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Community College Energy Code Training Needs Assessment

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Executive Summary

The University of Illinois Smart Energy Design Assistance Center (SEDAC), in collaboration with the State Energy Offices of Illinois, Nevada, and Hawaii, conducted a needs assessment to evaluate interest in and feasibility of a Community College Energy Code Training Program in these three pilot states: Illinois, Nevada, and Hawaii. This work is funded by the Office of Energy Efficiency and Renewable Energy (EERE), Department of Energy (DOE). The award number is DE-EE0009092.

We interviewed community college administrators, instructors, and local code officials to assess interest in and feasibility of offering energy code training to students. In addition to this stakeholder outreach, we surveyed existing community college programs and curricula to identify training gaps and feasibility of integrating new curriculum into existing content. 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.

Need for and interest in training

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 we will focus on developing curriculum 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.

Conclusions and next steps

This needs assessment has led us to conclude 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.

Our next steps are to:

- Gather syllabi from interested community college instructors. Review syllabi to identify curriculum gaps and explore ways to integrate training modules in these courses.
- Form a technical advisory committee to offer feedback on developing the training modules and make sure they align with industry and college needs.
- Leverage existing resources to develop the modules.
- Continue to reach out to more community college instructors to invite them to adopt the curriculum modules in their courses.
- Test the modules with a handful of instructors and gather feedback.
- Train participating instructors to utilize the curriculum.
- Assist participating instructors in delivering the curriculum and evaluate the results.

We look forward to our continued partnerships with the Department of Energy and the State Energy Offices of Illinois, Nevada, and Hawaii as we develop and deliver this training program.

Introduction and Methods

The Smart Energy Design Assistance Center (SEDAC), in collaboration with the State Energy Offices of Illinois, Nevada, and Hawaii, conducted a needs assessment for a Community College Energy Code Training Program. This work is funded by the Office of Energy Efficiency and Renewable Energy (EERE), Department of Energy (DOE). The award number is DE-EE0009092.

The overarching goal of the training program is to prepare a new generation of energy-literate professionals that will be responsible for widespread adoption of energy efficiency in new construction and existing buildings. Because we intend to pilot our training program in Illinois, Hawaii, and Nevada, we focused our training needs assessment on these three states.

The purpose of the needs assessment is to evaluate interest in and feasibility of our proposed training program in these three states. 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 in particular on DOE's Guidelines for Building Science Education (GBSE) as well as the resources in the Building Science Education Solution Center.

We present our results in three sections. First, we explore the need for and interest in energy code training and energy efficiency training at the community college level. Next, we present the results of our survey of community college programs and curriculum in the three target states to determine what is and isn't being taught and how energy code/energy efficiency curriculum might feasibly be integrated into this curriculum. We explore key factors in the short term and long term feasibility of incorporating

curriculum changes. Finally, we review best practices and building science education guidelines to determine the content and proficiency levels for the training program, and to chart a path forward.

Need for & Interest in Training

Energy code training

One important way to improve compliance with energy codes and standards, and thereby improve the efficiency of new and existing buildings, is to enhance education and training efforts. 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).

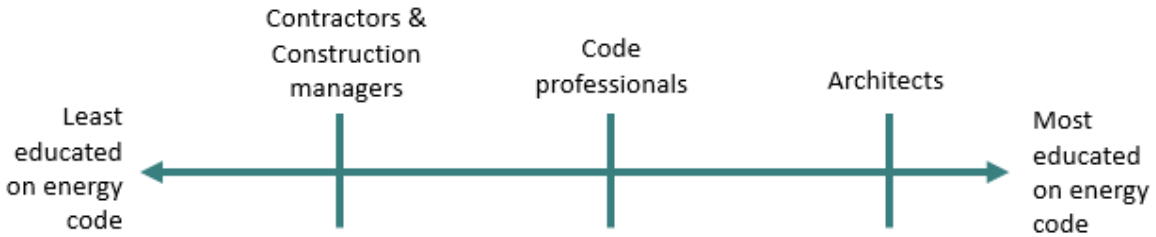

Figure 1. Level of energy code education for building and construction professionals

The code officials we spoke to said that architects used to be unfamiliar with the energy code, but that has changed. They are often introduced to the energy code in their schooling, and their licensure programs require them to receive continuing education credits. Energy code workshops and webinars are an easy way to meet these continuing education requirements. While they are familiar with energy code requirements, one code official noted there were still issues. 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. Because code officials lack a basic understanding of the energy code, they typically rely on architects to determine compliance, according to one participant. He noted that 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 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 educated about 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, people in the trades were "not motivated to learn" about the energy code. One code official argued, "The general contractors are the ones that need to be required to take energy training. Most contractors here feel that as long as they have R13 in the walls and R19 in the ceilings, that's good enough. Any more is a waste of money and only adds cost to build. They do not care that a more energy compliant home saves the homeowner energy costs." Code officials complained that they "got resistance from following the code" because 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 eduction, 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, for instance, remarked that he was in the process of getting rid of his building codes class and instead integrating building codes into several of his other courses. He 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.

On the other hand, one instructor in Southern Nevada indicated that his construction management students were not very interested in Energy Code trainings because the major focus is on large projects that generally seek LEED accredidation and have specialists employed to manage those aspects of the project. Other interviewees pointed out that the requirements of LEED accreditation often fall short of minimum requirements for IECC code compliance in Nevada. Still, this instructor linked LEED and energy codes together 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

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.

Of course, 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.

Although some of the instructors of community colleges we interviewed indicated that energy efficiency is included in the curriculum, 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 and colleagues 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. Peters et al. (2010) noted that most of this on-the-job training relied on older, more experienced employees who may not be familiar with new techniques and approaches.

This 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. One of our interviewees noted that instructors struggled to keep up with new technology and energy code changes.

Our interviews with energy efficiency employers and community college instructors support these 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 described recommendations to fill skill gaps of community college programs--namely, 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 is 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, the majority of 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

Building code careers. 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 of 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.

Feasibility of Training Program

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 1 shows the breakdown of these programs.

Table 1. 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

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).

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 2). 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.

Table 2. Community college coursework focused 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

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.

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 3 for an overview of the number of courses in energy efficiency, energy codes, and building codes.

Table 3. 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 Approach and Topics

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:
    1.1. Introductory courses (intro to building construction)
    1.2. Construction materials and methods
    1.3. Mechanical systems courses
    1.4. Courses that introduce building codes
    1.5. "Green" sustainable courses
2. There were 36 **architectural technology/engineering/drafting programs** in Illinois 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:
    2.1. Intro courses (Construction of buildings, Construction 1 and 2)

2.2. Materials and methods courses
2.3. Detailing and construction documents courses
2.4. Mechanical/electrical courses
2.5. Building systems courses
2.6. Building codes courses
2.7. Sustainability courses

3. There were 19 traditional **trade programs** related to carpentry or HVAC/R in Illinois, 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:
    3.1. Fundamentals of construction
    3.2. Carpentry and concrete
    3.3. Rough frame construction
    3.4. Air conditioning
    3.5. Heating
    3.6. Load calc/duct system design
    3.7. Energy management principles

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.

Preliminary curriculum outline

Based on our review of literature and discussion with code officials and instructors, we developed a list of potential curriculum topics. In general, the topics focus on high-level basics that address the "why" and "how" of the energy code, with an emphasis on energy efficiency and technologies that different professionals will need to be familiar with.

- Intro topics
    - Codes and standards professions/career paths
    - Energy basics (What is energy? How do we measure it? Heat transfer, etc.)

    - Energy code basics
        - The why: Cost/energy savings benefits of energy code
        - The what: Energy codes, standards, updates, and amendments
        - The how: Compliance paths + compliance software
- Energy codes and standards about **envelope**
    - Envelope & insulation basics (heat transfer, U value, R value . .)
        - Wall insulation
        - Roof insulation
        - Air barriers & blower door
- Energy codes and standards about **mechanical/electrical/plumbing** (MEP)
    - Manual J/N/S/D
    - Duct leakage testing
    - Lighting—interior and exterior
    - Domestic hot water
- Energy codes and standards for **existing building renovations**
- Beyond code
    - Net Zero
    - ENERGY STAR®, renewables, etc.

The topics will be adapted to the needs of the different programs (trades, construction management, architecture). Core competencies and proficiency levels will be tailored to these programs. In addition, the envelope and MEP topics will need to account for climate differences in the three states. However, the goal will be to focus on the general energy efficiency principles and how to reference the code, rather than the specific regional requirements.

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 4 below 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.

Table 4. 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?

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 5 below lists the proficiency levels for each of these topics.

Table 5. Proficiency levels for building science topics by job category (from GBSE except where highlighted)

Building science topic	Bldg Code Official	Contractor: Builder, remodeler, HVAC	Constr. Manager	Arch. Engr.
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.

Table 4 above reflects these proficiency levels for the different types of programs. Note that the curriculum is still in the early development phase, and we will work with our technical advisory committee to determine objectives, proficiency levels, and content for each module.

Utilizing existing resources

The Building Science Education Solution Center has many useful resources that we intend to leverage to develop our modules. The Building Science Topics page, for instance, contains learning objectives, lecture notes, teaching materials, and problem sets for many of the building science topics listed above. Learning objectives are organized by proficiency level for some topic areas so that instructors can tailor the content to what their students need to know in their professions. In addition, there are images, presentations, videos, and handouts on a variety of the building science topics we will be addressing.

These resources are by no means comprehensive, however. Several of the building science topics (control layers, whole building performance, and integrated design and construction, for instance) have

few if any available resources. The available lecture notes are presented in word document, with few visuals and little engaging content that might help students apply the content. Problem sets are generally multiple choice. Only a few topics have videos or presentations and those do not stand alone without an accompanying lecture. There are few ideas for activities that might help students apply or demonstrate their understanding. In addition, the codes and standards topic is approached as a stand-alone topic, and not integrated into the other topics. This is a missed opportunity to introduce the larger context behind energy codes and standards, and to show how requirements impact building components and energy use.

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. We will therefore work to leverage existing materials and create new ones that can increase the proficiency levels of students. Our goal is not to duplicate material already created, but to supplement it and fill any gaps that are present, especially with regard to codes and standards topics.

Conclusion and Next Steps

Based on the results of this needs assessment, we conclude that a) there is a need for more energy code and energy efficiency training at the community college level, b) there is interest in integrating energy code/energy efficiency curriculum into existing courses, and c) it is feasible to integrate short, interactive training modules and resources into existing courses. While there are many existing courses that address building codes and energy efficiency, these courses are far from sufficient in preparing students to apply energy codes and standards in their professional careers. Our next steps are to:

- Gather syllabi from interested community college instructors. Review syllabi to identify curriculum gaps and explore ways to integrate training modules in these courses.
- Form a technical advisory committee offer feedback on developing the training modules and making sure they align with industry and college needs.
- Leverage existing resources to develop the modules.
- Invite community college instructors to adopt the curriculum modules in their courses.
- Test the modules with a handful of instructors and gather feedback.
- Train participating instructors to utilize the curriculum.
- Assist participating instructors in delivering the curriculum and evaluate the results.

We look forward to our continued partnerships with the Department of Energy and the State Energy Offices of Illinois, Nevada, and Hawaii as we develop and deliver this training program.

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