Webinar - April 7, 2022

Workshop 1. Building Energy Efficiency Fundamentals and Energy Code Basics

HAWAII STATE Energy Office
Building Energy Education fundamentals
SEDAC
ILLINOIS

Presentation Collaborators

Hawai'i Energy
AIA Honolulu
ASHRAE Hawaii Chapter
USGBC HAWAII
BOMA HAWAII Building Owners and Managers Association

Section 1
Introduction

Building Energy Education fundamentals

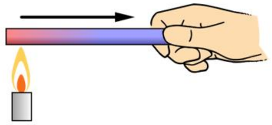
10

Section 2
Prof. Norman Takeya

UNIVERSITY of HAWAI'I®
HONOLULU
COMMUNITY COLLEGE

29

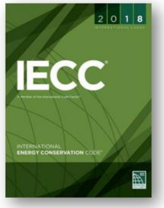
Section 3
Building energy fundamentals & building envelope basics



https://bsesc.energy.gov/

30

Section 4
Energy code introduction



75

Section 5
Hawaii Energy

Hawai'i Energy

98

Section 6
Wrap Up

117

Webinar - April 7, 2022

Workshop 1. Building Energy Efficiency Fundamentals and Energy Code Basics

HAWAII STATE Energy Office

Building Energy Education fundamentals

SEDAC SMART ENERGY DESIGN ASSISTANCE CENTER

ILLINOIS

Presentation Collaborators

Hawai'i Energy

AIA Honolulu

ASHRAE Hawaii Chapter

U.S. GREEN BUILDING COUNCIL USGBC HAWAII

BOMA HAWAII Building Owners and Managers Association

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

COURSE DESCRIPTION

This is the first in a series of three webinars covering building energy efficiency and the energy code in Hawaii, with a focus on residential buildings. This session introduces a set of education modules that cover a range of building efficiency topics and then focuses on the topics of building energy fundamentals and an overview of Hawaii’s building energy code.

LEARNING OBJECTIVES

At the end of this course, participants will be able to:

1. Access 15 online education modules covering energy efficient building envelope, mechanical systems, lighting systems, and beyond code design
2. Identify careers related to building energy efficiency
3. Apply basic heat transfer knowledge to building design
4. Identify Hawaii energy code requirements for residential buildings

Welcome

Chris Perry
Engineer
Building Energy Codes Program
U.S. Department of Energy

Introductions

Presenters

- Howard Wiig, State Energy Office
- Chris Perry, U.S. Department of Energy
- Sumi Han, Smart Energy Design Assistance Center
- Norman Takeya, Honolulu Community College
- Erik Kolderup, Kolderup Consulting
- Justin Bizer, Hawaii Energy

Acknowledgments

- Karen Shishido, Hawaii Energy
- Gail Suzuki-Jones, State Energy Office
- Kiera Williams, State Energy Office
- Alan Okimoto, State Energy Office
- Elena Arinaga, State Energy Office

Topics

Building Energy Education Fundamentals program

Hawaii college programs

Building energy fundamentals & building envelope basics

Energy code introduction

Hawaii Energy project examples

Zippy’s cards!

Coming up

Workshop 2

Comfort, Air Quality and Lighting

Thursday, 4/14/2022, 12:00 – 1:30 pm HST

Workshop 3

Beyond Code, Net Zero Energy and Existing Buildings

Thursday, 4/21/2022, 12:00 – 1:30 pm HST

BEE Fundamentals: Train-the-Trainer Workshop

Friday, Apr 29, 2022 9:00 – 11:00am HST

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

Section 1

Introduction

Building
Energy
Education
fundamentals

Building Energy Education | fundamentals

Partnered with HI Energy Office
Sponsored by DOE

April 7, 2022

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Providing effective energy strategies for buildings and communities

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.

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

BEE Fundamentals Partners & Participants

Illinois Environmental Protection Agency

Lewis & Clark Community College
McHenry County College
Moraine Valley Community College
Southwestern Illinois College
Triton College
Illinois Central College
Kishwaukee College
Olive-Harvey College
Oakton Community College
Illinois Eastern Community College
John A Logan College
Hartland Community College
Rend Lake College
Harper College

University of Illinois
University of Chicago
Northern Illinois University
Chicago Public Schools

Ameren Illinois / Leidos
Illinois Green Alliance (IGA)
Illinois Green Economy Network (IGEN)

Village of Matteson
City of Rock Island
City of Naperville
City of Ottawa
Village of Midlothian
City of Peoria **and many more**

HAWAII STATE Energy Office

Kauai Community College
Honolulu Community College
UH Maui College
Brigham Young University-Hawaii

Leidos – Hawaii Energy
Hawaiian Electric

Island Green Architecture
Bowers + Kubota Consulting
STUDIO OXEYE
D.R. Horton
Saito Design Associates
Plumbing & Mechanical Contractors Association of Hawaii (PAMCA HI)
Islandwide mechanical service
Oahu Air Conditioning Service, Inc.
TMA Architects
Economy Plumbing & AC
Bowers and Kubota Consulting
Mason Architects
S. Biniaris Architect
Colliers

Kauai County
Maui County Office of Economic Development
City & County of Honolulu
County of Hawaii
Hawaii Community Development Authority
Hawaii Department of Education **and many more**

Nevada Governor's Office of Energy

Western Nevada College
College of Southern Nevada
Truckee Meadows Community College

Western Washington University
Clark County School District

Desert Research Institute
International Code Council (ICC)
Envirolution
Plumbing, Heating, Colling Contractors of Nevada (PHCC NV)
Home Energy Connection

Clark County
City of Las Vegas
City of North Las Vegas
City of Henderson
City of Mesquite
City of Elko
City of Sparks **and many more**

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

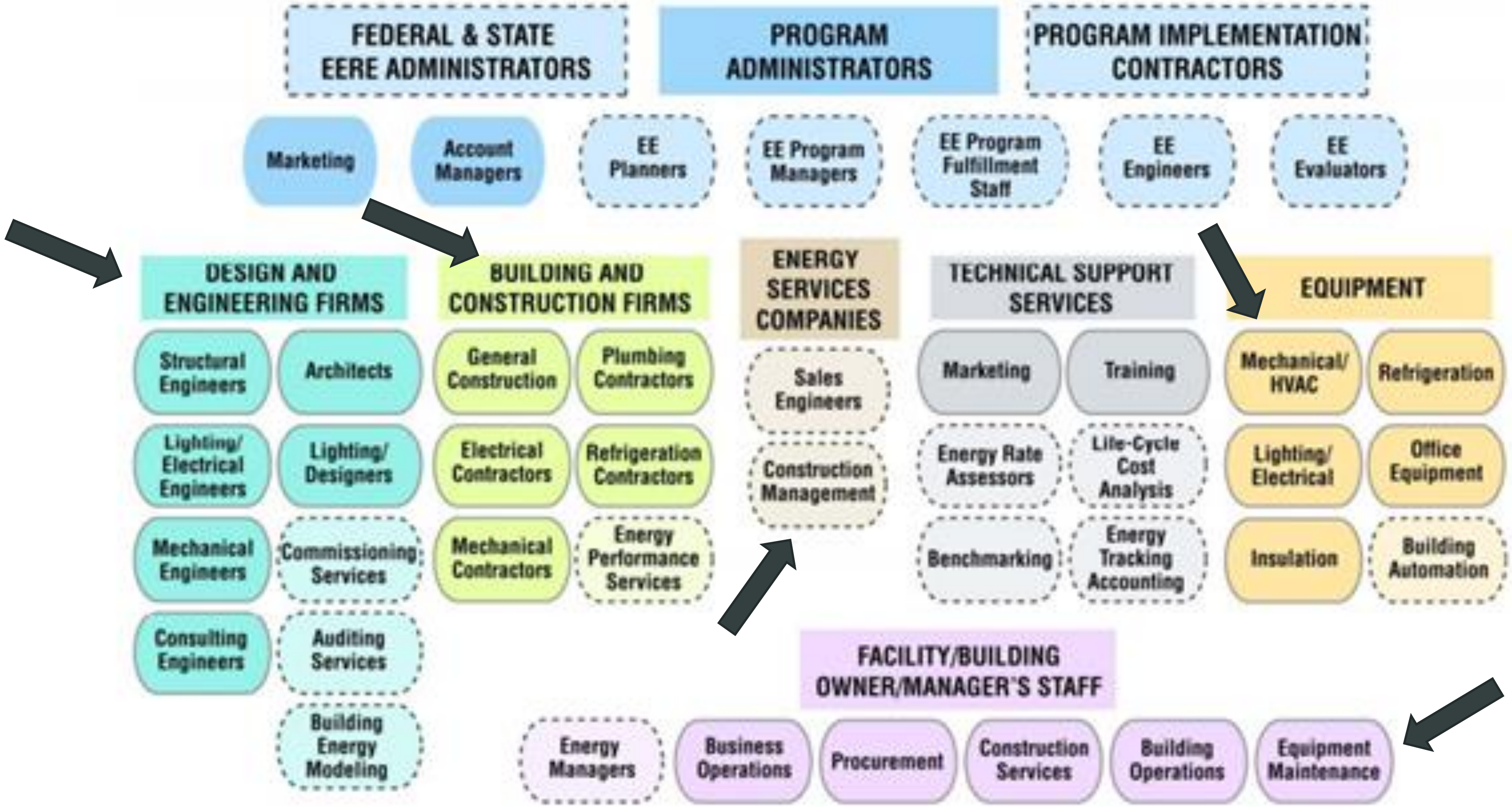
What is BEE Fundamentals?

This program introduces community college students and young professionals to **energy efficiency and energy code topics** to prepare **the next generation of professionals** to integrate energy efficiency into their work.

Building Energy Education | fundamentals

Careers in Energy Efficiency

There are many different energy efficiency jobs.

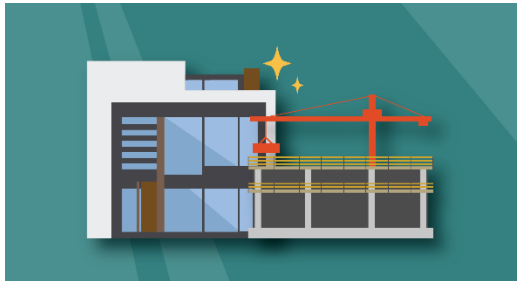


https://emp.lbl.gov/publications/energy-efficiency-services-sector

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Careers in Energy Efficiency

Energy efficiency jobs span a range of skills.



Building Related Jobs:
- ✓ Design
- ✓ Construction
- ✓ Operation

Policy & Planning
- ✓ Marketing
- ✓ Proposal Writing
- ✓ Research

Analysis & Computation:
- ✓ Calculate Savings
- ✓ Manage Data
- ✓ Generate Reports

Financial:
- ✓ Sales & Cashflow Analysis
- ✓ Project Financing
- ✓ Project Management

Customer Service & Training
- ✓ Sell Products and Services
- ✓ Quality Control
- ✓ Teach Students

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Careers in Energy Efficiency

Building related jobs address energy efficiency.

DESIGN

Architects & Engineers
- ✓ design for efficiency
- ✓ ensure code compliance and safety

BUILD

Contractors and Construction Managers
- ✓ build efficiently
- ✓ make buildings more efficient when they renovate

INSTALL

Installers & Technicians
- ✓ install efficient equipment
- ✓ make sure it is operating properly

OPERATE

Building Operators
- ✓ ensure that buildings run smoothly and efficiently
- ✓ maintain efficiency

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

https://unsplash.com/: clockwise from upper left: Ryan Ancill, Gregson Joralemon, Emmanuel Ikwuegbu, Christopher Burns

Careers in Energy Efficiency

There are many non-construction, technical energy efficiency jobs, too.

Industrial: Factories and manufacturing have big energy efficiency opportunities

Product Development: Engineers and designers develop products to support energy efficiency in other sectors

Program Implementation: Identify opportunities for clients to take advantage of utility energy efficiency programs

Public Works: Reduce the energy use of vital public services such as water treatment and public transportation.

Careers in Energy Efficiency

There are many non-construction, technical energy efficiency jobs, too.

Sales and marketing: Sell energy efficiency products and services

Accounting: Help finance and facilitate energy efficiency projects

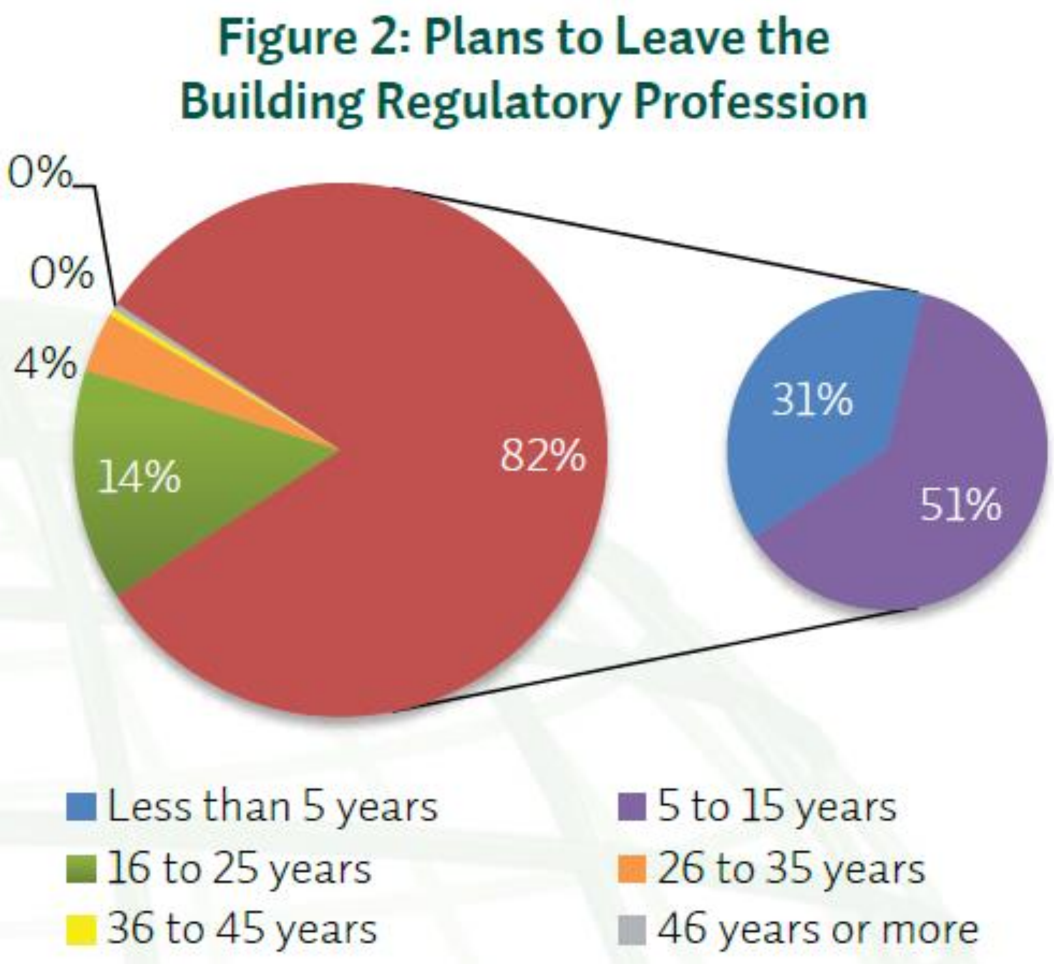
Program management: Help manage utility energy efficiency programs

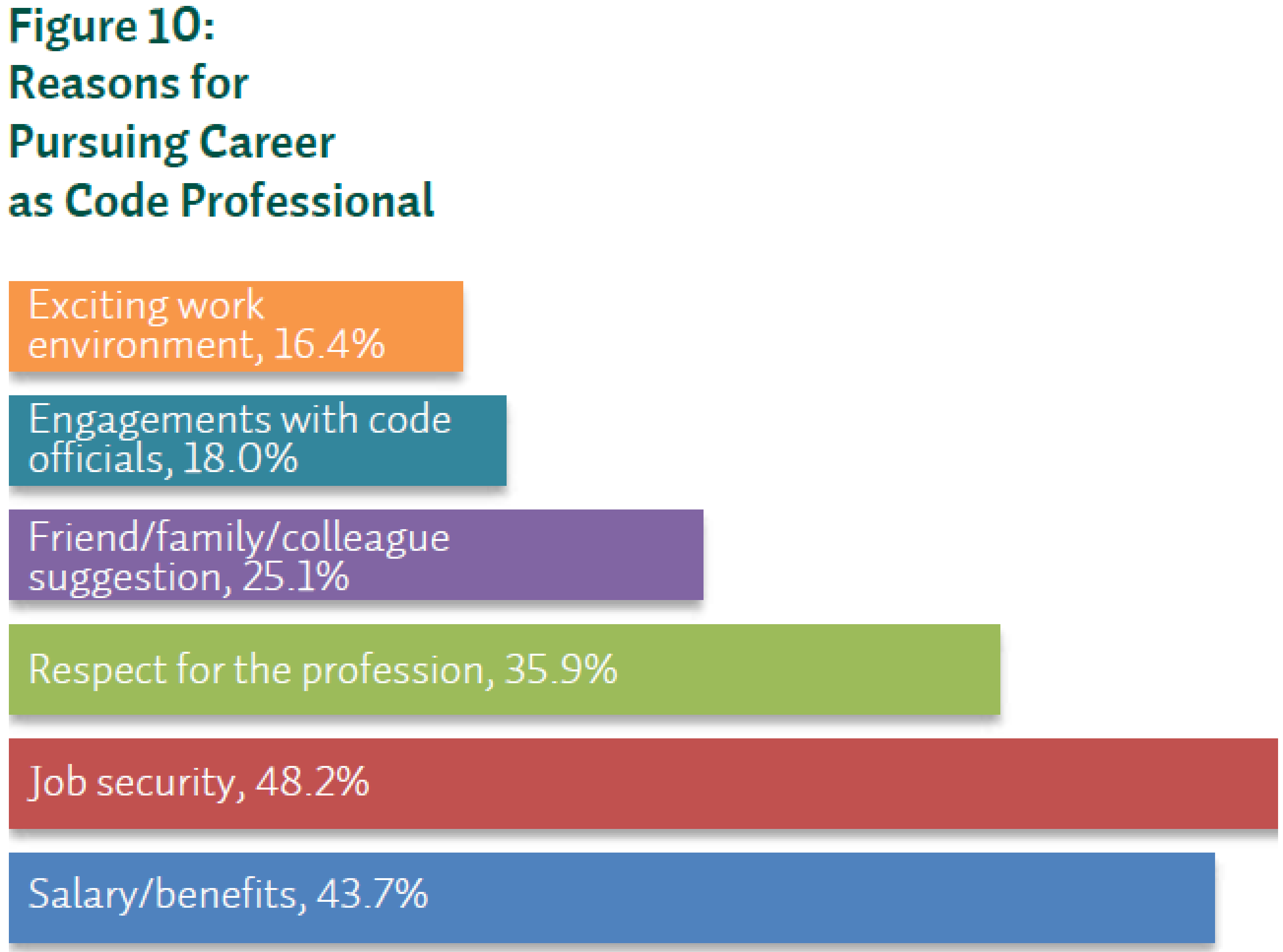
Policy making: Help develop the policies that prioritize energy efficiency

Educating: Educate people about the benefits of energy efficiency

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Code Professional Career





SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

International Code Council (ICC) “The Future of Code Officials”. 2014

Code Professional Career

"… far more rewarding, as you **maintain vigilance** over all structures built in your jurisdiction to ensure they meet the minimum standards of the laws and codes."

"**Extremely rewarding**, always helping people, always learning, never a dull moment, always in demand."

"I believe that my 25 years in the field of commercial construction as an **apprentice, journeyman, foreman and supervisor** served me well when I made the decision to enter the inspection field."

"Get all of the vocational training you can, and work in the building trades field, so you have a **good understanding** of how a structure should go together. Work for a good, reputable contractor for at least two years and **train, train, train**."

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

International Code Council (ICC), "The Future of Code Officials". 2014

Why BEE Fundamentals?

"We're going to keep struggling with code compliance **until energy code training permeates the building trades**."
- IL Code Official

"We offer basic, introductory exploration of the topic…it would be great to **focus more on the IECC and how it relates**"
- IL Instructor

"I don't just keep using the same book over and over…I like to keep [my students] appraised of **what's going on in the world today**"
- NV Instructor

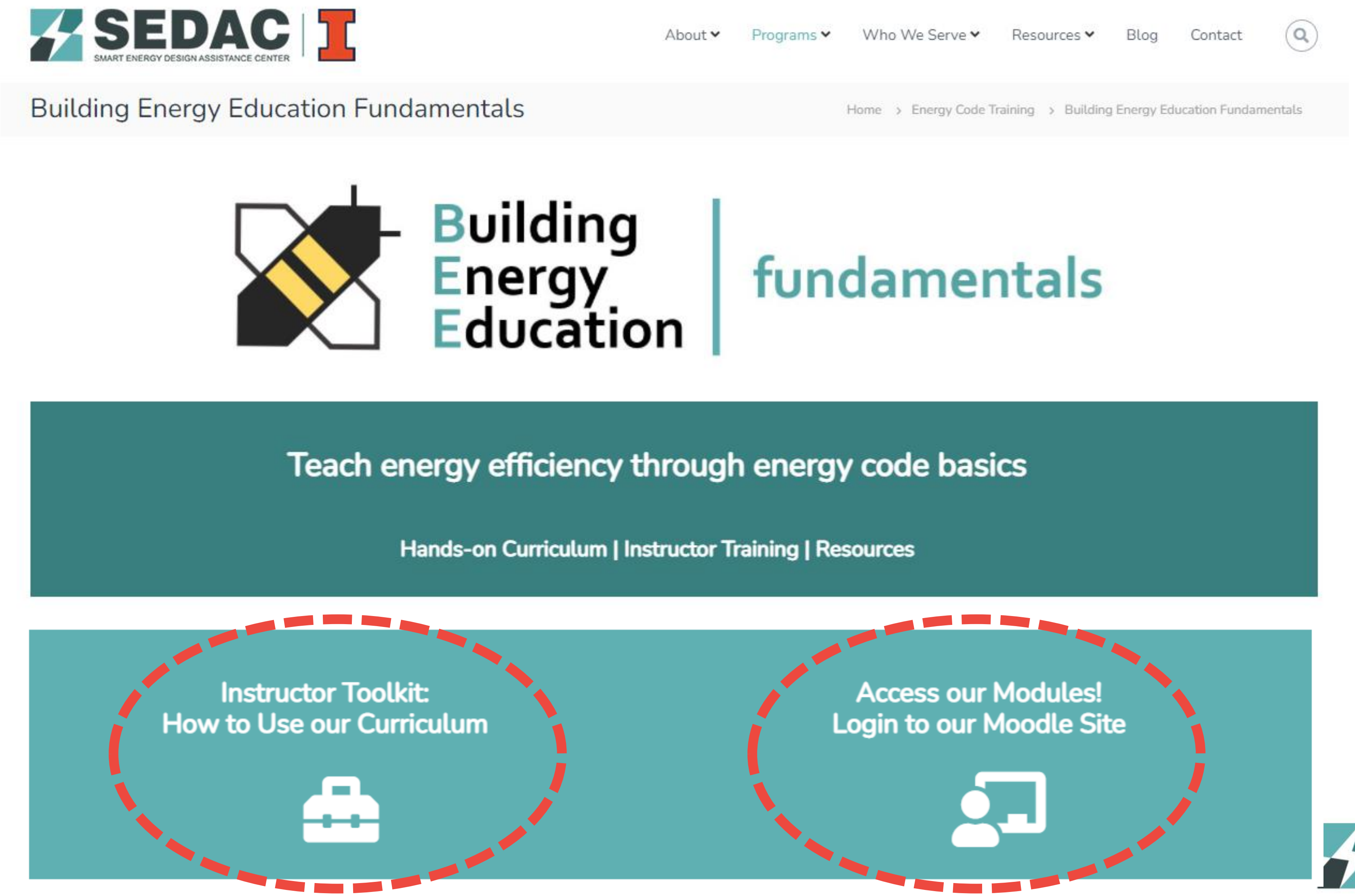
"Most people tend to learn better when they are able to have **hands-on experience or see live examples** instead of only reading about it."
- HI Code Consultant

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

SEDAC, Interview with Code Professionals and Instructors, 2021

BEE Fundamentals Program Webpage

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



SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Instructor Toolkit

https://smartenergy.illinois.edu/instructor-toolkit

Instructor Toolkit:
How to Use our Curriculum

INTRO MODULES

Community College Energy Code Training Program: ...

Copy link

1. Energy Efficiency Careers & Pathways

3. Introduction to Energy Codes & Standards +

4. Navigating Energy Codes & Standards –

1. Accessing the Codes: Presentation
2. Looking up Requirements: Presentation
3. Energy Code Compliance Paths: Presentation
4. The Approval and Permit Process: Presentation
5. Combined presentation, in-class exercise, review worksheet, and Jeopardy activity

ABOUT OUR PROGRAM

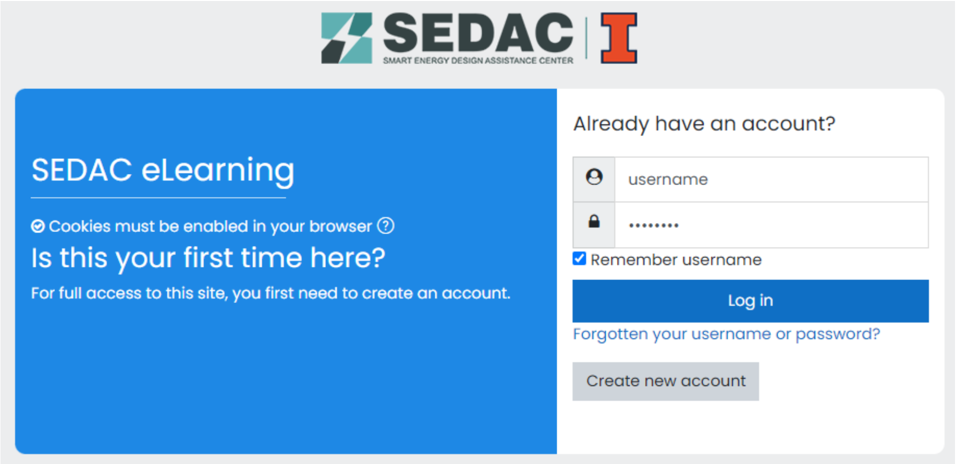
- What is this training program about? +
- Why all the focus on energy codes? +
- Who should use this program? +
- Will this training prepare students for a job or certification exam? +
- Who created this training program? +
- How can I be involved and get updates? +

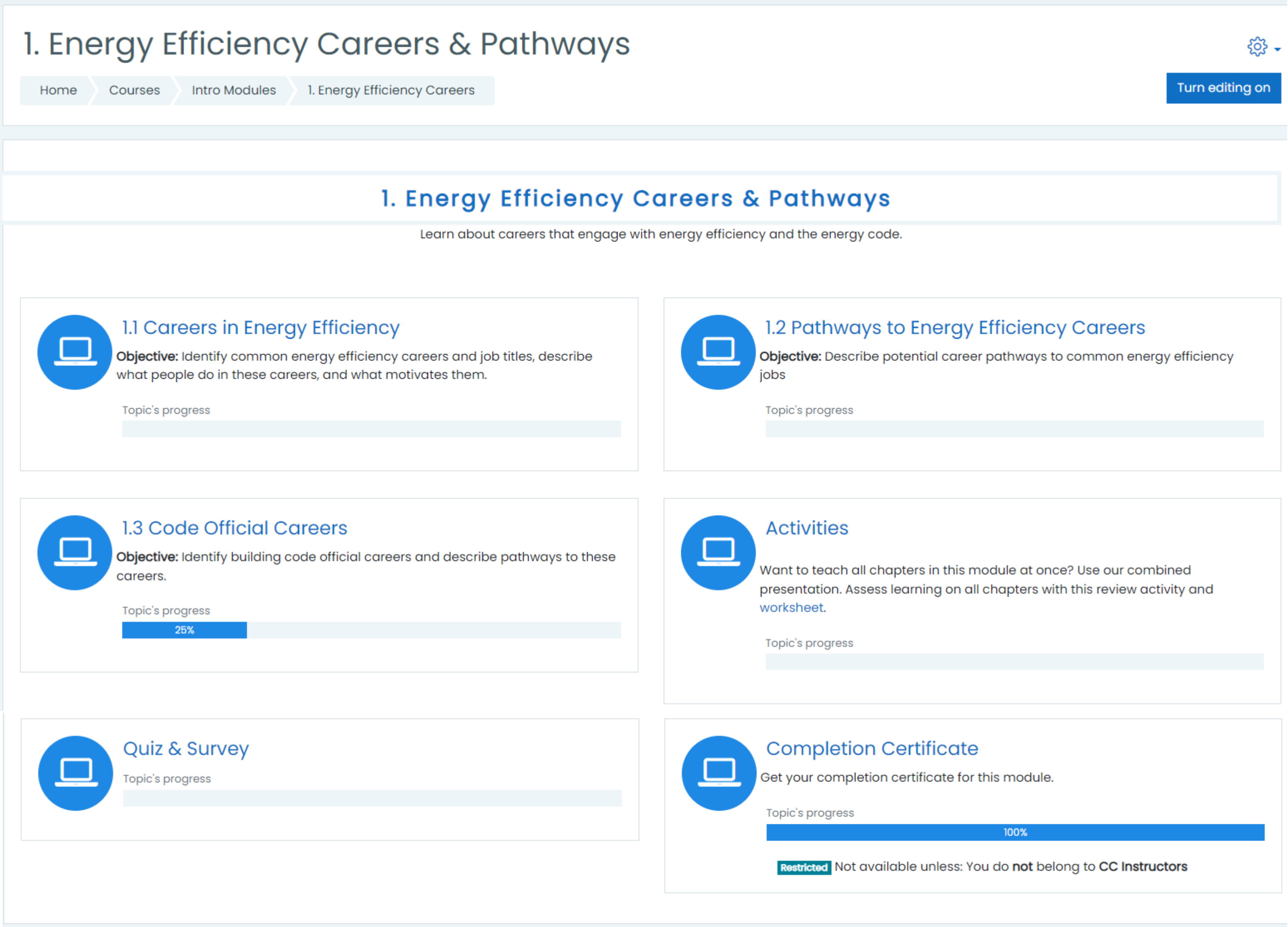
USING OUR CURRICULUM

- Are the modules free to use? +
- Do I need to use all of the modules? +
- How should I select which curriculum to use? +
- How do my students and I access the modules? +
- Can my students work through the material on their own? +
- How can I provide feedback? +

Moodle

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





Moodle: How to Navigate

BEE Fundamentals Webinars & Workshop

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

PROGRAM LAUNCH

HAWAII LAUNCH WEBINARS

Part 1: April 7, 2022, 12:00-1:30 pm HST

Register here

Part 2: April 14, 2022, 12:00-1:30 pm HST

Register here

Part 3: April 21, 2022, 12:00-1:30 pm HST

Register here

Hawaii Launch Part 1 Agenda +

Hawaii Launch Part 2 Agenda +

Hawaii Launch Part 3 Agenda +

NEVADA LAUNCH WEBINAR

April 20, 2022 from 10am-12pm PST

RSVP via email: info@energy.nv.gov

Nevada Launch Agenda +

ILLINOIS LAUNCH WEBINAR

April 22, 2022 from 2-4pm CST

Register here

Illinois Launch Agenda +

TRAIN-THE-TRAINER WORKSHOP

(for All States)

April 29, 2022
2:00-4:00 pm CST (12 – 2pm PST, 9 – 11am HST)
Register here

Train the Trainer Workshop Agenda +

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Questions?

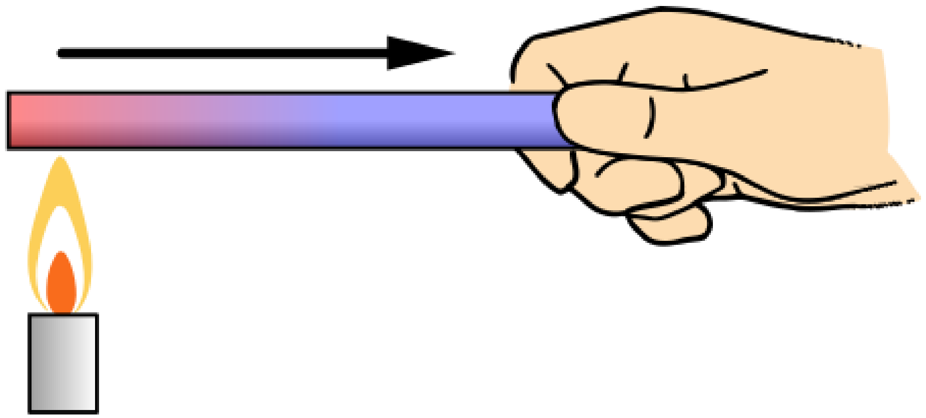
sumihan@illinois.edu
217-300-1820

Section 2

Prof. Norman Takeya

Section 3

Building energy fundamentals & building envelope basics

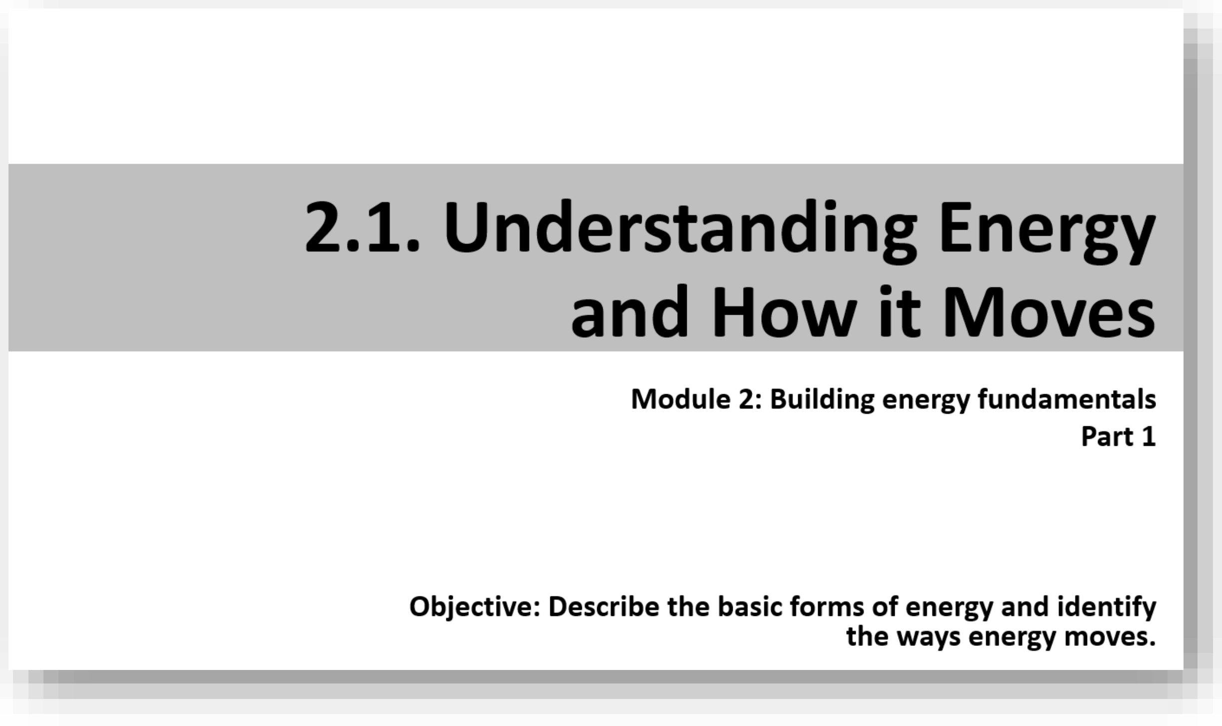


https://bsesc.energy.gov/

BEE Modules

2. Building Energy Fundamentals
    - 2.1 Understanding energy and how it moves
    - 2.2 Heat transfer and the building envelope
    - 2.3 Energy and mechanical systems
5. Envelope and Insulation Fundamentals
    - 5.1 Envelope and insulation fundamentals
    - 5.3 Air barriers and thermal bridging
6. Walls & Openings
    - 6.1 Walls & openings fundamentals
    - 6.2 Residential systems
    - 6.3 Commercial systems
7. Roofs & Ceilings
    - 7.1 Roofs & ceilings
    - 7.2 Commercial roof & ceiling insulation
    - 7.3 Residential roof & ceiling insulation

Building Energy Education fundamentals



2.1. Understanding Energy and How it Moves

Module 2: Building energy fundamentals

Part 1

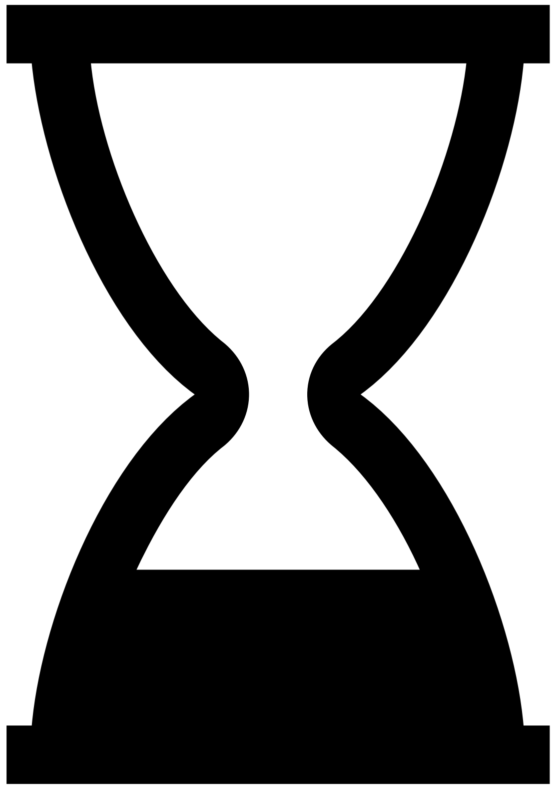
Objective: Describe the basic forms of energy and identify the ways energy moves.

Energy and power

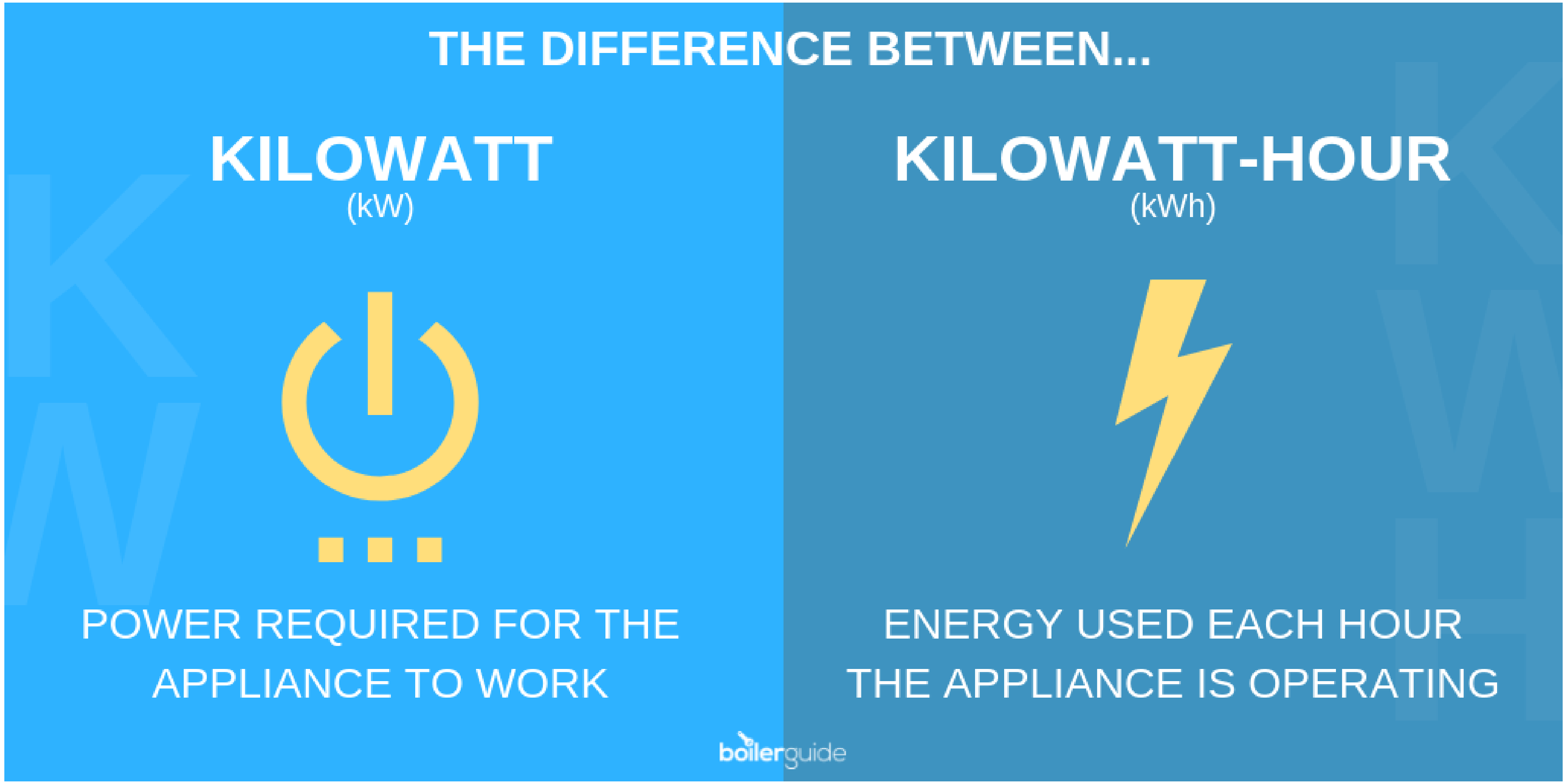
Energy is not the same as power

Power is energy per unit time—it's the rate that energy flows.

$$\boxed{Power = \frac{Energy}{Time}}$$



Power (Demand) x Time = Energy used



https://lge-ku.com/residential/billing/time-of-day-rates/understanding-demand

Energy and power terms

Definitions:

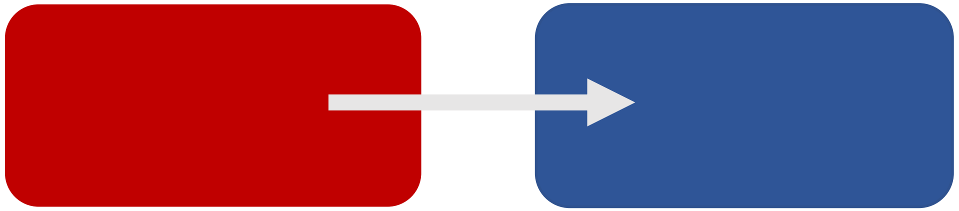
- Btu – energy to raise 1lb of water 1°F
- kW – electrical energy 3,412 Btu per hour (1,000 watts)
- kWh – power 3,412 Btu
- Therm – 100,000 Btu
- Horsepower – 0.746 kW
- Cooling ton – 12,000 Btu (btu required to melt 1 ton of ice)

$$Energy = Power \times Time$$

$$kWh = kW \times hr$$

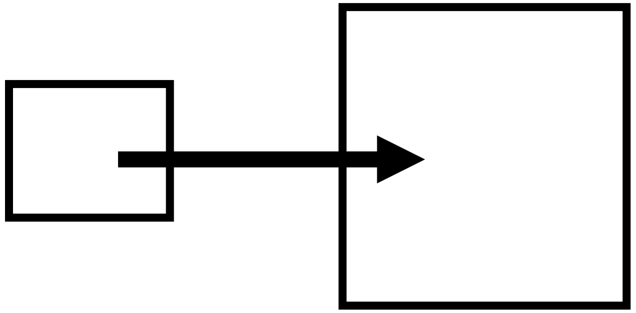
3 factors affect heat transfer

Temperature difference (2nd law)

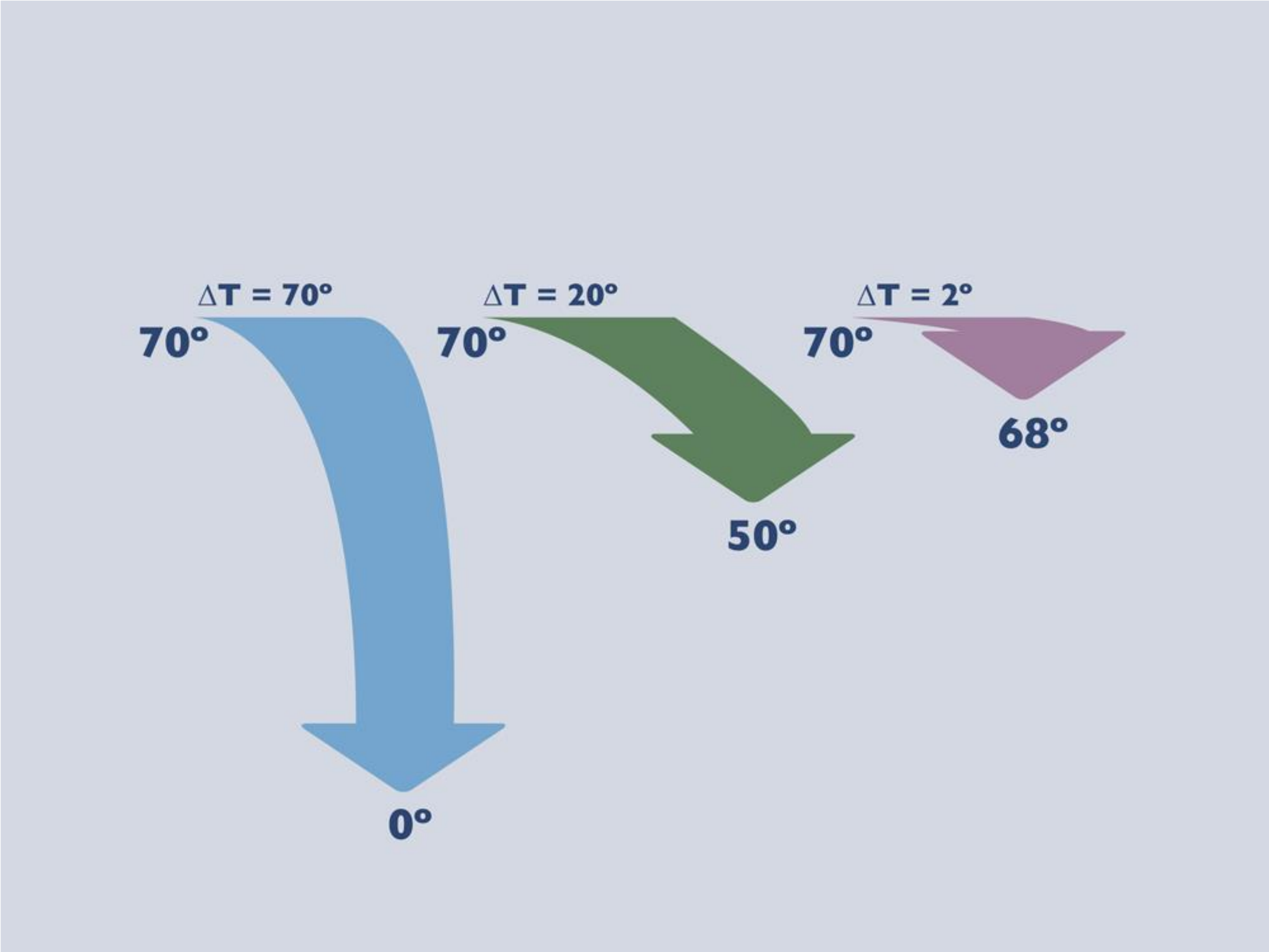


Time over which the transfer occurs

Area over which the transfer occurs



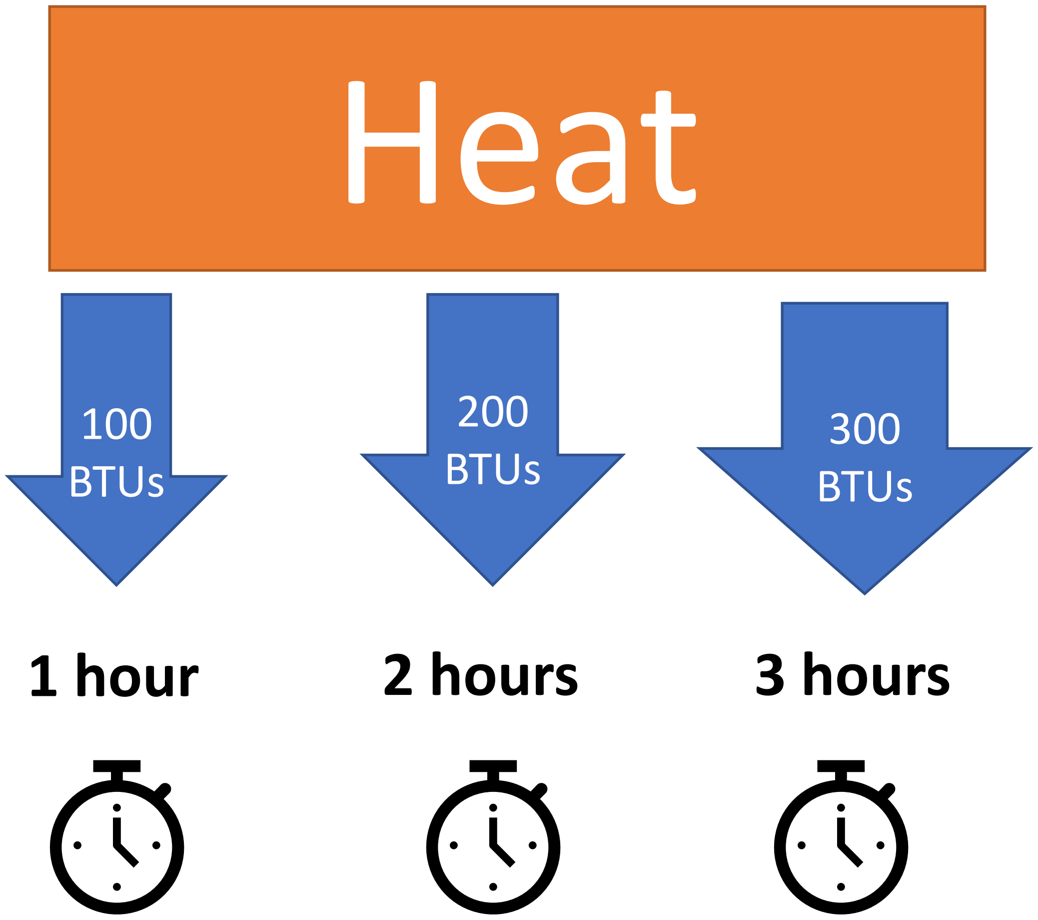
The effect of temperature gradients



Heat transfer will flow quicker the greater the temperature difference.

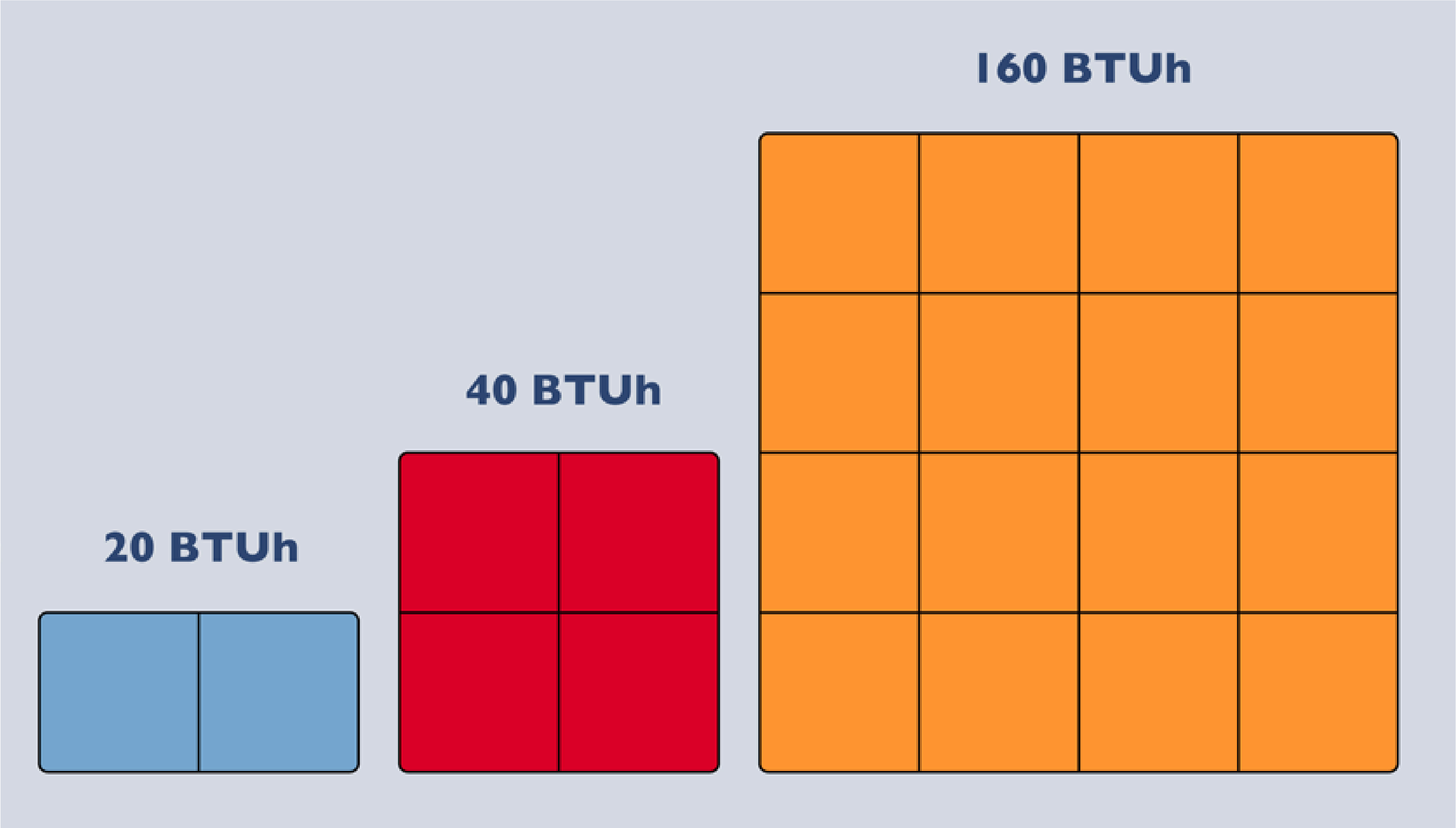
https://bsesc.energy.gov/

The effect time



The greater the amount of time, the greater the transfer of heat.

The effect of area



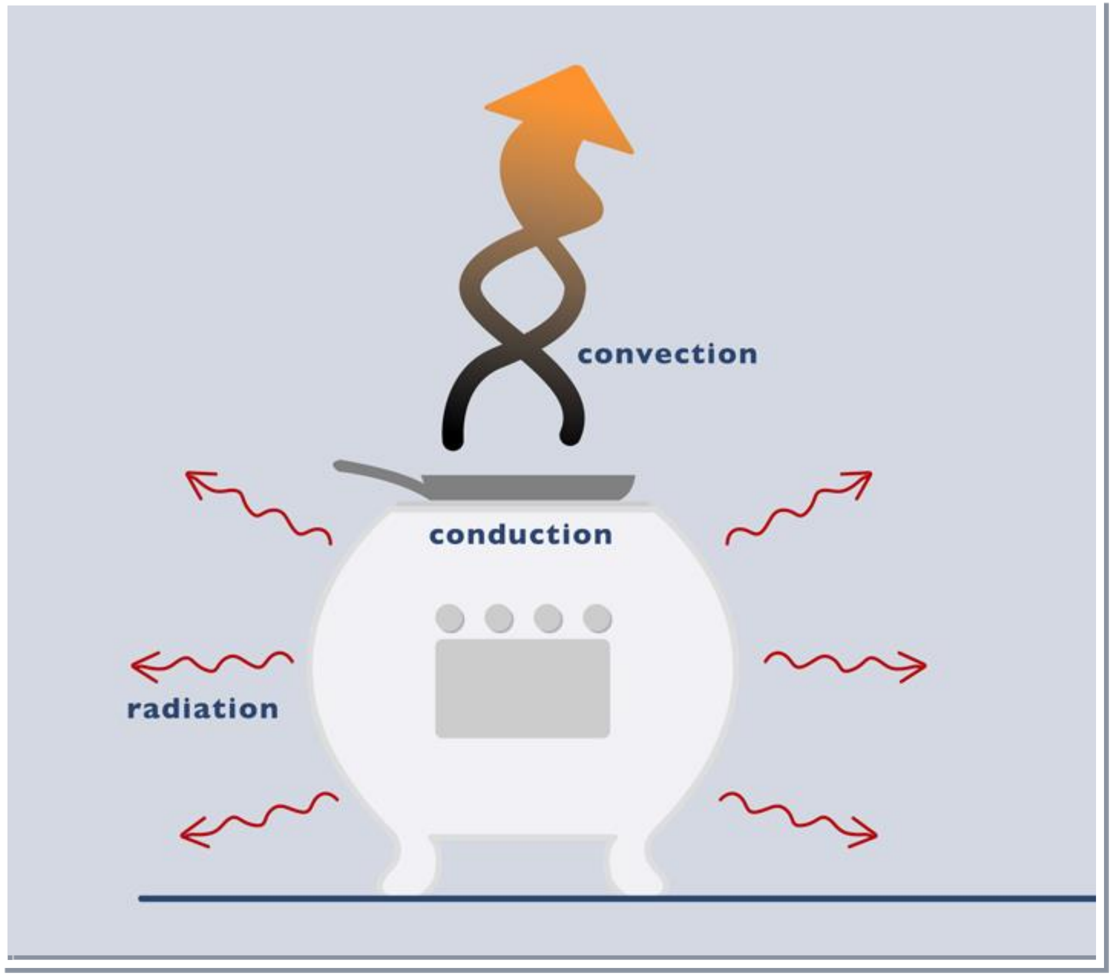
A building with a larger surface area will take more energy to heat or cool because there is more surface area that transfers heat.

https://bsesc.energy.gov/

Modes of heat transfer

- Conduction
- Convection
- Radiation

Most systems in buildings experience a combination of all three forms of heat transfer.



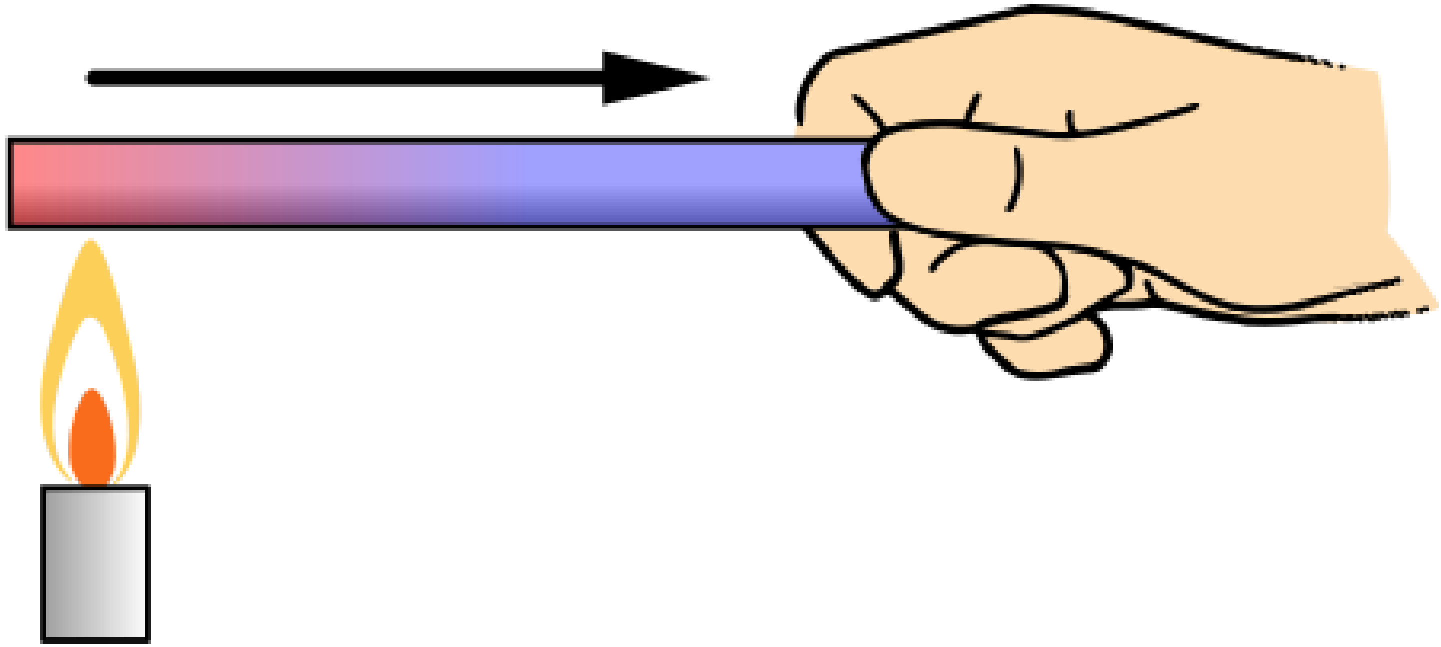
https://bsesc.energy.gov/

2.2. Heat Transfer and the Building Envelope

Module 2: Building energy fundamentals
Part 2

Objective: Describe the way control layers reduce energy transfer and how thermal performance is measured.

Methods of heat transfer: conduction



Will the flame burn your hand? It depends on whether the stick is a conductive material.

https://bsesc.energy.gov/

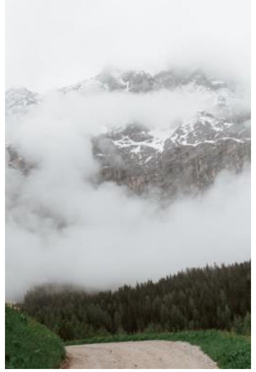
How would you rate these materials in order of highest to lowest conductivity?

Copper

Styrofoam

Cotton

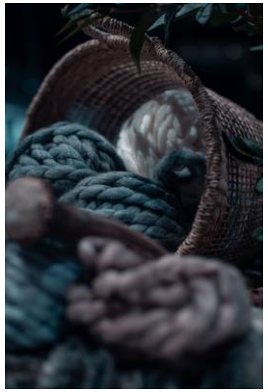
Air



Wood

Brick

Wool

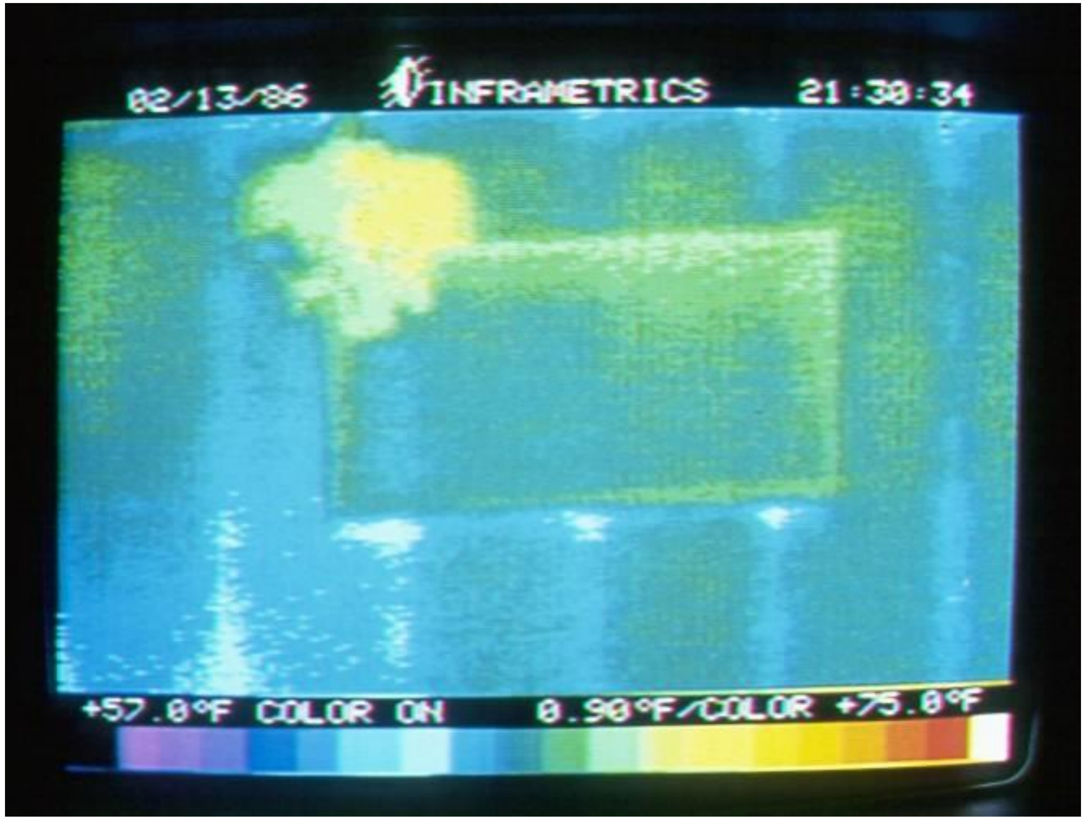


Stainless steel

https://www.pexels.com/

Heat loss to outside

Inside view



https://bsesc.energy.gov/

How do we measure conduction?

R-value

- A material's **resistance** to heat flow
- The higher the R-value is, the better the insulative properties are (or less heat loss by conduction).

U-value vs. R-value

Both ways of measuring material property.

U-value: Predicts rate of heat transfer

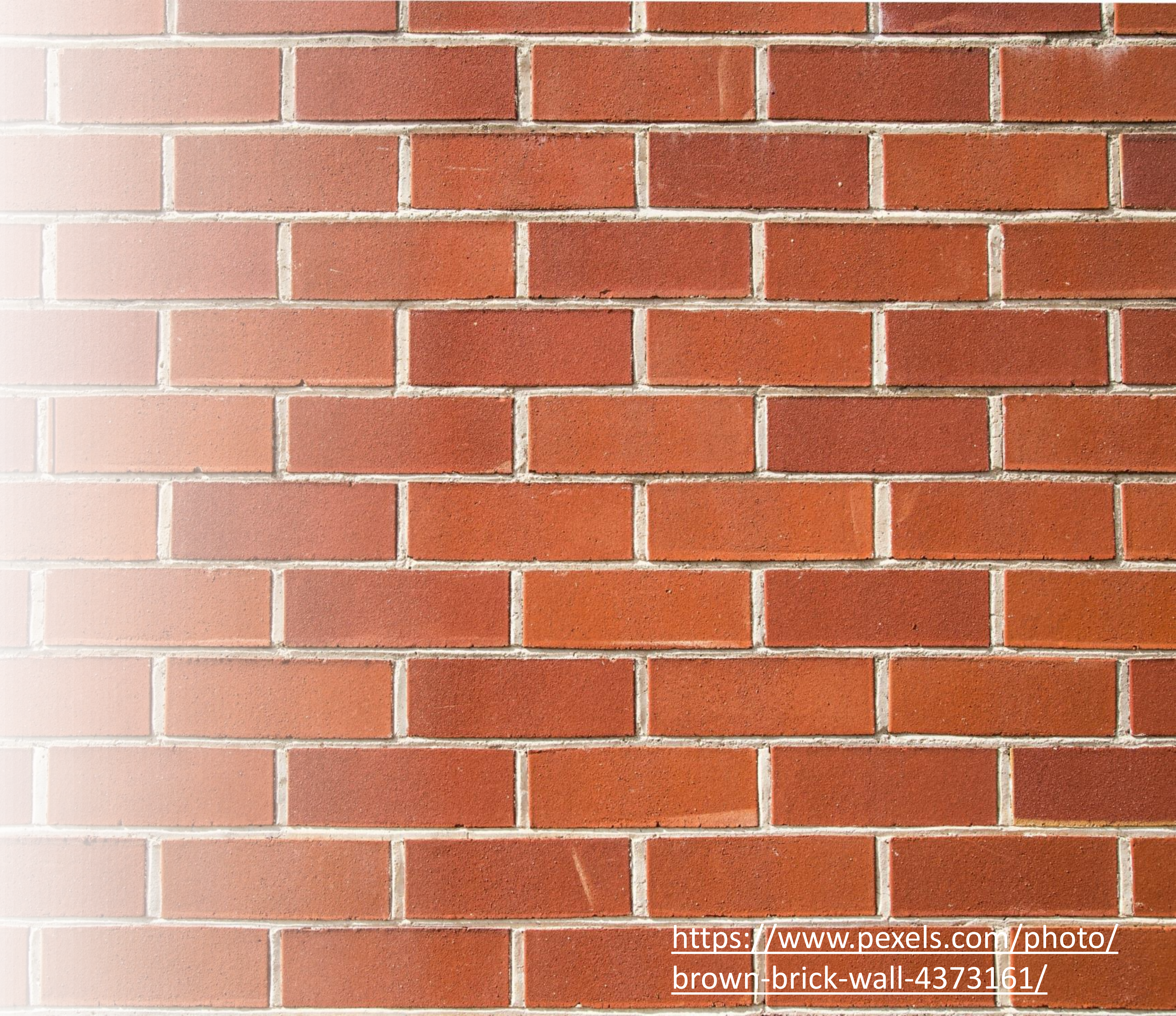
R-value: Predicts resistance to heat transfer

$$U = 1/R \qquad R = 1/U$$

R-value		U-value
1	=	1.00
2	=	.50
3	=	.33
4	=	.25

Typical R-values

Material	R-value
1” fiberglass batt	3
1” polyiso foam	6-7
1/2" drywall	0.45
1/2" plywood	0.62
2" lumber	1.45
8" poured concrete	0.64
8” poured hempcrete	16
concrete block	0.70-2.0
single glazed window	0.91-1
double glazed window	2-3



https://www.pexels.com/photo/brown-brick-wall-4373161/

Calculating heat loss by conduction

- To calculate heat loss, you need to know:
- U-value (U)
- Area
- Temperature difference between inside/outside
- Time

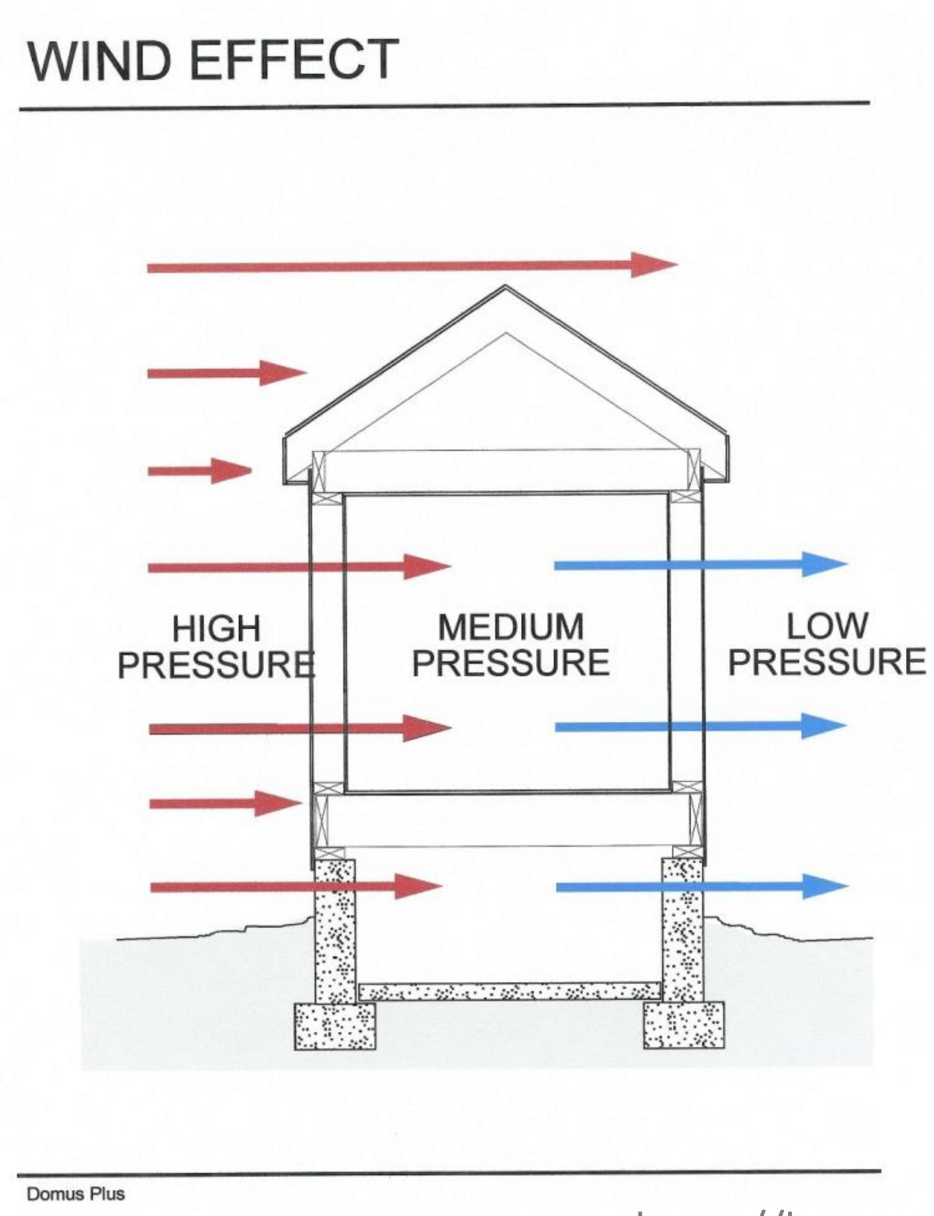
- **$Q = U \times A \times \Delta T \times t$**
- **$Q = BTU/ft^2 hr^{\circ}F \times ft^2 \times {}^{\circ}F \times hr$**

https://basc.pnnl.gov/images

Forced convection

Air Infiltration

- Wind



https://basc.pnnl.gov/images

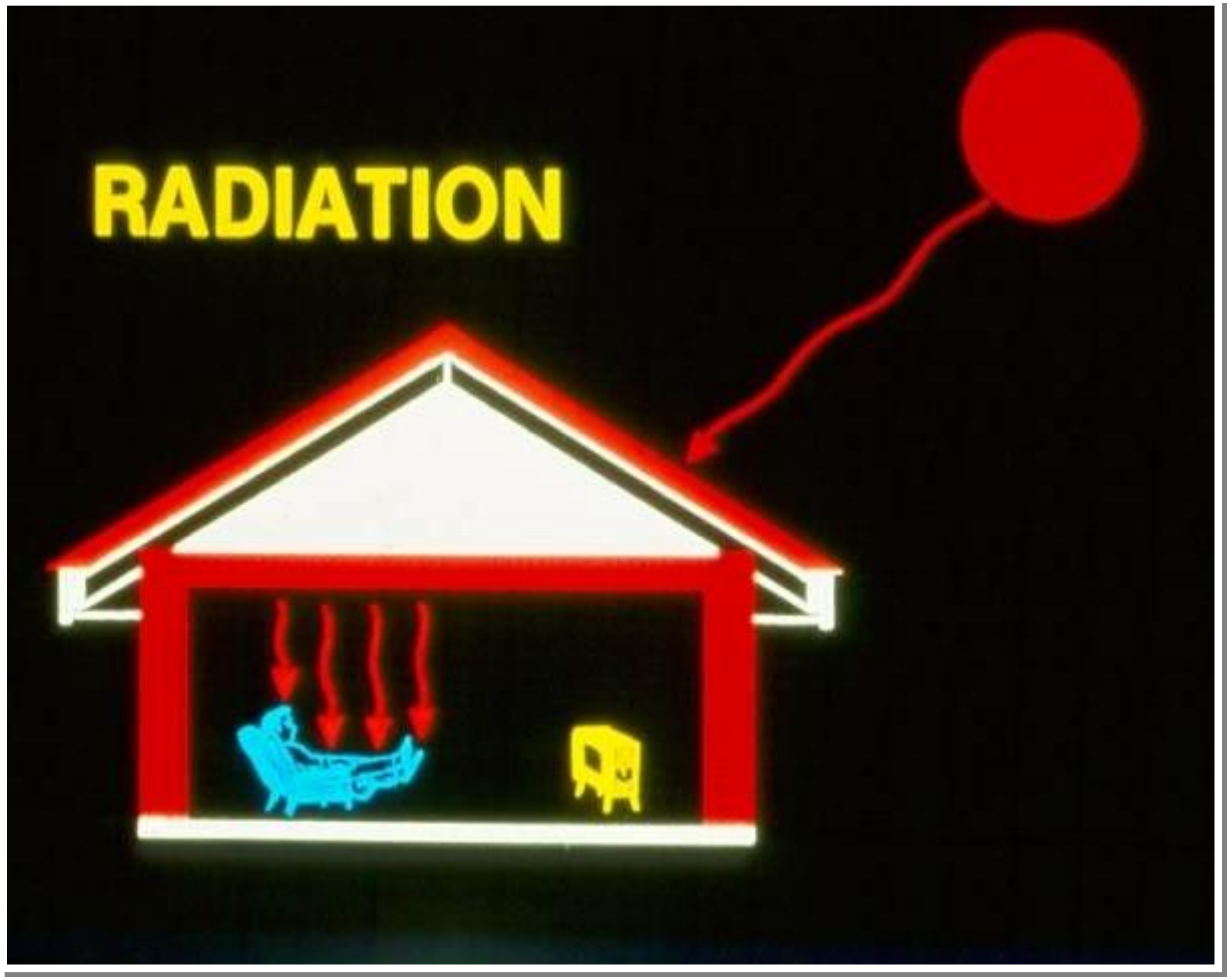
Good air sealing practice

https://basc.pnnl.gov/images

Attic air leaks

https://basc.pnnl.gov/images

Methods of heat transfer: radiation



https://basc.pnnl.gov/images

Radiation

- **Does not require any contact between heat source and heated object.**
- **The sun**
  - The sun's heat comes to earth via radiation.
  - No air or materials in outer space
    - i.e., no conduction or convection

https://basc.pnnl.gov/images

Surface temperature: stucco

https://basc.pnnl.gov/images

Surface temperature: T-111

https://basc.pnnl.gov/images

Radiant barrier

https://basc.pnnl.gov/images

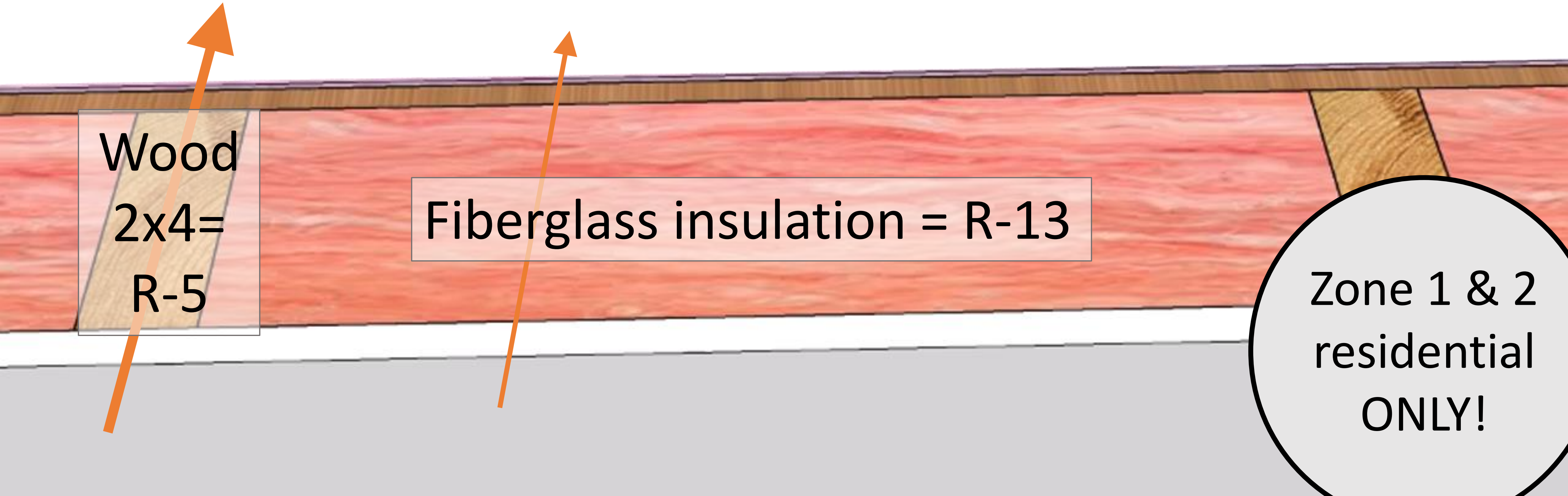
5.3 Air Barriers & Thermal Bridging

Module 5: Envelope & insulation fundamentals
Part 3

Objective: Understand ways energy moves in systems and its impact on thermal envelope design and code compliance.

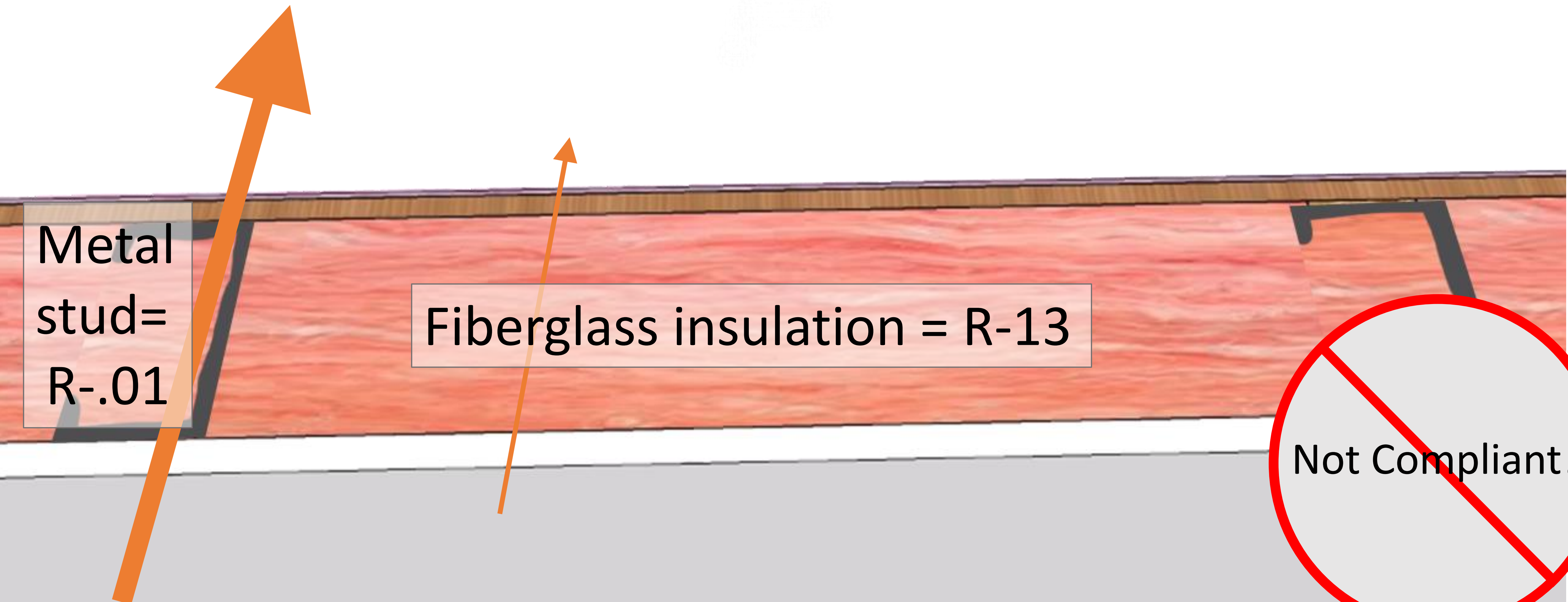
Thermal bridging

Thermal bridging occurs when materials with lower R-value interrupt insulation materials. For example, wood studs in a wall transmit more energy. Therefore, more insulation is required where a thermal bridge exists to limit total energy loss.



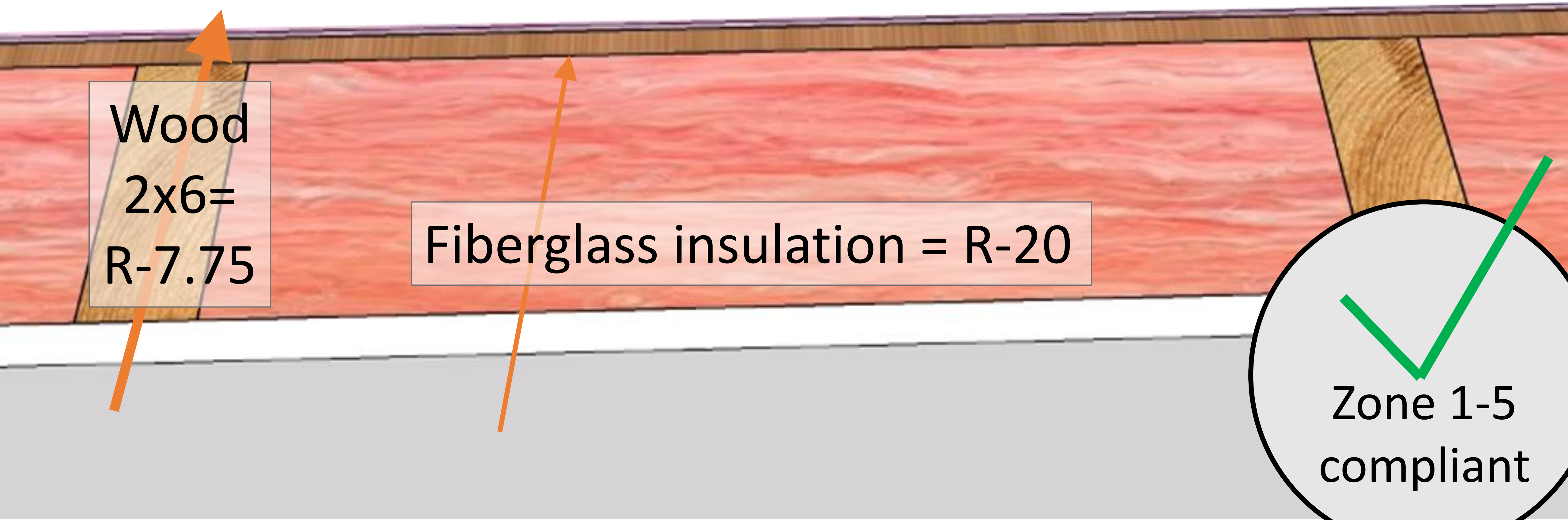
Why continuous insulation?

Metal studs conduct more heat. ASHRAE studies indicate that metal studs 16" on center reduce the effective R-value by 63%!



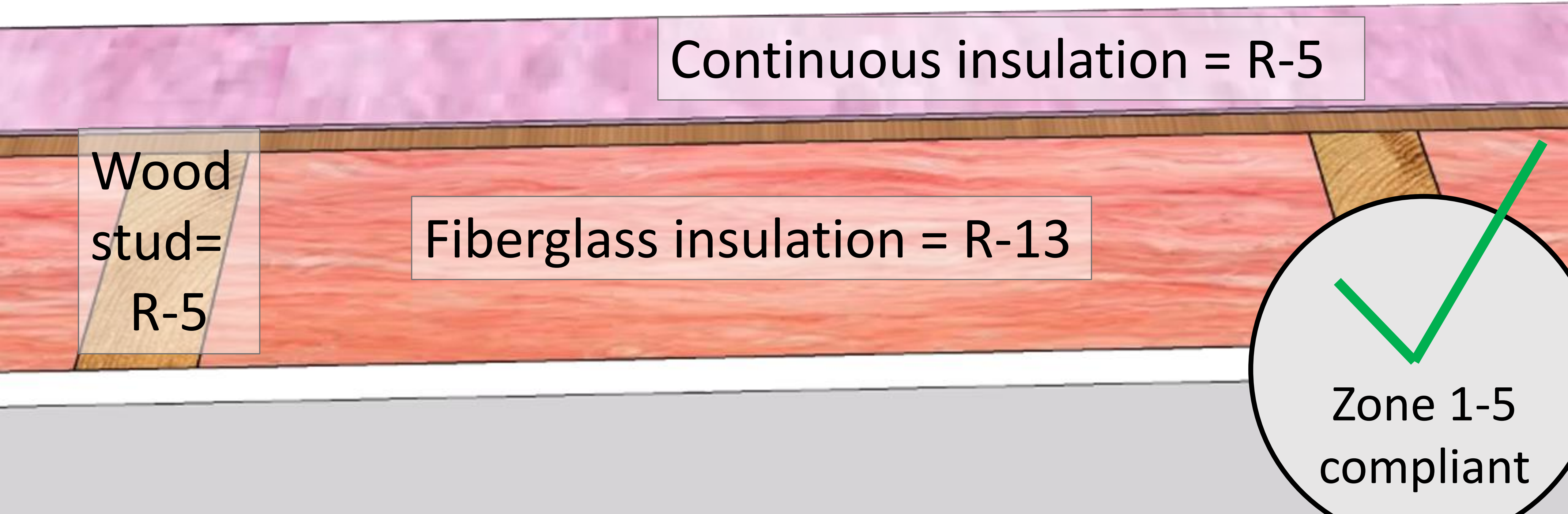
Solution 1 – Add thickness

Increasing the thickness and insulation value can create a code compliant wall without exterior insulation.



Why continuous insulation?

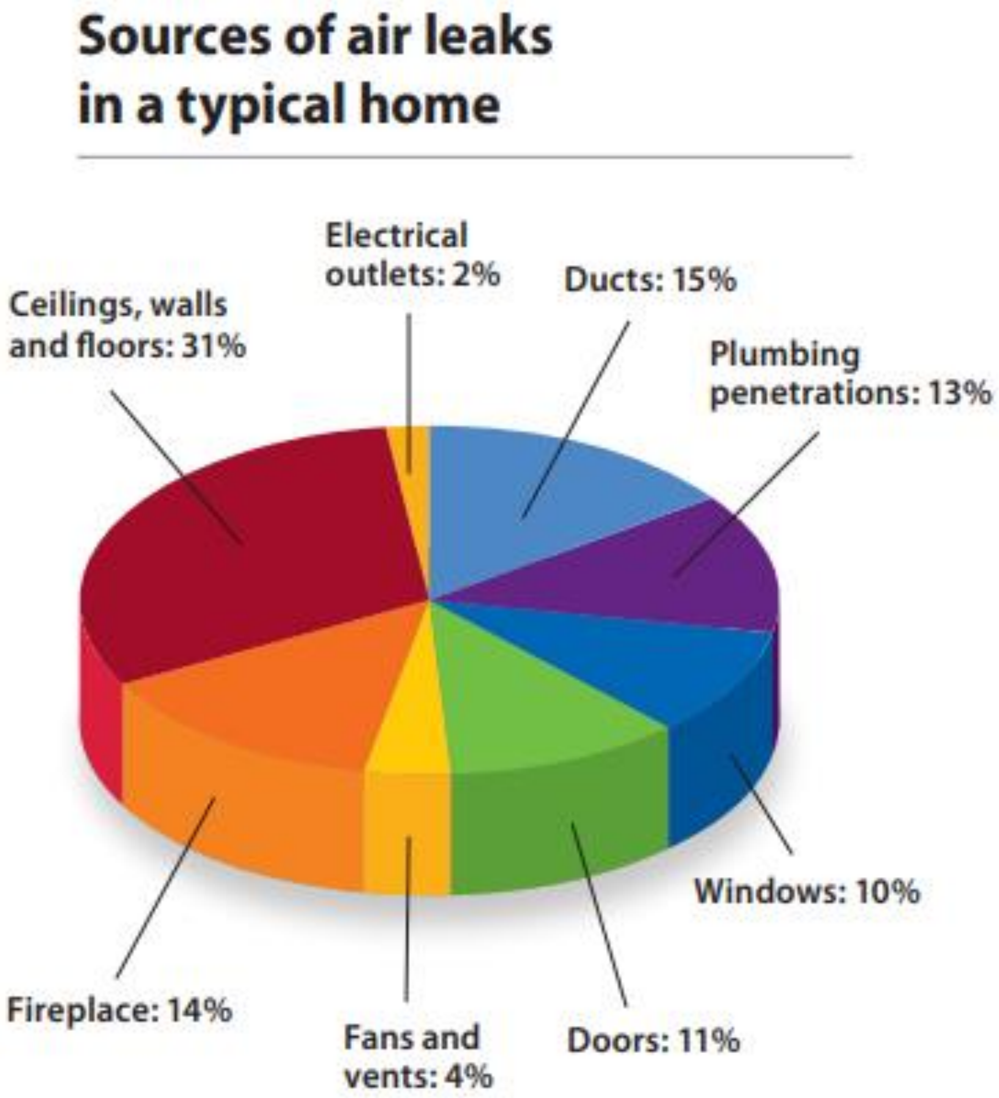
Continuous Insulation blocks the thermal bridge and increases performance. Therefore, the energy code allows lower overall R-value if continuous insulation is used. R-13+R-5 < R-20 but performs equally well because the thermal bridge is blocked. The U-values of each assembly is equivalent.



Prevent air leakage

Air infiltration: The unintentional introduction of outside air into a building.

Air exfiltration: The unintentional passage of interior air out of a building.



https://www.iowaeda.com/userdocs/programs/HomeSeries1.pdf

R402.4.1.2
Blower door testing

- Mandatory for residential construction
- Residential air leakage rate not to exceed:
    - 5 ACH in Zones 1-2
    - 3 ACH in Zones 3-8

      @ 50 pascals

6.1 Walls & Openings Fundamentals

Module 6: Walls & Openings
Part 1

Objective: Describe how control layers work in a wall system, identify the control layers within a wall system, define thermal bridging, and identify the parts of the assembly that are inside and outside of the thermal envelope.

Wall insulation types: applied

Batt Insulation

R-Value/Inch: **2.9-3.3**

$\boxed{\text{Cavity}}$ Continuous Both

$/SF: **$0.69** (3-1/2")

Rigid Insulation

R-Value/Inch: **3.8-4.7**

Cavity Continuous $\boxed{\text{Both}}$

$/SF: **$3.81** (3")

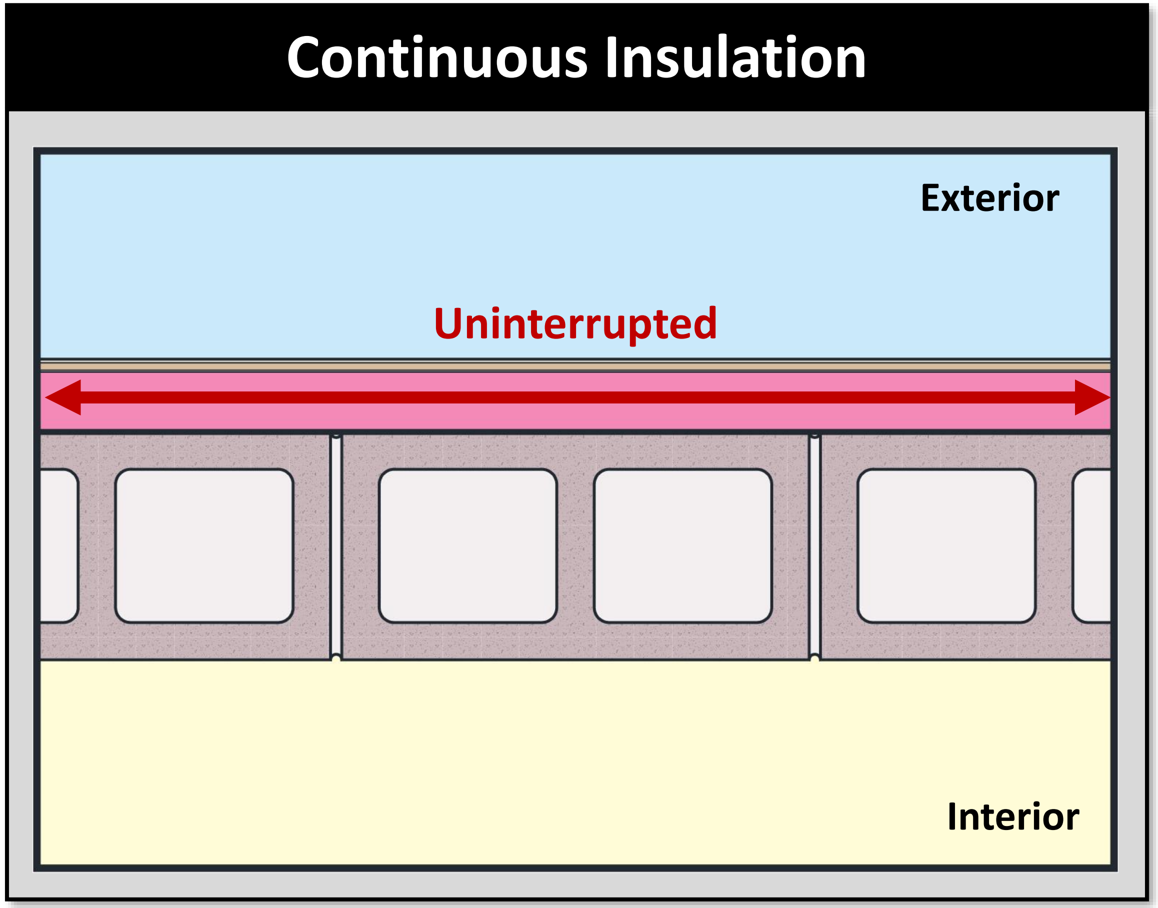
Spray Foam Insulation

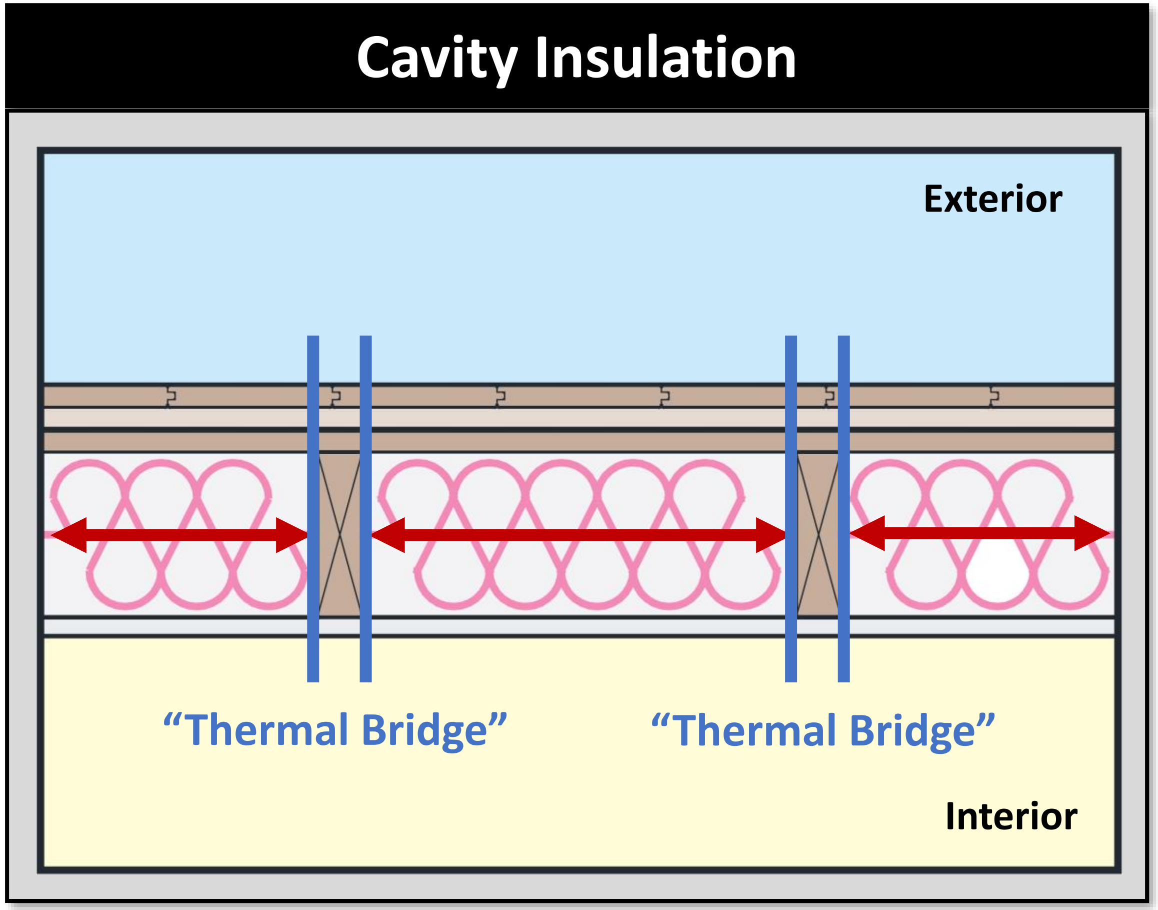
R-Value/Inch: **3.5-6**

$\boxed{\text{Cavity}}$ Continuous Both

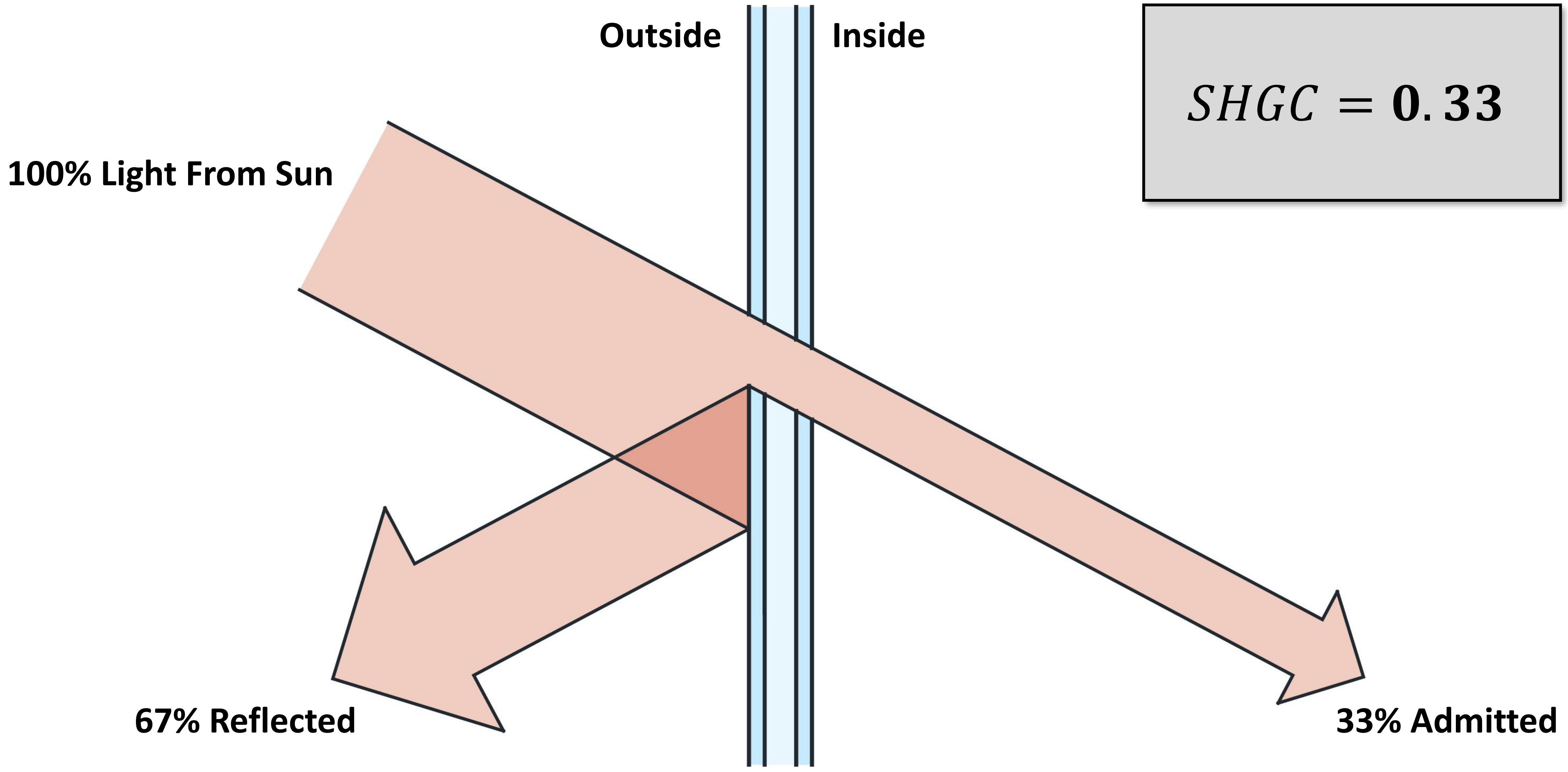
$/SF: **$2.62 (3")**

Continuous and cavity insulation





Solar heat gain coefficient

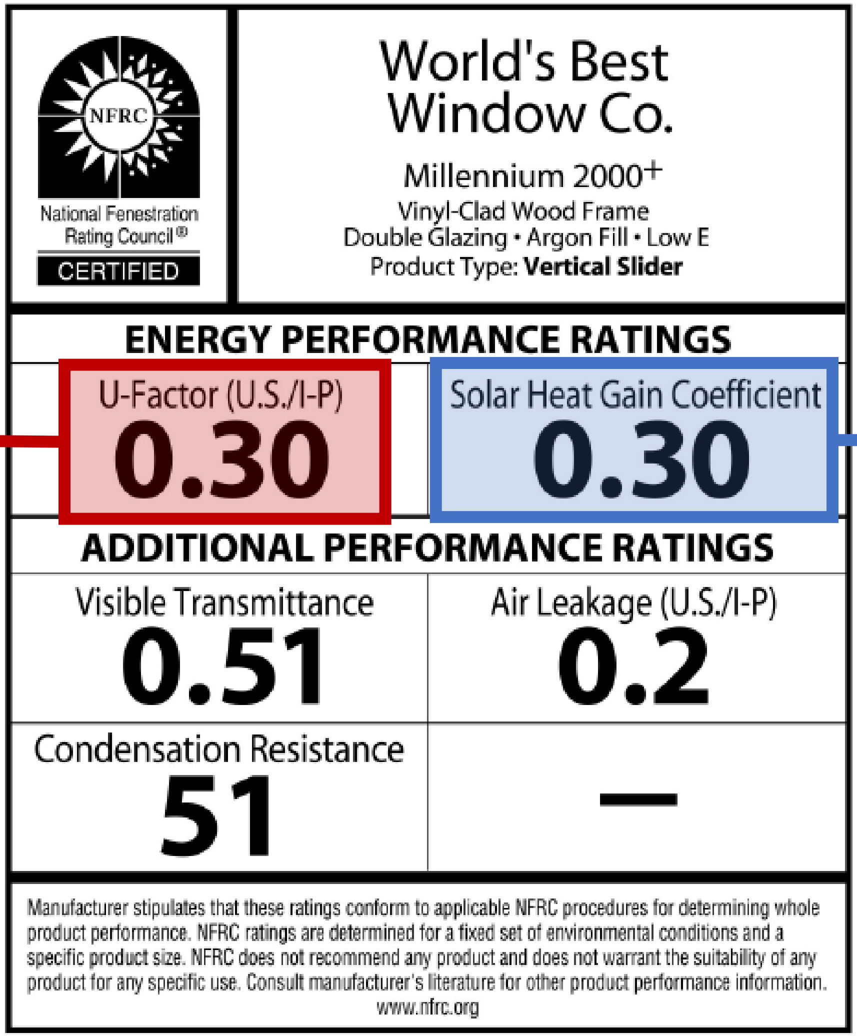


$$SHGC = \mathbf{0.33}$$

Windows and transparent doors

U-factor

$$u = \frac{1}{R}$$



Solar Heat Gain Coefficient

$$SHGC = \frac{\textit{Solar radiation admitted}}{\textit{Solar radiation incident}}$$

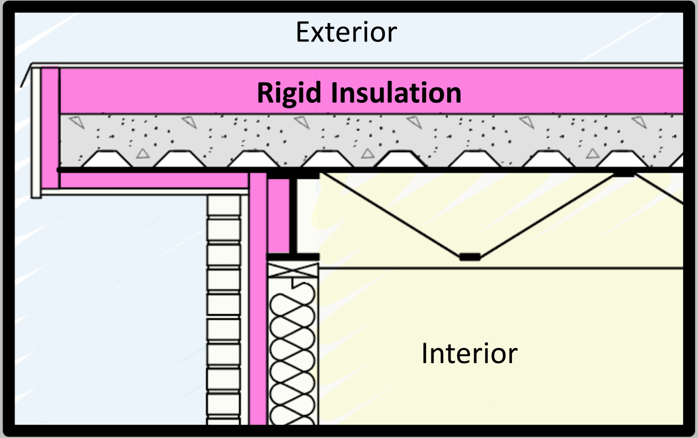
7.1 Roofs & Ceilings

Module 7: Roofs & ceilings fundamentals
Part 1

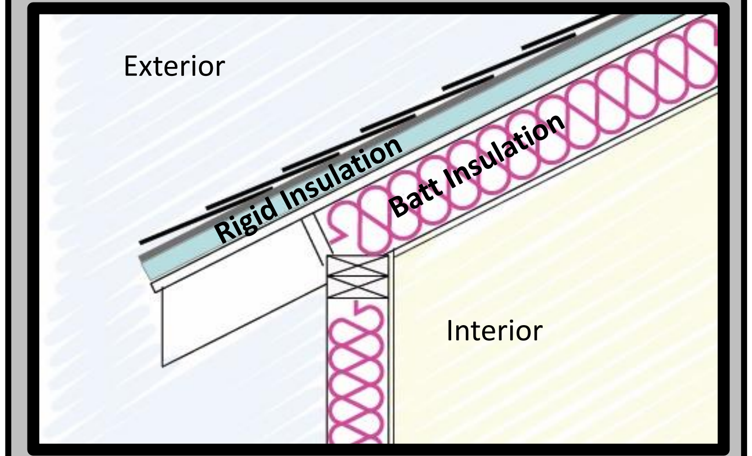
Objectives: Identify the control layers within wall and roof assemblies. Describe the parts of the assembly that are inside and outside of the thermal envelope.

Roof and ceiling insulation locations

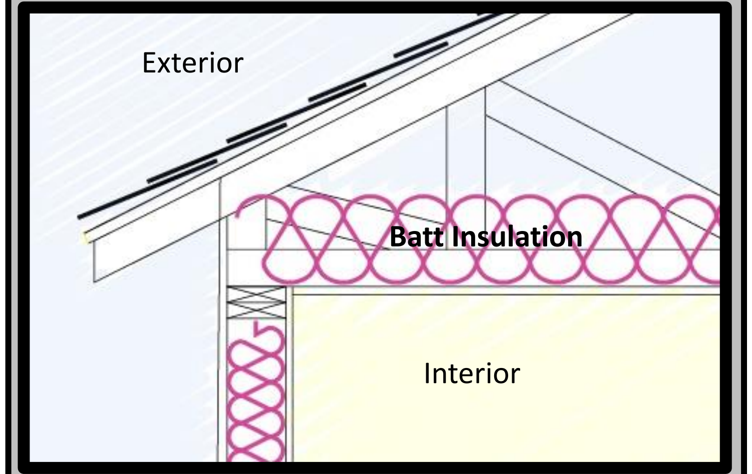
Insulation on exterior side

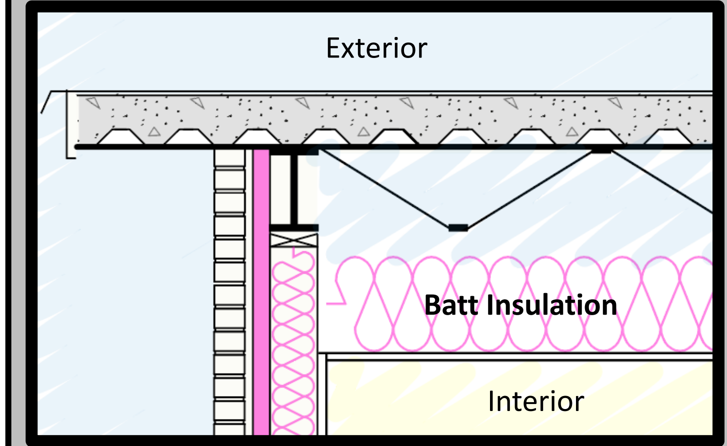


Combination



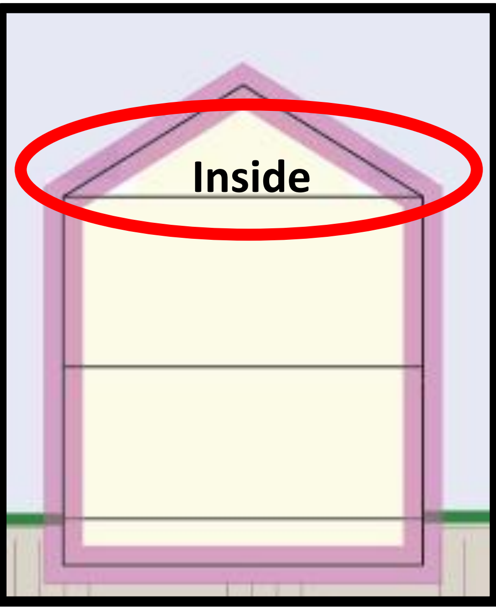
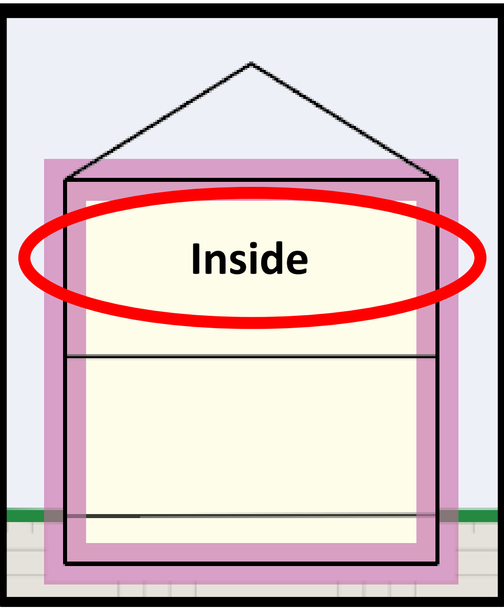
Insulation inside an attic





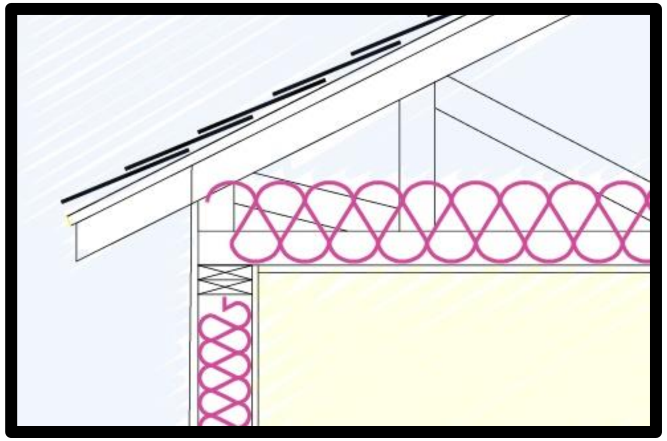
The bulk water control layer and the thermal and air barrier control layers are not necessarily in the same place.

Identifying the thermal envelope

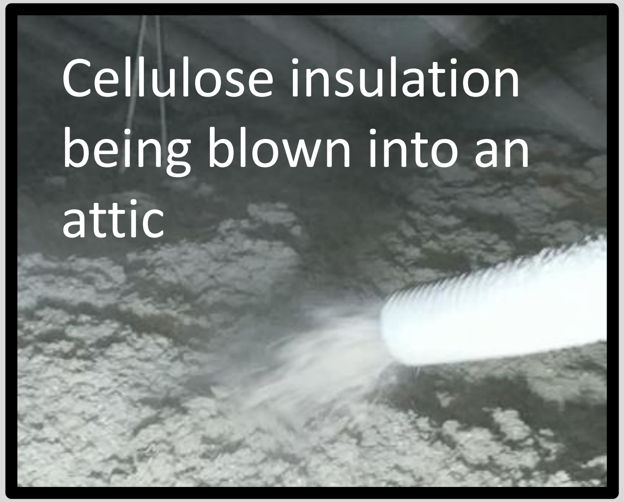
Encapsulated attic		**The thermal envelope is in line with the roof plane.** The roof and attic are *inside* the thermal envelope.		**Insulation is integrated into the roof system.** Condensation of vapor must be mitigated by exterior insulation or with an air and vapor barrier.
Attic outside the thermal envelope		**The thermal envelope is in line with the ceiling plane.** The roof and attic are *outside* the thermal envelope.		**Insulation is laid directly on the top of the ceiling.** Vapor retarder, if present, must be located as not to trap moisture (varies based on climate).

Ceiling insulation types

Attic insulation



Loose fill



Cost - $

R-value/inch:

- Cellulose ~ R-3.6
- Fiberglass ~ R-2.2
- Rockwool ~R-2.75

Loose-fill is generally composed of cellulose, fiberglass, or rock wool. It is typically blown in with a machine, as shown. Does not contain a vapor retarder. Air permeable.

Batt insulation

Cost - $$

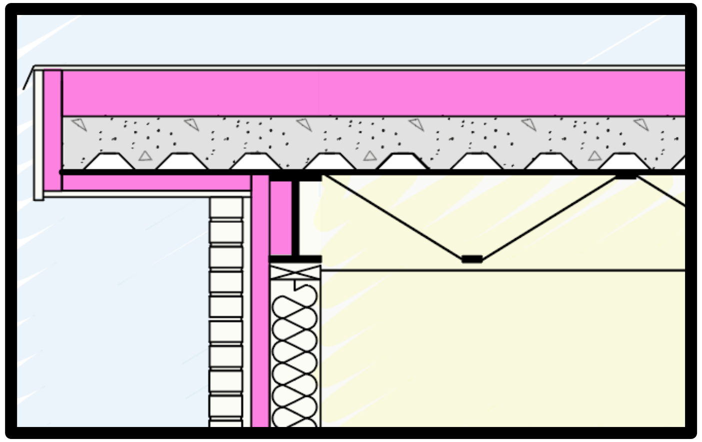
R-value/inch:

- Rockwool ~ R-3.7
- Fiberglass ~ R-3.1

Batts are often of the same materials as loose-fill insulation but has a slightly higher R-value due to the composition of the fibers. It is installed by hand. Can incorporate a paper face vapor retarder.

Ceiling insulation types

Exterior Roof Insulation



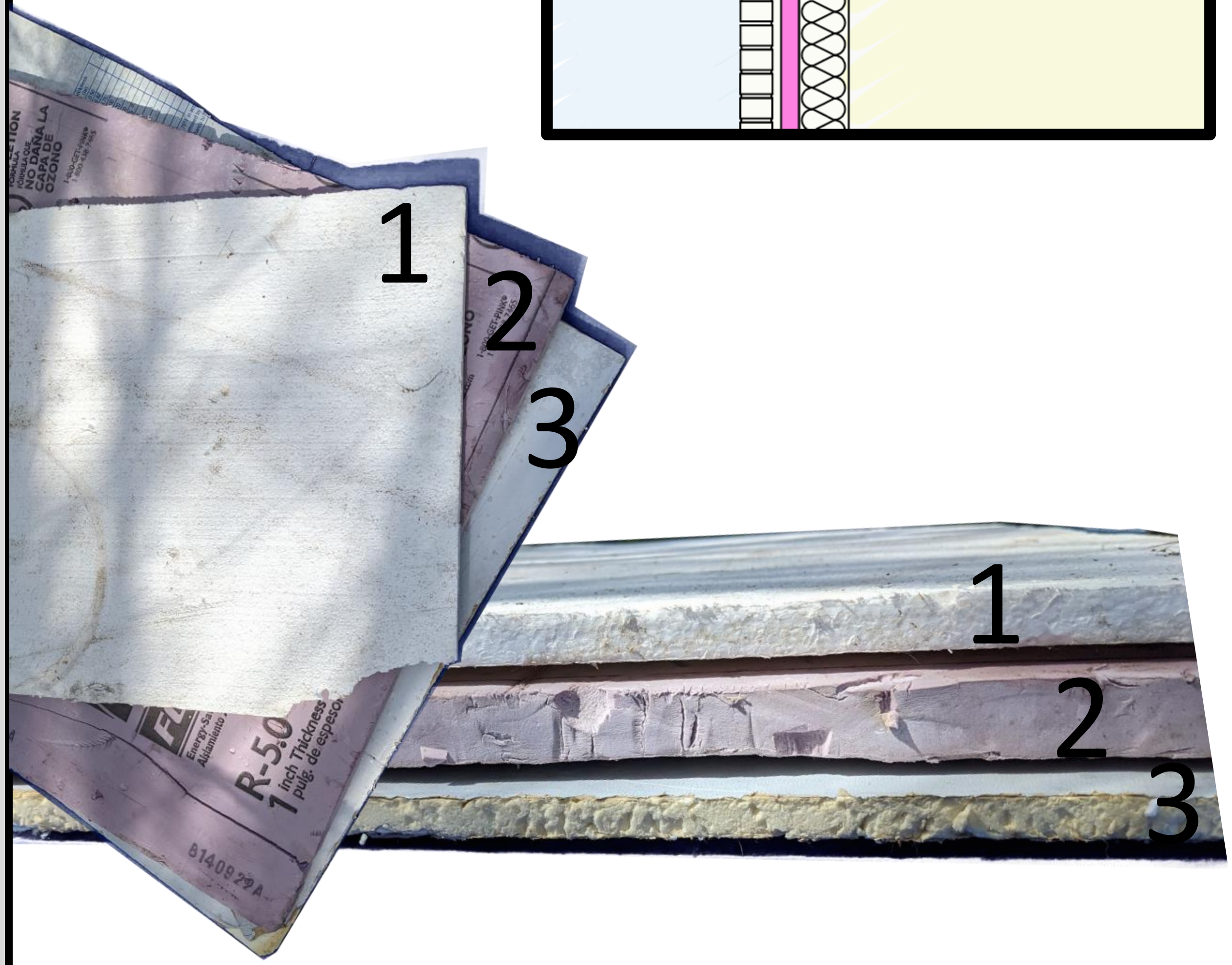
Rigid foam

Cost - $$$

R-value/inch:

1. Polystyrene (bead board) ~ R-4
2. Extruded polystyrene (XPS) ~ R-5
3. Polyisocyanurate (polyiso) ~ R-6

Rigid foam insulation is commonly applied on the top of structural roof decking directly underneath the bulk water control layer. This is especially common in commercial buildings with low slope roofs but is also increasingly common on sloped roofs with vaulted ceilings or where the decking is exposed.



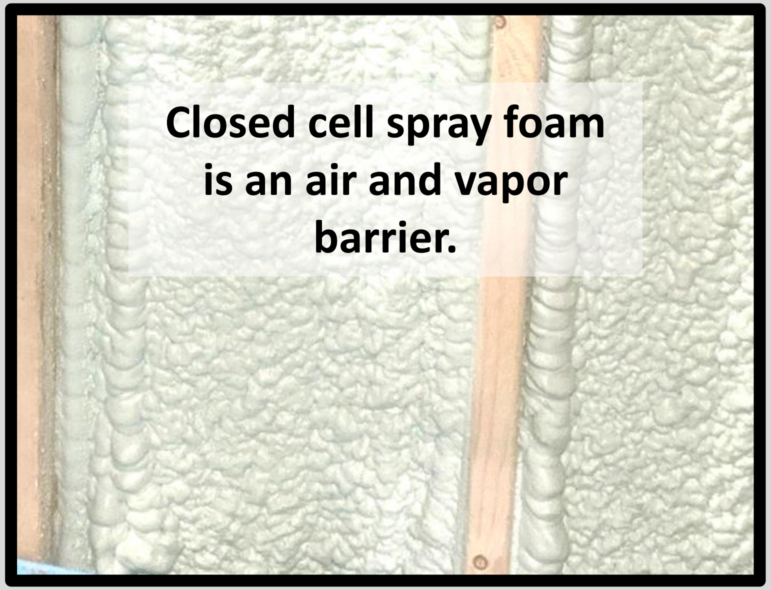
Roof insulation types

Interior & combination

Spray foam

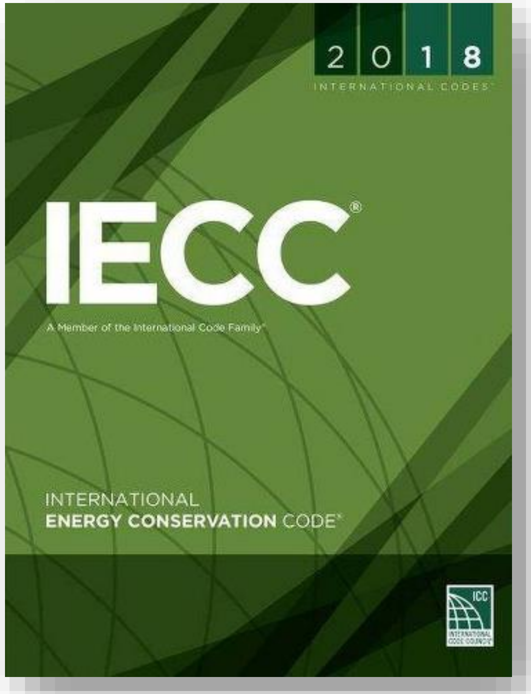
Cost - $$$$
R-value/inch:

- Closed cell ~ R-7
- Open cell ~ R-3.8



Section 4

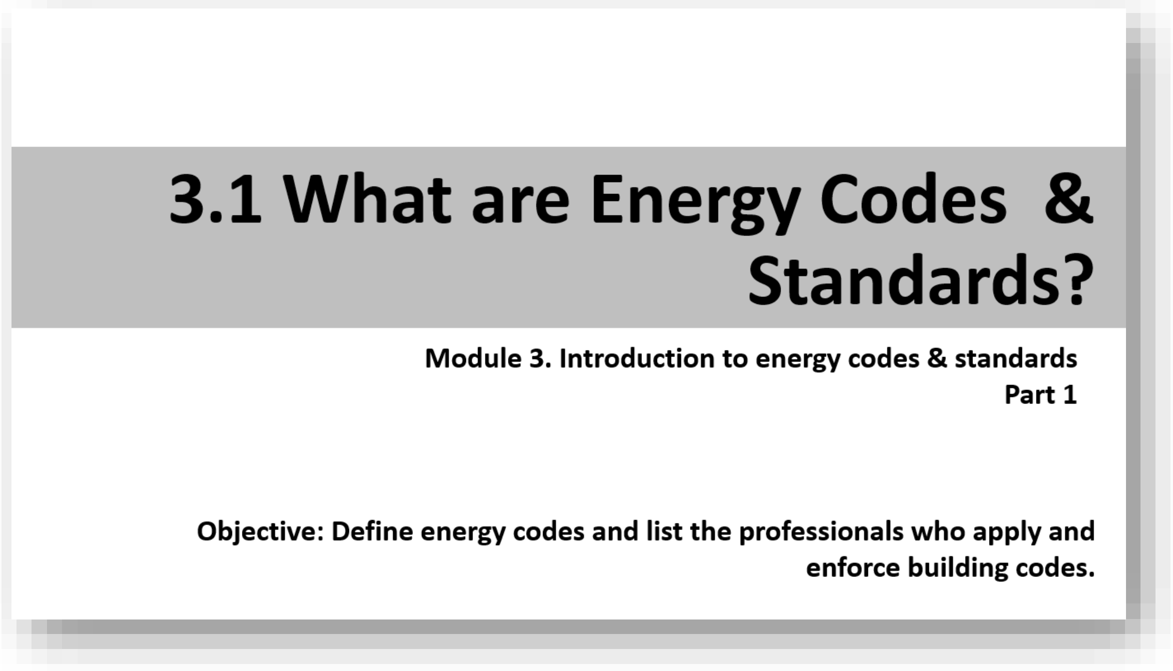
Energy code introduction



BEE Modules

3. Introduction to Energy Codes & Standards
    - 3.1 What are Energy Codes and Standards
    - 3.2 What is the Purpose of Energy Codes and Standards
    - 3.3 What Energy Code Does Your State Use
    - 3.4 Energy Code Adoption Process
4. Navigating Energy Codes & Standards
    - 4.1 Accessing the Codes
    - 4.2 Looking up Requirements
    - 4.3 Energy Code Compliance Paths
    - 4.4 The Approval/Permit Process

Building Energy Education fundamentals

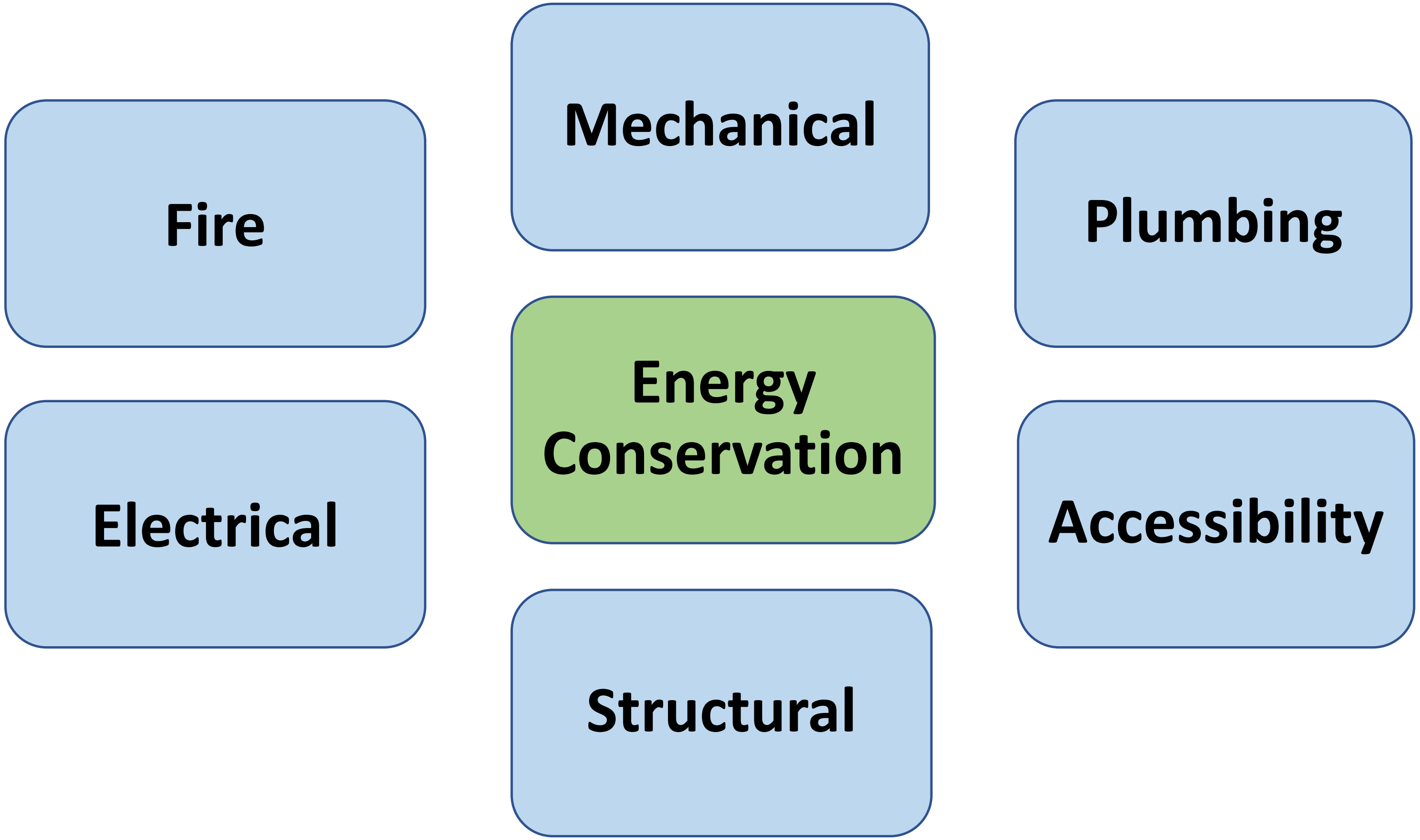


3.1 What are Energy Codes & Standards?

Module 3. Introduction to energy codes & standards
Part 1

Objective: Define energy codes and list the professionals who apply and enforce building codes.

Energy conservation code: one of many codes & standards



Codes & standards to make buildings safe, healthy & accessible:

- Fire
- Mechanical
- Plumbing
- Electrical
- Structural
- Zoning
- Accessibility
- More…

Codes & standards to save energy and money:

- Energy Conservation

Energy codes & standards apply to residential and commercial buildings

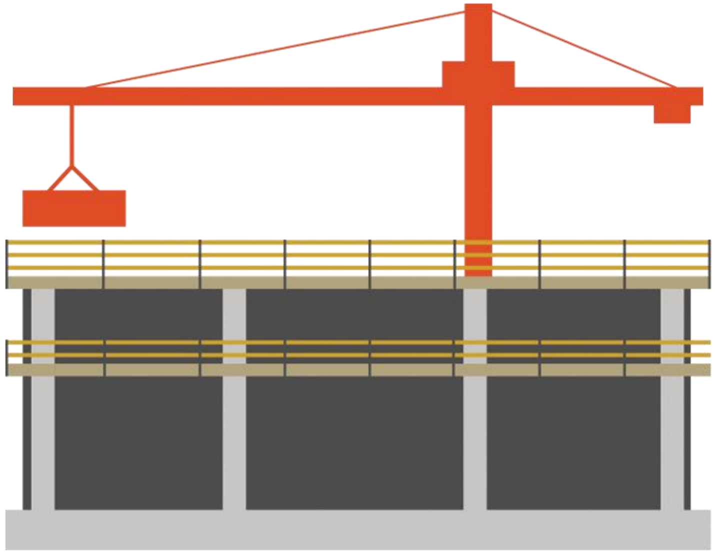
Residential

- A detached 1-2 family dwelling
- Multi-family housing 3 stories or lower (some codes differ)

Commercial

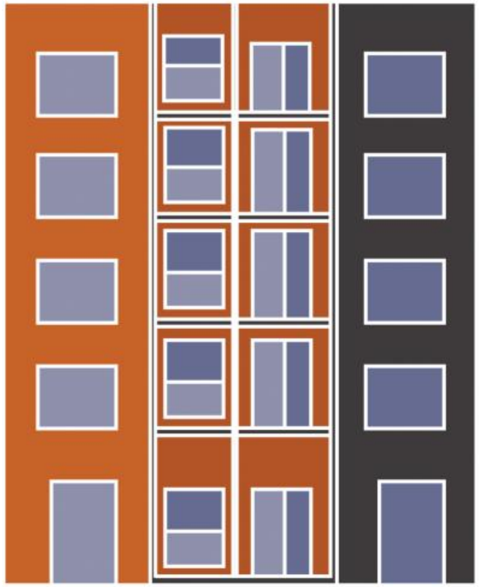
- Any commercial or public sector building
- Multi-family housing units 4 stories or higher (some codes differ)

Energy codes & standards apply to both new and existing buildings.



New Buildings

- Anything requiring a permit



Existing Buildings

- Any additions, alterations requiring a permit

Energy codes & standards make allowances for different climate zones that impact buildings.

versus

Image source: Pexels.com

Image source: Pexels.com

Energy codes affect design & construction

- Wall, floor, ceiling
- Doors, windows
- Heating, ventilating, & cooling systems & equipment
- Lighting systems & equipment
- Water-heating systems & equipment

3.2 What is the Purpose of Energy Codes & Standards?

Module 3: Introduction to energy codes & standards
Part 2

Objective: Explain the purpose of energy codes & standards.

Building energy use makes up 32% of total U.S. greenhouse gas emissions.

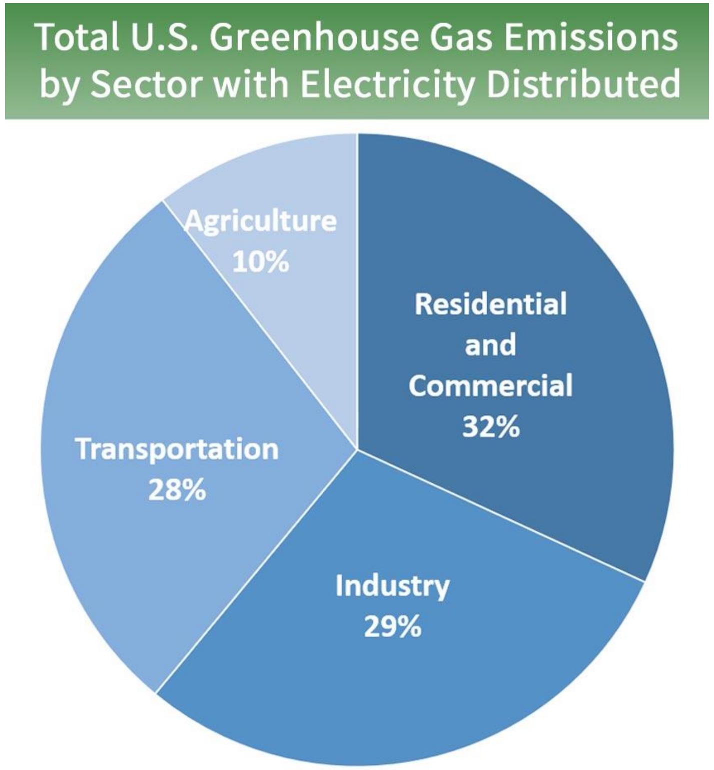
GHG emissions

↓

Climate change

↓

Extreme weather events, rising temperatures, species loss, much more



U.S. Environmental Protection Agency (2020). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018

https://www.eia.gov/totalenergy/data/monthly/archive/00352004.pdf.

Energy codes: an opportunity to design for efficiency.

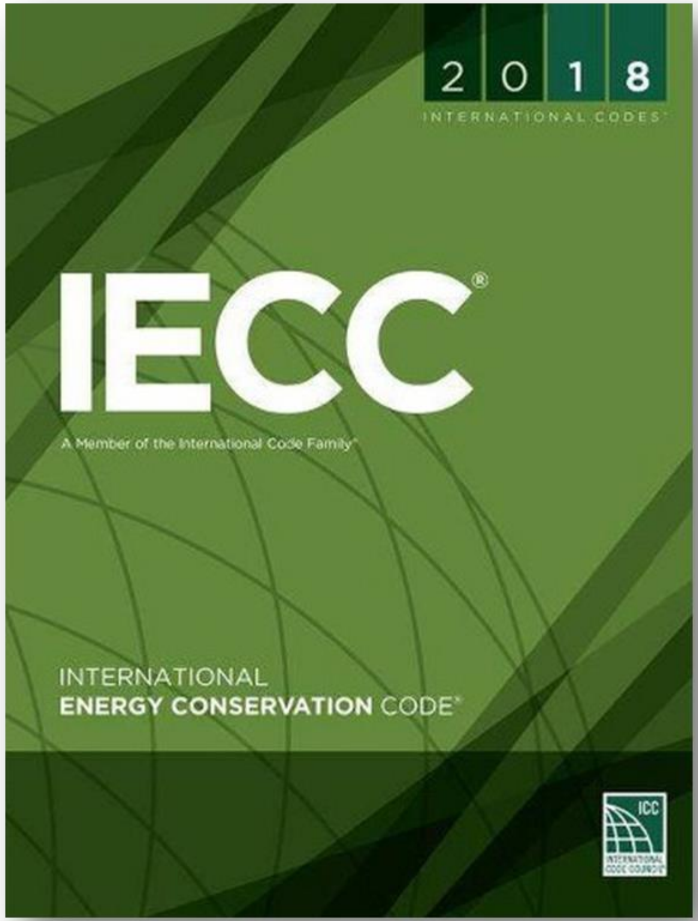
- It’s easier and less expensive to make a building efficient from the start, rather than trying to make it more efficient later.
- Upfront design and construction decisions largely determine a building’s efficiency.

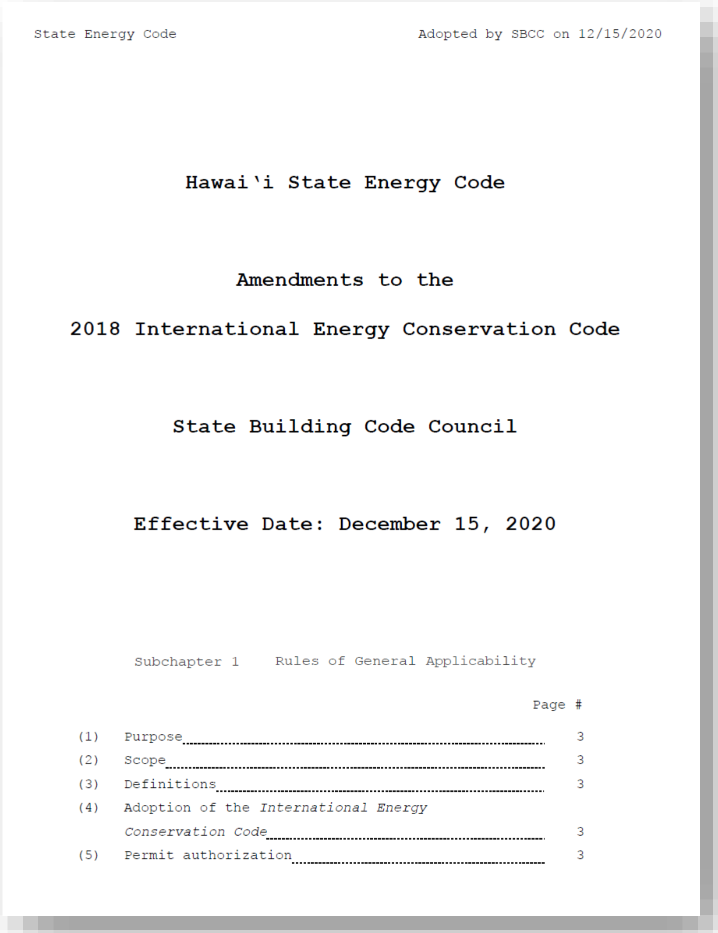
Building energy codes help reduce energy burden for households.

Your energy burden is the portion of your income you spend on energy bills.

https://www.efficiencyvermont.com/blog/our-insights/what-is-the-impact-of-energy-burden-in-vermont

Hawaii Energy Code





State Energy Code Adopted by SBCC on 12/15/2020

Hawai'i State Energy Code

Amendments to the

2018 International Energy Conservation Code

State Building Code Council

Effective Date: December 15, 2020

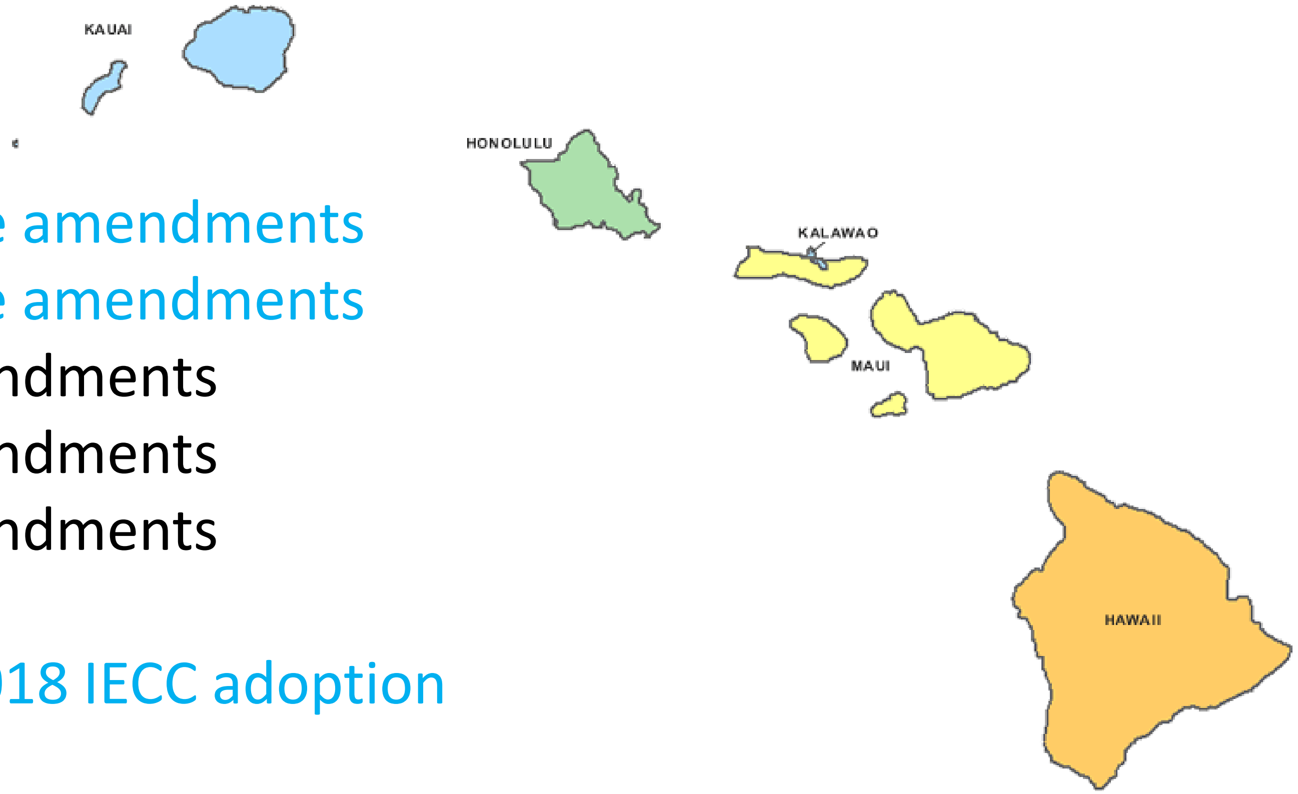
Subchapter 1 Rules of General Applicability

		Page #
(1)	Purpose	3
(2)	Scope	3
(3)	Definitions	3
(4)	Adoption of the *International Energy Conservation Code*	3
(5)	Permit authorization	3

State amendments
12 pages

County amendments

Hawaii Energy Code Adoption

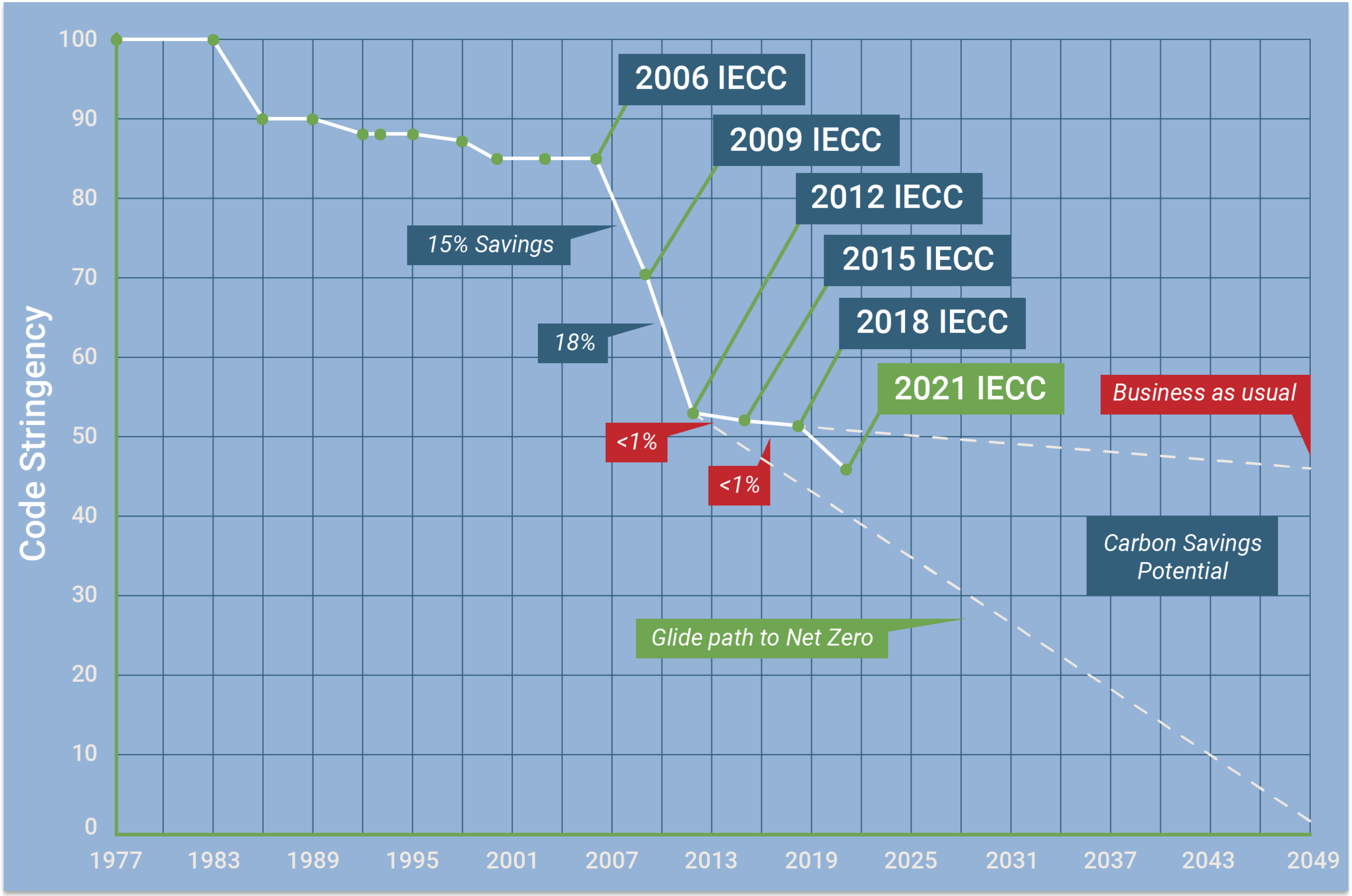


Current Status

State Buildings	2018 IECC with State amendments
Hawaii County	2018 IECC with State amendments
Honolulu County	2015 IECC with amendments
Kauai County	2015 IECC with amendments
Maui County	2015 IECC with amendments

Dec. 15, 2022 – Deadline for County 2018 IECC adoption

State amendments
https://ags.hawaii.gov/wp-content/uploads/2021/01/soh_bcc_energycode_20201215.pdf
2018 IECC
https://codes.iccsafe.org/content/iecc2018



Source: Energy Efficient Codes Coalition. https://energyefficientcodes.org/iecc/

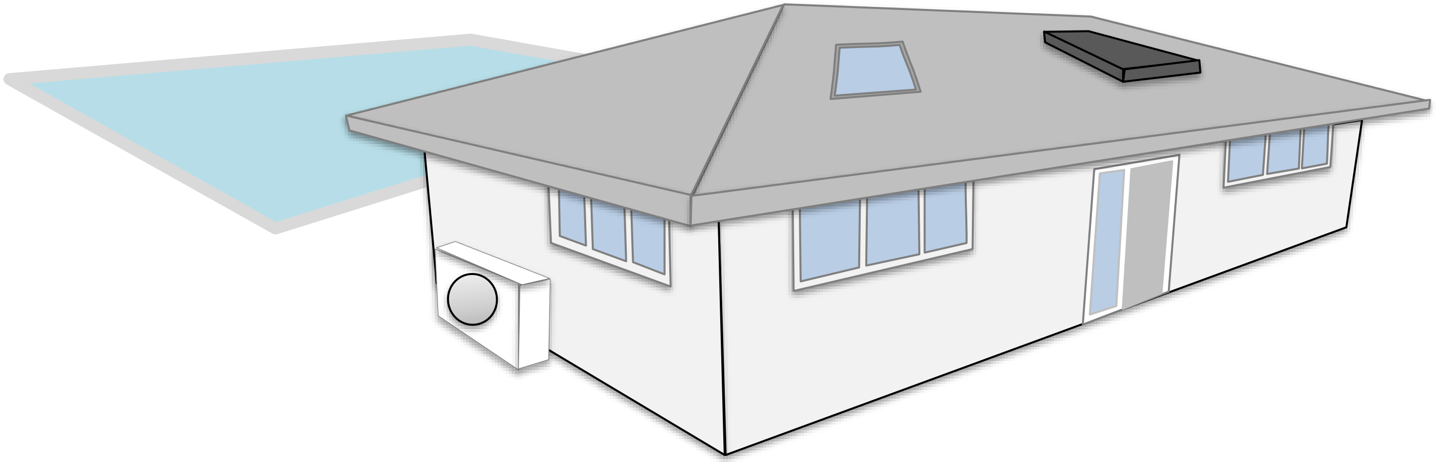
What's covered

Envelope
Roof
Walls
Window & skylights
Air leakage

Systems
Air conditioning controls
Duct insulation
Duct leakage
Water heating
Swimming pool

Electrical
Permanently installed lighting
Ceiling fan
~~EV readiness~~
~~PV readiness~~
Up to counties for 2018

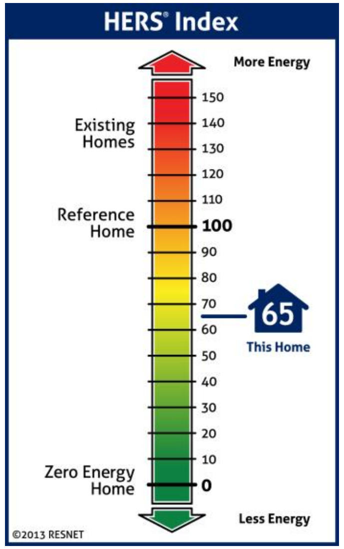
Not covered
AC efficiency
Water heater efficiency
Plug-in lighting
Appliances



Compliance options - residential

1. Tropical Zone
   - ≤50% air conditioned
   - not heated
   - elevation < 2,400 feet
2. Prescriptive
   - Envelope (+ Points Option)
   - Systems
   - Electrical power and lighting systems
3. Simulated performance alternative
   - Proposed design energy cost ≤ standard reference design
4. Energy rating index (ERI)
   - ERI ≤ 57

Climate Zone	Fenestration U-Factor	Skylight U-Factor	Glazed Fenestration SHGC	Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall R-Value	Floor R-Value	Basement R-Value	Slab R-Value	Crawl Space Wall R-Value
1	NR	0.75	0.25	30	13	3/4	NA[1]	0	0	0



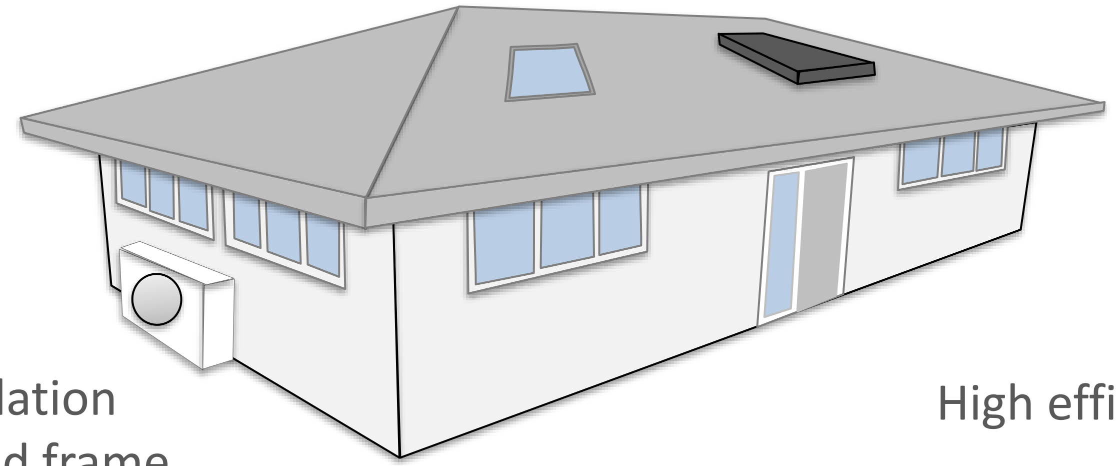
Prescriptive

Points system allows
some flexibility

R-30 roof
insulation

Skylight ≤ 0.30
U-factor ≤ 0.75

Solar
water heating



Duct insulation

Duct air leakage testing

Window
SHGC ≤ 0.25

AC thermostat

High efficacy lighting

Wall insulation
R-13 in wood frame
R-13 + R-4.2 in metal frame

Envelope
air leakage
testing

Ceiling fan or
ceiling fan rough-in

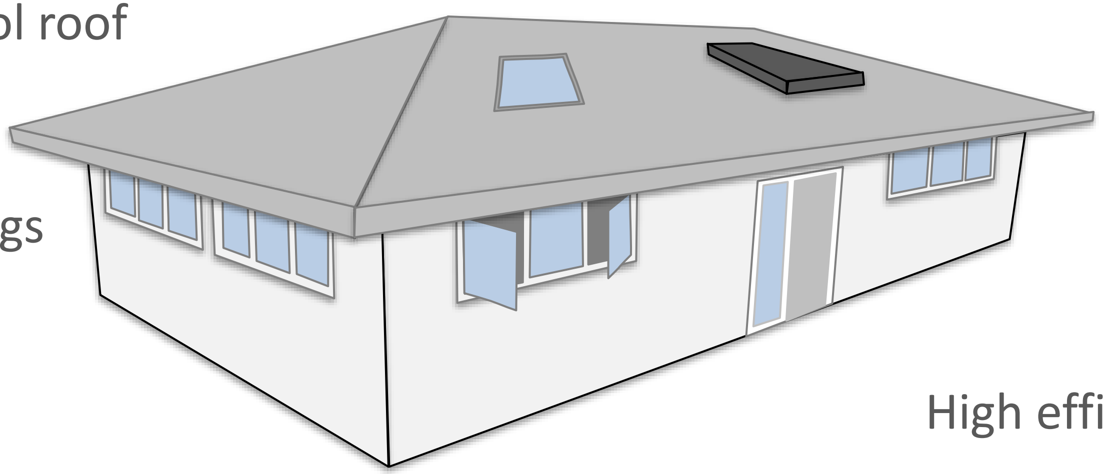
Tropical Zone

≤50% Air conditioned
Not heated
Elevation < 2,400 feet

Skylight
U-factor ≤ 0.75

Solar
water heating

R-19 roof insulation or
R-13 + cool roof



Window overhangs
or SHGC limit

High efficacy lighting

Natural ventilation
openings ≥14%
of floor area

Ceiling fan or
ceiling fan rough-in

Checklist

RESIDENTIAL CHECKLIST
IECC 2018 with State Amendments

HAWAII STATE Energy Office

Hawaii Energy
YOUR CONSERVATION & EFFICIENCY PROGRAM

This checklist covers requirements of the 2018 IECC with State-adopted amendments, approved in December 2020. Check with individual Counties for County - adopted versions of the code. See https://energy.hawaii.gov/hawaii-energy-building-code.

Red text in this checklist indicates changes between this 2018 version of the code and the previous 2015 IECC with Hawaii Amendments.

SCOPE

Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane. The code applies to new construction, additions and alterations. See a separate Commercial Checklist for high-rise residential and commercial buildings.

RESIDENTIAL COMPLIANCE OPTIONS

Tropical Zone	Prescriptive	Simulated Performance Alternative	Energy Rating Index Compliance Alternative
Allowed when: 1. ≤50% air conditioned, 2. not heated, and 3. elevation < 2,400 feet.	Includes three options for walls and roof compliance: 1. Prescriptive 2. Total UA (typically with ResCheck software) 3. Points option (added by Hawaii amendment)	Simulated energy performance analysis for heating, cooling and SHW. Proposed design must have annual energy cost less than or equal to energy cost of reference design.	Third-party Home Energy Rating System (HERS) calculation. Allows the designer to pick and choose from many efficiency options. Scores range from 100 to 0. The 100 score indicates compliance with the 2006 IECC. Each efficiency measure beyond 2006 lowers the score. A passing score for Climate Zone 1 is 57.
See Tropical Zone Checklist below	See Prescriptive Checklist below. See Points Option tables below.	See code Section R405	See code Section R406

CHECKLIST CONTENTS

CHECKLIST CONTENTS	PAGE
Tropical zone checklist	2
Prescriptive checklist	4
Additions and alterations checklist	8
Points option tables	11

Sponsor: Hawaii State Energy Office
Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number EE0006986

https://energy.hawaii.gov/hawaii-energy-building-code/building-code-resources

Checklist

PRESCRIPTIVE REQUIREMENTS CHECKLIST

Component/System	Requirement	Code Section	Plan Review Notes	Info on Plans
Roof – wood frame	☐ **R-30,** ☐ **U-0.035,** ☐ Total UA alternative, or ☐ Points option	R402.1, R402.1.5, R407*	Some R-30 options: 10 in. batt insulation	☐ Insulation location on plans ☐ R-value on plans
Roof – metal truss	☐ **R-38,** ☐ **U-0.035,** ☐ **R-30** + **R-3,** ☐ **R-26** + **R-5,** ☐ *Total UA alternative*, or ☐ *Points option*	R402.1, R402.2, R402.1.5, R407*	Metal frame creates a thermal bridge, and more insulation is required. "R-3" and R-5" refer to continuous insulation, typically foam board.	☐ Insulation location on plans ☐ Insulation R-value on plans
Roof – metal joist	☐ **R-38** in 2x4, 2x6 or 2x8 framing, ☐ **R-49** in any framing ☐ *Total UA alternative*, or ☐ *Points option*	R402.1, R402.2, R402.1.5, R407*		☐ Insulation location on plans ☐ Insulation R-value on plans
Wall – wood frame	☐ **R-13,** ☐ **U-0.084,** ☐ *Total UA alternative*, or ☐ *Points option*	R402.1, R402.1.5, R407*	Some R-13 options: • 3.5 in. batt insulation • 2 to 3.5 in. spray foam	☐ Insulation location on plans ☐ Insulation R-value on plans
Wall – metal frame	Framing 16 in. on center: ☐ **R-13** + **R-4.2** ☐ **R-21** + **R-2.8** Framing 24 in. on center: ☐ **R-13** + **R-3.0** ☐ **R-15** + **R-2.4** ☐ *Total UA alternative*, or ☐ *Points option*	R402.1, R402.2, R402.1.5, R407*	Requires insulation in framing cavity plus a layer of continuous insulation (typically foam board).	☐ Insulation location on plans ☐ Insulation R-value on plans
Wall – mass (CMU or concrete)	☐ **R-3** exterior, ☐ **R-4** interior, ☐ **U-0.197,** ☐ Exterior reflectance ≥**0.64,** ☐ Overhang projection factor ≥**0.3,** ☐ Mass wall thickness ≥ **6** inches, ☐ *Total UA alternative*, or ☐ *Points option*	R402.1*	Requires either exterior or interior insulation, typically foam board. CMU integral insulation does not comply. Hawaii amendments add several alternatives .	☐ Insulation location on plans ☐ Insulation R-value on plans

Asterisk = State amendment

Red text = change vs. 2015

RESIDENTIAL pg. 4 of 13 May 2021

https://energy.hawaii.gov/hawaii-energy-building-code/building-code-resources

Recorded webinars

HAWAII ENERGY BUILDING CODE TRAINING

The Hawaii State Energy Office and allied professional organizations sponsor free training sessions on energy building code requirements.

April 29, 2022: Train-the-Trainer Workshop – Building Energy Education Fundamentals

April 2022: Three Webinars on Building Energy Efficiency Fundamentals and Energy Code Basics

December 9, 2021: Complying With the Energy Code – 2018 IECC with Hawaii Amendments

December 2, 2021: Zero Energy Home Design

May 2021: Low-rise and Commercial, High-rise Residential Requirements

July 2020: Dueling UV Pulses: The Most Efficient Way of Zapping the COVID Virus?

https://energy.hawaii.gov/building-code-training

Section 5

Hawaii Energy

Hawai’i Energy

Residential Energy Efficiency Programs

New Construction | Direct Installation | In-home Retrofit

Justin Bizer

AFFORDABILITY & ACCESSIBILITY PROGRAM SUPPORT SPECIALIST

JUSTIN.V.BIZER@LEIDOS.COM

Residential Programs Overview

(New & Existing)
COMMUNITY-BASED
ENERGY EFFICIENCY

RESIDENTIAL NEW CONSTRUCTION

New construction & major renovation projects can receive rebates for incorporating energy-efficient features into building designs and exceeding building code requirements.

Whole Building Approach

Systems Approach

WHOLE BUILDING APPROACH (WBA)

About

- Holistic approach to building design
- Analyze building performance as a whole, by incentivizing developer to provide a Design Energy Model
- Leverage Design Team's ability to optimize interactive efficiency effects of the various building systems

Requirements

- WBA projects must incorporate a minimum of **three energy efficiency measures** (EEM) from at least two of the following systems: lighting, envelope, and mechanical

SYSTEMS APPROACH (SA)

About

- Encourage designers to optimize the EE of the systems within a building.
- Most appropriate for **less complex projects,** in-unit and common area systems
- For those whose systems that were designed at different times.
- Does not include EE built into Envelope

Requirements

- Provide a straightforward approach to **identify potential EE options and impacts** for common building systems.
- Each system **needs to exceed current IECC minimum** thresholds.

RESIDENTIAL NEW CONSTRUCTION (IN UNIT SYSTEMS)

SYSTEMS APPROACH (Single Family (Detached))

Minimum Requirements

- 85% LED Lighting
- 50% ENERGY STAR® Appliances Installed

  ENERGY STAR® certified (refrigerator, dishwasher, clothes washer, and clothes dryer)

Optional Incentives

- High SEER A/C (Window, VRF, Central)
- Smart Thermostats
- Ventilation Fans (whole house fan)
- Custom EE Systems exceeding IECC (e.g. SWH for Multifamily)

Kūlia at Hoʻopili

D·R·HORTON America's Builder HAWAII

- In-Unit ENERGY STAR Lighting
- Solar Water Heating
- ENERGY STAR Refrigerators
- ENERGY STAR Window A/C
- Community Center ENERGY STAR Lighting

"D. R. Horton's Hoʻopili is a thoughtfully designed master-planned community that offers Kūlia residents schools, shopping, and parks all within walking distance."

Kūlia must comply with a variety of government funding programs. Household incomes cannot exceed 60% of Honolulu’s current median incomes.

- Spacious 1, 2, and 3 bedroom floor plans
- Walnut wood veneer solid cabinets
- Cultured marble countertops
- Solar water heating
- Energy efficient appliances and lighting
- Ceiling fans and air conditioned living room
- Vinyl plank simulated wood floors
- Assigned parking stalls

MUTUAL HOUSING
ASSOCIATION OF HAWAI'I

Building Our Communities with Respect, Integrity,

KULIA PROJECT ESTIMATED ENERGY SAVINGS

Estimated Total Annual kWh Savings

3,035 kWh / Avg. Per Unit / Per Year

396,621 kWh 1st Year Project Savings

Oahu

Rate Schedule	2021 Average Cents/kWh
"R" Residential	32.47

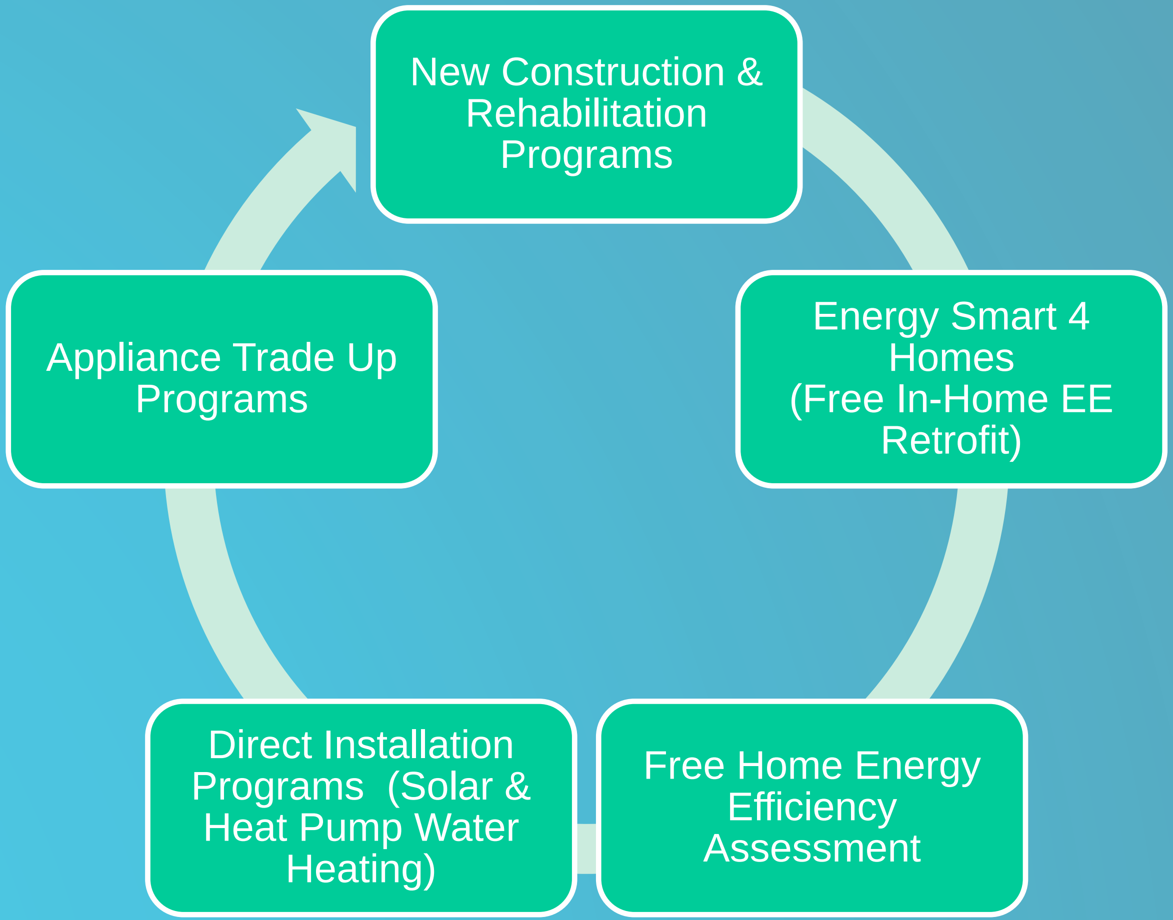
Estimated Total Lifetime kWh Savings

5,638,020 kWh

Total Demand Savings

64.41 kW

COMMUNITY BASED ENERGY EFFICIENCY PROGRAMS



EAH HOUSING
50 YEARS OF SERVICE

Affordable Housing for older adults and persons with disabilities serving the Koʻolauloa community.

Kahuku Elderly Hauoli Hale

- Kahuku Elderly Hauoli Hale is a affordable housing community for older adults and persons with disabilities in the north shore Oahu Enterprise Zone.

- The community consists of 64 affordable apartment homes in 32 single-story duplex buildings on 6 acres.

- All units are reserved for residents who earn at or below 50% of the Area Median Income (AMI), and rents are no more than 30% of income.

Home Energy Retrofits & Home Energy Assessments

Hawaiʻi Energy

Cut Your Electricity
Costs Up To $160*Per/Unit
Each Year!

Existing Building & Community Programs

Energy Smart 4 Homes "Free"(Home Retrofits)

- LED Lighting
- High-Efficiency Water Measures
- Advanced Power Strips
- $160 Annual Savings*

Home Energy Assessment

- Identify Inefficient Systems (A/C, WH, Fridge) For Additional HE Programs

Direct Installations & Trade Ups

- Appliance Trade Ups
- Solar and Heat Pump Water Heating Programs

Refrigerator Trade Up

56 x New ENERGY STAR Refrigerators

Estimated kWh Savings – (1st) 45,300 kWh Annual / 379,512 kWh liftime

EAH Housing | Pacific Appliance Group | DSR | Refrigerant Recycling, Inc.


Kalihi Valley Homes
Solar Water Heater
Tune-Up Project


Molokai
Solar Water Heater Retrofits


Kunia Village
Heat Pump Water Heater Retrofits

Project Scope

			
	Kalihi Valley Homes	**Kunia Village**	**Molokai**
Underserved Community	State public housing (apartments)	Agriculture workers and retirees (low-income)	Low-income renters & homeowners
Service	Tune-up maintenance service for (75) solar water heaters	(43) Heat pump water heaters replacing electric water heaters	(29) Solar water heaters replacing electric water heaters
Funding	Service costs partially subsidized by Hawaiʻi Energy	All labor & materials fully funded by Hawaiʻi Energy	All labor & materials fully funded by Hawaiʻi Energy

MAHALO!

Justin Bizer

Residential New Construction and A&A Program Specialist

Justin.V.Bizer@leidos.com | 808-848-8534

Section 6

Wrap Up

Q&A

Howard Wiig, State Energy Office

Chris Perry, U.S. Department of Energy

Sumi Han, Smart Energy Design Assistance Center

Norman Takeya, Honolulu Community College

Erik Kolderup, Kolderup Consulting

Justin Bizer, Hawaii Energy

Zippy’s gift cards

Hawaiʻi Energy

https://www.zippys.com/

Coming up

Workshop 2

Comfort, Air Quality and Lighting

Thursday, 4/14/2022, 12:00 – 1:30 pm HST

Workshop 3

Beyond Code, Net Zero Energy and Existing Buildings

Thursday, 4/21/2022, 12:00 – 1:30 pm HST

BEE Fundamentals: Train-the-Trainer Workshop

Friday, Apr 29, 2022 9:00 – 11:00am HST

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

Evaluation Survey

https://www.surveymonkey.com/r/HC7VN5R

Attendee Feedback Survey - Building Energy Webinar - April 7, 2022

1. My role

- [ ] Student
- [ ] Educator
- [ ] Contractor
- [ ] Architect or designer
- [ ] Other (please specify)
- [ ] Engineer
- [ ] Vendor
- [ ] Government

For more energy information

Howard C. Wiig

Hawaii State Energy Office

Office (808) 590-9555

Howard.c.wiig@Hawaii.gov

Building Energy Education Fundamentals

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

2018 IECC available

- http://iccsafe.org/publications
- https://codes.iccsafe.org/content/iecc2018

State Energy Code Website

- http://energy.hawaii.gov/hawaii-energy-building-code

Hawaii Energy Code Website

- https://hawaiienergy.com/codes