



FINAL REPORT

Measuring the Baseline Compliance Rate for Residential and Non-Residential Buildings in Illinois Against the 2009 International Energy Conservation Code

(ARRA funded)

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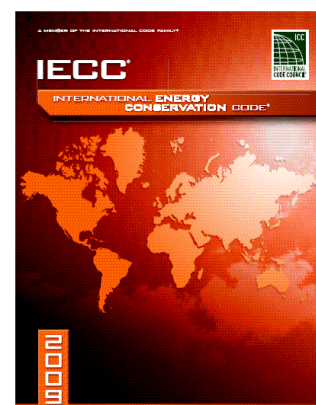
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Executive Summary

Over the past year, the U.S. Department of Energy's (DOE) Building Energy Codes Program (BECP) and the five national energy efficiency partnerships (EEPs) funded nine energy code compliance evaluation pilot studies¹ in eight states designed to measure code compliance based on these procedures and tools. During the period of April 1st to June 30th, 2011, the Association of Professional Energy Consultants, Inc. (APEC), a professional association dedicated to education and technology transfer in the energy and environmental marketplace, in cooperation with eZing, Inc. (eZing), specializing in home energy auditing and efficiency improvements, and a number of respected Illinois code professionals, conducted a field assessment to ***Measure the Baseline Compliance Rate for Residential and Non-Residential Buildings in Illinois Against the 2009 International Energy Conservation Code.***

Over the course of the 120-day project term, the APEC team evaluated a statistically-relevant sample of 44 residential buildings and a short-sample of 10 non-residential buildings across 35 distinct Illinois jurisdictions that have authority to adopt building codes. The compliance evaluation procedures and tools developed by the BECP were used to assess the implementation (a.k.a., enforcement) rates of the 2009 edition of the *International Energy Conservation Code*® (IECC®) in Illinois through measurement of the compliance rates² of these buildings as they were submitted for plan review and then constructed in the aforementioned jurisdictions.

The goals of this study were threefold: 1) Provide feedback to the BECP on the implementation of the BECP protocol 2) Develop a preliminary pattern/range of the existing compliance rates of newly constructed residential dwellings and commercial buildings based on jurisdictions in Illinois that have adopted the building energy codes and 3) Identify areas where home performance and codes training and education activities could be improved or refocused. Measurements of a small sample set (10) of commercial buildings were also taken. Due to the insignificant sample size, a commercial compliance rate is not reported here.

It must be emphasized that the primary goal of the effort centers on the first point. For the following reasons, discussed in more detail in this report, the compliance rates measured may not be an accurate representation of the true compliance rate. Nevertheless, the measurements do represent an important start, along with additional and actionable feedback to the protocol derived from jurisdictional questionnaires, in the effort by the state of Illinois and the BECP to improve the measurement tools that will be used to assess compliance requirement found in the The American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

Obstacles to Achieving an Accurate Measurement:

¹ The [pilot studies](#) concluded June 30, 2011, and the final results are being compiled.

² BECP's [Measuring State Energy Code Compliance](#) 

The following issues represented systematic obstacles to achieving an accurate compliance rate. The report will go over some of these items in more detail. Moreover, many of these issues were found to be similar to other pilot studies (other than Illinois), as identified during project “close-out” discussions.

1. Inability to achieve a true random sample because of lack of accessibility to several jurisdictions. This is a particularly sensitive issue in Illinois as it remains a home rule state, even though the state building energy code supersedes home rule. Jurisdictions with strong enforcement commitment were more likely to cooperate than those that did not. In the case of rural communities there was evidence of no enforcement capability at all. One would expect such a circumstance would introduce a significant upward bias to the results.
2. Time constraints borne out of the Grant requirements did not allow the project team to collect a statistically valid sample of commercial buildings (10 versus 44).
3. The lack of time also prevented a more thorough accounting of possible problems with performance software. Compliance is a measurement of how the built structure complies with code. While performance simulation software can allow some changes to prescriptive requirements, inaccurate inputs imparted by the user can, and will introduce non-compliance into the built structure; unless steps are taken with the software developers, users, and code compliance officials to correct the problems.

Along with identifying these issues, the APEC team will provide possible solutions geared toward generating a more accurate compliance rate.

The team of experts that conducted the study included: the principal engineer at a Model Code Organization(MCO) charged with the development and expansion of the MCO’s energy codes and sustainability initiatives; a practicing building official holding the Master Code Professional certification, the highest level of certification the International Code Council (ICC) has to offer; two highly-skilled professional energy engineers; a prominent Heating & Cooling contractor that has served the needs of the St. Louis and Illinois “Metro-East” community for more than 29 years; and a respected team of cutting-edge building science and home performance technology entrepreneurs.

As to the measurement of compliance rates, the APEC Team used the BECP State Sample Generator to cultivate 44 randomly selected new residential and 10 randomly selected new non-residential buildings located in Illinois jurisdictions based on total permits representing an annual average of 2008-2009 construction starts.

Upon receiving U.S. Department of Energy (DOE) sponsored training to ensure that plan reviews and field inspections were conducted according to the BECP-developed protocol and checklists, the APEC team utilized its code professionals and an iterative process of telephone calls and e-mail introductions to convey the purpose, scope and key-benefits of jurisdictional participation



in the study (see Appendix 'A') to the jurisdictions identified in the State Sample Generator process. Approximately 153 person-hours were spread among two code-specialists to coordinate the 54 site data collection visits among the 35 Illinois jurisdictions selected for participation. The average number of hours spent with jurisdictional partners was 3.97 hours [including brief interview (45 min.), plan-review of 2-3 project files (60 min.), and onsite visit and job-shadow of projects reviewed in the office (2:15)] at an average cost of \$496.62 per visit. Average trip distance to participating jurisdictions (one-way) varied, but on average amounted to approximately 65 miles (one-way). Note that for APEC's "North Team" trip distances, primarily in the Chicago-land suburbs, averaged 27 miles (one-way). For APEC's "Central and South Teams" trip distances, primarily in rural Illinois, averaged 115 miles (one-way).

APEC went further with its network of jurisdictional partners (i.e., Illinois building officials, field inspectors and plan reviewers) through the use of a BECP-developed jurisdictional questionnaire customized to suit the APEC interview, plan review, site and field investigation process for each jurisdiction (Appendix 'D'). APEC conducted interviews with building department personnel believing that it would help compliment its field data collection and contribute to the overall accuracy of in-situ and field-verified observations. In completing each survey, particular emphasis was placed on in-field-corroboration of plan-checked details, along with the jurisdiction's participation being part of the national effort to measure compliance rates with building energy codes and to ultimately support and improve vital efficiency measures that would help the State of Illinois address its energy and environmental challenges.

Throughout the process of compliance evaluation, the APEC team used commonly understood energy plan review and field-inspection techniques to gather and appraise data from the construction documents and various code compliance tools such as REScheck™, COMcheck™, and performance software³, utilizing the BECP-developed checklists.

³ REM/Rate™ software produces a home energy rating report based on the RESNET® National HERS Technical Standards

The state compliance metrics derived from the study and reflected in Score + Store for the following Illinois building populations are:

1. 87.2% for Residential new construction
(44 randomly selected samples from participating jurisdictions)
2. 79.1% for Residential new construction
(52 randomly selected samples from participating and non-participating jurisdictions)
3. Commercial new construction (10 randomly selected samples). A specific compliance rate is not reported due to the fact that the sample size for commercial new construction was not statistically significant.

For Residential new construction, the top three code requirements with the lowest compliance rate included: 1) The review and verification of Heating and Cooling system size(s), type and capacity, either did not meet those depicted in 2) the HVAC load calculations as submitted, or the HVAC load calculations were not submitted at all; and 3) a majority (but not all) fenestration and doors were not labeled for air leakage. Of the 44 residential building samples reviewed, 47% (20/44) utilized a prescriptive-based compliance approach, 36% (16/44) utilized the UA trade-off approach afforded by REScheck™, and 18% (8/44) utilized performance software to establish compliance based on simulated annual building energy costs.

Throughout APEC evaluators' peer-to-peer consultations, it was identified that approximately half (8/16) of the REScheck™ (UA trade-off) compliance reports and nearly all (8/8) of the performance Software compliance packages had enough errors and/or omissions in them that would significantly affect compliance assessment and ultimately field-installation and inspection. Put another way, the trade-off (REScheck™) and performance-based designs had omissions or discrepancies that were not picked-up by building department plan review personnel alone, or in the absence of dedicated plan review staff, the chief building official. This leads us to conclude that the design, home-building and code enforcement communities are either not attending dedicated training (i.e., web-based or classroom) on the proper use of the REScheck™ code compliance tool or are simply not comprehending the connectivity between the actual code text and their corollary applications in REScheck™. Chances are that if there is a question on whether something complies or not, it will more than likely pass.

The APEC team believes that the use of "customizable" building envelope libraries facilitates the inaccurate and non-uniform approval of Simulated Performance designs across Illinois. For example, the most common form of non-compliance among "customizable" building envelope libraries was observed in attic insulation designs submitted where dense-packed cellulose located in the interstitial attic floor-joist locations is assigned a density of $\rho = R-3.2/\text{in.}$ and the loose-fill cellulose piled on-top of the attic floor-joists is assigned a "continuous insulation" density of $\rho = R-5.0/\text{in.}$ The "continuous insulation" density of $\rho = R-5.0/\text{in.}$ is more suited for rigid, extruded polystyrene or polyisocyanurate insulations than for loose-fill cellulose installations ($\rho = R-3.7/\text{in.}$). It is not common for energy raters to submit construction library

details to the building department. In some instances, the “Projected Rating” depicted normalized air leakage at levels below $0.35 \text{ ACH}_{\text{nat}}$, where the code requires residential mechanical ventilation. Accordingly, the APEC team believes attention should be paid to educating the energy rater and code enforcement communities particularly with respect to the connectivity between the code text of the IECC and its corollary applications in various performance software platforms. For Commercial new construction the top three code requirements with the lowest compliance rate included: 1) The review and verification of Heating and Cooling system size(s), type and capacity, to meet those depicted in the HVAC load calculations as submitted, and 2) the appropriate Slab-edge insulation R-value 3) has been installed in accordance with the requirements of the code and the manufacturer’s installation instructions. Of the 10 non-residential building samples reviewed, 70% (7/10) utilized a prescriptive-based compliance approach, 30% (3/10) utilized the UA trade-off approach afforded by COMcheck™, and no designs utilized software to establish compliance based on annual performance. Of the 10 COMcheck™ submittals, none utilized the ASHRAE Standard 90.1-2007 compliance alternative to the 2009 IECC.

Throughout APEC evaluators’ peer-to-peer consultations, it was identified that all (3/3) of the COMcheck™ (UA trade-off) compliance reports had errors and/or omissions in them that would significantly affect compliance assessment and ultimately field-installation and inspection. In other words, the trade-off (COMcheck™) designs had omissions or discrepancies that were not picked-up by building department plan review personnel alone, or in the absence of dedicated plan review staff, the chief building official. This leads us to conclude that the design and code enforcement communities are either not attending dedicated training (i.e., web-based or classroom) on the proper use of the COMcheck™ code compliance tool or are simply not comprehending the connectivity between the actual code text and their corollary applications in COMcheck™.

1.0 Scope of Work

There were seven (7) aspects of the Illinois Baseline Compliance Rate Project that were identified in the scope of work and fulfilled by the APEC Team:

1. Evaluators to participate in DOE-approved training to ensure plan reviews and inspections are evaluated according to the BECP-developed protocol and checklists;
2. Conduct outreach to building departments with the intention of gaining access to construction drawings and gaining the ability to perform on-site inspections;
3. Schedule and perform the plan reviews and inspections;
4. Measure compliance of 44 residential buildings to the 2009 IECC using the BECP-developed sample generator, protocol and checklists;
5. Measure compliance of 10 non-residential buildings to the 2009 IECC using the BECP-developed sample generator, protocol and checklists;
6. Input the results compliance measurements and inspections into the BECP-provided database known as Score + Store; and
7. Provide both monthly reports detailing project progress and a final report.

1.1 Final Totals on Compliance

The state compliance metrics derived from the study and reflected in Score + Store for the following two Illinois building populations are:

1. 87.2% for Residential new construction⁴
2. 79.1% for Residential new construction⁵
3. Commercial new construction (10 randomly selected samples). No metric is reported due to the fact that the sample size is not statistically significant.

The APEC team questions whether the 87.2 percent compliance rate is a reasonable reflection of the residential buildings constructed in Illinois jurisdictions that have building energy codes. Reason being, this compliance rate will likely be materially affected if the APEC Team were to have received confirmation from the BECP to account for those Illinois jurisdictions that have

⁴ Score includes 44 randomly selected samples from all participating jurisdictions.

⁵ Score includes 52 randomly selected samples including all participating and non-participating jurisdictions.



authority to adopt building codes, but for the lack of political will, have elected not to, thereby ignoring State Law, the [Illinois Energy Efficient Building Act](#) (Public Act 096-0778).

More specifically, the APEC team encountered uncooperative pockets of resistance to participation in the study from jurisdictions located in the Counties of Bureau, Knox, Sangamon, Stephenson, Washington and Woodford counties. For those jurisdictions in non-participant counties with the authority to adopt building codes and with the resources (personnel) to do so, the reasons offered were attributed to an overall “lack of political will.” However, there were just as many jurisdictions in non-participant counties that while adopting a building code is a priority, adopting an energy conservation code (much less enforcing it) was simply not an option. There were also instances where the jurisdictions selected by the BECP Sample Generator either had no construction going on at all, or otherwise had, for fiscal reasons, dismissed their building official in charge of assuring construction compliance.

Through consultations with the MEEA project administrator and the BECP it was recommended that the APEC team compensate for non-participant jurisdictions with participant jurisdictions located as reasonably close (in climate zone and latitude) as that originally selected by the BECP Sample Generator. The 87.2 percent compliance score reflects this approach.

For a more accurate reflection of the circumstances on the ground, APEC also elected to report a second compliance score for residential construction that includes both participant and non-participant jurisdictions. In this way, some presumption of “minimum insulation values and U-factors” could be made, say at 30 percent or 60 percent compliance levels. Put another way, while certain jurisdictions may not have a building code in place, new homes and additions thereto will still be provided with a minimum level of insulation and energy conservation measures considered “standard” to Illinois housing stock. The APEC team recommends the BECP consider some form of “default” compliance position or guidelines which could be used by future compliance assessment teams. Accordingly, the APEC team elected to apply to the following scores to jurisdictions selected by Sample Generator for data collection from which the team was unable to collect data:

- **30%** - Jurisdiction adopts building codes but has no resources (single-man-shop) to implement IECC based on construction volume;
- **60%** - Jurisdiction adopts building codes, has resources (personnel) to enforce IECC, but does not due to political pressure;
- **Disregard Data Point** - Jurisdiction adopts building codes but has had no new construction in past 12 month period;
- **30%** - Jurisdiction does not adopt building codes, but construction continues at a “proceed-at-your-own-risk” pace;

In accounting for all participant and non-participant jurisdictions the 79.1 percent compliance score reflects this approach.

Regarding non-residential building stock, the APEC team recommends a larger and statistically relevant sample size of 44 be evaluated at a later date.

In conducting the compliance study for Illinois, APEC sees it vital to the consistent evaluation and reporting functions of the team that evaluators have familiarity, even design experience, with commercial energy systems (particularly mechanical and lighting systems design) over simple plan-review and field inspection experience. Code familiarity, understanding building department operations, plan review and field inspection experience are important. However, experience in mechanical/lighting system design, building department operations and plan review and field inspection in this order, should be considered by those appropriating monies to future studies of this kind. It is also important for the evaluation team to conduct more than one “group-evaluation” (as a team) during the initial residential and non-residential evaluations, to ensure consistency in the interpretation and field-verification of code requirements, particularly how such verifications are to be entered on BECP-developed checklists.

1.2 Assessment of Cooperation & Outreach to Building Departments

Steps taken to help secure Department cooperation included: phone contact, e-mail follow up, phone confirmation, e-mail confirmation, and a site visit to perform the work as described in Section 1.3.

Overall, there were little to no obstacles to performing the work, other than the 120-day period of performance, and roughly 6-8 weeks to reach out to ultimately 35 jurisdictions that elected to participate. Building department personnel of those 35 participant jurisdictions were cooperative, knowledgeable and helpful. While some of the participant jurisdictions were tentative at first, a majority, particularly those in the mid-central portion of the state, and those receiving a detailed description of the compliance assessment process (Appendix ‘A’), were enthusiastic about the opportunity to talk with an expert from the evaluation team. Using a modified form of the BECP questionnaire/survey, the APEC Team of evaluators concluded each site survey by giving departmental energy code plan review and enforcement operations subjective grades ranging from “Developmental” (10 of 35 jurisdictions) and “Average” (13/35) on the lower side to “Above Average” (10/35) and “Excellent” (2/35) on the higher side.

In most instances, the 35 participant jurisdictions were very eager to learn and doing particularly well with regard to attending available State-sponsored training opportunities on the 2009 IECC, despite many being single-man operations. Several jurisdictions were interested in how their region’s construction professionals, as well as their own building department personnel, compare with respect to the Illinois normative, and asked that the APEC Team report back once the Illinois normative was determined.

Documentation showing contact with Illinois building departments is provided in Appendix ‘B’. In addition to the prototypical “letter of introduction” previously cited in Appendix ‘A’, the documentation provided in Appendix ‘B’ demonstrates the depth and breadth of iterative



contact with department heads and building officials that required two dedicated code professionals and 150 person-hours of time to accomplish.

Approximately 153 person-hours were spread among two code-specialists primarily over an 8-week period during project-start, in order to coordinate the 54 site data collection visits among the 35 Illinois jurisdictions ultimately selected for participation.

The process and procedures describing how the main points of contact were initiated follows:

1. Illinois jurisdictions were identified by Sample Generator;
2. APEC code specialist assigns APEC evaluator using state map (see Appendix 'C');
3. Jurisdiction contact information identified either by their municipal web site listing or through trade association/code chapter contact(s);
4. Phone contact initiated by APEC Team utilizing the following "script" (see Appendix 'A');
5. Leave message and follow-up via formulaic e-mail "script" (see Appendix 'A');
6. Iterative contact with building official to determine acceptable time, schedule meeting;
7. Report back to APEC Administration regarding jurisdiction's desire to participate or not;
8. Select APEC evaluator and assign;
9. APEC evaluator contacts jurisdiction by phone/e-mail to confirm scheduled meeting;
10. Conduct site interview and assessment; and
11. Conduct follow-on, peer-to-peer learning visit(s) with jurisdiction as necessary

1.3 Time and Cost in Scheduling and Completing Plan Reviews and Inspections

Pricing for the scope of work included a detailed budget broken out by task, details of how personnel would be leveraged, a staffing list using fully burdened rates and expected total hours broken out by month, and a sketch of each monthly budget, as proposed.

Average trip distance to participating jurisdictions (one-way) varied, but on average amounted to approximately 65 miles (one-way). Note that for APEC's "North Team" trip distances, primarily in the northern ¼ of the state (i.e., Chicago-land suburbs north of I-80), averaged 27 miles (one-way). For APEC's "Central and South Teams" (south of I-80 to Springfield, and South of Springfield, respectively), trip distances in rural Illinois averaged 115 miles (one-way).

The travel costs included in the proposed budget were based on U.S. General Services Administration (GSA) per diem rates. An average of all of the locations in Illinois was taken, totaling \$171.00. Mileage was then added at a rate \$0.51 per mile based on the U.S. Internal Revenue Service (IRS). It was estimated that a maximum of 200 miles of travel would be



needed per trip (100 miles one-way). Each travel date was then based on \$171.00 (per diem) plus \$100.00 mileage for a total of \$271.00 per trip.

The average number of hours spent with jurisdictional partners, and therefore billable at a fixed price per visit, was 3.97 hours [includes interview (45 min.), plan-review of 2-3 project files (60 min.), and onsite visit and job-shadow of projects reviewed in the office (2:15)] at an average cost of \$496.62 per visit (excluding travel).

The costs for the Local Jurisdiction Site Visits were based on an estimated fixed price per visit with the addition of travel. The fixed price included the interview/assessment at the local jurisdictions as described. Telephone and e-mail assistance were both a flat rate fee as a “pass-through” cost for phone and internet services, and hourly rates from APEC. Data Collection and Reporting are all hourly rates.

Allocation of resources applicable to this proposal is depicted in the table below in terms of a percentage of the total work (% of total). Initially APEC identified the anticipated team members responsible for the specific task.

Function	Name	Est. Billable	Act. Billable	Est. % of total	Act. % of total
Lead Consultant	Frederick Schreiber	\$28,425.14	\$30,513.21	14%	14%
Team Coordinator	Ken Weiland	\$31,240.14	\$35,194.27	15%	17%
Treasurer	Treasurer/Supplies	\$7,250.00	\$0.00*	1%	0%*
Code Liaisons	Darren Meyers	\$31,430.14	\$48,875.02	14%	23%
	Don Plass	\$33,275.00	\$26,044.38	14%	12%
HVAC&R Tech.	Patrick Dodd	\$27,075.14	\$18,551.43	14%	9%
Building Scientists	John Porterfield	\$26,565.14	\$19,512.55	14%	9%
	Travis Yutzy	\$27,255.14	\$19,512.55	14%	9%
Total		\$212,516.00	\$198,203.41	100%	93%
* Expected Time and material for APEC Treasurer involvement did not occur during the contract term and was not itemized as originally proposed. Regarding Office supplies allocated to this line item, there were dollars allocated for equipment rental/purchase at the time that was not known if it would be needed (light meter, blower door, thermal imaging camera, etc.) that was neither purchased nor rented.					

1.4 Observed Patterns of Compliance and Non-Compliance

Illinois municipalities have been inspecting buildings and reviewing plans for commercial energy code compliance since April 8, 2006 when the Illinois *Energy Efficient Commercial Building Act* established the 2000/2001 IECC Supplement effective for public and privately-funded commercial buildings. On October 9, 2007, the Law was revised to authorize the latest published edition, excluding supplements, of the *International Energy Conservation Code*, the 2006 IECC, thereafter. As of August 18, 2009 the Illinois Energy Conservation Code for Commercial Buildings is the 2009 IECC (ASHRAE 90.1-2007). On August 28, 2009, Public Act 096-0778 requiring an energy code for residential buildings was signed into law. It became effective on January 29th, 2010, officially establishing the 2009 IECC as the energy code for Residential

Buildings in Illinois.

Most code officials appreciate and take advantage of available trainings. Builders were present at several sites; perhaps because these builders were selected based on a trusting and cooperative relationship with the building official. APEC evaluators generally heard positive comments on the 2009 IECC. As noted, the APEC evaluation team performed compliance evaluations of 44 randomly selected residential buildings and 10 randomly selected non-residential buildings consistent with the BECP-developed protocol and checklists⁶. Across these 54 evaluations, certain patterns of compliance and non-compliance were observed.

A) Residential Buildings. Demonstrating compliance with the 2009 IECC at plan review then proceeding through field verification is a process, and is not mastered immediately or without some thought, care, and effort.

PATTERNS OF NON-COMPLIANCE

1. **2009 IECC 403.2.3 Building Cavities.** Stud-joint cavity returns in internal walls, external walls and floor-joists are commonplace in construction practice, as is allowed by the governing “life-safety” code, 2006/2009 IRC M1601.1.1, Item 7. We question the need to score the evaluation of stud-joint cavities used as supply plenums as a Tier 1 Item (3pts), until all building framing cavities (both supply and return) are expressly prohibited by the 2012 ICC *International Codes*® (2012 IECC R403.2.3). Recommend re-scoring for 2009 Checklists as a Tier 2 (2pts) item.
2. **2009 IECC 402.4.3 Fireplaces.** 2009 *International Residential Code*® (IRC) Sections R1001.11, R1004.1, R1004.4, R1005.4 and 2009 *International Fuel Gas Code*® (IFGC) Section G2445.7 require factory-built, wood-burning fireplaces to be listed and labeled in accordance with UL127-1996, *Safety Standard for Factory-built Fireplaces with Revisions through November 2006*. These fireplaces are intended to be installed and used in accordance with the product Listing and the manufacturer’s installation instructions. To date UL has not investigated and certified such an arrangement. Accordingly the IRC’s (IECC 101.3) “life safety” provisions take precedence over the IECC 402.4.3 provisions for gasketed doors.
3. **2009 IECC 403.6 Equipment Sizing.** Compliance was generally not evident for calculating heating and cooling loads. In some cases, where calculations are presented, output of equipment specified or actually installed is substantially greater than load. In many instances, “paper” compliance varies from that observed on-site. For instance none of the permit document specified measuring duct tightness. Many Illinois municipalities license their contractors (HVAC, Plumbing, Electrical, General, etc.). Accordingly, these jurisdictions have found it to be more expedient to let the contracting community address “right-sizing” issues. In a quote from one mechanical inspector, “We’ve tried collecting Manual ‘J’, ‘S’, and ‘D’ calculations. Our contractors keep coming back to complain that ‘right-sized’

⁶ DOE Building Energy Codes Program (BECP) *Measuring State Energy Code Compliance Report*, Section 5.0.

equipment increases their costs (comfort call-backs increase), thereby decreasing their profit margin.”

4. **2009 IECC 402.2.7 Basement walls and 402.2.8 Slab on grade floors.** Compliance is spotty and intermittent. For instance maintaining the continuity of exterior foundation wall and slab-edge insulation above grade and providing opaque weather-resistant protection for exterior above-grade insulation is not the norm. The APEC team observed a substantial number of interior, draped-fiberglass batt installations compared to exterior foundation wall installations of rigid insulation.
5. **2009 IECC 403.2.1 (503.2.7) Duct installations in exterior walls.** In observations, the evaluation team noted several instances of kitchen exhaust and environmental supply and return duct and stud-cavities being located within exterior walls. Exchanges between evaluation teams and jurisdiction field inspection staff lead us to conclude there is still confusion with regard to code-compliant installations and their affect on the overall building thermal envelope. Recommend a two-fold approach: 1) A code change offering language (similar to 2009 IECC 503.2.7 for commercial ducts) to the residential 2009 IECC 403.2.1, and 2) Some form of “pop-up” window or “flag” in the applicable Wall Insulation categories of the REScheck™ and COMcheck™ code compliance tools such that code enforcement and design professionals, alike, are informed of how to account for reductions in building thermal envelope performance when ducts or plenums are located within building envelope assemblies.
6. **2009 IECC 405.4.1 Compliance Software Tools.** During the course of conducting site plan reviews and field assessments, the evaluation team identified that all (8/8) of the performance software compliance packages submitted for compliance assessment had enough errors and/or omissions in them that would significantly affected compliance assessment and ultimately field-installation and inspection.

Building simulation software programs have been developed for many types of buildings (commercial, residential, etc.) and for many different uses (building design, HVAC equipment sizing, code compliance, etc.). Most performance based simulation tools build a model of the house and simulate energy use for one calendar year using standard assumptions for the required information that is not gathered by the rater (TMY weather data, thermostat setpoints, hot water usage, personal appliance usage, etc.). Unfortunately, almost no information to address the question of the accuracy of performance-based software has been made publicly available⁷.

⁷ Stein, Jeff Ross; *Accuracy of Home Energy Rating Systems*, LBNL Report No.40394, June 1997
<http://eetd.lbl.gov/ea/reports/40394/40394-2>.

Observations from a peer-review of performance software submittals indicate discrepancies, not only with capacity of the software to be in-sync with the provisions of the IECC, but also in the proper use and application of the performance software among energy raters and code officials, alike.

In particular, the Building Code Enforcement offices of Champaign, Hoffman Estates, Naperville, Peoria and Urbana, led by the Champaign Building Safety Division, have spent a good deal of time (i.e., three evaluator visits to Champaign and two Urbana/Champaign home-builder “listening sessions” during the project term), during which each jurisdiction independently questioned the accuracy, conformance and compliance assessment of the performance software with respect to the aforementioned sections of the 2009 IECC and the following:

- a) **2009 IECC Table 405.5.2(1) entries for “Heating systems”, “Cooling systems”, and “Service Water Heating”**, require an “apples-to-apples” comparison. In other words, the efficiencies of the Proposed Design and the Standard Reference Design shall be the same. It is clear from a review of all eight designs submitted using performance software that rating providers and quality assurance designees (who review rating providers’ work) are not aware of the code compliance issues raised questions relative to the suitability of performance software submittals, much as the U.S. code enforcement community maintains an interest in its robustness and that of similar software and code compliance tools.
- b) **2009 IECC Table 405.5.2(1) entries for “Air exchange rate,” for residences without mechanical ventilation**, require a field test to be performed in accordance with ASHRAE 119, Section 5.1 (i.e., ASTM E779-2003, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*) as approved, but no less than the code minimum Htg: 0.35 ACH_{nat} Clg: 0.35 ACH_{nat}. The evaluation teams and the Jurisdictions of Champaign, Hoffman Estates, and Urbana repeatedly received HERS “Preliminary Rating” reports for homes seeking credit for measured air exchange rates less than the minimum Htg: 0.35 ACH_{nat} Clg: 0.35 ACH_{nat} allowed in accordance with Section 405. In essence, these Jurisdictions questioned whether these homes required additional mechanical ventilation (i.e., whole-house or energy recovery ventilation).
- c) **IECC Table 405.5.2(1) entry for the “Window U-factor Check”** of the Standard Reference Design is noted to be 0.48 (IECC 402.5). The Maximum fenestration U-factor and SHGC provisions of Section 402.5 are, and have always been, intended as “hard maximum, area-weighted average limits” **solely applicable to the Proposed Design not the Standard Reference Design**. From all appearances, performance software platforms appear to allow a Zone 4A/5A U-factor of U-0.48 to apply to the Standard Reference Design. This is inaccurate and not supported by the framers and supporting testimony of the original change to the IECC. The specific reference in IECC Table 405.5.2.1 for the Standard Reference Design “Glazing U-factor” is to be determined solely by the prescriptive requirements of IECC Table 402.1.3. Accordingly, the Standard Reference



Design U-factor shall be 0.35 for Zones 4A and 5A, with an accompanying SHGC no greater than 0.40 under a Section 405 approach.

d) **IECC 303.1.4 Insulation Product Rating and Table 405.5.2(1) entry for the “Window U-factor Check” of the Proposed Design.**

With the assistance of concerned jurisdictions and APEC’s building science team, APEC identified the use of “customizable” building construction libraries in performance software platforms as potentially problematic to the uniformity of IECC interpretation and enforcement, and therefore, the overall compliance effort in Illinois. Non-standardized, software “customizable” building envelope libraries make it extremely difficult and time-consuming for jurisdiction plan-review staff to review composite building envelope assemblies according to accepted engineering practice: the U.S. Federal Trade Commission R-value rule (CFR Title 16, Part 460, May 31, 2005) and the methodologies adopted by ASHRAE, the IECC and the REScheck™ and COMcheck™ code compliance tools for assigning cavity, continuous, and parallel-path corrections for insulation and overall assembly types.

The APEC team believes that the use of “customizable” building envelope libraries facilitates the inaccurate and non-uniform approval of Simulated Performance designs across Illinois. For example, the most common form of non-compliance among “customizable” building envelope libraries was observed in attic insulation designs submitted where dense-packed cellulose located in the interstitial attic floor-joist locations is assigned a density of $\rho = R-3.2/\text{in.}$ and the loose-fill cellulose piled on-top of the attic floor-joists is assigned a “continuous insulation” density of $\rho = R-5.0/\text{in.}$ The “continuous insulation” density of $\rho = R-5.0/\text{in.}$ is more suited for rigid, extruded polystyrene or polyisocyanurate insulations than for loose-fill cellulose installations ($\rho = R-3.7/\text{in.}$). It is not common for energy raters to submit construction library details to the building department.

In another instance, of incongruence among purveyors of “above code programs” (IECC 102.1.1), building department personnel were unable to establish the significance of a “Rating Type.” For example, the sheer size and number of pages submitted in reporting packages made it difficult (without peer-to-peer guidance at the plan review desk) to determine whether the energy rating was a “Projected Rating” (based on pre-construction assumptions with field performance testing t.b.d.) or a “Complete Rating” (based on in-field conditions and verified by in-situ performance testing) In some instances, the “Projected Rating” depicted normalized air leakage at levels below 0.35 ACH_{nat} , where the code requires plan review personnel to identify deficiencies in residential ventilation levels (i.e., mechanical ventilation required). Accordingly, the APEC team believes attention should be paid to educating the energy rater and code enforcement communities particularly with respect to the connectivity between the code text of the IECC and its corollary applications to performance software platforms.

7. The aforementioned 6a) through 6d) must be clearly depicted in sufficient clarity in performance Software reports and submitted with construction documents (plans) that are representative of the information depicted in those reports in accordance with Sections 103 and 405.4 of the code, as approved (IECC 103.2, 405.4). Note that the Illinois *Energy Efficient Commercial Building Act* [20 ILCS 3125] and thereby, the *Illinois Energy Conservation Code*, provides but three methods for submitting a Residential design for compliance assessment to the Act:

Section 600.430 Compliance.

a) Compliance with the Illinois Energy Conservation Code as described by this Subpart D (applicable to residential buildings) shall be determined by the local authority having jurisdiction (AHJ).

b) Minimum compliance shall be demonstrated by submission of:

- 1) **Compliance Certificates generated by the U.S. Department of Energy's REScheck™** code compliance tool; or
- 2) **Other comparable compliance materials that meet or exceed**, as determined by the authority having jurisdiction, to the U.S. Department of Energy's REScheck™ code compliance tool; or
- 3) **The seal of the architect/engineer** as required by Section 14 of the Illinois Architecture Practice Act [225 ILCS 305], Section 12 of the Structural Engineering Licensing Act [225 ILCS 340] and Section 14 of the Illinois Professional Engineering Practice Act [225 ILCS 325].

Without explicit guidance from the DOE and BECP in this regard, significant time and resources to scrutinize performance software submittals (which Illinois jurisdictions do not have). The added time for plan-review will be necessary to verify that the appropriate modifications have been correctly executed to approve performance software submittals in accordance with the provisions of the 2009 IECC.

8. Which leads to other questions raised by Illinois jurisdictions on two separate occasions and specific to **2009 IECC 402.4.1 and 402.4.2 Air sealing and insulation** and the “prescriptive” air sealing methodology prescribed in the 2009 IECC:
 - i. **Quote from Jurisdiction No. 1**, “We [the jurisdiction] know the energy code tells [us] you need 7 ACH or less @ 50 Pascal (ACH50), but we feel the code has created another problem. Most of our results coming back from blower door tests [conducted on prescriptively-air-sealed designs] have been around 2.5 to 3.5 ACH50. With that, by calculating for ACH_{nat} it always comes out less than 0.35, which is the minimum. For a two story house it would almost have to be between 5.5 to 7 ACH50 or 6.75 to 7 ACH50 for a single story home to meet prescribed minimum 0.35 ACH_{nat}. Something is not making sense here and we have several complaints [from homebuilders] about their houses being too tight and having to

spend more money [to mechanically ventilate].”

- ii. **Quote from Jurisdiction No. 2**, “We [the jurisdiction] are providing you a scan of the significant changes to the 2012 IRC regarding required ventilation. Hopefully it will start a discussion about the potential for a significant problem for homes built in Illinois after the 2012 IECC goes into effect. The current 2009 IECC requires no more than 7 ACH50 with a blower door test. The 2009 IRC relies on a combination of 7 ACH50 air infiltration and operable windows for adequate natural ventilation. The 2012 IECC reduces air changes per hour to no more than 3 ACH50. The 2012 IRC requires mechanical ventilation when the ACH50 is less than 5. When the State of IL moves to the 2012 IECC [likely] in May 2012, most Illinois municipalities will not have adopted the 2012 IRC and probably will not for months, maybe years thereafter. Homes built to the 2012 IECC and an older version of the IRC will be very tight (< 3 ACH50) with inadequate natural ventilation and there will be no code requirements for mechanical ventilation. Then there is the question of why does the 2012 IECC code require the house to be built so tight (3 ACH) only to then have to introduce outdoor air to provide adequate ventilation.”

In conducting three distinct evaluator visits to the Champaign Building Safety Division and two Urbana/Champaign home-builder “listening sessions” during the project term, APEC energy-engineers and building science technicians believe there exist both “structural” (meaning IECC code development) and “cross-functional” knowledge-management barriers among stakeholders to IECC implementation and enforcement in Illinois. This appears most evident among and between the homebuilder and sub-contracted home performance contractor and/or between the homebuilder and the builder’s in-house air-sealing field teams where the homebuilder perceives rumor and innuendo among peer groups or receives inconsistent/non-uniform guidance from an Authority Having Jurisdiction (AHJ) and translates/interprets that rumor/innuendo or inconsistent/non-uniform code advice to their air-sealing field teams, home energy raters and or Home Performance with Energy Star (HPwES) contractors.

The instances identified by the Building Department quotes above are the topic of debate among the Illinois’ Energy Conservation Code Advisory Council (IL ECAC), an advisory council created by the Illinois General Assembly charged with recommending to the Capital Development Board ways to better administer Illinois’ energy conservation code for design and construction and with the power to adopt amendments to the rulemaking entitled, *Illinois Energy Conservation Code* (71 Ill Adm. Code 600; Ill Reg. 2582). The rulemaking implements Public Act 96-778, which applies State energy efficiency guidelines and standards for commercial and residential buildings.

Building Performance Institute (BPI)-certified building auditors (BA's), Residential Energy Services NETwork (RESNET)-certified Home Energy Raters, and HPwES contractors take on the order of 16 to 24 contact hours of in-class instruction, six (6) additional contact hours of field-training, and must each pass a two-hour, 100 question exam and a field-practicum to

complete the training before they become qualified/certified home-performance contractors. Despite various professional licensure programs required by some (not all) jurisdictions and the State of Illinois, these home performance professionals are not yet categorized by any state-wide professional practice, trade-association, or licensure board in the State.

We have received enough feedback from building departments and homebuilders to question whether there exist the proper forum(s) for candid, cross-functional communication (and training) to take place between and among the Builders hiring home-performance contractors, the home performance contractors conducting the audit and the AHJ, and the Builder or home performance contractor scoping-the-work and the insulation-air-sealing contractor ultimately hired to performing a "prescriptive-seal" of the home (2009 IECC 402.4.2.2). Although we have captured the rudimentary exchange in a somewhat hypothetical form, the APEC team has enough information to support the typical discussion as follows: Builder says, "Hey! I've got to do this air-sealing stuff in the energy code. Can you do it for me? How much and how long will it take?" The result: Homes that are prescriptively sealed to meet code where the Builder now believes that he/she has met the "prescriptive" ... "visual-inspection" option of the code (i.e., No performance testing), yet the home—upon inspection by an ICC-certified IRC-/IFGC-/IMC-/IECC- residential inspector—finds the home has been sealed to levels "tighter" (lower-) than 7 ACH50 (0.35 ACH_{nat}). The APEC team of building scientists have seen Final HERS Ratings on homes sealed "prescriptively" and "visually-inspected" that are "tighter" (lower-) than 7 ACH50 (0.35 ACH_{nat}).

Achieving "prescriptive" seals at levels below that permissible for operable windows and normalized leakage (0.35 ACH_{nat}) to overcome without mechanical ventilation has implications to the Builder's bottom-line, as well as the future health and safety of the future occupants of the house.

By code, the building inspector will likely require, or at least question, whether the home has enough combustion air and ventilation air for human health (these are two separate code compliance evaluations) to now meet the 2009 IRC-Fuel Gas, 2009 IRC-Mechanical and 2012 IECC-R requirements. If not, the implication to the Builder's bottom line is now the additional cost to provide constant- or intermittent-mechanical ventilation for human health despite electing a "prescriptive" air sealing package.

APEC believes that without some form of dedicated curriculum or mass-appeal that breaks-down, then bridges the cross-functional gap(s) in knowledge among energy-engineering, education, architecture, code, utility, and building diagnostics professionals, there could be a legion of BPI Building Analysts (BA), HERS raters and home-performance contractors sealing houses too-tightly to IECC prescriptive criteria, requiring builders to fix the work they started because of the inadvertent and resultant health and life-safety impacts of fervent air-sealing work. Another consideration for the DCEO and BECP, we feel, is that without a consensus code of ethics or licensure board in place to manage these BA, HERS

and home-performance professionals, they may be unaware of the inadvertent impacts their actions/services are having on home builders and occupants.

All signs point to why the oversight provided by the certified Illinois building code enforcement profession will continue to play "key" roles in preserving the energy-conservation integrity of our buildings and structures, thereby protecting the lives of our citizenry from the unscrupulous and ill-informed.

9. **2009 IECC 402.4.4 Fenestration and doors labeled for air leakage.** The APEC team found very few fenestration products (windows, skylights and doors) with labeling addressing air leakage limitations. At best, our evaluators noted a few references to the AAMA/WDMA/CSA 101/I.S.2/A440 on manufacturer's product literature and wet-stickers applied to the product directly, but no such information depicted on NFRC labels.

B) Non-Residential Buildings. Demonstrating compliance with the 2009 IECC at plan review then proceeding through field verification is a process, and is not mastered immediately or without some thought, care, and effort.

PATTERNS OF NON-COMPLIANCE

1. **2009 IECC 505.2.4 Exterior lighting controls.** In APEC interviews with jurisdiction electrical inspectors, there is curiosity, at worst—confusion, whether products exist to provide at least a 10-hour battery backup to the time-clocks serving exterior lighting sources. One electrical inspector asked, "Do we need 10 hours in Miami, Knoxville, or Springfield? Perhaps 10 hours makes sense for Alaska or Maine."
2. **2009 IECC, 503.2.1 Calculation of Heating and cooling loads and 503.2.2 Equipment and system sizing.** Many Illinois municipalities license their contractors (HVAC, Plumbing, Electrical, General, etc.). Accordingly, these jurisdictions have found it to be more expedient to let the contracting community address "right-sizing" issues. In a quote from one mechanical inspector, "We've tried collecting Manual 'J', 'S', and 'D' calculations. Our contractors keep coming back to complain that 'right-sized' equipment increases their costs (comfort call-backs increase), thereby decreasing their profit margin."
3. **2009 IECC 502.4.1 Air leakage of window and door assemblies.** The APEC team found very few fenestration products (windows, skylights and doors) with labeling addressing air leakage limitations. At best, our evaluators noted a few references to the AAMA/WDMA/CSA 101/I.S.2/A440 on manufacturer's product literature and wet-stickers applied to the product directly, but no such information depicted on NFRC labels.

1.5 Assistance and Obstacles to Performing the Work

1. Having Team members familiar with or known to the state-wide code enforcement community its networks, list service e-mail queues, and ICC Chapter Structure allowed for access to jurisdictions with mild to moderate reservations. In jurisdictions lacking building

departments, primarily zoning and/or zoning sub-code officials (property maintenance only), APEC's code professionals proved to be valuable assets in providing access to inspection sites not otherwise accessed without the Certified Building Official or Master Code Professional (MCP) credential.

2. From the meetings with the jurisdictions a number of obstacles to enforcing code were named that went beyond what might have met the entries recorded in the original BECP-developed questionnaire. Accordingly, as APEC evaluators conducted the initial site assessments, issues were brought to the attention of the APEC team leaders such that course corrections were made directly to the questionnaire (see Appendix 'D').
3. Bordering jurisdictions not enforcing a code or enforcing an older code. An example can be found where one particular city adopted the 2006 IRC while the surrounding county in which it was located does not enforce any building code of any kind. The situation that is now occurring is that subdivisions and developments are forming outside the city limits to take advantage of being close to the county seat, yet not having to pay the same tax burdens as living within the city limits would imply. The population of the city is 7,000, and another 4,000 people live in the county, within two-miles of the city center, but outside of the city limits.
4. Building departments are downsizing. Building departments are getting smaller because of the downturn in new home building. Responsibilities are spread out amongst those few who remain, making it difficult to add more steps to the plan review and inspections process.
5. State and local jurisdiction relations. Most of the smaller, rural building departments that were visited commented on the lack of communication prior to new mandates/changes in the code taking place. Several central Illinois cities and counties do not enforce the 2009 IECC because their respective corporate legal counsels have advised them that the State Law does not apply to them. While the APEC teams did not delve into the exact wording of the legal statements, their existence represents a tension in the relationship between the state and local jurisdictions.
6. Different jurisdictions (cities, townships, municipalities and villages) are experiencing different types of construction volume. While some are landlocked and have expanded to their full potential, others still have land for development. The city of Oak Park, a land locked city that issues about 3,000 residential alterations permits a year (only 5-6 being for new residential construction) expressed that a number of the 2009 IECC code requirements were difficult to enforce because of the added cost to the project. Specifically having the ducts tested for air tightness because of the proportionate increase to costs of the addition/alteration compared to the ratio of duct sealing costs if the home were built new.

1.6 Code Requirements Difficult to Ascertain

For the experienced evaluator, no specific code requirements were difficult to ascertain. The APEC team includes additional comments here that we believe are germane to the “ascertaining of code requirements” issue:

1. Time did not allow for multiple visits to conduct assessment viewing of site at various stages of construction (Foundation, Framing, Insulation, Rough-In M-P-E, and Final). However, the APEC Team did not feel this detracted from the study or the ability of APEC evaluators to ascertain compliance. Rather, compliance verification depended somewhat more on permit documents, a traceable legal record of construction progress. In addition to time constraints, most jurisdictions have little in the way of new construction in progress. Countering these constraints, most jurisdictions that were visited had very thorough and well organized permit documents and filing procedures.

Typically jurisdictions have project file for each project where the permit and all progress photographs, inspection reports, and correction notices are included. When conducting in-office plan-reviews, a short but diligent review of the project file will reveal whether correction notices have been made, deficiencies have been noted, and a re-inspection date has been made. Under all circumstances, the permit holder has been notified not to cover or conceal anything until the deficiency has been corrected and re-inspected.

While it is not possible to substitute “kicking the tires” with “paper” compliance, the high level of documentation observed speaks to both a willingness and capacity of code officials and builders to comply with the IECC.

2. APEC instilled in its evaluation teams, at all times, the reluctance to mark “yes” on compliance checklists when work was not directly observed, though in reality our experienced evaluators felt comfortable with a “yes” entry judging from either overall consistency in the builder’s practice, confidence in the field inspector/building official to assess compliance, or pictures and anecdotal notes to the project file. There were several instances where APEC evaluators reported listening to in-office or in-field cellular phone conversations of the building officials with contractors and builders and in several instances we noted clear correspondence trails directed to achieve compliance. Among several jurisdictions, APEC evaluators inquired about items shown not in compliance on the construction documents. The building officials would state the items would be corrected, calling attention to several other IECC provisions that had already been, or were in process of being corrected.
3. As noted for **IECC 403.6 Equipment Sizing**, compliance was generally not evident for calculating heating and cooling loads. In some cases, where calculations are presented, output of equipment specified or actually installed is substantially greater than load. In many instances, “paper” compliance varies from that observed on-site.

Many Illinois municipalities license their contractors (HVAC, Plumbing, Electrical, General, etc.). Accordingly, these jurisdictions have found it to be more expedient to let the contracting community address “right-sizing” issues. If it is the desire of the BECP and the State (DCEO) to seek better compliance, enforcement and thereby, implementation of right-sizing HVAC and Service Water Heating systems, APEC recommends Manual ‘J’, ‘S’, and ‘D’ training for jurisdiction mechanical personnel. Jurisdictions generally do not have mechanical inspectors. By and large, the field inspector simply looks to see if a furnace(s) and water heater are installed. With the requirement of having HVAC calculations to be submitted and actually checking to see if the submittal is sized appropriately to what is installed is a foreign subject to most building departments.

4. Most jurisdictions have some type of “hand out” for the homebuilder, homeowner, or subcontractor. Kane County has developed a matrix for type of insulation because they have found the information depicted in wall sections of the construction documents does not often coincide with what the builder installs in the field. With the builder inserting their choice of insulation in the matrix and then it becomes part of the construction documents. It’s much easier for the inspector in the field to see if the correct insulation was installed, and removes the time it takes for the superintendent and field inspector to reconcile the insulation system in the field.
5. We also noted that a few Illinois jurisdictions have decided to provide the homebuilding community with a “Wall Section – Specification” handout, prepared with leaders and “fill-in-blanks” where the builder must indicate various wall components (sheathing thickness, weather barrier, stud depth, cavity insulation, etc.) to be installed (see Appendix ‘E’). Communities like Highland, Troy, Geneseo and Pontiac have adopted this approach due to the quality, or lack thereof, of construction documents submitted for residential designs. The building officials in these communities believe that a detailed wall-section prepares them for up to half of the code omissions and deficiencies relating to building structure and envelope that they can identify prior to field inspection.

2.0 Overall Assessment of Compliance Methodology

COMMENTS SPECIFIC TO BECP COMPLIANCE METHODOLOGY

1. Compliance seems to focus more on products than on practices. Despite inquiring whether products are installed according to manufacturer's instructions, the instruction for verification did not display or reference any such instructions. In many cases manufacturer's instructions dwell on the handling, placement, and fastening of a product, such as insulation, without much detail on the myriad circumstances encountered with construction – especially the complex framing often seen in large residences of-late.
2. Inconsistencies in the BECP-approved training (February 2011, Des Moines) for non-residential buildings were not addressed by the BECP in a timely manner during post-training and follow-up conferences. In particular, during U.S. Department of Energy (DOE) sponsored training to ensure that plan reviews and field inspections were conducted according to the BECP-developed protocol and checklists, BECP personnel insisted that in addition to plan-review, evaluation teams perform field-inspections at the foundation, framing, insulation, rough-in, and final phases of construction, in order to assure jurisdiction field-inspection personnel maintained the capacity to identify omissions and deficiencies in energy efficient construction practices across all inspection-types. This is neither cost effective nor possible if there are time constraints.

While the course of construction for a single-family dwelling may take anywhere from 3 weeks to 3 months, the pace of construction and permitting is dictated as much by material availability and manpower, as it is the weather.

The APEC team found it just as expedient and informative to walk building construction sites with field inspection personnel during any of the aforementioned inspection phases in order to make a value judgment on both the quality of the work and the minimum competency of the code professional conducting the site inspection. Therefore, it is APEC's recommendation that evaluators accompany the building official or jurisdiction inspectors to an onsite visit or job-shadow of the projects reviewed in the office in whichever stage of construction they may be in (Foundation, Rough, Insulation, or Final). It is the capacity and experience of the evaluator and his or her knowledge of building department operations here that is the paramount consideration.

3. Only two jurisdictions, Hoffman Estates (BPI) and Naperville (HERS) have invested a portion of their ARRA Energy Efficiency Community Block Grant (EECBG) monies in the building diagnostic equipment (combustion analyzer, blower door, duct blaster kit, thermal imaging camera, etc.) and home energy performance contractor certifications (BPI and HERS) of their building department personnel required for conducting the performance testing of residential structures. Most code official's wished they would have the opportunity to

receive blower door and duct blaster training. Most building department staff did not understand the difference between “Air Changes per Hour” (ACH_{nat}) and ACH50.

COMMENTS SPECIFIC TO BECP CHECKLISTS

1. **2009 IECC 403.2.3 Building Cavities.** Stud-joint cavity returns in internal walls, external walls and floor-joists are commonplace in construction practice, as is allowed by the governing “life-safety” code, 2006/2009 IRC M1601.1.1, Item 7. We question the need to score the evaluation of stud-joint cavities used as supply plenums as a Tier 1 Item (3pts), until all building framing cavities (both supply and return) are expressly prohibited by the 2012 ICC *International Codes*® (2012 IECC R403.2.3). Recommend re-scoring for 2009 Checklists as a Tier 2 (2pts) item.
2. While it the BECP intends the checklists (Residential and Commercial) to be used for all three methods of compliance assessment (Prescriptive, Trade-Off (UA), Performance), the checklist is laid out specifically for prescriptive compliance. APEC is not suggesting separate checklists for all three forms of compliance assessment, but there should be some form of the checklist denoting all mandatory compliance items and for performance based compliance, a list of “quick-check” items (see Section 1.4 A, Item 5 of this report) would aid the compliance evaluation process.
3. **2009 IECC 502.4.7 Vestibules.** The ‘Complies?’ cell should be designed to accept the addition of rigid, continuous insulation (+8 ci’).
4. **ASHRAE 90.1-2007 Sections 5.5.4.2.1/5.5.4.2.2 [FR7]** appear on a 2009 IECC Compliance Checklist for the “Performance compliance approach where vertical fenestration area >40% or skylight area >3%.” ASHRAE Standard sections should not appear on an IECC checklist. Recommend the reference be to the Total Building Performance calculation procedures of Section 506. We question how or why there is a need to score the evaluation of the Total Building Performance approach as a Tier 1 Item (3pts). Considering a building taking the Section 506 approach is likely designed with more sophistication relative to building energy using systems, a 3 point credit or debit amounts to approximately (3/110) no more than 2.7% of the overall points allocated to the compliance score. Recommend removing, re-scoring as a Tier 1 (1pts) item, or consulting our “Comments Specific to Checklists,” Item 2 (above).
5. **2009 IECC 502.2.1 Roof insulation.** The ‘Verified Value’ cell should be designed to accept the addition of rigid, continuous insulation (+8 ci’).
6. **2009 IECC 502.2.3 Above-grade wall insulation.** The ‘Verified Value’ cell should be designed to accept the addition of rigid, continuous insulation (+5 ci’).



APPENDIX A – SAMPLE CONTACT WITH ILLINOIS JURISDICTIONS

Good Afternoon Mike,

Thank you again for taking my call. Here is the information I promised:

As mentioned, APEC is conducting a study in conjunction with the Illinois State Energy Office and the U.S. DOE as part of a major national effort to measure compliance rates with building energy codes and ultimately support and improve vital efficiency measures that will help the State of Illinois address energy and environmental challenges.

For Illinois, Jurisdiction participation is crucial, and it comes with key benefits: energy code training for local personnel, the chance to identify areas for compliance improvement and the availability of data to document the need for additional resources to support code enforcement initiatives. The overall benefit is to help increase energy savings for the citizens you serve and protect, protecting them against the fluctuating costs of natural gas and electricity.

- We would like to schedule a visit where an APEC professional would visit your community to review a "project file" (plans, specifications and related documentation) for one (1) single-family home project that has been permitted within Clinton or the County limits (October 2010 to current) or (more preferably) currently under construction.
- **Even if there is currently no building code adopted or enforced in your community**, we would appreciate your cooperation (for purposes of the study) assisting APEC to get in touch with a local developer or home builder who has recently completed (or is currently completing) home construction in the community.
- With your permission, during the visit, APEC will conduct a brief interview with you at the County, using the attached survey.
- An APEC professional will then use the project files to collect data on the home's energy-relevant features in the office using the attached checklist.
- Once we have reviewed the project on paper, the APEC consultant would like to accompany you and/or one of the County inspectors to an onsite visit and job-shadow of the projects reviewed in the office in whichever stage of construction they may be in (Foundation, Rough, Insulation, or Final).

All told, the visit should take no more than 2-3hrs, and it would be great if the Building Official or Zoning Officer would join us during the "in-office" and "in-field" portions, to exchange useful energy codes-related feedback on implementation issues and your experience with the homebuilding and development community in this regard.



As carefully as our energy codes are written, they do not save energy unless buildings actually comply. Further, knowing on-the-ground code implementation and compliance challenges can generate improvements in the codes, increase educational and training activities, and reinforce the continuing need to support code enforcement compliance efforts in Illinois with funding.

Again, the compliance data collected from individual buildings and jurisdictions will not be made public. Illinois' aggregated state compliance rate is the study's only public result.

I look forward to hearing back from you Mike, with your availability to participate in this important work.

Truly, -Darren

Points of Contact:

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APPENDIX B – OUTREACH TO ILLINOIS JURISDICTIONS – TRACKING

[illegible]

APPENDIX C – SAMPLE EVALUATION TEAM ASSIGNMENTS ILLINOIS

44x Residential

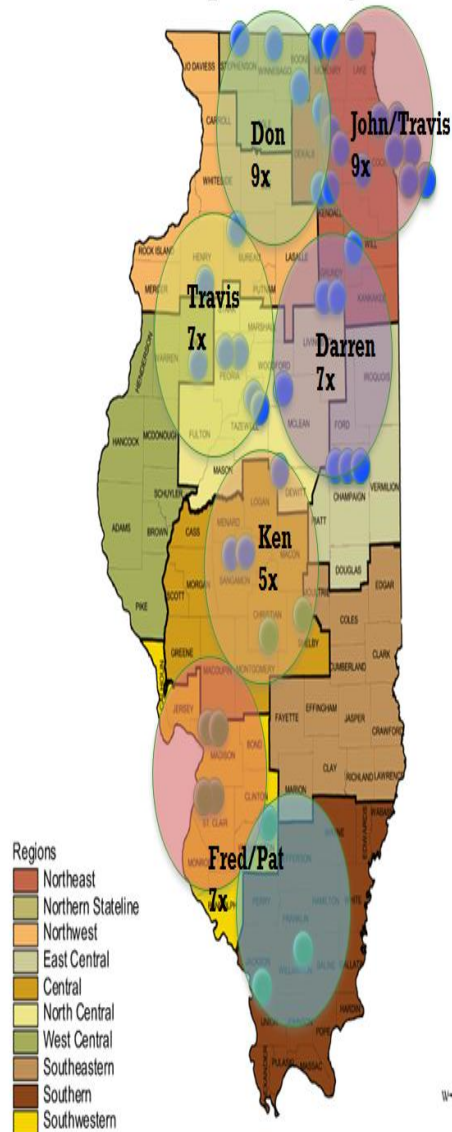
CONSTRUCTION SAMPLES

Residential New Construction & Renovations

Total permits represent an annual average from 2008-2009 data.

Location	Total Permits	Sample Size
State Totals	10,451	44
Climate Zone 4 Totals	1,923	9
Christian County	40	1
Jackson County	69	1
Madison County	493	2
Shelby County	81	1
St. Clair County	550	2
Washington County	32	1
Williamson County	108	1
Climate Zone 5 Totals	8,528	35
Boone County	69	1
Bureau County	44	1
Champaign County	359	3
Cook County	1,305	6
De Witt County	21	1
DuPage County	586	1
Grundy County	101	2
Henry County	39	1
Kane County	785	3
Kendall County	284	2
Knox County	40	1
Lake County	565	1
McHenry County	453	2
Peoria County	295	2
Sangamon County	314	2
Stephenson County	31	1
Tazewell County	271	2
Will County	815	1
Winnebago County	234	1
Woodford County	88	1

Governor's Economic Development Regions





APPENDIX D – SAMPLE QUESTIONNAIRE for ILLINOIS JURISDICTIONS

(The BECP-developed a jurisdictional questionnaire which was customized by APEC energy engineers and evaluators into an interview format to suit Illinois jurisdictions and the circumstances experienced during compliance assessment work.)

PNNL/APEC Survey - Jurisdictional Information

Agency Name: [Building Safety Division](#)

Jurisdiction Served: [City of Champaign – Champaign County, IL](#)

Name, Title, and Contact for person completing this survey:

Name: [APEC – D.MEYERS – Interview of Building Safety Division personnel](#)

Title: [APEC Evaluator - ILLINOIS](#)

Email Address: meyers7877@att.net

Telephone Number: [\(708\) 790-4602](#)

Please estimate the population of the jurisdiction served by your agency [81,055](#)

During the previous year (1/01 to 12/31/2010), how many building permits were issued by your agency?

Total One- and Two-family Dwelling permits issued: [115](#)

New building permits issued: [67](#)

Additions permits issued: [30](#)

Alterations permits issued: [18](#)

Total Commercial permits issued: [213](#)

New building permits issued: [69](#)

Additions permits issued: [16](#)

Alterations permits issued: [128](#)

How is your agency funded⁸? (Check all that apply)

Permitting revenue to sustain departmental operations (i.e., Enterprise Fund⁹)

Jurisdictional budget (i.e., General Fund¹⁰)

Subsidy or funding from State/Federal Government (e.g., Community Development Block Grants)

Other _____

⁸ **Fund types** are categorized into one of 11 classifications. Government Fund types include: 1) the general fund, 2) special revenue funds, 3) debt-service funds, 4) capital projects funds and 5) permanent funds. Proprietary fund types include 6) enterprise funds and 7) internal service funds. Fiduciary fund types include 8) pension (and other employee benefit trust funds), 9) investment trust funds, 10) private purpose trust funds and 11) agency funds.

⁹ An **Enterprise Fund**, in public sector accounting, is a proprietary fund type that provides goods or services to the public for a fee that makes the entity (or internal Divisional Unit, such as a Building Department) self-supporting.

¹⁰ A **General Fund**, in public sector accounting, is used to account for all financial resources except those required to be accounted for in another fund of the governmental unit (i.e., City of “Best City U.S.A.”). It provides the resources necessary to sustain the day-to-day activities and thus pays for all administrative and operating expenses of the governmental unit as a whole.

Staffing:

By whom are plan reviews for energy code compliance conducted by? (Check all that apply)

In-house staff [Seven (7) FTE's, 1 PTE]

(1x CBO; 2x COM Plan Rvw; 2x RES Plan Rvw/Insp; 1x MECH Insp; 1x PLBG Insp; 1x PT ELEC Insp)

3rd party entities

Other jurisdictions or government agencies

Not done

Other _____

By whom are field inspections for energy code compliance conducted by? (Check all that apply)

In-house staff [Seven (7) FTE's, 1 PTE]

(1x CBO; 2x COM Plan Rvw; 2x RES Plan Rvw/Insp; 1x MECH Insp; 1x PLBG Insp; 1x PT ELEC Insp)

3rd party entities

Other jurisdictions or government agencies

Not done

Other Blower door testing performed by a few third-party providers. We check they are BPI- or RESNET-certified.

What level of education and training¹ does your agency staff receive specifically for energy codes?

Residential Energy Codes Training:

Choose One

High

Medium

Low

None

Commercial Energy Codes Training:

Choose One

High

Medium

Low

None

¹ **High:** Professional certification by ICC or similar credentialing and receives annual training on the energy code.

Medium: Receives periodic training on the energy code.

Low: Receives on-the-job training on the energy code but seldom receives formal training.

None: Energy code training is never provided.

If training is received, how is it delivered? (Check all that apply)

Webinar / Online

Classroom

In the field

Other _____

How would you prefer to receive training? (Check all that apply)

Webinar/Online Don't like Webinars or Online offerings (uninteresting – often too fast passed with too few openings for instructor-participant interaction).

Classroom

In the field – Code officials are “visual” learners. If we see it, we know it.

Other

Operations:

What methods are used as a basis for documenting energy code compliance and in what percentages?

Residential Buildings

Prescriptive: 90%

Trade-off²: 5% (mostly Architects)

Performance: 5% (rarely)

Commercial Buildings

Prescriptive: 0%

Trade-off²: 100%

Performance: (rarely)

Commercial Approach

IECC Designs: 95%

ASHRAE Designs: 5%

² Include **REScheck™** and **COMcheck™** submissions

How much time is devoted to the average plan review for energy codes? If energy plan reviews are performed in conjunction with reviews for other code provisions, please estimate the time for the energy-related reviews only.

Residential Buildings: [20 min. \(0.333 hrs\)](#)

Commercial Buildings: [30 min. \(0.5 hrs\)](#)

How much time is devoted to the average field inspection for energy codes? If energy field inspections are performed in conjunction with inspections for other code provisions, please estimate the time for the energy-related field inspections only.

Residential Buildings: [30 min. \(0.5 hrs\)](#)

Commercial Buildings: [60 min. \(1 hr\)](#)

How long does your agency maintain permitting data and in what format?

Residential Buildings

Paper, [5 Years](#)

Digital, [No](#)

Commercial Buildings

Paper, [5 Years](#)

Digital, [No](#)

What major issues impede your ability to enforce the energy code? (Check all that apply)

Residential Buildings

Lack of time

Lack of money (resources, personnel)

Lack of code books

Lack of education

Insufficient data provided with the plans

Lack of access to all or portions of the building

Lack of equipment (e.g. duct blaster)

Other – [Interpreting software submittals](#)

Commercial Buildings

Lack of time

Lack of money (resources, personnel)

Lack of code books

Lack of education

insufficient data provided with the plans

Lack of access to all or portions of the building

Other – [Interpreting software submittals](#)

In your jurisdiction, what plan review and/or inspection items do you generally find do not comply with the code? (Check all that apply)

Residential Buildings

Envelope insulation levels

Envelope insulation installation

Envelope sealing (infiltration)

Fenestration

Duct insulation

Duct sealing

Piping insulation

Lighting fixtures

Other [Interpreting software submittals](#)

Commercial Buildings

Envelope insulation levels

Envelope insulation installation

Envelope sealing (infiltration)

Fenestration

Duct insulation

Duct sealing

Piping insulation

Lighting fixtures

Lighting controls

HVAC system controls

Other _____

Does the energy plan review and inspection cover all aspects of the energy code?

Yes

No

If No, what aspects are not covered? _____

What information is available to your staff during field inspection? (Check all that apply)

Residential

The approved plans
Energy code compliance checklist(s)
The published energy code and/or standard
Other

Commercial

The approved plans
Energy code compliance checklist(s)
The published energy code and/or standard
Other

If you receive software compliance reports with permit applications or plans, do you accept them in lieu of a plan review?

Residential

Yes
No, **they must pass the “smell-test.”**
We are scrutinizing REMrate’s more and more.

Commercial

Yes
No, **but generally rely on the RDP’s sig and seal.**

If you receive construction documents and software compliance forms signed and sealed by a registered design professional (R.D.P.) with permit applications, do you accept them in lieu of a plan review?

Residential

Yes
No
R.D.P. N/R in Illinois

Commercial

Yes
No, **significant reliance on RDP sig and seal.**

What information is typically missing from plans, specifications and/or actual construction that preclude your ability to determine compliance?

Residential Buildings: **Slab on grade/Basement wall “thermal break.”**

Commercial Buildings: **Slab on grade/Basement wall “thermal break.”**

What software and/or other information technologies do you use to facilitate the plan review and inspection process and associated record keeping and communications with permittees?

- **CRW-Track (enterprise development software). Tracks permitting, but primarily for Planning & Zoning. DOS-based, and not flexible.**

Evaluator Postmortem Observations:

- **Two residential job files/plan sets were evaluated. Champaign’s permit intake requirements (i.e., “Energy Code Requirements for Residential Construction based on 2009 IECC”). No job sites shadowed;**
- **Department personnel were cooperative, willing and eager to learn and helpful;**
- **Commercial** departmental energy code plan review and enforcement operations are average; **Residential** departmental energy code plan review and enforcement operations are above average;
- **There were no obstacles to performing the work;**
- **For the experienced evaluator, no specific code requirements were difficult to ascertain at plan review;**
- **Steps taken to help secure Department cooperation include: phone contact, e-mail follow up, phone confirmation, e-mail confirmation, and a site visit to perform the work.**
- **Patterns of Compliance/noncompliance:**



1. 2009 IECC **403.6** and **503.2.2, Equipment Sizing**. The jurisdiction relies on its licensure programs for contractors (PHCC, Electrical, General, etc.) They find it to be more expedient to let licensed contractors to address “right-sizing” issues under ACCA Manual ‘J’, ‘S’, and ‘D’ calculations.
 2. Stud-joist returns in internal walls and floor-joist returns are commonplace, as is allowed by 2006/2009 IRC M1601.1.1, Item 7.
 3. 2009 IRC R1001.11, R1004.1, R1004.4, R1005.4 and G2445.7 require factory-built, wood-burning, fireplaces to comply w/ UL127-’96. Gasketed doors, violates appliance listing, thereby IECC 101.3 life safety conflict takes precedence over gasketed door provision.
- **Residential-Commercial Checklist comments:**
 1. For code provisions that are met “by exception,” how best to complete the “Complies?” entry? ... If we say “Yes,” then points are awarded in the numerator and denominator of the PASS v. FAILS “score.” If we say “No,” then no points are awarded in the numerator and denominator of the PASS v. FAILS “score.” See barometric damper and damper leakage exceptions to Sections 502.4.5 and 503.2.4.4 for buildings < 3ST in height.

APPENDIX E – SAMPLE WALL SECTION for ILLINOIS JURISDICTIONS

Building & Zoning Department

Residential Specification Sheet

pitch _____

Roofing Covering _____ lbs. per square
Minimum 20 year, 3 tab shingle; 15 lb felt

Roof Sheathing (1/2" minimum or equal)

Roof Trusses/Rafters @ _____ centers
manufactured roof truss plan required

Attic Insulation (R38 minimum)

Double Plate

Interior Wall/Ceiling Finish (Minimum 1/2" sheetrock)
Fire separation required between garage and house.

Wall Studs @ _____ centers
(Supporting two floors and roof, 2" x 6" minimum)

Exterior Sheathing (Minimum 7/16" plywood or equal)
Felt or approved weather-resistant barrier required around entire structure (exterior)

Wall Insulation (R13 minimum)

Exterior Wall Finish
All plumbing materials to be in compliance with latest adopted edition of the Illinois Plumbing Code.
All electrical must comply with the latest adopted issue of the NEC.

Sub-floor (3/4" tongue & groove minimum)

Band Board

Floor Joists (Manufactured joists require floor joist plan)

Type used _____
Span _____
Spacing _____

Support Beam
Type used _____
Span _____

Termite Shield (Metal)

Anchor Bolts 1/2" with 2" washers (1' from corners @ 6' centers - 1-story)
(1' from corner @ 4' centers - 2-story)

Foundation
Minimum thickness: 8"
3 row rebar = 8' walls
4 row rebar = 9' walls

Water Proofing/Damp Proofing
Four inch plastic drain tile inside and outside foundation walls. Properly installed form-a-drain acceptable

Foundation Insulation (either of two options)
R10 min outer
R13 min inner

Half inch #4 rebar, 12' long minimum, 12" from all corners @ 2' centers, or 2"x2" keyway

Footings
Minimum 8" thickness; minimum width is twice the thickness of foundation.

Gravel 2" below drain tile

Gravel 6" above drain tile

Gravel minimum 1' from footing/foundation

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