Community College Energy Code Training Program

Final Technical Report

November 2023

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Signature of Certifying Official *Date*

By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate. I am aware that any false, fictitious, or fraudulent information, misrepresentations, half-truths, or the omission of any material fact, may subject me to criminal, civil or administrative penalties for fraud, false statements, false claims or otherwise. (U.S. Code Title 18, Section 1001, Section 287 and Title 31, Sections 3729-3730). I further understand and agree that the information contained in this report are material to Federal agency's funding decisions and I have any ongoing responsibility to promptly update the report within the time frames stated in the terms and conditions of the above referenced Award, to ensure that my responses remain accurate and complete.

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Executive Summary

The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) funded a series of research and training programs under the Advanced Building Construction with Energy Efficient Technologies and Practices (ABC) initiative. The aim is to develop new training programs to support the development of a skilled workforce in the building energy efficiency industry. In response, the University of Illinois Smart Energy Design Assistance Center (SEDAC), in collaboration with State Energy Offices in Illinois, Hawaii, and Nevada, developed the Community College Energy Code Training Program. The program is designed to prepare a new generation of energy-literate professionals that understand energy efficiency and its relation to energy codes for new construction and existing buildings through: a) the development of a curriculum and innovative pedagogical materials, b) dissemination through a national network of state energy offices: c) outreach targeting Community College students and instructors.

The approach included establishing partnerships between energy code training programs and community college instructors, developing hands-on energy code materials, deploying curriculum materials through a “train-the-trainer” approach, connecting energy code officials to community college training programs, and promoting wide distribution the program through a national network of state energy offices. Specific Program tasks include: a training needs and interest assessment (task 1), curriculum development (task 2) and evaluation (tasks 3 & 7), the development of an instructor toolkit (task 4) , train-the-trainer workshops (tasks 5 & 6), and outreach and an outreach toolkit (task 8). All deliverables associated with each task have been completed and delivered on time.

Community college administrators and instructors, local code officials, and construction professionals were interviewed to identify needs and assess interest in offering energy code training. In addition, existing community college programs and curricula were surveyed to identify potential gaps in existing training related to energy codes and energy efficiency. A review of the literature on barriers, best practices, and curriculum for teaching energy code and energy efficiency more generally was completed to help determine training approaches and content.

The needs assessment results suggest that there is an interest in energy code/energy efficiency curriculum and that the most effective approach for its delivery is to develop a series of short learning modules with subtopics, resources, videos, and activities that can be easily integrated into existing curricula, trade, continuing ed, and training materials - rather than as a stand-alone topic. Architects were found to be most knowledgeable about the energy code, followed by code officials, construction managers, and contractors. Most energy code information is obtained through continuing education credits with a deficiency in programs that train design and construction professionals. Instructors expressed interest in building-system approaches that engage real-life scenarios. Code professionals reported hiring difficulties and a lack of new professionals in the field.

Three academic programs are targeted for code curricula inclusion 1) construction management/construction tech programs; 2) architectural technology/engineering/drafting programs; and 3) traditional trade programs related to carpentry or HVAC/R. A list of curricular topics include:

- Intro topics (codes and standards careers, energy basics, energy code basics);

- Envelope topics (envelope basics, insulation, air barriers);
- Mechanical/electrical/plumbing topics (Manual J™, duct leakage testing, lighting, domestic hot water),
- Existing building renovation topics, and
- Beyond code topics (net zero, ENERGY STAR®, renewables).
- Online resources and activities that asynchronous and easily accessible

These align with core building science concepts and existing training resources in the DOE's Guidelines for Building Science Education (GBSE). The Building Science Education Solution Center was also evaluated for gaps in training resources that are addressed in the Building Energy Education (BEE) Fundamentals on-line training modules developed as a part of this work. An evaluation of the BEE Fundamentals curriculum demonstrates a high level of satisfaction with a steady stream of registrants and a high number of course modules completed.

Outreach and workshop feedback suggest that the educational content and materials developed as a part of this program are effective in increasing energy literacy but that more effective strategies to recruit participation is needed. There are opportunities to forge connections between State Energy Offices and colleges to leverage resources and reach potential students and professionals in energy code related curricula. Connections with other workforce development programs are needed to increase the level of interest and engagement by other related stakeholders.

1. Introduction

The Better Buildings Workforce Guidelines and the Guidelines for Building Science Education specify that all builders, remodelers, design and construction professionals, along with code officials, should be able to understand and apply national codes and standards. However, many community college building trade programs don't teach core competencies related to energy codes, in part because instructors themselves may not have up-to-date knowledge about energy code requirements and the energy efficiency principles that inform these requirements. As a consequence, their students are not entering the workforce prepared to understand energy codes, nor do they understand the energy efficiency basics that are the foundation of these codes.

In addition, at the state level, although state agencies (such as state energy offices) are increasingly involved in energy code training, these efforts are largely focused on practicing code officials and design professionals, not professionals-in-training or the instructors who teach them. This gap in training material and the consequent gap in expertise, is contributing to a labor shortage among energy code professionals and building and construction professionals who can adequately understand and apply national codes and standards.

Project Approach
The Community College Energy Code Training Program aimed to fill this critical workforce gap in the energy efficiency industry through:

- The development and dissemination of an engaging curriculum and innovative pedagogical materials that can be used to train a new generation of energy-literate building professionals.
- Bringing state energy code and energy efficiency training opportunities to community colleges and other building trade programs through a national network of state energy offices.
- A training program that prepares instructors to become energy code advocates in their classrooms.

The goals of the program are to:

- Increase participant knowledge of advanced design and construction practices among instructors and students in community college trade and continuing education programs; and
- Increase awareness of employment opportunities in code official/code verification professions.

The stated project objectives include:

1. Establish partnerships between energy code training program and community college trade programs and instructors.
2. Develop a hands-on energy code training curriculum that incorporates the latest energy code research and technologies.
3. Deploy the curriculum at community colleges through a "train-the-trainer" approach.
4. Increase energy literacy of community college students and instructors.
5. Connect energy code officials to community college training programs to increase awareness of code official careers.
6. Promote wider distribution and sustainability of the training program through a national network of state energy offices and community colleges.

The work of accomplishing these objectives included the following 8 tasks:

Task 1: Needs and interest assessment. The project team completed a training needs assessment to evaluate interest in and feasibility of a community college energy efficiency and energy code training program. Additionally, we reached out to stakeholders to invite them to support the program by testing and utilizing the curriculum or serving on a technical advisory team. We received letters of commitment from the 3 instructors to test the curriculum, 3 code officials to be part of a technical advisory team to review the curriculum, and 10 community college instructors to utilize the training curriculum.

Task 2: Curriculum development. The project team developed 15 training modules and instructor resources to teach community colleges students about energy efficiency and energy code topics and technologies. Curriculum and resources were based on current model energy efficiency codes, with examples from different state amendments and different climate zones. The 15 modules were categorized into four topic areas: introduction modules, envelope modules, mechanical and electrical modules, and advanced modules. Modules consisted of presentations and supportive resources, such as in-class activities, worksheets, quizzes, and videos. All materials were delivered through Moodle, an online learning management system.

Task 3: Curriculum testing, review, and revision. The project team tested the curriculum with students and instructors and reviewed it with the technical advisory group. Three instructors and 30 students tested the curriculum, and a technical advisory group of 3 code officials and other project team content experts reviewed and rated the curriculum for relevance, technical accuracy, appropriateness, understandability, and content mastery. Results from this review were compiled in an evaluation summary, and the modules were revised according to the feedback received.

Task 4: Instructor toolkit development. We packaged the modules into an online Instructor Toolkit that community college instructors could utilize to deliver the curriculum to their students. This toolkit included information about the program and how to use the curriculum. It contained videos and overviews of the different modules and a description of the tools and resources that are included.

Task 5: Train-the-trainer workshop preparation. The project team organized and developed training curriculum and recruitment material for launch and train-the-trainer webinars in the three partner states: Illinois, Nevada, and Hawaii. We recruited code officials and other guests to speak at the webinars and recruited participants to attend.

Task 6: Workshop delivery and support. State Energy Offices, in coordination with the project team, delivered program launch webinars to introduce the curriculum and instructor toolkit to interested stakeholders. A train-the-trainer workshop for participants from all three states was held to provide specific guidance for instructors on how to utilize the curriculum.

Task 7: Curriculum delivery and evaluation. 60 instructors delivered some or all curriculum modules for their students. Portions of the curriculum were also delivered through webinars and online courses to 947 existing code officials and building professionals. We collected learning metrics and feedback from curriculum users to evaluate the program.

Task 8: Curriculum and outreach toolkit development for State Energy Offices. The program team reached out to the National Association of State Energy Offices (NASEO) to promote our program more widely and in other states. We created a Curriculum and Outreach toolkit for state energy offices to use.

The toolkit included outreach messaging and strategies to share the curriculum more widely. Five organizations, including state energy offices or other organizations, expressed support to use the toolkit and disseminate the curriculum, through letters of commitment.

This report describes the products and accomplishments of the work including project methods, results, and findings. We end with some conclusions and suggestions for future work/research.

2. Project Team

The following comprised the Community College Energy Code Training Program project team:

- **Smart Energy Design Assistance Center (SEDAC) at the University of Illinois at Urbana-Champaign.** Principal investigator, overall project management, deliverables, and strategic direction.
- **360 Energy Group.** Project support, outreach, research, and specific project tasks.
- **Illinois EPA Office of Energy.** Marketing, workshop recruitment, and curriculum rollout to Illinois stakeholders.
- **Hawaii State Energy Office.** Marketing, workshop recruitment, and curriculum rollout to Hawaii stakeholders.
- **Nevada Governor's Office of Energy.** Marketing, workshop recruitment, and curriculum rollout to Nevada stakeholders.

3. Project Approach

The project involved extensive stakeholder outreach, curriculum and resource development, review and testing of the curriculum, and collecting metrics to evaluate the impact of the curriculum. The methods associated with each task are summarized in Table 1 and described in more detail below.

Table 1. Summary of methods associated with the project tasks.

Task	Project Methods
T1. Training needs and interest assessment	- 49 code officials and 13 community colleges surveyed - 7 code officials/building consultants; 6 community college instructors interviewed - Existing community college programs and curricula surveyed - Literature on barriers, best practices, and curriculum reviewed - Training needs and interest assessment developed
T2. Curriculum development	- 15 module topics selected - Learning objectives developed - Presentations and learning materials/activities developed for each module - Learning management system developed for modules
T3. Curriculum testing, review, and revision	- Curriculum tested with 3 instructors, 30 students, 5 advisory team members - Training metrics and learning assessments collected - Student/teacher experience surveys collected - Curriculum reviewed by technical advisory group - Evaluation summary developed based on training metrics, advisory review - Modules revised and delivered to technical advisory group for final review
T4. Instructor toolkit development	- Modules packaged into an online Instructor Toolkit - Instructor resources developed - Summaries of material content and FAQ developed - Videos developed to promote curriculum
T5. Train-the-trainer workshop preparation	- Outreach and promotion - Guest speakers recruited
T6. Workshop delivery and support	- Workshops delivered for each state - Before/after surveys conducted and analyzed - Follow-up with attendees to support integrating material in their courses
T7. Curriculum delivery and evaluation	- Training metrics collected for students and instructors utilizing curriculum - Feedback surveys conducted for instructors and students - Training metrics and feedback surveys synthesized into an evaluation report
T8. Curriculum and outreach toolkit development for State Energy Offices	- NASEO, State energy outreach to promote training program dissemination - Outreach messaging and fliers developed for wider curriculum dissemination - 5 letters of commitment to disseminate curriculum solicited - Outreach evaluation

3.1. Training Needs and Interest Assessment Methods (Task 1)

Working across Illinois, Nevada, Hawaii, and with State Energy Offices, the project team reached out to community colleges and national/state/regional code official organizations to identify training needs and interests. We identified instructors to test the curriculum and code officials to participate in a technical advisory group to review curriculum. We utilized findings from recent State Energy Code Field Studies by DOE and examined high-impact energy efficiency measures and technologies that are introduced to codes and the industry.

The purpose of the training needs assessment was to evaluate interest in and feasibility of our proposed training program in Illinois, Nevada, and Hawaii. We sought to build relationships among state energy offices, community college administrators and instructors, and local code officials to identify needs and assess interest in offering feedback on training program curriculum or delivering the curriculum. We reached out via phone and email to community college building science, design and construction instructors and administrators, as well as code officials in Illinois, Nevada, and Hawaii. We invited them to complete a survey that addressed their overall experience with energy codes/energy efficiency and interest in participation. We invited survey respondents to participate in a follow-up interview.

In total, 49 code officials and 14 community college instructors participated in the survey, and 13 participated in follow-up interviews. We interviewed 4 code officials from Illinois, 1 from Nevada and 2 building consultants from Hawaii (one a HERS rater and the other BPI auditor). We interviewed 6 community college instructors (3 from Illinois, 2 from Nevada and 1 from Hawaii). We interviewed our partners at the three state energy offices in Illinois, Hawaii, and Nevada to get a broader perspective of workforce training needs, legislative differences, and programs in three states.

We also referenced results from an Illinois energy efficiency workforce stakeholder outreach project conducted by SEDAC during the previous year. This research was focused on the need for education and training in energy efficiency more broadly and was used to gain a more complete picture of the larger workforce needs related to energy efficiency. During the stakeholder outreach process for this project, we interviewed 8 energy efficiency employers, 5 community college instructors or administrators, and 8 energy efficiency workforce coordinators (all from Illinois).

In addition to this stakeholder outreach, we surveyed existing community college programs and curricula to identify training that is already occurring related to energy code and energy efficient construction practices, as well as training gaps. We reviewed literature on barriers, best practices, and curriculum for teaching energy code and energy efficiency more generally to help determine training approaches and content. We focused on DOE's Guidelines for Building Science Education (GBSE) as well as the resources in the Building Science Education Solution Center.

3.2. Curriculum Development Methods (Task 2)

The project team developed resources and training modules that instructors can use to teach students about energy code topics and technologies. Curriculum and resources were based on the current model codes (i.e. 2018/2021 IECC and ASHRAE 90.1-2016/2019) and tailored where appropriate for unique state amendments and climate zones. We submitted topics and learning objectives for advisory group review prior to developing the training modules. Completed draft modules were submitted to the advisory group for review and finalized based on feedback received.

3.3. Curriculum, Testing, Review, Delivery, and Evaluation Methods (Tasks 3 & 7)

We tested the curriculum with students and instructors, reviewed it with the technical advisory group, and revised based on this feedback. We collected training metrics from the learning support system, including completion rates, time spent on each module, learning assessments, and student/teacher experience surveys. Concurrently, the technical advisory group reviewed the curriculum, using criteria including relevance, technical accuracy, appropriateness, understandability, and content mastery.

After revising the curriculum, the project team conducted extensive outreach to recruit community college instructors to participate in the program and use the modules to deliver the content to their students.

The evaluation explores the results of a) early feedback from test users and the technical advisory group, b) participant feedback on finalized modules, and c) participant data from the learning management system data.

Early Curriculum Feedback Methods
The main purpose of this early feedback was to ensure that the proposed curriculum was on the right track, using the feedback received to make necessary adjustments to better meet industry needs and to encourage participation. Industry experts, including code officials, design professionals, contractors, and community college instructors from Illinois, Nevada, and Hawaii were invited to review the course modules. Energy code industry experts were identified through previously conducted outreach and through the State Energy Offices in each state. Of the 50 individuals contacted, 14 provided reviews (a 28% response rate). Reviewers were asked to assess at least two of the following nine modules: 1. Energy Efficiency Careers & Pathways; 3. Introduction to Energy Codes & Standards; 5. Envelope Fundamentals; 6. Walls & Openings; 7. Roof & Ceiling Insulation; 8. Foundations & Floors; 9. Mechanical Equipment Sizing; 10. Duct Design & Installation; and 12. Lighting.

Following the assessments, reviewers were asked to complete an online survey on the overall curriculum organization, along with more detailed reviews of individual modules. Reviewers were asked to examine the curriculum based on relevance, content, usability, and activities. Of the 14 respondents, 7 completed the survey and 7 sent their comments directly to SEDAC.

Participant Curriculum Feedback Methods
After the curriculum modules were finalized, instructors, students, and other construction, design, and building code professionals began utilizing the curriculum. All users who signed into the BEE Fundamentals curriculum Moodle site and completed one or more modules were asked to complete a feedback survey. Participants were asked to respond to 7 questions/statements:

- Please indicate what type of program you are enrolled in.
- This module focuses on issues that interest me.
- What I learned in this module is important for my future or current professional practice.
- Please indicate your knowledge about the module topic BEFORE taking the module.
- Please indicate your knowledge about the module topic AFTER taking the module.
- What is the likelihood that you will use information from this module to apply a practice?
- Was the information presented too technical, too basic, or just right?

A total of 112 users completed the survey. 55 (49%) respondents were enrolled in community colleges, 9 (8%) respondents were enrolled in continuing education programs, 1 (1%) respondent was enrolled in a high school trade program, and 47 (42%) respondents were enrolled in other programs.

Learning Management System Data Collection Methods
In addition to analyzing respondent feedback survey data, we examined data from our learning management system (Moodle) to determine the effectiveness of our curriculum. The Moodle learning

management system collected data regarding enrollment, completion rates, and multiple course enrollment.

3.4. Instructor Toolkit Development Methods (Task 4)

The revised modules were packaged into an online Instructor Toolkit containing a) an introduction; b) complete education modules; and c) resources with links to the code book, factsheets, career information, and the project team's tech support center.

3.5. Train-the-Trainer Workshop Methods (Tasks 5 & 6)

To prepare for the workshops, the project team worked with State Energy Offices to organize and develop training curriculum and recruitment material for a 2-day workshop for community college instructors in Illinois, Nevada, and Hawaii. Outreach effort for the events included recruiting code officials as guest speakers and community college instructor participants.

The team conducted before/after surveys to evaluate findings and workshop effectiveness. We performed follow up with participating instructors after the to address challenges they have in integrating the material in their courses and provide support and trouble shooting.

3.6. Curriculum and Outreach Toolkit Development Methods (Task 8)

We reached out to the National Association of State Energy Offices (NASEO) and other organizations to promote our program to other states and organizations that could disseminate the curriculum for broad use beyond the performance period. We created a Curriculum and Outreach toolkit that these states and other groups can use to disseminate the curriculum. This toolkit includes: a) "Train-the-trainer" curriculum for an energy code training workshop for community college instructors; b) the "Instructor Toolkit" with curriculum and resources for instructors to use in their classrooms; and c) Outreach messaging and strategies to build partnerships among code official organizations, community colleges, and state energy code training programs.

We completed a summary of all outreach activities associated with the project to recommend strategies to expand awareness and use of the curriculum beyond the three partnering states of Illinois, Nevada, and Hawaii. To do this, the project team collaborated with partner Energy Offices in Illinois, Nevada, and Hawaii to recruit participants to complete surveys and interviews for the needs assessment, to evaluate and use the curriculum, and to attend program launch webinars and train-the-train workshops. Outreach methods included newsletters, webpage announcements, mass emails, social media, and one-on-one meetings with key stakeholders. We reached out to networking organizations to tap into their networks of professionals or community college partners.

Our team conducted extensive outreach to community college instructors and other building design and construction professionals to encourage use of our modules. We developed and shared an Instructor Toolkit with videos, instructions, and other resources to help instructors see the value of the curriculum and become interested in using it. Outreach activities to recruit users included:

- Reaching out to state and regional code official organizations
- Reaching out to professional home builder associations
- Reaching out individually via phone and email to community college instructors in Illinois, Nevada, and Hawaii

- Utilizing professional community college associations to encourage use of the curriculum.
- Arranging meetings with instructors and code officials to discuss the curriculum.

Finally, we engaged in outreach to promote wider distribution and sustainability of the training program through a national network of state energy offices and community colleges. We sought to gain letters of commitment from at least five state energy offices or other state/national organizations, indicating their commitment to promote the curriculum through their networks.

To assist their efforts with future outreach and dissemination, we developed an Outreach Toolkit that includes a flier that introduces the curriculum, sample messaging for newsletters and social media, links to module videos, and a link to the Instructor Toolkit, and a Q&A resource about the program. The marketing materials in the toolkit could be utilized by State Energy Offices and other organizations to spread word about the training curriculum. We host these materials on the SEDAC website and will continue to promote and maintain them.

4. Results and Key Work Products

4.1. Summary of Project Goals Accomplished

Table 2 summarizes the planned and actual outcomes related to the program goals in the Statement of Project Objectives (SOPO).

Table 2. Summary of project outcomes related to performance goals in the SOPO.

Task		Description	Result	Completion
1		**Training needs & interest assessment**		**4/29/2021**
	1.1	3 instructors commit to test the curriculum	Letters of commitment from 3 instructors	10/30/2020
	1.2	3 code officials commit to being part of technical advisory group	Letters of commitment from 3 code officials	10/30/2020
	1.3	Training needs assessment summary	Assessment summary report submitted	1/29/2021
	1.4	10 instructors/administrators express interest in utilizing curriculum	Letters of commitment from 10 instructors	4/29/2021
2		**Student curriculum development**		**10/25/2021**
	2.1	15 module topics with learning objectives	15 topics with learning objectives submitted	4/29/2021
	2.2	8 of 15 modules developed	8 modules submitted to advisory group	7/31/2021
	2.3	Remaining 7 modules completed	7 modules submitted to advisory group	10/25/2021
3		**Curriculum testing, review & revision**		**10/25/2021**
	3.1	Evaluation summary	Evaluation summary report submitted	10/25/2021
4		**Instructor toolkit development**		**1/13/2022**
	4.1	Instructor toolkit complete	Instructor toolkit materials submitted	1/13/2022
5		**Program delivery, evaluation & wider dissemination**		**4/30/2022**
	5.1	Workshop agenda complete	Complete workshop agenda submitted	1/31/2022
	5.2	Min. 1 code official per workshop recruited	103 code officials recruited; contact list submitted	4/30/2022
	5.3	Approx. 20 instructors recruited per workshop	80 instructors recruited; contact list submitted	4/30/2022
6		**Workshop delivery & support**		**10/31/2022**
	6.1	3 workshops delivered in anticipated states	3 workshops completed	4/30/2022
	6.2	3 workshop summary	Workshop summary report submitted	10/26/2022
7		**Curriculum delivery & evaluation**		**4/27/2023**
	7.1	60 instructors deliver modules to 900 students	60 instructors recruited to deliver modules; 110 non-instructor participants utilize modules	6/30/2023
	7.2	Deliver curriculum to 900 existing code officials and building professionals	949 participants received curriculum training	3/28/2023
	7.3	Evaluation report of training metrics results	Curriculum evaluation report submitted	4/27/2023
8		**Curriculum & outreach toolkit development**		**10/27/2023**
	8.1	5 state energy offices express support to use toolkit	Letters of commitment from 2 state energy offices; Letters of commitment from 3 other organizations	10/6/2023
	8.2	Training program toolkit available online	Training program toolkit posted to SEDAC website	12/31/2022
	8.3	Outreach report	Outreach report submitted	10/27/2023

We met or exceeded all outreach and curriculum use targets. Targets for utilization by community college students is under-reported because we found that instructors preferred to use their existing learning platforms instead of the Moodle platform we used for this project – so participation is harder to measure. Our curriculum toolkit instructions encouraged instructors to download and incorporate the content into their preferred content delivery method – this was to be used as a means for tracking student use. If faculty incorporated our project material into their own delivery system however, we could no longer track students utilizing our curriculum.

We exceeded our goals for participation by code officials and other attendees for our program webinars, suggesting that there was wide interest in the curriculum across the three states. We also exceeded our goals for building and construction professionals (including code officials) who encountered the training modules through webinars offered through energy code training programs in Illinois, Nevada, and Hawaii. Though the curriculum was intended for community college students, we found that existing professionals were also appreciative of the content provided.

Other accomplishments include the delivery of the following three reports, whose results and findings are discussed in this report:

- Training Needs Assessment Report
- Evaluation Report
- Outreach Report

Finally, the main accomplishment of the project is the development and dissemination of the curriculum, the Building Energy Education (BEE) Fundamentals and associated resources, the Instructor Toolkit and the Outreach Toolkit. The results and findings of these work products are discussed later in this report.

4.2. Training Needs and Interest Assessment Results (Task 1)

Through the Needs Assessment process, we built relationships among state energy offices, community college administrators and instructors, and local code officials to identify needs and assess interest in offering feedback on training program curriculum or delivering the curriculum. In total, 49 code officials and 14 community college instructors participated in the survey, and 13 participated in follow-up interviews. We interviewed 4 code officials from Illinois, 1 from Nevada and 2 building consultants from Hawaii (one a HERS rater and the other BPI auditor). We also interviewed 6 community college instructors (3 from Illinois, 2 from Nevada and 1 from Hawaii). In addition, we interviewed state energy offices in Illinois, Hawaii, and Nevada to get a broader perspective of workforce training needs, legislative differences, and programs in three states.

4.2.1. Stakeholder Commitments to Support Program Development

The project team obtained commitment from key stakeholders to assist with early-stage program development.

Instructors representing the following 3 colleges agreed to test the curriculum:

- City Colleges of Chicago, Illinois
- Western Nevada College, Nevada
- Honolulu Community College, Hawaii

Code officials representing the following 3 jurisdictions agreed to participate on the technical advisory team:

- Building and Zoning, City of Ottawa, Illinois
- Clark County Department of Building & Fire Prevention, Nevada
- Department of Public Works, County of Hawaii, Hawaii

Instructors representing the following colleges agreed to utilize the curriculum:

- Construction Management Technology, Southwestern Illinois College, IL
- Construction Technology and Renewable Energy Technology, Triton College, IL
- STEM Department, Olive-Harvey College, IL
- Career and Technical Education, McHenry County College, IL
- Energy Management Unit, Elgin Community College, IL
- Business and Career Technologies, Oakton Community College, IL
- Construction Management, John A. Logan College, IL
- Applied & Engineering Technologies, Lincoln Land Community College, IL
- Construction Management, Western Nevada College, NV (instructor 1)
- Construction Management, Western Nevada College, NV (instructor 2)
- Transportation and Trades Program, Honolulu Community College, HI (instructor 1)
- Transportation and Trades Program, Honolulu Community College, HI (instructor 2)

4.2.2. Needs and Interest Assessment Results

Energy code training review

In a multi-state study exploring compliance with residential energy codes, Xie et al. (2020) found that training and education played a recognizable role in improving compliance for 5 of the 7 states. Because many different professionals (building officials, design and construction professionals, subcontractors) are responsible for applying and verifying these codes and standards, it is paramount that energy code training extend to a wide variety of professionals. Indeed, DOE's Guidelines for Building Science Education (2017) indicate that an understanding of building codes and standards is a "core competency" of building science education. Their building science education matrix shows that nearly all professions involved in design and construction of buildings should achieve a proficiency level of 3 in codes and standards. That is, they should be able to 1) remember, 2) understand, and 3) apply energy codes and standards. And yet, as Cohan (2012) writes, only a "small fraction of the people affected by the [energy] code" attend training sessions and achieve this core competency.

The code professionals we interviewed claimed that, across the board, people are not as educated as they should be about energy codes and standards. According to our interviewees, architects seem to receive the most training about the energy code, followed by building officials and last of all contractors (see Figure 1).

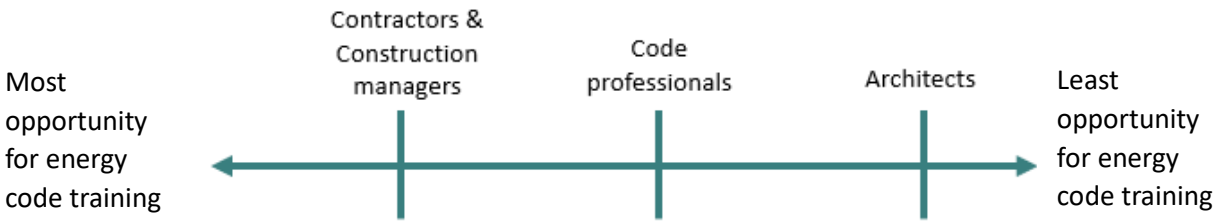

Figure 1. Level of energy code education for building and construction professionals

The code officials we spoke to that noted that in general, the architects in their region are becoming more familiar with the energy code. The energy code is now introduced earlier in their training and current licensure programs require architects to receive continuing education credits - energy code workshops and webinars are one way to gain these credits. While architects are more are familiar with energy code requirements, one code official noted there were still gaps. He noted that designers often change what they need to in the compliance software to make the building compliant without understanding the significance of the changes. There are also frequently mistakes with the sizing of mechanical equipment.

In contrast, some of our interviewees noted that there was a "very large gap" in education on the code official side, while others felt that code officials were in general familiar with the energy code. Though the International Code Council offers three certification tests to demonstrate knowledge of the energy code, many municipal code officials are not required to take it. Regarding continuing education, one code official in Illinois said that only a small percentage of his code official colleagues across the state attend energy code training sessions, where code officials would be introduced to the most up-to-date requirements. One code official said among his colleagues, there was "less comfort" with the energy code, mainly due to lack of familiarity. If a code official lacks understanding of the energy code, they typically rely on architects to determine compliance, according to one participant. He noted that some code officials "check the box" if the architect has signed off on the project, without verifying compliance, usually because they don't have time or training to do anything more. Another code official noted that some plan reviewers don't have time to check the details—they do a quick review of COMcheck and move on.

Many of the code officials we interviewed and surveyed indicated that contractors were the least likely to be trained on the energy code. They seldom encountered it in their training (especially in trade school), and they were seldom required to meet continuing education requirements that might motivate them to attend energy code training sessions. According to one building official, some people in the trades were "not motivated to learn" about the energy code. One code official recommended that general contractors should be required to take training on the energy code. Code officials complained that they "got resistance from following the code" because some contractors and homeowners did not understand the benefits of the code. Code officials felt that energy code compliance will not be as high as it should be until "energy code training permeates the building trades."

Most energy code training is not offered at the community college and trade school level, where many design and construction professionals and subcontractors get their training. Instead, it is provided for existing professionals, often through state-sponsored training programs that offer a series of workshops

the first year of new code implementation. Energy code training is usually encountered on the job, and students in union trade and community college programs have little exposure. The community college instructors we interviewed explained that they often cover building codes in their classes—and several of them had stand-alone classes specifically on building codes--but they admitted that energy codes were often viewed as the "least important" of the building codes and were rarely covered in much depth, if at all.

This is a critical oversight as early exposure to energy codes and standards in trade school or community college curricula may provide important context into why energy codes are important, how energy codes address a whole-building-system approach, and what technologies can be used to comply with energy codes.

Cohan (2012) describes what energy code training for existing professionals typically looks like: State training programs offer several stand-alone workshops or webinars that focus on the what of the energy code (i.e., what the requirements of the energy code are) and neglect the why and how. Cohan notes that these workshops are often monotonous and typically use a "teacher-centric format," although training that is more learner-centered would be much more effective. There are few real-world examples or opportunities for experiential learning. This type of training often uses a fragmented approach and doesn't show how various building components interface with each other.

One notable exception to these trends regarding code education is the International Code Council (ICC) College Technical Training Program, which "works to integrate courses on one or more of the International Codes [including the energy code] into schools' current construction trade curricula." After completing coursework with code content integrated into it and passing a final exam, students receive a nationally-recognized Certificate of Completion from the ICC. Instructors report that contractors have expressed a desire to employ students with ICC certificates. Unfortunately, this program is currently only available at 8 colleges. The ICC program teaches students hands-on skills, as well as the codes behind those skills. Students use the codes in real life situations and apply the code in labs and construction projects.

In a video describing the program, instructors noted the benefits of the program: "We've always taught code, but never at this extent. We're teaching the code in every class that I have. Every project, they look it up. We'll pretend we're in a different part of the country." A student talked about how the program "opened my mind up to be an inspector" and helped him to "understand how important those codes are in the construction of the home."

This program hints at an approach that could be pursued in other community college contexts. The key aspects of the approach seem to be a) to integrate the codes into multiple aspects of curriculum, and b) to apply the codes in real life situations. This approach is emphasized in other studies as well. In a study by the International Code Council (ICC) and the National Institute of Building Sciences (NIBS), interview participants recommended ways to train community college and union trade school students about the energy code. One participant recommended providing code books to students, having them "read it in class, discuss what it means; test them on it; and then implement code readings during workshop projects or the field to physically see it in action. Teach the right and wrong ways to comply with the codes." This hands-on application of the codes would better help them to understand the significance of

the codes than workshops or webinars for existing professionals. Cohan (2012) encourages combining classroom energy code training with field trips to construction sites or using physical props.

Integrating energy code training into trade programs or community college curricula would offer context into the purpose and scope of the energy code, help students develop the tools to apply the energy code in their professions, and provide for experiential learning opportunities that most workshops and webinars for existing professionals lack. Teaching the energy code in a more contextual, holistic way would also introduce building science topics, from heat transfer to mechanical systems. Introducing students to performance compliance paths is an ideal way to address whole-building energy efficiency and show how building components work together to impact energy use. It would help to address three important knowledge gaps commonly referenced by interviewees: a) a lack of understanding of building science basics, b) a lack of whole building system approaches, and c) a lack of understanding about energy codes and standards.

Most of the community college instructors we interviewed and surveyed not only described a need for energy code education, but also an interest in receiving curriculum and resources related to energy codes and standards. Of the 14 instructors we surveyed, 7 indicated that they were “very interested” and 5 indicated they were “somewhat interested” in enhancing the level of energy code or energy efficiency training at their college. The instructors we surveyed indicated that they needed “up to date materials and information,” and more information about the energy code.

An instructor in Hawaii remarked that they were in the process of getting rid of a specific building codes class in favor of integrating building codes into several other courses. They said it “would be wonderful if he could get some materials and curriculum on energy codes to integrate”. Several other instructors felt that they were already doing a pretty good job integrating energy codes in their curriculum, but indicated that it would be helpful to have more resources to reinforce these topics—videos and hands-on learning opportunities would be especially helpful, they noted.

Another instructor in Southern Nevada indicated that their construction management students were not very interested in Energy Code training because the major focus is on large projects is LEED and that there are typically specialists employed to manage those aspects of the project – including code compliance. Other interviewees pointed out that the requirements of LEED accreditation often fall short of minimum requirements for IECC code compliance in Nevada. This instructor linked LEED and energy codes and considered energy (and design considerations generally) to be outside the scope of Construction Management for larger projects where each person’s role was highly specialized. This same instructor was enthusiastic about developing a code-specific curriculum for professions focused on the codes, such as building officials, but did not feel that students in construction management needed more code training.

Another instructor also indicated that his students did not need to have a deep understanding of the energy code, but was supportive of helping them understand the basics. A code official in Illinois stressed the need for people in the trades who are starting their careers to “know a little bit of everything,” including energy code basics.

Several instructors admitted that they were not up to date on the latest energy code requirements. Only one indicated that he attended the energy code training sessions offered by the state energy office. In fact, this instructor required his students to attend these training sessions as well. Only a few instructors

expressed confidence in their understanding of energy codes and standards. This suggests that there is a need to provide training about energy code topics to instructors to help them understand these topics before teaching them to their students.

Energy efficiency training review

The need for and interest in training in energy codes and standards goes hand-in-hand with the need for overall energy efficiency and building science training. Goldman and his colleagues at the Lawrence Berkeley National Laboratory (2010) noted that very few colleges and universities offer degree programs or even classes that focus on or address energy efficiency, and new programs in energy efficiency are difficult to roll out. Our review of community college curricula in Illinois supports this finding. Energy efficiency, if taught at all, is usually included as a subset of a broader topic such as environmental science or construction practices (Goldman, C.A., 2010; Hardcastle, A. & Waterman-Hoey, S., 2009).

Mid- and high-level engineering and management positions in energy efficiency require knowledge and experience in fluid and thermodynamics, building energy systems, performance optimization of existing HVAC, refrigeration, or industrial process systems. Most engineering undergraduates lack a solid foundation in these topics and may only encounter them in graduate level studies (Zhang, X., 2018). Few engineers enter the field with a broad knowledge of or experience in energy efficiency.

Many energy efficiency jobs do not require an engineering degree from a 4-year college or extensive knowledge of thermodynamics and industrial process systems. However, most of these positions still require basic building science and energy efficiency competencies, and many potential employees coming out of trade programs or community colleges do not possess these basic competencies (Hardcastle & Waterman-Hoey, 2009). Hardcastle and Waterman-Hoey also warn that the field of energy efficiency is constantly evolving, requiring up-to-date training that addresses new technologies and energy efficiency strategies. Current training programs are not adequately meeting the evolving demands of the energy efficiency industry.

Some of the instructors of community colleges we interviewed indicated that energy efficiency is included in the curriculum, but only a few colleges offer courses or certificates specifically focused on energy efficiency. A few programs had specific classes on LEED and sustainability. Construction workers are unlikely to have received specific energy efficiency training from community colleges or technical schools, and after-hire training is needed.

In a 2010 ACEEE study, Peters et.al. (2010) interviewed employers in the contracting and building trades, professional organizations (engineers, architects), and mechanical and electrical trades and found that most participants felt that job applicants were unprepared for the energy efficiency tasks that they are increasingly involved in. The lack of training and experience was particularly evident in the construction trade associations and unions. Respondents noted that “the most advanced training for journeymen sometimes [emphasis added] addressed how to improve a project’s energy performance” but that in general, it was not addressed. Instead, energy efficiency was more typically taught on the job. Most of this on-the-job training has relied on older, more experienced employees who may not be familiar with new techniques and approaches – or codes (Peters et al., 2010).

The ACEEE study concluded that there was a strong need for more energy efficiency offerings and instructors to train the building and construction trades and contractors. They note, “It will be important to integrate building and industrial process system efficiency into existing building and construction

technical, apprenticeship, and trades curricula." They support more train-the-trainer programs to improve the quality of energy efficiency training at all levels (Peters et al., 2010). Confirming this point, one of our interviewees noted that instructors struggle to keep up with new technology and energy code changes.

Generally, our interviews with energy efficiency employers and community college instructors support the ACEEE study findings. Participants talked about how they wished they could hire employees with more energy efficiency knowledge. Several participants noted that for professionals in the trades, the knowledge deficits were a) a general lack of information about energy efficiency, and b) a lack of a whole building system approach. People doing home repairs, for instance, "don't have a ton of exposure to energy efficiency." Several complained that basic carpentry and trade classes don't address energy efficiency and weatherization. "I took basic carpentry and mechanical and different things and what I use now never got brought to me," one installation supervisor explained. In addition, trade school training doesn't usually take a whole system approach: "People who maybe have been in somewhere in carpentry, [have] not had to do the whole system approach before. It's a different approach at looking at things, at the housing system." Another workforce coordinator concurred: "I think there's probably some opportunity for more education or individuals to be better versed in energy efficiency . . . to bring the bigger picture together—not just the pieces."

Several participants suggested recommendations for filling the gaps in community college programs (i.e. a lack of training and hands-on experience specifically focused on energy efficiency). One workforce coordinator suggested incorporating energy efficiency into existing trade program curriculum. Goldman (2010) recommended that energy efficiency content be integrated into existing curricula to cost-effectively train large numbers of building professionals. The advantage of this approach was noted that it does not require the development of new programs, and energy efficiency content is not seen as a stand-alone subject but a topic that should be addressed in every step of building design, construction, maintenance, and optimization.

Another energy efficiency employer we interviewed recommended that community colleges offer more credentialing and certification in energy efficiency, and work with employers to recognize those credentials and certifications "as a currency to be able to do the job." We heard this echoed from community college instructors who were very attentive to providing value for students and focusing on employable skills that could realistically be demonstrated to employers. The Connecticut Business & Industry Association (2017) recommends providing "stackable" community college certificate programs and classes to fill gaps in energy efficiency skills. One job training program in Arkansas provides a 2-year degree, a certificate, and short courses on energy efficiency, including energy measurement devices and data interpretation, DOE software tools for energy management, and preventive and predictive maintenance techniques.

Many of the community college instructors we interviewed indicated that they were already integrating energy efficiency and building science education into their curriculum. Indeed, the people who were most likely to respond to our request for interviews were the proactive ones who already had a passion for energy efficiency. However, they noted that other colleges and programs do not have the same focus. For two survey participants, "finding qualified instructors" was listed as a big reason why programs aren't able to teach energy efficiency content. They expressed a desire for more "train the trainer" curriculum that could bring their colleagues up to speed. There was an understanding among the

instructors we surveyed that energy efficiency needs to permeate all community college training programs that relate to building construction, design, operations, or maintenance. Contractors, electricians, plumbers and architects all need an understanding of whole building energy efficiency.

Instructors indicated that they were unwilling to teach classes where there isn't student interest and where this is not a clear path to a job outcome. Fortunately, most respondents noted that the students they teach are increasingly interested in energy efficiency topics and understand how these skills will be valuable in their future professions. Instructors noted that young people are more aware of sustainability topics in general.

A few instructors felt that there was a lack of interest in energy code and energy efficiency topics. Two instructors from Illinois noted that "lack of interest" and "lack of demand" were barriers to offering energy efficiency or energy code-focused courses. One instructor from Illinois noted that it had been over two years since he had enough students register for classes focused on energy efficiency.

An instructor from Hawaii noted that there was an overall lack of interest in energy efficiency among his students. Although he had taught energy efficiency and sustainability themed courses for years and was a sustainability champion at his college, he found that students were less interested in taking sustainability-focused courses than they used to be. He postulated several reasons for this lack of interest: 1) less emphasis on sustainability at the K-12 level, 2) the feeling that energy efficiency is less relevant in HI because of the forgiving climate, and 3) a lack of available jobs in energy efficiency and renewables in HI (he claimed that many of these jobs are outsourced). Though the instructor was not optimistic about students' interest in energy efficiency and energy codes, he still expressed willingness to integrate energy code content and energy efficiency basics in his curriculum. This individual was the only community college instructor we were able to interview in HI for this assessment and may not be representative of the attitudes of the other instructors. More exploration is needed to determine Hawaii college instructors' perspective on the need for such a training program.

Career awareness

We also assessed interest in and need for raising awareness of building code careers and energy efficiency careers through our training program. Building code and energy efficiency professions are experiencing severe hiring challenges. The situation is especially grim for code professionals. According to a 2014 study by the International Code Council (ICC) and the National Institute of Building Sciences (NIBS), nearly 80% of code professionals are planning on retiring in the next 15 years, with more than 30% retiring in the next 5 years. Hiring shortages are listed as the number one challenge in the profession.

All the code officials we interviewed from the three states indicated that it was increasingly difficult to fill jobs and that their municipal building departments were short staffed. One code official explained that during the 2008-2009 recession, many municipalities had to lay off building department staff. Although they are hiring again, these departments are finding it difficult to fill jobs with qualified candidates. "There's no qualified employees to hire back," one code official explained. They explained that many professionals are unmotivated to become code officials because can find higher-paying jobs elsewhere in the construction trades.

Code officials we interviewed in both Illinois and Hawaii noted that their municipalities were understaffed or were forced to hire underqualified people. Few new hires come with an understanding

of building codes such as the energy code. This has created a situation where architects are largely responsible for overseeing energy code compliance, and many know more about the energy code than code officials. Architects sign off on the compliance paperwork, and code officials just look for the signature. One participant noted, “Code officials don’t want to trust the architects, but they’re stuck with it right now. They are so short [on staff and time] right now.”

Code professionals come from a variety of fields, many of them in the construction trades, and they have a variety of educational experience. A study by ICC and NIBS explored the highest level of education attained by code professionals and found that 23% of code professionals attained an associate’s degree at a community college, while 27% received a bachelor’s degree (and may have also attended a community college). 16% of code professionals participated in technical or vocational programs, which are occasionally found in community colleges as well. Of the 23% who attained an associate degree, their programs were largely in construction management (21%), architecture technology (16%), engineering technology (20%) and the trades (13%). This suggests an opportunity to raise awareness of energy efficiency and code professional careers at community colleges, in construction management, architecture, and engineering programs, as well as trade programs.

The code officials we interviewed had a different perspective on where code officials are coming from today and what their education level is. According to one code official in Illinois, code professionals rarely come from programs at community colleges, and they seldom come from construction management or trade fields, either. “That may have been the case in the past,” he said, “but not so much anymore.” Instead, professionals frequently enter the field without experience in the construction trades and get training on the code through ICC’s training program. This code official felt that building and construction trade positions were able to pay better than code professional positions, and so people from the trades weren’t as attracted to the available jobs. Several participants noted that government jobs (such as code professional positions) are not considered as desirable or as stable as they once were and are just as vulnerable to budget cuts as any other job.

In addition, states or municipalities may have different requirements for the training and certification needed to become a code professional. Code officials in Hawaii, for instance, are required by law to have a professional architecture or engineering license. This restriction greatly limits the type of people who can apply to become a code official.

Many participants who were interviewed as part of the ICC and NIBS study indicated that they joined the profession based on engagement with code professionals, or at the suggestion of friends, family, and colleagues. While word of mouth remains a primary way of drawing people to the field, more awareness needs to be raised through educational institutions and construction training programs.

Participants in the ICC study recommended several ways to raise awareness of code professions. One code professional recommended, “Allow drive-alongs for students/people interested in this profession.” Another suggested, “It would be helpful to get the trade schools [to] have a course available to show the students . . . what it is that code officials do.” Another recommended that code officials take a more active role in “fostering and promoting the need for building codes with the associated professions, including builders and designers.”

Several of the code professionals we interviewed recommended highlighting the key benefits of these jobs to raise awareness: job security, a decent salary with benefits, room for growth and advancement,

and the opportunity to make a difference. Another mentioned that it's important to emphasize that most code professions don't require a four-year degree or a huge amount of education; simply taking a few of the ICC tests can be a good "foot in the door" for municipal building departments and there are opportunities for advancement without a 4-year degree.

We also explored the lack of career awareness for energy efficiency professions more broadly. According to the 2020 US Energy and Employment Report (USEER), 91% of energy efficiency employers in construction reported that it was difficult or very difficult to find qualified job candidates, and 80% of energy efficiency employers in professional and business services reported that it was difficult or very difficult to find qualified job candidates.

A lack of awareness of energy efficiency careers is noted as one of the key barriers to growing the energy efficiency workforce. Goldman (2010) noted that among construction and trade programs, there is limited awareness of energy efficiency jobs and training programs. Many are unaware of the significant growth anticipated for this sector. In our interviews with instructors and energy efficiency employers, several participants said that developing basic energy efficiency literacy was needed to raise awareness of energy efficiency careers. "There's a whole bunch of people who have absolutely no idea about anything related to energy . . . other than paying their bill every month," one participant explained. Another participant argued, "Energy efficiency is a whole specialty trade that nobody really understands." Participants noted that young people "need to be more aware of the range of opportunities [in energy efficiency], from customer service to engineering." Interviewees frequently complained that career paths to energy efficiency jobs are not clear: "People kind of come to it accidentally."

Among the professionals and educators we interviewed, there was interest in raising awareness in community college programs not just of energy efficiency careers, but also code professional careers. Recommended practices to raise awareness of these careers include a) highlighting the benefits of these careers, b) providing clear information about career pathways, and c) connecting students with professionals to see what they do, through class visits, job fairs, field trips or job shadowing. These strategies will increase awareness and lead students towards energy efficiency and building code careers.

Survey of existing programs

To assess the feasibility of integrating our content into existing community college training programs, we surveyed existing community college training programs. We began by identifying public community colleges in Illinois, Nevada, and Hawaii with degree or certificate programs related to building systems/building design or construction. Table 3 shows the breakdown of these programs.

Illinois, which has a population of 12.7 million, has an extensive community college system, with 39 community college districts and 48 community colleges. 29 of the 39 districts have programs in building construction, design, and/or technology. The Illinois system dwarfs both Nevada, which has a population of 3 million and only 4 public community colleges, and Hawaii, which has a population of 1.4 million and 7 public community colleges (only 4 with building construction, design, and technology programs).

Table 3. Community college building trade programs in IL, NV, and HI

State	Technical/management programs	Traditional "trade" programs

	Const. Manag.	Const. Tech	Arch/ Engr/ Drafting	Envr/ Energy Tech	Facility Manag.	Electric.	Carpen.	HVAC/R install repair
IL (n=48)	14	4	36	16	3	18	7	12
NV (n=4)	3	0	3	1	0	0	0	2
HI (n=7)	1	1	1	2	1	2	2	1

We divided the programs into two main categories: technical/management programs, such as drafting and engineering, architecture, construction technology, energy technology, construction management, facility management; and traditional building trades programs, including electrical, carpentry, HVAC/R installation and repair. According to the community college instructors we interviewed, students in technical/management programs often go on to get 4-year degrees or find a job in a construction management or architecture firm. Some work in quality control, code enforcement, or marketing. Students in traditional building trades programs may go on to join a formal apprenticeship program or become a professional tradesperson.

Interview respondents noted that most tradespeople do not enter the trades through community colleges but go directly to an apprenticeship program run by the unions. Code officials and instructors in both Illinois and Hawaii noted the dominance of union trade programs in training workers in the construction and building maintenance industry, and argued that more work needs to be done to reach out to these unions to improve training in energy efficiency and energy code.

In Illinois community colleges, there were 73 technical/management programs, with 30 drafting and engineering programs and 16 environmental or energy technology programs among the 39 community college districts. There were far fewer traditional building trade programs (electrical, carpentry, HVAC/R installation & repair): 37, compared to 73. 18 were in electrical, 7 in carpentry, and 12 in HVAC/R.

Next, we surveyed the courses offered by these colleges that specifically focused on building codes, energy codes, or energy efficiency (see Table 4). Building code focused courses included the words “building code” or “building standard” or “building inspection” in the course title. These courses included both commercial and residential code courses. Energy code focused courses included “energy codes” or “energy standards” in the course title. Energy efficiency focused courses included the words “energy efficiency,” “energy conservation,” “LEED,” “green building,” “sustainability,” “weatherization,” or “energy audit” in the title.

23 community colleges in IL, NV, and HI had coursework focused on building codes more generally. In Illinois, of the 18 colleges with building code-related courses, 9 of them have multiple courses related to building codes. Most of these courses are located within building trade programs. Some of these building code courses may indeed cover energy code requirements, but energy codes and standards were not included in the descriptions. Only two community colleges (both in Illinois) had coursework specifically focused on energy codes.

Table 4. Community college coursework on energy codes, building codes, and energy efficiency in IL, NV, and HI

	Number of public community colleges with coursework specifically focused on:		
State	Energy code	Building codes	Energy efficiency
IL (n=48)	2	18	15
NV (n=4)	0	3	4
HI (n=7)	0	2	1

19 colleges offered at least one course specifically on energy efficiency—and many of these colleges offered multiple courses on this topic. Some additional courses included energy efficiency topics, but energy efficiency was not featured in the title, indicating that energy efficiency was not the main focus of the course.

In Illinois, we surveyed course descriptions by program in more depth to better understand where the gaps are in building code/energy code/energy efficiency training. We found that a fair number of courses introduced building codes either in the title or the course description, particularly in construction or construction management programs. Though there were fewer architecture courses, a fair number of them also addressed building codes. Courses in construction management, facilities management, and environmental/energy technology and engineering programs included many energy efficiency-focused courses, as well as a few courses that included energy efficiency as one of the key topics. However, there were many other building related courses that did not address energy efficiency or building codes in either the course title or description, suggesting an opportunity to integrate this content into existing courses. See Table 5 for an overview of the number of courses in energy efficiency, energy codes, and building codes.

Table 5. Energy efficiency, energy code, and building code courses in community college programs in IL, NV, and HI

	*Technical/management programs					Traditional trades programs		
	Const. Manag.	Const. Tech	Arch/ Engr/ Drafting	Envr/ Energy Tech	Facility Manag.	Electric.	Carpen.	HVAC/R install repair
Number of courses with:								
Building codes in title	3	4	2	2	1			
Building codes in description	3	3	1	1	3			1
Energy codes (in title)	1		1					
Energy codes (in description)								
Energy efficiency (in title)	5	6	3	18	10			2
Energy efficiency (in description)	3	4	3	2	4			1

According to interview participants in the three states, there seemed to be a trend towards not having courses that focused entirely on building codes, but to integrate codes into existing classes. One instructor noted that they were planning to remove their building codes class from the curriculum and instead put information about the code throughout most of their classes. One notable exception was

one program in NV in which the coordinator noted that non-degree seeking students often took building codes classes as test prep for exams to become code officials. Instructors likewise seemed to agree that energy efficiency should permeate all curriculum, rather than being approached as a stand-alone topic, though there were examples of sustainability-focused courses in several of the programs.

Overall, the results of our survey of community college curriculum suggest that there is plenty of room to implement more energy code and energy efficiency curriculum in community college programs, especially in Illinois. Because there are many existing programs that relate to the building trades, there is an opportunity to integrate energy code training and energy efficiency training in general in existing programming. About half of the colleges in Illinois have at least one course on building codes, but it is unclear how much the energy code is addressed. Also surprisingly, there were fewer energy-efficiency focused courses than we expected. While it is true that energy efficiency may be covered as an aspect of other courses, relatively few colleges offered courses specifically focused on energy efficiency or indicated that energy efficiency was a main focus in the course descriptions. There is potential to develop an energy code and energy efficiency curriculum based on the current courses available.

Feasibility of making curriculum changes

Participants noted the difficulty of modifying their existing curriculum. According to several instructors, to make any substantive changes to the curriculum would require approval from program administrators and the curriculum advisory board—a board made up of professionals and local employers. The board typically meets twice a year, and the process of changing the curriculum can be long and arduous. Curriculum advisory boards are the norm in most of the community college programs we surveyed. While these boards are important in making sure that curriculum aligns with industry needs, they do make it difficult to make substantive changes quickly. One survey respondent said that any changes in curriculum would have to be brought up with the administration, and that the instructors have very little power to initiate the changes.

For 2-year associate degree programs intended to transfer to 4-year degree programs, curriculum change was especially challenging as these courses have to be eligible for transfer credits, which requires coordination with nearby 4-year institutions. One instructor had developed curriculum on building performance but could not implement it because there was no “transfer destination” in 4-year institutions. One instructor we surveyed indicated that he had built an Architectural Technology Program centered around building performance, but he was having difficulty finding a transfer destination. For certificate programs, changes have to consider the industries accepting the certificates. Are these industries willing to accept these changes? In short, major changes can require a multi-year process with multiple stakeholder groups involved.

Our interviewees noted that instructors and program administrators are allowed to make small changes to the curriculum, as long as learning objectives were met and important concepts covered. A limited amount of “add-on” content can be easy to integrate. However, class time is a serious limitation. Several of our interviewees warned that “for anything you add, something has to be removed.” One instructor we surveyed explained, “There is only a short amount of time to reinforce the chapters on energy and energy codes as building technology is the primary focus.” Instructors noted that it was hard to cover everything that they were required to cover, so making room for additional content would be difficult. One instructor felt like it would be easier to integrate content if it was related to what was being taught, if it supported students’ understanding of concepts that they were already covering.

When asked if it would be easier to simply offer a new course (rather than integrating content into existing courses), they said that the same problems would generally still apply. This would require approval from the administration and review by the curriculum advisory committee. Instructors noted that it was difficult to add a course without removing an old one; generally there was not a whole lot of flexibility in course offerings.

One participant expressed interest in developing a stand-alone class in COMcheck and REScheck, and another was trying to develop a class that would teach students how to use Excel, but struggled to get support from the program coordinator to implement it. Another participant in Nevada indicated that he would like to see an entire building codes certificate program developed, complete with courses on energy code and other building codes, that could coordinate with local authorities to prepare code officials.

The consensus seemed to be that instructors would not be able to easily make large changes to curriculum or programs, and, aside from a few outliers, most saw no need to do so. Most participants did indicate that they had the ability to making small changes to the curriculum, and they were open to using resources that would help them reinforce topics they are already covering.

We determined that the most feasible program approach in the short term is to integrate targeted and accessible energy efficiency and energy code content into key coursework to form a foundation of energy awareness for the new generation of building professionals. We will develop a series of short learning modules with subtopics, resources, videos, and activities that can be easily integrated into lectures, labs, supplemental materials, and homework assignments. There should be no expectation for instructors to use all of the curriculum in their courses. Instead, they should be encouraged to select the content that best fits their individual course needs from a menu of topics, resources, videos, and assignments.

In the long term, we see an opportunity to forge connections between State Energy Offices and colleges to leverage the resources and reach of each to integrate and implement rapidly evolving advances in energy efficiency on the ground and in the professions where they are most needed.

Another long-term approach would be to work with community colleges to rework or add entire units of content to their courses, or to add an entire course on energy efficiency/energy code to their program's required course sequence. This long-term approach would require significant stakeholder outreach and advanced planning to shepherd the changes through the curriculum and administrative review processes, and to make sure the changes meet certification and transfer credit requirements. This longer-term approach is not feasible given the time constraints of the project. It is also challenging to implement on a wide scale because there are so many differences in programs, requirements, and curriculum. We saw little evidence of a "standard" curriculum that could be adapted across many community colleges.

Curriculum Needs

To determine what should be taught at the community college level about energy codes (and building science more generally), we asked our interview participants to identify topics of specific interest. We also asked them to explain how this content could be effectively taught and what kinds of learning materials would be most helpful. Although most of the instructors we interviewed indicated that they were already teaching both energy efficiency and building codes in their programs, they all noted that

there was definitely room for improvement and indicated a willingness to adopt new curriculum and resources to their existing courses.

Big-picture basics. Instructors noted a need for curriculum that addressed "big picture basics" related to energy efficiency, and curriculum that can help them "sell" energy efficiency to students, moving away from a "save the world" approach to a "save money and make more comfortable" approach. Code officials likewise indicated that students in community college programs needed an understanding of big picture basics related to energy codes and standards, but shouldn't be expected to master the finer details of the code. "I don't even have that stuff memorized," one participant remarked noting the large volume of code books they had to regularly reference. Another code official said that the program should focus on the basic "why" behind the energy code. One participant indicated the code officials and contractors lack a basic understanding of building science, which can lead to a lot of uncomfortable houses being built. He said most students aren't ready to talk about anything as sophisticated as blower doors. Energy code trainings offered by state energy offices are "only valuable to a few" because they are "in the weeds and long." Students at community colleges need to understand building science basics first.

Mechanical equipment/sizing. Code officials noted architects and construction managers needed more knowledge of mechanical equipment, especially when it comes to sizing. One participant described an encounter with an architect who had no exposure to Manual J™: "He should have known what it is and who he needed to contact," she explained.

Implementation and code technology. Instructors indicated that topics for contractors should focus on implementation of energy efficiency practices. One code official also noted that contractors—especially those involved in design-build projects--were unprepared to use compliance technology. "We ask for the full calculations," she explained, "but they don't change any of the defaults in the system. They don't put any thought into it." She blamed the lack of continuing education requirements for contractors' lack of understanding of energy codes and associated technology. Several participants asked for COMcheck and REScheck training.

Recent codes and amendments. Participants also noted a lack of knowledge about the most recent version of the energy code, as well as state or local amendments. They indicated that they would like building professionals and even community college instructors to be more aware of updates and amendments. In Illinois, 2018 IECC has been adopted statewide, with Illinois amendments. However, this has not ensured universal compliance. Chicago has its own energy code with additional amendments and many municipalities simply do not comply with the State mandate. Code officials and designers in Illinois frequently bemoaned the difficulty of explaining the inconsistencies to clients. One code official attributed the inconsistent implementation to a lack of training, "Most towns either understand and enforce the code or not. Towns that do not understand it do not enforce it."

Hawaii is in the process of approving the 2015 IECC and also has statewide amendments. The Energy Code also allows an alternate Tropical compliance path for projects with less than half conditioned space (R401.2.1). Individual counties in Hawaii are also allowed to have their own amendments. This creates a fair amount of confusion and difficulty.

Nevada has adopted the 2018 IECC Statewide. While amendments can be adopted locally, they are generally led by Code Officials' organizations of Northern Nevada and Southern Nevada for their

respective regions so regional amendments are standard. However, some interviewees suggested that, like Illinois, uniform adoption has not necessarily lead to universal compliance and knowledge of the Energy Code and that professionals and instructors had a variety of levels of knowledge and familiarity with the IECC in different parts of the State. This also applied to the level of understanding that students were expected to have of the code. One Construction Management instructor in Las Vegas noted that his students were likely to rely on specialists and did not need to know the specifics of energy code while an instructor in a smaller city in the North indicated that after graduation her students were often acting as designer, contractor and manager on their smaller construction projects and needed knowledge of all aspects including energy efficiency and Energy Code.

Code officials wanted students to be aware of and have exposure to these different codes and standards—not to memorize the key differences in requirements, but rather to be able to utilize the most current codes and amendments more strategically and effectively.

Regional differences and climate. Among the code officials and community college instructors, there was discussion about the need for regional-based training. In Illinois, people noted that code requirements are very different for Chicago than Southern Illinois, and it's important for students to be aware of those differences. The differences were even more stark among the three states we chose. A code professional and community college instructor in Hawaii both noted that energy efficiency—especially as it relates to the envelope—can be a tough sell in Hawaii. But others noted that in Hawaii and in Nevada elevation is a huge factor in climate and areas that are geographically close can have significantly different climate patterns.

Instructors also indicated that it would be helpful for students to better understand how the climate impacts energy efficiency practices. Even in Illinois, they noted that there were two distinct climate zones, and that students should be made aware of the differences in energy efficiency practices in those two zones. There was an awareness that energy efficiency, especially in residential buildings, looks completely different in Hawaii than it does in Illinois, and that curriculum will need to be tailored to the unique climate zones. Students need to think about exposure to the elements, pressures, wind, and rain.

Career paths. Code officials and community college instructors agreed about the need to raise awareness of building code careers— classes often provided opportunities for them to introduce students to potential jobs. Several of the instructors indicated that they had curriculum that addressed different career paths, and that they could help students become more aware of code professional career paths.

Hands-on, visual material with real life examples. Participants noted that hands-on learning opportunities are the best way to learn. "The best would be to feel the difference if at all possible," one participant in Hawaii explained. "Builders are making houses and then not being in them. They don't feel what it's like to not have insulation." One code official we surveyed noted, "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." Another requested "actual examples of proper installations and improper installations." Participants also indicated that they would welcome short videos (no more than 5 minutes) that instructors could show in class to reinforce topics. They also recommended handouts and on-demand resources. Instructors were particularly interested in curriculum that contained activities to make

learning more interesting, engaging, and interactive, especially as the pandemic has moved most instruction online. One participant requested hands-on demonstrations for his students.

Online resources during pandemic. Many of the instructors we interviewed were unable to hold in-person classes due to the COVID-19 pandemic, or were offering hybrid classes to limit in-person exposure. Several remarked that it was challenging to transition their curriculum to an online format. One instructor noted that their student enrollment was way down because students weren't interested in taking classes online. Instructors struggled to meet learning objectives in an online environment, especially in classes that relied on hands-on activities and project-based learning.

Instructors requested online materials and resources to help with the transition to online learning. They wanted advice on how to make online learning interactive, engaging, and hands-on. While they looked forward to the return of in-person learning, many recognized that the trend towards online learning was likely to continue, even after the pandemic.

Building science concepts and proficiency levels

Next, we turned to the DOE's Guidelines for Building Science Education (GBSE) and the Building Science Education Solution Center to determine how our energy code curriculum might align with core building science concepts and existing training resources.

First, we identified the building science topics that are most relevant to our proposed curriculum. We identified "core" building science topics, as well as "related" building topics. We used the list of building science topics in the Building Science Education Solution Center, which are slightly different from the core competencies listed in the GBSE, because these building science topics have associated educational content, which we intend to leverage when we develop the modules.

Table 6 lists the core and related building science topics for each of the proposed modules. The "codes and standards" topic will be relevant to most of the modules because of our overall focus on energy codes and standards. As we explain in the literature review above, too often training on codes and standards is divorced from a larger understanding of building science and energy efficiency topics. The purpose of our curriculum is to teach codes and standards through the lens of basic building science topics. Relevant building science topics will include heat transfer, whole building performance, air and moisture transport, control layers, HVAC systems, annualized cash flow, fenestration, and more.

Next, we considered the jobs listed in the GBSE that align best with community college 1) traditional trade programs, 2) construction management programs, and 3) architecture/engineering/drafting programs. Students in construction technology or construction management programs are likely to pursue careers as construction managers. Students in architectural/engineering/drafting programs may receive additional training to get an advanced degree in engineering or architecture, and may get jobs as architectural engineers or in construction management firms. Students in traditional trade programs may train to become HVAC/mechanical contractors or builder/remodelers. We also included building code official as a potential career since one of the goals of the project is to encourage students to pursue this as a career path.

Then we looked at the desired proficiency levels for each of the core competency topics for each job category. Proficiency levels in the GBSE are derived from Bloom's Taxonomy and include: 1) remember,

2) understand, 3) apply, 4) analyze, 5) evaluate, and 6) create. Table 7 lists the proficiency levels for each of these topics.

Table 6. Energy Code Training topics, building science topics, and proficiency levels.

Category	Proposed Modules	Core Building Science Topics	Related Building Science Topics	Proficiency levels		
				Costruction Trade Classes	Construction Management/Building Official Prep Classes	Architectural and Engineering Classes
Intro	Career Paths & salaries, including code professions	Codes and standards		Remember: List professionals who apply building codes	Remember: List professionals who apply building codes	Remember: List professionals who apply building codes
	Energy basics	Heat transfer, whole building performance	Integrated design and construction, life cycle analysis	Understand principles of coduction, convection heat transfer etc.	Understand basic principles of coduction, convection heat transfer etc.	Understand basic principles of coduction, convection heat transfer etc.
	The why: Cost/energy benefits of energy code and energy efficiency	Codes and standards	Life cycle analysis	Understand: Explain the purpose of building codes	Understand: Explain the purpose of building codes	Understand: Explain the purpose of building codes
	The what: Energy codes, standards, updates, and amendments	Codes and standards		Apply: Demonstrate understanding of how codes are developed and adopted	Apply: Demonstrate understanding of how codes are developed and adopted	Apply: Demonstrate understanding of how codes are developed and adopted
	The how: Compliance paths + Compliance Structure	Codes and standards	Whole building performance	Understand: Demonstrate understanding of compliance path use, demonstrate	Understand: Demonstrate understanding of compliance path use, apply software to sample building	Understand: Demonstrate understanding of compliance path use, apply software to sample building
Envelope	Envelope/Insulation Basics	Heat transfer, air. moisture transport, control layers, fenestr.	Codes and standards, control layers	Apply: How to detail to maintain, how insulation prevents heat transfer	Evaluate: Problem areas to look on plans and during inspection	Create: How to design and demonstrate compliance, how to read code, detailing
	Foundation insulation	Control Layers	Heat transfer, air & moisture transport, codes & standards	Apply: How to install properly	Evaluate: What to look for on the plans and during inspection	Create: Types of insulation, How to read the code, Detailing
	Roof insulation	Control Layers	Heat transfer, air & moisture transport, codes & standards	Apply: How to install properly	Evaluate: What to look for on the plans and during inspection	Create: Different configurations, detailing
	Air barriers/Blower door testing	Air transport, control layers, codes & standards	Moisture transport, fenestration, quality management	Apply: How to install properly, conduct a BD test & interpret results	Evaluate: What to look for on the plans and during inspection, read a BT test	Create: Materials & how to detail. Understand blower door test
MEP	Manual J/N/S/D intro	Interactions btwn HVAC systems & enclosure, HVAC systems		Understand: Understand the effects of HVAC system sizing	Understand: How to read & check results	Apply: How to use manuals
	Duct blaster testing	Air Transport	Annualized cash flow	Understand: How to conduct testing	Understand: How to read & check results	Understand: How to detail a tight duct system
	Lighting- Int. & Ext.	Lighting, appliances and misc. electric loads		Remember: Lighting power density	Apply: Checking to verify compliance	Create: How to design a compliant system
Other	Beyond Code - Renewables, Passive house, advanced framing	Certification programs, whole building performance	Annualized cash flow	Remember	Remember	Understand: Beyond the minimum
	Net Zero - what, why & how to get there	Integrated design and construction	Annualized cash flow	Remember: What is NZ?	Remember: What is NZ?	Understand: Intro to NZ
	Existing buildings renovations	Codes & standards	Whole buidling performance	Apply: What do remodelers need to know about energy code?	Evaluate: What in the codes applies?	Evaluate: What in the codes applies?

Table 7. Proficiency levels for building science topics by job category

Building science topic	Building Code Official	Contractor: Builder, Remodeler, HVAC	Construction Manager	Architect Engineer.
Codes & standards	4	3-4	3	3
Whole building performance	3	5	6	6
Cost trade-off analysis	2	4-5	5	5
Heat transfer	3	3-4	3	5
Control layers	3	4-5	5	6
HVAC systems	3	5	4	6
HVAC + enclosure	3	4-5	3	5
Fenestration	3	3-4	4	6
Lighting/appliances/ electrical load	3	3	3	4

The overall goal of this curriculum is to increase students' knowledge and understanding of codes and standards. The professions listed above require a level 3 or 4 proficiency level in codes and standards, meaning that students must be able to remember, understand, and apply (1, 2, 3) these codes and standards, and some professions must also be able to analyze (4). We will therefore build into our curriculum content on various codes and standards sub-topics that achieves levels 1-4 proficiency.

For all other related building science content, we will seek to help students reach the appropriate proficiency levels required by their future profession. Note that construction managers and architectural engineers in general require a deeper level of proficiency than building code officials or contractors for topics such as heat transfer and control layers. We will focus on helping students in building trades programs achieve a level 3 competency (remember, understand, and apply) for most building science topics. We will help students in construction management and architecture programs achieve higher levels of proficiency (apply, evaluate, and create) for these topics.

4.3. Curriculum Development Results (Task 2)

4.3.1. Preliminary Curriculum Design

Based on our findings about interest in and feasibility of integrating energy code/energy efficiency curriculum, we determined that we would focus on developing curriculum for 3 types of programs:

1. Construction management/construction tech programs
In Illinois, there are 18 such programs and 4 programs in Hawaii and Nevada. While several of these programs had energy efficiency and building code courses, there were many more programs that did not. We therefore concluded that there was room to integrate code and energy efficiency content into curriculum in the following course categories:

- Introductory courses (intro to building construction)
- Construction materials and methods
- Mechanical systems courses
- Courses that introduce building codes
- "Green" sustainable courses

2. Architectural technology/engineering/drafting programs

In Illinois, there are 36 such programs and 4 programs in Hawaii and Nevada. Once again, only a few of these programs had courses that addressed building codes or energy efficiency. This suggests room for integrating code and energy efficiency content into the following course categories:

- Intro courses (Construction of buildings, Construction 1 and 2)
- Materials and methods courses
- Detailing and construction documents courses
- Mechanical/electrical courses
- Building systems courses
- Building codes courses
- Sustainability courses

3. Trade programs related to carpentry or HVAC/R
In Illinois, there are 19 such programs, 2 in Nevada, and 3 in Hawaii. Again, only a few had courses specifically focused on building codes or energy efficiency, suggesting room for improvement. Typical courses that could integrate energy code/energy efficiency content include:

- Fundamentals of construction
- Carpentry and concrete
- Rough frame construction
- Air conditioning
- Heating
- Load calc/duct system design
- Energy management principles

4.3.2. Curriculum topics and learning objectives

From the curriculum design approach above, and in consultation with the advisory group, we developed the following structure of the curriculum topics and learning objectives:

- **Introductory modules**

1		**Energy Efficiency Careers and Pathways**	
	1-1	Intro: Careers in energy efficiency	Identify several prominent energy efficiency careers and job titles and describe what people do in those careers.
	1-2	Job Outlook: Energy Efficiency Careers	Describe the job outlook for key energy efficiency careers and show how to find job outlook information for other careers
	1-3	Career pathways to energy efficiency jobs	Describe potential career pathways to common energy efficiency jobs
	1-4	Code Official Careers	Identify building code careers and describe pathways to these careers.
2		**Building Energy Basics / Fundamentals of Building Science**	
	2-1	Understanding Energy & How it Moves	Explain the basics of conduction, convection, and radiation and describe an example of each type of energy transfer.

2-2	Envelope	Describe how control layers impact thermal performance and how thermal performance is measured.
2-3	Mechanical	Explain the ways energy is transferred in heating and cooling, describe the basics of Psychrometrics, and explain the difference between sensible and latent heat.
3	**Introduction to Energy Code**	
3-1	Intro to energy codes and standards	Define energy codes and list professionals who apply and enforce building codes.
3-2	What is the purpose of energy codes and standards?	Explain the purpose of energy codes and standards.
3-3	What energy codes and standards does your state use?	Identify which energy codes or standards are used in different states or municipalities
3-4	What does the compliance and enforcement process look like?	Describe the compliance and enforcement process for design and construction professionals and code officials in their state.

- **Envelope modules**

4	**Navigating Energy Code**	
4-1	Intro to Navigating Energy Codes and Standards	Access the energy codes and standards of their state and describe the general structure of these codes and standards.
4-2	Looking up requirements	Locate and cite the relevant energy code sections for a specific project.
4-3	How to read Energy Code tables	Use energy code tables to find requirements for a specific project based on different climate zones and building components.
4-4	Selecting a Compliance Path	Explain the difference between common compliance paths and how they affect building design.
5	**Envelope/Insulation Basics**	
5-1	Control Layers - Controlling Energy Movement in Buildings	Describe how control layers impact thermal performance in a building.
5-2	Thermal Envelope - R Value and Conduction	Describe how thermal resistance applies to different building components, identify thermal envelope components and location and analyze their impact on energy transfer.
5-3	Air and Vapor Barriers - Permeability, Convection and Blower Door Tests	Describe how convection and permeability apply to different building components, identify air and vapor control layers and explain the importance of these control layers.
5-4	Windows - U Value and Radiation	Describe how radiation and thermal resistance apply to windows, identify the thermal properties of windows that are regulated by the IECC and explain why they are important.

6	**Wall Insulation**		
	6-1	Introduction - Wall Types and Fundamentals	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.
	6-2	Residential Walls - How to Design for Code Compliance with Confidence	Analyze common residential wall systems in terms of energy transfer and control layers, identify common problems, describe why they occurred and how they can be remedied, and identify related code requirements.
	6-3	Commercial Walls - How to Design for Code Compliance with Confidence	Analyze common commercial wall systems in terms of energy transfer and control layers, identify common problems, describe why they occurred and how they can be remedied, and identify related code requirements.
7	**Openings**		
	7-1	Introduction - Windows, Doors and Storefronts	Identify the control layers within wall and roof assemblies and describe the parts of the assembly that are inside and outside of the thermal envelope.
	7-2	Residential Openings - How to Design for Code Compliance with Confidence	Analyze common residential fenestration systems in terms of energy transfer and control layers, identify common problems, describe why they occur and how they can be remedied, and remember related code requirements.
	7-3	Commercial Openings - How to Design for Code Compliance with Confidence	Analyze common commercial fenestration systems in terms of energy transfer and control layers, identify common problems, describe why they occur and how they can be remedied, and identify related code requirements.
8	**Roof Insulation**		
	8-1	Introduction - Ceiling and Roof Insulation	Identify the control layers within wall and roof assemblies and describe the parts of the assembly that are inside and outside of the thermal envelope.
	8-2	Residential Roofs - How to Design for Code Compliance with Confidence	Analyze common residential roof and ceiling systems in terms of energy transfer and control layers, identify common problems, describe why they occur and how they can be remedied, and identify related code requirements.
	8-3	Commercial Roofs - How to Design for Code Compliance with Confidence	Analyze common commercial roof systems in terms of types of energy transfer and control layers, identify common problems, describe why they occur and how they can be remedied, and identify related code requirements.
9	**Foundation Insulation**		
	9-1	Introduction - Foundation Categories and Fundamentals	Define the types of foundations found in the code and describe how they are generally insulated and why.

9-2	Slab on Grade Foundation Insulation	Identify the general requirements for insulating slabs and explain why the requirements exist.
9-3	Basement and Below Grade Wall Foundation Insulation	Identify the general requirements for insulating below grade walls and explain why the requirements exist.

- **Mechanical & electrical modules**

10	**Mechanical Equipment Sizing**	
10-1	Introduction to Mechanical Equipment Sizing	List the energy, economic, and sustainability impacts of proper equipment sizing on building performance, and broadly describe the different methods of sizing residential and commercial equipment.
10-2	Sizing Residential Equipment - Manual J and S	List what information is input into a Manual J and S calculation, explain why the information that is relevant, and describe how the Manual J and S work together to size equipment.
10-3	Using Manual J	Identify required information in building and project plan documents, and describe how climate data provided in the Manual J is used to determine loads.
10-4	Using Manual S	Identify the information needed from the Manual J calculation to size equipment and describe why the manufacturer's rating must be modified to meet design conditions.
11	**Duct Design & Installation**	
11-1	Introduction to Duct Systems	Identify duct system components and major leakage areas and define duct system components and terms
11-2	Duck Leakage Impacts on Buildings	Describe the impact of duct sizing on air balance and distribution
11-3	Understanding ACCA Manual D	Analyze a simple duct system using ACCA Manual D speed sheet and identify problem areas and how they can be remedied.
11-4	Leakage Testing-Methods and Requirements	Students will be able to describe duct leakage testing methods and code requirements
12	**Mechanical Ventilation**	
12-1	Introduction to Building Ventilation	Define ACH, infiltration, ventilation, effective leakage area, latent and sensible heat, and IAQ; and identify difference between ventilation and infiltration
12-2	Ventilation and Building Performance	Describe the impact of fresh air ventilation on indoor air quality, energy consumption, occupant health and performance
12-3	Ventilation Design Standards	Identify the ASHRAE 62.1 (commercial) and 62.2 (residential) ventilation design standard procedures, and explain the benefits and limitations of these standards.

12-4	Advanced Ventilation Design Topics	Describe the benefits and energy impact of increasing ventilation beyond ASHRAE 62.1/62.2, and identify ways to design resilient ventilation systems
13	**Lighting**	
13-1	Efficient Lighting Fundamentals	Broadly define the requirements of lighting power density and controls and how these contribute to an efficient lighting system.
13-2	Lighting Power Density	Calculate the allowable lighting power budget for a commercial building and explain why lighting power density is important and how it can be reduced.
13-3	Lighting Controls	Identify different lighting control technologies, describe the similarities and differences between occupant controls and daylight controls, and identify the applicable code requirements.

- **Advanced topics modules**

14	**Beyond Code**	
14-1	Purpose of Code - Minimum Energy Conservation	Describe the benefits of going "beyond code" for different building components (control layers, energy consumption, mechanical system efficiency, etc).
14-2	Sustainability and Construction - Embodied energy and new construction / lifecycle costs	Describe the relationship between sustainability and energy efficiency, describe the environment impact of manufacturing and disposal of building materials, and explain the concept of embodied energy and lifecycle cost as it relates to energy efficient building components.
14-3	Other Certifications - LEED, Energy Star, Healthy Bldg, Passive House	Identify sustainability-related certifications (LEED, Energy Star) outside the jurisdiction of the Energy Code, explain why they exist, and describe how they compare with or complement the energy code.
15	**Net Zero**	
15-1	Defining Net Zero	List several definitions of net zero and explain the difference between those definitions
15-2	Energy Usage Index	Identify, utilize, and compare different Energy Usage indices
15-3	Renewable capacity	Calculate building level or site level renewable energy capacity
15-4	Energy Storage	Identify different energy storage technologies and explain when each technology is appropriate.
16	**Existing Buildings**	
16-1	Introduction to Existing Building Upgrades	Describe best practices for assessing existing buildings, including process flow and prioritization of projects
16-2	Existing Building Inspections	Identify diagnostic techniques such as thermography, leakage testing, and retro-commissioning techniques, and explain how they are used to assess energy performance and identify problems.

16-3	Addressing Existing Deficiencies	Identify common envelope and mechanical deficiencies that impact energy performance and describe common strategies to address these deficiencies
16-4	Energy Code Applications to Existing Buildings	Describe the "grandfather clause" and list several common types of renovations which necessitate bringing existing buildings "up to code."

4.3.3 Curriculum Product Developed: BEE Fundamentals Moodle Learning Management System

The Building Energy Education (BEE) Fundamentals Learning Management System is housed in Moodle, at https://learn.smartenergy.illinois.edu/. Instructors, students, and other interested individuals can register for free to access the modules. Once in the site, they can access the 15 modules, as shown in the table below.

Table 8. BEE Fundamentals Module Titles

Introduction Modules	Envelope Modules	Mechanical & Electrical Modules	Advanced Modules Beyond Code
1. Energy Efficiency Careers & Pathways 2. Building Energy Basics 3. Introduction to Energy Codes & Standards 4. Navigating Energy Codes & Standards	5. Envelope Fundamentals 6. Walls & Openings 7. Roof & Ceiling Insulation 8. Foundations & Floors	9. Mechanical Equipment Sizing 10. Duct Design & Installation 11. Mechanical Ventilation 12. Lighting	13. Beyond Code 14. Net Zero Buildings 15. Existing Building Renovations

Each module contains 3-4 subtopics, with a separate presentation for each subtopic that last about 15 minutes. For instance, the Energy Efficiency Careers & Pathways has the following 3 subtopics:

- Careers in Energy Efficiency
- Pathways to Energy Efficiency Careers
- Code Official Careers

In addition to presentation slides (with instructor notes), the modules also include a variety of activities and resources, including videos, review worksheets, quizzes, games, and other activities to make the content more engaging and accessible. Curriculum materials include video clips and graphics that were developed using SketchUp (3-dimensional modeling software) and AutoCAD (drafting software).

The materials can be downloaded and integrated into existing syllabi and course work in the construction and building trades. The material is presented in 15-minute chunks to encourage instructors to integrate energy efficiency topics in their existing coursework, without the need for major changes, which can be difficult to implement.

4.4. Curriculum Evaluation Results (Tasks 3 & 7)

4.4.1. Reviewer Feedback on the Draft Modules

As part of this evaluation, industry experts, including code officials, design professionals, contractors, and community college instructors from Illinois, Nevada, and Hawaii were invited to review the organization and information in course modules. Of the 50 individuals we contacted to review the curriculum, 14 provided reviews through surveys and written feedback. Reviewers overwhelmingly indicated that they were likely to use the modules and reported a high score for the quality of the content.

Though the sample size was small, responses from reviewers suggest that the modules are well organized and that the content is relevant and engaging for the users. Specific feedback related to relevance, quality of content, usability and navigability, and engaging activities) is summarized in detail. This is followed by some general conclusions on the continued viability of the project.

Participants were asked several questions related to the training curriculum all. Scores ranged from 0 (not at all) to 5 (high). See Table 9. Questions were also asked about the specific modules that were reviewed. See Table 10.

In comments, reviewers complimented sections on lighting power density, lighting controls, and lighting efficiency. One reviewer noted that the modules had “great content” and that there was “nothing missed,” while other reviewers identified some areas where the content could be improved. Regarding lighting, one reviewer felt that the definition of lumens could be clearer, and another felt that using more current graphics would be more appropriate. Another reviewer thought that the Energy Efficiency Careers & Pathways module could have been more in-depth.

A few comments offered suggestions on how to improve usability. For example, one reviewer felt that it would be helpful to provide both “student and teacher” versions of some of the presentation content. This would ensure that additional content appropriate only to the needs of the instructor (e.g., lecture notes) could be included with presentation materials.

Some reviewers offered suggestions to make the activities more engaging. For example, one found the “game show” to be “a little repetitive”. Another reviewer felt that the activities for Module 3 “needed a little more work”. These indicate the need for greater diversity in the activities proposed for each module. Reviews on module quizzes were mixed. One reviewer felt that going “back” to the quiz after finishing the module “didn’t work.” Another reviewer disagreed, saying that the quiz mechanics “worked well.” Another reviewer felt that a “short assessment” should be included with each module, suggesting that the quizzes (which provided just such an assessment) were too difficult for users to find.

We revised the modules based on reviewer feedback.

Table 9. General curriculum questions

Question	Average score
How likely are you to use the educational content or portion of the curriculum in your teaching?	4.67
How would you rate the quality of the educational content?	4.28
How would you rate the overall usability of the educational content for instructors?	4.28
How easy was it to navigate the content?	4.28

Table 10. Module-specific questions

	Module 1 (7 reviews)	**Module 3 (5 reviews)**	**Module 5 (4 reviews)**	**Module 6 (1 review)**	**Module 7 (1 review)**
Module topic	Careers & pathways	Intro to energy codes	Envelope fundamentals	Walls & openings	Roof & ceilings
How likely are you to use this module?	4.5	4.8	5.0	4.0	5.0
How would you rate the content of this module?	4.1	4.8	4.8	4.0	5.0
How would you rate the quality of the presentation for this module?	4.4	4.6	4.8	4.0	5.0
How would you rate the other activities of the module?	4.4	4.6	4.8	4.0	5.0

4.4.2. Participant Feedback on Finalized Modules

A total of 112 participants utilized the curriculum through the Moodle site and completed the feedback survey. 55 (49%) respondents were enrolled in community colleges, 9 (8%) respondents were enrolled in continuing education programs, 1 (1%) respondent was enrolled in a high school trade program, and 47 (42%) respondents were enrolled in other programs.

67 (89%) respondents expressed that they either “Strongly agree” or “Somewhat agree” that modules focused on issues they are interested in. This suggests that the participants found that the provided materials had a strong degree of interest focused on their respective interests. See Figure 2.

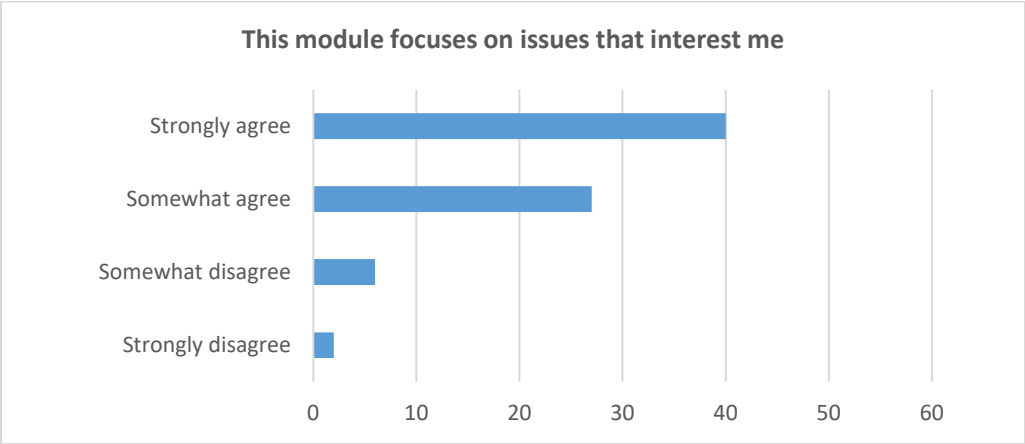

Figure 2. Relevance of Training Topics to Participants' Interest

70 (93%) respondents strongly agreed or somewhat agreed that the modules were relevant to their future or current professional practice. These results indicate that the training program is reaching the intended audience of current and future energy code and design professionals. See Figure 3.

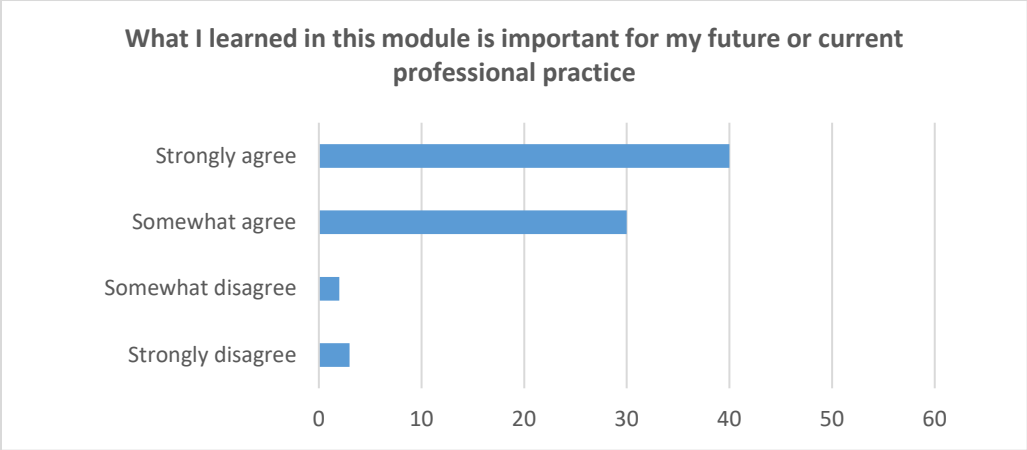

Figure 3. Relevance of Training Topics to Participants' Profession

68 (81%) respondents indicated they had a moderate, low, or very low level of knowledge about the module topic BEFORE taking the module. Only 14 (19%) stated that they had a very high or high level of knowledge. See Figure 4.

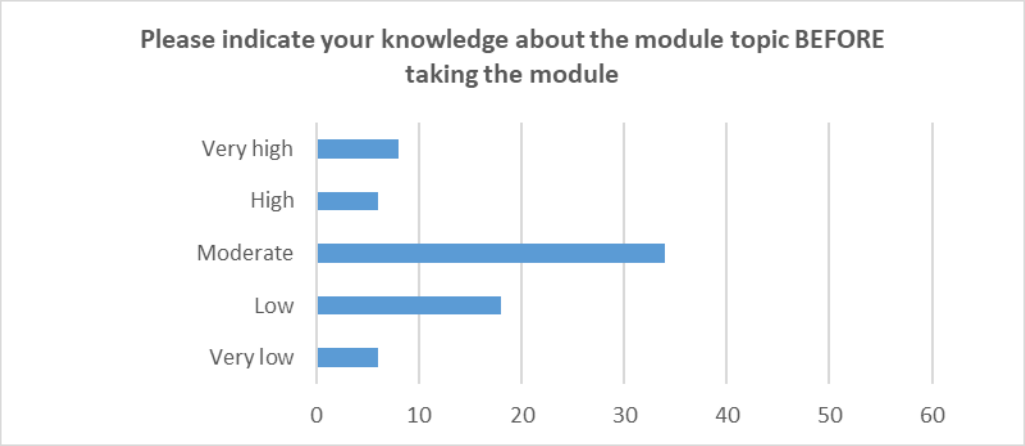

Figure 4. Knowledge of Training Topics BEFORE Taking the Module

After taking the module, 40 (53%) respondents stated that they had a very high or high level of knowledge. 17 (23%) had a moderate level of knowledge; 18 (24%) had a low or very low level of knowledge. These results demonstrate that participants perceived an overall improvement in their self-assessed level of knowledge after completing the modules. See Figure 5.

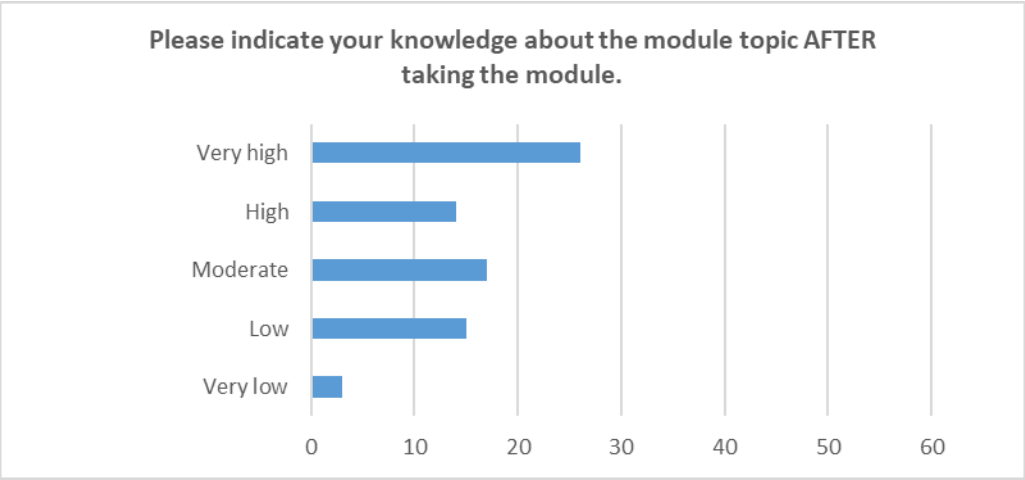

Figure 5. Knowledge of Training Topics AFTER Taking the Module

When asked about the likelihood of using information from the modules to apply in practice, 29 (39%) respondents indicated a very high or high likelihood. 28 (37%) people responded that there was a moderate likelihood; 18 (24%) responded that the likelihood was low to very low. See Figure 6.

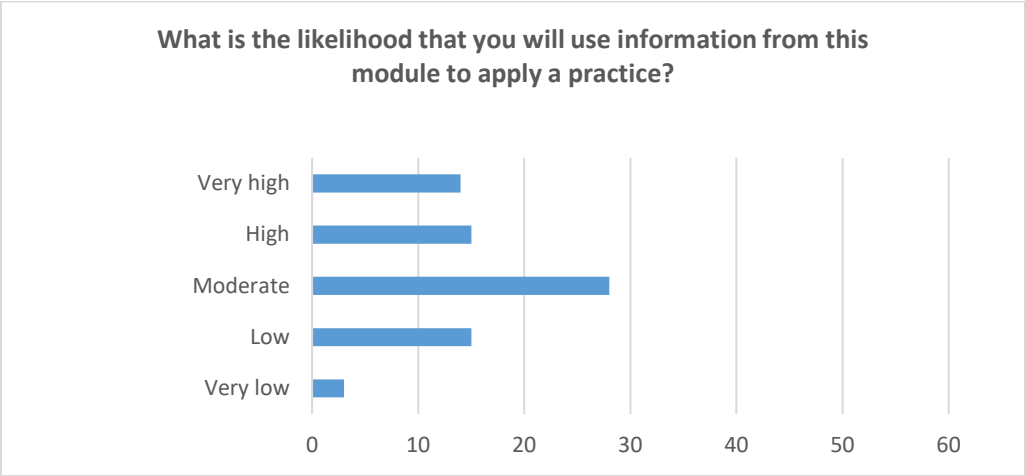

Figure 6. Professional Applicability of Training Topics

61 (82%) respondents stated that the level of content of the modules was just right. 7 (9%) considered the content too technical; 7 (9%) responded that the content was too basic. These results indicate that the modules are at the appropriate learning level for participants. See Figure 7.

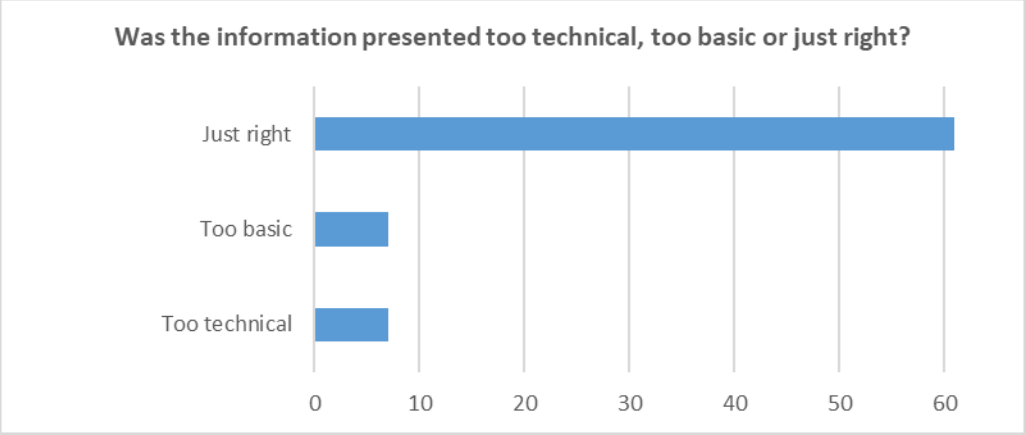

Figure 7. Level of Module Content

4.4.3. Analysis of Learning Management System Data

In addition to analyzing respondent feedback survey data, we examined data from our learning management system (Moodle) to determine the effectiveness of our curriculum.

As of June 30, 2023, our online curriculum had a total of 170 registrations. Since the program's inception in April 2021, we have experienced consistent growth in the number of registrants. Notably, in August 2021, we received 22 new registrations when we invited reviewers to assess our curriculum. In addition,

April 2022 saw 41 new registrants, coinciding with the launch of webinars in Hawaii, Nevada, and Illinois, as well as a nationwide train-the-trainer workshop. See Figure 8.

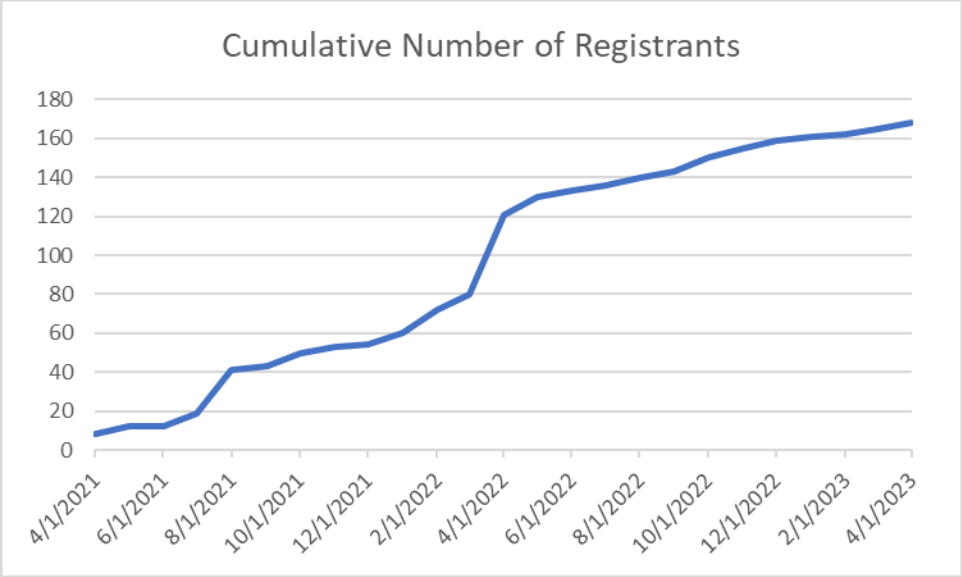

Figure 8. Cumulative Number of Registrants

Course enrollment data reveals that college instructors and students constitute the two primary professional groups enrolling in all 15 modules. Although our courses are primarily designed for college instructors, it is evident that the curriculum effectively serves students as well, enabling them to utilize the materials for self-guided learning. See Figure 9.

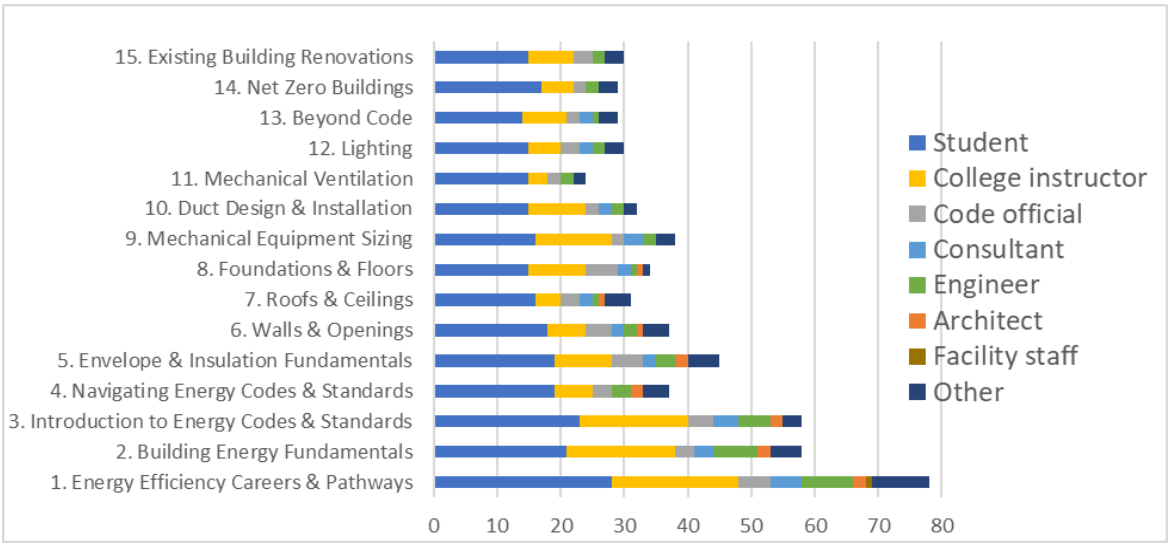

Figure 9. Course Enrollment by Profession

Completion rates were determined by comparing the number of enrollees to the number of individuals awarded certificates of completion. Certificates were only issued to non-instructors who completed courses and achieved quiz scores of 70% or higher. The majority of courses have completion rates ranging from 30% (Module 9: Mechanical Equipment Sizing) to 57% (Module 12: Lighting). The course with the lowest completion rate is Module 15: Existing Building Renovation. We believe the reduced completion rate for Module 15 can be attributed partially to its later development compared to other courses, as well as the tendency for participants to initially engage with the introductory modules. See Figure 10.

Most registrants enrolled in just one course (28 people), but there were 13 individuals who enrolled in all 15 courses. Figure 12 illustrates the distribution of the number of courses enrolled in per registrant. With an average of 5.2 courses per registrant, this demonstrates a substantial level of interest in enrolling in multiple courses. See Figure 11.

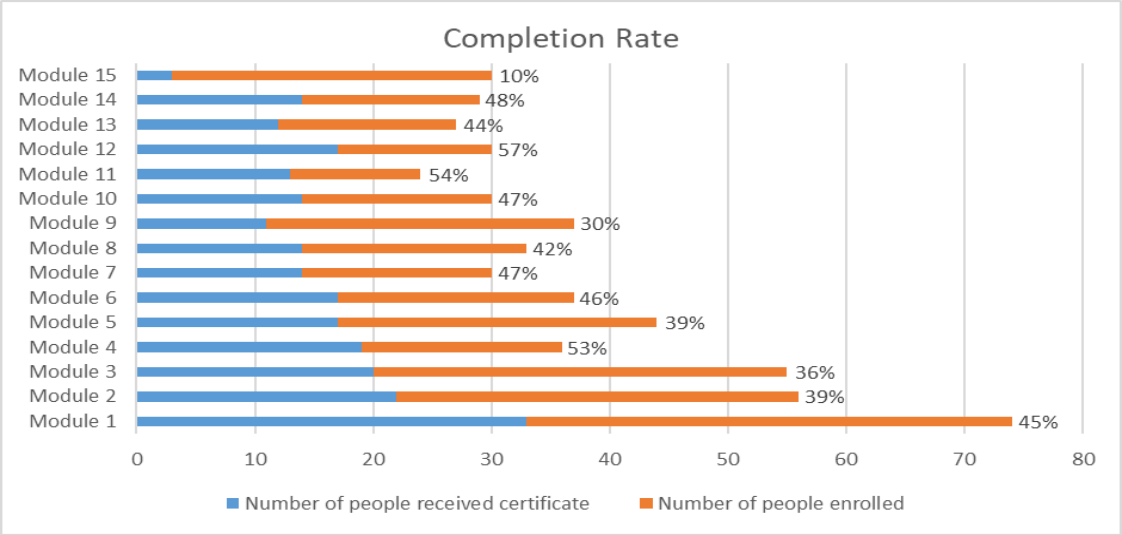

Figure 10. Course Completion Rate

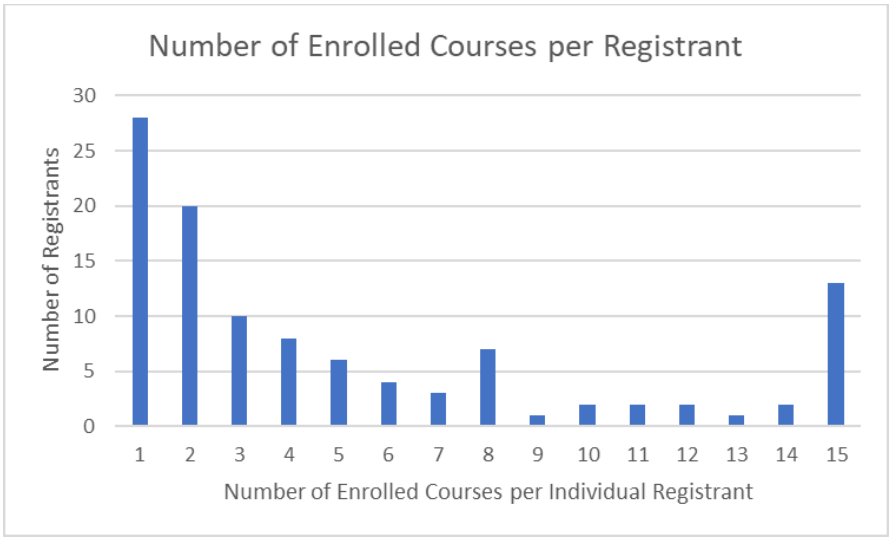

Figure 11. Number of Enrolled Courses per Individual Registrant

4.5. Instructor Toolkit Development Results (Task 4)

To make the program materials accessible, we created a program webpage, "Building Energy Education (BEE) Fundamentals," on the SEDAC website https://smartenergy.illinois.edu/bee_fundamentals/. See Figure 12. We posted the BEE Fundamentals curriculum and related products on the SEDAC website at https://smartenergy.illinois.edu/instructor-toolkit.

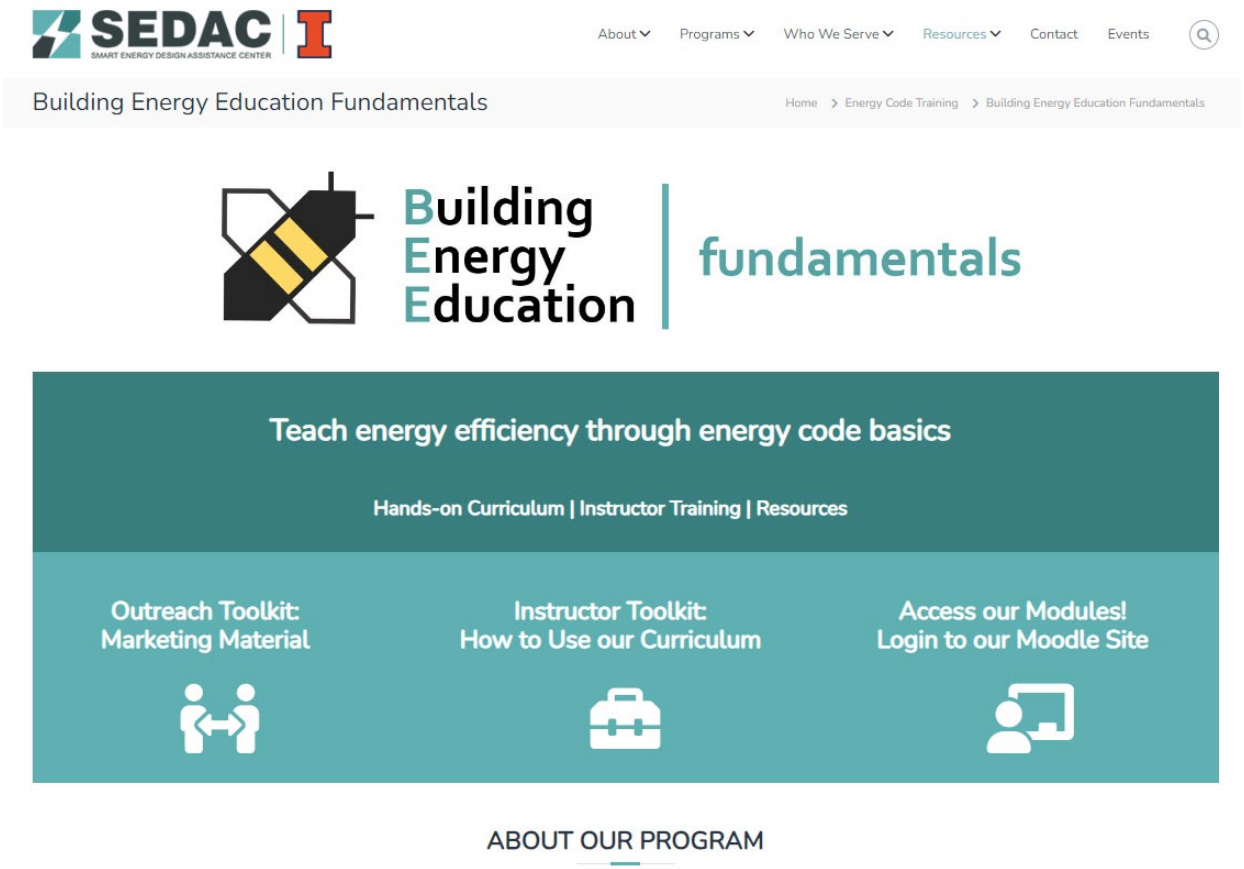

Figure 12. Screenshot of BEE Fundamentals Homepage

The Instructor Toolkit provides information about the curriculum and how to use it. It begins with some frequently asked questions. See Figure 13.

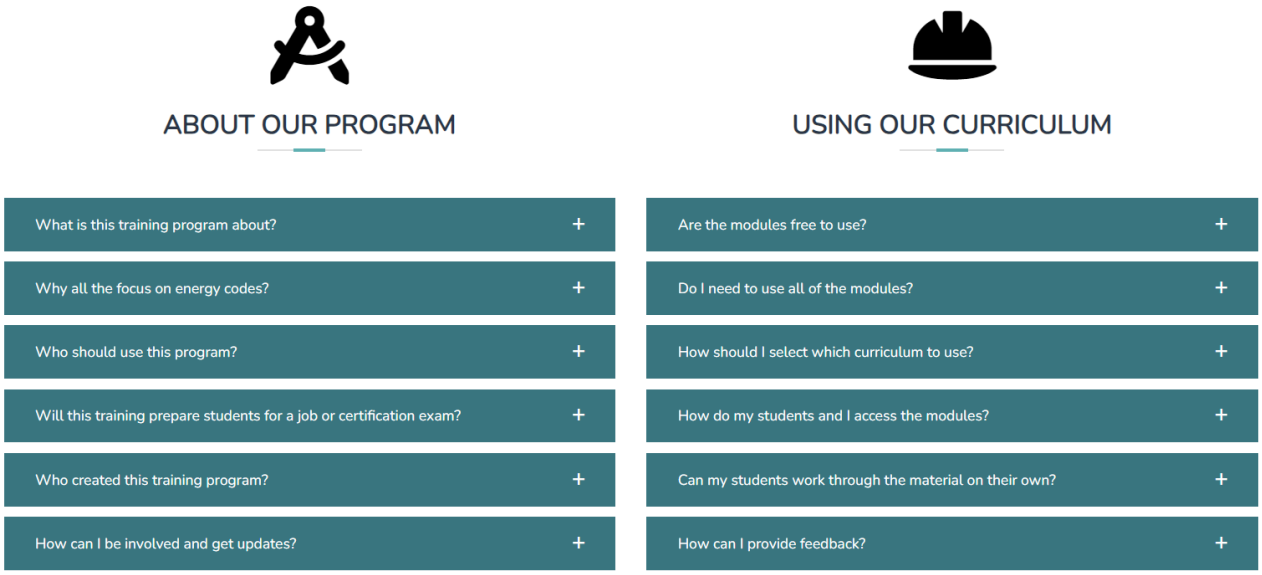

Figure 13. Instructor Toolkit screenshot

Next, it includes videos about the four different categories of modules, followed by a short description of the content included in each module. See Figure 14.

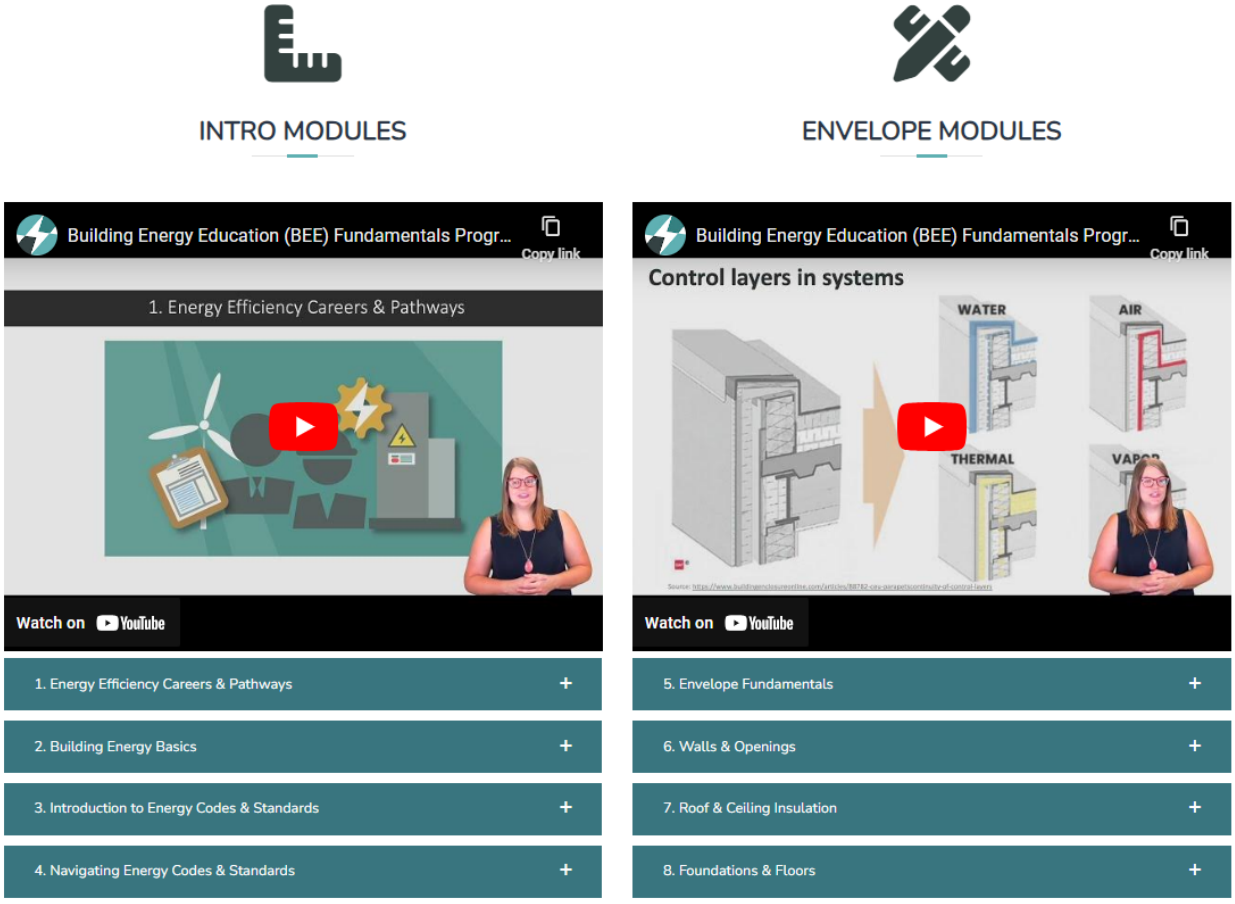

Figure 14. Instructor Toolkit Screenshot

It provides a sample of "tools" instructors can use in their classroom, including presentations, worksheets, in-class activities, and videos. Finally, it provides a link to the Moodle site where instructors can access the modules. See Figure 15.

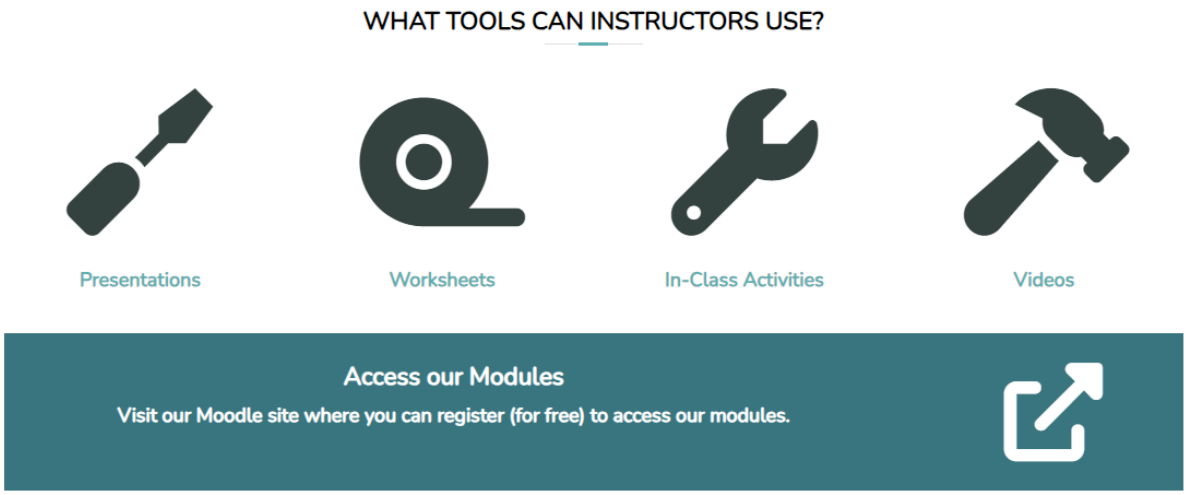

Figure 15. Instructor Toolkit Screenshot

4.6. Train-the-Trainer Workshop Results (Tasks 5 & 6)

Due to our outreach efforts, 433 people attended the Hawaii launch webinars, 19 people attended the Nevada Launch Webinar, 41 people attended the Illinois launch webinar, and 16 people attended the Train-the-Trainer workshop. Interestingly, of these 509 participants, only 39 were community college instructors. Other attendees were primarily building design and construction professionals (including code officials, architects, and engineers).

The project team delivered a series of launch webinars in each participating state (Hawaii, Nevada, Illinois) prior to the train-the-trainer workshop for all participating states. This strategy allowed the project team to build up participants' interest in each state and encourage them to attend the train-the-trainer workshop and interact with professionals and educators from different states in order to better utilize the program curriculum and resources.

4.6.1. Hawaii Launch Webinar Summary

We delivered a series of three launch webinars for participants in Hawaii. This was to attract participants interested in learning energy code content as well as receiving professional continuing education credits (especially AIA CEUs). We selected webinar topics based on the BEE curriculum, Hawaii-specific energy code related items, and Hawaii utility energy efficiency programs.

We selected topics for the HI launch webinars to utilize a range of content from the BEE Fundamentals curriculum - from relatively easy content to more advanced content. Selected topics and BEE Fundamentals modules selected for the webinars are listed in Table 11.

Table 11. Hawaii Launch Webinar Topics & BEE Fundamentals Curriculum Used

Webinar Topics	BEE Fundamental Modules
Webinar 1. BEE Fundamentals & Energy Code Basics	Module 1. Energy Efficiency Careers & Pathways Module 2. Building Energy Basics Module 3. Introduction to Energy Codes & Standards Module 4. Navigating Energy Codes & Standards
Webinar 2. Comfort, Air Quality & Lighting	Module 5. Envelope Fundamentals Module 9. Mechanical Equipment Sizing Module 10. Duct Design & Insulation Module 11. Mechanical Ventilation Module 12. Lighting
Webinar 3. Beyond Code, Net Zero & Existing Buildings	Module 13. Beyond Code Module 14. Net Zero buildings Module 15. Existing Building Renovations

We had presenters from SEDAC, DOE, HI State Energy Office, Honolulu Community College, Hawaii Energy, an architecture firm, and City and County of Honolulu. Attendance for all three webinars is summarized in Table 12 and Figure 16.

Table 12. Hawaii Launch Webinar Participants

Webinar Topics	Registrants	Presenters	Attendees
Webinar 1. BEE Fundamentals & Energy Code Basics	232	6	174
Webinar 2. Comfort, Air Quality & Lighting	233	4	110
Webinar 3. Beyond Code, Net Zero & Existing Buildings	258	5	149
Total	910	15	433

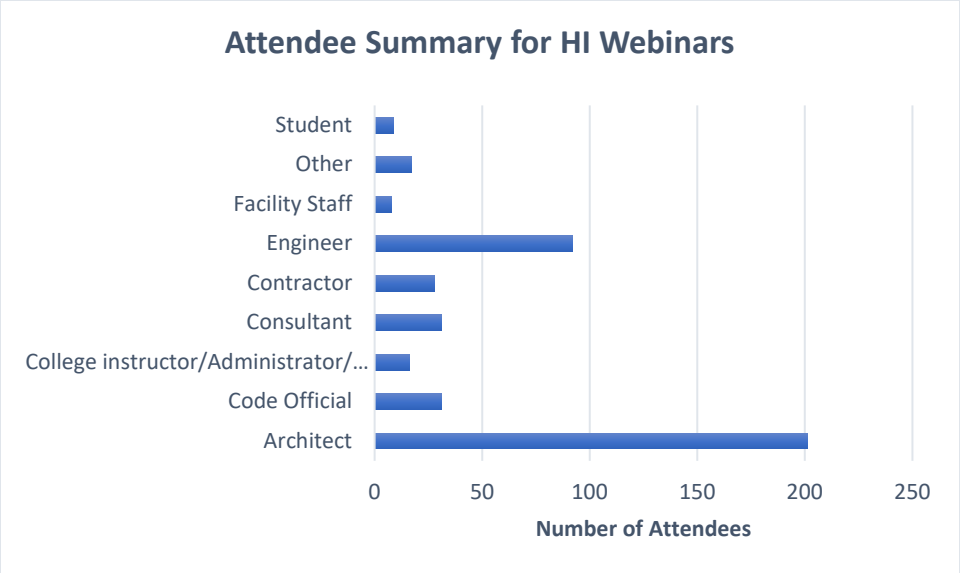

Figure 16. Attendee Professions for Hawaii Webinars

Feedback from the Hawaii Launch Webinar Attendees

We sent a follow-up survey to all attendees and received 90 responses (36 for webinar 1; 25 for webinar 2; and 29 for webinar 3). Most respondents indicated that they were satisfied with the webinars. 92% of respondents indicated that they were satisfied with the content and quality of webinars, as shown in Figure 17.

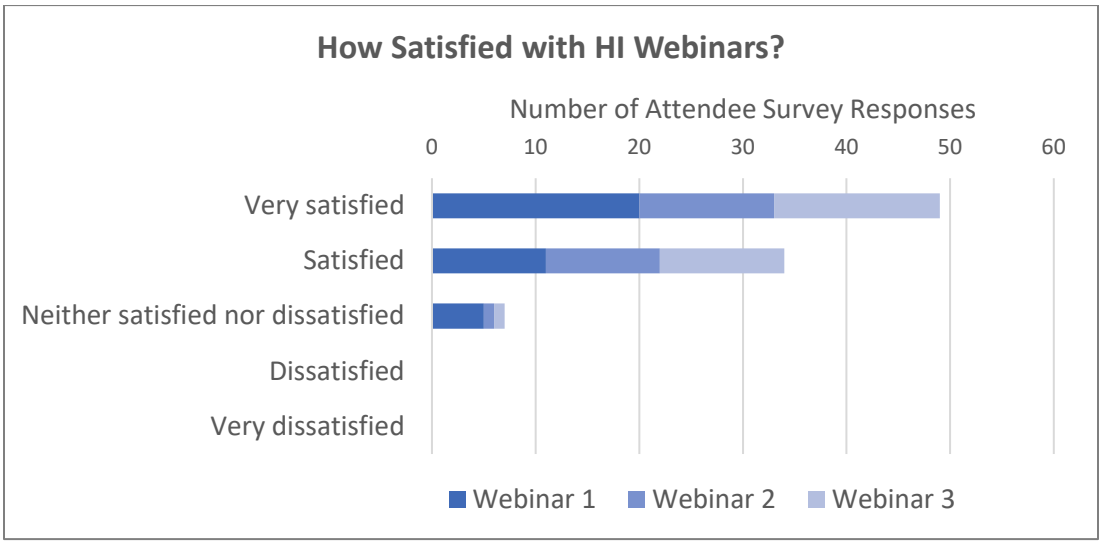

Figure 17. Survey Result: Degree of Satisfaction of Hawaii Launch Webinars

When asked if the webinar improved their knowledge of the subjects (Energy Code Basics; Comfort, Air Quality & Lighting; Beyond Code, Net Zero & Existing Buildings), 88% of the survey respondents reported that they agreed, as shown in Figure 18.

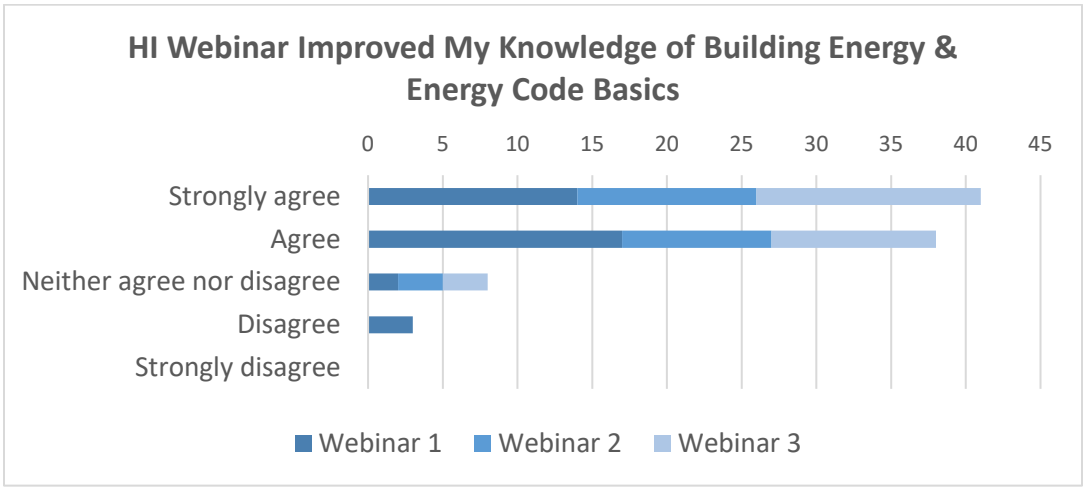

Figure 18. Survey Result: Energy Code Knowledge Improvement as a Result of the Hawaii Webinars

We also received many positive comments from participants, including:

- "Info was good for my level of existing knowledge of the subject matter."
- "Presenters were knowledgeable in their fields and spoke clearly. I also appreciated the weblinks in the chat that coincided with the presentation!"
- "Well organized and comprehensive. Specific to our climate."
- "Loved the presentation, would appreciate updates and any content in the future to stay up to date and get ahead of the power curve for 2030."

4.6.2. Nevada Launch Webinar Summary

The topic of the NV launch webinar was "BEE Fundamentals Overview," covering the content of BEE Fundamentals Module 1. Energy Efficiency Careers & Pathways. An important part of the webinar was the panel discussion, moderated by Envirolution, a non-profit organization who develops K-12 energy efficiency and sustainability curricula for educators. The panel discussion topic was the nexus between building design and energy code knowledge and panelists shared their thoughts while responding to the questions listed in Table 13.

Table 13. Nevada Launch Webinar Topics & BEE Fundamentals Curriculum Used

Webinar Topic: BEE Fundamentals Overview & Panel Discussion	
BEE Fundamentals & Energy Efficiency Careers	Utilized BEE Fundamental Modules: • Module 1. Energy Efficiency Careers & Pathways
Panel Discussion Questions: • In your field, what role do building energy codes play; how important are building energy codes? • What is your sense of how prepared the workforce is to enter this field, specifically as it relates to building energy codes? • What training opportunities would you like to see in building energy codes, to ensure a prepared workforce? • Can you briefly describe the modules you've been able to use in your classroom, and how you think they're helping prepare the workforce? • What do you see as the nexus between building design and knowledge of energy codes? • What do you wish more architects knew about energy codes and energy efficiency?	

Responses from panelists were insightful and provided confirmation of the program goals and objectives. Instructors who have utilized our curriculum vouched for its content quality and ease of navigating the Moodle site. An interesting remark from a code official about workforce development for building officials was that she thinks that it is important to enhance the image of code officials to attract younger people to the field. She expressed that many times code officials are seen as doing just enforcement, but they need to be seen as partners for designers and contractors.

One of our survey findings that we shared with panelists and attendees is that respondents consider architects the most knowledgeable about energy codes, compared to other professionals. An architect panelist disagreed, commenting that many architects only care about the bare minimum for code compliance ("barely being legal") and need more education. Ignoring energy efficiency is no longer an option, and they cannot offload this responsibility to other professionals, such as mechanical engineers, anymore. Another architect shared his positive outlook on the younger generation's passion and ability to design high-performance buildings. He thought that unlike older generations, they are savvy in using

energy modeling tools in the early design stage, which makes it possible to demonstrate to the client the energy and cost savings of high-performance buildings.

A code official panelist expressed that this event reminded her of the important role in providing proper education and training for her team and shared her commitment to utilize our "completely thorough" curriculum.

Presenters and panelists came from SEDAC, DOE, NV Governor's Office of Energy, Truckee Meadow Community College, Envirolution, College of Southern Nevada, City of North Las Vegas, and an architectural firm. Attendance is summarized in Table 14 and Figure 19.

Table 14. Nevada Launch Webinar Participants

	Registrants	Presenters & Panelists	Attendees
Nevada Launch Webinar	34	6	19

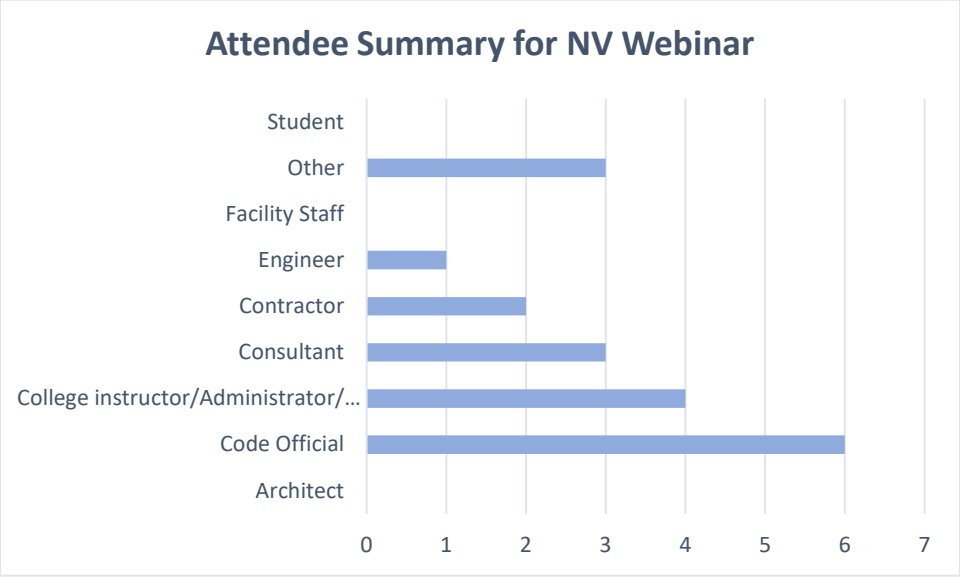

Figure 19. Attendee Professions for Nevada Webinar

Feedback from the Nevada Launch Webinar Attendees

We sent a follow-up survey to all attendees and received 10 responses. Most respondents indicated that they were satisfied with the content and quality of the webinar as shown in Figure 20.

When asked if the webinar improved their knowledge of the importance of building energy codes in a variety of building design careers, all respondents reported that they agreed. See Figure 21.

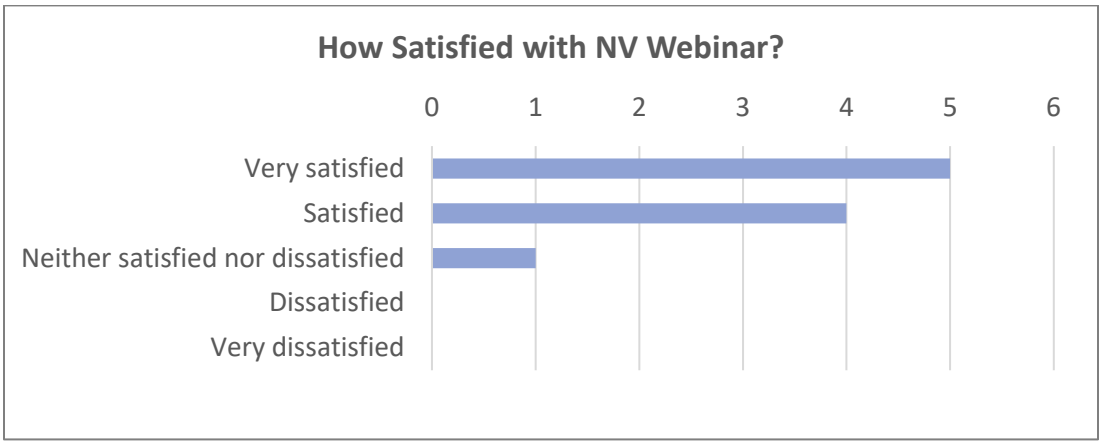

Figure 20. Survey Result: Degree of Satisfaction of Nevada Launch Webinar

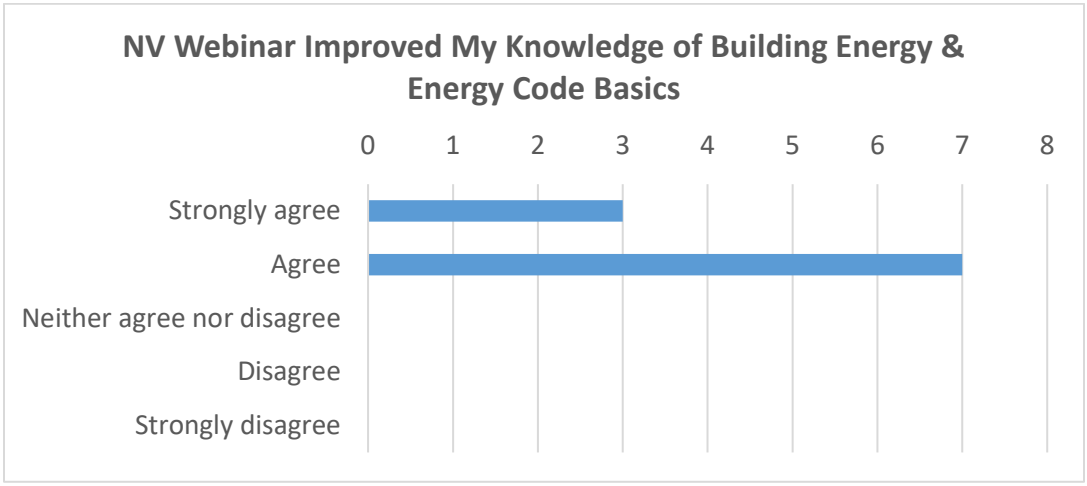

Figure 21. Survey Result: Energy Code Knowledge Improvement as a Result of the Nevada Webinar

4.6.3. Illinois Launch Webinar Summary

The topic of the IL launch webinar was BEE Fundamentals Overview, covering the content of BEE Fundamentals Module 1. Energy Efficiency Careers & Pathways. The course demonstration and discussion session and instructor case studies were important components of the webinar. See Table 15.

Table 15. Illinois Launch Webinar Topics & BEE Fundamentals Curriculum Used

Webinar Topic: BEE Fundamentals Overview & Workforce Development	
BEE Fundamentals & Energy Efficiency Careers	Utilized BEE Fundamental Modules: • Module 1. Energy Efficiency Careers & Pathways
Instructor Case Studies	Presented by Chris Chwedyk, Harper College & Bart Pulliam, John A Logan College
Career Development Resources	Presented by Katie Stonewater, Illinois Department of Commerce & Economic Opportunity

Presenters and panelists came from diverse organizations, including: SEDAC, PNNL, Illinois EPA Office of Energy, DCEO, Harper College, and John A. Logan College. Webinar attendance is summarized in Table 16 and Figure 22.

Table 16. Illinois Launch Webinar Participants

	Registrants	Presenters	Attendees
Illinois Launch Webinar	109	7	41

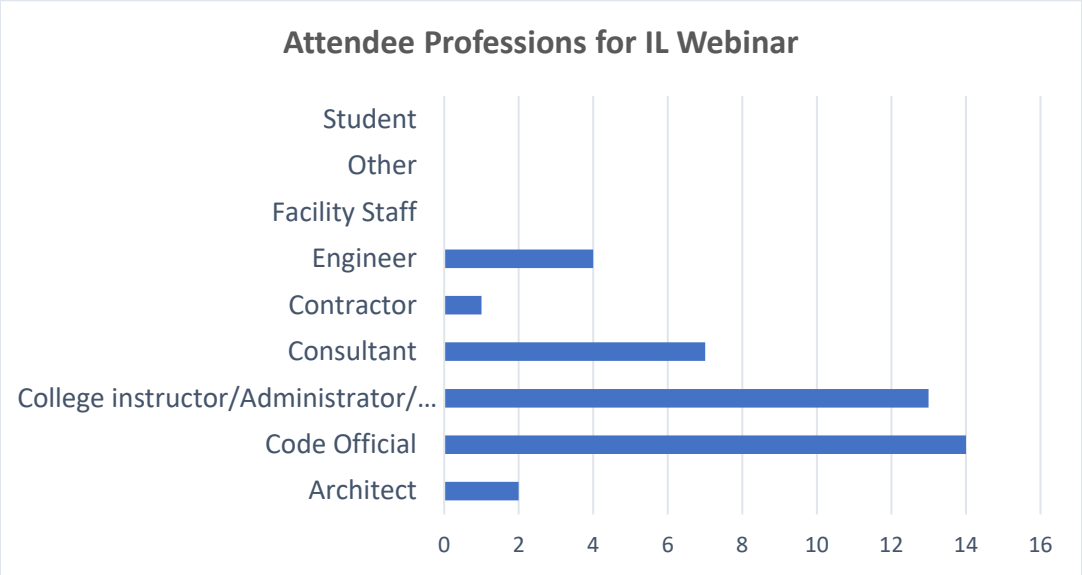

Figure 22. Attendee Professions for Illinois Event

Feedback from the Illinois Launch Webinar Attendees

We sent a follow-up survey to all attendees and received 5 responses. Most respondents indicated that they were satisfied with the content and quality of the webinar, as shown in Figure 23.

When asked if the webinar improved their knowledge of the importance of building energy codes in a variety of building design careers, 80% of respondents reported that they agreed. See Figure 24.

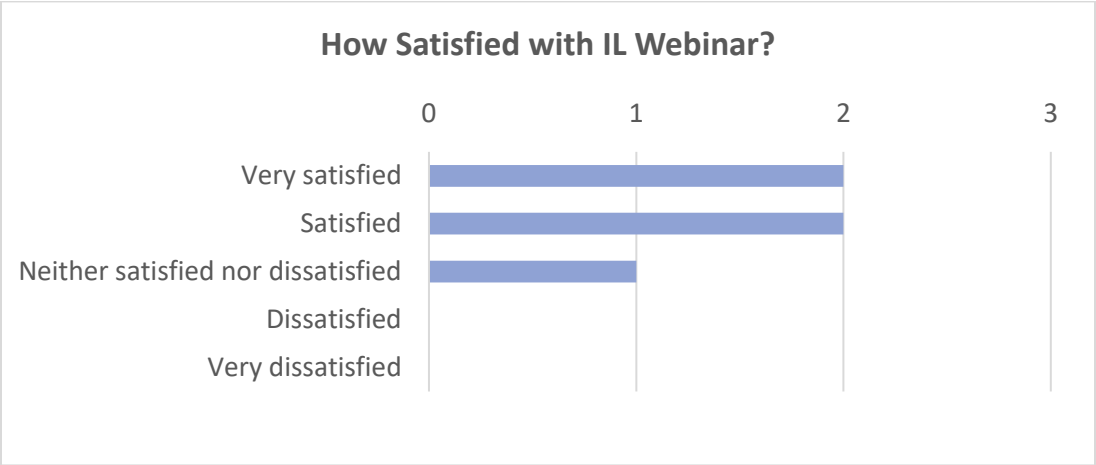

Figure 23. Survey Result: Degree of Satisfaction of Illinois Launch Webinar

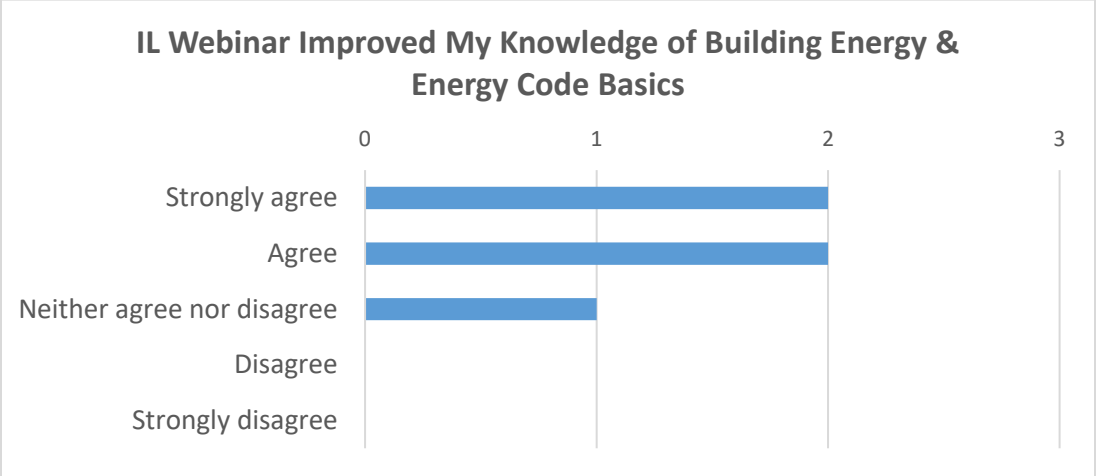

Figure 24. Survey Result: Energy Code Knowledge Improvement as a Result of the Illinois Webinar

4.6.4. Train-the-Trainer Workshop Summary

The topic of the all-state Train-the-trainer workshop was the BEE Fundamentals Curriculum with hands-on activities. The breakout discussions, with a resource scavenger hunt activity and facilitated by SEDAC staff members, were a key component of the workshop. We used a Miro Board to facilitate the interactive group discussion. See Table 17 for a summary of topics at this workshop.

We featured presenters from SEDAC and PNNL. Workshop attendance is summarized in Table 18 and Figure 25.

Table 17. Train-the-trainer Workshop Topics & BEE Fundamentals Curriculum Used

Webinar Topics: BEE Fundamentals Curriculum	
BEE Fundamentals Overview, Energy Efficiency Careers & Energy Code 101	Utilized BEE Fundamental Modules: • Module 1. Energy Efficiency Careers & Pathways • Module 2. Building Energy Basics • Module 3. Introduction to Energy Codes & Standards • Module 4. Navigating Energy Codes & Standards
Breakout Discussion	Resource Scavenger Hunt Activity using Miro Board

Table 18. Train-the-trainer Workshop Participants

	Registrants	Presenters	Attendees
All-state Train-the-trainer Workshop	44	3	16

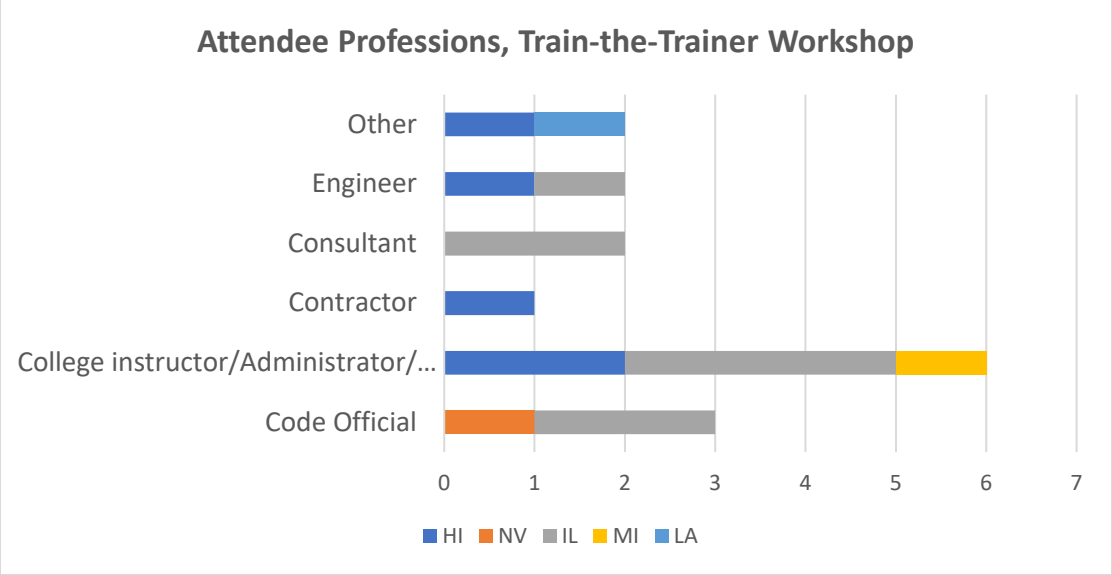

Figure 25. Attendee Professions for the Train-the-Trainer Event

Feedback from the Train-the-Trainer Workshop Attendees

We sent a pre-workshop survey to workshop registrants a week before the event. There were 3 respondents from IL, 3 from HI, 3 from other states (participants from multi-state or national organizations) and 1 from NV. Of the 10 respondents, there were 5 educators, 2 government employees such as code officials, and 3 participants from nonprofit organizations including the National Council of Workforce Education (NCWE) and the Illinois Clean Energy Community Foundation (ICECF).

- Half of the respondents indicated that they plan to use the BEE Fundamentals curriculum in their courses, and the other half indicated that they are not sure if they would. Respondent stated they were considering utilizing the BEE Fundamentals in these courses:
    - Renewable Energy & Renewable Energy
    - Courses for fellow code officials
    - Green Building
    - Construction Law & Construction Accounting
    - Net Zero Energy Buildings
    - Sustainable Hospitality Facility Design & Operations
    - Hawaii (Energy Code) Training
- Respondents indicated that their courses train students in following careers:
    - Electricians
    - Architects
    - Engineers
    - Code officials
    - Energy auditors
    - Construction (Bachelor's degree)
    - Building operators or managers
    - HVAC installers
    - Resort management

For the post-workshop survey, there were 3 respondents from IL, 2 respondents from HI, and 1 respondent from NV. Of the 6 respondents, there were 4 educators and 2 government code officials. Overall, most survey respondents reported that they were likely to use the curriculum, were confident in their ability to teach it, and were willing to recommend the curriculum to others. Refer to Figure 26, Figure 27, and Figure 28.

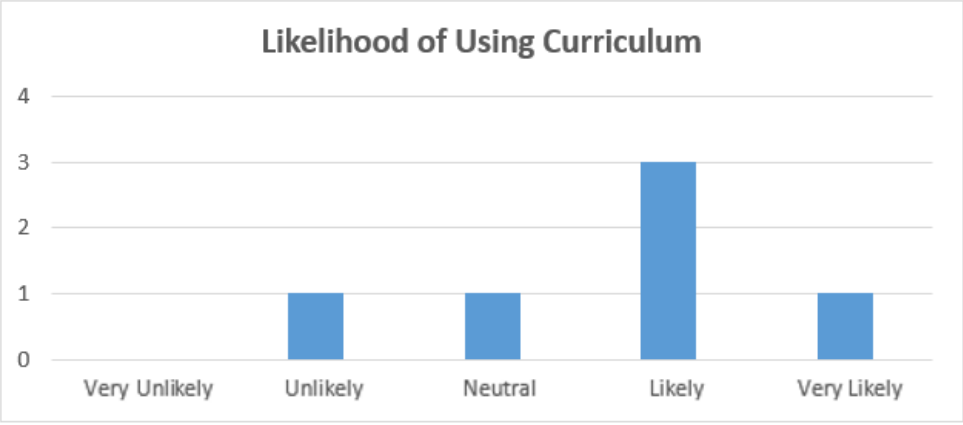

Figure 26. Attendee Survey Responses Indicating Likelihood of Using the Curriculum

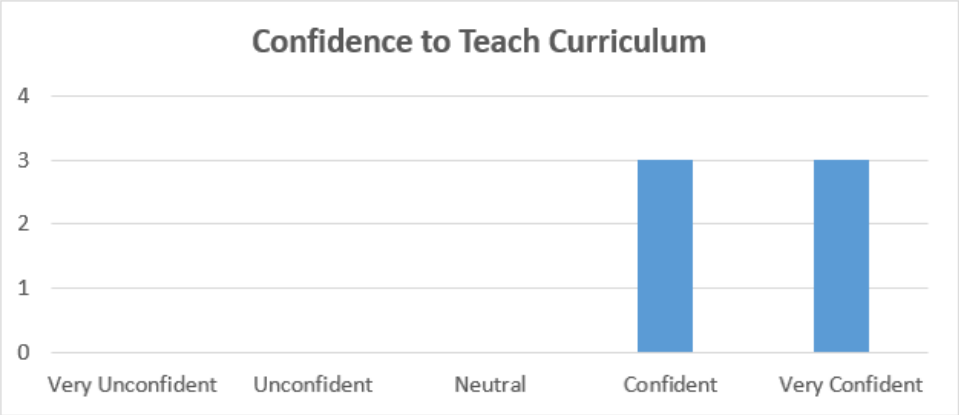

Figure 27. Attendee Survey Responses Indicating Confidence in Ability to Teach the Curriculum

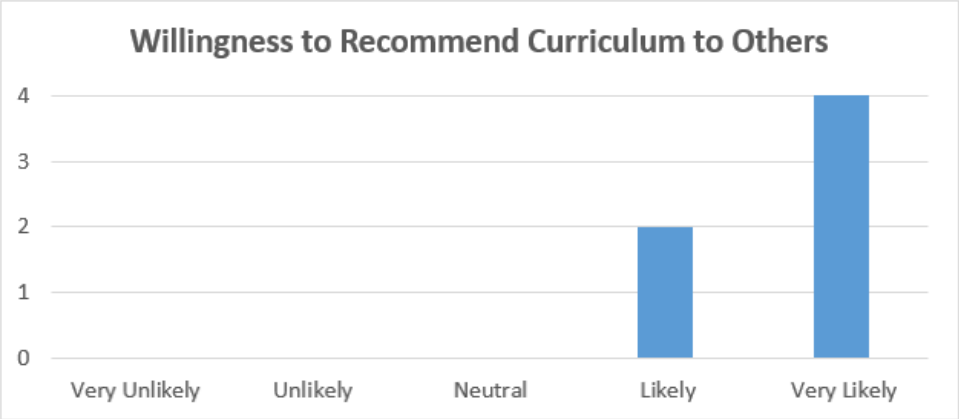

Figure 28. Attendee Survey Responses Indicating Willingness to Recommend the Curriculum to Others

4.6.5. Overall Summary of Train-the-Trainer Launch Events

Overall, we conducted 6 events – 5 launch webinars in IL, NV and HI, and an all-state train-the-trainer workshop. The overall participation summary is presented in Figure 29. Overall participant satisfaction is presented in Figure 30.

For the Hawaii launch webinars, we hosted a series of 3 webinars and provided professional continuing education credits. At the Nevada launch webinar, we incorporated a panel discussion with industry professionals. For the Illinois launch webinar, we had a speaker from the Illinois Department of Commerce and Economic Opportunity (DCEO) to further discuss the workforce development aspect of the program, and speakers from community colleges to share their experience in utilizing the BEE Fundamentals curriculum. For the train-the-trainer workshop for all states, we had breakout room discussion sessions to conduct “Syllabus Scavenger Hunt” activities, where we utilized a Miro Board to find appropriate resources from the BEE Fundamentals curriculum for an example class, Residential Energy Auditing. It took longer than we expected for participants to navigate the Moodle site, but it provided an opportunity for participants to become familiar with the curriculum structure.

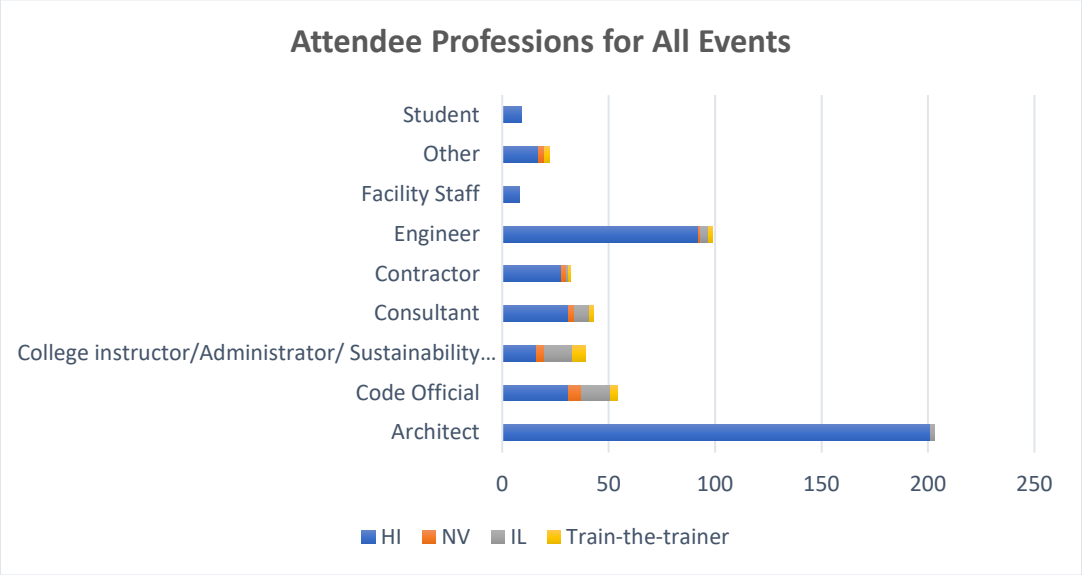

Figure 29. Attendee Professions for All Events

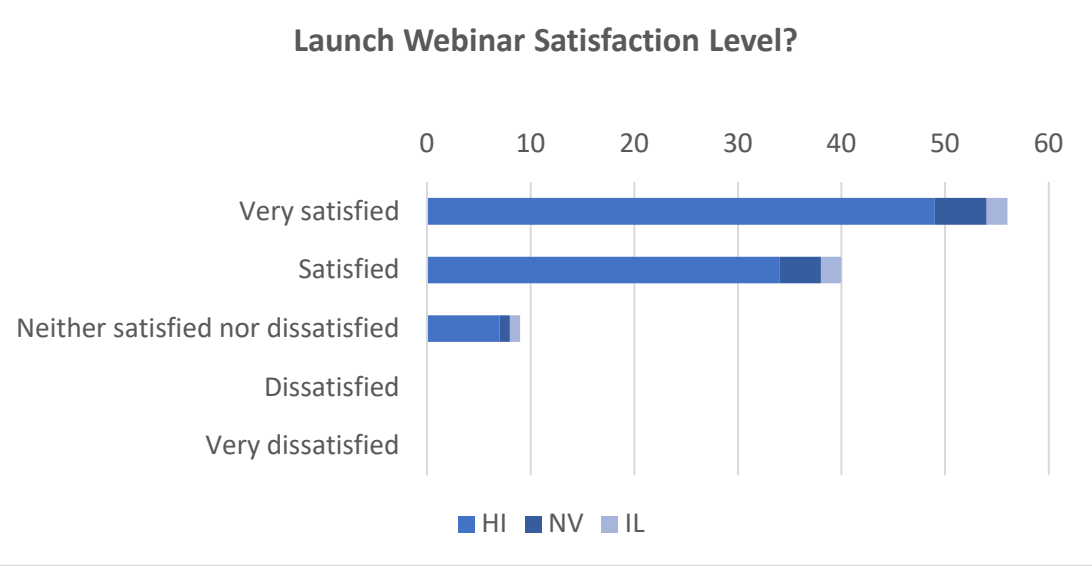

Figure 30. Survey Result: Degree of Satisfaction of All Launch Webinars

4.7. Curriculum and Outreach Toolkit Development Results (Task 8)

4.7.1. Outreach to Drive Curriculum Use

The project team conducted extensive outreach to community college instructors and other building design and construction professionals to encourage use of our modules. Through this outreach, we solicited 12 letters of commitment from community college instructors to utilize the curriculum, 8 from Illinois, 2 from Nevada, and 2 from Hawaii. As a result of our outreach efforts, a total of 170 participants utilized our modules, including 60 instructors, 26 students, 16 engineers, 14 code officials, 11

consultants, 9 architects, 3 facility staff, 2 contractors, and 29 other professionals as of June 30, 2023. For more discussion about the participant information, refer to section 4.4.3 in this report.

4.7.2. Final Outreach Push to Support National Dissemination of the Curriculum

The final objective of the project was to promote wider distribution and sustainability of the training program through a national network of state energy offices and community colleges. We sought to gain letters of commitment from at least five state energy offices, indicating their commitment to promote the curriculum through their networks. Unfortunately, despite extensive outreach, we received two letters of commitment from State Energy Offices:

- **Maine:** Dan Burgess, the Director of Maine Governor's Energy Office, confirmed their support of the BEE Fundamentals Program. He wrote, "We are excited about the opportunity to extend this energy code training to community college instructors, training providers, and building professionals." He indicated that the training aligns with their vision to train the next generation of energy code officials and design professionals.
- **Northern Mariana Islands:** Thelma B. Inos, Director of the Office of Energy Efficiency and Renewable Energy for Northern Mariana Islands, committed to participate in the BEE Fundamentals Program by promoting the program at the islands' community college. "We have the capacity to engage in outreach and training activities to support this program and help ensure its success," she wrote.

However, State Energy Offices are not the only organizations that can connect instructors and potential users of the curriculum. We found that other organizations may be better positioned to broaden the curriculum's reach. Thus, we identified other types of organizations that could reach community college instructors and other end users (trade programs, building design and construction professionals, etc.). We reached out to union trade programs, community college networks, state workforce entities, and green business programs to provide information about the Program and to solicit interest. Based on these efforts, we received Letters of Commitment from the following three organizations.

- **Illinois Green Economy Network (IGEN).** IGEN is a community college network that provides training resources and support to Illinois community colleges. IGEN Executive Director David Husemoller expressed IGEN's commitment to promote the BEE Fundamentals Curriculum. He noted that the "BEE Fundamentals curriculum will help equip students with skills and proficiencies for designing and constructing energy efficient buildings of the future."
- **The Heat and Frost Insulators Local 17** expressed willingness to "promote BEE Fundamentals as a resource to teach clean energy basics and highlight how mechanical insulation plays a role in efficient and safe building systems."
- **Community Climate Collaborative.** The Community Climate Collaborative, an organization that promotes green business operations and training in Virginia, expressed commitment to amplify and share the BEE Fundamentals Program with businesses. Director of Corporate Sustainability Coles Jennings wrote, "There is a great need for increased energy efficiency and sustainability education in the building sector. . . I am confident that BEE Fundamentals curriculum will help our team continue to direct businesses to energy efficiency opportunities and help train new professionals on building energy efficiency."

4.7.3. Outreach Toolkit Product Developed

The BEE Fundamentals curriculum site (https://smartenergy.illinois.edu/bee_fundamentals/) provides links to outreach toolkit, the curriculum, and other program resources. The outreach toolkit is posted at https://smartenergy.illinois.edu/bee-fundamentals-outreach-toolkit/, and it contains materials to support the dissemination efforts of interested partners. It includes a flier, messages for newsletter and social media, and videos that organizations can utilize to spread the word about the BEE Fundamentals curriculum. It also contains a link to the Instructor Toolkit and Q&A. See Figure 31.

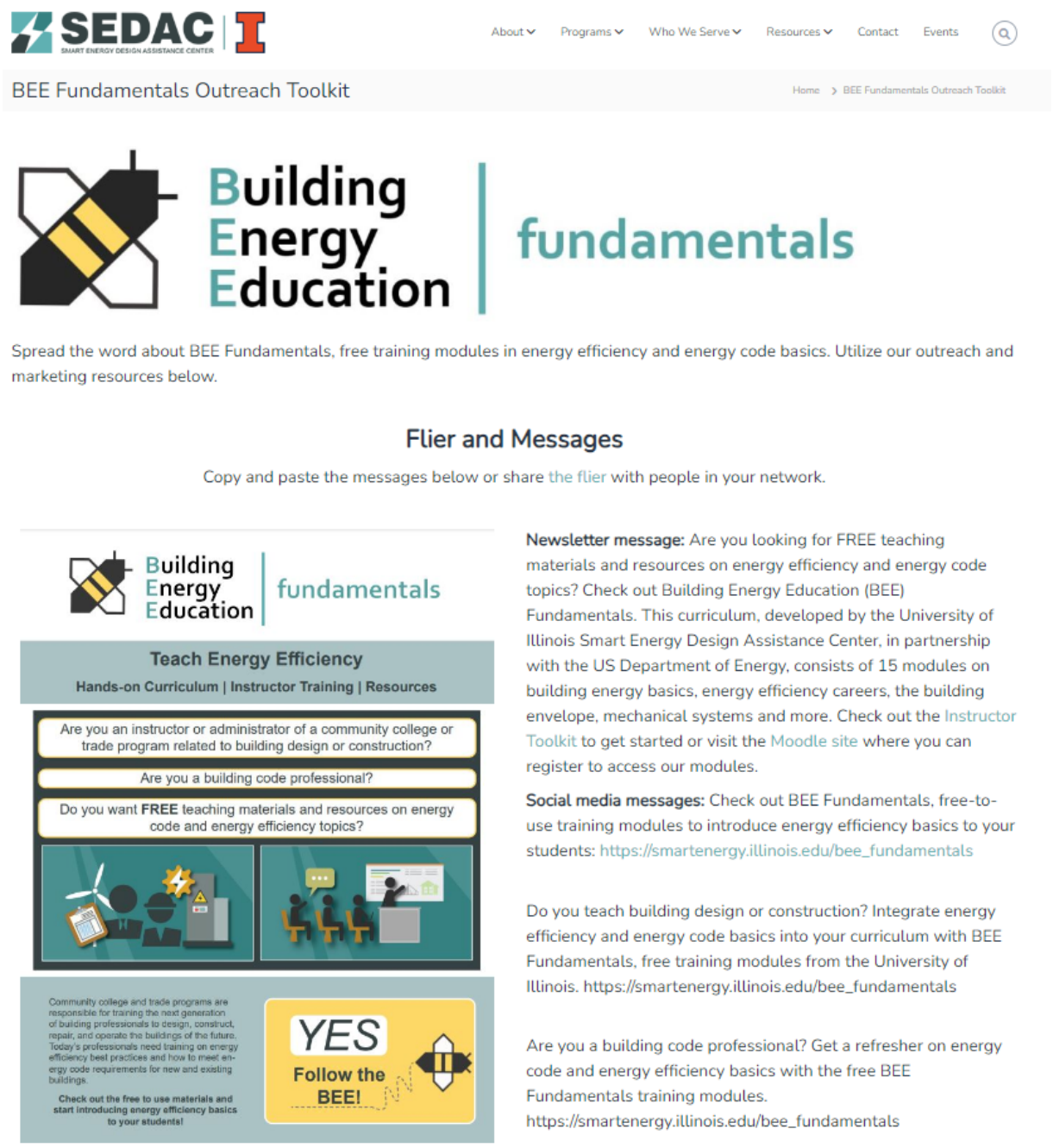

Figure 31. Screenshot of webpage for the BEE Fundamentals Outreach Toolkit

5. Findings

5.1. Training Needs and Interest Assessment Findings

Our needs assessment results suggest that: a) there is interest in integrating energy code/energy efficiency curriculum into existing courses, and b) the most feasible approach to deliver this content is to develop a series of short learning modules with subtopics, resources, videos, and activities that can be easily integrated into lectures, labs, supplemental materials, and homework assignments.

Training need and interest

Improved energy code training plays a recognizable role in improving energy code compliance. Our stakeholder outreach and literature review reinforce the argument for more energy code and energy efficiency training at the community college level. According to the stakeholders we interviewed, architects are most knowledgeable of the energy code, followed by code officials, and last of all construction managers and contractors. While most energy code training is offered through continuing education credits to existing professionals, there is a large gap related to energy code and energy efficiency training in the programs that train design and construction professionals.

Most of the instructors we interviewed expressed an interest in receiving curriculum and resources related to energy codes and energy efficiency. There was interest in energy code and energy efficiency training that is integrated into existing community college and trade program curricula. Our results suggest that energy code training will be most successful if it explores the "why" and "how" of energy code compliance, not just the "what." Instructors expressed a desire for curriculum that uses a whole-building-system approach, and that provides ample opportunities for students to practice what they are learning in real-life scenarios or in the field.

Many of the instructors we interviewed were strong advocates for building science and energy efficiency and were already including energy efficiency content in their curriculum. However, they noted they were not representative of the other instructors in the field. They also admitted gaps in their knowledge of energy codes and standards. They expressed a desire for "train the trainer" workshops, especially regarding the energy code.

The code officials we interviewed expressed a desire for more awareness of code professional and energy efficiency careers. They recommended ways to provide guidance to students interested in pursuing these careers. Code professionals and energy efficiency employers report extreme hiring difficulties and note that a lack of awareness of these careers contributes to hiring difficulties. Best practices to raise awareness of these careers include a) highlighting the career benefits, b) providing clear information about career pathways, and c) connecting students with professionals through class visits, job fairs, field trips, job shadowing, and apprenticeship/internship opportunities. These strategies will increase awareness and lead students towards energy efficiency and building code careers.

Feasibility of training program

To assess the feasibility of integrating new content into existing curriculum, we surveyed existing community college training programs related to building systems, building design, or construction in Illinois, Nevada, and Hawaii. There were 29 colleges in Illinois with related programs, 4 colleges in Nevada, and 4 in Hawaii. The majority of these programs were technical or management programs in drafting and engineering, architecture, construction technology, and construction management. There were fewer traditional building trades programs in electrical, carpentry, HVAC/R installation and repair,

as most trades training is offered through unions. Less than half of these programs had dedicated curriculum on building codes (and only 2 specifically addressed the energy code). Likewise, most programs did not offer courses specifically related to energy efficiency. Reading through course descriptions and syllabi suggests that there are a fair number of courses that address energy efficiency or building codes as subtopics, but there is an opportunity to integrate energy efficiency and energy code content into more existing courses.

Instructors we interviewed agreed that energy efficiency and energy code content should permeate the curriculum, rather than being approached as a stand-alone topic. However, many also noted the challenge of making significant changes to existing curriculum, which typically requires consultation with a curriculum advisory board and administrative approval. Most instructors preferred small add-on elements to curriculum, rather than major changes or stand-alone courses.

We verified that the most feasible program approach in the short term is to integrate targeted and accessible energy efficiency and energy code content into key coursework to form a foundation of energy awareness for the new generation of building professionals. There should be no expectation for instructors to use all of the curriculum in their courses. Instead, they should be encouraged to select the content that best fits their individual course needs from a menu of topics, resources, videos, and assignments.

In the long term, we see an opportunity to forge connections between State Energy Offices and colleges to leverage the resources and reach of each to integrate and implement rapidly evolving advances in energy efficiency on the ground and in the professions where they are most needed.

Curriculum approach and topics
Based on the results of our needs assessment, we determined that curriculum was needed for 3 types of programs: 1) construction management/construction tech programs; 2) architectural technology/engineering/drafting programs; and 3) traditional trade programs related to carpentry or HVAC/R.

The instructors we interviewed expressed a need for “big-picture basics” related to energy efficiency. They wanted to help “selling” energy efficiency to students and helping them understand building science basics. They were less interested in the finer details of the energy code. Code officials and instructors noted a need for training on mechanical equipment and sizing, as well as code implementation technology, code updates and amendments, climate differences, and career paths. They expressed an interest in hands-on, visual material to reinforce topics and enhance learning.

Further, we developed a preliminary list of curricular topics to address. Identified module topics included

- Intro topics (codes and standards careers, energy basics, energy code basics);
- Envelope topics (envelope basics, insulation, air barriers);
- Mechanical/electrical/plumbing topics (Manual J™, duct leakage testing, lighting, domestic hot water),
- Existing building renovation topics, and
- Beyond code topics (net zero, ENERGY STAR®, renewables).
- Online resources and activities that can be utilized during the COVID-19 pandemic

We turned to the DOE's Guidelines for Building Science Education (GBSE) and the Building Science Education Solution Center to determine how our proposed curriculum might align with core building science concepts and existing training resources. We identified the core building science topics that relate to our proposed training modules and used the guidelines to identify the proficiency levels required for different professions served by the community college training programs.

Finally, we reviewed the Building Science Education Solution Center to identify existing resources that we can leverage as we develop our modules. We identified gaps in resources that we can fill with our training program. Our needs assessment suggests that instructors would welcome more interactive, multi-media, hands-on resources and activity ideas to help their students engage with the content more.

5.2. Train-the-Trainer Workshop Findings

Even though it was challenging to provide presentations that satisfied diverse attendees' interests and different levels of expertise, participant feedback results led us to the following conclusions:

- **Our educational content and materials demonstrated effectiveness in increasing energy literacy.** Of the survey respondents, 89% either agreed or strongly agreed that the events improved their knowledge of the building energy fundamentals and energy code basics.
- **More effective strategies to recruit participation by college instructors are needed.** A total of 509 participants from diverse professions participated in the events. However, only 39 (8%) of them were from our main target audience group – community college instructors. Recruiting college instructors has been an ongoing challenge of the program. We have used various outreach strategies, including targeted emails by SEDAC and the State Energy Offices; quarterly newsletters featuring curriculum highlights and instructor interview videos; and outreach to organizations (Illinois Green Economy Network, National Council of Workforce Education, Illinois Community College Board, Illinois Community College Faculty Association, AIA Nevada, AIA Honolulu, and Hawaii State Building Code Council). A bottom-up outreach strategy, where we reach out directly to college instructors and professionals, might be more effective than a top-down approach, where we reach out to organizations who represent their members.
- **Explore opportunities to strengthen partnerships that connect State Energy Offices, colleges, and code officials.** The State Energy Offices of Illinois, Nevada, and Hawaii hosted the launch webinars in their respective states. Each office sent out the invitations, set up the registration, and sent out the feedback surveys. SEDAC intentionally used this strategy so that the State Energy Offices could build strong relationships with participants, especially college instructors. A total of 54 (11%) code officials participated in the events. Some of them participated as panelists and guest speakers to share their career experiences, which was well-received.
- **Explore connections with workforce development to increase the level of interest and engagement by other related stakeholders.** This is a preliminary finding, but further exploration was outside of the scope of this project. However, the level of interest about our content related to related career paths indicate that this is a topic worth deeper evaluation.

5.3. Curriculum Evaluation Findings

The evaluation of the Building Energy Education (BEE) Fundamentals curriculum demonstrates a high level of satisfaction among industry experts, community college instructors, and students. The feedback received highlights the relevance, quality of content, usability, and engaging activities within the

curriculum. Furthermore, the steady increase in registrants and the number of courses completed show that the curriculum effectively serves its target audience and meets their needs.

The participant feedback and data analysis from the learning management system suggest that the curriculum is reaching the intended audience of current and future energy code and design professionals. The modules have proven to be effective learning tools, increasing participants' knowledge about energy efficiency and energy codes. Moreover, the level of content was found to be appropriate for most participants, with the majority stating that the content was just right.

In conclusion, the BEE Fundamentals curriculum has made significant strides in increasing participant knowledge of advanced design and construction practices among instructors and students. By incorporating the valuable feedback received from industry experts and participants, the program can make necessary adjustments to further enhance the curriculum, better meet industry needs, and ultimately expand participation beyond the partnering states of Illinois, Nevada, and Hawaii.

Continued efforts will be made to address any areas for improvement highlighted in the feedback, such as diversifying in-module activities and refining content based on expert suggestions. By maintaining a focus on delivering a high-quality, relevant, and engaging curriculum, the BEE Fundamentals program will continue to contribute to the growth and development of professionals in the energy efficiency and energy code sectors. Although the tracked utilization by students fell short of the project goals, the content of the curriculum was downloaded and utilized by instructors, and therefore, it was difficult to determine how many end users were encountering our curriculum. Future efforts at tracking impacts via student utilization will need to address this issue.

5.4. Outreach Findings

We were surprised at the difficulty engaging the sustained interest of State Energy Offices, despite earlier successful engagement and expressions of interest by multiple State Energy Offices. It is possible that some State Energy Offices may not have strong connections with community colleges, and they were unsure of how they could promote the curriculum to community colleges. Some State Energy Offices responded positively, but they were too busy responding to new federal funding programs and were not able to overcome the administrative hurdle of getting authorization to provide a signed letter of commitment.

However, we are encouraged by the response by State Energy Offices and other organizations that ultimately submitted Letters of Commitment. Each of these entities identified different ways to use the program. The Community Climate Collaborative anticipates promoting the curriculum to training providers and building professionals to make buildings more sustainable. The Insulators Union provides training and consulting to the building industry and anticipates utilizing the BEE Fundamentals in their union training program. The State of Maine has many connections through their Clean Energy Partnership and has a goal to double the clean energy and efficiency workforce to reach 30,000 workers by 2030. They see the BEE Fundamentals program as key in achieving that goal. Northern Mariana Islands will utilize the BEE fundamentals program to expand local education and job opportunities for young people. IGEN anticipates students across their community college network utilizing the BEE Fundamentals curriculum to increase their ability to design and construct energy efficient buildings. These letters of support demonstrate a range of uses and benefits.

Some organizations that we contacted did not submit letters of commitment but are nevertheless utilizing or promoting the curriculum. The Illinois Department of Commerce and Economic Opportunity (DCEO) is already promoting and utilizing portions of the BEE Fundamentals Curriculum in their Clean Jobs Curriculum Framework, a standard curriculum that will be taught in 13 clean energy workforce hubs and 4 Illinois prisons throughout the state. The BEE Fundamentals Curriculum will be promoted as part of the "clean energy basics" portion of the curriculum to introduce people to building energy efficiency fundamentals. The programs will begin training participants in January 2024.

6. Conclusions and Suggestions for Future Research

6.1. Conclusions

Our stakeholder outreach reinforced the argument for more energy code and energy efficiency training at the community college level. The following summarizes our major conclusions from the needs assessment, curriculum evaluation, and outreach efforts described above.

Needs assessment:

- Community colleges would welcome the opportunity to incorporate more energy efficiency and energy code topics into their existing courses.
- Instructors prefer an "a la carte" curriculum approach, rather than teaching the curriculum in its entirety, as energy efficiency and energy codes are best integrated into many building and construction topics.

Curriculum evaluation:

- Reviewers had overall positive interactions with the curriculum and were enthusiastic about using it in the future.
- Changes to improve the usability and hands-on nature of the curriculum will encourage usage of the curriculum.

Outreach feedback:

- Reaching out directly to community college instructors was more effective than communicating through newsletters and larger organizations who represent their members.
- Broadening the target audience focus from community college instructors to other end users is important. Building design and construction professionals were more interested in our curriculum than previously assumed—reaching out to them is a good strategy to increase participation.

Based on our outreach to drive curriculum use by instructors and students, we suspect that the number of students who are using the curriculum is much higher than captured in the Moodle Learning Management System because instructors downloaded the training materials from the Moodle site and utilized them in their classrooms using their own platforms and methods. It is impossible for Moodle to capture the number of students who are exposed to downloaded materials. This is a utilization tracking issue that should be addressed in any related future efforts.

Our efforts to promote the BEE Fundamentals program nationwide have met the project outreach targets. Our team has received 5 letters of commitment from entities who agreed to promote the BEE Fundamentals across their organizations and those they work with. They see the value in using the program to educate people about building energy basics. To help organizations promote the curriculum, SEDAC developed a marketing toolkit that people can use to market and explain the program to those in their network. While we only received 2 letters of commitment from State Energy Offices, we obtained additional letters of commitment by expanding our outreach to union trade programs, community college networks, state workforce entities, and green business programs. We are confident that awareness and use of the curriculum will continue to grow in subsequent years.

Though we initially targeted community college instructors and their students, our outreach efforts suggest that this curriculum is likely to interest a broad range of audiences. This includes high school students in construction programs or technology classes, college students or apprentices in trade programs, or those who are entering building related trades such as architects, engineers, code officials, or project managers. Even while the specifics of codes will change over time, building energy basics will always be relevant.

State Energy Offices that utilize the BEE Fundamentals Program in their energy code training programs (such as SEDAC's Energy Code Training Program) will be able to increase knowledge of energy efficient design and construction practices among architects and code officials. Community colleges and other workforce and trade programs that utilize BEE Fundamentals will be able to increase awareness of energy efficiency employment opportunities and promote energy efficient practices.

6.2. Continued Use of BEE Fundamentals

We are seeing continued interest in the BEE Fundamentals curriculum from past users. This fall we had returning utilization of our modules in Moodle from the following schools and organizations:

- Community Climate Collaborative in Virginia
- McHenry County College in Illinois
- Arkansas State University in Arkansas
- Addison Township in Illinois

It is likely that other community college instructors and other users have downloaded the BEE Fundamentals materials from our Moodle site and are continuing to use them. We have encouraged instructors to download the materials and incorporate them into their own curriculum content. Instructors and other users who want to avoid operating multiple learning management systems may download the materials from the Moodle system and upload them to their college or organization learning management system to streamline their training. This will mean that the training will likely reach more users than we can track through our Moodle site. It will be difficult to track the curriculum's continued use beyond the initial download.

SEDAC and its State Energy Office Partners in Illinois and Hawaii continue to utilize portions of the BEE Fundamentals curriculum in their energy code training programs. All three organizations have regular opportunities to train code officials and architects about energy efficiency and energy codes. The content of BEE Fundamentals curriculum has permeated SEDAC's energy code training materials. The materials have also been utilized in building energy fundamentals courses taught by SEDAC at the University of Illinois.

SEDAC maintains ongoing collaborative networks that support continued outreach. The Illinois Green Economy Network (IGEN) is a consortium of Illinois community colleges that works to advance the green economy in Illinois. Envirolution is a non-profit organization that is working closely with K-12 teachers on energy related curricula and activity development. SEDAC has participated in the National Council for Workforce Education (NCWE)'s meetings with IGEN faculty members to develop energy efficiency courses such as: 1) Solar, 2) Weatherization, Building Performance, Green Construction and Net Zero, and 3) Air Source Heat Pumps. NCWE staff participated in the BEE Fundamentals program and are

encouraging their members to participate. SEDAC plans to continue collaborating with NCWE on outreach and educational material development.

In short, though the BEE Fundamentals was initially thought of as an entry-level curriculum, we have found much of the content to be relevant for university students in energy coursework and building and design professionals. We regularly utilize portions of the BEE Fundamentals in the energy code training we provide for building and design professionals and code officials, suggesting the need for a "refresher" in building energy fundamentals for existing professionals.

6.3. Suggestions for Future Research

To date, the Building Energy Education (BEE) Fundamentals curriculum has been utilized by 60 community college instructors who accessed the modules on our Moodle site. As noted, building professionals (including architects, engineers, and building code professionals) have also shown an interest in the curriculum. Nearly 950 encountered the curriculum through webinars, and 84 professionals accessed the curriculum directly through the Moodle site.

We were surprised that the interest of existing professionals exceeded the interest of our target community college audience. Future work should explore how the BEE Fundamentals program is used and whether it is appropriate for its intended audience, or whether the audience for the program should be expanded.

Future research should also explore the impact of the program on end users: the students. It was difficult for the project team to collect information from end users because most community college instructors downloaded the curriculum from the Moodle site for use in the classroom. Thus, we were not able to collect information such as quiz results and student feedback. Future research could work with instructors to collect information to assess student learning outcomes and gather student feedback.

We had limited success soliciting commitments from State Energy Offices and other organizations beyond Illinois, Nevada, and Hawaii to share and promote the curriculum. We recommend that future research consider other ways to expand the curriculum's reach. Strategies might include reaching out to instructor consortiums and linking it on existing educational resource websites produced by DOE and other entities.

While the curriculum is meant to be an a la carte experience (with instructors choosing the parts that are relevant to their existing courses), future research should consider whether instructors may wish to utilize the curriculum as a whole. Credentialing organizations may be interested in providing certifications based on completion of this curriculum.

Finally, our curriculum presents building energy education basics that are based on the most recent energy efficiency codes and standards. Because these codes and standards are continually being updated, future research should consider how these materials can remain current in the future. Updates to the curriculum should be considered to integrate new technologies related to energy efficiency design and construction.

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