laboratory, May 2015, PNNL-23977

[12] ANSI/ASHRAE/IES Standard 90.1-2013 Determination of Energy Savings: Quantitative Analysis, Halverson M et al, Pacific Northwest National Laboratory, August 2014, PNNL-23479

Table 2. Energy Use Intensities Used to Model Code Compliance Savings

Code Version	Code-Compliant EUI Data	Year Adopted	Code-to Code Savings Applied	Source
Residential				
IECC 2009	kWh and therms per household by end use and Illinois climate zone	2010		PNNL Model
IECC 2012	kWh and therms per household by end use and Illinois climate zone	2013	2014/2015	PNNL Model
IECC 2015	IECC 2012 kWh and therms per household adjusted by overall energy consumption reduction resulting from IECC 2015	2016	2016/2017	Adjusted PNNL-23977
Commercial				
ASHRAE 90.1 2007	kWh and kBtu per square foot of commercial buildings by end use and Illinois climate zone	2010		PNNL Model
ASHRAE 90.1 2010	kWh and kBtu per square foot of commercial buildings by end use and Illinois climate zone	2013	2014/2015	PNNL Model
ASHRAE 90.1 2013	ASHRAE 2010 adjusted by overall energy consumption reduction	2016	2016/2017	Adjusted PNNL-23479

Table 3 shows the EUIs, separated by end use and fuel type for fully code-compliant homes, we used for our savings model.

Table 3. Residential Energy Use Intensities per Household by End Use for Fully Compliant Buildings

Code Version	Climate Zone	Heating (kWh)	Cooling (kWh)	Water Heating (kWh)	Other (kWh)	Heating (therms)	Water Heating (therms)
IECC 2009	4	2,264	3,110	803	1,430	442	145
IECC 2009	5	2,796	2,071	868	1,339	512	154
IECC 2012	4	1,355	2,685	722	1,222	250	130
IECC 2012	5	1,779	1,953	781	1,144	311	139
IECC 2015	4	1,353	2,677	721	1,220	248	129
IECC 2015	5	1,776	1,949	780	1,143	308	138

Table 4 shows the EUIs, separated by end use and fuel type for fully code-compliant commercial buildings, we used for our savings model.

Table 4. Commercial Energy Use Intensities by End Use for Fully Compliant Buildings per Square Foot

Code Version	Climate Zone	Heating and Cooling (kWh)	Light / Other (kWh)	Heating and Cooling (kBtu)	Water Heating (kBtu)
ASHRAE 2007	4	5.90	9.91	18.6	6.64
ASHRAE 2007	5	4.89	9.65	23.6	5.96
ASHRAE 2010	4	4.10	8.51	10.5	6.63
ASHRAE 2010	5	3.65	8.43	15.2	5.95
ASHRAE 2013	4	4.04	8.22	10.4	6.58
ASHRAE 2013	5	3.59	8.16	15.0	5.91

Nominal Code-to-Code Savings

The first step in the analysis is to calculate the code-to-code savings per home (residential) and building square footage (commercial) from adopting a new energy code. Energy savings from adopting a specific code are calculated as the difference between the previous code building EUI and the current code EUI. We applied this change in building energy consumption for each year that the current code has been in effect. When Illinois adopts a new code version, the energy consumption under the immediately preceding code becomes the new baseline energy consumption.

Savings from Increased Code Compliance

We estimate program savings by adjusting the code-to-code savings for estimated levels of code compliance. To account for code compliance we adjusted code-to-code EUIs for two scenarios, the baseline scenario and alternative scenario.

We applied the following formula to calculate EUIs under the baseline and alternative scenarios:

$$Scenario\ \ EUI = Current\ code\ EUI + (1 - baseline\ or\ alternative\ compliance\ rate) * (Previous\ Code\ EUI - Current\ Code\ EUI)$$

This approach means that if the compliance rate with the current code is 100% the scenario EUI is the EUI of the current code. If compliance is 0%, the scenario EUI is the previous code's EUI. Per unit savings are the difference between baseline EUI and the alternate EUI. This per unit savings value is multiplied by the number of units in each year or program year to estimate annual savings.

Because energy savings can be achieved in buildings that do not meet every provision of the energy code, we calculated the compliance rate as a weighted average of fully code compliant buildings (buildings that meet all provisions of the building code) and partial compliance (the average levels of savings achieved by buildings that meet some requirements of the building code)[13]. We applied the following formula to calculate code compliance:

$$Code\ Compliance = \%\ fully\ compliant\ + (1 - \%\ fully\ compliant) * (\%\ partially\ compliant)$$

Cadmus asked the members of the expert panel to provide estimates of these two elements of code compliance. We utilized the experts' feedback as inputs to generate program savings estimates using the modeling approach described here.

[13] PNNL-22610 Rev 1, p. 3.18.

Construction Data

Cadmus obtained residential construction permit data from the U.S. Census Bureau and commercial construction starts from Dodge Data and Analytics for 2014, 2015, and 2016. We mapped Illinois' two climate zones onto the data by county, utilizing the IECC climate zone map. We also incorporated parts of the Census Bureau's multifamily permit data into our commercial floor space data. Additionally, Cadmus forecast construction data for the first five months of 2017 to calculate savings for program year six, which runs from June 2016 through May 2017.

Adjustment of Residential and Commercial Building Stock

The Census Bureau reports residential permit data by the number of units per building, including a category for buildings with five or more units. Because buildings with four or more floors are treated as commercial buildings, rather than residential buildings, we adjusted the units in the "five or more" units per building category according to the method described in PNNL-22610 (p. 4.6). This method utilizes 2011 Residential Energy Consumption Survey (RECS) data to disaggregate residential buildings into the bins of buildings with one to two floors, three to four floors, and buildings with four or more floors. The PNNL team calculated the number of buildings with four floors by applying a 60% multiplier to the number of buildings in the three to four floors category.

According to this methodology 68% of the units in the Census Bureau category of buildings with five or more units were covered by the residential code. We adjusted the residential building stock accordingly and applied 32% of the multifamily buildings in the "five or more units" category to the commercial building stock.

The commercial analysis relies on building square footage, rather than the number of buildings. Accordingly, Cadmus converted the number of residential buildings with five or more units into mid and high-rise buildings in order to apply square footage assumptions found in PNNL-23479 (p. 3.2). Based on an analysis of the 2011 RECS data we found that 15% of the buildings in the Census Bureau's five or more unit category were mid-rise apartments, and 17% of the buildings in this category were high-rise buildings. We applied the PNNL assumption that mid-rise buildings on average have 33,741 square feet and high-rise buildings have 84,320 square feet in order calculate to calculate the square footage of the mid and high-rise buildings from the Census Bureau data.

2017 Forecast

Because we also provided our analysis for three program years, which run for from June to May, we forecast construction activity for the first five months of 2017. Because building construction is a seasonal activity, Cadmus calculated the overall year-on-year building stock trends with our available data to find the growth rate of construction activity in January through May 2016. We then used the 2016 growth rate to forecast construction activity for the first five months of 2017. This approach captures both the seasonal construction activity and the overall trend. We calculated an annual growth rate of three percent in the residential sector and an annual growth rate of 0.4% in the commercial sector.

Construction Data Overview

We applied the following construction data to our model.

Table 5. Commercial Construction Starts by Calendar Year (1,000 square feet)

Climate Zone	2014	2015	2016
4	3,335	4,203	2,193
5	32,450	37,882	35,317
Total	**35,785**	**42,085**	**37,510**

Table 6. Commercial Construction Starts by Program Year (1,000 square feet)

Climate Zone	EPY7/GPY4	EPY8/GPY5	EPY9/GPY6
4	3,270	4,399	1,523
5	33,112	45,970	30,396
Total	**36,382**	**50,368**	**31,919**

Table 7. Residential Construction Units by Calendar Year

Climate Zone	2014	2015	2016
4	1,941	1,869	2,483
5	15,711	14,966	16,538
Total	**17,652**	**16,835**	**19,021**

Table 8. Residential Construction Units by Program Year

Climate Zone	EPY7/GPY4	EPY8/GPY5	EPY9/GPY6
4	1,972	2,090	2,250
5	16,217	16,002	16,749
Total	**18,189**	**18,092**	**18,999**

Participant Feedback

To create a record of how the program affected code compliance and enforcement, Cadmus conducted in-depth interviews with 25 individuals who had attended one or more residential or commercial energy code classroom training sessions sponsored by DCEO as part of the program.

The primary goals of these interviews were to determine whether and how the skills and knowledge obtained from the training sessions are being applied in the field by training participants, as well as to assess the impact the training and technical assistance offered by the program has had on compliance with the 2012 IECC throughout the state. Cadmus provided the expert panel with a summary of the interviews in order to allow the panel to estimate how much the program affected commercial and residential code compliance in Illinois.

Interview Design

To determine the impact the program has had on compliance with the 2012 IECC, Cadmus assumed training participants were generally aware of and complying with the 2009 IECC. As such, interview guides focused on provisions that were added or became more stringent in the 2012 IECC when compared to the 2009 IECC and that had the most impact on energy efficiency. These provisions were identified by Cadmus staff with extensive knowledge of current and previous versions of the IECC.

Table 9. Interview Focused Code Provisions

Residential Provisions	Commercial Provisions
Ceiling insulation of R-49	Continuous roof insulation of R-25
Window U-factor of 0.32 in Climate Zone 5	Slab-on-grade insulation of R-10
Service hot water heating piping insulation of R-3	Maximum window-to-wall ratio of 30 percent
Maximum duct leakage requirement of 4 cfm (cubic feet per minute)/100 ft2 of conditioned floor area	HVAC commissioning requirements for buildings with a cooling capacity of at least 480,000 Btu/hour and heating capacity of at least 600,000
Air leakage testing requirements and four maximum air changes per hour (ACH)	Reduced whole building lighting power density and the space-by-space approach based on space type
	Additional efficiency package options
	Lighting control testing requirement (commissioning)
	Continuous air barrier requirements

Cadmus asked code officials and building professionals about each of the measures in Table 9 and the ways in which their enforcement of or compliance with the given provision had been influenced by their participation in the program.

Additionally, interviewers asked all respondents a series of open-ended questions about the impact of the training on their work, information from the training that they shared with other parties, key sources of code-related information, and perceived effects on code compliance.

Interview Respondents

Twelve of the 25 respondents worked for municipalities enforcing the building code. The remaining 13 respondents worked as design professionals, home performance contractors,[14] HVAC contractors, educators, and utility program managers. Table 10 lists the occupations of the 25 respondents as well as whether their occupations had a residential or commercial focus. Cadmus asked respondents questions that corresponded to the focus of their occupations; 12 respondents had a residential focus, seven had a commercial focus, and the remaining six respondents had both a residential and commercial focus.

Table 10. Program Participant Interview Respondents

Position	Total Respondents	Residential Focus	Commercial Focus	Res. and Comm. Focus
Inspector	8	2	1	5
Plan Reviewer	1	1	0	0
Permit Technician	1	1	0	0
Other	2	2	0	0
All Code Officials	**12**	**6**	**1**	**5**
Home Performance Contractor	3	3	0	0
Design Professional	7	1	5	1
HVAC Contractor	1	0	1	0
Educator/Instructor	1	1	0	0
Utility Program Manager	1	1	0	0
All Building Professionals	**13**	**6**	**6**	**1**
All Respondents	**25**	**12**	**7**	**6**

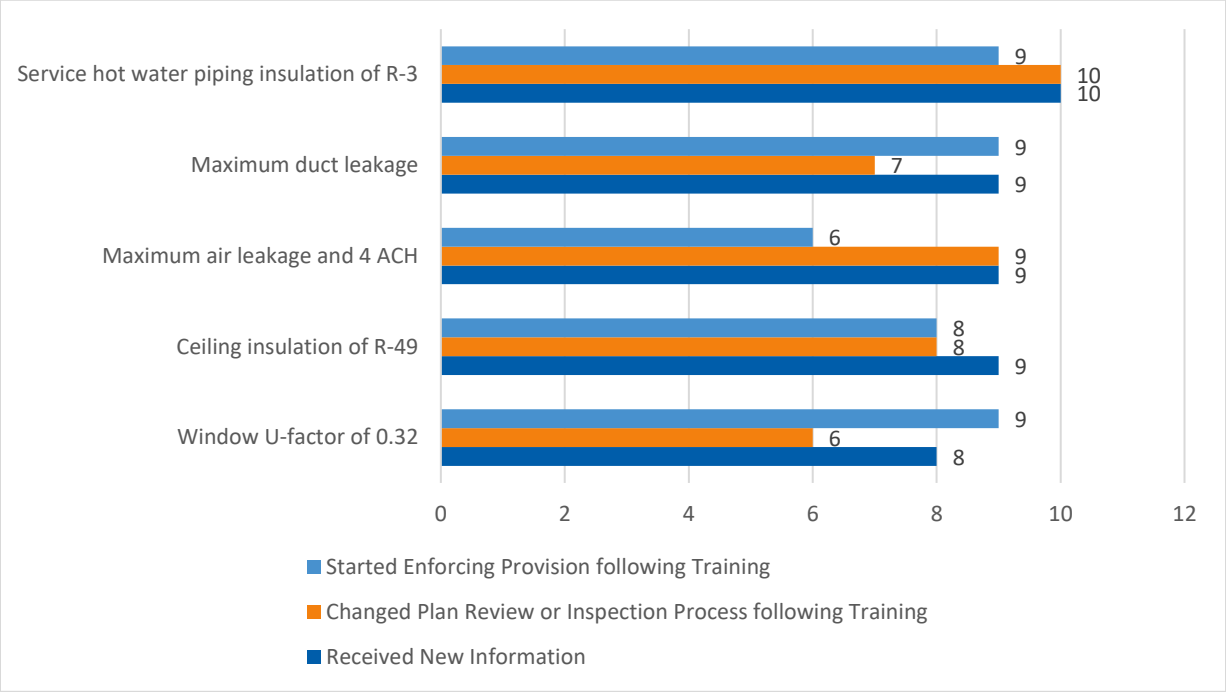
All code officials stated that their jurisdictions are currently enforcing the Illinois Energy Conservation Code based on the 2015 IECC and all building professionals (excluding educators/instructors and utility program managers) stated that most of their projects are completed in a jurisdiction that has adopted the IECC (based on the 2015 International Energy Conservation Code).

Interview Results: Residential Code Provisions

Cadmus asked code officials if they received new information about five significant residential code changes during the trainings. We also asked code officials if the training influenced them to make changes in their plan review or inspection processes regarding the provisions and if the training influenced them to begin enforcing the provisions. Figure 4 summarizes the responses from code officials focusing on residential construction. As demonstrated in the figure, most code officials received new information on each of the five significant code changes. Additionally most code officials said that they also started enforcing the provisions and made changes to their plan review or inspection processes.

[14] Home performance contractors include HERS raters, duct and envelope testing verifiers, LEED consultants, etc.

Figure 4. Code Official Feedback Regarding Training on Residential Code Provisions (n=11)



Code officials offered the following additional comments regarding the residential code trainings. In regards to the maximum duct leakage testing requirements, one respondent, stated:

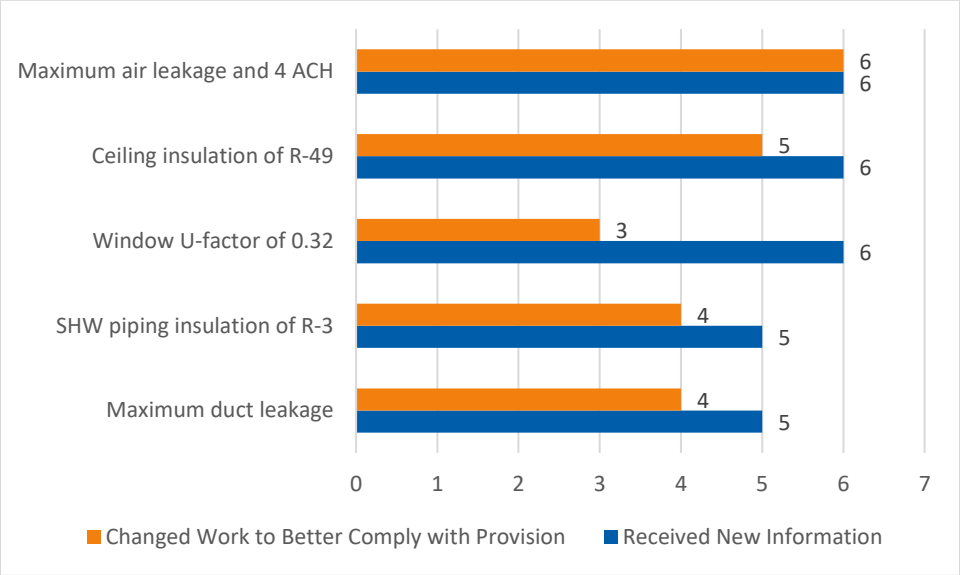
> *The testing requirements for envelope and ducts were the biggest takeaways for me from this training. The course provided a lot of explanation you may not otherwise get*.

Regarding the service hot water heating piping insulation requirement, a plan reviewer stated:

> *This was a great part of the training. We actually received a lot of calculations, explanations of distances, and the like that were very helpful in understanding the requirements. Our plumbing inspector has changed a lot of what he looks for because of training on this.*

Cadmus asked industry professionals if they received new information about five significant residential code changes during the trainings. We also asked industry professionals if the training influenced them to make changes in their work to better comply with the code provisions. Figure 5 summarizes the responses from industry professionals focusing on residential construction. As demonstrated in the figure, most industry professionals received new information on each of the five significant code changes. Additionally most industry professionals said that they were better able to comply with the code provisions following the training.

Figure 5. Industry Professional Feedback regarding Training on Residential Code Provisions (n=7)



Building professionals offered additional comments regarding the training. Regarding the ceiling insulation provision, one home performance contractor said that the training helped her understand how Illinois interprets the performance path of the energy code and enabled her to direct clients in how to trade off the ceiling insulation requirement and still achieve compliance with the code:

> *We are energy raters and we mostly work with builders to ensure they are complying with the code. We mostly do the performance path so many of the prescriptive measures are traded off using REM/Rate, HERS, or REScheck for remodels. Most builders aren't doing R-49 but we are now able to get them to comply with the energy code in other ways.*

A second home performance contractor added:

> *From our end, we're verifying [ceiling insulation]. I would say the knowledge from this class has had an impact on our ability to work with clients who are achieving [compliance with] the 2015 or 2012 [IECC} both prescriptively and using the performance path. The class has helped me ensure clients are making compliant decisions.*

Regarding the Illinois air leakage amendment, a home performance contractor added that the instructor "did a great job explaining when testing has to occur and the significance of air changes per hour," which enabled him to better perform in the field.

An architect explained that he updated his notes to include the requirement, but that contractors and inspectors were responsible for compliance:

> *Chicago doesn't [require] this so we defer to building inspectors instead. If the inspectors think the envelope is leakier than it needs to be, they can require testing, but Chicago does not require this up front. We revised our notes to specify how the test needs to be performed, but it is up to the contractors and the inspectors to make sure it complies.*

In regards to the maximum duct leakage testing requirement, one home performance contractor said:

> *This was a big change for us and the training definitely helped with that. Just clarifying total duct loss and defining areas to seal has helped me perform better. There is a lot of trial and error on the job site for how to best make everything work and that isn't something that is generally taught well in a course.*

Interview Results: Commercial Code Provisions

Figure 6 shows that most code officials that focus on commercial construction learned new information about the eight commercial code provisions that are particularly impactful in regards to energy savings. For many of the impactful code provisions the training also influenced code officials' enforcement processes, or influenced them to enforce the provisions.

Figure 6. Code Official Feedback Regarding Training on Commercial Code Provisions (n=6)

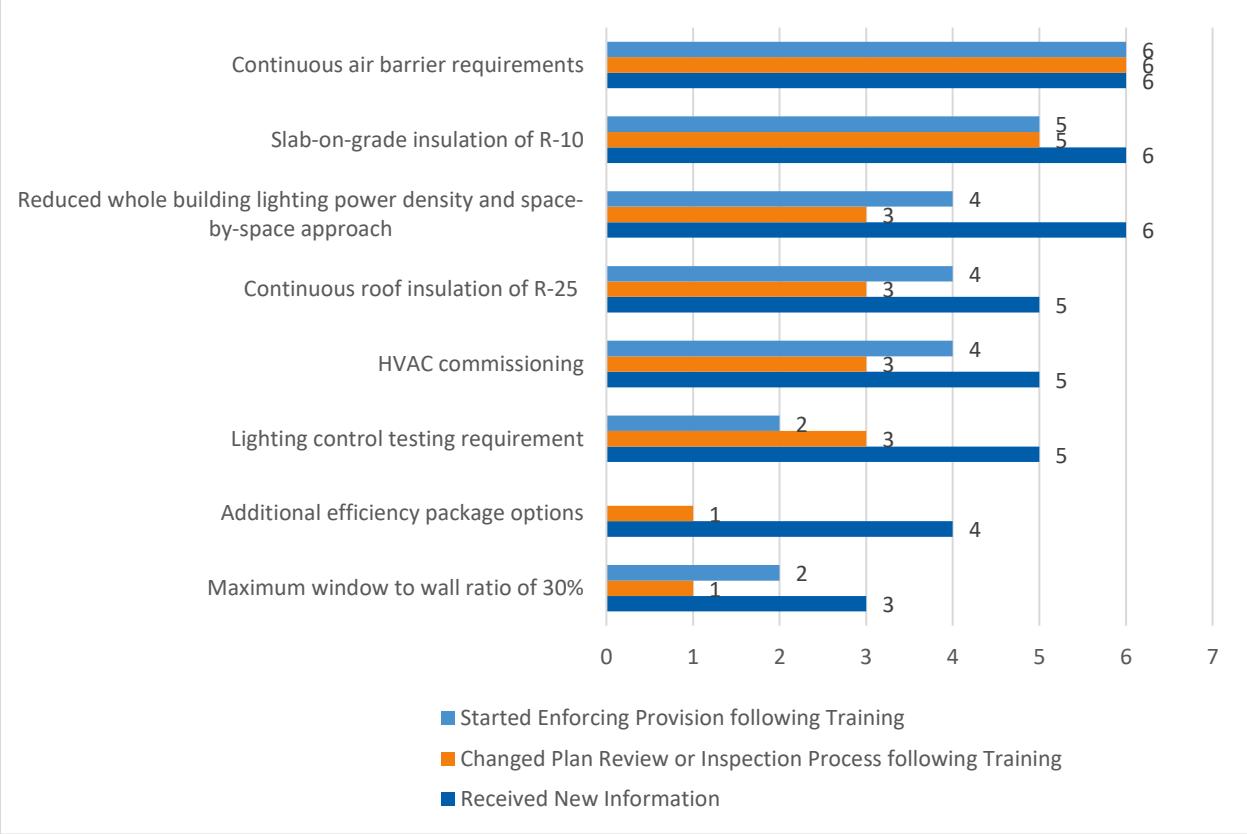
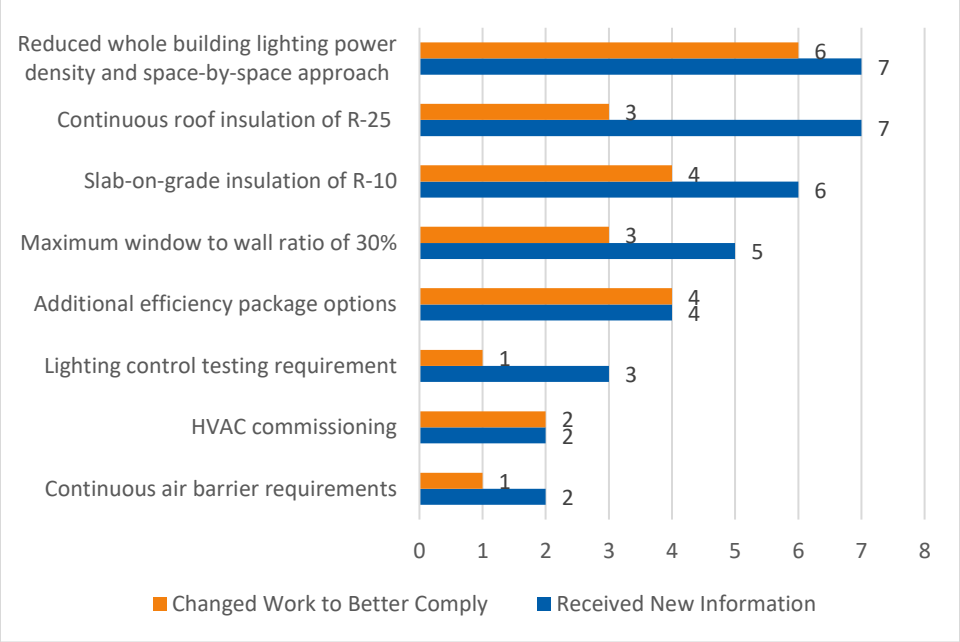


Figure 7 indicates shows that most building professionals that focus on commercial construction learned new information from the program about the code requirements listed.

Figure 7. Industry Professionals' Feedback Regarding Training on Commercial Code Provisions (n=7)



Regarding the continuous roof insulation requirement, an engineer said that "prior to training, I was loosely aware of the requirement, but the course increased my ability to confidently give advice to architects." He added that his role in compliance is to remind architects of the energy code requirements and to incorporate code minimums into energy models, both of which he has improved because of the course.

Another engineer stated, that regarding the continuous air barriers provision, "in general, we use lower infiltration rates in energy models and load calculations because of the training."

An HVAC contractor and an engineer added comments regarding the HVAC commissioning provision. The HVAC contractor said, "We learned what is required on the larger projects we do. We don't do commissioning ourselves, but we now know what to expect from third party commissioning agents." The engineer said that he now leaves notes on his drawings to alert contractors to pay attention to commissioning requirements, an action he did not take prior to the training.

Participant Feedback: Areas Where Training Influenced Code Inspections

Five of the eight code inspectors interviewed identified additional areas where training provided solid knowledge of the energy code basics and changes, which they applied to conducting energy code inspections (see Table 11). One inspector added, "I think it's mostly about getting used to the code and code changes and the cumulative experience of years looking at the energy code. The changes are a large part of becoming familiar and comfortable with the code."

Table 11. Other Areas Where Training Influenced Energy Code Inspections (Multiple responses; n=8)

Areas	Number of Code Officials
Energy code basics/ changes	5
Wall insulation requirements	2
Plumbing requirements	2
Building envelope requirements	1
Skills and qualifications of third-party verifiers	1
Illinois amendment cheat sheet	1

Two respondents also identified wall insulation requirements covered by the training as an area in which the training has influenced how they conduct inspections. A code official elaborated:

> *For one, [the training] has helped with our enforcement of wall insulation. The examples that were provided, including the moisture barrier and insulation have helped us with one of our biggest enforcement issues. Insulation has been the biggest thing we end up with pushback on from the contractors. Having that training, especially on attic insulation, has been important for plan review and enforcement. If nothing else, we have the backup we need to show contractors that we are enforcing insulation requirements because they are in the code and therefore, it's the law.*

Seven code officials also stated that the general knowledge gained from the course, ability to discuss code changes with builders and contractors, and focus on hot water piping increased their awareness and improved their plan review process.

One code official also identified the focus on REScheck and COMcheck as having an impact on her plan review process. She stated:

> *[The training] has helped us immensely with the proverbial RES and COMcheck. Many of our contractors try to submit parts of the RES or COMcheck programs but not all of it, so the training has helped with correcting that. We understand it better so we have an easier time explaining it to them. And not just the submittal requirements but…the proper way to trade off elements of the building and other specific code requirements that need to be included.*

Participant Feedback: Areas Where Training Helped Building Professionals Comply with the Energy Code

Nine of the 12 building professionals said that the trainings about the mechanical provisions of the 2012 IECC helped them better comply with the code. As illustrated in Table 12, additional training topics that helped building professionals better comply with the energy code included building envelope requirements and Illinois code interpretations.

Table 12. Other Areas Where Training Increased Code Compliance (n=12)

Areas	Number of Building Professionals
Mechanical requirements (all)	9
Load calculations	2
Minimum efficiency for HVAC equipment	2
Motor requirements	1
Economizer requirements	1
Mechanical ventilation requirements	1
Demand control ventilation requirements	1
Bob's House as a reference	1
Building envelope requirements (all)	3
Insulation R-value requirements	1
Building tightness requirements	1
Additional duct requirements	1
Illinois code interpretations	2
Daylighting requirements	1
Ability to share information with others	1
Performance path	1

Additionally, two respondents said that receiving information about the Illinois amendments and code interpretations helped them achieve compliance with the code. A home performance contractor said:

> *The true benefit for us is to see how Illinois interprets a lot of the code. The most valuable part of the training is [the trainer's] viewpoints, considering he is the voice of the Energy Department in Illinois. We really value his viewpoints on how certain sections are or should be enforced versus what is written in the code since that is often interpreted different ways. We work in multiple states and the code is enforced two ways depending on the state or even within municipalities. I would say that's the real benefit for us as a rating company.*

Another home performance contractor, described how the training focused equally on prescriptive and performance requirements, which helped her better comply with the performance path:

> *The training has been important to understanding that there's two ways to achieve these metrics - performance or prescriptive. For us, we prefer the performance path. It allows flexibility - over-excelling in one area, can back off in others. Clients are given ability to do more of what they want to do or what is important in a specific project. The training has supported us in achieving compliance with the performance path also.*

Participant Feedback: Code Compliance Issues Corrected by Training

Both code officials and building professionals described a number of ways in which the training helped them find and correct compliance issues that they might have missed prior to the training. Table 13

summarizes the variety of answers provided by both the code official and building professional respondents.

Table 13. Code Requirement Compliance Issues Missed Prior to Training (Multiple responses; n= 25)

Core Requirement Compliance Issue	Total Respondents (n = 25)	Code Officials (n=12)	Building Professionals (n=13)
Issues, but no specifics provided	6	1	5
Piping insulation	3	1	2
Duct leakage/ sealing	2	1	1
Not applicable	2	1	1
Tradeoffs/ performance option	2	2	0
Duct work in unconditioned spaces	1	1	0
Slab insulation	1	1	0
Attic insulation	1	1	0
Gasketed joints	1	1	0
Kneewalls	1	1	0
Air conditioners in attics	1	1	0
Fireplace door requirements	1	1	0
Fresh air requirements	1	1	0
Lighting controls	1	0	1
Equipment compliance	1	0	1
Air infiltration	1	0	1
Continuous insulation	1	0	1

Six respondents (five building professionals) most commonly said there were compliance issues prior to the training that the training addressed, but did not provide specifics.

Additionally, six respondents noted that they had no code requirement compliance issues, or could not think of any, prior to the training. One home performance contractor said, "Rather than totally changing the way I help others comply with the code, the training helped fill in informational gaps I had and allowed me to better and more confidently convey information to builders and code officials." An inspector also said that his department would have missed the code changes, but the training ensured they fully understood them.

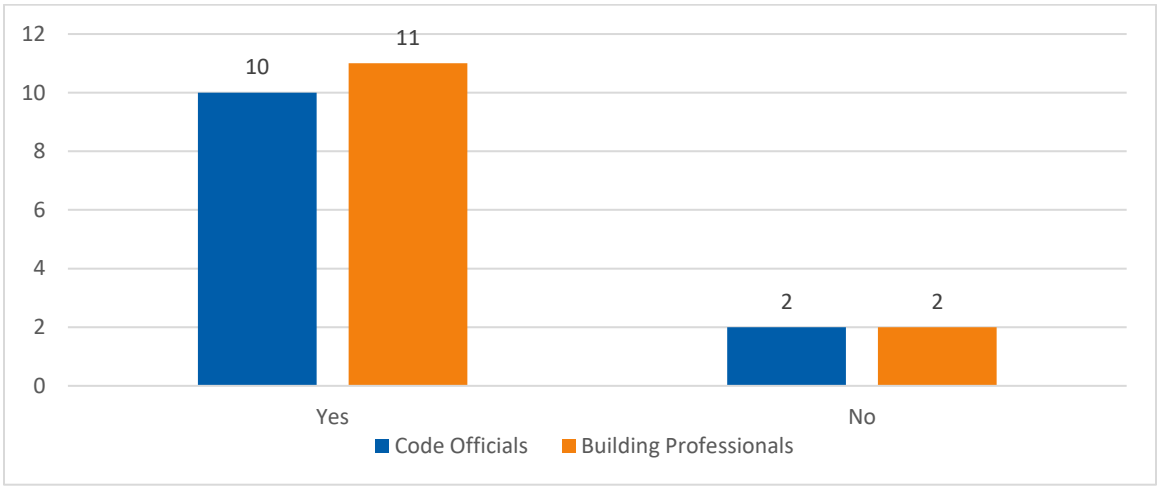
Participant Use of Training Materials

Training participants received a variety of handouts at each training offered by DCEO, included training slides, along with supplemental material, such as the International Energy Conservation Code Book (subsequently referred to as the Code Book), a success manual for complying with the energy code, a copy of Bob's House[15], a duct calculator, or HVAC equipment manuals.

[15] The Air Conditioning Contractors of America publishes Bob's House, a step-by-step case study in the proper design of a residential HVACR system.

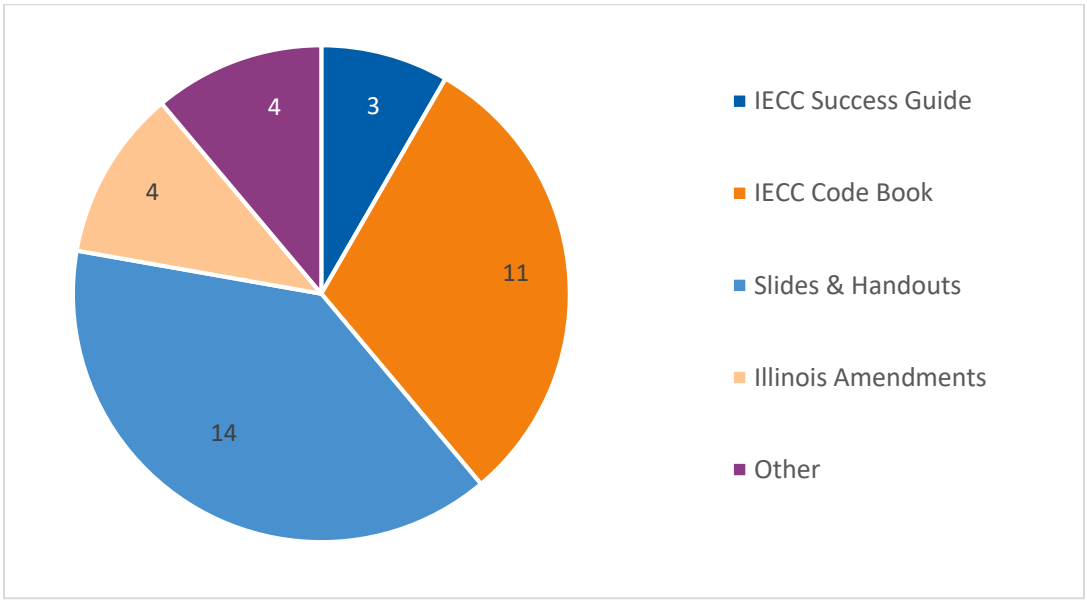
As indicated in Figure 8, 21 of the 25 respondents indicated that they had used the training materials since attending the training session. The remaining four respondents had not used the training materials; however, two of these respondents indicated that they referred to the Code Book itself for any references.

Figure 8. Use of Training Materials (n=25)



As shown in Figure 9, respondents most commonly referenced the slides and handouts (14 out of 20) and the Code Book (11 out of 20).

Figure 9. Type of Training Materials Used (Multiple responses; n= 25)



An architect said the handouts were useful "because they are a shortcut to searching throughout the code." An HVAC contractor added, "One of the nice takeaways from the course was getting a copy of the

Code Book. Having the Code Book in our office as a reference and being able to share that was good. I came back to the office with a good stack of information that we use pretty regularly."

A plan reviewer noted that she received several handouts at the training, made copies of them, and shared them within her office. She also received a copy of the 2012 Code Book and Illinois amendments, which she found "very helpful to the department." A second code official said that the handouts "are especially useful if we're dealing with a contractor or homeowner without a good understanding of energy. We always use them in those scenarios."

Training participants also indicated that they further disseminated the knowledge that they gained from the trainings. Table 14 illustrates the parties with whom code officials and building professionals shared information from the trainings.

Table 14. Parties with Whom Training Information Was Shared (Multiple responses; n=25)

Parties	Total Respondents	Code Officials	Building Professionals
Colleagues	15	6	9
Contractors	14	8	6
Design Professionals	5	2	3
Builders	5	4	1
Everyone / All Interested Parties	5	4	1
Other Jurisdictions	3	3	0
Professional Organizations	2	1	1
Code Officials	2	0	2
Inspectors	1	1	0
Clients	1	0	1
Students	1	0	1
Energy Raters	1	0	1
Developers	1	0	1
Residents	1	1	0

Code officials and building professionals most commonly shared the information with their colleagues (15 out of 25) and contractors (14 out of 25). About sharing the information with his colleagues, one code official said, "We have a very vast networking group in our area and we always discuss what we learn with those other individuals. We make sure we all have the same baseline of knowledge and same level of enforcement." An inspector added, "I don't like surprises, so when contractors are trying to bid these jobs, it's better for them to know upfront what I expect than to take things apart to redo it. That's why I share [the information]."

One architect elaborated on the importance of sharing information with contractors and developers:

> *I share much of the information from the training with fellow architects, but it is especially important for me to share it with contractors and developers who are often unaware of the*

codes that they are responsible for upholding. Contractors and developers need education, as well as the code enforcement agencies to prevent misunderstandings about compliance details.

Interview participants further elaborated on the kind of information that they shared. As shown in Table 15, nearly one-third of respondents (8 out of 25) shared key code changes they learned from the training with other parties and almost one-fourth (6 of the 25) shared general training information. Respondents also said they shared various mechanical provisions (4 out of 25) and insulation requirements (4 out of 25). Three code official respondents did not specify the type of information they shared with other parties.

Table 15. Information Shared from the Training (Multiple responses; n= 25)

Information	Total Respondents
Key code changes	8
General training information	6
Mechanical provisions (all)	4
Equipment sizing	2
Ventilation requirements	1
General HVAC	1
Insulation requirements	4
Did not specify	3
Slides/notes from training	2
Links/resources shared at the training	2
Hot water piping requirements	1
Lighting controls	1
Illinois amendments	1
Return on investment	1

Training and Compliance with the Energy Code

Interviewers asked code officials and building professional if, in their opinion, training increased compliance with the energy code.[16] All respondents (10 code officials and 11 building professionals) agreed that training increased compliance with the code. Several respondents provided additional information as to why they believed training impacted compliance. A permit technician explained:

I have always believed that knowledge is power. I am able to enforce the energy code at the level I do because of the training. The DCEO training is especially helpful. If I am learning something every time I go to those classes, they are doing exactly what needs to be done. … I am taking it back, applying it, and explaining it to others; this is crucial to compliance overall and to the success of the energy code.

A code official also explained why training was crucial to enforcement:

[16] Four respondents did not answer because this question was added after the interview process started.

> *[The training is useful] especially when we can use the information as reinforcement. We can tell people what they need to do over and over again, but when we have solid code knowledge and know where in the code the requirements are located, we can tell people how [the requirements] apply to different projects and in different scenarios. We are ensuring the code is followed and people can't argue with that.*

A second inspector provided his own insight into the importance of training on the enforcement community:

> *In my experience, most of my people who have been in the industry for a period of time have the basics down. They have a grasp on the basics, but they won't keep up with changes unless they have to. Instead, they rely on HERS people and those in the trades. If they have questions, they are likely to throw them to HERS raters for compliance verification. But attending training helps with all of that and they can rely more on their own knowledge, which of course helps with compliance and verification.*

An engineer, however, had a different perspective, saying that training impacts compliance, but has no effect on enforcement.

While the respondents overwhelmingly believed training increased compliance, an inspector added:

> *But I don't think more training is the answer. The answer is possibly some type of assistance in getting enforcement of the energy code accomplished. For example, finding out who doesn't have the personnel to enforce the code; we can assist by providing third-party people to do paperwork, review, inspections. I am not sure how to get that accomplished, but it's the missing piece. You will see the same people at the training all the time so you likely won't reach those that aren't interested, can't budget it, or aren't enforcing the code at all.*

Participant Feedback: DCEO Technical Assistance

Over half of the total respondents (13 out of 25) named the program implementer as their key source for code interpretations and code-related questions; eight of those respondents were code officials. Other key resources for code officials included colleagues and the International Code Council (ICC)(3 out of 12). Building professionals (n=13) were most likely to turn to colleagues (46 percent), ICC commentary (31 percent), and code officials or jurisdictions (31 percent) for code-related questions. An architect said, "We mostly go to colleagues and then code officials, if they answer the phone. After that, we just make our own interpretations." Table 16 illustrates the sources of technical information regarding the building codes.

Table 16. Key Sources of Technical Information (Multiple responses; n= 25)

Parties	Total Respondents (n=25)	Code Officials (n= 12)	Building Professionals (n=13)
Program Implementer	13	8	5
Colleagues / Internally	9	3	6
IECC Commentary	6	2	4
DCEO Contact	4	2	2
Code Officials / Jurisdiction	4	0	4
International Code Council	3	3	0
Online	2	0	2
DCEO Website / FAQs	1	1	0
Contractors	1	0	1
Green Building Advisor	1	0	1
Peer Reviews	1	0	1
Self-study	1	0	1

Eight code officials and seven building professionals identified the technical support services provided by DCEO when asked where they would first look for information about energy code interpretations and for answers to code-related questions. The number of times the respondents used the technical service provided by DCEO varied from one time per year to over 20 times in the last 12 months; many respondents were unable to provide an estimate because they were so comfortable with contacting DCEO that it was not an activity they tracked. All eight of the code officials who identified DCEO technical assistance as their key source of information said that they were "very satisfied" with the information they received in response to their technical assistance questions. A permit technician elaborated, "[DCEO and the implementer] are very responsive. They won't come right out and say this is how you should handle this situation; they will give you the interpretation and make sure you understand the science behind it." An inspector agreed, saying he was very satisfied, "because [the implementer] doesn't give an answer, he gives the logic behind the answer. That extra bit of explanation goes a long way."

Building professionals were less likely than code officials to be "very satisfied." Of the seven respondents who identified DCEO technical assistance as their key source of information, slightly more than half (4 out of 7, or 57 percent) indicated that they were "very satisfied," one respondent said they were "satisfied," and two respondents indicated they were "moderately satisfied."

A home performance contractor who said he was moderately satisfied offered:

> *I think a code official or a builder or someone who may be needing interpretation services on a more regular basis would benefit more by [this service]. I have reached out to DCEO for technical assistance twice and have mixed reviews. In one case, I received a response quickly and with fairly good insight. In another instance, I never got a response. I am not sure if I didn't get a response because it was in the middle of a funding gap or if they just forgot to get back to me.*

All eight of the code officials said the technical assistance was vital. Five of the seven building professional respondents agreed that DCEO technical assistance was vital; the other two believed the assistance to be of "medium" importance. A home performance contractor who said the technical assistance was vital elaborated:

> *It is extremely important because, at the state level, that is what code officials are looking for as interpretation. I also do work in a state that doesn't have a centralized energy department you can turn to for questions or interpretations and it's a nightmare. That's the one nice thing with Illinois – a centralized department for interpretations. I would say it's the single most important source the state has for understanding the code.*

Once again, all eight code official respondents said the technical assistance helped them enforce compliance with the code. Six of the seven building professional respondents also said DCEO technical assistance helped them achieve compliance with the code. An HVAC contractor said, "Usually I need to know something very specific and whether it is compliant. There were times the answer I received from [the implementer] was different from what I was thinking and I know that I was only compliant because of [the implementer] in those situations."

Participant Feedback: Changes in Code Compliance

As shown in Table 17, code officials and building professionals provided many examples of how compliance is increasing in their jurisdictions or areas of work.

Table 17. Indicators That Compliance Is Increasing (Multiple responses; n= 23)

Indicators	Total Respondents (n=23)	Code Officials (n=	Building Professionals (n=
Jurisdiction enforcing code better	7	3	4
Contractor knowledge increasing	5	4	1
Jurisdiction more knowledgeable	3	2	1
Increasing but no indicator specified	3	0	3
Homeowners more interested	2	2	0
Designer knowledge increasing	2	1	1
Greater builder awareness	2	1	1
Complete documentation submitted by contractors	2	2	0
Observations made in the field	1	1	0
Education effort by jurisdiction	1	1	0
Ease of passing inspections	1	1	0
Code compliance products available	1	1	0
Tighter houses in jurisdiction	1	1	0
Increased use of solar panels	1	1	0
Fewer legal issues for non-compliance	1	1	0
Wider use of the energy code	1	0	1
Use of third party verifiers	1	0	1
Increased efficiency requirements in utility program	1	0	1

Seven of the 23 respondents said that the increase in jurisdictions enforcing the energy code, either for the first time or in a better and more consistent manner than before, was an indicator that compliance with the energy code is increasing. A home performance contractor said:

> *It is hard to find a municipality in the areas that I work where the energy code isn't enforced. This hasn't always been the case. What this says to me is that code officials are taking the training, are properly informed, and are understanding the code. If a code official hasn't been to the training or isn't informed properly, we see that they tend to not enforce the code. They don't understand and don't care. Since I've been attending the training and using [DCEO] as a resource, I've noticed a change in how code officials enforce the code.*

Respondents also noted that an increase in compliance with the energy code was evident because contractor knowledge of the code was increasing, jurisdictions were more knowledgeable, homeowners showed more interest in code compliance, and documentation submitted for code compliance was more complete, among other indicators.

Non-Participant Feedback

Cadmus conducted in-depth interviews with five code officials who had not attended any of the 2012 IECC residential or commercial program trainings. We focused on code officials for these interviews since we were able to identify a pool of interview candidates. We had no source for nonparticipant industry stakeholders so we were unable to interview any of them.

The objective of the non-participant interviews was to identify differences between nonparticipants and participants in terms of their knowledge and application of the 2012 IECC once it became effective. As with the program participant interviews, nonparticipant interviews focused on the code changes between the 2009 IECC and the 2012 IECC that had the largest potential to create energy savings.

Sampling

Program trainings were available to builders and code officials anywhere within the IOUs' service territories. As such, this program covered almost the entire state, with the exception of small rural towns that did not often have building departments. Rather than trying to find builders and code officials from portions of the state not covered by the program, Cadmus searched for nonparticipants within three of Illinois' code official associations. Cadmus researched email addresses and phone numbers for all the eligible members listed on the websites of the Code Officials of Southern Illinois (CEOSI), the ILLOWA chapter of the International Code Council (ICC), and the South Suburban Building Officials Association (SSBOA)[17].

We verified that non-participant code-officials did not participate in program trainings by cross-referencing their names against those in the phone and email lists of participants from program trainings. Cadmus emailed 152 non-participant code officials (75 members of the CEOSI, 51 members of ILLOWA, and 26 eligible members of the SSBOA) to request interviews with them. We also called 96 of these individuals as an additional method to recruit some of them for interviews. In the end, we found five non-participant code officials willing to be interviewed.

Interview Respondents

We summarize the non-participant's profiles in Table 18. Unlike the program participant respondents, all of whom said they were currently enforcing the 2015 IECC building code, two non-participants told us that their jurisdictions were not enforcing the 2015 IECC. Additionally, even though the interview respondents were not on the lists of training participants that the program implementers provided, one attended trainings offered by the program on the 2015 IECC. Additionally two code officials stated that they attended trainings offered by entities other than DCEO.

[17] The Illinois Association of County Engineers (IACE), the Illinois Council of Code Administrators (ICCA), and the Northwest Building Officials and Code Administrators (NWBOCA) did not have membership contact information listed publicly on their websites, and were unwilling to provide it when contacted.

Table 18. Non-Participant Profile

County	Code Enforced	Energy Code Training	Official's Focus
Madison	2012 IECC	2012 IECC – sponsored by Lewis and Clark Community College	Commercial and Residential
Effingham	1999 BOCA National Building Code	None	Commercial and Residential
Cook	2015 IECC	None	Commercial and Residential
Cook	2015 IECC	2012 IECC – sponsored by District Council of Carpenters Chicago	Commercial and Residential
Will	2015 IECC	IECC 2015 – sponsored by DCEO	Residential

Residential Code Provisions

Four of the five interview respondents provided information on how their jurisdictions enforced the 2012 IECC (prior to the effective date of the 2015 IECC). One respondent told us that her jurisdiction is enforcing the 1999 BOCA National Building Code.

Table 19. Non-Participant Feedback on Residential Code Provisions (n=4)

Code Provision	Awareness of Provision When Code Adopted	Source of Learning about Provision	Issues Faced Enforcing Provision
R-49 Ceiling Insulation	• Aware at adoption (3)	• Southern Illinois Code Officials' meeting (1) • Review of code document (2) • International Code Council (1)	• None (3)
Window U-factor of 0.32 (CZ 5)	• Aware at adoption (2) • Not located in CZ 5 (1)	• Review of code document (2) • International Code Council (1)	• None during plan review (2) • Informing contractors to update windows during inspections challenging (1)
Building Envelope Air Leakage Testing and 4 ACH 50	• Aware at adoption (2) • Became aware in 2015 (1)	• Southern Illinois Code Officials' meeting (1) • Review of code document (1) • Training Seminar (1)	• None during plan review (2) • Difficulty utilizing necessary software at adoption (1)
Water Heating Piping Insulation Requirement of R-3	• Aware at adoption (1) • Not aware (2)	• State of Illinois (1)	• No issues faced (1), but 2 respondents were not aware of requirement: One had never heard of the provision but enforcing it is in their job description. One said the plumbing inspector he works with handles this during inspections so he never needed to learn about it.

Commercial Code Provisions

In terms of commercial code provisions, we found with the first individual contacted that our interview guide was not effective and so the information collected was limited. We also did not learn much from the person whose jurisdiction enforced the old BOCA code since she was mostly unaware of current energy code provisions. With a restructured interview guide, we asked the other three officials about important provisions of the commercial energy code. Their responses are summarized in

Table 20.

Table 20. Non-Participant Feedback on Commercial Code Provisions (n=3)

Code Provision	Awareness of Provision when Code Adopted	Source of Learning about Provision	Issues Faced Enforcing Provision
R-25 Continuous Roof Insulation	• Aware at adoption (2) • Not aware (1)	• Review of code document (2)	• None at plan review (2) • Occasional difficulty inspecting work because contractors move quickly (1)
R-10 Slab-On-Grade Insulation	• Aware at adoption (3)	• Review of code document (2) • Plan review staff (1)	• No issues faced (3)
Window to Wall Ratio of 30%	• Not aware (2) • Aware at adoption (1)	• Plan review staff (1)	• No issues faced (1) but 2 were not aware
Continuous Air Barrier Requirements	• Aware at adoption (2) • Not aware (1)	• Southern Illinois Code Officials' meeting (1) • Review of code document (1)	• No issues faced (2) but 1 was not aware
HVAC Commissioning Requirements	• Aware at adoption (2) • Not aware (1)	• Southern Illinois Code Officials' meeting (1) • Review of code document (1)	• No issues faced (2) but 1 was not aware
Lower Lighting Levels – reduced whole building LPD and addition of the space-by-space approach	• Aware at adoption (3)	• Southern Illinois Code Officials' meeting (1) • Review of code document (1) • Training Seminar (1)	• No issues faced (3)
Functional Testing or Commissioning of Lighting Control Systems	• Not aware (2) • Aware at adoption (1)	• Plan review staff (1)	• No issues faced (1) but 2 were not aware
Additional Efficiency Package Options	• Aware at adoption (2) • Aware at adoption but did not understand it (1)	• Review of code document (1) • Training Seminar (1) • Does not recall	• No issues faced (3)

Assistance with Enforcement Issues

One code official noted that his jurisdiction does not have a lot of new construction so it is generally easy to stay on top of code compliance requirements. Another respondent said they always go straight to their plan review consultant, who answers any code questions related to either the IECC or the fire code. Another respondent, who attended a seminar taught by the program implementer said that he usually contacted this trainer with questions because "he is extremely knowledgeable and gives really good guidance on how to handle [code related issues]." The code official also consults for the Code Enforcement Officials of Southern Illinois (CEOSI), which has a forum for information sharing.

Technical Assistance and Other Sources of Code Education

Cadmus also asked non-participant code officials where they usually go for assistance with code related questions. One respondent mentioned each of the following as sources of information when they had technical questions about the energy codes: the DCEO, the program implementer, resource persons within their jurisdiction, the International Code Council, and the department's paid plan reviewer.

One official described the DCEO as a "vitally important resource" for getting answers to technical questions regarding energy codes. Another official stated that he had contacted the implementer over 30 times since late 2015 with technical questions, receiving assistance in person, online, and by telephone. The official has been "very satisfied" with the information he received.

Code Officials' Perceptions on the Importance of Training for Code Enforcement

Three of the four code officials mentioned that they attended training other than the program's. These included seminars with the Southern Illinois Code Officials Association, the Building and Fire Code Academy, the International Code Council, and the local community college. All four respondents stated that trainings increased enforcement with the energy codes. The officials' remarks included the following:

> *…[T]he more you know about a subject the less grey area there is for someone to try to get into … if I didn't know this stuff then contractors would have tried to manipulate the situation to get away with noncompliance…*
>
> *… [E]ven if you pick up a few items during a training…. when you go back to enforcement you're better, no matter what there's always something good to take away…*
>
> *… [Training] not only helps us enforce the code, but when our builders and contractors are up to speed, it helps them comply with the code. An increase in knowledge also saves us a lot of time - we aren't sending plans back or doing repeat inspections and we aren't spending a lot of time explaining why we require what is in the code…*

Previous Compliance Studies Review

Cadmus reviewed two studies that had analyzed energy code compliance in Illinois. One study, conducted by ADM Associates,[18] was prepared for DCEO to "[t]o determine the statewide baseline level of code compliance of [both residential and nonresidential] new construction projects." ADM's report was published in 2014. The other study was prepared by Association of Professional Energy Consultants (APEC), Inc. and was published in 2011.[19] Cadmus shared a summary of these reports with the expert panel to inform their input for the energy savings model. Table 21 presents a summary of the reports.

Table 21. Summary of Previous Compliance Studies

	ADM Associates (2014)	APEC (2011)
Code version(s)	2012 IECC	2009 IECC
Estimated Residential Compliance	90%	79%-80%
Estimated Commercial Compliance	Inconclusive	Inconclusive
Methods	• 30 residential, 13 commercial sites constructed after January 2013 visited • PNNL Score+Store forms utilized to estimate compliance • Residential non-compliance primarily attributed to failure to perform duct blasting tests or provide HVAC sizing calculations	• 44 residential, 10 commercial sites evaluated • PNNL Score+Store forms utilized to estimate compliance • PNNL Score+Store approach utilized to estimate compliance • REScheck, COMcheck, and REM/*Rate* software used in field visits
Notes	• Opt-in nature of study could have created a self-selection bias • Sample size too small to report commercial compliance	• Report identified errors in with the compliance software that would "significantly affect compliance assessment" (See page 6) • Sample size too small to report commercial compliance

[18] Evaluation of Illinois Baseline Building Code Compliance, ADM Associates, June 2014

[19] Measuring the Baseline Compliance Rate for Residential and Nonresidential Buildings in Illinois, Association of Professional Energy Consultants, Inc. (APEC), June 2011

Expert Panel

To produce an attribution estimate that reflects the share of energy savings resulting from an increase in code compliance attributable to the program activities, Cadmus assembled a panel of experts in building energy codes and code compliance. Cadmus shared participant and non-participant interview results and findings from previous compliance studies, and asked experts on the panel to provide estimates on how much the program affected energy code compliance in the residential and commercial sectors in Illinois. We used the panel's estimates to model energy savings for the program.

Expert Panel Selection and Participation

To create a candidate list of knowledgeable, objective panelists, Cadmus sought experts both in and out of the state of Illinois with the experience and credentials necessary to evaluate the impact of the program on energy savings. Cadmus invited 18 individuals to participate as part of the expert panel, including code officials, architects, homebuilders, energy code consultants, trainers, educators, energy engineers, policy experts, and program managers. The experts' work included firsthand experience with the Illinois energy code, participation in code enforcement organizations and regional energy efficiency organizations, and involvement in similar studies conducted in other states. Nine of the 18 experts invited to serve on the panel agreed to participate, including four in-state experts (a policy manager, architect, and two code officials with experience in code enforcement organizations) and five out-of-state participants (an energy efficiency scientist, code consultant, energy code trainer and educator, and two program managers).

Expert Panel Process

To facilitate the expert panel process and to familiarize the panelists with the intent of the evaluation, Cadmus sent all nine experts who agreed to participate a package of review materials via e-mail. Panelists received a memo that summarized the information (including interview results, previous study findings, and program activities) collected as part of the evaluation, which could be used to support an assessment of the program's impact.

Cadmus hosted a webinar in April 2017 and question and answer session to discuss the materials sent to panelists and to address any questions or concerns from the experts. We then asked each panelist to individually review the information and provide feedback on their attribution estimate in the form of commercial and residential code compliance levels in 2013, 2014, and 2015 under a "with program" and hypothetical "without the program" scenario.

Expert Panel Findings

Three members of the expert panel provided estimates of commercial and residential building code compliance under scenarios with and without the program. Cadmus used each expert's estimates to model energy savings, and averaged each expert's modeled results to produce the program savings summarized in the chapter Energy Impacts of the Program.

Of the six experts that did not provide inputs, three of them told us they could not provide estimates based on the information Cadmus provided. Cadmus contacted each of the other three experts—by telephone and email—multiple times. We offered to work through the exercise with each of them in case that would be helpful. We learned that other demands on their time made it difficult for them to

review the materials and provide estimates as requested. Each of the three told us that they would provide estimates (since we extended our deadline by a few weeks) but ultimately none of them actually did.

In order to model the energy savings resulting from the program with the methodology described in the Modeling Approach to Estimate Energy Savings section above, Cadmus asked the experts to provide the inputs for two different scenarios:

Current Illinois Code Compliance Scenario (with the program):

- Estimated percent of new residential construction that is fully code compliant for 2013-2015
- Estimated percent of energy savings achieved by new residential construction that partially meets energy code (buildings that are not fully code-compliant) for 2013-2015
- Estimated percent of new commercial construction that is fully code compliant for 2013-2015
- Estimated percent of energy savings achieved by new commercial construction that partially meets energy code (buildings that are not fully code-compliant) for 2013-2015

Alternative Illinois Code Compliance Scenario (without the program):

- Estimated percent of new residential construction that would be fully code compliant in 2013-2015 if there were no program
- Estimated percent of energy savings that would be achieved by new residential construction that partially meets energy code (buildings that are not fully code compliant) for 2013-2015 if there were no program
- Estimated percent of new commercial construction that would be fully code-compliant for 2013-2015 if there were no program
- Estimated percent of energy savings that would be achieved by new commercial construction that partially meets energy code (buildings that are not fully code-compliant) for 2013-2015 if there were no program

Cadmus focused the experts' estimates on compliance with the 2012 IECC since we believed that this would enable the experts to consider the evidence assembled by Cadmus and then to make meaningful estimates of compliance. Rather than ask the experts to consider separate questions of code compliance to the 2015 IECC, we used the code compliance findings for 2013, the first year that the 2012 IECC was in effect as a model for 2016, the first year that the 2015 IECC was in effect.

Expert Code Compliance Estimates

We present the experts' feedback regarding code compliance with and without the program for residential and commercial new construction in Table 22.

Table 22. Expert Compliance Estimates

		% New Construction That Is Fully Code Compliant				% Energy Savings Achieved by Partially Meeting Code Requirements - Average for New Construction That Is Not Fully Code-Compliant		
		2013	2014	2015		2013	2014	2015
Residential Sector								
Without Program	Expert 1	50%	55%	61%		50%	53%	55%
	Expert 2	63%	66%	69%		50%	53%	55%
	Expert 3	55%	58%	61%		35%	36%	36%
With Program	Expert 1	65%	78%	94%		65%	78%	94%
	Expert 2	70%	77%	85%		60%	66%	73%
	Expert 3	60%	63%	66%		45%	47%	50%
Commercial Sector								
Without Program	Expert 1	50%	53%	55%		50%	53%	55%
	Expert 2	54%	64%	70%		40%	42%	44%
	Expert 3	50%	51%	51%		60%	61%	61%
With Program	Expert 1	65%	75%	86%		65%	72%	79%
	Expert 2	70%	80%	96%		60%	70%	80%
	Expert 3	55%	58%	61%		70%	74%	77%

Energy Impacts of the Program

Overview

Cadmus utilized the average of the expert panel's estimates of baseline compliance (hypothetical compliance in a scenario without the program) and with-program code compliance in order to estimate the energy impact of the program (according to the methods described above). We utilized an average of the expert panel's estimates of compliance rates to model the program's energy impacts, and provided results by calendar year and by program year.

To provide context, we calculated the total statewide potential using the same data on the level of construction activity. We summarized our potential findings in Appendix B.

As illustrated in Figure 10, we estimated the cumulative energy savings from the program in Illinois to be 32,300 MWh and 1,440,000 therms for 2014 through 2016. Savings shown for each year are cumulative (2015 includes the savings from 2014 construction activity and 2015 construction activity, and 2016 includes savings from construction activity in all three years). The incremental savings from 2015 to 2016 are modest because the codes adopted in 2016 in Illinois resulted in smaller overall energy savings (see: Analysis Approach, above).

Figure 10. Annual Cumulative Energy Savings by Calendar Year

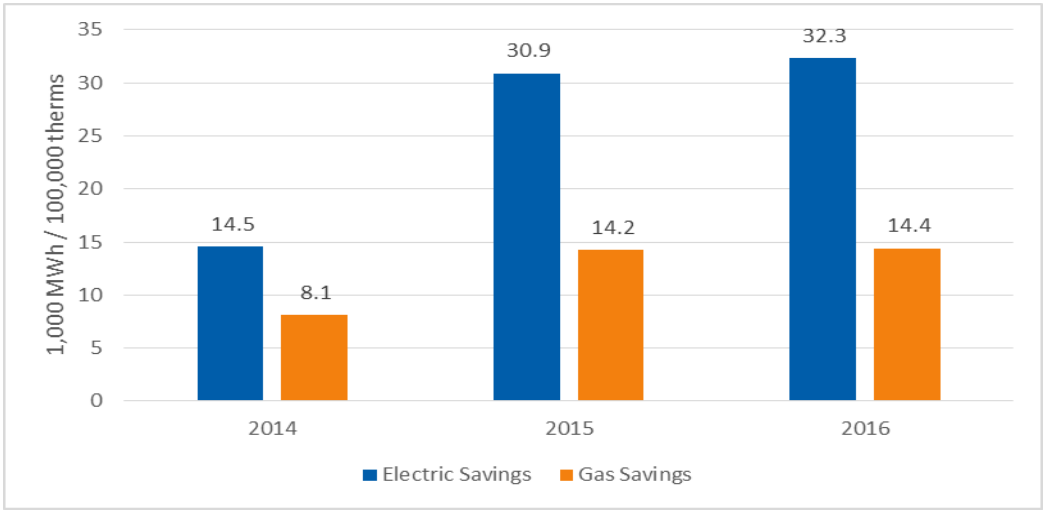
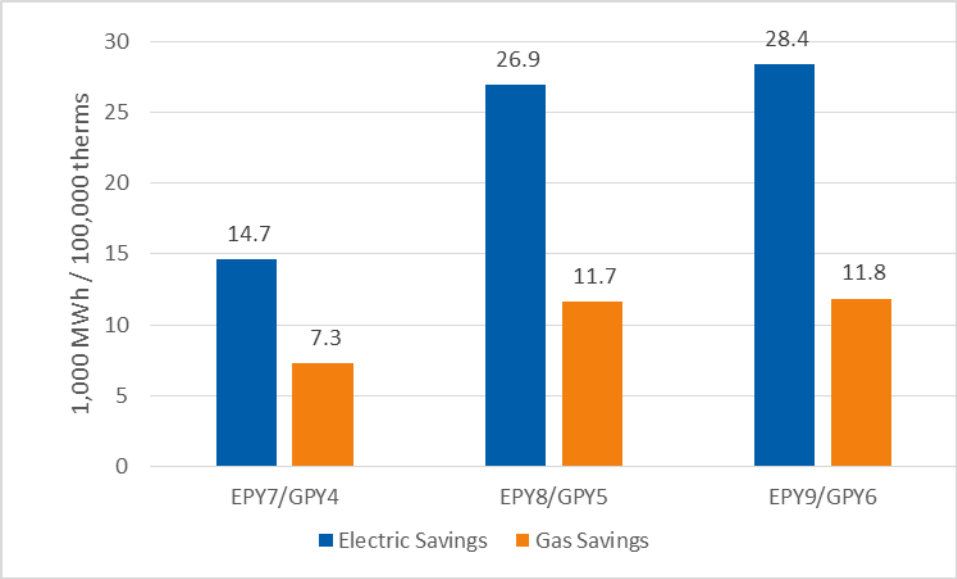


Figure 11 presents the energy savings for the DCEO program years. As shown, we estimate the total cumulative savings in PY6 (June 2016 through May 2017) to be 28,400 MWh and 1,180,000 therms. We estimate lower savings for the cumulative program years because program years run from June through May, which shifts more of the timeframe for which we analyzed into savings into the latest code versions, for which overall energy savings are lower.

Figure 11. Annual Cumulative Energy Savings by Program Year



In Table 23 we summarize the incremental savings for EPY8/GPY5 by sector and fuel. The estimated statewide energy savings attributable to the program were allocated to individual utilities through a two-step process. In the first step, total energy savings were attributed to the electric and gas utilities. Then the savings were allocated to the individual utilities.

For the electric savings, U.S. Energy Information Agency data were referenced to estimate the portion of electric impacts that accrued to the electric utilities that funded the program operations. According to 2015 data on utility retail sales, in Illinois, 78.03% of electricity was sold by ComEd and Ameren Illinois.[20] Total program-attributable electric energy savings were multiplied by 78.03% to calculate the total claimable electric energy savings, ensuring that energy impacts are not inappropriately associated with ComEd or Ameren Illinois customers. Table 23 shows the resulting utility savings of 9,568,241 kWh as the share of electric savings attributed to ComEd and Ameren Illinois.

For the gas savings, American Gas Association data were referenced to estimate the portion of natural gas impacts that accrued to the natural gas utilities that funded the program operations. According to 2015 data on natural gas utility sales volume in Illinois, 94.97% of statewide residential, commercial, and industrial gas sales volume was associated with Nicor, North Shore Gas, Peoples Gas, and Ameren

[20] https://www.eia.gov/electricity/sales_revenue_price/xls/table10.xlsx

Illinois.[21] Total program-attributable natural gas energy savings were multiplied by 94.97% to calculate the total claimable natural gas energy savings, ensuring that energy impacts are not inappropriately associated with Nicor, North Shore Gas, Peoples gas, or Ameren Illinois customers. Table 23 shows the resulting utility savings of 414,828 therms as the share of natural gas sold by Nicor, North Shore Gas, Peoples Gas, and Ameren Illinois.

Table 23. Summary of EPY8/GPY5 Savings

EPY8/GPY5 Savings	Electric Savings (kWh)			Gas Savings (Therms)		
	Statewide Savings	Utility Share	Utility Savings	Statewide Savings	Utility Share	Utility Savings
Residential	1,826,998	78.03%	1,425,607	110,877	94.97%	105,300
Commercial	10,435,262	78.03%	8,142,635	325,922	94.97%	309,528
Total	**12,262,260**	**78.03%**	**9,568,241**	**436,799**	**94.97%**	**414,828**

In the second step, the total claimable electric energy savings were allocated to ComEd and Ameren Illinois in proportion to the financial contribution of each electric utility to program operations for EPY8/GPY5. Table 24 summarizes the share of financial contribution and program savings for each electric utility.

Table 24. Share of Financial Contribution and Program Savings by Electric Utility

Electric Utility	Share of Financial Contribution	EPY8/GPY5 Savings (kWh)
Ameren	27.62%	2,642,748
Comed	72.38%	6,925,493
Total	**100.00%**	**9,568,241**

The same approach was used for natural gas utilities: the total claimable natural gas energy savings were allocated to Nicor, North Shore Gas, Peoples Gas, and Ameren Illinois in proportion to the financial contribution of each natural gas utility to program operations for EPY8/GPY5. Table 25 summarizes the share of financial contribution and program savings for each natural gas utility.

Table 25. Share of Financial Contribution and Program Savings by Gas Utility

Gas Utility	Share of Financial Contribution	EPY8/GPY5 Savings (Therms)
Ameren	15.52%	64,375
Nicor	54.48%	226,018
North Shore	5.70%	23,629
Peoples	24.30%	100,806
Total	**100.00%**	**414,828**

[21] https://www.aga.org/sites/default/files/2015_fields.xls

Savings by Construction Sector

Cadmus estimated savings for the commercial and residential sectors separately. As illustrated in the graphs below (see Figure 12 through Figure 15), most of the energy savings for the program came from commercial construction.

Figure 12. Cumulative Electric Savings by Sector and Calendar Year

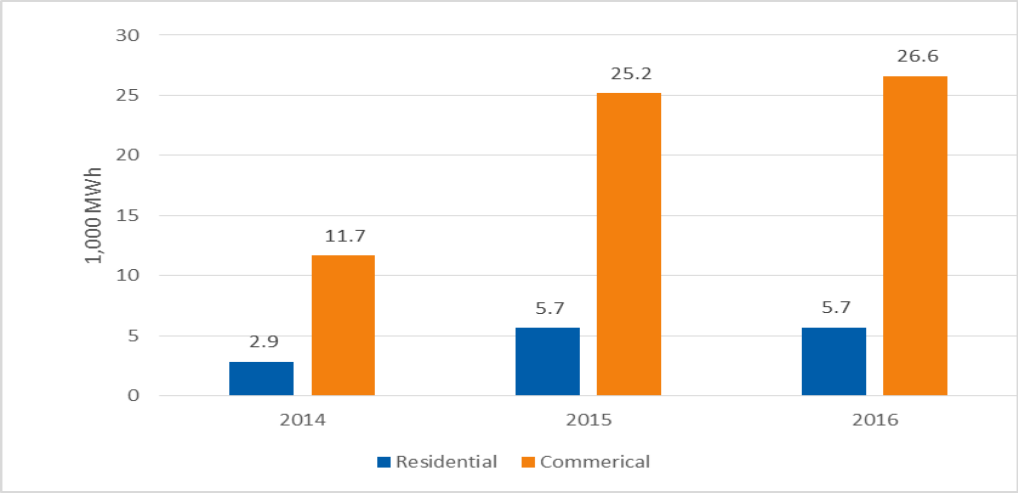


Figure 13. Cumulative Gas Savings by Sector and Calendar Year

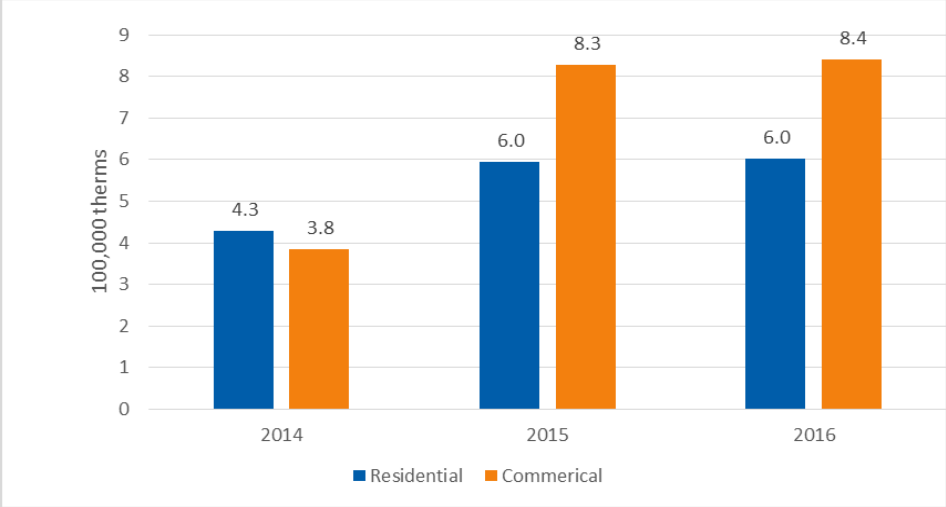


Figure 14. Cumulative Electric Savings by Sector and Program Year

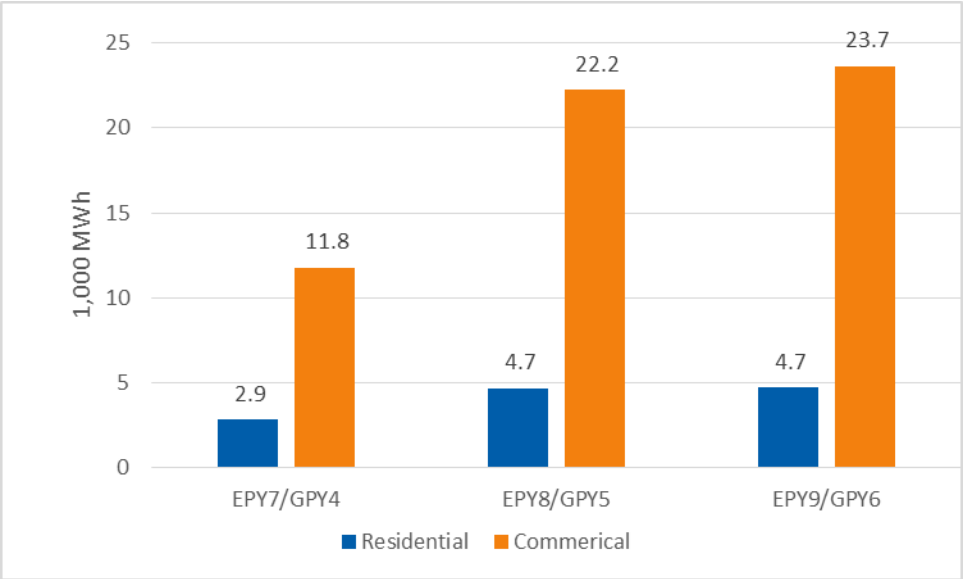
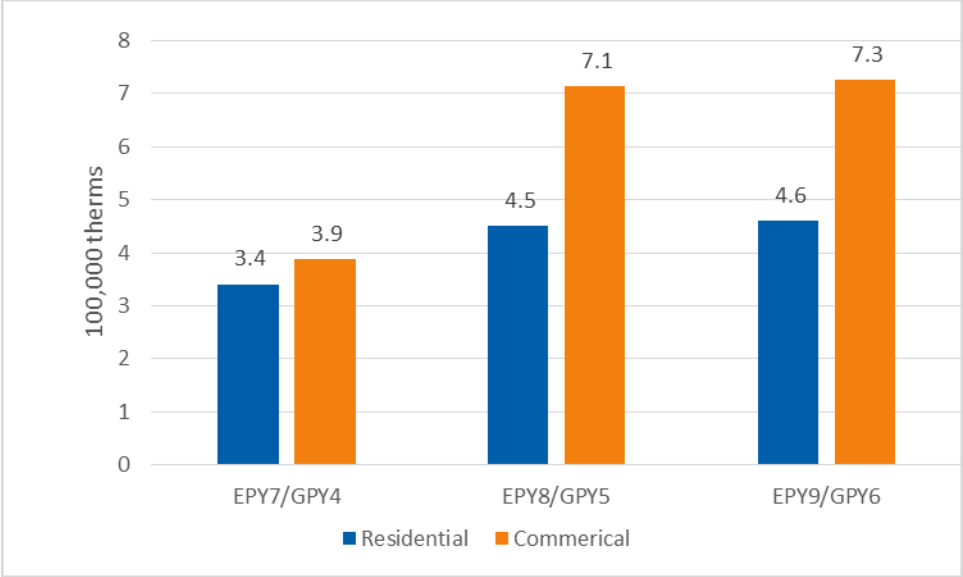


Figure 15. Cumulative Gas Savings by Sector and Program Year



Conclusions and Recommendations

Code officials and industry professionals that participated in DCEO's program, as well as code officials that did not participate, found that the program had a strong influence on the extent to which residential and commercial buildings comply with Illinois' energy codes. Enhanced code compliance in Illinois since 2014, which our study's expert panel attributed to the program, has resulted in significant energy savings over the three calendar years and three program years that we analyzed. Based on our modeling approach, available new construction data, and expert panel estimates, we calculated cumulative energy savings attributable to the program to be 32,300 MWh and 1,440,000 therms for 2014 through 2016 and 28,400 MWh and 1,180,000 therms for PY4 though PY6. Cadmus did not have any information on the cost of implementing the program, and were therefore unable to estimate the cost effectiveness of the program.

> **Recommendation:** We recommend that the Illinois utilities continue to fund a code compliance program in Illinois in order to achieve enhanced energy savings from Illinois energy codes in the future, assuming that the program is cost effective.

While the program achieved significant cumulative energy savings by increasing residential and commercial code compliance rates in Illinois, incremental savings after the adoption of the 2015 IECC were more modest than for previous years because overall energy savings from that code versus the 2012 IECC are lower than when Illinois moved from the 2009 IECC to the 2012 IECC. We observed this trend for both commercial and residential codes.

> **Recommendation:** Cadmus recommends that the Illinois utilities identify the provisions of the 2015 IECC that result in the highest levels of energy savings, and target code compliance and code enforcement training on those provisions in order to maximize the impact of the program.

Appendix A. DCEO Calculation Methodologies

Calculation Methodologies Submitted by DCEO (DCEO Exhibits 6.1 and 6.2 in Docket 13-0499)

ILLINOIS DCEO / UTILITY CODE SUPPORT PROGRAM
Residential Energy Savings Calculation Methodology

1) Calculate the gas and electric energy use of an IECC 2012 compliant home (2400 SF) and an IECC 2009 compliant home (2400SF) for Climate Zone 5A and for Climate Zone 4A using REM/Rate. The difference between the IECC 2012 energy use (compliant home) and the IECC 2009 energy use (non-compliant home) is the potential per home energy savings.[22]

2) Calculate the average number of single family and two-family homes constructed in each utility territory for the 2009-2011 period[23]. Where more than one electric or gas utility serves a county, the construction activity is divided proportionally.

3) The 2009-2011 average number of homes was increased based on the 2014-2016 residential construction forecast provided by ComEd. The same percentage increase in residential construction was assumed to apply to all other utility territories. Each investor owned utility territory was mapped by county. Where more than one electric or gas utility serves a county, the construction activity was divided proportionally.

4) Potential energy savings per home*estimated number of new homes = potential residential energy savings.

5) It was assumed that the utility program would move an average of 10% of residential construction from non-compliant (IECC-2009) to compliant (IECC-2012) – 5% first year, 10% second year and 15% third year.

6) Per home energy savings * forecasted new homes * percent of new homes affected by program = program claimable savings.

[22] A compliant residential building was assumed to meet all the requirements of the 2012 Illinois Energy Conservation Code (which is mostly equivalent to the 2012 International Energy Conservation Code). A non-compliant residential building is deemed to meet the 2009 IECC. It was assumed that non-compliant building would be built to earlier versions of the code (what contractors are used to building). Once the code compliance study is completed, there will be a much better idea of the deficiencies in a non-compliant building.

[23] US Census, Building Permit Survey, 2009-2011. http://www.census.gov/construction/bps/

ILLINOIS DCEO / UTILITY CODE SUPPORT PROGRAM
Commercial Energy Savings Calculation Methodology

1) Calculate ASHRAE 90.1-2010 code compliant energy use (kbtu/sf) for electric and natural gas for each commercial building type for Climate Zone 5A and Climate Zone 4A from PNNL Report, Appendix F

2) Calculate ASHRAE 90.1-2004 code compliant energy use (kbtu/sf) for electric and natural gas for each commercial building type for Climate Zone 5A and Climate Zone 4A from PNNL Report, Appendix F

3) Calculate average commercial construction activity (new and additions) for the period 2009-2011 for each county from REED Construction Data[24].

4) Calculate average commercial construction activity (new and additions) for the period 2009-2011 for each county by building type and by size (square feet) from REED Construction Data[25].

5) Calculate the average number of multi-family buildings (a building with over 2 units is required to comply with the commercial energy code) for the 2009-2011 period from US Census data.[26]

6) Calculate average annual ASHRAE 90.1-2010 energy consumption for commercial construction (new and additions) for each utility territory (Climate Zone 4 – Ameren, Climate Zone 5 – ComEd, Nicor, Peoples Gas and Integrys). Total building type SF per utility territory * code compliant energy use per SF.

7) Calculate average annual ASHRAE 90.1-2004 energy consumption for commercial construction (new and additions) for each utility territory (Climate Zone 4 – Ameren, Climate Zone 5 – ComEd, Nicor, Peoples Gas and Integrys). Total building type SF per utility territory * code compliant energy use per SF.

[24] Achieving the 30% Goal: Energy and Cost Savings Analysis of ASHRAE Standard 90.1-2010. PNNL-20405.
[25] REED Construction Data – Illinois, 2009-2011.
[26] A compliant commercial building was assumed to meet all the requirements of the 2012 Illinois Energy Conservation Code (which is mostly equivalent to the 2012 International Energy Conservation Code). A non-compliant commercial building was deemed to meet ASHRAE 90.1-2004. It was assumed that non-compliant building would be built to earlier versions of the code (what contractors are used to building). Once the code compliance study is completed, there will be a much better idea of the deficiencies in a non-compliant building.

8) Where a REED building type did not have a corresponding PNNL building type (PNNL building types cover approximately 70% of commercial construction), a weighted average of PNNL derived energy use was used.

9) The difference between the ASHRAE 90.1-2004 energy use (modeled as a non-compliant building) and the ASHRAE 90.1-2010 energy use (compliant building) equals the potential energy savings.

10) The 2009-2011 average square footage was increased based on the 2014-2016 commercial construction forecast provided by ComEd. The same percentage increase in construction was assumed to apply to all other utility territories. Each investor owned utility territory was mapped by county. Where more than one electric or gas utility serves a county, the construction activity was divided proportionally.

11) Potential energy savings / average annual construction (square feet) = potential commercial energy savings per square foot.

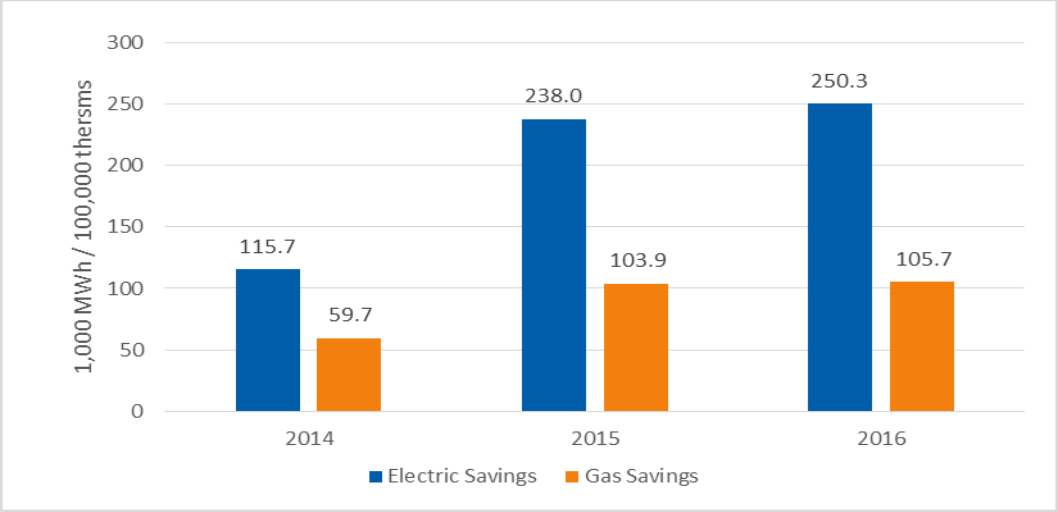
12) It was assumed that the utility program would move an average of 10% of commercial construction from non-compliant (ASHRAE 90.1-2004) to compliant (ASHRAE 90.1-2010) – 5% first year, 10% second year and 15% third year.3

13) Potential commercial savings per square foot * commercial square feet * percent of SF affected by program = program claimable savings.

Appendix B. Total Achievable Savings Potential

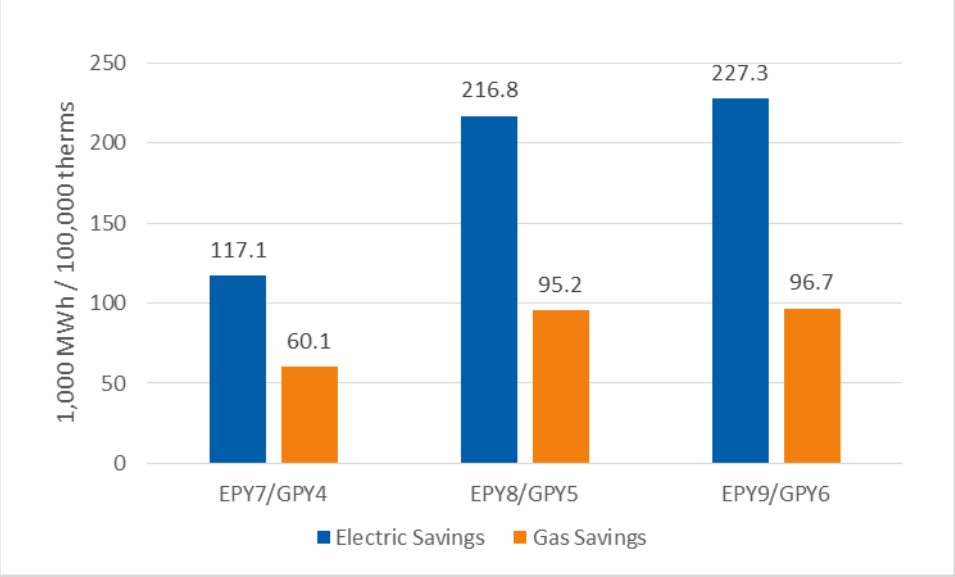
Cadmus estimated the total achievable energy savings potential from full code compliance. This energy savings estimate is based on the assumption that 100% of the commercial building stock fully complies with all code provisions. The savings result is therefore the PNNL's EUI for each year's current code version minus PNNL's EUI for the previous code version applied to the residential and commercial building stock (square footage and units respectively). As illustrated in Figure 16, the total savings potential in 2016 from full code compliance is 250,300 MWh and 10,57,000,000 therms.

Figure 16. Annual Cumulative Energy Savings Potential by Calendar Year



The total achievable energy savings potential from full code compliance in PY6 is 227,300 MWh and 967,000,000, as illustrated in Figure 17.

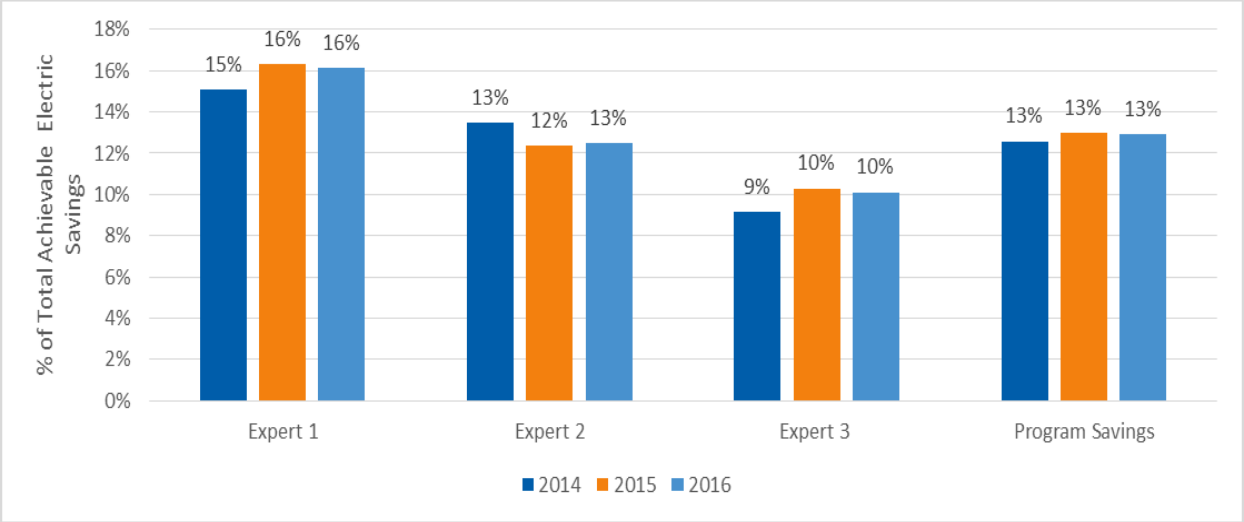
Figure 17. Annual Cumulative Energy Savings Potential by Program Year



Program Achievement as a Percent of total Energy Savings Potential

We calculated that the electric savings attributable to enhanced compliance with Illinois' energy codes was approximately thirteen percent of the total savings potential electricity savings in each calendar year. Figure 18 also shows each experts estimate as a percent of total achievable savings.

Figure 18. Percent Program Electricity Savings of Achievable Potential



As illustrated in Figure 19 the program achieved approximately fourteen percent of the total savings potential gas savings in each calendar year.

Figure 19. Percent Program Gas Savings of Achievable Potential