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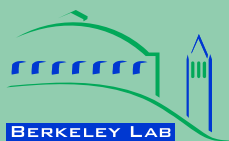
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Energy Efficiency Services Sector: Workforce Education and Training Needs

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*** Lawrence Berkeley National Laboratory
** Research Into Action, Inc.**

**Environmental Energy
Technologies Division**

March 2010

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Energy Efficiency Services Sector: Workforce Education and Training Needs

Prepared for the
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

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Acronyms and Abbreviations

AEE	Association of Energy Engineers
AESP	Association of Energy Services Professionals
AIA	American Institute of Architects
ARRA	American Recovery and Reinvestment Act
ASEE	American Society for Engineering Education
ASHRAE	American Society for Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
BCA	Building Commissioning Association
BLS	Bureau of Labor Statistics
Btu	British thermal unit
BOMA	Building Owners and Managers Association
BPI	Building Performance Institute
CEE	Consortium for Energy Efficiency
CEEBS	Center for Energy Efficiency and Building Science
CEM	Certified Energy Manager
COMNET	Commercial Energy Services Network
DOE	Department of Energy
EE	energy efficiency
EERE	(DOE Office of) Energy Efficiency and Renewable Energy
EESS	energy efficiency services sector
EIA	Energy Information Administration
ESCO	energy services company
EUCI	Electric Utility Consultants Inc.
FTE	full-time equivalent
FY	fiscal year (for federal government, starts October 1)
HERS	Home Energy Rating System
HVAC	heating, ventilation, air conditioning
IAC	Industrial Assessment Centers
IBEW	International Brotherhood of Electrical Workers
IEPEC	International Energy Program Evaluation Conference
LBNL	Lawrence Berkeley National Laboratory
LEED	Leadership in Energy and Environmental Design
LIHEAP	Low Income Home Energy Assistance Program
LIPA	Long Island Power Authority
NAHB	National Association of Home Builders
NARI	National Association of the Remodeling Industry
NATE	North American Technician Excellence
NECA	National Electrical Contractors Association
NEEA	Northwest Energy Efficiency Alliance
NYSERDA	New York Energy Research and Development Authority
PA	program administrator
PIC	program implementation contractors
PSC	program support contractor
PY	program year
PYE	person years of employment

EESS Workforce Education and Training Needs

R&D	research and development
RESNET	Residential Energy Services Network (RESNET)
RSES	Refrigeration Service Engineers Society
WAP	Weatherization Assistance Program
WTC	Weatherization Trainers Consortium

Executive Summary

This report provides a baseline assessment of the current state of energy efficiency-related education and training programs and analyzes training and education needs to support expected growth in the energy efficiency services workforce. In the last year, there has been a significant increase in funding for “green job” training and workforce development (including energy efficiency), through the American Recovery and Reinvestment Act (ARRA). Key segments of the energy efficiency services sector (EESS) have experienced significant growth during the past several years, and this growth is projected to continue and accelerate over the next decade. In a companion study (Goldman et al. 2010), our research team estimated that the EESS will increase two- to four-fold by 2020, to 220,000 person-years of employment (PYE)¹ (low-growth scenario) or up to 380,000 PYE (high-growth scenario), which may represent as many as 1.3 million individuals.²

In assessing energy efficiency workforce education and training needs, we focus on energy-efficiency services-related jobs that are required to improve the efficiency of residential and nonresidential buildings. Figure ES- 1 shows the market value chain for the EESS, sub-sectors included in this study, as well as the types of market players and specific occupations. Our assessment does not include the manufacturing, wholesale, and retail distribution subsectors, or energy efficiency-focused operations and maintenance performed by facility managers.

¹ One person year of employment (PYE) equals one person working full time for one year. For example, 100 person years may translate into 50 jobs for 2 years or 100 jobs for 1 year or 500 people spending 20% of their work year on energy efficiency projects.

² We estimated the current size of the EESS and projected growth under alternative scenarios of future spending and investment in energy efficiency programs funded by utility ratepayers, state and federal energy efficiency programs, ARRA programs, market activity of energy service companies (ESCOs) and other private sector firms.

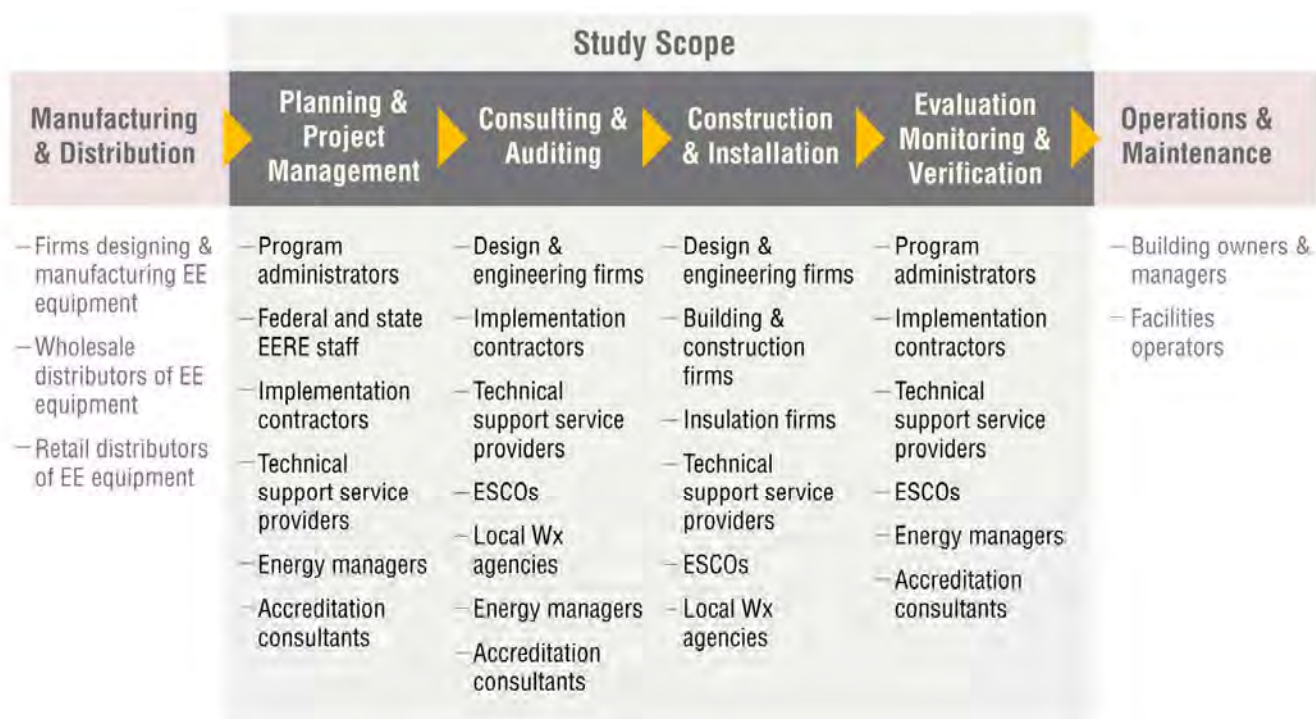


Figure ES- 1. Energy Efficiency Services Sector and Key Market Actors

Our research included interviews with over 350 program administrators, education and training providers, implementation contractors, energy services companies (ESCO), trade associations and sector experts and revealed three key challenges to expansion of the EESS workforce: 1) shortage of management-level applicants with experience in energy efficiency 2) shortage of experienced energy efficiency engineers, and 3) limited awareness on the part of building and construction tradespeople and contractors that the energy efficiency services sector exists, is poised to expand significantly, and their skills will be required, even though this sub-sector of the EESS accounts for most of the employment activity.

We also identified 492 higher education and/or training programs and conducted a screening analysis to identify engineering, architecture, policy, building trades technical training, and interdisciplinary programs whose curricula met our minimum criteria of a specific emphasis on energy efficiency. We identified 43 such programs and interviewed staff at 33 of these programs.

The Role of Education and Training in EESS

Our interviews and analysis suggest that many ‘new’ EESS jobs will actually be existing jobs that are refocused toward providing more energy efficient practices and services. There are currently two primary paths for those who want to enter the EESS workforce:

- Existing occupations (e.g., HVAC technicians, lighting contractors, construction trades, project managers) which are transformed into more energy efficiency-focused positions via retraining, and
- Emerging occupations that are somewhat unique to the EESS (e.g., home energy raters, commissioning services, energy/home performance services, energy auditors).

In the future, as the EESS expands and EESS-related training programs become more widespread, it is likely that more new hires will receive initial training through apprenticeship programs and through certificate and degree programs offered at community and technical colleges & universities that are directly related to occupations in the EESS.

Below is a summary of findings pertaining to employer educational requirements, hiring and training practices in the EESS.

- Management and professional positions (e.g., energy efficiency engineers, architects, energy efficiency program managers) generally require a four-year college degree at a minimum, while many building and construction trades may require technical training but not necessarily a college degree.
- Program administrators, program implementation contractors,³ and ESCOs generally use a variety of after-hire training resources because few candidates with specific training in energy efficiency are available. Engineers with knowledge of energy efficiency are in greatest demand. EESS employers face stiff competition with other industries for talented engineering graduates; engineering graduates often are unaware of the opportunities available in the EESS.
- Program administrators and program implementation contractors that target residential customers (e.g., low-income weatherization) typically hire trades workers that are unlikely to have energy efficiency-specific skills. These employees often subsequently receive energy efficiency training through organizations certified by Residential Energy Services Network (RESNET) or through the Weatherization Assistance Program (WAP).

³ Program implementation contractors are hired by program administrators to design and implement energy efficiency programs.

EESS Workforce Education and Training Needs

- Most building and construction contractors⁴ and workers in the building and construction trades who work on energy efficiency projects were unlikely to have received specific energy efficiency training, although respondents from unions noted that advanced journeyman training sometimes includes energy efficiency.
- EESS program administrator organizations and program implementation contractors view on-the-job training as the most valuable training available to their staff (see Figure ES-2).

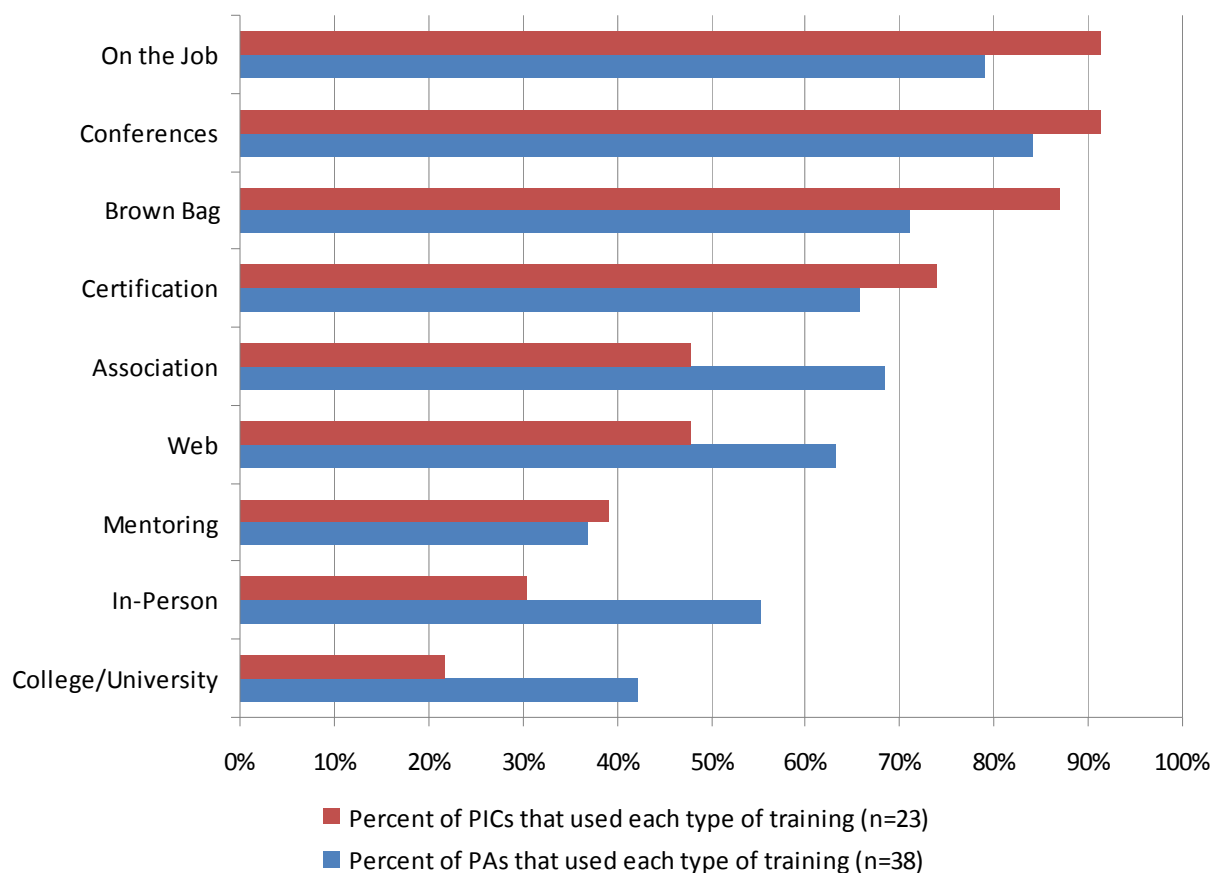


Figure ES- 2. Types of training used by Program Administrators and Program Implementation Contractors

⁴ Building and construction contractors refers to the mechanical, electrical, and general construction contractors involved in the direct construction and installation of building systems and equipment. These contractors typically employ trades people trained either through union apprenticeship programs, technical colleges and training programs, the military or through informal on-the-job training.

Energy Efficiency Education and Training Resources

Energy efficiency training and education is provided through professional trade associations and unions for building and construction contractors and trades, utility ratepayer-funded energy efficiency programs, third-party and trade association programs, community and technical colleges, universities, and third-party certificate and accreditation programs:

- Buildings and construction contractors and tradespeople typically receive initial training in their field (e.g., electrician, HVAC contractor) through union apprenticeship training programs, technical schools or community colleges. Representatives of trade unions report that thousands of apprentices and journeymen take these classes each year, including through technical and community colleges. These programs also provide continuing education for professional development or licensure. Union and industry association interviewees report that energy efficiency is included in many training programs. However, based on our review of course titles and topics on the websites of these training programs, we found that most courses lack a specific focus on energy efficiency and it is unclear if these courses truly meet the demand for efficiency-specific training.
- Third-party and trade association programs provide an array of energy efficiency-specific professional development and certification courses. A number of organizations, including the Association of Energy Engineers (AEE), the Building Performance Institute (BPI), RESNET and WAP offer energy efficiency-related certification programs and exams. The Association of Energy Services Professionals (AESP) provides training targeted specifically for professionals supporting energy efficiency program planning, implementation, and evaluation. Enrollment in AESP training programs is projected to increase from ~350 in 2008 to between 1,000 and 2,000 in 2010. BPI certified about 300 people in 2005; certifications are expected to approach 12,000 by 2011-2012. Contacts at RESNET and BPI expressed some concern that rapid program expansion could lead to reduced quality of training; both organizations are establishing guidelines for recruitment of effective trainers.
- Administrators of large-scale, ratepayer-funded energy efficiency programs often promote education and training initiatives that involve collaboration with community and technical colleges, trade associations and professional organizations, and the development of training centers. Collaboration also includes acting as affiliates to offer certificates from organizations such as BPI or RESNET. Ratepayer-funded energy efficiency education/training programs supplement community college offerings, including training for building analysts, building envelope engineering and HVAC. Utility programs also provide professional development and design assistance for professionals (e.g., architects, lighting designers, engineers and building and construction contractors) looking to expand their energy efficiency knowledge.

- Community and technical college programs that focus on energy efficiency typically include training for energy managers, HVAC technicians, energy auditors and raters, and building performance analysts. We interviewed five community college programs that were identified as energy efficiency education/training “leaders:” Lane Community College, Hudson Valley Community College, Laney College, Iowa Lakes Community College, and Oakland Community College. Demand for these programs is uniformly high and exceeds capacity; many programs have waiting lists. Contacts at several of these programs report an increase in enrollment by four-year degree holders looking to receive practical training as preparation for a job in the EESS. Survey respondents from community colleges report that they can often ramp up energy efficiency-oriented programs more quickly than universities. Typically, these colleges have a different staffing model from four-year colleges: a small core of full-time faculty instructors who recruit and rely heavily on part-time adjunct teachers and trainers from the community workforce as appropriate. However many core faculty at community/technical colleges are near retirement age, which could challenge the sustainability of the existing and emerging programs.
- We identified 28 four-year colleges and universities with architecture, engineering, policy, planning or interdisciplinary programs that offered degrees directly relevant to the EESS in 2008. We spoke with 19 of these programs and estimate that about 5,100 students are currently enrolled in energy efficiency-focused courses with about 1,200 student graduates per year from these programs. Many of the courses are interdisciplinary; educators expressed the importance of cross-training, emphasizing whole systems, and integrating energy efficiency into engineering, architecture, policy and management courses.

States and regions that have offered large-scale energy efficiency programs for a long time (e.g. California, the Pacific Northwest, New York, and New England) have begun to systematically address the impending energy efficiency workforce education and training challenges. For example, the Northwest Energy Efficiency Task Force (NEET) Workforce group recommended a regional energy efficiency workforce assessment detailing skill standards, job classifications, employment levels and projected demand and that the region build and maintain a regional jobs and skills clearinghouse and establish a strategic coordinating body (e.g., Center of Excellence for Energy Technology at Centralia College). In California, the research arm of the community colleges (i.e. Centers of Excellence) surveyed all campuses and completed a comprehensive inventory of energy efficiency-related education and training programs currently offered or under development targeted at eight specific occupations. These types of comprehensive baseline assessments and inventories of education and training resources is a first step in identifying potential gaps. However, in states and regions that are just ramping up energy efficiency programs, these types of efforts and even a basic EESS education and training infrastructure are often lacking.

Meeting Projected Demand for Energy Efficiency Education and Training Programs

There is significant pent-up demand for energy efficiency education and training programs; most programs indicated that they have waiting lists. Demand for hiring graduates with energy efficiency education is also strong; respondents at community colleges and universities all report easily placing graduates. However, the challenge of responding to this demand is different for different parts of the workforce, for example:

- Survey respondents at universities indicated that existing energy-efficiency-related programs are currently approaching capacity and universities typically take many years to develop new programs. Moreover, in many cases, public funding is not available to add faculty and/or space at these institutions. Some universities plan to offer distance learning options as a partial solution, though they acknowledge that certain classes and equipment skills cannot be taught well online.
- Community colleges are able to more easily ramp up than universities, but many still have waiting lists for their programs. Supporting training for the building and construction industry will be especially challenging for those states and regions that have limited energy efficiency services infrastructure to rapidly create and support increased education and training opportunities.
- An alternative approach is to integrate building and industrial process system efficiency into existing curricula or union apprenticeship programs. This could be a cost-effective way to train large numbers of electricians, HVAC contractors, mechanical insulators, and home builders. While some respondents said this was beginning to happen in a few states, there appears to be an opportunity to make this happen on a much larger scale.

Recommendations

New education and training programs should be developed and implemented quickly to increase the skills of those already active in the field and to help prepare new EESS employees. We recommend the following six actions to enable the EESS workforce training infrastructure to keep up with projected demand:

- **Provide energy efficiency education and support targeted at building and construction contractors and tradespeople.** We found a notable lack of awareness on the part of building and construction contractors and tradespeople that energy efficiency is poised for significant growth. Building and construction contractors and trades constitute about 65-75% of the overall workforce in the EESS. Thus, it is important to educate and support the building and construction contractors and tradespeople to ensure that they are able to provide a trained workforce to support projected growth. This problem appears more severe in states that do not have long-running ratepayer-funded programs. There is also the issue of limited access to resources in addition to lack of awareness. Even in cases where there is interest, the expertise and training required may not be available in the local area. It will also be important, especially in states that are ramping up energy efficiency, to integrate building and industrial process system efficiency into existing building and construction technical, apprenticeship, and trades curricula.

- **Coordinate and track training efforts within states; share best practices across states.** With the influx of ARRA funding, many states are initiating and/or ramping up a range of training and education activities that target workforce development in the “clean energy” sector. However, it was challenging to identify and determine those programs/courses that will provide specific education and training for the energy efficiency services sector. This information needs to be tracked in a systematic way going forward. There also needs to be greater coordination between the various types of EESS training programs within each state. Establishing broad statewide education/training efforts, such as NYSERDA’s collaboration with Hudson Valley Community College, may be helpful to avoid duplication of efforts at the local level. This type of training infrastructure can help states that are ramping up energy efficiency programs if building and construction contractors and tradespeople are much less aware of energy efficiency-specific design and construction practices. Finally, it is also important to note that similar efforts are happening in a number of states, so increased sharing of best practices and high-quality curriculum could help lead to more rapid launch of effective training programs.
- **Increase short-duration, applied trainings to augment on-the-job training and/or introduce new entrants to a field.** Much of the growth in the EESS will come from new entrants who already have some applicable skills (e.g. building and construction contractors who become efficiency retrofit specialists). There is also a strong demand for up-to-date training for those who are currently employed in the EESS but who need to update or augment their skills. In both cases, short-duration courses on specific, applied topics will be more relevant than a 2 or 4-year degree program. These types of offerings will need to be significantly ramped up in the next few years and could be funded by government and/or utility ratepayer energy efficiency programs.⁵
- **Increase funding to “train the trainers.”** Our research indicates that there is likely to be a lack of qualified trainers to train the workforce needed to support the projected growth in the EESS. For example, the WAP network estimates they will need 700 *additional* trainers by summer 2010 to meet their goals. Similarly, many community colleges rely on a small group of key instructors to teach courses, and many are nearing retirement age. The Building Performance Institute, which provides certifications for residential retrofit contractors, experienced 5-fold increase in number of certifications between 2005 and 2008, and believe the number will almost triple between 2008 and 2009. These growth rates strain the capacity of existing trainers; additional resources from government and/or ratepayer energy efficiency program funds could be directed towards training the next generation of EESS trainers.

⁵ For example, a number of states have committed ARRA funds for energy efficiency workforce training and development.

- **Increase access to on-the-job and other formal training for mid- and senior-level engineers and managers.** Our interviews revealed a need for more managers and engineers experienced with energy efficiency. Managers and engineers in potentially related fields need to understand the opportunity in the EESS and have increased access to professional training that they can complete on the job, or if they decide to make a career change. However, most firms report relying on on-the-job and informal training to ensure their staff was skilled and knowledgeable after hiring. Examples of more formal resources that address this need and could be expanded include training offered by the Association of Energy Services Professionals and the Certified Energy Manager certificate program offered by the Association of Energy Engineers.
- **Prepare the next generation of EESS professionals.** We learned from our interviews that most professional roles within the EESS require at least a four-year degree. However, few colleges or universities offer EE-specific curriculum, and those that do stated that funding to grow these programs was extremely limited in most cases. Additional funding is needed to support new energy efficiency-related, inter-disciplinary programs and expand existing programs and course offerings. Four-year colleges, especially in states that are ramping up large-scale energy efficiency programs, need to provide additional courses with multi-disciplinary and system-based approaches to energy efficiency. The Department of Energy Industrial Assessment Centers have been a successful model to provide energy efficiency services to industry and a training ground for engineering students. Similar centers could be developed in conjunction with college- and university-based engineering, architecture, planning, and policy-focused programs and could include building science centers for architecture and engineering students and policy/planning centers that emphasize education/training needed for energy efficiency program design and project implementation. Initial support for these centers could come from federal/state energy efficiency program funds.

1. Introduction

Throughout 2009, there was a significant increase in funding for “green job” training and workforce development. The American Recovery and Reinvestment Act (ARRA) provided \$500 million to the Department of Labor to fund new training programs and related research to support the development of a “green” workforce. Energy efficiency workforce training is also one of the programmatic activities that are supported by ARRA funds for State Energy Programs (SEP). Fourteen states that received SEP funds directed \$64 million toward energy efficiency training programs.

This study provides an initial assessment of the current state of workforce development in energy efficiency and identifies high-priority training needs for this sector.⁶ We focus specifically on the energy efficiency services sector (EESS), which includes those service-oriented jobs that target improving the energy efficiency of residential and nonresidential buildings. Key segments of the EESS have experienced significant growth during the past several years. For example, from 2006 to 2008 energy efficiency program administrator budgets grew 19% per year (Consortium for Energy Efficiency 2008), and energy service company (ESCO) revenues grew by 22% per year (Goldman, Hopper, Gilligan, Singer and Birr 2007).

In 2009, our research team estimated the size of the current EESS workforce, and projected changes to the size and composition of the EESS workforce under low-growth and high-growth scenarios through 2020 (et al. 2010). The research team also sought to understand education and training needs for the expanding EESS. We conducted ~350 interviews with program administrators, program implementation contractors, ESCOs, representatives of building and construction trades and professional groups, and educational and training institutions between September 2008 and September 2009.⁷ These interviews included questions about respondents’ expectations for skills and knowledge of new hires and needs for ongoing education and training in energy efficiency. This report summarizes the findings from that research, beginning with a review of key findings from our companion report that assesses the size, composition and projected growth of the EESS workforce.

⁶ Most of the interviews and research for this study were conducted prior to this upsurge in funding.

⁷ We conducted 300 interviews with representatives of program administrators, implementation contractors, ESCOs, trade associations, education and training organizations, and unions. We also spoke with approximately 50 energy efficiency experts on workforce and training issues.

1.1 Overview of the Energy Efficiency Services Sector⁸

For the past 30 years, public policy has been the key driver of energy efficiency investment in the United States. State policies that support ratepayer-funded energy efficiency programs, federal and state low-income weatherization efforts, energy efficiency programs administered by state energy offices, enabling legislation that facilitates performance contracting for ESCOs, and building codes and standards have been major contributors to the increase in energy efficiency investments (see Figure 1). Program administrators design and manage efficiency programs that facilitate the implementation of energy-efficient solutions by working with program implementation contractors⁹, manufacturers, distributors, ESCOs, architects, engineers, building and construction contractors and tradespeople¹⁰, and building owners.

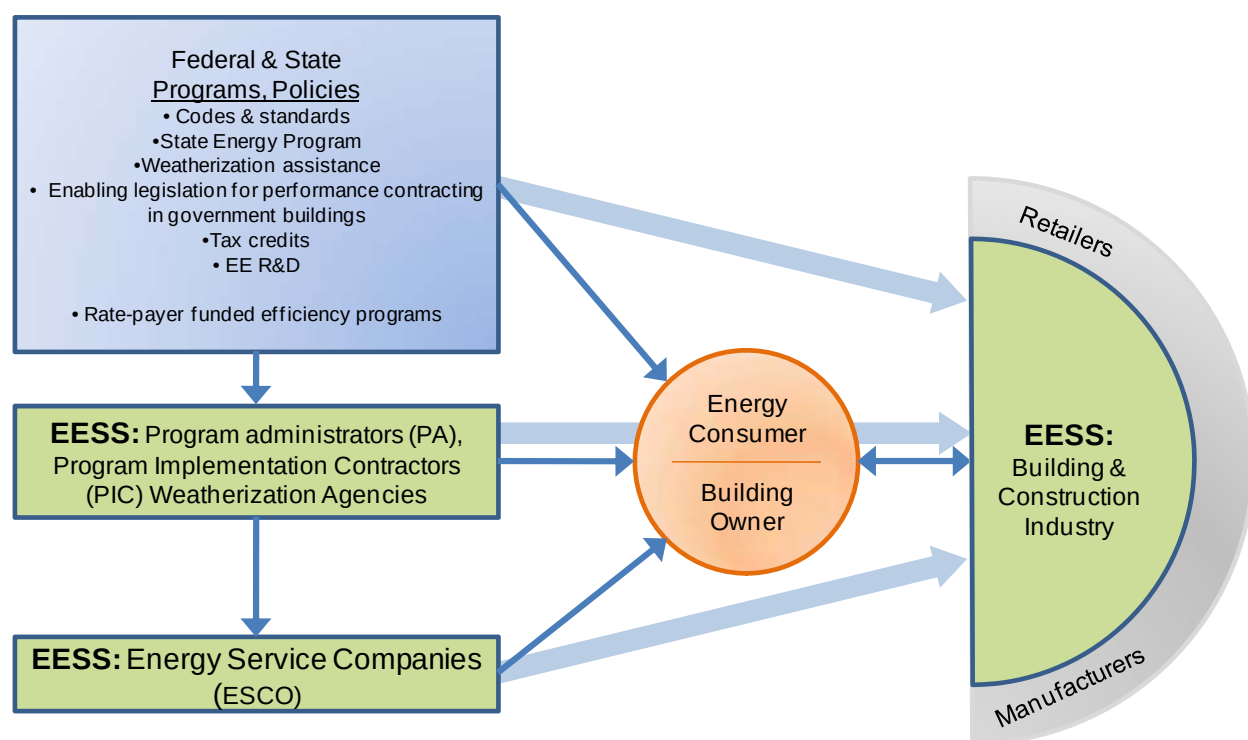


Figure 1. Impact of public policy on the Energy Efficiency Services Sector (EESS)

⁸ This section summarizes and highlights key findings from the LBNL workforce study on EESS size and projections for growth (Goldman et al. 2010) in order to provide context for our discussion of workforce education and training needs for the EESS.

⁹ Program implementation contractors are hired by program administrators to design and implement energy efficiency programs.

¹⁰ Building and construction contractors refers to the mechanical, electrical, and general construction contractors involved in the direct construction and installation of building systems and equipment. These contractors typically employ trades people trained either through union apprenticeship programs, technical colleges and training programs, the military or through informal on-the-job training

Efficiency efforts have fluctuated over the past 30 years in response to public concerns about unstable energy prices and uncertain supplies, national security, and environmental issues. In recent years, interest in and support for energy efficiency has broadened among state and national policymakers. Prominent examples include ~\$18 billion in new funding for energy efficiency programs (e.g., State Energy Program, Weatherization, and Energy Efficiency and Conservation Block Grants) in the 2009 American Recovery and Reinvestment Act (ARRA) and increasing commitments to energy efficiency programs funded by utility ratepayers (Barbose et al 2009).

Figure 2 illustrates the market value chain for the EESS and includes specific occupations associated with each subsector: manufacturing and distribution; planning and project management; consulting and auditing; construction and installation; evaluation, monitoring and verification; and building and equipment operations and maintenance. Our estimate of the size of the future EESS workforce and the need for education and training focuses on energy efficiency services-related jobs that are required to improve the energy efficiency of residential and nonresidential buildings and industry. Our assessment of EESS workforce size does not include the manufacturing, wholesale, and retail distribution subsectors or operations and maintenance of energy-efficient buildings and equipment performed by end users (e.g., facility managers at customer facilities).¹¹ Figure 2 shows the segments of the EESS that are covered in this study.

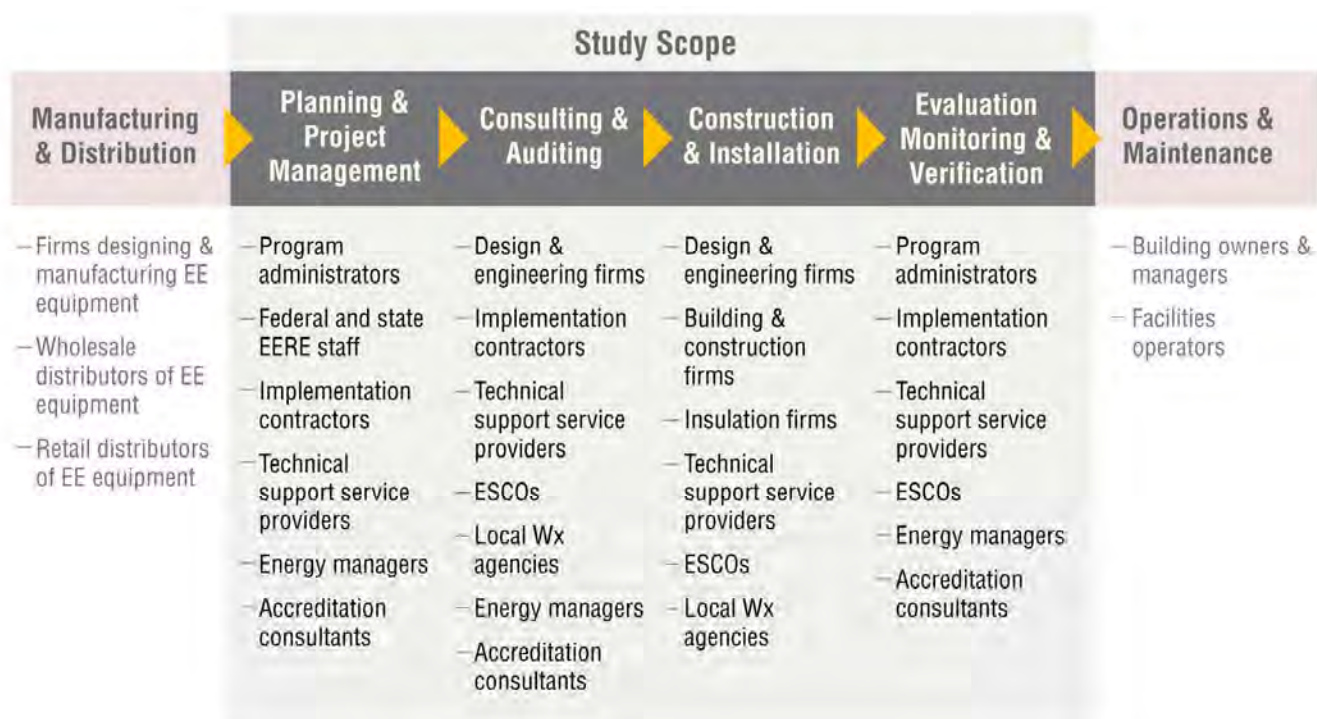


Figure 2. Energy Efficiency Services Sector and Key Market Actors¹²

¹¹ We do not anticipate a significant net growth in manufacturing jobs because the increased demand for energy-efficient products is likely to be offset by reduced demand for existing products and services (i.e., substitution effects). See Goldman et al. (2010) for a detailed description of occupations in the EESS.

¹² Program administrators manage and direct energy efficiency programs; implementation contractors are hired by program administrators to plan, design, implement and evaluate energy efficiency programs; technical support

1.2 Estimated Size and Projected Growth of the EESS Workforce

The LBNL workforce size study estimated that the energy efficiency services sector accounted for about 114,000 person-years of employment (PYE) in 2008 (Goldman et al. 2010). We also developed low-growth and high-growth estimates of future energy efficiency spending based on an analysis of state energy efficiency legislation, regulatory policy and market activity and the expectations of program administrators, program implementation contractors, and ESCOs that were interviewed as part of this study. We then projected future workforce size based on our analysis of the relationship between energy efficiency spending/investment and employment in different parts of the EESS.

Federal and state energy efficiency policies influence job development through effects on organizations such as program administrators, program implementation contractors, weatherization agencies, and energy service companies (ESCOs), direct effects on purchase and investment decisions of energy consumers and building and construction industry firms that provide energy efficiency services and products (see Figure 1). This occurs not because job creation is a primary motivation, but because the effects of policy are to stimulate demand for services from specific subsectors of the economy. For instance, the Clean Air Act of 1963 and the Clean Water Act of 1972 and subsequent amendments increased employment in the environmental services industry for environmental engineers, researchers, regulators, product developers, manufacturers, installers, and support staff (Pew 2009), although job creation was not an explicit goal of that legislation.

We estimate that the national EESS workforce will increase to 220,000 PYE (low-growth scenario) or 380,000 PYE (high-growth scenario) by 2020. This represents a two to four-fold increase in the size of the EESS from the 2008 baseline. Our estimates of future size of the EESS workforce may be conservative because they do not explicitly account for the impacts of proposed federal climate change legislation with aggressive greenhouse gas reduction targets or a national energy efficiency portfolio standard, which could spur additional investment in energy efficiency and more job growth.

1.3 EESS Workforce Expansion Challenges

The interviews with energy efficiency program administrators, program implementation contractors, and building and construction industry professional and trade association representatives identified three major challenges to the projected expansion of the EESS workforce:

- Shortage of management-level applicants with experience in energy efficiency;
- Shortage of experienced energy efficiency engineers; and

service providers are firms that provide technical services to program administrators or implementation contractors; local weatherization agencies are approved to receive federal and state weatherization funds; accreditation consultants provide technical services to building owners and building and construction firms that need to meet energy efficiency code requirements.

- Limited awareness by building and construction contractors and tradespeople that the EESS is poised to expand significantly and their skills will be required.

We discuss each of these potential bottlenecks to the expansion of the EESS as context for our analysis of education and training needs of the EESS.

1.3.1 Shortage of Managers with Energy Efficiency Experience

According to program administrators and program implementation contractors that were interviewed, *it is extremely challenging to find management-level applicants with experience in energy efficiency.*

The primary limitation on implementation contractor firm growth or expanded program offerings by administrators is the lack of management-level applicants with experience in energy efficiency.

Respondents reported that about 6% of the program administrator and program implementation contractor staff held manager-level positions; several noted that these positions had not been growing in number. Respondents said they highly valued people with energy efficiency knowledge and experience, both as effective employees and as mentors of the next generation of the EESS workforce. However many respondents noted challenges in hiring managers with significant energy efficiency knowledge and experience. One implementation contractor put it succinctly: *“It is almost impossible to find someone with energy efficiency program management experience.”* Some respondents indicated that the lack of management-level applicants with experience in energy efficiency was the primary limitation on growth of implementation contractor firms. Several program administrators also noted that difficulties in finding experienced energy efficiency managers constrain the pace at which they can expand both the number and scope of program offerings.

This issue may become increasingly important as the EESS workforce expands, because few schools and training centers offer energy efficiency curricula for managers. As a result, on-the-job mentoring is the primary source of training for managers that work for ESCOs and program administrators and implementation contractors.

An additional concern is the lack of sufficient staff in mid-level positions that can progress to senior-level positions throughout the EESS. This situation arose in part because many firms and organizations did not hire much or had layoffs during the 1990s (e.g., spending on ratepayer-funded energy efficiency declined from 1993 to 1998 due in part to uncertainties surrounding electricity restructuring and low gas prices). As a result, EESS companies lack or have a shortage of mid-level staff that can orient recent hires and develop into senior managers. While managers who have experience with other industries can provide some capacity, in order for the EESS to expand effectively and maintain high standards of service delivery, the EESS must attract, train, and retain new managers who have experience in energy efficiency that is deep enough to provide guidance to others.

1.3.2 Shortage of Energy Efficiency Engineers

Program administrators, program implementation contractors, and ESCOs that work with commercial and industrial customers indicated that it has been very difficult to find experienced energy efficiency engineers. Engineers play a key role in these organizations because they create and/or review the design and specifications for most energy efficiency projects and also often ensure that completed projects meet energy efficiency requirements. Engineers constitute between 20% and 25% of the workforce for program administrators and implementation contractors respectively and about 60% of the workforce for ESCOs (see Table 1).

Table 1. Role of engineers in different types of energy efficiency services organizations

Organization Type	Number of Engineers in Survey Respondents' Organization	Engineers as Percent of Total Staff
Program Administrators (n=17 of 39)	548	17%
Program Implementation Contractors (n=37 of 37)	661	26%
ESCOs (n=9 of 9)	3,268	60%
TOTAL	4,477	

Survey respondents reported that few engineers enter the field with energy efficiency knowledge or experience. To be effective, EESS engineers need knowledge of, and preferably experience with: fluid and thermodynamics; building energy systems; performance optimization of existing HVAC, refrigeration, or industrial process systems; and communication skills that foster good working relationships with customers. Employers that are unable to hire engineers with all or most of these skills typically hire engineers with technical aptitude, communication skills, and/or some engineering experience.

Historically, engineering talent has been fungible when industries expand. Bell (1982) reported that the energy industry met the increased demand for engineers in the 1970s by hiring from related fields. For example, while oil companies preferred to hire engineers with expertise in the areas of petroleum engineering or geology, when people with these skills could not be found, they hired mechanical engineers and trained them in petroleum engineering. A similar phenomenon is happening currently in the EESS. Many program administrators, implementation contractors, and ESCOs indicated that they preferred to hire energy or mechanical engineers, but often hired engineers with technical aptitude who were interested in energy efficiency, and then trained them to work on energy efficiency projects. Several of the larger implementation contractors and ESCOs noted that they have little difficulty attracting talented engineers who then develop energy efficiency skills. However, a number of smaller firms said it was much harder to attract engineers due to their companies' limited recruitment and training resources.

1.3.3 Lack of Awareness by Building and Construction Tradespeople and Contractors

Another important finding is the need to inform the building and construction industry that the EESS is expanding. In our interviews, program administrators and implementation contractors understood that there was an increased demand for energy efficiency services, which was likely to continue in the future; these organizations were anticipating and planning for a growing workforce. For example, based on survey results, in aggregate, program administrators estimated that their energy efficiency staff would grow by about 19% by 2010, while implementation contractors anticipated a 64% increase.

In contrast, less than 50% of ~170 respondents who represented building and construction industry associations and trades could even estimate the percent of the workforce that was involved in energy efficiency. Of those who could, virtually all representatives of the design and engineering professional associations indicated that energy efficiency had a “dominant” or “moderate” influence on their activities. In contrast, over 70% of the representatives of other building and construction trade associations characterized the influence of energy efficiency on their activities as “moderate” or “limited” (see Figure 3).¹³

Fewer than half of the building and construction industry association and trades contacts were able to estimate the role of energy efficiency on their members’ businesses, and even fewer could estimate the impacts on their members’ businesses if energy efficiency funding were to increase. Among the respondents who offered an estimate, those working in the residential sector anticipated a somewhat greater effect on their business than those working in the commercial and industrial sectors.

¹³ Respondents from the building and construction industry included trade associations and unions for a wide range of building trades, contractors, and construction professionals active in residential and commercial construction. Design professionals were more likely to be involved primarily in commercial construction, while trades and contractor association contacts were less specialized. We had limited responses from trade associations primarily engaged in industrial projects.

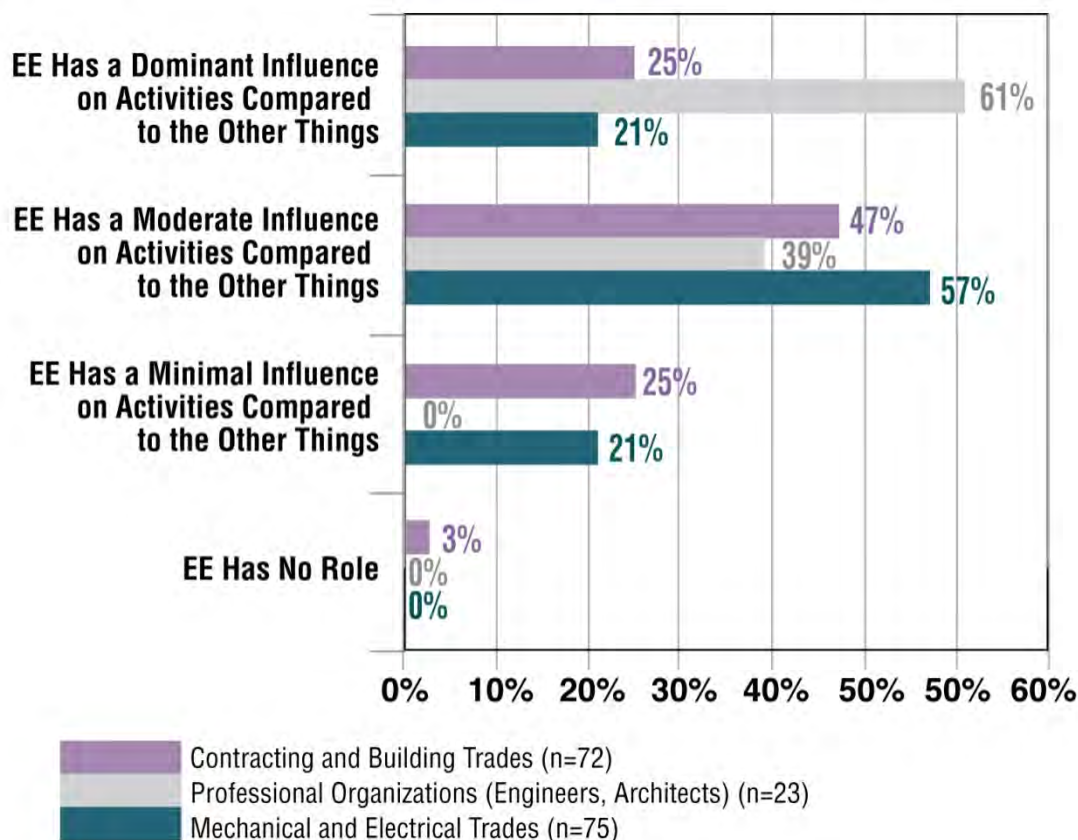


Figure 3. Influence of energy efficiency on the Building and Construction Industry

The representatives of building and construction industry associations and trades who were aware of these increases in energy efficiency funding and spending tended to be located in states with active energy efficiency programs, or represented a national organization or union. This lack of awareness among building and construction industry associations and labor unions is a concern overall, but particularly in those states and regions (e.g., Midwest) that are currently ramping up energy efficiency programs and who historically have not offered large-scale energy efficiency programs.

1.4 Methods for Assessing EESS Education and Training

Our investigation of education and training needs for the EESS workforce has several components. First, in our interviews with various types of EESS providers (e.g. program administrators, implementation contractors, ESCOs, members of the building and construction trades) conducted between May 2008 and June 2009, we asked about and identified current needs and gaps in education and training. Second, in late 2008 we identified education and training programs using multiple sources and conducted an initial screening analysis in order to identify training and education programs whose curricula focused on energy efficiency. Third, between January and June 2009 we interviewed representatives of organizations (e.g., trade associations, specialized training companies, community colleges, and colleges and universities)

that offered energy efficiency-related education or training programs.¹⁴ Using results of these interviews, we estimated the number of graduates that are entering the workforce and characterize the education and training organization's plans for future expansion and growth.¹⁵

We identified education and training programs using the following sources:

- List of clean energy programs identified by the U.S. Department of Energy;¹⁶
- List of programs offered by universities/colleges identified by the International Energy Program Evaluation Conference (IEPEC)¹⁷, an organization dedicated to evaluating energy efficiency programs;
- List of engineering programs identified by the American Society for Engineering Education (ASEE);¹⁸
- Program administrators, implementation contractors, evaluator agencies, academic institutions, ESCOs, and government officials that were surveyed for this project; and
- General web searches and library databases such as Academic Search Premier.

We identified 492 education and training programs through this process and then did a web search of each program. We categorized each organization based on program description, institutional website, and phone calls to organization staff when needed. We conducted a screening analysis in order to identify those engineering, architecture, policy, building trades technical training, and interdisciplinary programs whose curricula emphasized energy efficiency. This was particularly challenging, in part because we had to develop criteria and use judgment in classifying education and training programs into various categories. We established the following criteria for energy-efficiency related education: educational organizations had to offer a certificate or degree program directly related to energy efficiency or at least two energy-efficiency-related courses to be included in this category. For energy efficiency training, organizations had to offer explicit energy efficiency courses or programs in order to be included in this category.

¹⁴ We identified the population of program administrators, program implementation contractors, ESCOs, and building and construction trade and professional associations and union building and construction trade councils for the eleven states selected for the study (see Goldman et al 2010). We then attempted to complete calls with all program administrators, implementation contractors and building and construction trade councils as well as a sample of trade and professional associations.

¹⁵ The timing of this study is such that it provides a baseline for conditions just prior to increased energy efficiency funding from the American Recovery and Reinvestment Act (ARRA) of 2009.

¹⁶ EERE Energy Education and Workforce Development: Colleges and Universities.
http://www1.eere.energy.gov/education/colleges_universities.html.

¹⁷ IEPEC website <http://www.iepec.org/IEPECHome.htm?links.htm>

¹⁸ American Society of Engineering Education website <http://www.asee.org/publications/profiles/index.cfm>

We found that many education and training programs that were initially identified through this process did not focus on energy efficiency, but instead offered “clean energy” or “green” or “sustainable” programs (see Table 2). For example, we identified 30 programs that focus on renewable energy training and more than 40 general environmental education & training programs. We called programs that appeared promising in terms of offering energy efficiency-related programs, courses, certificates or degrees and interviewed appropriate contacts. We confirmed that 43 programs met our criteria for energy efficiency education/training, including five 2-year colleges that offered Associate’s degrees, 28 four-year colleges, and nine professional or trade organizations that offered energy efficiency training or certifications (see Appendix A for the list of energy efficiency education and training programs included in this study).¹⁹

Table 2. Education and training programs screened for this study

Category	Examples	Total Programs
Energy efficiency	Includes specific courses on methods to improve the energy efficiency of equipment; covers energy policy with a specific focus on energy efficiency, etc.	43
General environmental program	Emphasizes environmental education, policy, water conservation or other non-energy-related environmental programs	41
General technician training	Trains HVAC technicians, electricians, or other building tradespeople without emphasizing efficiency	2
Other	Educates students in specialized categories such as environmental law, sustainable design, etc.	8
Other energy	Educates students in petroleum engineering, electrical engineering, or another type of energy source	12
Other engineering/science	Educates students in broad engineering and scientific principles without emphasis on efficiency	349
Outside U.S.	Educates students outside of the U.S.	5
Renewable energy	Educates students and technicians in renewable energy systems without specific focus on efficiency	30
Transportation	Educates students in efficiency as it relates to cars, trains, or other transportation	3
TOTAL		492

¹⁹ Union contacts that were interviewed indicated that every union serving the construction trades has training programs that prepare their members to install energy efficiency projects. However, in many cases, we could not find energy efficiency training components explicitly listed among the training offerings on union websites.

We conducted interviews with these organizations between January and July 2009²⁰; interviews lasted about one hour. We were able to talk with contacts at 33 of the 43 energy efficiency education and/or training programs. Potential contacts at six education and training programs declined to be interviewed or did not return inquiries; we were unable to contact four programs because we learned of these programs too late in the study.

We also classified energy efficiency-related education and/or training programs into three key occupational categories: 25% target building trades occupations, 50% target building design and analysis skills, and 25% target energy efficiency programs, policy, and evaluation skills (see Table 3). In addition to programs that are currently operational, we also learned of at least 10 energy efficiency education/training programs that are under development, which may be operational by 2010-2011.

Table 3. Energy efficiency education and training programs by occupational specialization

Occupational Specialization	Number of Programs Identified Nationally	Programs Interviewed
Building Trades	11	10
Building Design and Analysis	22	16
Energy Efficiency Programs, Policies, and Evaluation	10	7
TOTAL	43	33

We interviewed ~190 representatives of trade and industry associations that represent professional groups (e.g., architects and engineers) or technicians involved in the building and construction industry (e.g., sheet metal workers, electrical and HVAC contractors) as well as representatives from labor unions (see Table 4).²¹ An important objective of these interviews was to obtain a better understanding of how these building-related professions and trades approached education and training of their workforce.

Goldman et al. (2010) revealed that workers in the building and construction industry typically learn about efficiency either through on-the-job training in order to comply with energy efficiency program requirements or through training or certificate programs that focus on energy efficiency.

²⁰ We conducted additional follow-up interviews between July and October 2009 as we learned about programs beginning to experience rapid growth and acceleration.

²¹ Trade and professional association representatives from AFL-CIO State Chapters-Building and Construction Trades Department, Air Conditioning Contractors of America, American Institute of Architects, American Society of Heating, Refrigerating and Air-Conditioning Engineers, American Society of Mechanical Engineers, Associated General Contractors, Association of Energy Engineers, Insulation Contractors Association of America, National Association of Home Builders, National Association of the Remodeling Industry, National Electrical Contractors Association, National Insulation Association, Refrigeration Service Engineers Society and Sheet Metal and Air Conditioning Contractors' National Association were interviewed in the eleven states.

Table 4. Energy efficiency education and training contacts: Unions and trade associations

Energy Efficiency Education and Training Contacts – Unions and Trade Associations	Number of Association Chapters identified nationally	Number of Association Chapters identified in 11 state sample²²	Association Chapters interviewed
Building Trades and Contractors	1,171	290	163
Design and Engineering Professionals	559	43	23
TOTAL	1,730	333	186

We asked contacts about the type of training sponsored by their association, training needs of their members, where members received training if it was not provided by their association, and credentials that were valued by industry. Our contacts at the Refrigeration Service Engineers Society (RSES), National Association of Home Builders (NAHB), and National Association of the Remodeling Industry (NARI) indicated that their organizations offered energy efficiency training. Several respondents explicitly referenced the North American Technician Excellence (NATE) certification, which includes energy efficiency training. However, most contacts stated that energy efficiency was typically offered as a topic in a training and/or certificate program on “green buildings” or discussed as part of a training course on HVAC equipment and controls.

1.5 Study Limitations

This report represents a first attempt to identify certificate and degree programs (and associated courses) that are targeted explicitly at energy efficiency across the full range of college degree programs and technical skills training programs that support the EESS.

Our screening method and criteria is not comprehensive and does not identify at least two types of education and training offerings:

1. Energy efficiency can be incorporated into education and training efforts in any course, even if it is not specifically identified as an “energy efficiency course.” For example, a community college may offer a traditional building trades program and not indicate that there is a focus on energy efficiency. Some faculty members in that program may incorporate energy efficiency into their coursework because they are interested in the subject, but it is not apparent from reviewing course descriptions. Similarly, a professor in a marketing department might include energy efficiency products and services in her examples without specifically identifying the course as having an energy efficiency focus or an apprenticeship program could address a variety of installation issues associated with energy-using equipment that improves energy efficiency, without a specific focus on energy efficiency.

²² In Goldman et al. (2010) we focus on an 11 state sample which includes California, Connecticut, Illinois, Iowa, Maryland, Massachusetts, New Jersey, New York, Texas, Washington, and Wisconsin. These 11 states represent roughly seventy percent of all 2008 ratepayer-funded energy efficiency (CEE 2008), about 45% of the ESCO-reported activity (Barbose 2009), and 40% of the U.S. population (U.S. Census Bureau 2009).

2. Energy efficiency might be addressed in courses within the broader contexts of sustainability, resource management, or environmental systems. For example, individual faculty members at institutions may specialize in understanding energy efficient technologies or market adoption and diffusion of high-efficiency products but courses may not have explicit references to a focus on energy efficiency.

It is also important to note that our efforts focused on programs, courses, and certification efforts that already were in operation.²³ We did not attempt to interview contacts involved in education and training programs under development.

1.6 Report Structure

Chapter 2 describes the current role of education and training for the EESS and employers' education and training expectations for staff at the time of hire based on our discussions with program administrators, ESCOs, program implementation contractors, building trade association contacts, and education and training program contacts. Chapter 3 discusses the various workforce development education and training opportunities for energy efficiency that are currently available. Chapter 4 discusses the expectations for growth reported by existing education and training organizations. Chapter 5 summarizes our key findings and offers recommendations to address education and training gaps for the EESS.

²³ We depended on respondents from building and construction trades and professional associations and the AFL/CIO Building and Construction Trades Councils to inform us of training and education efforts within their organizations. We did not independently identify the training capabilities of their organizations.

2. The Energy Efficiency Services Sector: Role of Education and Training

In this section, we discuss how program administrators, implementation contractors, ESCOs, and building tradespeople hire and train staff. We explore their expectations for staff at hiring, the types of education and training aligned with different EESS occupations, and staff training on energy efficiency after hiring.

2.1 Current Education and Training of EESS Entrants

Program administrators, implementation contractors, and ESCOs said that they are often unable to hire candidates with specific education or training in energy efficiency for a simple and compelling reason: there are few candidates with that experience. As a consequence, these contacts said they used a variety of informal training resources to ensure their staff was skilled and knowledgeable after hiring.

Survey respondents reported that for professional job openings in the EESS, they generally hire applicants with at least a bachelor's degree in a field most likely to meet their firms' energy efficiency project requirements: engineering, economics, architecture, financial analysis, evaluation, statistics, and computer technologies. Most new hires require additional training to supplement their bachelor's degree in order to meet the organization's needs. Many program administrators expect some of their staff to have an MBA or experience with financial analysis and economics. ESCOs typically seek engineers with professional engineer (PE) licenses. Implementation contractors seek to hire employees who had earned the Certified Energy Manager (CEM) designation, but said they often paid for employees to take CEM training because relatively few applicants were CEM-certified.

Contacts reported that their greatest demand was for engineers with knowledge of energy efficiency and that there was stiff competition with other industries for talented engineering graduates. Contacts indicated that they were often able to find and hire engineers who were interested in, but had not already received, training in energy efficiency and then trained them on the job. A key challenge for the EESS is that many engineering graduates are unaware of the EESS and the potential career opportunities in this sector. Many disciplines within engineering align with specific occupations. For example, a degree in aerospace engineering can lead to a job with an airline manufacturer, a defense contractor, or a government agency that engages with the aerospace industry. Although the Association of Energy Engineers (AEE) has more than 9,500 members (Gibbons 2009), the federal Bureau of Labor Statistics (BLS) does not track energy engineering as an independent engineering discipline. Moreover most engineering schools do not offer courses specifically on energy efficiency topics.

A key challenge for the EESS is that engineering graduates often are unaware of opportunities the EESS offers.

Program administrators and implementation contractor respondents involved in delivering programs that target residential customers (e.g., low-income weatherization, appliance recycling, or building shell efficiency improvements) indicated they hired employees with less than a bachelor's degree. After hiring, these employees often obtain certifications from training organizations certified by Residential Energy Services Network (RESNET) or through the federally-funded low-income Weatherization Assistance Program (WAP). The WAP Technical Assistance Center website identifies 12 locations that offer energy efficiency-specific training, as well as many other organizations that provide training resources.

We also learned that most workers in the building and construction trades who worked on energy efficiency projects were unlikely to have specific energy efficiency training, except in a few cases.²⁴ Respondents from building and construction trade associations and unions noted that the most advanced training for journeymen sometimes addressed how to improve a project's energy performance. Training on high-performance equipment (e.g., furnaces, air conditioning systems, energy management, and/or lighting controls) typically was provided by the equipment vendor or was discussed in the manufacturers' instructions regarding the installation, use, and maintenance of the equipment.

2.2 Education and Training Requirements for EESS Occupations

Education and training requirements vary across occupations in the EESS. Some professional positions require a college degree, while building construction contractor and trades positions may require technical training, but not necessarily a college degree.

There are currently two primary paths for those who want to enter the EESS workforce:

- Existing occupations (e.g., HVAC technicians, lighting contractors, construction trades, project managers) which are transformed into more energy efficiency-focused positions via retraining, and
- Emerging occupations that are somewhat unique to the EESS (e.g., home energy raters, commissioning services, energy/home performance services, energy auditors) and learning on the job.

In the future, as the EESS expands and EESS-related training programs become more widespread, it is likely that more new hires will receive initial training through certificate and degree programs offered at community and technical colleges and universities that are directly related to occupations in the EESS.

²⁴ These few cases include certification programs in the residential home remodeling and new construction market that were limited in their outreach prior to 2009, when they began to grow more rapidly.

Figure 4 displays **existing** occupations and companies that may provide services in various parts of the energy efficiency market value chain (e.g. planning and project management, analysis and design of solutions, installation of high-efficiency equipment and strategies, and evaluation, monitoring and verification) with appropriate training.²⁵ The majority of jobs in these occupations are in the residential and/or commercial building and construction industry (e.g. engineers and architects and various types of contractors and trades workers). If employees receive additional training and or complete certificate programs offered by trade associations, unions, or colleges then through re-training, workers in existing occupations can become more effective participants in the EESS.

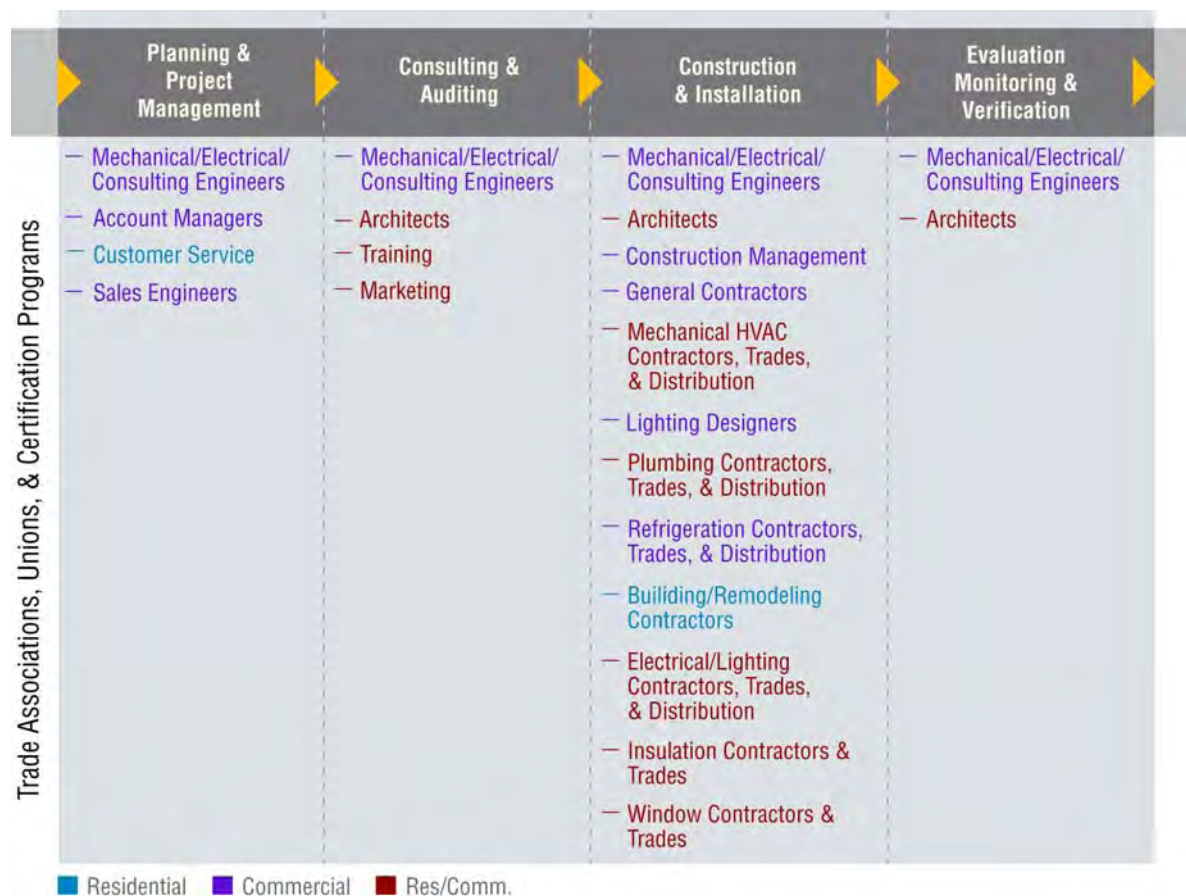


Figure 4. Re-training existing occupations to provide services in the Energy Efficiency Services Sector

Emerging occupations that are specific and somewhat unique to the EESS also can be found across the energy efficiency value chain (see Figure 5). These emerging occupations have varying education requirements, but most will require at least a bachelor's degree (i.e., 4 years or more of college).

²⁵ The initial EESS workforce study (Goldman et al 2010) provides a more detailed characterization of EESS occupations.



Figure 5. Emerging occupations in Energy Efficiency Services Sector: Education requirements

2.3 Current Approaches to After-Hire Training

Program administrators, implementation contractors, ESCOs, and associations representing building and construction contractors indicated that they typically provided on-the-job training after hire for all entry- and mid-level employees. We asked program administrators (PA) and implementation contractors (PIC) to indicate the type of training resources used for their staff after hiring (see Figure 6 for percent of PA and PIC respondents that use each type of training). Overall, survey respondents used conferences most frequently for training staff after hire, followed by on-the-job training. Respondents indicated that conferences are valuable as networking opportunities and as a good way to keep abreast of industry developments and not solely for training. Mentoring is used least (<40%) by program administrators and college/university and other in-person training courses are used least (by only 20-30%) by program implementation contractors.

Program implementation contractors include many small- to medium-sized companies (usually less than 100 employees), most of which have limited number of senior- and mid-level staff that can provide training/mentoring. Contacts said that senior staff increasingly had to train new hires while continuing to perform their other job responsibilities. This reliance on senior staff for on-the-job training and mentoring is challenging because it limits the rate at which new staff can be hired. As one implementation contractor respondent said, “This will not be a problem in 10 years, but it is a problem today.”

EESS Workforce Education and Training Needs

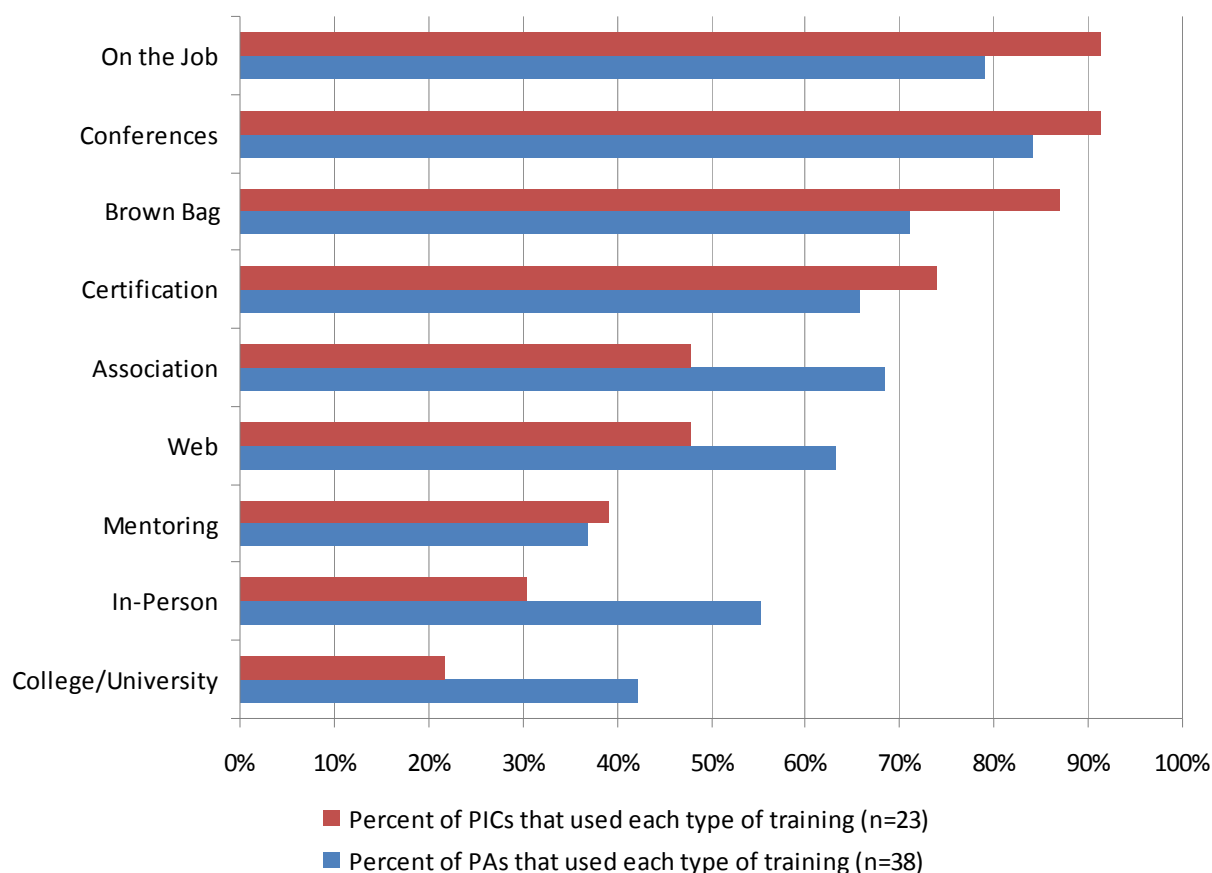


Figure 6. Types of training used by Program Administrators and Implementation Contractors

In the commercial/industrial sector, the building and construction contractors and trades involved in the EESS include mechanical insulators, mechanical contractors, electricians, and air conditioning, refrigeration, and sheet metal workers. Our contacts said that these people typically receive their technical training through trade apprenticeship programs, technical schools, and/or applicable military training prior to joining a company. Once these contractors and tradespeople are working, they receive on-the-job training, primarily from senior people in their company, and secondarily from vendors, trade associations, or union-based training programs.

The workforce in the residential building and construction industry consists of homebuilders, remodelers, and trades workers (e.g., carpenters, electricians, insulators, plumbers, and window installers). Survey respondents indicated that these workers are less likely to receive training through apprenticeship programs or trade schools compared to contractors and tradespersons in the commercial/industrial sector because their work requires lower-level skills and typically does not flow through the apprenticeship process.

“A home builder can construct a building envelope designed to maximize efficiency, but if an electrician punches holes throughout the house to run wires, they may have compromised the envelope.” – Electrical contractor

Workers in the residential EESS market receive most of their training on-the-job after they are hired, though some who become contractors and builders take technical training.

On-the-job training of new employees by senior staff is standard practice across the trades. However, respondents noted concerns about this approach. One respondent from the Refrigeration Service Engineers Society (RSES) pointed out another shortcoming of this reliance on workers learning on the job from what he called “old people like me: This is good and bad, because we have lots of experience but they may also assume our bad habits.” Additionally, relying solely on on-the-job training may be problematic for energy efficiency solutions that require new techniques or an approach that differs from common practice. If the senior electrician does not teach the electrician trainee to air-seal holes when running wire, that trainee will not learn this energy efficient construction technique.

Many building equipment contractors also receive training from equipment vendors and manufacturers, which is often their primary source of information about the latest equipment and technologies, including those that are energy efficient. However, contacts at EESS firms said they often were able to send only a limited number of employees – typically managers – to such trainings. Managers may benefit from this training; however, some contacts also indicated that it was difficult to assess the extent to which managers transferred information provided by vendors to their employees as part of on the job training.

One program administrator noted another concern with vendor-based training: such training often is both technical and sales-oriented. Thus, vendors may be incented to promote a particular product, not necessarily those that are most energy efficient.

Respondents from building and construction trade associations also noted that there is a need to respond to customers, and that energy efficiency programs and mandates often make it easier for an HVAC or electrical contractor to promote the energy-efficient product to a customer. As one contractor stated, “If the customers aren’t educated or the cities don’t mandate energy efficiency, it’s hard for contractors to convince customers to choose more energy-efficient equipment.”

“If the customers aren’t educated or the cities don’t mandate energy efficiency, it is hard for contractors to convince customers to choose more energy-efficient equipment.” – RSES association

Trade associations supporting commercial/industrial and residential building and construction contractors also offer energy efficiency training, from brief webinars to multi-day classroom trainings that lead to a specific energy efficiency certification or designation. Contacts involved with these training programs noted that a main challenge for expanding training was that the market does not yet adequately support builders and contractors who are “green” or those who are certified by North American Technician Excellence (NATE) or Refrigeration Service Engineers Society (RSES). As a consequence, few contractors are willing to invest their own time and money to receive this training.

3. Current Workforce Development

In this section, we describe the types of education and training offerings for the EESS, which include unions and trade association training programs for construction trades and contractors, community and technical college programs, specialty energy efficiency targeted programs developed through ratepayer funding sources, third-party and trade association programs supporting energy efficiency, third-party certificate and accreditation efforts that focus on energy efficiency, and four-year and post-baccalaureate programs. These offerings span various occupational categories due to the multidisciplinary nature of energy efficiency and to the fact that these efforts are emerging and being refined as the EESS becomes more established.

3.1 Union and Trade Association Training for Building and Construction Tradespeople and Contractors

Building and construction contractors and tradespeople typically gain their initial training in their field of specialization from a union apprenticeship training program, technical school, or community college. These courses prepare them to be HVAC technicians, electricians, or specialists in another construction trade. Community colleges and technical schools also offer training in construction industry-related topics of interest to contractors (e.g., management and estimating); some offer specific courses or certificates in energy efficiency.²⁶

Course work usually leads to apprenticeships, certificates, or sometimes a degree in a construction specialty. Beyond that, learning typically moves to on-the-job training. Following school-based and on-the-job training, building and construction contractors, and tradespeople may decide to receive additional training through their trade association or union, or from equipment vendors. These continuing education opportunities for journeymen and contractors help them improve their skills; continuing education courses or training are required for licensure or good standing in a trade association in some cases.

Apprenticeship and continuing education training comprise as much as 95% of all training for union members. All union representatives that were interviewed indicated that their members were most likely to receive energy efficiency training through existing union training opportunities. As one union contact said, “[Training] is all through the apprenticeship model, which evolves to meet needs.”

Contacts that are affiliated with union and nonunion apprenticeship training programs indicated that thousands of apprentices and journeymen take classes each year at training centers in their states, including those offered by a community college or technical college, or in conjunction with technical institutes or training centers that are often jointly administered by industry and unions [e.g., National Electrical Contractors Association/International Brotherhood of Electrical Workers (NECA/IBEW)]. Building and construction union representatives and workforce association representatives tended to think their workers receive sufficient energy efficiency

²⁶ Only a few of our contacts with contractor trade associations mentioned hiring from apprenticeship programs, no geographical pattern could be detected, but hiring from apprenticeship programs was more common for commercial sector compared to residential sector activity.

training through these traditional training programs. One contact said that, “efficiency is part of everything we [the building and construction trades] do.” This makes it difficult for them to identify, characterize, and report on training programs that are specific to energy efficiency. Furthermore, union and trade association respondents told us that building and construction tradespeople “already have the skill sets. [They] just need specific training on the new apparatus/technology.”

Organizations in most of the construction specialties develop written and field exams and provide certification to workers or specialists who pass those tests. For example, Refrigeration Service Engineers Society (RSES) and North American Technician Excellence (NATE) offer advanced training in HVAC specialties. The National Association of the Remodeling Industry (NARI) and National Association of Home Builders (NAHB) also offer training opportunities to their members. Most organizations do not require their members to obtain specific training or certification, though advanced and continuing education is commonly available through and encouraged by most trade associations.

Contacts at RSES also noted this challenge. RSES has a module on energy efficiency in their technical service manual and survey respondents from RSES noted that people become RSES members in order to improve their knowledge and skills. Many want to become instructors to share their expertise with others in the industry, although we also learned that RSES is attracting fewer new members, and that many active members are nearing retirement. Thus, the availability of competent trainers may become an issue in the future if not enough technicians enter programs to enhance their knowledge and skills so they become proficient enough in advanced HVAC and refrigeration techniques to become instructors.

3.2 Community College and Technical College Programs

Our research identified programs at five community colleges that have a clear, well-established programmatic focus on energy efficiency.²⁷ These schools enroll fewer than 1,500 students, and need ~70 faculty trainers per year to teach approximately 130 courses. About half of the students are new to the field, while the other half are mid-career technicians interested in adding energy efficiency to their knowledge base, or expanding their previous expertise in that area. These programs train people to be energy managers, HVAC technicians, energy auditors, renewable energy technicians, and building analysts. Each program has a slightly different focus, but generally, they prepare students to examine buildings as integrated systems, instead of focusing on individual components.

Demand for community college programs with a clear focus on energy efficiency is high with waiting lists of interested students, although few of these programs exist today.

Demand for these programs is uniformly high. Contacts at the five programs indicated that they were unable to meet the demand for their services, had a waiting list of interested students, and were waiting for significant capital investments in order to expand. For example, one respondent

²⁷ Hudson Valley Community College, Iowa Lakes Community College, Lane Community College, Laney College, and Oakland Community College.

at a school in California noted that his program supported about 20 students per year three years ago and about 70 in 2009 and planned to accommodate as many as 400 by 2013.

One respondent noted that, “Community colleges can move faster than traditional universities.” Another respondent from a community college in the Midwest indicated that he expected enrollment to increase 50% as soon as their new facility is completed. Their community college is beginning to offer energy efficiency courses in addition to its renewable energy curriculum, and will expand these offerings after the college completes a major facility addition.

Lane Community College (LCC), which has the longest-running energy efficiency training program in the country (see sidebar), reported a recent trend: an increase in the percent of people with four-year degrees enrolling in its program. In 2009, about 70% of students entering the Lane Community College program had four-year degrees and sought practical training they believed would prepare them for a job in the growing EESS. This contact indicated that these students are “guaranteed to find work in the energy efficiency field if [they] are willing to relocate.”

Lane Community College Energy Management Program

In 1980, Lane Community College (LCC) in Eugene, Oregon became the first community college in the U.S. to offer training in energy management. Many of our contacts said they consider LCC a model for technical and community college energy programs.

The college provides degree and certificate programs in residential and commercial energy efficiency, resource conservation and renewable energy systems. In October 2009, LCC already had a waiting list for admission to the Energy Management Program scheduled to begin in September 2010. The program offers three options leading to an Associate of Applied Science Degree:

- Energy Efficiency, in which students learn to conduct comprehensive commercial building audits;
- Resource Conservation Management, which provides the foundation for an energy efficiency career in commercial buildings and for sustainable practices and waste management for institutions;
- Renewable Energy, which prepares students for careers in solar PV and thermal installation.

Students who attend the Lane program find jobs as energy auditors, facility managers, energy program coordinators, and related positions. Employers include utilities, energy equipment companies, engineering firms, and the Oregon and U.S. Departments of Energy.

LCC also houses the Northwest Energy Education Institute (NEEI) within the Energy Management Program offering standard and custom learning opportunities for practicing professionals in the energy industry. Certificate opportunities include:

- Energy Management Certificate, a two-week intensive energy efficiency workshop for engineers, facility managers, resource conservation managers and HVAC technicians;
- Building Operator’s Certification, a course series that has trained over 230 building operators;
- BPA Residential Auditor and Inspector Certification, for residential auditors and installation inspectors who need this certification for their working credentials.

One of the reasons that community and technical college programs are able to grow quickly is their heavy reliance on part-time adjunct teachers. All contacts at community colleges and technical schools stated that they rely on a small number of key full-time instructors who recruit adjunct trainers from the community workforce as appropriate.

However, over the long term, reliance on a small core group of key instructors to teach courses and staff programs could challenge the sustainability of these community college programs. Several contacts at these community colleges pointed out that they are nearing retirement age. One California community college respondent noted that, “I am the only full-time instructor and I am running out of gas.” Because energy efficiency has been a niche field until recently, there are not a large number of potential instructors to replace him. Furthermore, as these programs become more popular and interest in energy efficiency grows, these programs will need to expand quickly just when these key instructors are eligible to retire.

In addition to our interviews, LBNL established a partnership and collaborated with the California Community College Centers of Excellence (COE) as part of our workforce size and needs assessment. In 2009, the California Community College Centers of Excellence (COE)²⁸ completed a comprehensive inventory of energy efficiency-related education and training programs currently offered and under development by community colleges throughout California (Centers of Excellence 2009a-2009i; see Appendix B for detailed results of the COE 2009 survey). The approach taken by COE provides an excellent example of the value of a comprehensive inventory of energy-efficiency related education/training programs so that community colleges can develop a baseline assessment and identify gaps.

Hudson Valley Community College Center for Energy Efficiency and Building Science

Hudson Valley Community College in Troy, NY hosts the Center for Energy Efficiency and Building Science (CEEBS), which operates 10 training sites in New York. This program began in 2007 and is funded by NYSERDA, LIPA, and a U.S. Department of Labor Community Based Job Training Grant.

The CEEBS program offers courses and certificates for tradespeople, design professionals, building inspectors, and people interested in a career in energy efficiency. Course work leads to Building Performance Institute (BPI) certifications (Building Analyst, Building Envelope, Heating, A/C Heat Pump, and Multifamily Building Analyst) and RESNET certificates (Home Energy Rating System (HERS) Rater, and ENERGY STAR’s Sales and Marketing training).

NYSERDA reimburses 75-100% of the cost of each completed course for students living in the New York System Benefits Charge territory. BPI Building Analyst training is the most popular training offered at nine of the 10 training sites.

²⁸ The Centers of Excellence, formed as part of the California Community Colleges Economic and Workforce Development Program, delivers regional workforce research customized for community college program development.

The CA COE focused on programs which support workforce development for eight specific occupations that were identified as both high growth and in alignment with community college core competencies:

1. Energy Auditor/Home Energy Rater
2. Building Performance or Retrofitting Specialist
3. Compliance Analyst/Energy Regulation Specialist
4. Project Manager for Construction/Design Work
5. HVAC Technician or Installer
6. Resource Conservation/Energy Efficiency Manager
7. Building Controls System Technician
8. Building Operator/Engineer.

COE determined that nine programs were most likely to be related to these eight occupations (Environmental Science, Environmental Studies, Environmental Technology, Industrial Systems Technology and Maintenance, Environmental Controls Technology (HVAC), Energy Systems Technology (Energy Management), Construction Crafts Technology, Civil and Construction Management Technology, and Construction Inspection) and then conducted an online survey and follow-up phone interviews that was disseminated to the 110 California community colleges in California. Ninety-eight of California's 110 community colleges responded to the survey. About 45% of these colleges reported offering a combined total of 118 certificate and 2-year degree programs that target these eight occupations. Looking across the state, 12 colleges offer certificate programs for building retrofit specialist, while 18 colleges offer certificate programs targeted at HVAC installer/technicians. Enrollment data was not systematically reported by colleges that responded to the survey. Course enrollment data was reported by 21 community colleges in four of eight regions: a total of 2,252 students were enrolled in energy efficiency-related courses, and 4,234 students were enrolled in courses that may include energy efficiency content. The community colleges reported that almost all of these courses were enrolled at or above capacity with waiting lists (with a few exceptions).

3.3 Ratepayer-funded Energy Efficiency Education and Training Efforts

A variety of education and training efforts have developed through direct support by program administrators of ratepayer-funded energy efficiency programs. Activities include collaboration with community and technical colleges and collaboration with trade associations and professional organizations. Several states with large ratepayer-funded budgets have established workforce training centers and laboratories.

The approach taken by the California Public Utilities Commission and utilities has several distinctive features: 1) the importance of workforce education and development is recognized and identified as a separate programmatic element of the CPUC's Long-term Strategic Plan for Energy Efficiency and the utility's approved budgets for energy efficiency (spending on workforce education and training is ~4% of the total EE budget), 2) the CPUC is funding a comprehensive workforce education and training needs assessment, and 3) the utilities have developed energy efficiency centers during the last decade that provide a geographic focus and physical presence for workforce education and training. The California Public Utilities Commission (CPUC) recently approved a budget of about \$100 million for Workforce Education

and Training activities for the 2010-2012 program cycle for the four investor-owned utilities (CPUC 2009). The approved programs were consistent with the CPUC Long-Term Strategic Plan, which identifies WE&T strategies to promote the goal of "developing the human capital necessary to achieve California's energy efficiency and demand-side management potential." The four program strategies are: 1) a statewide WE&T needs assessment, 2) formation of a WE&T task force, 3) a WE&T web portal, and 4) development of programs for all levels of workforce education. About 67% of the WE&T budget is targeted towards the ongoing WE&T "Centergies" sub-program which supports the utilities' workforce development and education training centers: the Pacific Energy Center in San Francisco, the SCE Customer Technology Application Center (CTAC) in Irwindale, and the San Diego Energy Resource Center (SDERC). These centers provide classes for architects, engineers, lighting designers, contractors, building owners, and tradespeople on energy-efficient building solutions and showcase current lighting technologies so visitors can see the effects of these lighting solutions. About 16% of the WE&T budget will go to the "Connections" sub-program which focuses on all educational levels, including K-12, to inspire interest in energy careers as well as future EE skill development.²⁹ About 12% of the budget goes toward education and training for HVAC workforce and building energy code officials.

In New York, the New York Energy Research and Development Authority (NYSERDA) and the Long Island Power Authority (LIPA) are supporting the development of 10 training centers at local community and technical colleges (see sidebar). This effort is the first in the country and is becoming a model for other states such as Massachusetts, which is creating a similar energy efficiency training program.

The Northwest Energy Efficiency Alliance (NEEA) supports a network of integrated design and lighting design laboratories co-located with architectural programs at universities in four Pacific Northwest states (WA, OR, ID, MT). These design labs provide design assistance to architects, lighting designers, and engineers, and provide classes for contractors and building owners to increase their understanding of energy-efficient building solutions. NEEA also provides online access to information and tools through their BetterBricks.com website, an online portal to their commercial building services.

In Wisconsin, ratepayer funding supports the Energy Center of Wisconsin (ECW), which offers a variety of courses on technical topics for energy efficiency architects, engineers, contractors and tradespeople through their program Energy Center University. Energy Center University provides a residential and commercial training series, a daylighting collaborative, the Better Buildings, Better Business Conference, which draws 1,000 attendees, and webinars targeted at energy efficiency services practitioners. The Energy Center University program offerings are focused primarily on additional training for existing professionals and practitioners (e.g., advanced design and installation skills that move toward achieving net zero buildings). The webinars frequently garner 500-900 participants. Funding for Energy Center University has averaged about \$2M per year for the last 3 years, split roughly evenly between residential and C/I markets.

²⁹ The utilities will work with educational, labor and community institutions to promote interest in green careers by K-12, community college, occupational, vocational, and major university students and assist in the growth of low-income and transitional workforce-targeted clean energy training programs.

3.4 Third-party and Trade Association Programs supporting Energy Efficiency

The Association of Energy Services Professionals (AESP) and the Association of Energy Engineers (AEE) have courses directly targeted to energy efficiency. The AESP does not offer certificates, but does offer specific training in energy efficiency program planning, program implementation, marketing, and program evaluation targeted at professionals involved in ratepayer-funded energy efficiency efforts. AESP offered training courses between 1991 and 1995 and then resumed training courses in 2008. AESP reports training 350 professionals in 2008 and expects to train about 850 in 2009 and between 1,000 and 2,000 in 2010. AEE has offered training since 1981. AEE courses support a variety of certificates based on students' experience and completion of subject matter exams; AEE reports that they certify about 1,500 people per year.

There are two private-sector, for-profit organizations that offer training courses to managers and professionals in the energy industry (including courses in energy efficiency and DR). The Electric Utility Consultants (EUCI) reported that 60-80 professionals are trained each year in energy efficiency and demand response course topics.

Many professional trade associations expect members to obtain continuing education credits and have developed programs that focus on green or sustainable buildings. For example, the American Institute of Architects (AIA), the Building Owners and Managers Association (BOMA), and the American Society of Mechanical Engineers (ASME) offer specific training modules for energy efficiency or sustainability, but these modules are typically not certified by energy efficiency certification or accreditation bodies as they are focused on member needs. We were unable to obtain estimates of the number of members in these organizations that receive continuing education credits related to energy efficiency. However, based on our interviews with contacts at these organizations, participation in energy efficiency-related training is increasing and will likely continue to do so.

3.5 Third-Party Certification and Accreditation Efforts

Over the long term, the viability of the EESS depends in part on ensuring that energy efficiency projects are designed well, and installed by qualified professionals and technicians. Quality assurance has been a significant concern to program administrators and is increasingly a concern in this environment of rapidly increasing energy efficiency funding. The concern is that as new firms enter the market or existing firms expand rapidly, some of these firms and their employees may lack the necessary training to properly design and install high-efficiency systems, which may undermine the effectiveness of the energy efficiency investment for the customer. Energy efficiency certification and accreditation programs help address this issue.

The Association of Energy Engineers (AEE), the Building Commissioning Association (BCA), the American Society for Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Building Performance Institute (BPI), Weatherization Assistance Program (WAP), and

Commissioning refers to the process of providing documented confirmation that building systems function according to the criteria set forth in the project documents to satisfy the owner's operational needs. (Building Commissioning Association 2009)

Residential Energy Services Network (RESNET) have developed programs that are specific to the energy efficiency industry. Each of these organizations has committees of energy efficiency experts from industry, related associations, and academia that identify essential competencies for their field, and update them as technology and methods improve. These competencies form the framework of the certification testing processes they oversee. Some organizations also provide access to training courses to prepare professionals for the certification exams, others accredit courses and trainers who independently offer courses to prepare professionals for the certification exam. AEE, BCA, ASHRAE, BPI, and WAP certify individuals who meet eligibility requirements and complete a certification exam. These certification programs with exams offer additional assurance that people that have completed the program and passed the exam are knowledgeable about and qualified to provide specified building energy efficiency services.

AEE offers a wide range of certifications that recognize training and experience in various sub-areas of energy efficiency engineering. Most of these certificate programs have eligibility criteria that include combinations of formal training and job experience, making the certification relatively available to professional engineers and to individuals who have on-the-job experience without formal training. The Certified Energy Manager (CEM) certificate is the oldest and most widely known certificate with over 6,000 CEMs granted since 1981(see sidebar on requirements of AEE CEM certificate).

BPI's Knowledge Essential Task List (KETL) identifies the information that a BPI-certified person has studied. The BPI has affiliates that are permitted to offer training to people seeking to be certified and to proctor their students taking the BPI certification exam. BPI has seen rapid growth in both certifications and training affiliates. BPI certified about 300 people in 2005,

Certified Energy Manager (CEM) Certification

All AEE CEM candidates must attend one of AEE's preparatory CEM training seminars and complete and pass a four-hour written open-book exam, proctored by an approved exam administrators. The CEM training seminars are open to those with a four-year engineering or architectural degree, registered professional engineers (PE) or registered architects (PA) or equivalent combination of training and experience. Candidates must complete at minimum of 11 of the following 17 modules of the exam, including the three required modules. AEE also recommends completion of a self-study course on the Basics of Energy Management prior to taking the CEM seminar.

1. Codes & Standards & Indoor Air Quality - **Required**
2. Energy Accounting and Economics - **Required**
3. Energy Audits and Instrumentation - **Required**
4. Electrical Systems
5. HVAC Systems
6. Motors and Drives
7. Industrial Systems
8. Building Envelope
9. CHP Systems and Renewable Energy
10. Energy Procurement
11. Building Automation and Control Systems
12. Green Buildings, LEED & Energy Star
13. Thermal Energy Storage Systems
14. Lighting
15. Boiler and Steam Systems
16. Maintenance & Commissioning
17. Alternative Financing

700 in 2006, and 1,680 in 2008. Contacts indicated that certifications were expected to reach 5,000-6,000 in 2009 and possibly 12,000 in 2010-2011. BPI has also been adding training affiliates to meet the demand. As of October 2009, BPI had 121 training affiliates, is expected to have 150 by Dec 2009, and 200 to 250 by 2010-2011.

BCA offers certifications for commissioning, as do AEE and ASHRAE. ASHRAE also offers certifications for Design Professionals, for Operations and Performance Management and New Building Energy Modeling (starting in 2009).

Superior Energy Performance for Government and Large Commercial & Industrial Firms

In addition to ratepayer-funded energy efficiency efforts, new standards and programs to train and certify professionals will influence the energy efficiency practices of government and large commercial and industrial firms. In 2008, a national standard on management systems for energy was updated by the American National Standards Institute (ANSI/MSE 2000:2008). This standard sets requirements for organizations to take a systematic approach to continually improve energy performance. By 2011, an international energy management system standard developed through the International Organization for Standardization (ISO 50001 – Energy Management) will be released. In 2009/2010, the American Society of Mechanical Engineers (ASME) released four standards that establish requirements for conducting energy assessments at industrial facilities for compressed air, pumping, process heating, and steam systems. Guidance documents for these standards will be released later this year.

There is an ANSI-accredited professional certification and training effort getting underway to ensure that there are skilled and knowledgeable professionals available to assist government and large commercial and industrial firms with implementing these standards as part of a systematic approach to the continual improvement of energy performance. The certified practitioner programs are being developed in order to establish the credibility of the professionals (e.g., engineers, engineering technicians) that will be performing the services related to each of the technical areas listed above and help ensure that these standards are properly applied. The certified practitioner programs will also help potential users of these services locate a qualified person. Related training efforts to prepare professionals for certification are also being developed.

In 2009 there were less than 10 people in the US with this training and knowledge; by 2017 up to 5,000 people will be trained and providing these services to ~250,000 large commercial, industrial and government facilities that will be certified by 2017. Training venues are emerging; for example, the US Department of Energy hosted the second annual Energy and Innovation Summit in Grand Rapids, Michigan in May 2010, which included a one day energy training seminar on the new ASME/ANSI standards. More information about Superior Energy Performance can be found at <http://www.superiorenergyperformance.net>.

The WAP lists core competencies that all program staff must demonstrate before they do field work. The WAP network targets low-income weatherization efforts from 12 training centers across the country. The low-income weatherization agencies tend to use multiple sources for training. About 90% of states use state agency staff for some training, 75% of states also use “local agency peers,” and 70% use independent trainers. These agencies vary in the level and type of certification required of technical staff. Some develop their own certification, while others require certification from a national organization. While there is variation in how weatherization training occurs at the 12 WAP training centers, all must follow the core competencies developed by the Weatherization Trainers Consortium (WTC), whose members include weatherization training staff, independent trainers, state and local staff, community college instructors, and Department of Energy managers. With the passage of the ARRA in 2009 and the \$5 billion in incremental funding for low-income weatherization, the WAP program has set a long-term goal of weatherizing one million homes per year compared to the approximately 150,000 homes weatherized in 2008. As part of ramping up, the WAP network estimates they will need at least 700 additional trainers by summer 2010 (Adams 2008).

A number of organizations have also developed green building or sustainability certificates in addition to energy efficiency-focused certification. For example, AEE offers Sustainable Development Professional and Certified Carbon Reduction Manager certificates in addition to 10 energy efficiency-focused certificates.³⁰ The Leadership in Energy and Environmental Design (LEED) certification is offered by the U.S. Green Building Council (USGBC). USGBC has certified more than 114,000 LEED Accredited Professionals in the U.S.; architects comprise 30-40% of that total. LEED addresses energy efficiency in its building certification requirements, although LEED is not predominately an energy efficiency building certification. LEED contacts estimate that less than 2% of LEED Accredited Professionals have the skills to design and/or build a highly energy-efficient building.

The National Association of Home Builders (NAHB) and National Association of the Remodeling Industry (NARI) each have developed specialty certificates for member contractors in green building and remodeling. These programs are growing rapidly. For example, since program inception in February 2008, the NAHB certified 1,729 green professionals in 2008 and 2,759 green professionals as of November 2009. Furthermore, NARI certified approximately 100 people in 2008 but are on pace to certify about 200 in 2010. Approximately half of the curriculum for each organization concerns energy efficiency.

The Residential Energy Services Network (RESNET) has taken a somewhat different approach to training and offers accreditation. RESNET focuses on accrediting organizations such as community weatherization agencies, community colleges, and private organizations to provide residential weatherization and building performance training programs rather than individuals. As of October 2009, RESNET had 103 accredited affiliates and estimates that 1,200 to 1,600 individuals per year complete training with RESNET-accredited agencies and training organizations. RESNET is working with the New Buildings Institute (NBI) to develop a similar

³⁰ AEE has granted over 15,000 certificates since 1981. In 2008, AEE certified around 1,500 energy professionals in at least one of its 17 certificate programs although they expect numbers to be somewhat lower in 2009 due to the economy.

accreditation process for commercial energy efficiency training organizations, which is called COMNET and is anticipated to be available in 2010 or 2011.

As the EESS expands, there is some concern that the quality of training could suffer. RESNET and BPI contacts specifically voiced this opinion. Neither organization has a training curriculum. However, both want to ensure that their trainers are qualified to teach the appropriate material effectively, so that students pass the certification exams and subsequently provide high-quality energy ratings, audits, and field inspections. To address this concern, both RESNET and BPI are in the process of establishing guidelines for their affiliates and partners about how to select informed and effective trainers.

3.6 College- and University-based Energy Efficiency Programs

Program administrators and program implementation contractors reported that EESS professionals typically have at least a four-year college degree, although it is rare to hire someone with a degree or course work in energy efficiency. We identified 750 four-year colleges and universities with architecture, mechanical engineering, policy, planning, or interdisciplinary programs that could offer course work, degrees, or certification in energy efficiency. We determined that 28 of these schools (or 3.7%) offered degrees directly relevant to the EESS in 2008.

We completed in-depth interviews with directors or associate directors with 19 of these institutions. These programs enroll approximately 5,100 students (3,000 in engineering/architecture and 2,100 in programs/policy/evaluation) in classes that emphasized energy efficiency, and graduate about 1,200 students per year.

By comparison, mechanical engineering programs in the U.S. awarded 23,111 degrees in 2008, of which 5,787 were graduate degrees (Gibbons, 2009; National Science Foundation 2009), and architecture graduate programs produced 3,365 architecture new architects in 2007 (U.S. Department of Education, National Center for Education Statistics 2007).

Energy Efficiency at the University of California, Davis

UC Davis is one of the few universities with a series of graduate level classes and an academic center, the Energy Efficiency Center (EEC), specifically for energy efficiency. The EEC focuses on accelerating the development and commercialization of energy-efficient technologies and training future energy efficiency leaders. In addition to offering three energy efficiency classes, the EEC also selects graduate students from a variety of programs to serve as Emerging Venture Analysts (EVA) each year. EVAs receive a Graduate Research appointment and are trained to design and develop energy efficient technologies, conduct market analysis and complete business modeling in collaboration with EEC technology partners.

The EEC benefits from the long history of energy efficiency research at UC Davis. There are currently over 30 courses that include EE as a topic, taught by over 20 professors and researchers, in such areas as engineering, design, environmental science & policy, business, landscape architecture, and transportation, technology & policy. There are also a number of complementary research centers and groups that regularly engage students to assist with the research initiatives, including California Lighting Technology Center, Water Efficiency Center, Western Cooling Efficiency Center, Center for Entrepreneurship, Institute of Transportation Studies, Plug-in Hybrid Electric Vehicle Research Center, Postharvest Technology Research and Information Center, and The Energy Institute.

Other programs at Davis also offer professional and continuing education that include energy efficiency. An example is the California Advanced Lighting Controls Training Program (CALCTP), led by the UC Davis California Lighting Technology Center which partners with utilities, contractor and labor organizations, community colleges, lighting control manufacturers, and others to offer training for contractors and electrical workers in the proper design, installation, commissioning, and maintenance of advanced lighting control systems.

Energy efficiency course syllabi not only cross discipline boundaries, but also respond to the needs of students from several disciplines. Our contacts indicated that this kind of cross-training is necessary to optimize energy efficiency efforts. One respondent involved in an architecture school said that all engineers or architects should learn basic information about efficiency through their coursework. Another respondent who led an energy engineering program stated, “People design *components*, not *systems*, and the emphasis [for improving efficiency] needs to be on *systems*.” (Italics added.) Another contact who was just launching a policy program said that in her experience, energy efficiency has been included in engineering courses “forever” but “energy efficiency is more recently being integrated into policy and management courses.”

Many of the professional energy efficiency-related educational offerings were multi-disciplinary and incorporated elements from traditional disciplines such as engineering, architecture, planning, and public policy. Our college and university contacts said their institutions typically offered specialization in energy efficiency through focused programs or individual courses in energy efficiency technologies, practices, or policies. Examples include the UC Davis Energy

EESS Workforce Education and Training Needs

Efficiency Center (see sidebar), the Carnegie Mellon University School of Architecture's Master's degree in sustainable design which devotes about half of its curriculum to the optimization of building efficiency, and the Massachusetts Institute of Technology's (MIT) Department of Urban Planning's Energy Initiative which offers a class intended to prepare students for careers in energy efficiency program implementation and evaluation.

4. Meeting Projected Demand for Energy Efficiency Education and Training Programs

In this section, we present findings on the type of growth pressure faced by energy efficiency education and training programs, the requirements for creating and supporting new programs, resources and strategies to facilitate expansion of existing programs, and the need for curriculum development support.

4.1 Energy Efficiency Education and Training Program Trends

In interviews with education and training program contacts, we found that the evolution of energy efficiency education and training programs echoes historic trends in energy efficiency funding. Fifteen energy efficiency education/training programs were established before 1985, while six were launched between 1985 and 2005, and nine were established after 2006 (see Figure 7).³¹ If recent trends continue, there could easily be 20-30 additional energy efficiency education and training programs by 2020.

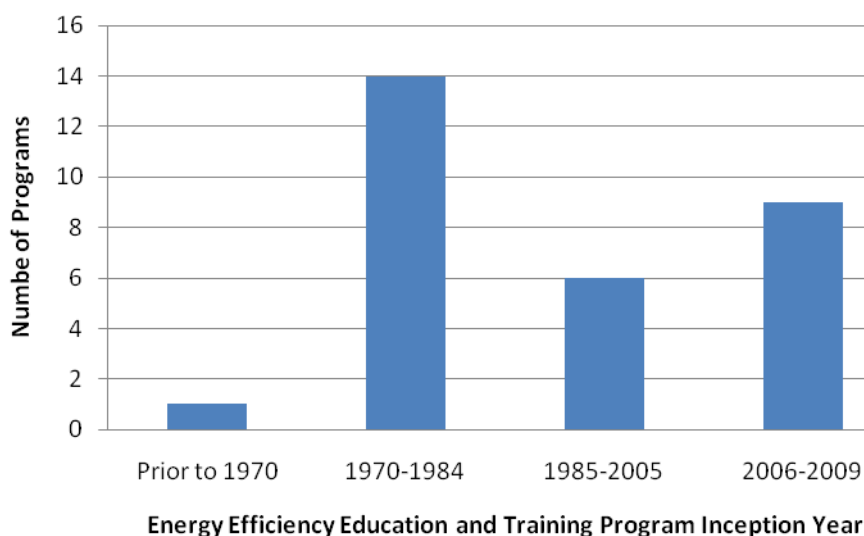


Figure 7. Energy efficiency education and training programs: Year of inception

4.2 Current Pressure on Education and Training Programs

Our contacts indicated that there was significant demand for energy efficiency education and training programs, and generally many job opportunities for graduates. Graduates from five community college energy efficiency programs typically have job offers. The Lane Community College respondent reported that he is able to place nearly every graduate each year, many of them in California, and tailors his enrollment to the number of jobs anticipated in the market.

³¹ A number of education programs targeted to the EESS that started in the 1970s and 1980s no longer exist. Examples include such programs as a Certificate in Applied Energy Economics and Policy at Portland State University that operated from 1995-2004 and the University of Pennsylvania Energy Management program, which began in 1970 and was the oldest and largest program when it was closed in the mid-1990s with over 400 graduates, many still working in energy efficiency and some in university positions.

Other community college programs reported no lack of students – including many four-year degreed professionals who want to learn about energy efficiency, or mid-career contractors and tradespeople seeking to expand their skills into energy efficiency.

Demand for courses is also very strong at four-year colleges. For example, an institution that is developing a new policy-focused program began receiving inquiries without advertising; through word-of-mouth communication alone, they anticipated having 25 students ready to enroll by the first year, and would have as many as 100 students enrolled in two years. One contact affiliated with a policy program indicated that program enrollment had grown 30% between 2003 and 2008, but did not expect to maintain that level of growth due to an inability to add space and/or expand faculty. A respondent from an engineering program noted that one energy efficiency-related class that used to have four to five students had grown to 15. Another respondent expected their institution's policy-oriented program to reach maximum capacity in 2009 after several years of growth and to start wait-listing potential students.

Survey respondents also indicated that job placement is high for four-year energy efficiency programs. In 2008, the pool of approximately 1,000 college and university graduates in energy efficiency quickly found work. Respondents at the various colleges and universities indicated that 90-100% of advanced-degree graduates found energy efficiency-specific jobs within six months of graduation. The following comments were common in our interviews with community and four-year colleges.

“We cannot fill demand now. I can pick up the phone and place people in jobs.”

“There is actually a waiting list of employers [for our students].”

“Students are overwhelmed with offers.”

However, as several respondents pointed out, the highly skilled graduates tend to congregate in the “states with strong energy efficiency policies,” such as California, New York, and Wisconsin. Similarly, in states with a long history of large-scale ratepayer-funded energy efficiency programs, many building and construction tradespeople have experience working with energy efficiency program administrators.

As energy efficiency expands to states without this history and infrastructure, members of the building and construction community will need support to build awareness, experience, and connected networks. One trades contact noted that “We're in the boondocks and it's hard to get any kind of [energy efficiency] speaker out here. [Training needs are] more acute here because we are so isolated.”³² Similarly, there will be a need for more four-year programs that will have graduates interested in placement in areas where energy efficiency is just surfacing.

³² Trades contacts in several Midwestern states and in rural areas of Texas indicated that their organizations could not attract enough qualified trainers to meet demand.

4.3 Creating and Supporting Training for the Building and Construction Industry

As large-scale energy efficiency programs expand beyond California, the Pacific Northwest, the Northeast, and upper Midwest, those states and regions that have limited energy efficiency services infrastructure will face the challenge of rapidly creating and supporting increased education and training opportunities, particularly for the building and construction industry. Energy efficiency education and training are a key component of a state's strategy to facilitate a smooth expansion of energy efficiency programs and market activity.

The effort underway in New York provides an example of a broad statewide education/training effort. As discussed earlier in this report, NYSERDA's collaboration with Hudson Valley Community College (see sidebar) is structured to increase the skills of the building and construction contractors and tradespeople. This type of training infrastructure can help states that are ramping up energy efficiency programs if building and construction contractors and trades are much less aware of energy efficiency-specific design and construction practices.

Another approach is to integrate building and industrial process system efficiency into existing curricula. This could be a cost-effective way to train large numbers of electricians, HVAC contractors, mechanical insulators, home builders and others. As one union contact said, teaching efficiency relies on "using existing skills and applying it to new technologies and measures." Because the building and construction trades constitute approximately 75% of the overall EESS workforce, this is the sector of the workforce for which training in energy efficiency can have a great impact.

One union trainer from a Midwestern state said his program was beginning to shift focus from specific systems, to providing "cross-skills training across our various unions." This could be useful for other, similar, union training programs. He said this change offered an ideal opportunity to integrate energy efficiency training into his programs, due to its whole-building approach. For instance, through cross-training, a carpenter can learn from an electrician how to make it easier for the electrician to run wire in a building, while also reducing the number of penetrations that might affect the building envelope's efficiency. Cross-training also helps the electrician collaborate with the mechanical contractor to integrate the building's lighting and HVAC systems to minimize energy use.

Expansion in training is underway, or soon will begin. Respondents at community colleges that already have HVAC, construction technology, and other building trades-related programs said their institutions were likely to incorporate energy efficiency into their curricula. In California, a concerted effort is underway to expand energy efficiency training at community colleges in selected occupations (see Appendix B). Respondents indicated that this change will not require a significant investment or a total revamping of their programs, but they will have to adapt their curricula and train more instructors.

4.4 Expansion of Educational Efforts for Professionals

While the primary need for expanded training in terms of sheer numbers is with the building and construction trades and contractors, four-year educational institutions also have an important role to play to prepare architecture, engineering, and social science professionals to be part of the EESS. Respondents expressed two needs: 1) multi-disciplinary approaches to energy efficiency education and training, and 2) an increase in the number of energy efficiency offerings and instructors.

For example, four-year educational institutions in states that are just ramping up their energy efficiency programs could provide additional courses with multi-disciplinary and system approaches to energy efficiency. A faculty member in an engineering program said, “Building systems are undervalued [in our programs]. Buildings should be the first step in carbon reduction. Energy efficiency should be [taught] in multiple areas of the campus, such as mechanical engineering, public policy, and business.”

While many Ph.D.s in other disciplines stay in academia, most of the Ph.D.s with energy efficiency expertise find jobs in industry, due to high demand, excellent compensation, and a shortage of high-level teaching positions. Most of the four-year colleges and universities interviewed prefer faculty with a Ph.D. and relevant experience and research, and an interest in teaching. Respondents from engineering and architecture departments also felt it was important for faculty to have some field or industry experience. As one respondent involved in an engineering program put it, “We need people with HVAC skills, modeling skills, and experience at the time of hire [because] we want [students] to have energy skills and think fluidly about energy.” Another respondent noted that industry experience provides a connection between academia and industry, which is important for graduates of these programs.

The growth in demand for energy efficiency-related courses and programs may require educational institutions to add physical space and equipment to support education and training activities. Respondents suggested that the current four-year programs were approaching maximum capacity and that future growth in these fields would have to occur at other institutions because funding is not available in public institutions to expand and grow programs. Moreover, it typically takes many years to create a new program in four-year colleges and universities. One respondent said it took him eight years to develop a Ph.D. program, and that it took several more years before the program awarded its first degrees. While several four-year institutions have begun the process to create new degree offerings, none had been established

Indiana Institute of Technology B.S. in Energy Engineering

In 2008, the Indiana Institute of Technology (IIT) began offering its B.S. in Energy Engineering. IIT’s program is unique because of its focus on practical field experience and preparing engineering students for a career in energy efficiency.

The program requires fundamental engineering courses, such as physics and calculus. Students spend their junior year on a practical project to help a local business make its facilities more energy efficient. The program also incorporates courses in renewable energy.

IIT promotes the program to potential students as an opportunity to launch a career in the industrial, commercial, and government sectors.

during our research period, though the Indiana Institute of Technology (see sidebar) had just successfully launched a new program in 2008.

Across all programs, recent academic hires were rare; no program had hired more than one new faculty person in the past few years. One respondent from a well-established energy policy program said they had not hired a new faculty person since the mid-1980s, while another respondent at a policy-focused program said their professors were “old” and their program “had not hired new people for a while.” Fifteen of 19 college and university respondents said they needed new faculty or staff positions to keep pace with enrollment, yet only one expected to receive funding for new faculty positions in the near term. As one architecture faculty contact noted, “We are desperate for two more faculty people, yet the university and state have no money [to support new faculty] even though the school has a clear interest in energy efficiency and sustainable living.”

One of the respondents noted that teachers and faculty also needed more opportunities to learn from one another at conferences or summer workshops. One such series was sponsored by the National Science Foundation between 2006 and 2008 and was commended by several respondents. These conferences or summer workshops also could raise the profile of the energy efficiency field and give graduate students venues to share their research about energy efficiency technologies, behaviors, and policies.

4.5 Continuing Education and Training for Professionals

While the primary approaches being considered for training and education is to expand current programs, build new ones, and to integrate energy efficiency into existing education curricula, many professionals are already working that want or need training and education in energy efficiency. Moreover, many of the people with the skills in energy efficiency are not in the universities. As one respondent noted, some design firms are so skilled at building commissioning that their staff should instruct Ph.D. university faculty about the topic. Thus, there is a need to bring the knowledge of the energy efficiency community into the training and education world and that takes different strategies.

Because professionals have many of the needed knowledge and skills, new skills for energy efficiency need to be targeted. For example, trade associations (and some four-year schools) are offering professional development courses to help practicing architects and engineers better understand system approaches to building design and construction. Some respondents pointed out that it is important that practicing professionals be exposed to energy efficiency education and training that is tailored to the building stock and conditions found in specific regions (e.g. weather and building practices). One respondent in the Northeast said it would be valuable to have more regional lighting and ventilation testing labs, similar to the Integrated Design Labs in the Pacific Northwest sponsored by the Northwest Energy Efficiency Alliance (NEEA).

University/college contacts are offering professional development courses as part of their strategy to reach out to practicing professionals and indicated that this strategy might allow them to expand and meet demand for energy-efficiency practitioners without the costs associated with starting a new program or hiring more tenure-track faculty. One university that offers such courses is considering adding an energy-efficiency certificate or degree. A number of colleges/universities that cannot expand established programs or hire more tenure track faculty are examining how to educate practicing professionals through short-term classes, online programs, and workshops. This interest is driven in part by their experience that practicing professionals may require relatively little additional training to become effective providers of energy efficiency services.

Some contacts said they planned to offer distance learning options such as online courses as a relatively inexpensive alternative to constructing new facilities and hiring new faculty. When asked how a program would respond if demand for workers and professionals trained in energy efficiency were to double in the next five years, one respondent in a large energy engineering program said, “We would develop more tools and make them available online [and] we would offer more [short-term] trainings.” He did not think that the program would grow proportional to demand by adding traditional classroom capability. Contacts at some of the engineering schools pointed particularly to the example of the Industrial Assessment Centers³³ (IAC) and suggested that such an approach could provide the additional benefit of training engineers, architects, and even policy and planning students in residential- and commercial-sector issues.

³³ The Industrial Assessment Centers (IAC) are funded by the US Department of Energy as a training facility for engineering students and as a resource for industrial firms. Through the IAC, engineering students conduct energy efficiency assessments of industrial processes and facilities and provide the results to the industrial facilities.

5. Conclusions

There will likely be significant growth in employment in the energy efficiency services sector (EESS) in the next decade; Goldman et al. (2010) estimates that employment is likely to increase by a factor of two to four by 2020. In the high-growth scenario, employment in the EESS could grow at a rate of about 11% per year to 2020 and the energy efficiency services sector would account for about 384,000 PYE (or 1.2 million people) by 2020. Various types of professional occupations (e.g. engineers, architects, managers, program planners, program evaluators) would account for about 25-35% of the future EESS workforce, while building and construction contractors and trades will account for the remaining 65-75%.

The results of our interviews with more than 350 representatives from about 150 organizations in the EESS highlight the need for additional education and training to meet the demands of a growing workforce to provide energy efficiency services. Our research indicates that diverse solutions will be necessary, including expanding both the number and capacity of formal community college and four-year energy efficiency-related education programs and encouraging the expansion of less formal, shorter duration energy efficiency trainings for the building and construction trades.

New education and training programs should be developed and implemented quickly to increase the skills of those already active in the field and to help prepare new EESS employees. The schools and organizations we identified as serving construction contractors and tradespeople enroll about 8,000 to 9,000 students per year, while those providing training for the professional efficiency occupations enroll about 6,000 students per year. This existing capability is unlikely to produce enough educated and trained EESS professionals and tradespeople to meet a projected four-fold increase by 2020 in the demand for a skilled, job-ready workforce.

5.1 Recommendations

We recommend the following six actions:

1. Provide energy efficiency education and support targeted at building and construction contracting and tradespeople

We found a notable lack of awareness on the part of building and construction contractors and tradespeople that energy efficiency is poised for significant growth. Because building and construction contractors and tradespersons constitute approximately 65-75% of the overall EESS workforce, it is important to educate and support the building and construction industries to make sure they are able to provide a trained workforce to support this growth. This problem appears more severe in states that do not have long-running ratepayer-funded programs. There is also the issue of lack access to resources in addition to lack of awareness. Even in cases where there is interest, the expertise and training required may not be available in the local area. As one contractor trade association contact noted, “We’re in the boondocks and it’s hard to get any kind of [energy efficiency] speaker out here. [Training needs are] more acute here because we are so isolated.” It will also be important, especially in states that are ramping up energy efficiency, to integrate building and industrial process system efficiency into existing building and construction technical, apprenticeship, and trades curricula. This could be a cost-effective way to

train large numbers of electricians, HVAC contractors, mechanical insulators, and home builders. As one union contact said, teaching efficiency relies on “using existing skills and applying it to new technologies and measures.”

2. Coordinate and track training efforts within states; share best practices across states

With the influx of ARRA funding, many states are initiating and/or ramping up a range of training and education activities that target workforce development in the “clean energy” sector. However, it was challenging to identify and determine those programs/courses that will provide education and training for the energy efficiency services sector. This information needs to be tracked in a systematic way going forward. There also needs to be greater coordination between the various types of EESS training programs within each state. Establishing broad statewide education/training efforts, such as NYSERDA’s collaboration with Hudson Valley Community College, may be helpful to avoid duplication of efforts at the local level. This type of training infrastructure can help states that are ramping up energy efficiency programs if building and construction contractors and tradespeople are much less aware of energy efficiency-specific design and construction practices. Finally, it is also important to note that similar efforts are happening in a number of states so increased sharing of best practices and high-quality curriculum could help lead to more rapid launch of effective training programs.

3. Increase short-duration, applied trainings to augment on-the-job training and/or introduce new entrants to a field

Much of the growth in the EESS will come from new entrants who already have some applicable skills (e.g. building and construction contractors who might become efficiency retrofit specialists). There is also a strong demand for periodic training for those who are currently employed in the EESS but who need to update or augment their skills. In both cases, short-duration courses on specific, applied topics will be more relevant than a two- or four-year degree program. These types of offerings will need to be significantly ramped up in the next few years and could be supported by energy efficiency programs funded by utility ratepayers and/or government. Examples of this type of offering include the Northwest Energy Efficiency Alliance’s network of integrated design and lighting design laboratories that provide design assistance to architects, lighting designers, and engineers, and provide classes for contractors and building owners to increase their understanding of energy-efficient building solutions. In California, each of the three investor-owned utilities has training centers that provide classes for architects, engineers, lighting designers, contractors, building owners, and tradespeople on energy-efficient building solutions.

4. Increase funding to “train the trainers”

Our research indicates that there is a lack of qualified trainers to train the workforce needed to support the projected growth in the EESS. For example, the WAP network estimates they will need 700 *additional* trainers by summer 2010 to meet their goals. Many community colleges rely on a small group of key instructors to teach courses and many are nearing retirement age. The Building Performance Institute, which provides certifications for residential retrofit contractors, experienced 5-fold increase in number of certifications between 2005 and 2008, and believe the number will almost triple between 2008 and 2009. These growth rates strain the capacity of existing trainers; additional resources from energy efficiency ratepayer and government funding could be directed towards training the next generation of trainers for the EESS.

5. Increase access to on-the-job training for mid- and senior-level engineers and managers

Our interviews revealed a need for more managers and engineers experienced with energy efficiency. There are some resources to address this, such as a growing number of industry conferences and formal trainings offered by the Association of Energy Services Professionals as well as certificate programs such as the Certified Energy Manager designation offered by the Association of Energy Engineers. Most firms report that they rely on on-the-job and informal training to ensure their staff was skilled and knowledgeable after hiring. Managers and engineers in potentially related fields need to understand the opportunity in the EESS and have increased access to professional training that they can complete on the job, or if they decide to make a career change. An energy efficiency certificate for managers may be a good addition to the current offering so that firms can more easily identify candidates who have some experience with energy efficiency topics.

6. Prepare the next generation of EESS professionals

We learned from our interviews that most professional roles within the EESS require at least a four-year degree and currently face a shortage of trained and knowledgeable workers. Few colleges or universities offer EE-specific curriculum and funding to grow these programs was extremely limited in most cases. Additional funding needs to support new programs and the expansion of existing programs and course offerings. Four-year colleges, especially in states that are ramping up large-scale, energy efficiency programs, need to provide additional courses with multi-disciplinary and system-based approaches to energy efficiency. The Department of Energy Industrial Assessment Centers have been a successful model to provide energy efficiency services to industry and a training ground for engineering students. Similar centers could be developed in conjunction with college- and university-based engineering, architecture, planning, and policy-focused programs. These centers could encourage research and innovation and attract new people to the field of energy efficiency by providing opportunities for students enrolled in energy efficiency programs to study, intern, and engage in energy efficiency programs. These centers could include building science centers for architecture and engineering students, and policy and planning centers that emphasize education/training needed for energy efficiency program design and implementation.

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Appendix A: Organizations Offering Energy Efficiency Courses, Degrees or Certificates Reviewed for This Study

The following organizations have energy efficiency courses, degrees, or certificates that were reviewed for this study (see Table A-1). Note some programs that were reviewed did not wish to be identified.

Table A- 1. Energy efficiency-related education and training programs

Organization	Program Name	Organization Type	Description
Arizona State University	Department of Architecture	College/University	The School of Architecture offers a Master's of Science in the Built Environment (MSBE), which trains professionals (B.Arch, M.Arch) in designing buildings in an energy-efficient manner.
Association of Energy Engineers (AEE)	Certified Energy Manager	Association	AEE offers several certifications that include efficiency in the training portion: Certified Energy Manager, Certified Energy Auditor, and Certified Green Building Engineer.
Association of Energy Service Professionals (AESP)		Association	AESP is a member-based association of energy efficiency experts. Members come from utilities and other program administrators, implementation contractors, consultants, evaluation firms, academia, and related organizations. They offer training relevant to groups that implement and evaluate efficiency programs.
Building Performance Institute (BPI)		Association	BPI offers training through its 121 affiliate organizations across the country and teaches students the fundamentals of home performance evaluation. Additionally, they offer quality assurance of all BPI-certified contractors.

EESS Workforce Education and Training Needs

Carnegie Mellon University (CMU)	Dept of Architecture, Center for Building Performance and Diagnostics	College/University	The CMU architecture program has a “defining interest” in sustainable design. Students take 2 studios and 6 courses that focus on environmental qualities. Additionally, students take 3-5 departmental electives and 8-12 university electives in the area of sustainability. Subjects such as Climate and Energy, LEED Building Design, and Zero Energy House are included in these courses.
Electric Utility Consultants (EUCI)		Conference & Training Provider	This firm trains utility staff in a variety of energy-related programs, including demand response and energy efficiency.
Hudson Valley Community College	Center for Energy Efficiency and Building Science (CEEBS)	Community or Technical College	The Center for Energy Efficiency and Building Science delivers energy efficiency and building science courses at a network of regional learning centers in New York State.
Humboldt State University	Environmental Resources Engineering (ERE)	College/University	ERE students apply science and engineering principles to solve various environmental resource management problems, one of which is energy and energy efficiency. This program is interdisciplinary in nature.
Indiana Institute of Technology	Energy Engineering	College/University	Indiana Tech’s Energy Engineering program prepares students for a career in energy-related fields. Each student’s junior year focuses on a practical assignment at a company to improve the efficiency of a commercial process.
Iowa Lakes Community College	Sustainable Energy Resource Management	Community or Technical College	This certificate is designed to enhance students’ existing degree (A.A. or B.A. preferably in business or science) and to provide individuals an opportunity to enter the sustainable energy field. This certificate will not provide an individual without prior education the course work necessary for entry into this field.

EESS Workforce Education and Training Needs

Lane Community College	Energy Management	Community or Technical College	Students gain an understanding of energy systems in today's built environment and the tools to analyze and quantify energy efficiency efforts. The program began with an emphasis in residential energy efficiency / solar energy systems and has evolved to include commercial energy efficiency and renewable energy system installation technology. This program was the first of its kind in the country and is considered a model program by efficiency experts.
Laney College	Building Performance and Energy Efficiency Program	Community or Technical College	Building Performance and Energy Efficiency is an accelerated interdisciplinary one-year job skills training program. The college collaborated with industry representatives to design a program that allows participants to qualify for immediate employment in weatherization and home energy assessment and provides a solid foundation for entry-level positions in energy efficiency firms.
Massachusetts Institute of Technology	Department of Urban Studies and Planning and MIT Energy Initiative	College/University	Efficiency lies at the heart of MIT's Energy Initiative, which looks at energy use from the university to the global level. According to MIT's website, the university offers 103 courses that include energy efficiency and recently hired an efficiency expert with over 30 years' experience to train students in the implementation of efficiency programs and policies.
National Association of Home Builders (NAHB)	Green Building for Building Professionals	Association	Approximately one thousand builders have received the Certified Green Professional designation from the NAHB. This program certifies that builders are knowledgeable about energy efficiency, sustainable materials, and other environmentally sound new construction and remodeling topics and practices. Approximately 40% of the course work pertains to energy efficiency.

EESS Workforce Education and Training Needs

National Association the Remodeling Industry (NARI)	Green Certified Professionals	Association	NARI's Green Remodeling certification is designed to recognize professionals with knowledge about energy efficiency as well as how to use sustainable and low-toxic materials and other environmentally sound remodeling techniques. Approximately 40% of the course work pertains to energy efficiency.
North American Technician Excellence (NATE)	[Certification] HVAC Efficiency Analyst	Association	North American Technician Excellence, Inc. (NATE) is a testing and certification organization for heating, cooling, and refrigeration professionals. Launched in 1997, NATE has administered more than 168,000 tests to 72,800 industry technicians. Currently, 26,500 HVACR professionals hold 35,000 NATE credentials. NATE launched an Efficiency Analyst certification program in 2008.
Oakland Community College	Environmental Systems Technology	Community or Technical College	Oakland Community College's alternate energies classes focus on harnessing energy from renewable sources – sun, wind, water, underground (geothermal) heat, and biomass – in order to have a sustainable environment. The curriculum includes energy management, energy efficiency, and energy conservation topics.
Oregon State University	Industrial Assessment Center: Energy Efficiency Center	College/University	There are 20 Industrial Assessment Centers across the U.S. The IAC at Oregon State University focuses on efficiency through its Energy Efficiency Center. While they do not teach courses in efficiency currently, they train students with practical experience in facilities assessment and there are plans to develop a curriculum and certification in energy efficiency aimed at engineering students.
Rensselaer Polytechnic Institute (RPI)	The Lighting Research Center	College/University	The Lighting Research Center is affiliated with RPI's School of Architecture and concentrates on all facets of lighting including energy efficiency. The Lighting Research Center is the only school in the country that focuses solely on research and development about lighting.

EESS Workforce Education and Training Needs

Residential Energy Services Network (RESNET)		Association	RESNET accredits organizations that certify energy raters and auditors across the country. Its mission is to set quality standards to ensure the success of the building energy performance certification industry.
San Francisco State University	Department of Mechanical Engineering	College/University	This mechanical engineering department has an energy specialization that prepares students to focus on energy efficiency.
Sonoma State University	Energy Management and Design	College/University	This program prepares students to be knowledgeable about energy efficiency and renewable energy. Specifically, the program focuses on energy-efficient building design, lighting, computer-aided energy analysis, economic payback analysis, and heat load analysis.
Texas A&M University	Energy Systems Lab	College/University	The Energy Systems Lab supports the education of undergraduate and graduate students interested in conducting energy-related research. The lab employs approximately 120 staff per year that focus on modeling energy use in buildings and building commissioning. Affiliated architecture and mechanical engineering departments provide relevant coursework.
University of California - Davis	Energy Efficiency Center (EEC)	College/University	UC Davis Energy Efficiency Center (EEC) was established in 2006 with a grant from the California Clean Energy Fund and is one of the few universities with a series of graduate-level classes and an academic center focused specifically on energy efficiency. A number of undergraduate classes are also offered in departments such as engineering, transportation, and design which emphasize efficiency in their curriculum. The EEC focuses on accelerating the development and commercialization of energy-efficient technologies and training future energy efficiency leaders.

EESS Workforce Education and Training Needs

University of California – Berkeley	Energy & Resources Group	College/University	The Energy and Resources Group at the University of California, Berkeley, has offered courses on a wide range of conventional and renewable energy subjects, including energy efficiency, for over 30 years.
University of California – Berkeley	Department of Architecture, Building Science Group	College/University	This program is dedicated to the energy efficiency and environmental quality of buildings.
University of Maryland – College Park	Department of Mechanical Engineering: Center for Environmental Energy Engineering	College/University	The Center for Environmental Energy Engineering integrates energy efficiency into its curriculum. Courses focus on energy conversion, energy engineering, heat pumps and refrigeration systems, and renewable energy technologies.
University of Massachusetts - Lowell	Department of Mechanical Engineering, MS in Energy Engineering (RE Option)	College/University	This engineering program prepares students to service and repair energy systems. This program has a concentration on solar energy engineering; energy efficiency plays a significant role in the curriculum.
University of Massachusetts - Amherst	Department of Mechanical Engineering, Center for Energy Efficiency and Renewable Energy (CEERE)	College/University	The Center for Energy Efficiency and Renewable Energy provides technological and economic solutions to environmental problems resulting from energy production, industrial, manufacturing, and commercial activities, and land use practices.
University of Wisconsin - Madison	Energy Analysis and Policy (EAP)	College/University	Associated with the Energy Institute of Wisconsin, the EAP program provides an interdisciplinary certificate to graduate students interested in learning more about the technical, economic, political, and social factors that shape energy policy.
United States Green Building Council (USGBC)	LEED	Association	A USGBC education helps green building professionals across all market sectors build the capacity to build their careers.

Appendix B: California Community Colleges' Energy Efficiency Programs

In 2009, the California Community College Centers of Excellence (COE)³⁴ completed a comprehensive inventory of energy efficiency-related education and training programs currently offered and under development by community colleges throughout California (Centers of Excellence 2009a-2009i). COE focused on programs which support workforce development for eight specific occupations that were identified as both high growth and in alignment with community college core competencies: (1) Energy Auditor/Home Energy Rater, (2) Building Performance or Retrofitting Specialist, (3) Compliance Analyst/Energy Regulation Specialist, (4) Project Manager for Construction/Design Work, (5) HVAC Technician or Installer, (6) Resource Conservation/Energy Efficiency Manager, (7) Building Controls System Technician, and (8) Building Operator/Engineer.

In terms of approach, COE initially reviewed the California Community Colleges Chancellor's Office Inventory of Approved Programs and determined that nine programs were most likely to be related to the eight occupations: Environmental Science, Environmental Studies, Environmental Technology, Industrial Systems Technology and Maintenance, Environmental Controls Technology (HVAC), Energy Systems Technology (Energy Management), Construction Crafts Technology, Civil and Construction Management Technology, and Construction Inspection.³⁵ In concert with Department chairs of these nine programs at each college, COE then conducted an online survey that was disseminated to Occupational, Career and Workforce Development Deans for the 110 community colleges in California. Follow up phone interviews were also conducted.

³⁴ The Centers of Excellence (COE), formed as part of the California Community Colleges Economic and Workforce Development Program, delivers regional workforce research customized for community college program development.

³⁵ COE reports that it was difficult to compile this first inventory because there is no standardization of energy-efficiency related college curricula; certificates, degrees and classes are scattered throughout different departments under a variety of program and course titles.

Summary of Findings

Ninety-eight of California's 110 community colleges responded to the survey. About 45% of these colleges reported offering a combined total of 118 certificate and 2-year degree programs that target these eight occupations. We divide the eight occupations into two groups: 1) emerging energy efficiency-specific occupations (see Table B- 1), and 2) occupations that may include energy efficiency activity (see Table B- 2). Many colleges offer both a certificate and a 2-year Associate Degree under the same program title and some certificate programs apply to more than one of the eight target occupations (e.g. Cabrillo College's Associate Degree and Certificate in Construction & Energy Management apply to the Project Management and Energy Efficiency Manager occupations). We list each program only once under the most applicable occupation. Looking across the state, 12 colleges offer certificate programs for building retrofit specialist, while 18 colleges offer certificate programs targeted at HVAC installer/technicians. In addition, twelve colleges reported offering energy efficiency-related classes but did not have certificate or Associate degree programs.³⁶

Table B- 1. Regional breakdown of California Community College Associate Degree and Certificate Programs related to four emerging energy efficiency occupations

Number of colleges offering degrees or certificates	San Francisco Bay Area 12 of 26 colleges		Inland Empire 5 of 10 colleges	Los Angeles Area 5 of 19 colleges		San Diego/Imperial Valley 6 of 9 colleges		Sacramento 2 of 8 colleges	Central 3 of 8 colleges
	2-Yr Degree	Certif.	2-Yr Degree or Certif.	2-Yr Degree	Certif.	2-Yr Degree	Certif.	2-Yr Degree or Certif.	2-Yr Degree or Certif.
Energy Auditor/Home Energy Rater		1			1		1		
Building Performance or Retrofitting specialist	2	6	1		1		2	1	1
Compliance Analyst or Energy Regulation Specialist	1	1							
Resource Conservation or EE Manager	1	1							
Totals	4	9	1	0	2	0	3	1	1

³⁶ For example Yuba College in the Sacramento area offers thirteen energy efficiency-related internet courses including Building Energy Efficiency and Energy Auditing.

Table B- 2. Regional breakdown of California Community College Associate Degree and Certificate Programs related to four occupations which may include energy efficiency activity

Number of colleges offering degrees or certificates	San Francisco Bay Area 12 of 26 colleges		Central Valley 7 of 8 colleges		Inland Empire 5 of 10 colleges	Los Angeles Area 5 of 19 colleges		San Diego/Imperial Valley 6 of 9 colleges		Sacramento 2 of 8 colleges	North 3 of 7 colleges	Central 3 of 8 colleges
	2-Yr Degree	Certif.	2-Yr Degree	Certif.	2-Yr Degree or Certif.	2-Yr Degree	Certif.	2-Yr Degree	Certif.	2-Yr Degree or Certif.	2-Yr Degree or Certif.	2-Yr Degree or Certif.
Project Manager, Construction or Design Work	2	2	3	1	3		1	2	1	2		2
HVAC technician or installer	1	5	4	4	4	3	2	2			1	2
Building Controls Systems Technician	1	4	3	2		2	2					
Building Operator/ Engineer	2	1	5	5	1		1	1				
Totals	6	12	15	12	8	5	6	5	1	2	1	4

- Unfortunately, enrollment data in courses was not systematically reported by colleges that responded to the survey. Course enrollment data was reported by 21 colleges in four of eight regions: a total of 2,252 students were enrolled in emerging energy efficiency-related courses (see Table B- 3) and 4,234 students were enrolled in courses that may include energy-efficiency content (see Table B- 4). Colleges reported that almost all of these courses are enrolled at or above capacity with waiting lists (with a few exceptions). Only two colleges provided information on the number of graduates completing certificate or Associate degree programs. DeAnza College in the San Francisco Bay Area reported that 20-25 students are completing the Energy Management Certificate and Degree program each year, and Shasta College in Northern California reported that 4-5 students have completed the home inspection and HVAC technician programs.

Table B- 3. Enrollment in energy efficiency-related courses and California Community Colleges: Spring 2009

	San Francisco Bay Area	Sacramento Area	Los Angeles Area	Northern Coast & Inland
	12 colleges	3 colleges	4 colleges	2 colleges
Energy Auditor/Home Energy Rater	0	0	40	0
Building Performance or Retrofitting specialist	1420	292	60	48
Compliance Analyst or Energy Regulation Specialist	55	0	0	0
Resource Conservation or EE Manager	220	48	69	0
Totals	1695	340	169	48

Table B- 4. Enrollment in courses with potential energy efficiency course content at California Community Colleges: Spring 2009

	San Francisco Bay Area	Sacramento Area	Los Angeles Area	Northern Coast & Inland
	12 colleges	3 colleges	4 colleges	2 colleges
Project Manager, Construction or Design Work	1018	150	0	0
HVAC technician or installer	1131	0	846	4 ³⁷
Building Controls Systems Technician	650	20	45	0
Building Operator/ Engineer	335	0	35	0
Totals	3134	170	926	4

- Information on future plans for potential energy-efficiency-related certificate programs and Associate degrees was provided by community colleges in five regions. Eighteen colleges reported plans to develop a total of three new 2-year degrees and 20 to 27 new certificates in 2010 or 2011. Two colleges plan to offer a degree and certificate in Building Automation and one college plans to offer a degree and certificate in Industrial Power. Other planned certificate programs include: Energy Auditor (4 to 8 programs, including 1 non-union apprenticeship), Green Building/Sustainable Design or Construction (5-6 programs), Retrofitting/Weatherization (4-5 programs), Building Envelope Analysis or Energy Management Technician (2 programs), Building Systems Operations (1 program), Lighting Efficiency (1 program), and HVAC (1-2 programs).

³⁷ Shasta College reported that five students have completed the home inspection and HVAC technician programs as of August 2009. The college did not report total enrollment in energy efficiency-related classes.

- To what extent can community colleges meet the growing workforce needs in these eight occupations? Do employers want workers with these certificates and degrees and are these degrees sufficient for hiring? In a related 2009 study, COE surveyed over 1,100 California companies in the energy efficiency services sector and found that these employers have ~19,700 employees in the eight occupations; 7,385 of these employees are in the four emerging energy efficiency-specific occupations. These employers indicated that they expect the number of available positions in the four energy efficiency-specific occupations to increase by 4,267 in 3 years (between 2008 and 2011). These results suggest that employer workforce needs in the energy efficiency-specific occupations (1,422 new jobs per year) may be met to some extent by community college graduates, based on reported current enrollment of 2,252 in the energy efficiency-specific courses in the 21 colleges. However, it is not possible to draw definitive conclusions because only ~50% of the 43 colleges reported enrollment data and because few colleges provided information on graduation and completion rates from energy efficiency certificate and degree programs. Community colleges do appear to be well-positioned to help meet workforce needs for several of these emerging energy efficiency occupations as well as occupations that are becoming more energy efficiency-focused, as most surveyed firms strongly preferred to hire certificate or 2-year degree holders for Energy Auditor, HVAC technicians and Building Controls technicians.

Given the uncertainty as to whether there will be a gap between projected energy efficiency workforce needs in California and number of graduates of related certificate and Associate degree programs, it would be useful to conduct follow-up research to compile information on the number of graduates per year in each California community college program (and occupation) area. We would also urge other states that are concerned about workforce training as they ramp up energy efficiency efforts to conduct similar studies of their two-year colleges in order to establish a baseline for determining the number of students that are being trained or receive certificates that are applicable for specified energy efficiency occupations.