Air Leakage and Blower Door Testing

March 23, 2022

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Providing effective energy strategies for buildings and communities

ICC Preferred Provider # 2396
ICC Course # 31633

Learning Objectives

1. Understand the benefits of air leakage testing
2. Identify energy code requirements for air leakage testing
3. Understand different testing metrics for air leakage in commercial vs. residential buildings
4. Identify alternative compliance methods to pressure testing for commercial buildings

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SEDAC is a Preferred Education Provider with the International Code Council (ICC). Credits earned on completion of this program will be reported to ICC for ICC members. Certificates of Completion will be issued to all participants.

This workshop is approved for 1.0 LU/HSW CES credits from the American Institute of Architects (AIA). Credits earned on completion will be reported for AIA members.

AIA
Continuing
Education
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Who We Are

The Smart Energy Design Assistance Center (SEDAC) is an applied research program at University of Illinois.

Our mission: Reduce the energy footprint of Illinois and beyond.

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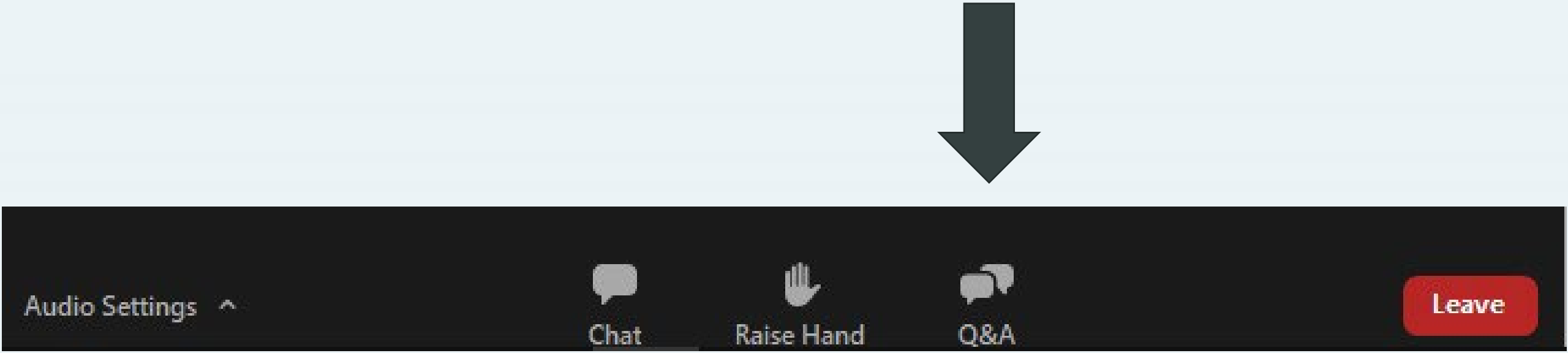
Questions

Questions are encouraged



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SEDAC is the Illinois Energy Conservation Code Training Provider

This training program is sponsored by

Illinois State Energy Office

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Energy Code Training Program

Technical support

energycode@illinois.edu
800.214.7954

Online resources at

smartenergy.illinois.edu/energy-code

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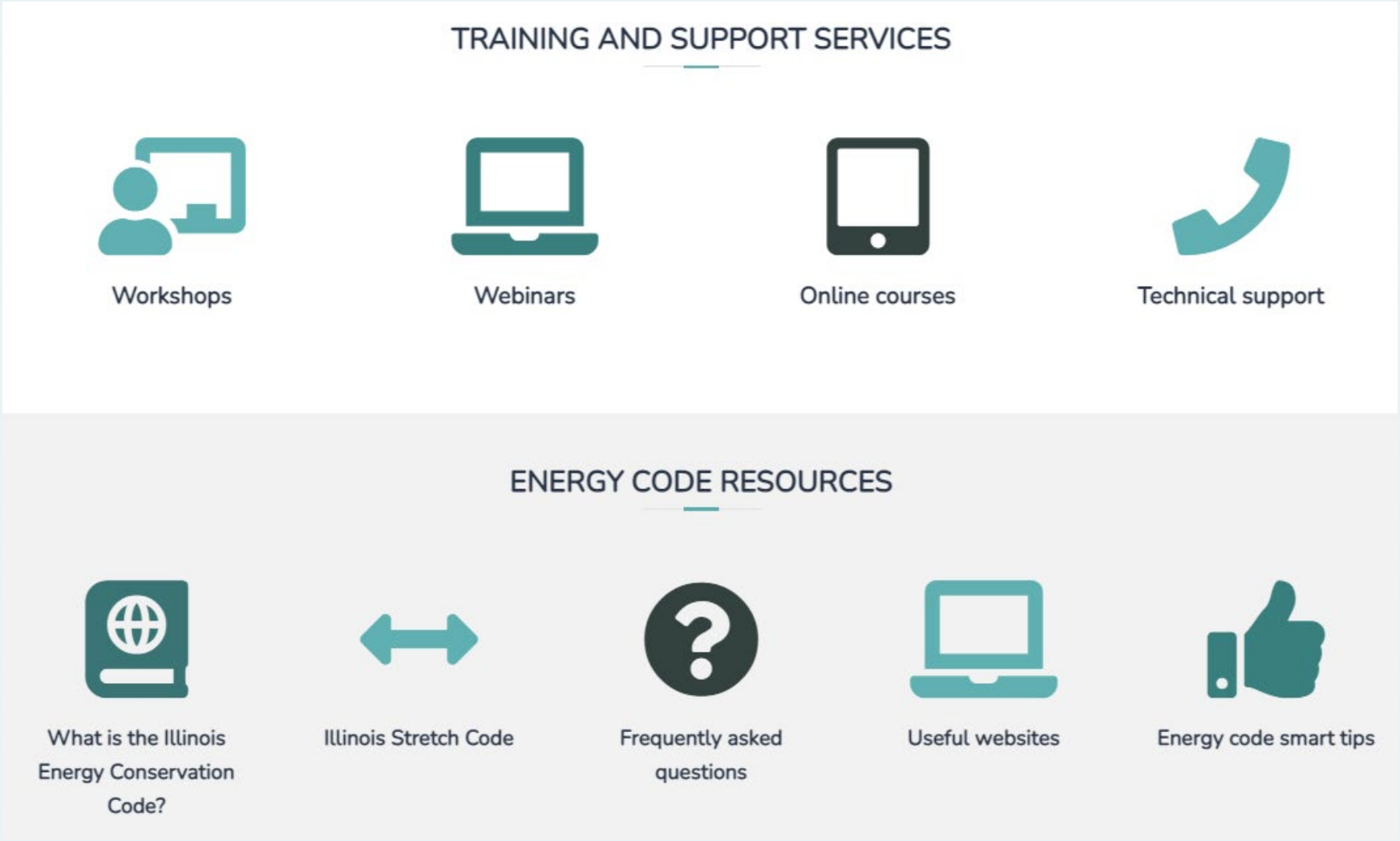
www.smartenergy.lllinois.edu/energy-code/



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Access to IECC, Illinois Amendments & Chicago Codes

https://codes.iccsafe.org/content/IECC2018P4

https://codes.iccsafe.org/content/IECC2021P2

https://www2.illinois.gov/cdb/business/codes/IllinoisAccessibilityCode/Documents/2018%20Illinois%20Specific%20Amendments%20with%20Modifications%20Shown.pdf

CHAPTER 1 [CE]
SCOPE AND ADMINSTRATION

SECTION C101
SCOPE AND GENERAL REQUIREMENTS

C101.1 Title. This code shall be known as the ~~*International Energy Conservation Code* of [NAME OF JURISDICTION] and shall be cited as such.~~ *Illinois Energy Conservation Code* or "this Code" and shall mean:

With respect to the State facilities covered by 71 Ill. Adm. Code 600.Subpart B:

This Part, all additional requirements incorporated within Subpart B (including the 2018 International Energy Conservation Code, including all published errata but excluding published supplements that encompass ASHRAE 90.1-2016), and any statutorily authorized adaptations to the incorporated standards adopted by CDB are effective July 1, 2019.

With respect to the privately funded commercial facilities covered by 71 Ill. Adm. Code 600.Subpart C:

This Part, all additional requirements incorporated within Subpart C (including the 2018 International Energy Conservation Code, including all published errata and excluding published supplements that encompass ASHRAE 90.1-2016), and any statutorily authorized adaptations to the incorporated standards adopted by CDB, are effective July 1, 2019.

C101.1.2 Adoption. The Board shall adopt

C101.1.3 Adaptation. The Board may appropriately adapt the International Energy Conservation Code to apply to the particular economy, population, distribution, geography and climate of the Sate and construction within the State, consistent with the public policy objectives of the EEB Act.

C101.5 Compliance. ~~*Residential buildings* shall meet the provisions of IECC—Residential Provisions.~~ *Commercial buildings* shall meet the provisions of ~~IECC-Commercial Provisions~~ the *Illinois Energy Conservation Code* covered by 71 Ill. Adm. Code 600.Subpart C. The local authority having jurisdiction (AHJ) shall establish its own procedures for enforcement of the Illinois Energy Conservation Code. Minimum compliance shall be demonstrated by submission of:

1. Compliance forms published in the ASHRAE 90.1 User's Manual; or
2. Compliance Certificates generated by the U.S. Department of Energy's COMcheck™ Code compliance tool; or
3. Other comparable compliance materials that meet or exceed, as determined by the AHJ, the compliance forms published in the ASHRAE 90.1 User's Manual or the U.S. Department of Energy's COMcheck™ Code compliance tool; or
4. The seal of the architect/engineer as required by Section 14 of the Illinois Architectural 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].

https://codes.iccsafe.org/codes/Chicago

ARTICLE XIII.
CHICAGO ENERGY CONSERVATION CODE

SECTION 1. The Municipal Code of Chicago is hereby amended by inserting a new Title 14N, as follows:

TITLE 14N ENERGY CONSERVATION CODE

PART I – COMMERCIAL PROVISIONS

CHAPTER 14N-C1 SCOPE AND PURPOSE

14N-C1-C001 Adoption of the commercial provisions of the International Energy Conservation Code by reference.

The commercial provisions of the *International Energy Conservation Code*, 2018 edition, second printing, and all erratum thereto identified by the publisher (hereinafter referred to as "IECC-CE"), except Appendix CA, are adopted by reference and shall be considered part of the requirements of this title except as modified by the specific provisions of this title.

If a conflict exists between a provision modified by this title and a provision adopted without modification, the modified provision shall control.

14N-C1-C002 Citations.

Provisions of IECC-CE which are incorporated into this title by reference may be cited as follows:

14N-C[IECC-CE chapter number]-[IECC-CE section number]

14N-C1-C003 Global modifications.

The following modifications shall apply to each provision of IECC-CE incorporated into this title:

1. Replace each occurrence of "*International Codes*" with "*Chicago Construction Codes.*"
2. Replace each occurrence of "*International Building Code*" with "*Chicago Building Code.*"
3. Replace each occurrence of "ASME A17.1" or "ASME A17.1/CSA B44" with "the *Chicago Conveyance Device Code.*"
4. Replace each occurrence of "NFPA 70" with "the *Chicago Electrical Code.*"

https://learn.smartenergy.illinois.edu/
https://smartenergy.illinois.edu/bee_fundamentals/

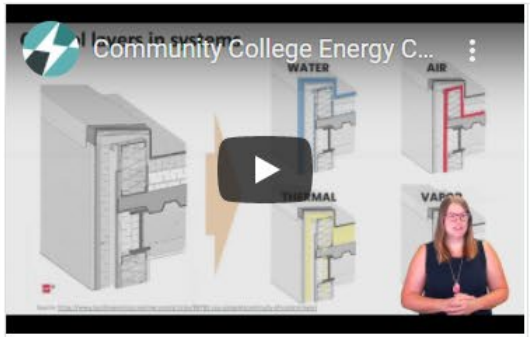
Building Energy Education | fundamentals

SEDAC's Building Energy Education (BEE) Fundamentals program offers **free** online energy code training that can be accessed anytime, anywhere. There is growing demand for skilled workers who know how to make buildings energy efficient. Today's professionals need training on energy efficiency best practices and how to meet energy code requirements for new and existing buildings. Join us for an exciting opportunity to bring energy code and building science basics to your students!

Check out our **Q&A**.

Intro Modules

1. Energy Efficiency Careers & Pathways
2. Building Energy Fundamentals
3. Introduction to Energy Codes & Standards
4. Navigating Energy Codes & Standards



Envelope Modules

5. Envelope & Insulation Fundamentals
6. Walls & Openings
7. Roofs & Ceilings
8. Foundations & Floors

Mechanical & Electrical Modules

9. Mechanical Equipment Sizing
10. Duct Design & Installation
11. Mechanical Ventilation
12. Lighting

Advanced Modules

13. Beyond Code
14. Net Zero Buildings
15. Existing Building Renovations

SEDAC Upcoming Energy Code Training

Air Leakage & Blower Door Test – TODAY!

90.1-2019 vs 2018 IECC: Lighting and Electrical – 4/12/2022

90.1-2019 vs 2018 IECC: Performance Based Compliance – 5/10/2022

2021 IECC Updates – 5/25/2022

Energy Code: Testing & Verification – 6/14/2022

Registration: https://smartenergy.illinois.edu/energy-code-training/webinars

Or: https://smartenergy.illinois.edu/energy-code/workshops/

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Blower Door Testing

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Building Pressure Testing

Commercial and Residential

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Why Blower Door Testing?

- Determines how leaky or how tight a building is.
- Diagnostic tool used to
  - find points of air leakage
  - diagnose building pressure problems
  - Evaluate moisture problems like condensation and mold
- Quantifies reduction of air leakage – how well the air sealing crew did their job
- For the crew doing air sealing, it helps test their work while on site!

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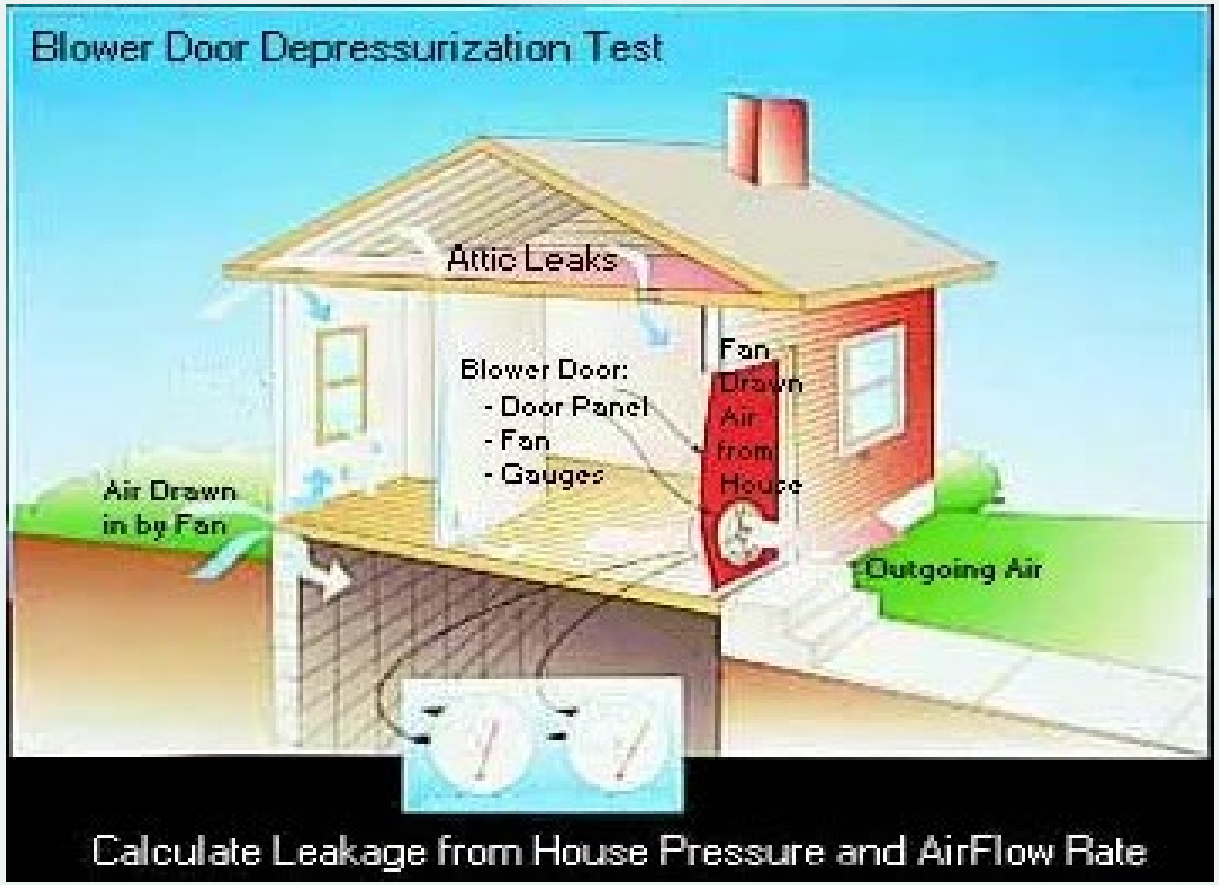
Residential Leakage Testing – 2018 IL ECC

Residential

- Pressure test at 50 Pa
- Leakage based on volume*
- Whole-building testing usually required
- 4 air changes per hour
    - *0.25 cfm/sf envelope for multifamily added by IL Amendment



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2021 IECC Updates to Requirements!

Residential

Adds back-stop air leakage for alternative compliance paths

- Air leakage can be no more than 5ACH or 0.28 cfm/sf enclosure area at 50 Pa.
- Exception for heated private garages – visually verify air barrier with 3rd party.
- IECC incorporates 0.30 CFM/sf at 50 Pa multi-family dwelling unit test

Image sources: pixabay .com

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Bloor Door Testing for Multifamily Housing

2018 IECC: IL Amendment

Air leakage ≤0.25 CFM/sf @ 50 Pa enclosure area (all six sides). Sampling methodology available for buildings >7 units

2021 IECC

Air leakage ≤0.30 CFM/sf @ 50 Pa enclosure area (all six sides). Sampling methodology available for buildings >7 units

https://www.mncee.org/blog/may-2019/research-sidesteps-obstacles-measuring-air-tightne/

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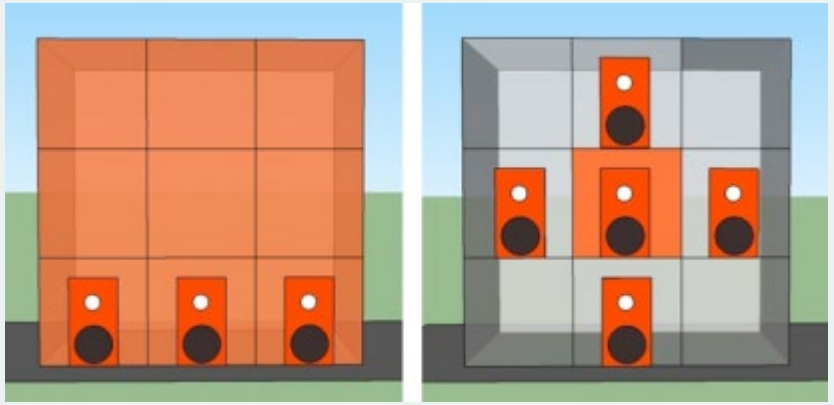
Types of Multi-Family Pressure Tests

Guarded

Compartmentalized testing of individual units.

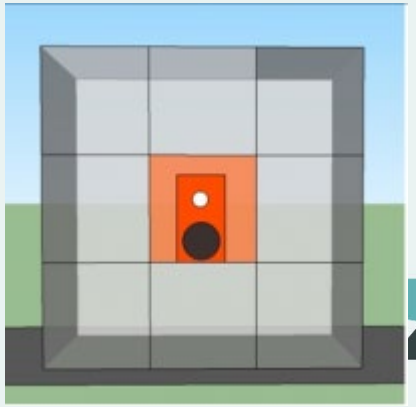
Units surrounding test unit are held at same pressure, so only leakage to outside is measured.



Unguarded

Leakage test for whole multi-family structure.

Only test unit is depressurized, to outdoor AND inter-unit leakage is measured.



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Blower Door Testing: Commercial

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2018 IECC Optional Leakage Testing

Commercial

- Pressure test at 75 Pa
- Leakage based on exposed envelope area
- Can sample areas of building and average results based on exposed area weighting
- 0.40cfm/sf envelope target

Image sources: https://flowtech.com.au/building-enclosure-duct-pressure-testing/

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2021 IECC Commercial Air Leakage

TESTING or VERIFICATION required for commercial buildings

- Certain climate zones allow exceptions for testing
  - Illinois CZ 4A and 5A not listed in exceptions
- Essentially, (envelope commissioning) pressure testing mandated for all new buildings in IL
- Two different pressure test methodologies
  - Dwelling units in Group R and Group I
  - All other building types

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2021 IECC Updates to Requirements

Group R & I

Group I & R Dwelling Units

- Unguarded unit pressure test at 50 Pa
- 0.30 cfm/sf enclosure area
- Greater of 7 units or 20% sample – all units if fewer the 7 units in building

All Other Commercial

All Other Buildings in CZ 4A and 5A

- Test pressure of 75 Pa
- 0.40 cfm/sf of enclosure area
- Can sample areas of building

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2021 IECC Updates to Requirements

Sampling

Must test:

- All envelope area of stories that have spaces directly under a roof
- All envelope area of stories with a building entrance, exposed floor, loading dock, or are below grade
- Representative above grade sections totaling at least 25% of the wall area in remaining conditioned space

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Who Does the Test? Who Verifies?

Commercial

Usually 3rd party contractor specializing in pressure testing large buildings.

AHJ must approve testing agent.

Residential

AHJ approved entity

Can be 3rd party or builder

Usually HERS rater or 3rd party contractor.

If builder, AHJ usually requests to verify test by being present.

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Blower Door Testing: Preparation and Performance

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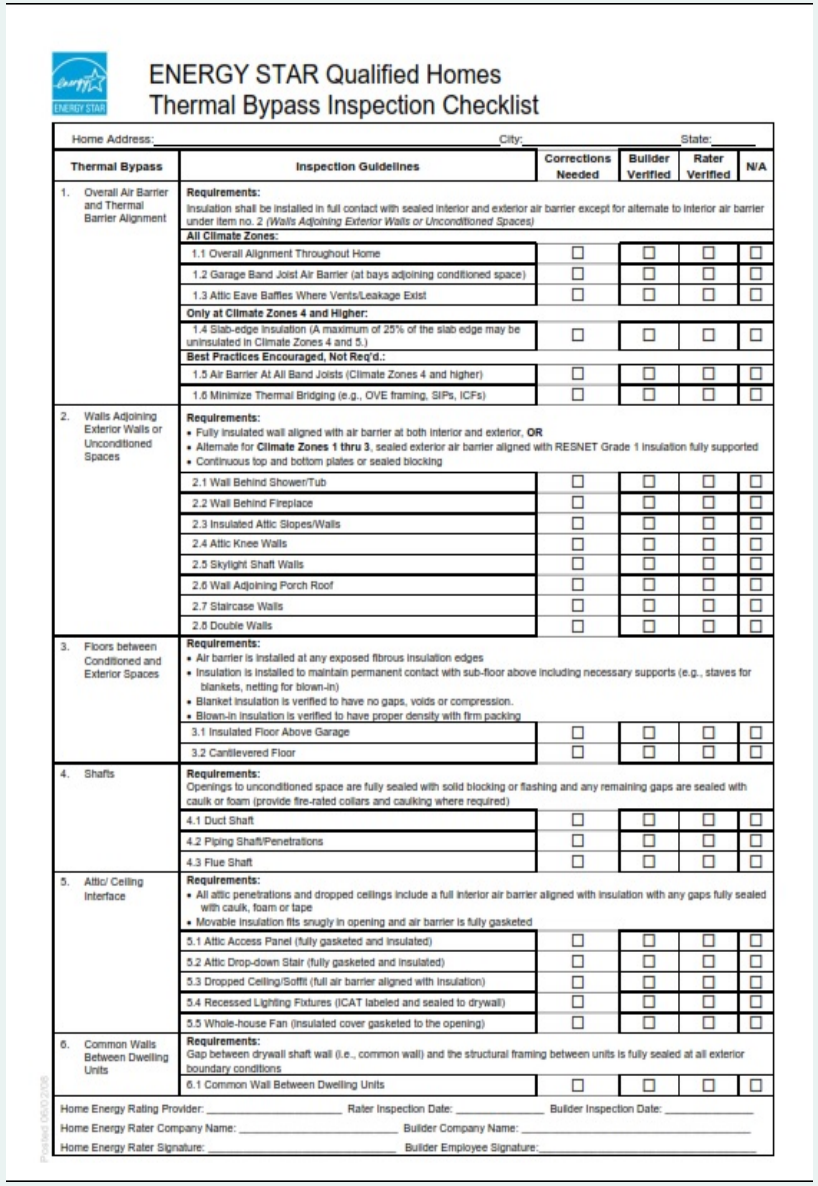
Preparing for Blower Door Testing



ENERGY STAR Qualified Homes
Thermal Bypass Inspection Checklist

Home Address:_____ City:_____ State:_____

Thermal Bypass	Inspection Guidelines	Corrections Needed	Builder Verified	Rater Verified	N/A
1. Overall Air Barrier and Thermal Barrier Alignment	**Requirements:** Insulation shall be installed in full contact with sealed interior and exterior air barrier except for alternate to interior air barrier under item no. 2 *(Walls Adjoining Exterior Walls or Unconditioned Spaces)*				
	All Climate Zones:				
	1.1 Overall Alignment Throughout Home	☐	☐	☐	☐
	1.2 Garage Band Joist Air Barrier (at bays adjoining conditioned space)	☐	☐	☐	☐
	1.3 Attic Eave Baffles Where Vents/Leakage Exist	☐	☐	☐	☐
	Only at Climate Zones 4 and Higher:				
	1.4 Slab-edge Insulation (A maximum of 25% of the slab edge may be uninsulated in Climate Zones 4 and 5.)	☐	☐	☐	☐
	Best Practices Encouraged, Not Req'd.:				
	1.5 Air Barrier At All Band Joists (Climate Zones 4 and higher)	☐	☐	☐	☐
	1.6 Minimize Thermal Bridging (e.g., OVE framing, SIPs, ICFs)	☐	☐	☐	☐
2. Walls Adjoining Exterior Walls or Unconditioned Spaces	**Requirements:** • Fully insulated wall aligned with air barrier at both interior and exterior, **OR** • Alternate for **Climate Zones 1 thru 3**, sealed exterior air barrier aligned with RESNET Grade 1 insulation fully supported • Continuous top and bottom plates or sealed blocking				
	2.1 Wall Behind Shower/Tub	☐	☐	☐	☐
	2.2 Wall Behind Fireplace	☐	☐	☐	☐
	2.3 Insulated Attic Slopes/Walls	☐	☐	☐	☐
	2.4 Attic Knee Walls	☐	☐	☐	☐
	2.5 Skylight Shaft Walls	☐	☐	☐	☐
	2.6 Wall Adjoining Porch Roof	☐	☐	☐	☐
	2.7 Staircase Walls	☐	☐	☐	☐
	2.8 Double Walls	☐	☐	☐	☐
3. Floors between Conditioned and Exterior Spaces	**Requirements:** • Air barrier is installed at any exposed fibrous insulation edges • Insulation is installed to maintain permanent contact with sub-floor above including necessary supports (e.g., staves for blankets, netting for blown-in) • Blanket insulation is verified to have no gaps, voids or compression. • Blown-in insulation is verified to have proper density with firm packing				
	3.1 Insulated Floor Above Garage	☐	☐	☐	☐
	3.2 Cantilevered Floor	☐	☐	☐	☐
4. Shafts	**Requirements:** Openings to unconditioned space are fully sealed with solid blocking or flashing and any remaining gaps are sealed with caulk or foam (provide fire-rated collars and caulking where required)				
	4.1 Duct Shaft	☐	☐	☐	☐
	4.2 Piping Shaft/Penetrations	☐	☐	☐	☐
	4.3 Flue Shaft	☐	☐	☐	☐
5. Attic/ Ceiling Interface	**Requirements:** • All attic penetrations and dropped ceilings include a full interior air barrier aligned with insulation with any gaps fully sealed with caulk, foam or tape • Movable insulation fits snugly in opening and air barrier is fully gasketed				
	5.1 Attic Access Panel (fully gasketed and insulated)	☐	☐	☐	☐
	5.2 Attic Drop-down Stair (fully gasketed and insulated)	☐	☐	☐	☐
	5.3 Dropped Ceiling/Soffit (full air barrier aligned with insulation)	☐	☐	☐	☐
	5.4 Recessed Lighting Fixtures (ICAT labeled and sealed to drywall)	☐	☐	☐	☐
	5.5 Whole-house Fan (insulated cover gasketed to the opening)	☐	☐	☐	☐
6. Common Walls Between Dwelling Units	**Requirements:** Gap between drywall shaft wall (i.e., common wall) and the structural framing between units is fully sealed at all exterior boundary conditions				
	6.1 Common Wall Between Dwelling Units	☐	☐	☐	☐

Home Energy Rating Provider: _____ Rater Inspection Date: _____ Builder Inspection Date: _____
Home Energy Rater Company Name: _____ Builder Company Name: _____
Home Energy Rater Signature: _____ Builder Employee Signature: _____

In advance of the test…

Is everything sealed?

- Penetrations through ceilings
- Penetrations through exterior walls
- Penetrations through foundation walls

https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/TBC_Guide_062507.pdf

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How to Conduct Pressure Test

Single-Point Test

Brings the building to a test pressure of 50 pascals with respect to the outdoors.

Multi-Point Test

Takes readings at a series of 5 or more test pressures.

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Intermediate Blower Door Testing

Blower doors can be used to evaluate the quality of air sealing during construction before all penetrations made.
Need doors and windows installed in order to achieve appropriate test pressures.

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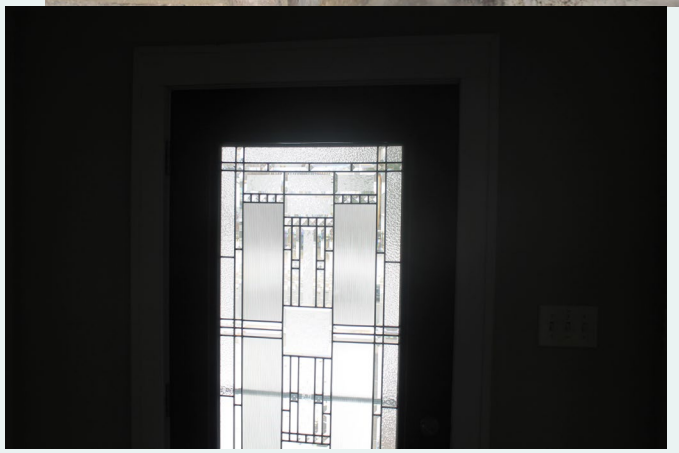
Testing Procedure

- Exterior windows and doors, fireplace and stove doors, and dampers including exhaust, intake, makeup air, backdraft, and flue dampers closed and latched, but not sealed beyond intended weather stripping or other infiltration control measures
- Exterior or interior terminations for continuous ventilation systems shall be sealed



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Testing Procedure

- HVAC systems, where installed, turned off
- Supply and return registers, where installed, fully opened
- Plumbing traps sealed or filled with water or oil

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How Many Fans Will I Need?

- ~18,000 SF envelope @ 0.3 CFM/SF @50Pa per fan (Group R or I)

- ~12,000 SF envelope @ 0.4 CFM/SF @75Pa per fan (Other commercial)

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Blower Door Testing: Alternatives

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2018 IECC Commercial Options

- Testing
- Materials and assemblies
    - (going away in 2021 IECC for climate zones 4A and 5A)

OR

Image sources:
Top left: https://efficiencymatrix.com/air-barrier-integrity-auditing/
Bottom Right: https://flowtech.com.au/building-enclosure-duct-pressure-testing/

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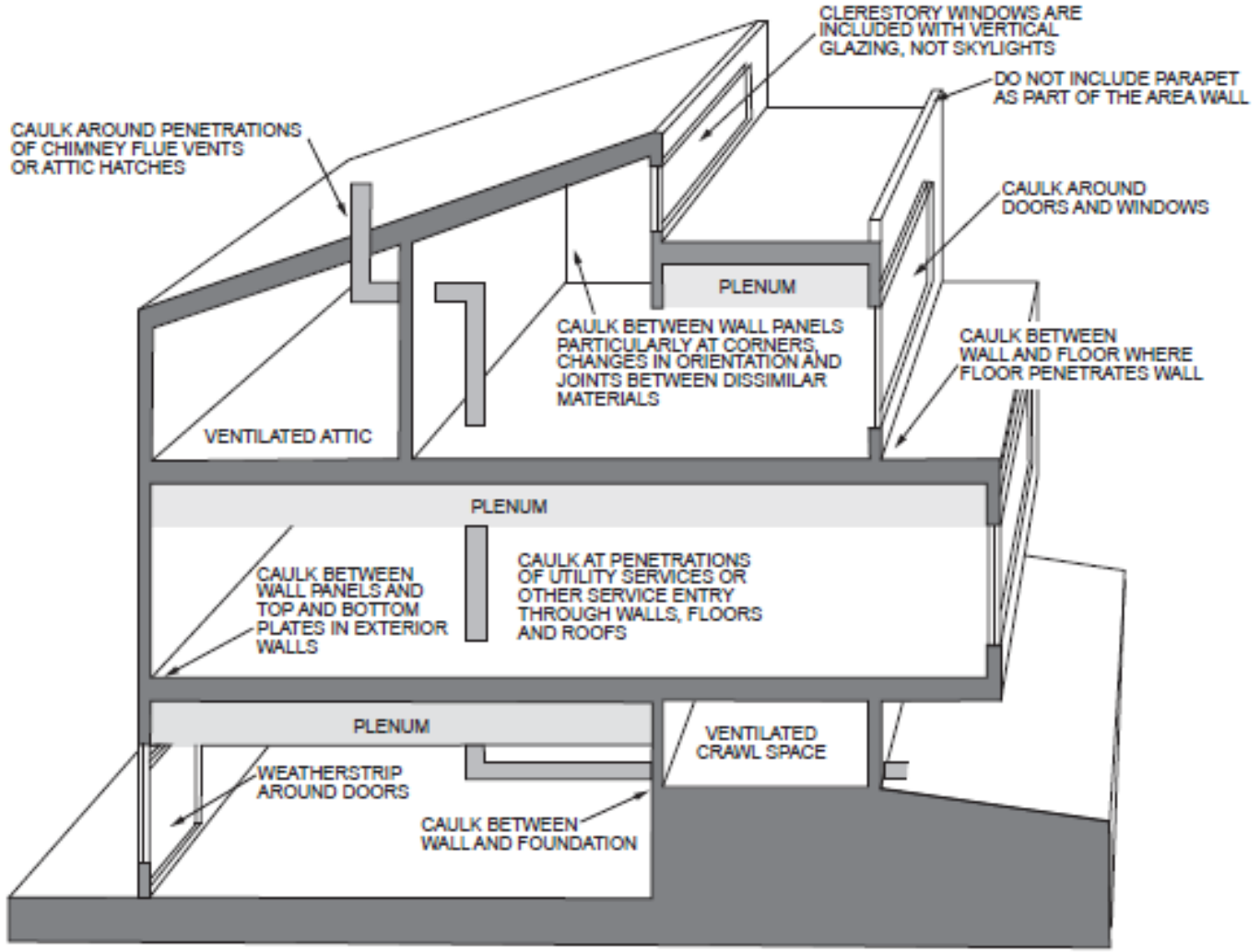
Commercial Plan Inspection



Commentary Figure C402.5.1.1
REQUIREMENTS FOR SEALING THE BUILDING ENVELOPE
(Courtesy of U.S. Department of Energy, Office of Building Technology State and Community Programs, www.energycodes.gov)

Call out air sealing details for trades to follow

Coordinate sealing with appropriate trades

- Joints between assemblies
- Fenestration
- Duct, plumbing and conduit penetrations

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Commercial Site Verification

Review envelope air sealing at multiple points in time

- Significant envelope completion, pre-drywall/finishing
- Post trades-work
  - Plumbing
  - Electrical Conduit
  - Duct and Vent Openings

Again – Coordinate with subcontractors and trades throughout construction

Sources: Right: https://www.buildingenclosureonline.com/articles/88617-solid-substrates-for-high-performance-air-barriers
Left: https://www.finehomebuilding.com/project-guides/insulation/a-roundup-of-air-sealing-products

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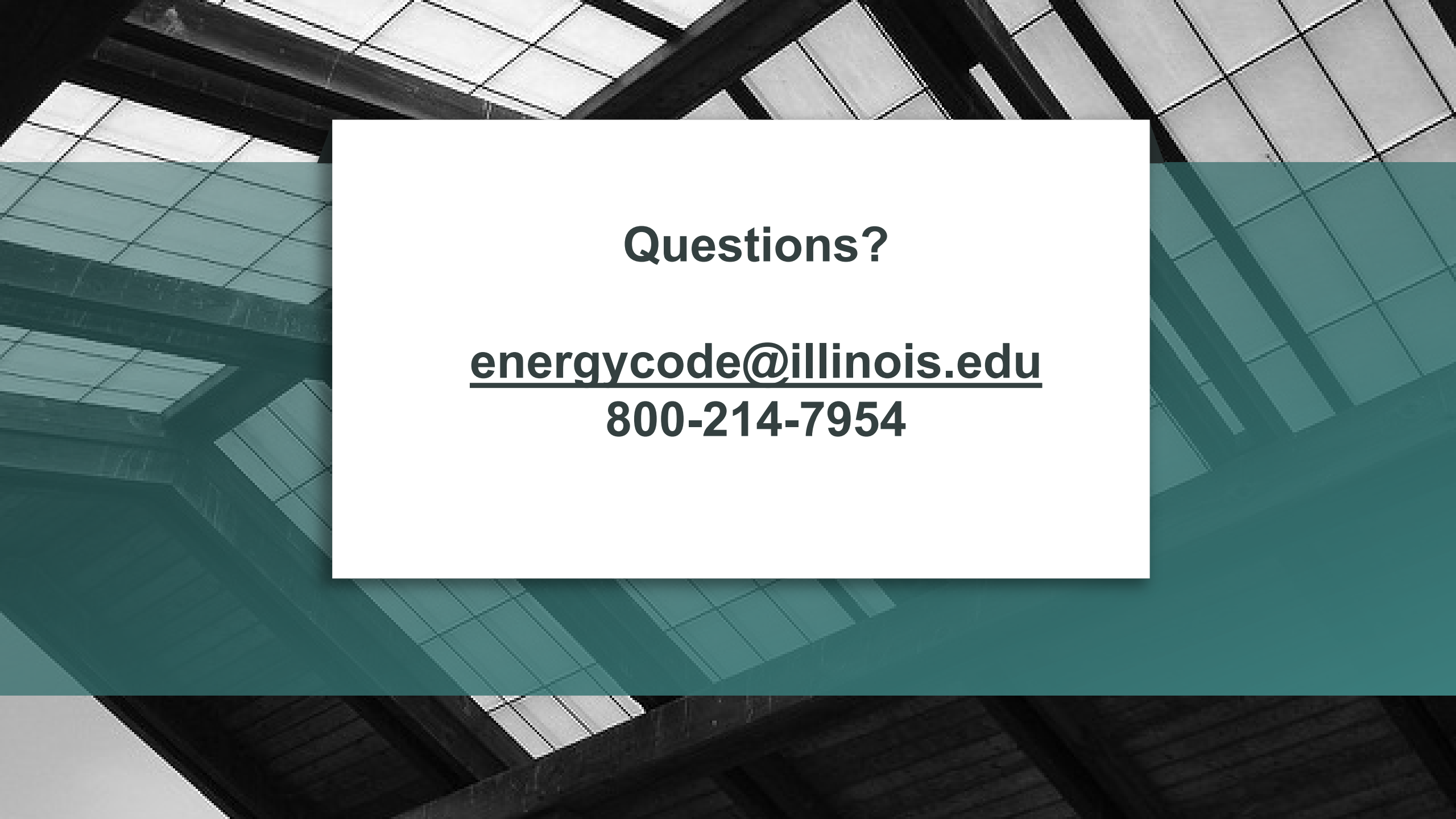

Questions?

energycode@illinois.edu
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