Community College Energy Code Training Program

Partnered with IL, NV & HI Energy Office
Sponsored by DOE

March 25, 2021

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Providing effective energy strategies for buildings and communities

AGENCY OVERVIEW

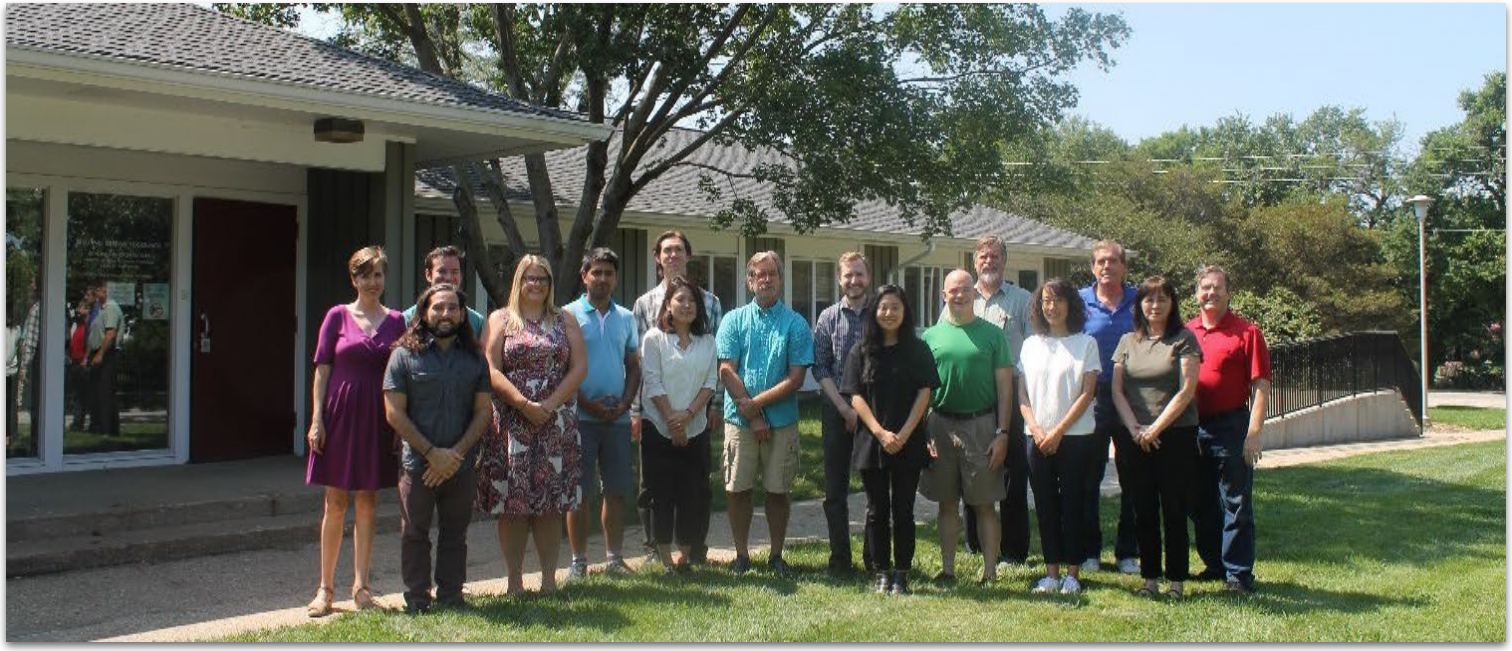
Mission

- to ensure the wise development of Nevada's energy resources in harmony with local economic needs and to position Nevada to lead the nation in:
  - renewable energy production
  - energy conservation
  - export of energy
  - transportation electrification

Who

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

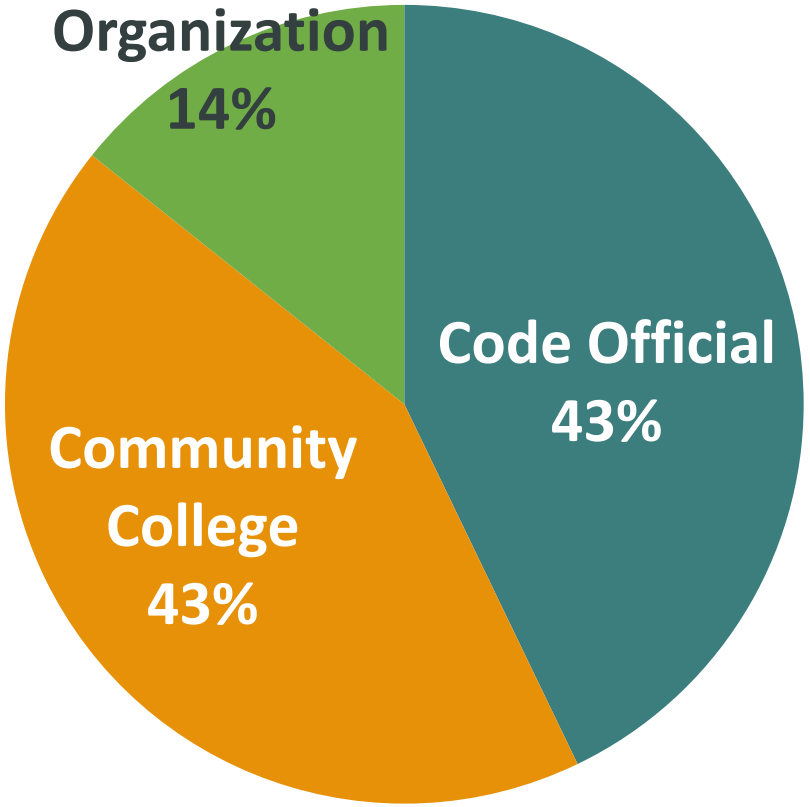
Our mission: Reduce the energy footprint of Illinois and beyond.



SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Who

Participants



Clark County
City of Las Vegas
City of North Las Vegas

Western Nevada College
College of Southern Nevada
Desert Research Institute

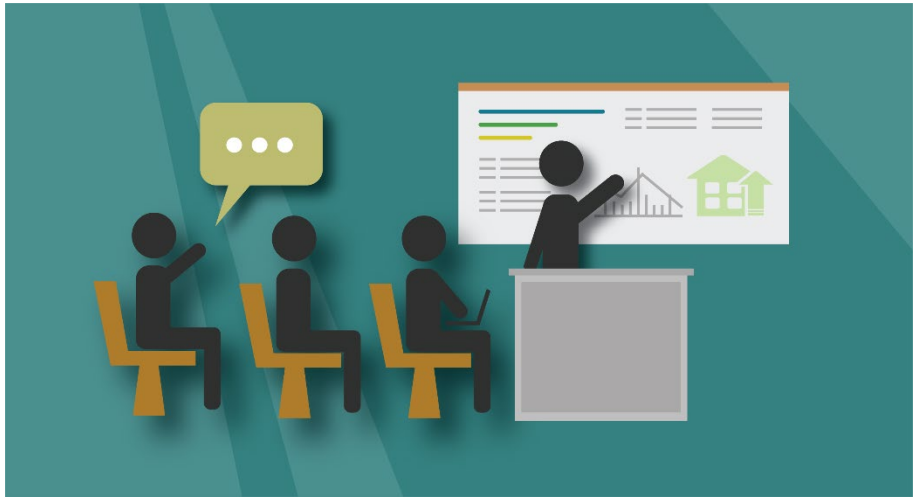
International Code Council
(ICC)

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Program Intro

Community College Energy Code Training Program:

Developing **energy efficiency and energy code resources and curriculum** to prepare **the next generation of professionals** to integrate energy efficiency into their work.



SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Program Q & A

- Who is the **target audience** for the energy code training program?

community college instructors & students + entry-level building design & construction professionals

- Is the energy code training program a "**stand alone**" program that prepares students for a **specific job and/or to sit for a certification exam**?

incorporated into existing courses/programs
to gain fundamental knowledge required for exams

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Program Q & A

- **How long** is the energy code training program?

  Flexible, 15 topics with multiple subtopics with multiple 15-min contents

- What **background knowledge** is required for someone to teach this topic? I am trying to determine if we have that knowledge on our campus.

  Building design and construction, Architecture, Mechanical engineering, Energy Management, Sustainability, HVAC trades & related fields.

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

What We've Learned:
Training Needs Assessment

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

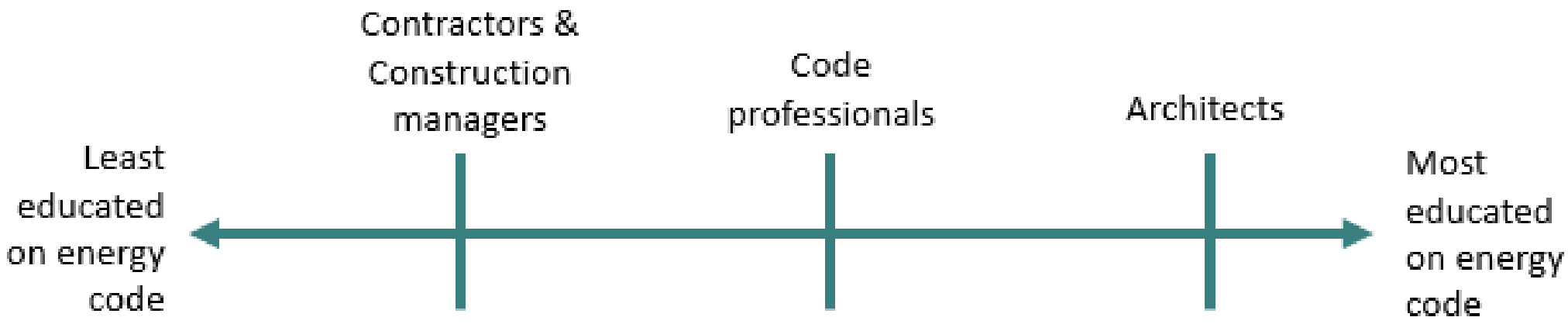
Methods

- Literature review & feedback from code officials, instructors in IL, NV and HI.
- Surveyed about 60 community college programs & curricula
- Reviewed literature on barriers & best practices

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Results

Interviewees agreed that there is a need for more energy code/energy efficiency training in the building trades



"We're going to keep struggling with code compliance until energy code training permeates the building trades."

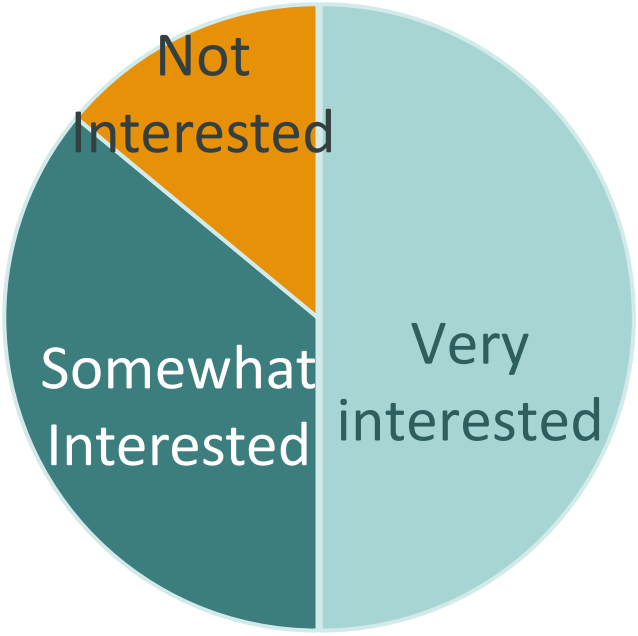
- IL Code Official

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Results

Strong Interest in additional training

86% of instructors are interested in enhancing energy and energy code education in their programs.



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

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Results

What content should be taught?

- Energy code/energy efficiency **basics**
- **Whole-building** approach
- Information about **new practices, technologies**
- Information about **careers** in codes, energy efficiency

"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

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Results

How should the content be taught?

Engaging teaching methods	Not engaging teaching methods
• Short videos • Demonstrations • Building science basics • Self-directed learning activities • Experiential learning	• Lectures • Route memorization

"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

Results

Is it feasible to integrate new content into existing curriculum?

Feasible	Not feasible
• Small, add-on elements • Resources to reinforce existing content	• Major changes, additions • Stand-alone courses

Barriers to making major changes:

- Class time
- Established learning objectives
- Administrative approval
- Advisory committee approval
- Transfer requirements

"For anything you add, something has to be removed." - IL Instructor

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Conclusions

Curriculum will be integrated into three types of programs, targeted to **audience needs**

Construction management/tech

- Intro courses
- Construction materials & methods
- Mechanical systems
- Building code courses

Architecture & Drafting

- Intro courses
- Materials and methods
- Detailing & construction documents
- Building systems courses

Trades (carpentry, HVAC)

- Construction fundamentals
- Carpentry/concrete
- Rough frame construction
- Air conditioning/heating

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Conclusions

SEDAC has created a modular curriculum outline to meet the **needs of students in different programs**

Intro

1. Energy Efficiency Careers
2. Building Science
3. Introduction to Energy Code
4. Navigating Energy Code

Envelope

5. Insulation Basics
6. Foundation Insulation
7. Wall Insulation
8. Roof Insulation

HVAC

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

Advanced

13. Beyond Code (LEED, ENERGY STAR®)
14. Net Zero
15. Existing Building Renovation

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Conclusions

Each topic will be addressed **in a variety of formats** to adapt to instructor **preferences** and **learning objectives**.

Learn

- Lecture Notes & Presentations
- Handouts
- Illustrations & Diagrams

Experience

- Short Videos
- Interactive Online Modules
- Demonstrations
- In-class Project Ideas

Practice

- Problem Sets
- Discussion Questions
- Design Assignments

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

What We've Developed:
Energy Efficiency & Energy Code Curriculum

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Curriculum

SEDAC is currently assembling the curriculum.

Our goal: we want to share progress and elicit feedback at collaborative meetings. We share these rough drafts to best target the material development that will meet your need. Please let us know what you think so that we can refine our ideas!

While we welcome all ideas We specifically, we wanted to ask about:

- Organization
- Content
- Style

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Organization

4 Main Topic Areas

Introduction	Envelope	HVAC & Lighting	Advanced
Career Paths	Intro	HVAC Equip & Sizing	Existing Building
Energy Basics	Foundation	Lighting & Controls	Beyond Code
Intro to Codes	Walls	OA & Ventilation	Net Zero
How to Navigate Codes	Roofs	Ducts	

Most general

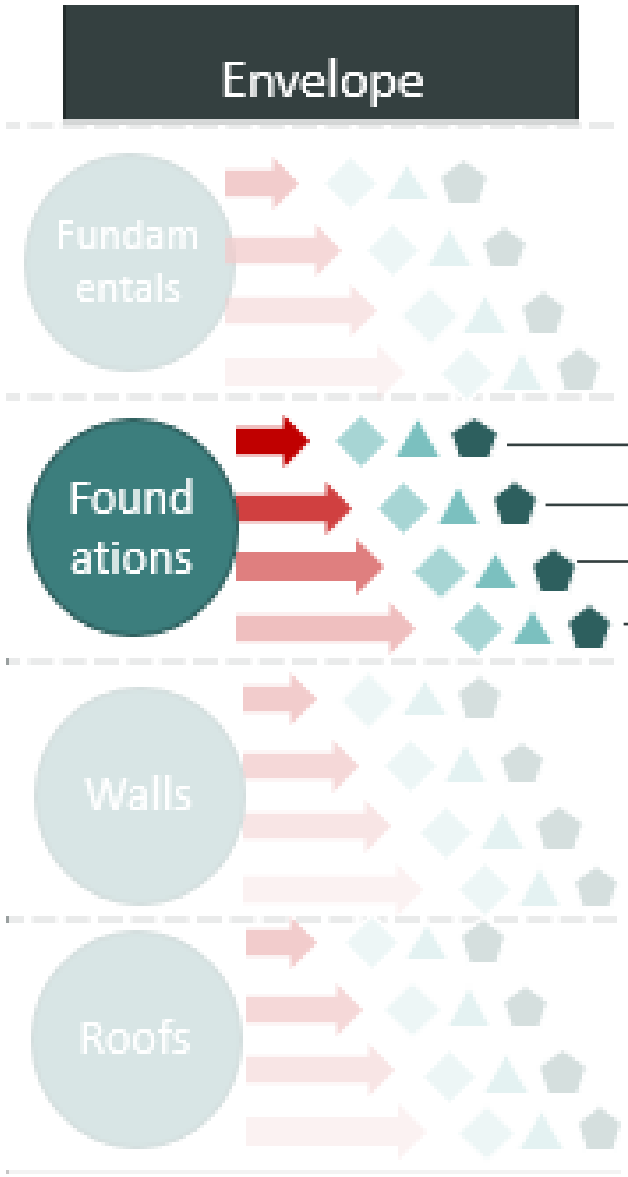
Subtopics

Most specific

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Organization

4 Sections



- Foundation Insulation Fundamentals
- Slab on Grade
- Basement and Below Grade Walls
- Special Conditions

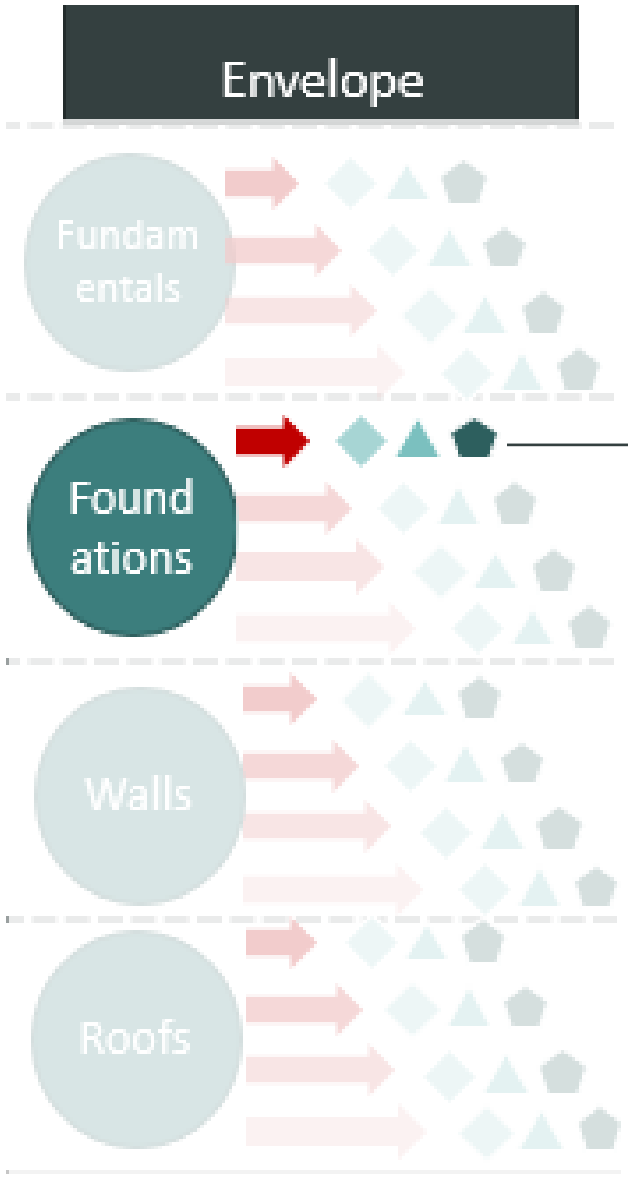
Most general

Subtopics

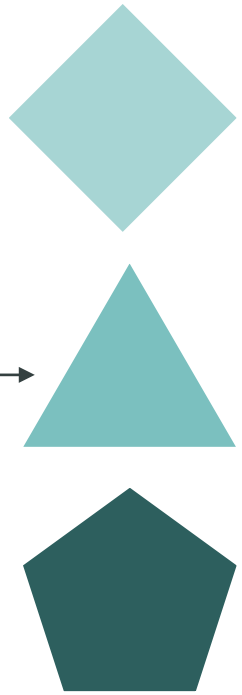
Most specific

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Organization



Teacher Focused Format – Individual Materials to Share



"Learn" Materials – Lecture slides and notes, short videos, PDF handouts, checklists, etc.

"Practice" Materials – Worksheets, discussion questions, exercises, etc.

"Experience" Materials – Short videos, demonstrations, activities, etc.

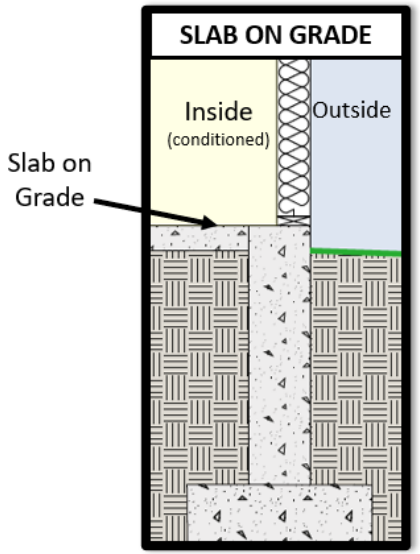
SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Organization

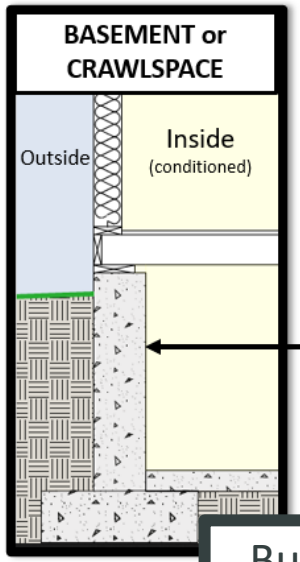
Student Focused Format – Interactive online Modules to navigate the materials independently.

Two Categories of Foundations

There are 2 categories of foundation in the Energy Code. There can be different structural systems and shapes but what makes them different is **what building component separates the conditioned space** from the most extreme temperature fluctuations of the exterior.



If a **FLOOR** is near the surface of the earth, it is a critical part of the **building thermal envelope**, this is called and Slab on Grade foundation.



If a **WALL** separated conditioned space from the earth, the wall is the critical part of the building thermal envelope. This type of foundation is a basement or below grade wall.

Below Grade Wall (Commercial)
Basement Wall (Residential)

Next Slide: Why does depth matter? | Practice: Identify Foundations and Slabs | More in the Code: Definitions

Buttons navigate to the next slide or to deeper exploration of the topic.

Enrichment

Essentials

Slide 1

Learn: Info and links on related topics of interest, links to code definitions and language, etc.

Slide 2

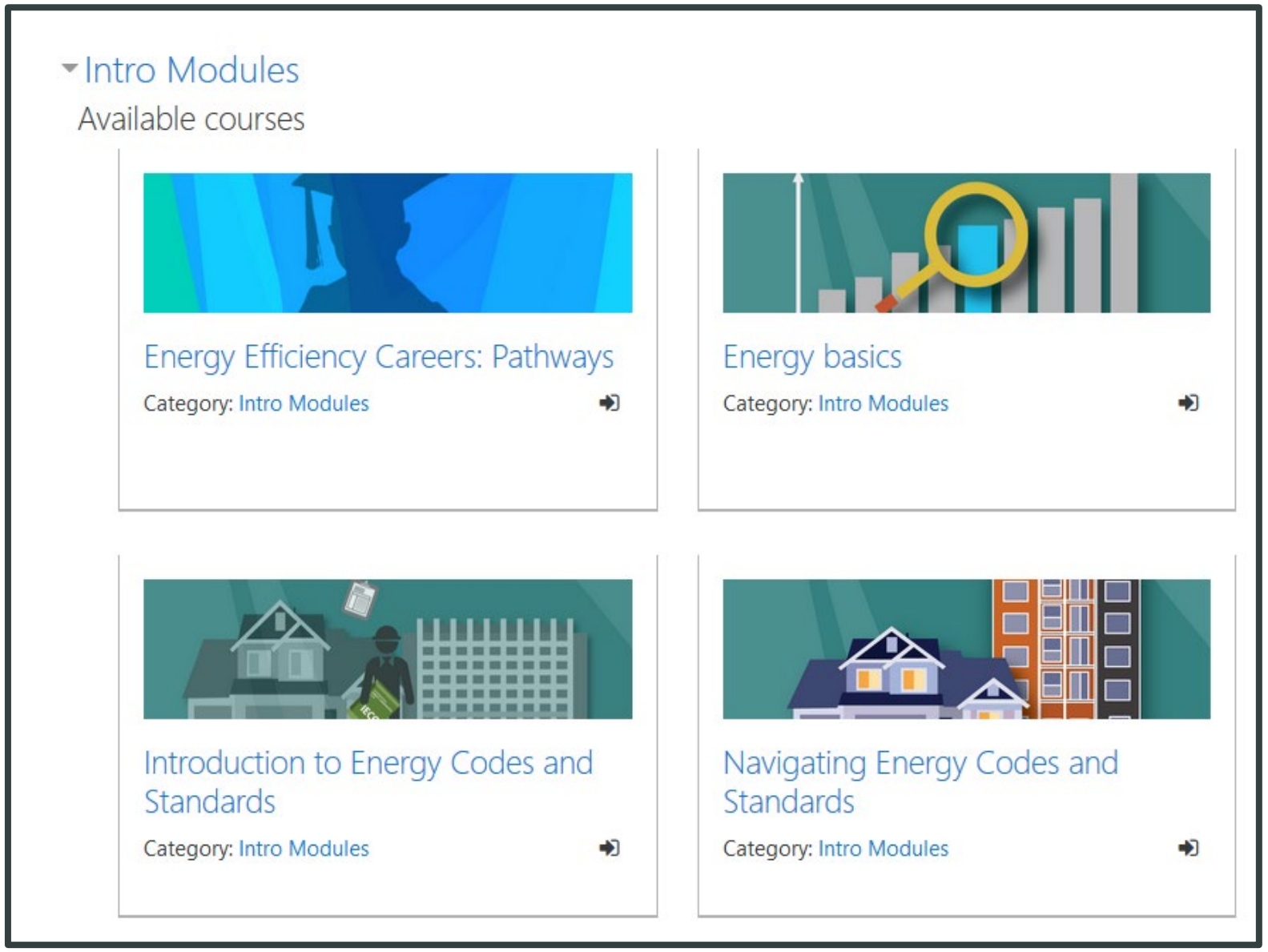
Experience: Links to videos, job site examples, projects, etc.

Etc.

Practice: Interactive question sets, problem sets, worksheets, etc.

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Organization

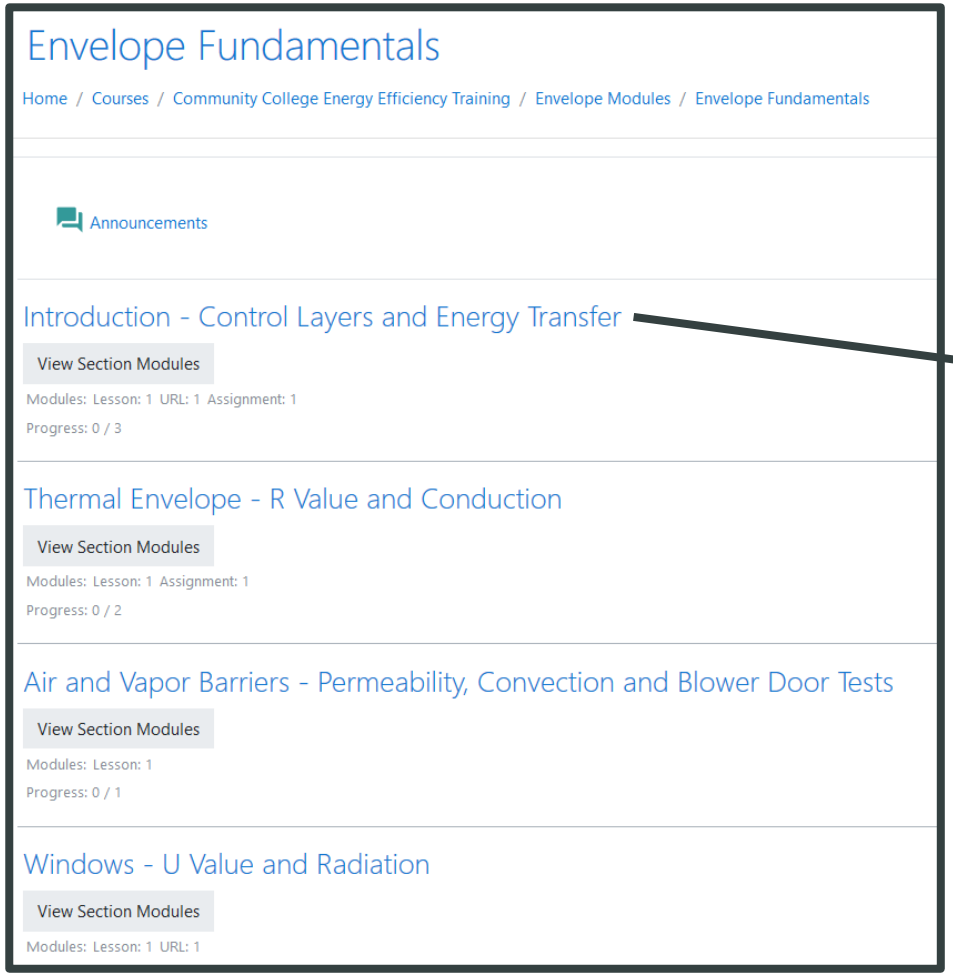


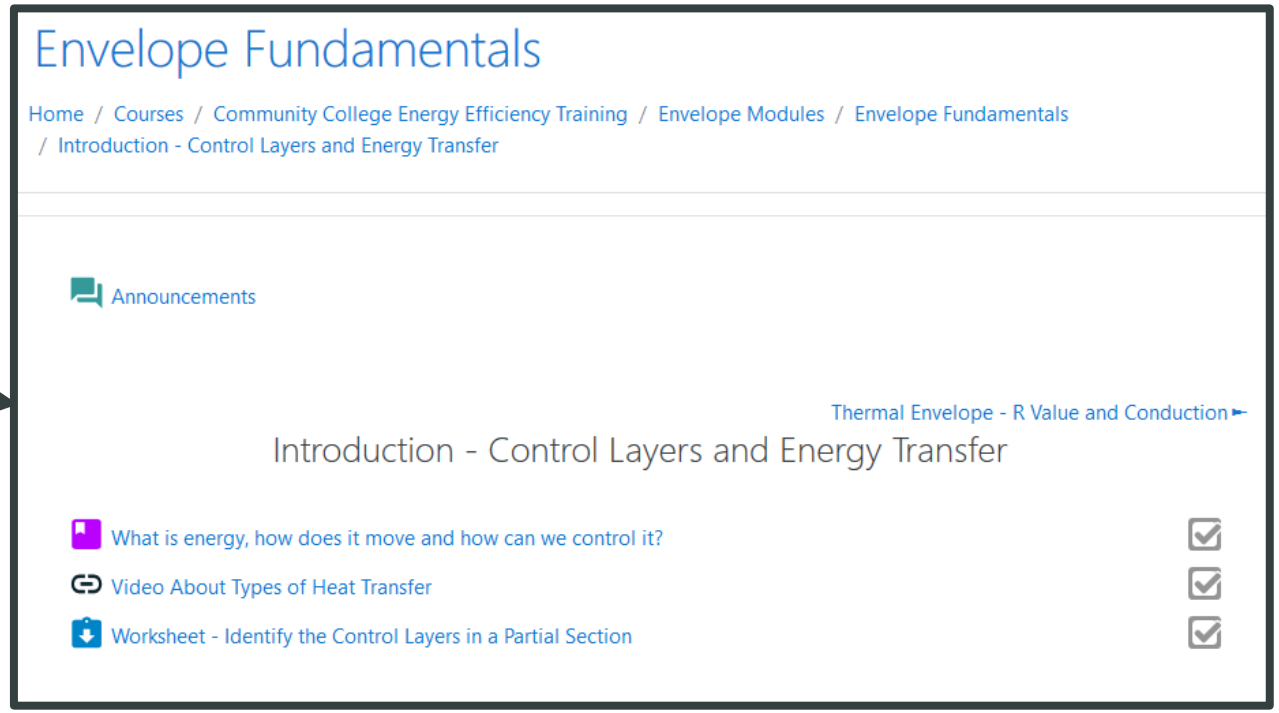
Moodle eLearn Dashboard example

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Organization

Moodle eLearn – Dashboard example





SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Content

Applies to All

Sections

More Specialized

Introduction

all audiences

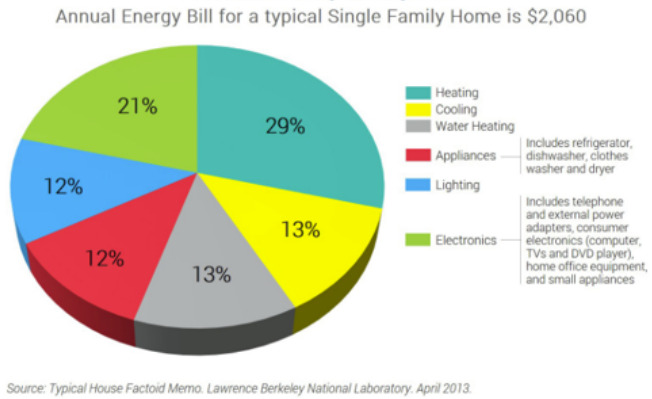
- Generates awareness
- Connects topic to major themes
- Building science principles

What is the Manual J Load Calculation?

Manual J load sizing calculations bring together the following information:

- Envelope component conductive heat loss values
- Window and door solar heat gains
- Envelope and mechanical air exchange rates
- Building equipment loads (appliances and lighting)
- Building occupant loads (activity level and number of people)
- HVAC equipment location impact on loads.

Calculates the load, not the equipment size! That's completed in a Manual S calculation



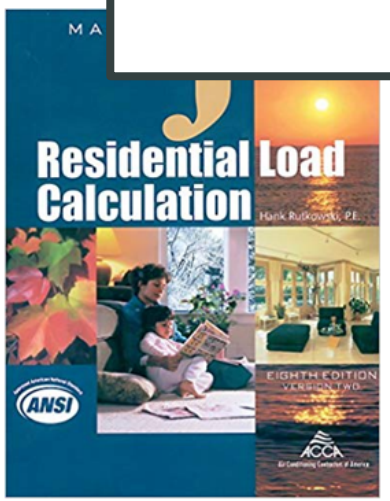
Source: Typical House Factoid Memo. Lawrence Berkeley National Laboratory. April 2013.

What is a Manual J?

ACCA Manual J calculates all the heating and cooling peak loads in a residential structures to allow for the sizing of mechanical systems.

Required by 2018 IECC and beyond, and ASHRAE90.1 2017 and beyond for new construction.

Replacement systems for existing buildings should also be sized based on a Manual J load calculations.



SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Content

Applies to All

Sections

More Specialized

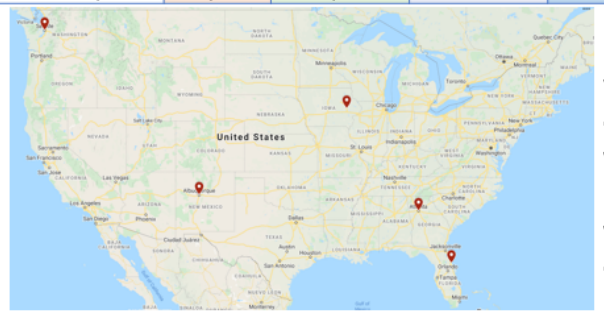
Sub-topics

most audiences

- Defines the topic or component and why it is important
- Introduces code requirements -- ***how*** *to find them and techniques for implementation*
- Applies the building science principles to the topics – ***why*** *the code requirements exist*

Impact of Weather Data: Same House, Different Locations

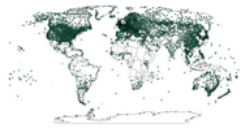
Location	BTUH Heating	BTUH Cooling Sensible	BTUH Cooling Latent	BTUH Cooling Total
Cedar Rapids AP, IA	40,453	18,004	1,805	19,809
Albuquerque AP, NM	27,580	17,290	0	17,290
Atlanta AP, GA	25,529	18,090	1,723	19,813
Daytona Beach, FL	18,173	18,670	2,291	20,961
Seattle-Tacoma AP, WA	24,018	16,812	800	17,612



Location and temperatures cause loads to vary widely! Make sure the values are correct!

ASHRAE Design Weather Data for Location

Weather files available in multiple locations:
ASHRAE website (see right)
https://www.ashrae.org/technical-resources/bookstore/weather-data-center



Hardcopies of Manual J book, Table 1A:

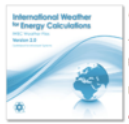
Table 1A
Outdoor Design Conditions for the United States

Location	Elevation Feet	Latitude Degrees North	Heating 99% Outdoor Dry Bulb	Cooling: Outdoor Air 1% Dry Bulb	Cooling: Outdoor Air Coincident Wet Bulb	Cooling: Design Grains 55% RH Indoors	Cooling: Design Grains 50% RH Indoors	Cooling: Design Grains 45% RH Indoors	Cooling: Daily Range (DR)	HDD_{65} / CDD_{50} Ratio
Illinois										
Aurora Municipal AP	705	42	1	88	74	30	37	44	M	2.22
Belleville, Scott AFB	453	38	10	93	77	44	51	58	M	1.13
Bloomington (Peoria DD)	875	40	-2	90	74	31	38	45	M	1.80
Cahokia, St. LouisDowntown Parks AP	413	39	14	91	76	43	50	56	M	1.06
Carbondale	411	37	7	93	77	44	51	57	M	1.31
Champaign, Urbana	754	40	2	92	74	28	34	41	M	1.77
Chicago, Meigs Field	593	41	3	89	73	26	33	40	M	1.72
Chicago Midway AP	617	42	4	90	73	27	34	41	M	1.77
Chicago Ohare IAP	673	42	2	89	73	29	36	42	M	2.08
Chicago CO	647	41	2	91	74	29	36	43	L	1.72
Danville	696	40	1	90	74	31	38	44	M	1.59
Decatur	699	40	5	91	76	41	47	54	M	1.55
Dixon	785	41	-2	90	74	31	38	45	M	2.56
Elgin	700	42	-2	88	74	34	41	48	M	2.53

Ensure that your Load or Energy Calculations Are Based on Climate Data from ASHRAE:

- International Weather for Energy Calculations—Typical weather files, suitable for use with building energy simulation programs for 3,012 locations outside the United States and Canada. Purchase the DVD or individual files.
- Chapter 14, Climatic Design Information, from the 2017 ASHRAE Handbook—Fundamentals—Climatic design information tables from ASHRAE Research Project RP-1699 for 8,118 locations in the United States, Canada, and around the world.
- Weather Data Viewer DVD 6.0—Comprehensive climate data for the 8,118 locations listed in the 2017 *ASHRAE Handbook—Fundamentals*, plus tools and calculators to help use the data effectively.
- Standard 169-2013, Climatic Data for Building Design Standards—Standard climate zone maps and data for 5,564 worldwide locations from ASHRAE Research Project RP-1453, as published in the 2009 *ASHRAE Handbook—Fundamentals*.

...rnational Weather for Energy Calculations, version 2.0



Purchase the DVD or Individual Files

This DVD contains "typical" weather files, suitable for use with building energy simulation programs, for 3,012 locations outside the United States and Canada.

DVD files format: CSV

View a list of station locations for IWEC2 files

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Content

Learn materials

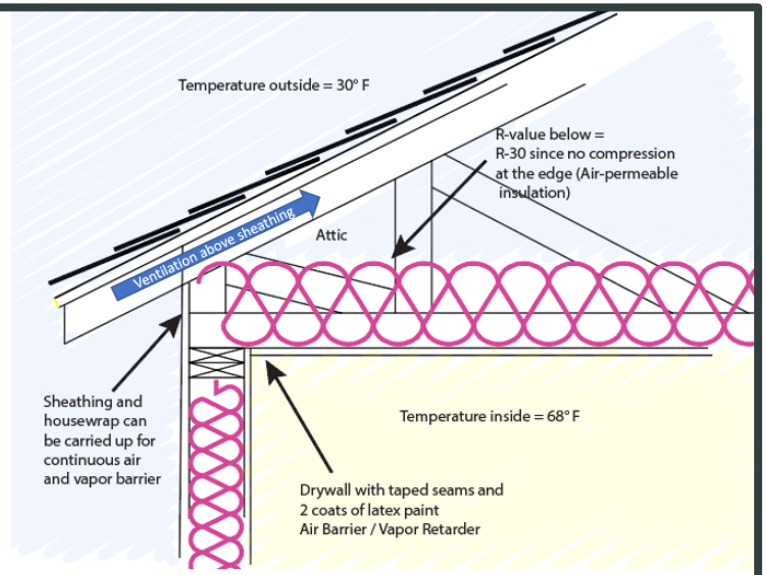
Vented Attic with a Raised Heel

This detail shows an improved method of constructing a typical vented attic. In this cause, a special kind of roof truss called a "raised heel" creates extra space at the roof and wall intersection and eliminates

- Any ductwork in the attic is in an **unconditioned space** and must be insulated.
- All penetrations in the ceiling must be **air**

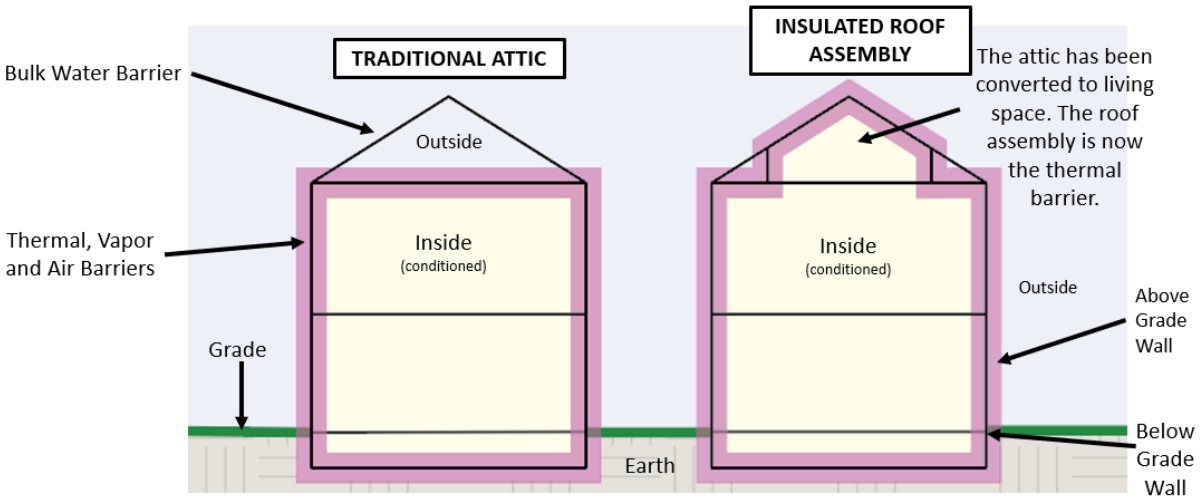
compressed at the
he wall and roof – IECC
e reduction for this

ed. Sufficient fresh air
e provided but the raised
easy way to include a
l above the wall



Graphic based on U.S. Department of Energy, Office of Building Technology State and Community Programs, www.energycodes.gov https://www.energycodes.gov/sites/default/files/documents/cn_unvented_attic_assemblies.pdf

Identify the Control Layers: Ceilings, Attics and Roofs



An attic is an uninsulated portion of a building outside of the thermal envelope of a building. Similar to a vented crawlspace, this space needs an exchange of fresh air and ductwork, if placed in a vented attic, must be insulated as though it were outdoors.

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

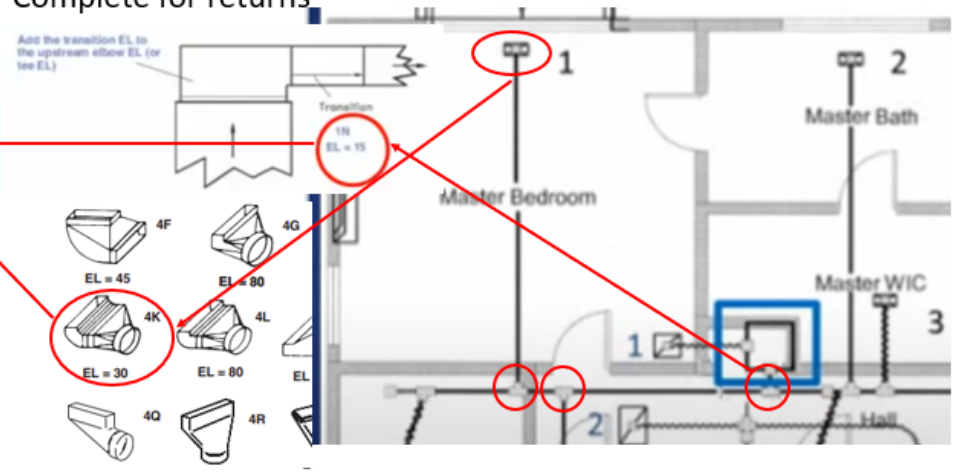
Content

Learn materials

Manual D – Effective Length of Duct Fittings

Identify fittings in 1st branch and add to sheet.
Complete for all branches. Longest branch equivalent length is used as supply equivalent length
Complete for returns

Element		
Straight Run	1	
		Length
Trunk Length		3
Trunk Length		8
Trunk Length		12
Runout Length		
		Effective Length
		15
		65
		30
		70
		203



2018 IECC Residential Basement and Crawlspace Insulation Requirements

HINT! – they're almost the same. Can you find the differences?

TABLE R402.1.2 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.32	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	20 or 13+5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20+5[h] or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20+5[h] or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

NR = Not Required. For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. U-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.
b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 1 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation on the interior of the basement wall. "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. Alternatively, compliance with "15/19" shall be R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.
d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs, as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.
e. There are no SHGC requirements in the Marine Zone.
f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.
g. Alternatively, insulation sufficient to fill the framing cavity and providing not less than an *R*-value of R-19.
h. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "13+5" means R-13 cavity insulation plus R-5 continuous insulation.
i. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

HINT: basement is not required for HOT/HUMID zone 3 but crawlspace is!

HINT: cavity insulation can be used for residential but NOT commercial.

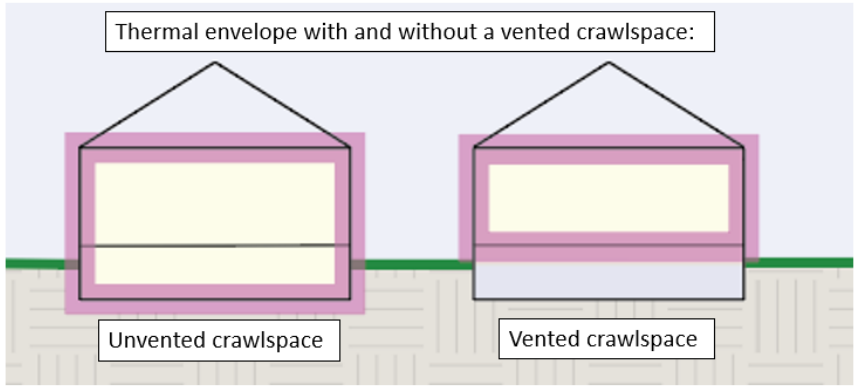
SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Content

Practice materials

What do you need to insulate: Vented and unvented Crawlspaces

- In a vented crawlspace, the first floor must be insulated (floors require at least R-13 to R-19 per 2018 IECC)
- In an insulated crawlspace, the perimeter needs to be insulated at least 24" from the finished floor horizontally and/or vertically.
- The crawlspace floor does not need to be insulation (although a vapor barrier must be installed per IBD requirements (see R402.2.11)



Exercise:
Compare the costs!
Given a home that is 24' x 40'. How much more costly would the foundation insulation need to be (per square foot) to equal the cost of insulating the crawlspace walls?

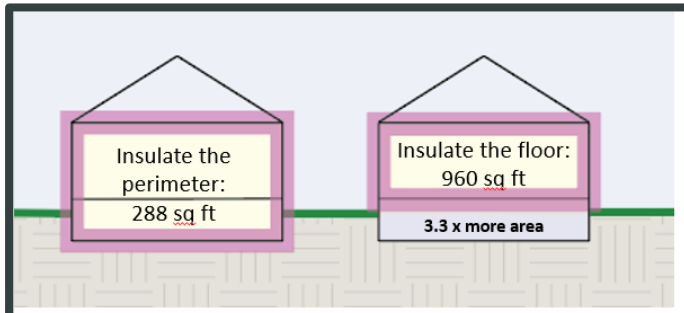
Test your knowledge:

Which roof do you think contains an attic and which is conditioned space (poorly insul

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Content

Practice materials (answers)



Vented crawlspace (floor is insulated)
Courtesy of basc.pnnl.gov

Insulated Crawlspace (closed cell spray foam)
Courtesy of Thermal Tech Insulation

- PROCESS:

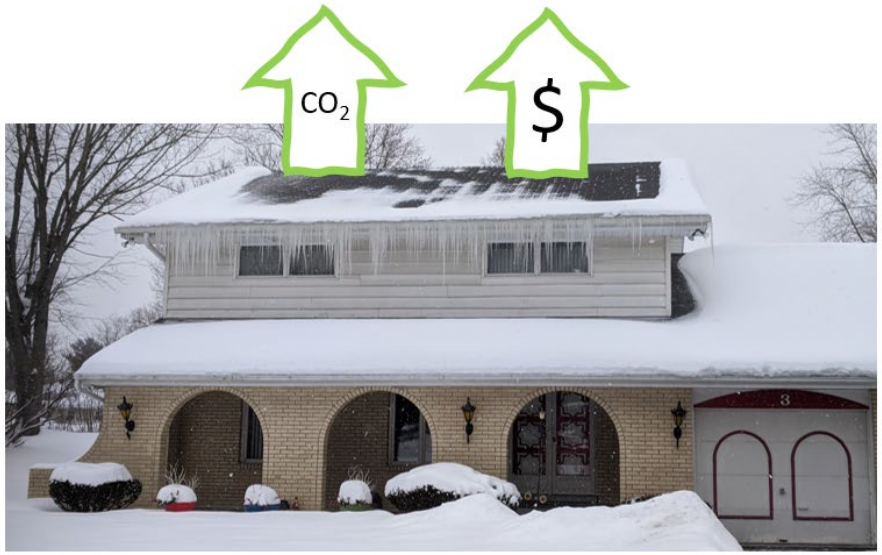
24 x 48 = 960 sq ft = floor area

Perimeter = 24 + 24 + 48 + 48 = 144 linear ft => 144 x 2' (depth of perimeter insulation) = 288 sq ft

960/288 = 3.33 => therefore since you'd need 3.33 times as much floor insulation to finish the job the perimeter insulation would have to cost 3 1/3 times as much to equal the cost of installing floor insulation.

- BONUS PROBLEM – how much more volume is inside the thermal envelope?
- DISCUSSION QUESTION – which do you expect would perform better and why?

This roof contains conditioned space that is poorly insulated. Heat from inside is escaping and melting the snow. And with the wasted energy, the homeowners is wasting money and impacting the environment!



When it's cold outdoors, heat rises!
We see where heat has risen from the conditioned second story of this suburban home. By contrast, the garage (below and to the right) appears to cover unconditioned space. Or it is well insulated!

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

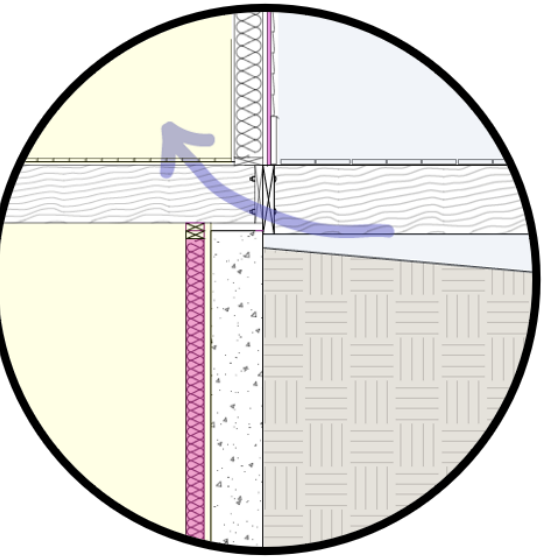
Content

Practice materials

1.

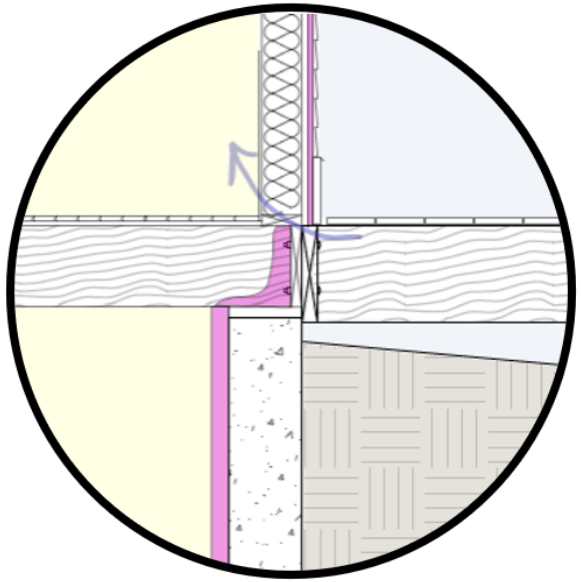
hermal Bridging

here dissimilar materials meet care must be taken to maintain a continuou
velope. This can be especially challenging when the insulation is on both s
ll structure. In the example below, a deck connected to the structure creat
idge if not addressed. See how the detail on the right is better?



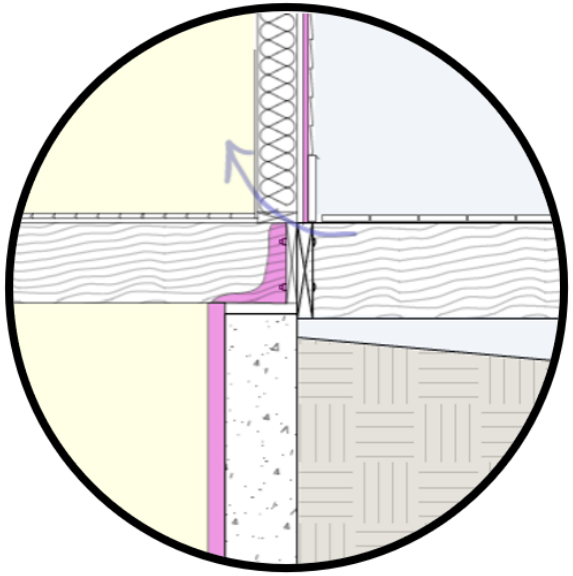
2.

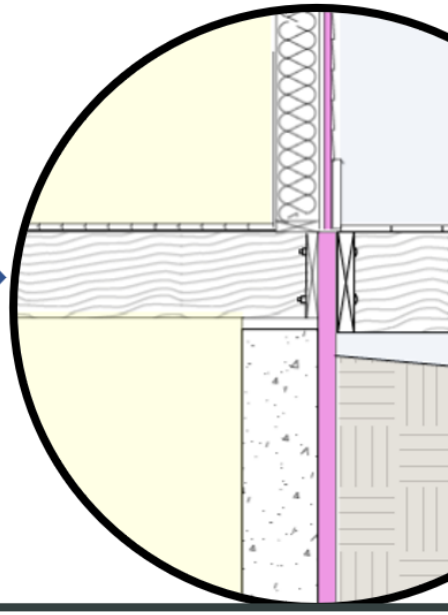
Practice. The improved detail still provides a path for thermal bridging. Can you think of a way to improve the detail?



3.

Continuous Insulation makes the detail better. While this isn't always practical, keeping the thermal layer lined up provides the most continuous insulation barrier.





SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Content

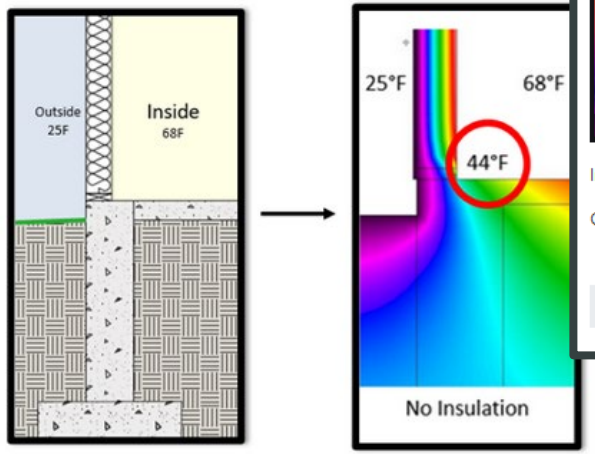
Experience materials

Why insulate foundations?

Just like above grade walls, insulation is required to **slow heat transfer** out of (or into) the conditioned space.

Insulating foundations is critical for:

- Comfort
- Condensation
- Costs



Thermal modeling by greenbuildingadvisor.com

Next Slide

Learn about Thermal Imagery!

What is thermal modeling? If you're wondering how to read this graphic, you're not alone! Thermal imagery is a useful way to visualize the way energy moves through components and systems. The colors represent different temperatures and show cooler and warmer areas. In this case, the image was created by a computer program that used analytics to predict the temperature of the components. Thermal cameras are devices that can create similar images from actually measuring the temperatures in a space.

Thermal cameras are very useful for identifying air leaks and thermal bridging in buildings. Here is an example of a thermal camera image:

Image courtesy of the Montgomery County Library where you can rent a thermal camera! https://www.montgomerycountymd.gov/library/services/thermal-cameras.html

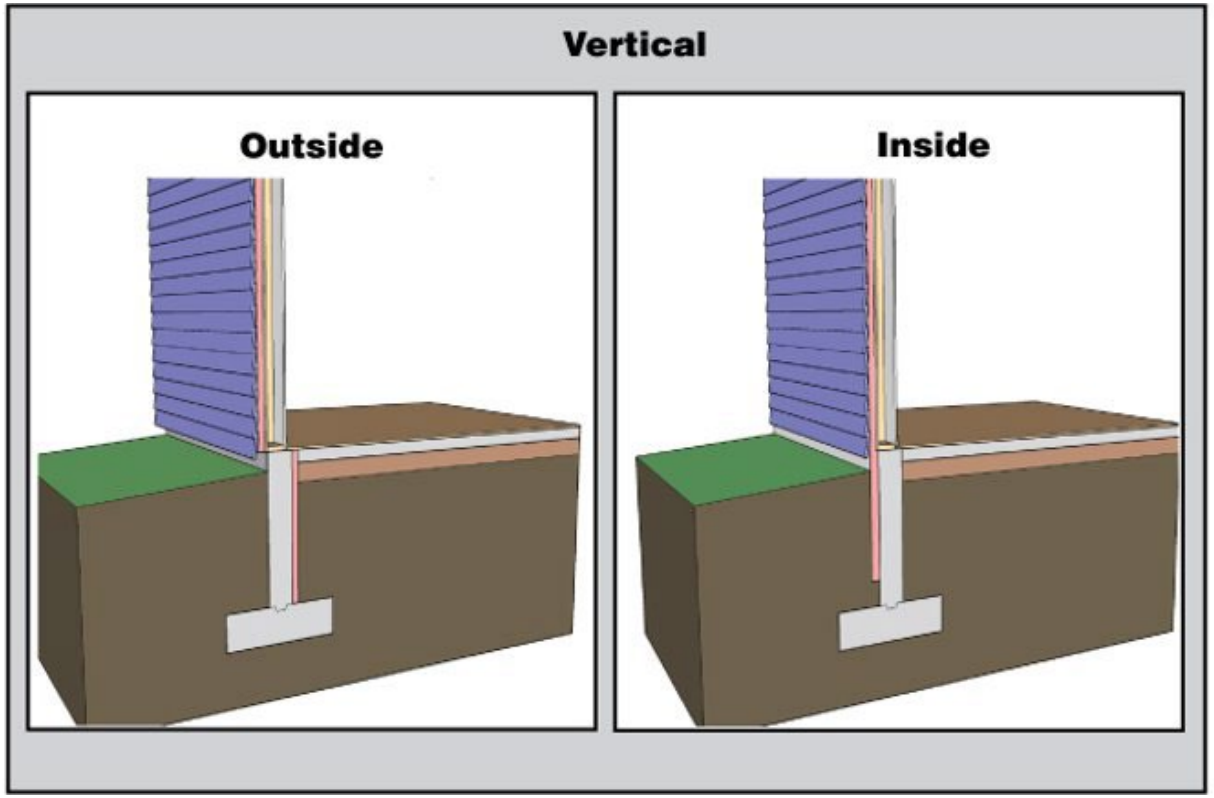
Check out whether you can rent a thermal camera from your school or public library! It's a great way to learn about thermal envelope hands on!

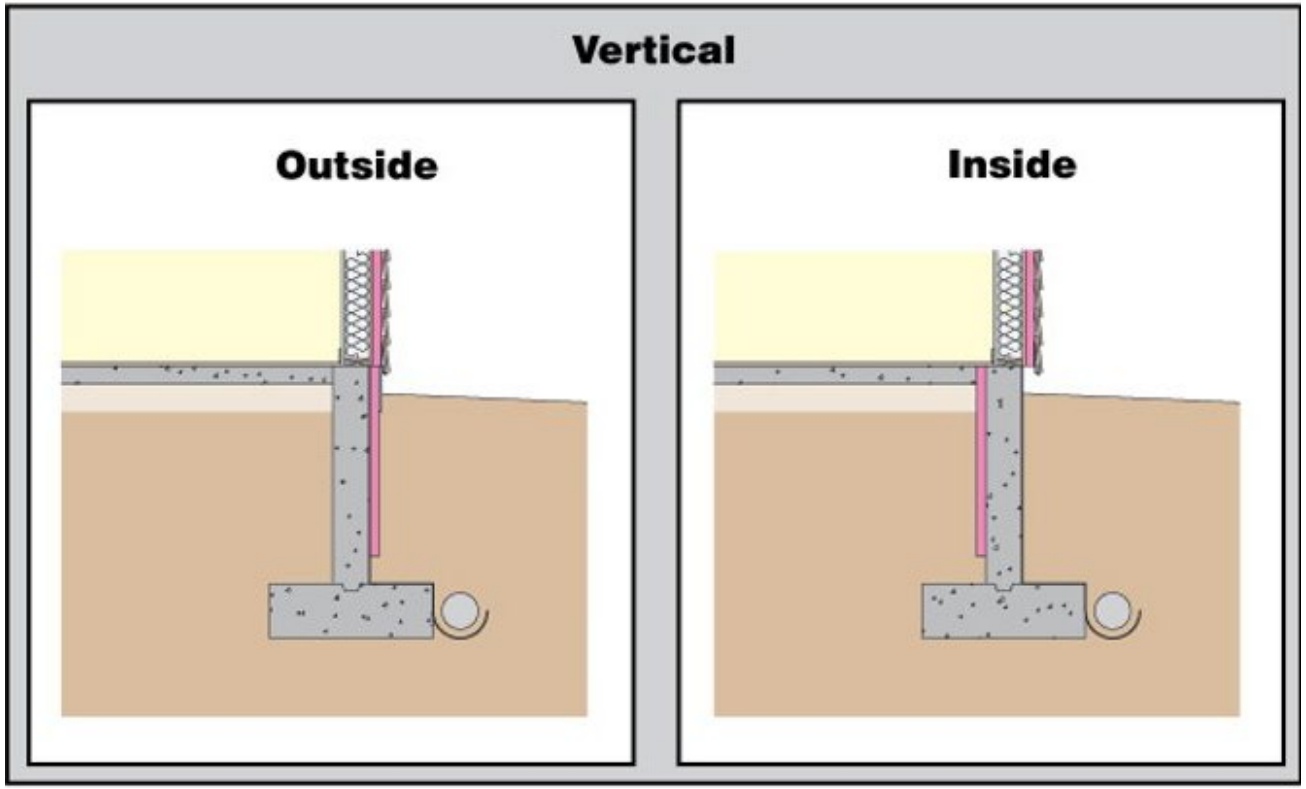
Back to the Lesson

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Style

What is easier for students to read? Is teaching drawing conventions a priority?





SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Style

Video

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Your Input & Feedback:
Curriculum & Program in general

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Discussion

Community College Energy Code Training Program (2020 – 2023)

Curriculum :
Feedback on curriculum organization, contents, presentation style

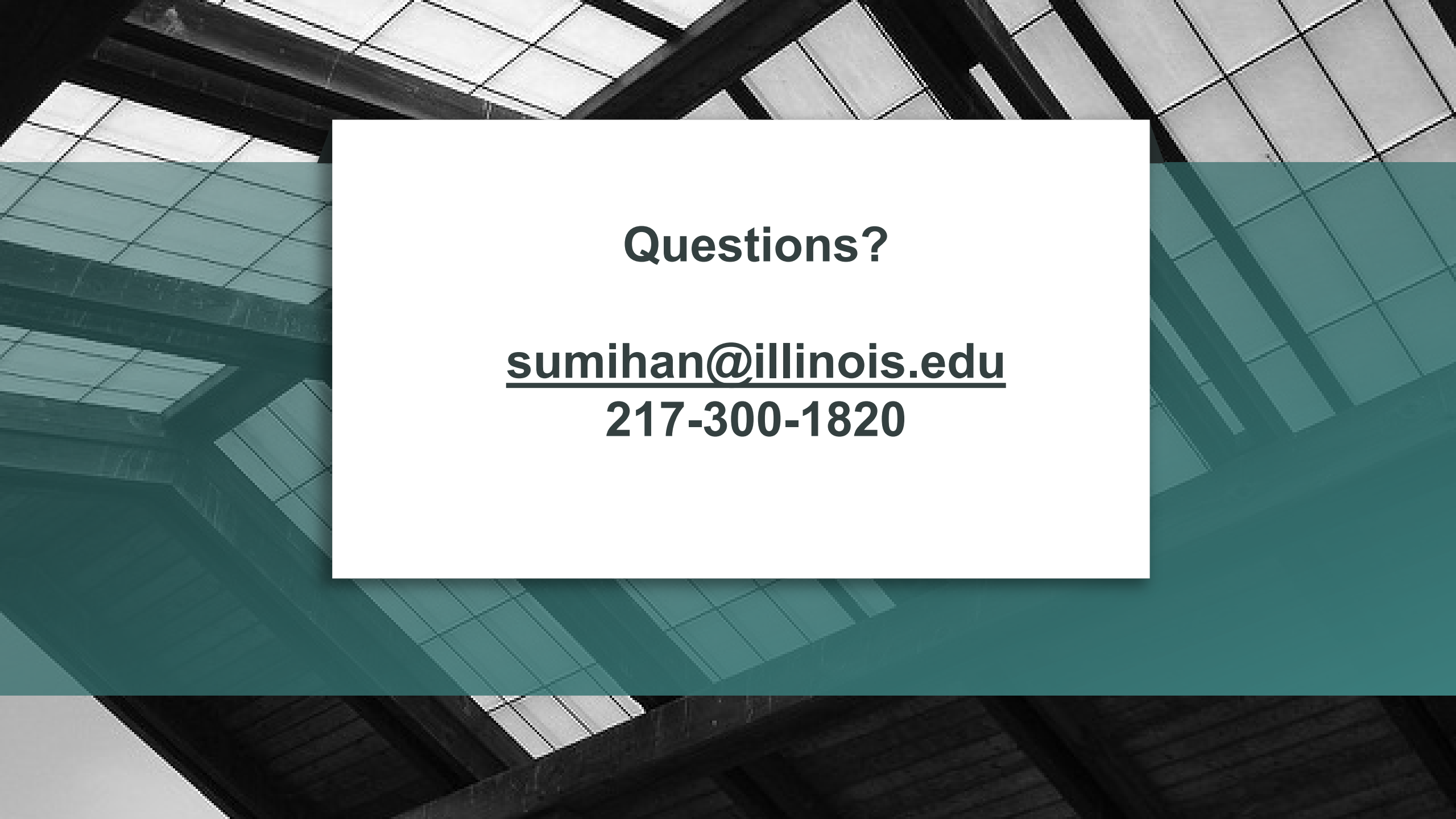
Community College:
How to support instructors and students to integrate EE & Energy Code

EE Career Paths:
How to Build Stronger Connection btw Colleges & Design / Construction / EE Industries

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

What's Next

Timeline	Milestone	Notes
April 2021	Instructors express interest in utilizing curriculum	Letters of commitment from instructors
January 2022	Instructor tool kit complete	Need help from Code Officials
Starting January 2022	Instructors and students utilizing curriculum	Need help on outreach from all stakeholders
Summer 2022	Workshops in 3 states	Need help from State Energy Offices
By October 2022	60 instructors deliver modules to 900 students	Need help from Colleges
By January 2023	900 professionals utilize curriculum	Need help from industries, organizations/
Spring – Summer 2023	Training program tool kit launch	
Summer 2023	National outreach	Need help from State Energy Offices



Questions?

sumihan@illinois.edu
217-300-1820