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Energy Efficiency Services Sector: Workforce Size and Expectations for Growth

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Environmental Energy
Technologies Division

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

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Acronyms and Abbreviations

ANSI	American National Standards Institute
ARRA	American Recovery and Reinvestment Act
BLS	Bureau of Labor Statistics
Btu	British thermal unit
CEE	Consortium for Energy Efficiency
DHHS	Department of Health and Human Services
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 service company
FERC	Federal Energy Regulatory Commission
FTE	full-time equivalent
FY	fiscal year (for federal government, starts October 1)
HVAC	heating, ventilation, air conditioning
ISO	International Standards Organization
LBNL	Lawrence Berkeley National Laboratory
LIHEAP	Low Income Home Energy Assistance Program
NASCSP	National Association for State Community Services Programs
PA	program administrator
PIC	program implementation contractors
PSC	program support contractor
PVE	Petroleum Violation Escrow
PY	program year
PYE	person years of employment
R&D	research and development
WAP	Weatherization Assistance Program

Executive Summary

The energy efficiency services sector (EESS) is poised to become an increasingly important part of the U.S. economy. Climate change and energy supply concerns, volatile and increasing energy prices, and a desire for greater energy independence have led many state and national leaders to support an increasingly prominent role for energy efficiency in U.S. energy policy. The national economic recession has also helped to boost the visibility of energy efficiency, as part of a strategy to support economic recovery. We expect investment in energy efficiency to increase dramatically both in the near-term and through 2020 and beyond. This increase will come both from public support, such as the American Recovery and Reinvestment Act (ARRA) and significant increases in utility ratepayer funds directed toward efficiency, and also from increased private spending due to codes and standards, increasing energy prices, and voluntary standards for industry.

Given the growing attention on energy efficiency, there is a concern among policy makers, program administrators, and others that there is an insufficiently trained workforce in place to meet the energy efficiency goals being put in place by local, state, and federal policy. To understand the likelihood of a potential workforce gap and appropriate response strategies, one needs to understand the size, composition, and potential for growth of the EESS. We use a bottom-up approach based upon almost 300 interviews with program administrators, education and training providers, and a variety of EESS employers and trade associations; communications with over 50 sector experts; as well as an extensive literature review. We attempt to provide insight into key aspects of the EESS by describing the current job composition, the current workforce size, our projections for sector growth through 2020, and key issues that may limit this growth.

1. Characterizing the Energy Efficiency Services Sector

There is a wide range of occupations that might be considered "green jobs." This study includes that portion of the EESS market supply chain that focuses on **deployment** and **installation** of energy efficiency products and measures (see Figure ES-1). And within this, we further limit our scope to those products and services whose demand is driven ***primarily*** by the energy savings. We make this distinction both because the jobs that require the most energy efficiency-specific training fall into this scope, and also because data is more readily available for this part of the market. We do not include manufacturing, distribution, or retail businesses. We also do not include jobs that are a small part of much larger non-EESS firms, such as building managers, energy managers, and operations and maintenance staff – other than the small portion of these activities that are conducted by energy service companies (ESCOs).

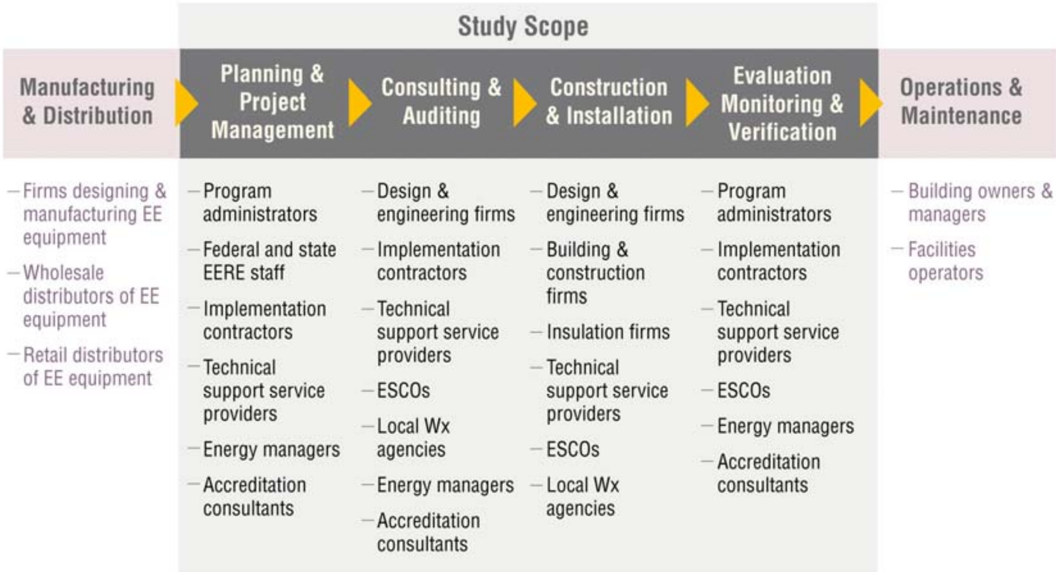

Figure ES-1. Energy Efficiency Market Value Chain

Using data collected from our interviews, we diagram the structure of the EESS for the commercial/institutional, residential, and industrial markets (see Figures ES-2, ES-3 and ES-4). The darker-colored boxes represent jobs that also exist outside of the EESS, while the lighter-colored boxes with dotted outlines represent jobs that are only found within the EESS. It is important to note that many of the EESS jobs do exist elsewhere; often the same services will be performed, such as building engineering or HVAC system installation, but the EESS will ensure that the highest-efficiency options are used. This implies one of the important insights of this study – many "new" EESS jobs will simply substitute for existing jobs, and in some cases it may be the same technicians and trades people updating their offerings through additional training or new suppliers. Another key insight is represented in the design of these diagrams – the administrators who manage EE programs and the implementation contractors who directly run EE programs are on the top tier. Even though public funds only directly make up 25% of the spending in the EESS sector, a majority of the activity in the EESS is spurred directly and indirectly by the government policies and ratepayer-funded programs.

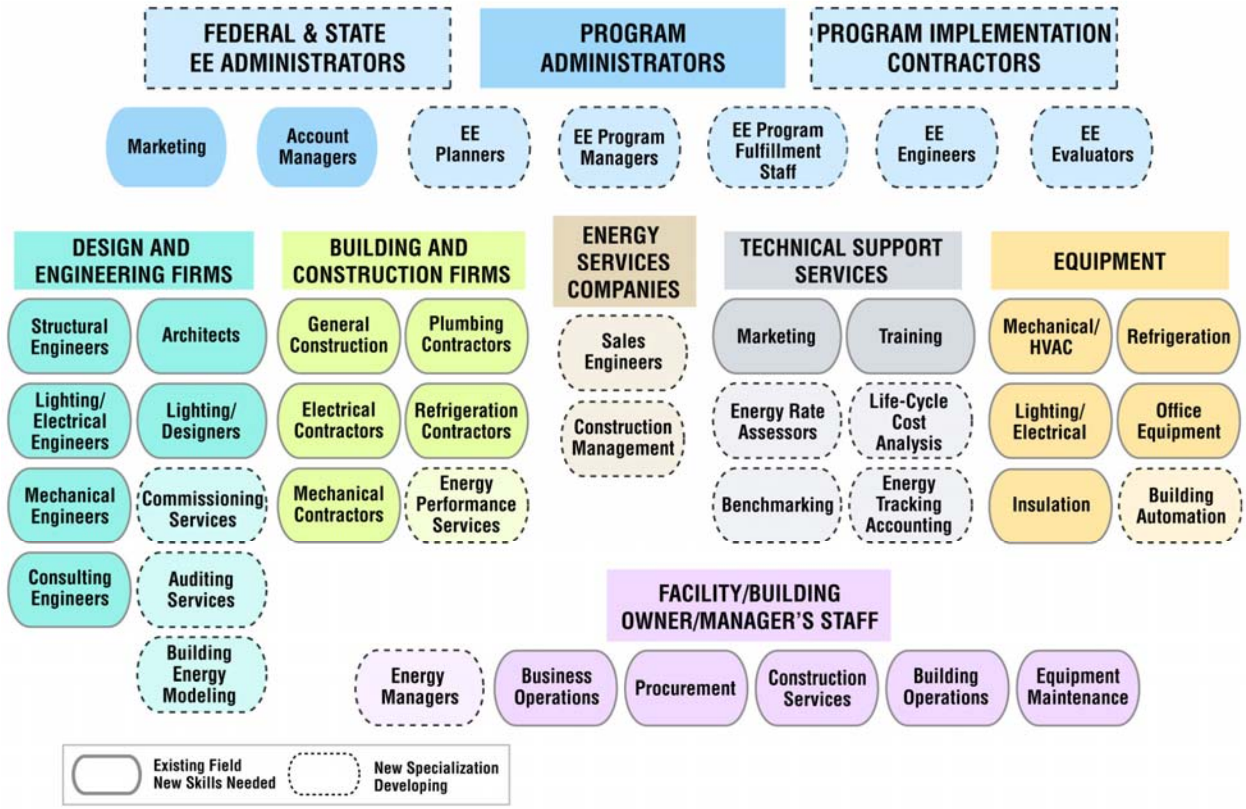

Figure ES-2. The Commercial-Institutional Energy Efficiency Services Sector

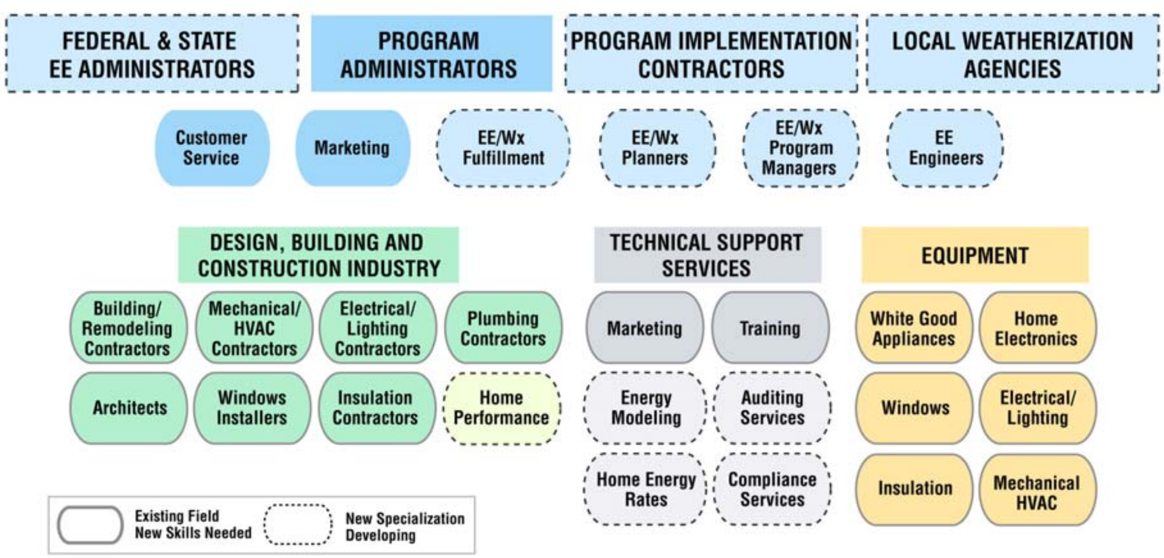

Figure ES-3. The Residential Energy Efficiency Services Sector

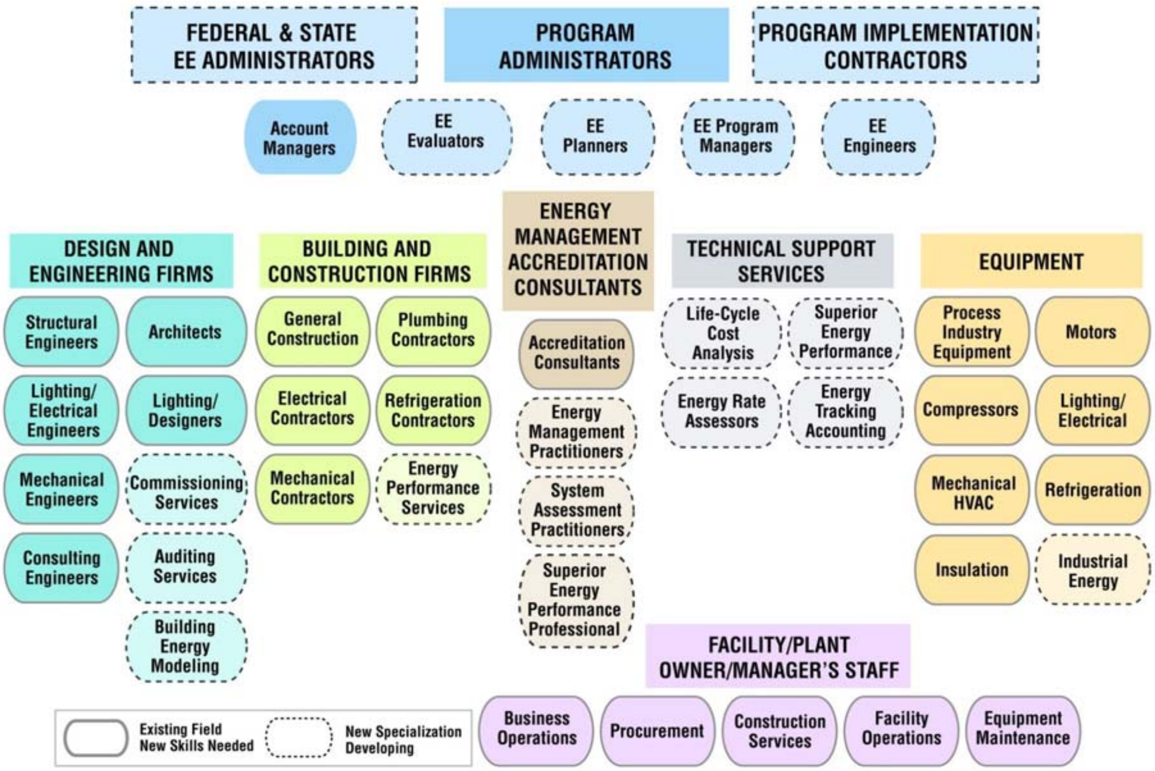

Figure ES-4. The Industrial Energy Efficiency Services Sector

2. EESS Workforce Size: Current and Projected

In 2008, the EESS workforce comprised about 114,000 person-years of employment (see Figure ES-5). One person year of employment (PYE) equals one person working full time in the EESS for a year. This is different than total number of employees, which can include people who either work part time or just work part time on EESS-specific activities. Many employees in the EESS only work part time or spend only a fraction of their full-time job providing energy efficiency services. We estimate that 380,000 individuals are employed in EESS activities in 2008 (see Figure ES-6), or over three times the estimated EESS workforce in person-years of employment. We also estimate that the EESS workforce currently comprises about 3% of the building and construction industry workforce.

We assume that the future expanded energy efficiency effort will require an EESS with the traditional and emerging activities and job types that we observe today. We develop assumptions about growth in energy efficiency from three primary drivers: growth in federally funded energy efficiency, ratepayer-funded energy efficiency, and market spending on energy efficiency. We posit alternative scenarios that vary in the aggressiveness with which energy efficiency savings are acquired, though given recent events we believe that the high growth scenario is most likely. The study develops predictions for three forecast years: near-term (2010), intermediate-term (2015), and long-term (2020).

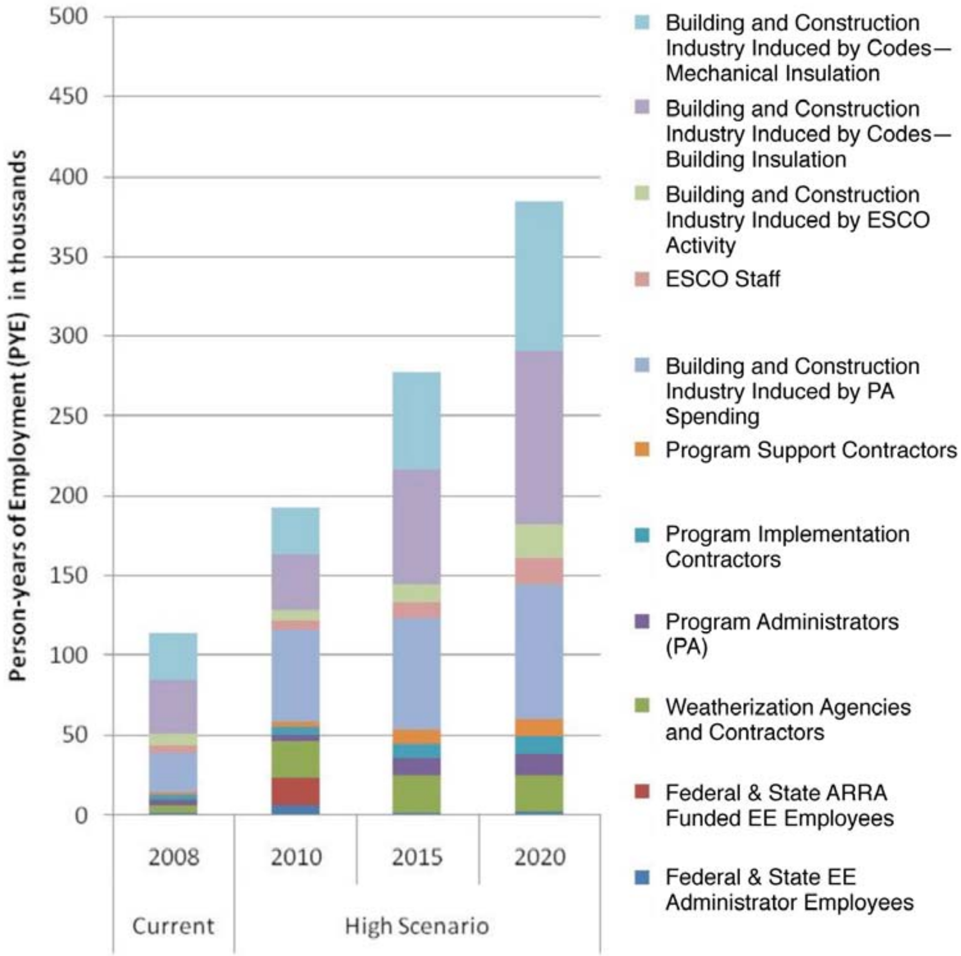

Figure ES-5. Current and projected EESS Person-Years of Employment (PYE) – high growth spending scenario

Ratepayer-funded energy efficiency efforts currently constitute about 30% of estimated EESS person-years. This employment includes the staffs of program administrators, the program implementation contractors, and program support contractors they hire, as well as the building and construction professionals and trades people that design and install the equipment that ratepayer funds subsidize. ESCO efforts constitute about 10% of the total person-years, including ESCO staff and the contractors they hire among the building and construction industry. The weatherization assistance efforts of the federal and state governments constitute about 5% of the total EESS person-years. Finally, the professionals and trades people responsible for building envelope insulation and those responsible for mechanical insulation each comprise more than 25% of the 2008 EESS person-years of employment.

For our high growth scenarios to 2020 we find that the EESS may grow to just under 400,000 person-years of employment by 2020, which may include as many as 1.3 million individuals (see Figure ES-6). This is a four-fold increase in jobs between 2008 and 2020; our low growth scenario predicts a two-fold increase over the same period.

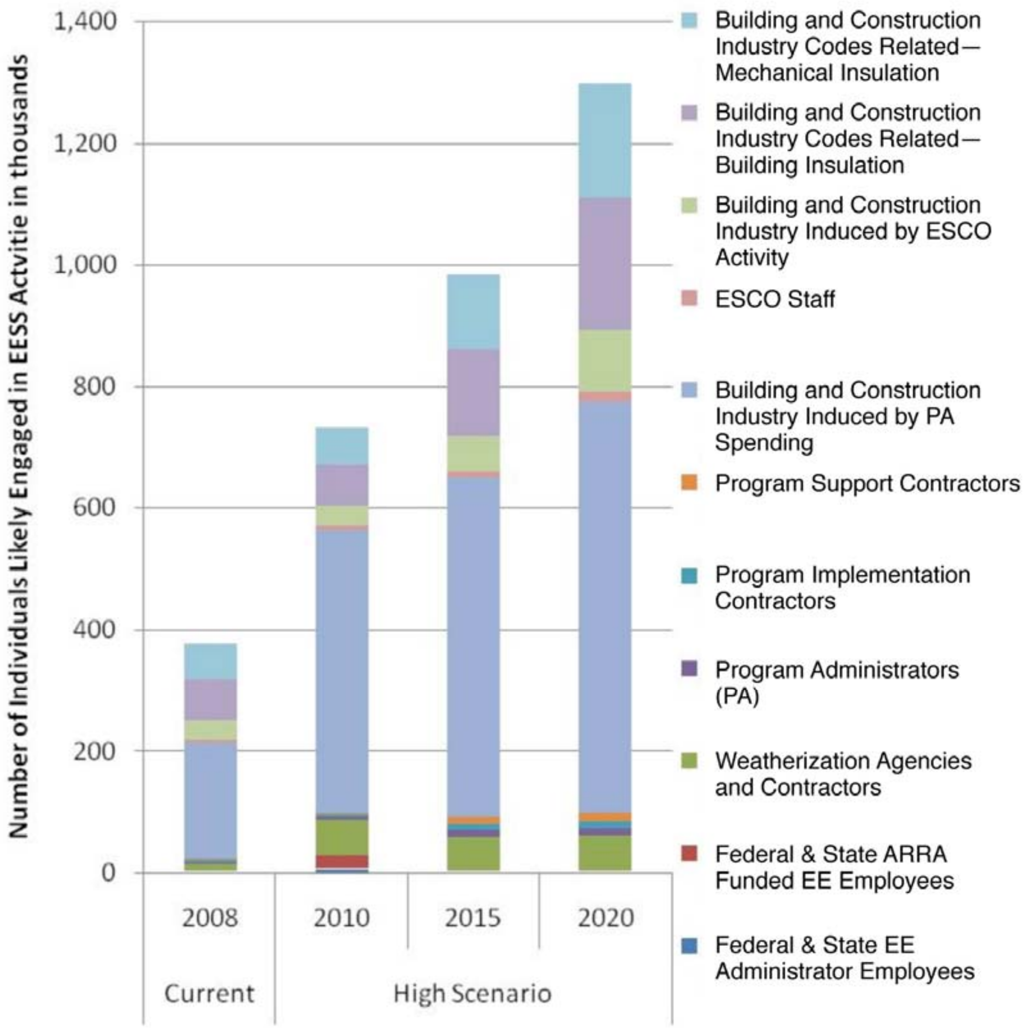

Figure ES-6. Illustrative sketch of number of individuals likely engaged in EESS activities

We also are able to estimate the person-years of employment per $1 million dollars in spending on EESS activity. Note that these figures capture direct employment in the activities of designing and installing efficiency measures. We explicitly exclude from this analysis manufacturing and retail jobs because we believe those jobs substitute for standard efficiency jobs and require little new training or knowledge for staff. We also do not capture jobs that indirectly result from EESS activity. On average, we find that per $1 million of investment in EESS activity, 6.3 jobs are created with a range of 2.5 jobs created per million dollars in ESCO activity to 8.9 jobs in weatherization and insulation activity. As Table ES- 1 illustrates, our estimate falls between that of the American Solar Energy Society (ASES 2007) at 3.8 jobs per million dollars investment, and that of the American Council for an Energy Efficient Economy (ACEEE 2009) at 9.8 jobs per million dollars of investment.

Table ES- 1. Person-Years of Employment per million dollars in EESS activity

Activity	2008	2008 Person-Years of	Person-Years of

	Spending (in $M)	Employment	Employment per $1M
Weatherization assistance (excluding program administrator assistance)	$528	4,676	8.9
Government (federal and state)	$243	1567	6.5
Program administrators, implementation contractors, support contractors, and associated building and construction industry	$5,224	32,596	6.2
ESCOs and associated building and construction industry	$4,957	12.205	2.5
Building and construction industry influenced by codes and standards (insulation)	$7.091	62,948	8.9
Total	**$18,043**	**113,857**	**6.3**

3. Lesson from Four Case Studies

In addition to our own interviews, we analyzed four recent studies that surveyed employers offering various types of energy efficiency services in California, Massachusetts, the Pacific Northwest, and Connecticut. We find the following trends across these studies:

- **Most firms providing energy efficiency services are extremely small (often under 10 people), with a few very large firms.** For example, well over 75% of firms in California, the Pacific Northwest and Massachusetts have 100 or fewer employees per firm, and ***at least*** 34% of each have 10 or fewer employees. These employers tend to include a large number of small consulting firms and startups, and a few very large engineering firms and ESCOs.

- **These firms' operations appear to frequently span more than one state.** For example, when asked directly how many of their employees are based in-state, the average per firm in Massachusetts is 27 employees (21% of the firms' average total employees). Most of these multi-state firms are the large engineering and energy service companies.

- **Expectations for growth are high, perhaps particularly in the EE portion of a firm's business.** In Massachusetts, most employers expect greater than 10% growth in revenue and an average 9% increase in employees in the next 12 months. In the Pacific Northwest, most employers expect revenues to grow at an annual rate of 5-7% over the next 5 years. In California, employers expect a 20% growth in energy efficiency-specific jobs in the next 12 months, versus 2% growth for all job categories.

- **"Premium" EE jobs are likely only a fraction of the total employees in many firms.** The eight energy efficiency-specific jobs identified at California firms make up only 28% of the total jobs at these firms. Recognizing the various job types at EE firms, and the fact that not all jobs at these firms require EE-specific skills, is important to inform the estimates of the overall number of EE-specific jobs and the need for training programs in these specific occupations.

- **Additional energy efficiency training is needed.** In California, 56% to 73% of employers (depending on the job category) have "Great" or "Some" difficulty in hiring. In the Northwest, 70% of employers "could not or sometimes could not find qualified applicants." In Massachusetts 24% of employers were not able to fill positions with qualified candidates.

The survey results highlight the makeup and size of the EESS in various states and regions and provide insight into the types of training and support that are valued by employers looking to provide energy efficiency services.

4. Key Challenges to Growth

Our interviews revealed a number of key challenges to growth for the EESS:

- **Difficulty hiring into the EESS for any position other than entry level.** According to our respondents, it often took two to three months to fill entry-level positions in the EESS. Management positions requiring at least 10 years experience and positions requiring engineering experience with high-efficiency technologies are the most difficult positions to fill; survey respondents noted that many position take three to five months to fill but that it can take up to 15 months to hire an engineer with managerial skills and energy efficiency experience. One company gave the example of receiving 80 applications for a senior level position only to find that only five applicants could pass the initial screening. Another company noted that they were planning to take several years to find a suitable candidate to take a senior position leading their energy efficiency group. In contrast, building and construction industry contractors do not hire for energy efficiency skills as most training is done on the job; they report relative easy in hiring from a variety of sources. However, union contractors and labor union respondents reported some difficulty recruiting qualified applicants into apprenticeship programs. They have many applicants, but a much smaller number who can pass the basic skills and drug screening tests. In a similar vein, several contractor association respondents expressed dismay over a lack of interest in jobs that are physically demanding.

- **The challenge of finding managers with EE experience is a significant issue.** The bi-modal age distribution that is observed in many firms suggests that in the next few years there could be a problem having sufficient staff to train and manage the new entrants. One implementation contractor stated that it is "almost impossible to find someone with energy efficiency program management experience." People with this knowledge and experience are highly valued by the industry. They are also vital mentors for the next generation of managers in the EESS. This issue may become increasingly important in the future as the EESS workforce demand increases because there are few schools and training centers that offer curriculum focused on energy efficiency; on-the-job mentoring currently fulfills EESS training needs.

- **Engineers with the appropriate skills are difficult to find**. Administrators, implementation contractors, and ESCOs who work with commercial and industrial customers indicate that engineering talent is difficult to find. Survey respondents reported that engineers with efficiency knowledge or experience are relatively nonexistent. To be effective, EESS engineers need training in fluid and thermodynamics, knowledge of building energy systems, an interest in optimizing the performance of existing HVAC or refrigeration or industrial process systems, and good communication skills for working with customers. The most likely near-term source for new EESS engineers is to transition engineers from other fields into energy efficiency. In addition, recognizing energy engineering as an engineering discipline will be helpful to recruiting and tracking engineers with energy expertise. A few of our survey respondents also noted difficulty competing for engineers with large international firms or high tech computing and aerospace companies that offer higher salaries and perks such as international travel.

- **Retirement is an issue for the building and construction industry.** Retirement is not currently a concern for program administrators or implementation contractors; however, the building and construction industry is facing substantial changes in the workforce due to retirements between 2015 and 2025. Builders/remodelers and mechanical and electrical trades people had the largest share of workers nearing retirement (38% to 44% are older than 50).

- **The building and construction industry in unaware that that the EESS is expanding.** Administrators and implementation contractors have fairly clear expectations for growth of energy efficiency services, and the likely effect on their workforce needs. For example, in response to a question which asked respondents to estimate the size of their organizations' workforce involved in energy efficiency by 2010, we found that in aggregate, program administrators estimated that their staff will grow about 19% by 2010 and that implementation contractors expect that their staff will increase by about 64%. In contrast, less than 50% of those in design, engineering, and building and construction industry associations could even estimate the percent of the current workforce affected by energy efficiency. Of those that could, the design and engineering associations perceive energy efficiency to have a dominant or moderate influence on their current activities while other building and construction association respondents see only a moderate or limited level of influence on their activities. National representatives of building and construction industry associations need to educate their state and local organizations on the policy and market drivers that are leading to significant increases in energy efficiency spending so that they can inform their members of the need to develop the necessary skills to provide energy efficiency-related services to meet the coming demand.

These challenges must be addressed to enable a smooth transition to a greatly expanded EESS. Additionally, at the root of the EESS workforce challenge is the fact the energy efficiency is not commonly understood in the population at large. Not only is this concept missing from the economic census and the occupational handbook, and from the tool box that contractors and building trades people use every day, but it is not a top of mind concept to the public at large. Today the EESS includes only around 100,000 to 500,000 workers; by 2020 we estimate it will be almost 400,000 PYE and likely well over a million workers who spend at least part of their year working on energy efficiency projects. This will become an important activity, one that people think about when they remodel their home or when they look for a new home or place of business.

1. Introduction

The energy efficiency services sector (EESS) is poised to become an increasingly important sector of the U.S. economy. Climate change and energy supply concerns, volatile and increasing energy prices, and a desire for greater energy independence have led many state and national leaders to support an increasingly prominent role for energy efficiency in U.S. energy policy. The national economic recession has also helped to boost the visibility of energy efficiency, as part of a strategy to support economic recovery.

The evolution and growth of the EESS has been heavily influenced by federal and state legislative, regulatory, and policy initiatives over the last 30 years (see sidebar on Timeline: Energy Efficiency Policy Milestones). Market barriers and failures that cause consumers and businesses to under-invest in energy efficiency has been a key rationale for government action and public policies that attempt to spur energy efficiency efforts among consumers and businesses. State policies that support ratepayer-funded energy efficiency programs[1], federal and state low-income weatherization efforts, enabling legislation that facilitates performance contracting by ESCOs, and building codes and standards have been major contributors to the increase in energy efficiency investments (see Figure 1-1).

One of the paradoxes of energy efficiency is the growing consensus among policymakers as to its importance as a low-cost, environmentally-benign resource juxtaposed with the fact that energy efficiency is not a distinct, well-defined industry that is easy to characterize. Erhardt-Martinez and Laitner (2008) identified the challenges for those seeking to assess the energy efficiency services market:

> *Energy efficiency is a means of using less energy to provide the same (or greater) level*

Timeline: U.S. Energ y Efficiency Policy Milestones

- **1975** - Energy Policy and Conservation Act creates programs for energy conservation in federal buildings; State Energy Conservation Program established
- **1976** - Congress creates the Weatherization Assistance Program
- **1977** - Department of Energy created by DOE Organization Act
- **1983** - Petroleum Violation Escrow (PVE) created by Congress in response to high oil prices; funds allocated to state energy offices
- 1992 - Energy Policy Act enhances energy efficient building codes, increases number of appliances covered by standards, gives authority to federal agencies to enter into ESPC; ENERGY STAR program started
- **2005 -** Energy Policy Act increases federal facility energy reduction goals to 2% annually, provides over $1B in tax incentives for residential and commercial energy conservation
- **2007 -** Energy Independence and Security Act establishes Energy Efficiency and Renewable Energy Worker Training Program, sets significantly higher efficiency standards for light bulbs, establishes program and incentives for industrial energy efficiency
- **2009 -** The American Recovery and Reinvestment Act provides billions of dollars in funding for state and local efficiency programs.

[1] State regulatory commissions in ~30-35 states have authorized expenditure of ratepayer funds to develop energy efficiency programs that reduce electricity and natural gas usage in customer facilities. Utilities typically collect these funds either as a separate charge on customers' bills (e.g. public purpose or benefit charge) or costs are included in rates; programs are administered by utilities, state agencies or third-party firms (see Barbose et al 2009).

> *of energy services… Efficiency gains are often embedded within existing technologies and practices and tend to be difficult to measure. In business and industry, efforts to increase energy efficiency or energy productivity can be ingrained in everyday operations and management practices, design decisions, and long-term capital investments. For individuals and households, investments in efficiency include choices in appliances, consumer electronics, and home improvements. Gains in energy efficiency are often bundled with other benefits of new technologies. How do we identify and measure all of the* areas *in which efficiency gains are made when they are so fragmented throughout industries, businesses and households?*

Similarly, the Northwest Energy Efficiency Task Force (2009a) noted that, "There is difficulty in identifying the true workforce and jobs data for the energy efficiency industry. Employment in energy efficiency is refracted across utilities, federal and state programs, manufacturing, construction, and other disparate job classifications."

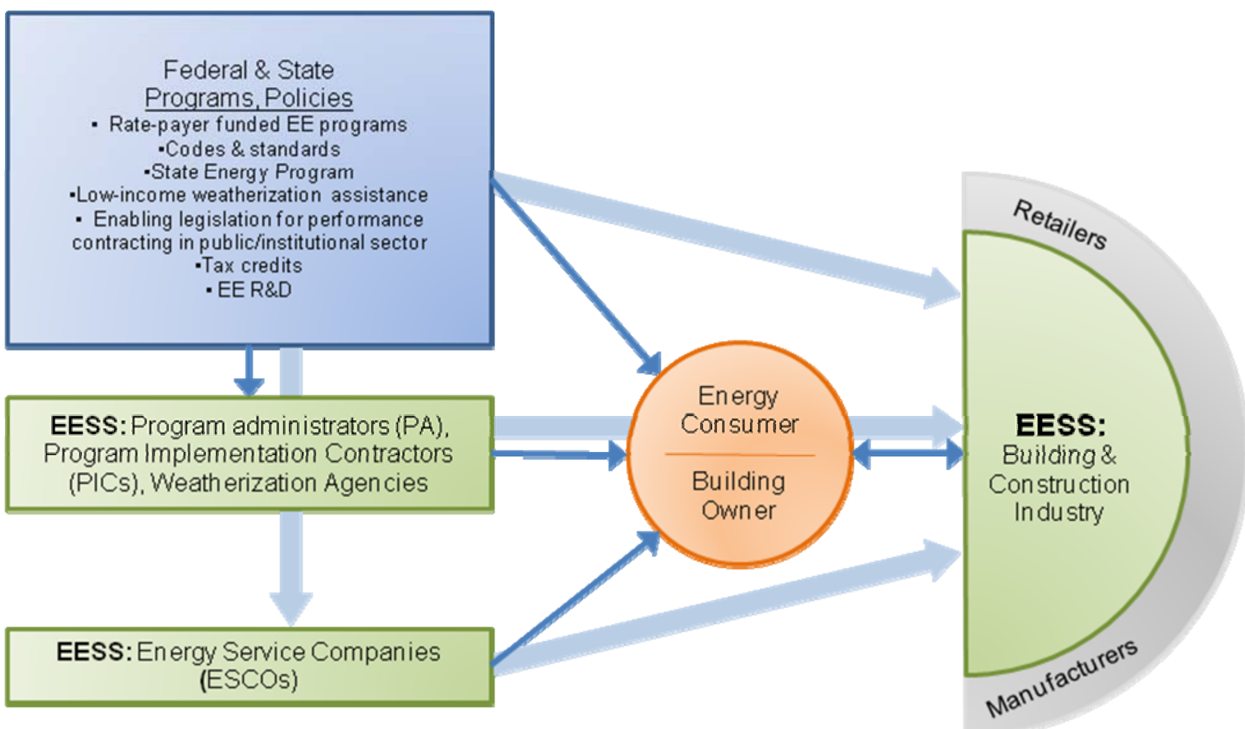

Figure 1-1. The Energy Efficiency Service Sector (EESS) and its relationship to public policy and funding

1.1 Why This Study?

The growth in public support for and spending on energy efficiency combined with increased investment by private sector market actors will require a significant expansion of the energy efficiency services sector workforce. Trained personnel will be needed to design, implement, and manage energy efficiency programs and to design, construct, install, and maintain efficient building systems. Bottlenecks may occur if the EESS workforce is unable to expand at the same pace as the increased demand for energy efficiency services.

To assess the likelihood of bottlenecks in providing energy efficiency services, one needs to understand the size and composition of the existing EESS as well as potential for growth in the future. We attempt to provide insight on these issues by describing the composition and types of jobs in the EESS, estimating the size of the current workforce, projecting growth in the EESS through 2020, and identifying key issues that may limit future growth. A companion report focuses on education and training activities and needs in the EESS (Goldman et al 2010).

The need to understand the EESS is heightened by the call for "green job" creation by politicians and other leaders (Garfield and Angelides 2008). The Center for American Progress defines "green jobs" as follows:

> *Green jobs represent new demand for labor that results from investments in transitioning our economy away from carbon-intensive energy, minimizing degradation of our natural resources, maximizing the efficient use of our natural capital, and protecting humans and the planet from pollution and waste. These green jobs include new jobs that will be created, imperiled jobs that will be saved through new investment, and critically, traditional jobs that will be transformed with new skills and new applications of existing skills* (Hendricks 2009).

The energy efficiency services sector (EESS) represents one part of the "green jobs" market (Dafoe 2007; Apollo Alliance 2007) and covers a range of occupational categories that already exist, as well as new job categories (California Employment Development Green Jobs Website 2009; Oregon Employment Department 2008). However, someone seeking to identify a job in the energy efficiency services sector through occupational research would find it difficult to do so. Consider that a search on *renewable energy* in the U.S. Department of Labor *Occupational Handbook* (http://www.bls.gov/OCO/) leads to *engineers* and *engineering technicians;* for each of these general categories, there are estimates of workforce needs, as well as discussions about a variety of sub-areas of engineering. It is easy to imagine a new industry emerging to make wind turbines and the jobs that industry would employ. A search of the DOL Occupational Handbook on *energy efficiency* is not similarly informative. It is less obvious that there are new jobs associated with manufacturers seeking consultants to help them use less energy, or the owners of buildings hiring contractors to optimize the performance of their heating and cooling systems.

1.2 Report Structure

The next chapter describes our approach used to characterize the structure and size of the EESS, with additional information on methods found in technical appendices.[2] Chapter 3 characterizes the structure and job categories found in the energy efficiency services sector. Chapter 4 presents estimates for of the size of the EESS workforce currently (2008), near term (2010), and in the future (i.e., 2015 and 2020). Chapter 5 provides a snapshot of regional EESS markets by presenting a comparative review and analysis of four recent studies that surveyed employers offering various types of energy efficiency services in Northern California, Connecticut, Massachusetts, and the Pacific Northwest. Chapter 6 discusses the experience of the EESS workforce managers as they seek to grow their staff skills and capabilities and hire new workers. Chapter 7 concludes with implications of this analysis for EESS workforce requirements in light of anticipated increased demand for energy efficiency. In a companion study (Goldman et al 2010), our research team 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.

[2] Appendix A includes interview protocols for various sub-sectors of the EESS. Appendix C includes a detailed summary of our approach to estimating energy efficiency spending and employment.

2. Methodology

In this chapter, we summarize our methodological approach used to estimate the current and projected size of the EESS workforce, including data and information sources. Characterizing and defining the energy efficiency services sector is a critical initial step in this process. For most sectors, one can use government occupational handbooks and statistics to identify the types and number of jobs associated with that industry. However, for the energy efficiency services sector (EESS), we are just beginning to characterize and report occupational categories in the EESS in government statistics.

2.1 Literature review: Other workforce studies compared to our approach

We found several recent studies that develop estimates of energy efficiency-related jobs and/or employment. However, most of these studies have different objectives and scope of industry/economic activity (e.g. "green jobs" or include renewable energy markets) or use different methods (see Table 2-1). Several studies estimate the potential employment impacts of proposed government programs (Pollin et al. 2008; Apollo Alliance 2004). For example, Pollin et al. (2008) forecast the employment outcomes from a proposal to invest $100 billion on "green recovery" programs. Due to the lack of government data on EE occupations, they created a "synthetic" building retrofit industry input-output model and estimated employment per dollar of spending for that industry. The scope of Bezdek (2007) is quite broad (i.e., the "green jobs" market) and includes jobs in the energy efficiency services and renewable energy sector.

In contrast, Apollo Alliance (2004) and U.S. Conference of Mayors (2008) defined a much narrower scope of economic activity and estimated energy efficiency-related jobs limited to the building retrofit market. Ehrhardt-Martinez and Laitner (2008) sum all efficiency-related spending (including transportation) and use an input-output model to generate employment estimates by sector. In a study directed by the Connecticut Clean Energy Fund (CCEF 2009), Navigant Consulting used a "bottom-up" approach, estimating the size of the energy efficiency workforce in Connecticut by identifying 97 key energy efficiency companies and conducting interviews with contacts at 37 of these companies and extensive secondary research on the remaining firms. Among recent workforce studies, our approach is most similar to the CCEF (2009) study (e.g., an interview-based, bottom-up approach), although we do not account for jobs from firms that manufacture or distribute energy-efficient equipment.[3]

The methods employed also vary significantly between studies. Economists often describe the employment impacts of proposed economic activity by identifying direct, indirect, and induced effects (see Appendix B for more detailed discussion). ***Direct effects*** are employment impacts that will occur in meeting the demand for a product or service (e.g., jobs created at an ESCO that develops energy efficiency projects). ***Indirect effects*** describe employment that will occur through the "ripple effects" of that activity on the larger economy. ***Induced effects*** are those created when employees or firms go out and spend their increased incomes (due to their additional employment/profit or due to energy savings) on consumer goods and services. It is also important to account for ***substitution effects*** in estimating net employment impacts (e.g., the

[3] See Section 3-1 for a more in-depth discussion of the energy efficiency market supply chain and sub-sectors that are included within our study scope (see Figure 3-1).

employee hired to sell hammers at a big-box store substitutes for the employee who lost a job at a local hardware store).

Our study only estimates the direct employment effects of energy efficiency investments. We do not attempt to capture indirect or induced effects, in part because a key objective of our study is to assess workforce needs and training that are specific to the EESS. We also decided not to estimate jobs directly involved in the manufacture and distribution (including retail sales) of energy efficiency products and equipment. We took this approach in part because we believe that most of the positive direct employment effects for firms that manufacture (or distribute) energy efficient equipment due to increased spending on high-efficiency equipment would likely be offset by negative substitution effects (e.g., loss of manufacturing jobs for less efficient products).

Table 2-1: Other Studies of U.S. Green Jobs Workforce

Source	Scope and approach used to estimate energy efficiency-related jobs	Job Estimates
The Size of the U.S. Energy Efficiency Market American Council for an Energy Efficient Economy (ACEEE) (Ehrhardt-Martinez and Laitner 2008)	**Scope:** Direct and indirect jobs from all EE-related spending in the residential, commercial, appliances & electronics, industrial, transportation, and utilities sectors. **Approach:** Identifies energy efficiency investments across multiple sectors, using the ENERGY STAR® standard where possible. Identifies the incremental cost or "premium" associated with more efficient vs standard product. Uses these investment estimates to get job and industrial output numbers from the IMPLAN database.	• **1.6 million** current jobs supported by the EE sector with **1 million** in buildings • **234,000** jobs directly associated with "premium" energy efficiency investments
Current and Potential Green Jobs in the U.S. Economy U.S. Conference of Mayors (2008)	**Scope:** Direct EE jobs from retrofitting commercial and residential buildings. **Approach:** Assumes a fixed number of jobs per unit of energy saved, and assumes an average savings of 35% of building energy by 2038 (~1.2% savings per year). Given this savings level and using their jobs per unit energy saved, they forecast annual employment.	• **750,000** "green jobs" in 2006, with **4.2 million** jobs forecasted for 2038 • **81,000** jobs in building retrofit work forecasted for 2018, 2028, 2038
Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy University of Mass and the Center for American Progress (Pollin et al. 2008)	**Scope:** Forecasts direct, indirect, and induced employment impacts from a proposed $100 billion "green recovery" program, part of which focuses on the building retrofit industry **Approach:** Due to lack of government data on EE occupations, authors create a "synthetic" building retrofit industry input-output model to find employment per dollar of spending. Based on assumptions about new spending through a green recovery program, they calculate expected employment impacts.	• Potential to create **2 million** additional "green jobs" (direct, indirect, and induced) across several sectors in two years; of which **800,000** jobs could put construction workers back to work.
Renewable Energy and Energy Efficiency: Economic Drivers for the 20th Century American Solar Energy Society (ASES) (Bedzek 2007)	**Scope:** Direct and indirect jobs across multiple sectors including insulation, ESCO activity, all ENERGY STAR® appliances and equipment, ratepayer spending, vehicles that get 10% better mileage than the CAFE standards, and the U.S. recycling and reuse industries. **Approach:** Estimates the spending in each sector and uses an input-output model to estimate employment	• **3.5 million** direct energy efficiency jobs and **8 million** direct and indirect energy efficiency jobs in 2006.

	impacts.	
New Energy for New America Apollo Alliance (2004)	**Scope:** Direct and indirect jobs created as a result of significant public investment, including EE financing, an income tax credit for retrofits, programs to support high performance buildings, and buildings R&D **Approach:** Economic modeling by Perryman Group to translate public investments to employment impacts	• Potential to create **827,000** jobs over 10 years to make new and existing buildings energy efficient, assuming a significant public investment.
CT Renewable Energy / Energy Efficiency Economy Baseline Study Navigant Consulting for the Connecticut Clean Energy Fund (CCEF) and the Connecticut Energy Efficiency Fund (Navigant & CCEF 2009)	**Scope:** Direct, indirect, and induced jobs from EE-related products and services in Connecticut. **Approach:** Identifies 97 key energy efficiency companies in Connecticut; conducted interviews with 37 of these companies and conducted secondary research on the remaining 60. Direct jobs are those reported by these companies. Indirect and induced jobs are estimated assuming a multiplier of 1.6 times direct jobs, based on the REMI model	• Currently **2,675** direct jobs and **4,280** indirect or induced jobs in Connecticut.

2.2 Our Approach and Scope

Our study draws upon ~300 interviews with program administrators, education and training providers and a variety of EESS employers and trade associations; communications with over 50 sector experts; as well as an extensive review of the literature and publicly available data. The interviews sought to establish the baseline workforce environment for each target group, assess current issues with hiring, and identify training and education needs. We also asked interviewees for their expectations regarding hiring and workforce expansion in the near term (see Appendix A for interview guides). We combine findings from these interviews with data on current funding for energy efficiency and our projections of energy efficiency program spending and market activity through 2020 to estimate the size of the current and future EESS workforce, and also to provide qualitative insights into the workforce challenges for this sector.

As others have noted, separating out "efficiency jobs" from the many existing products and services that involve energy efficiency in some way is extremely challenging (see Ehrhardt-Martinez and Laitner (2008). Energy efficiency may be a primary motive that drives investment in new equipment by a building owner. Conversely, new products or equipment may become more efficient over time (because of technological progress or standards), but energy efficiency may have little or no explicit role in the decision-making criterion used by consumers in their appliance or equipment purchase decisions.

We limit our scope primarily to estimating workforce size and needs of that portion of the EESS market supply chain that focuses on **deployment** and **installation** of energy efficiency products and services (see Figure 3-1 in Chapter 3). Our bottoms-up approach focuses on those energy efficiency programs and market-driven activities in which market actors and end users regard the energy & dollar savings derived from energy efficiency investments as an important, significant driver of consumer demand. We make this distinction both because the jobs that require the most energy efficiency-specific training fall into this scope, and also because data is more readily available for this portion of the energy efficiency services sector.

To develop estimates of current and projected employment in the EESS, we characterized and analyzed existing energy efficiency program and market activity for the following sub-sectors:[4]

- **Ratepayer-funded energy efficiency** activity including:
  - Program administrator workforce
  - Program implementation contractor workforce
  - Program support contractor workforce
  - Building and construction trades workforce that implements projects as part of ratepayer-funded activity

- **Low income weatherization workforce**

- **Energy Service Company (ESCO) workforce**, including
  - ESCOs that develop, construct and maintain energy efficiency projects
  - Building and construction trades workforce that are involved in installation of ESCO projects, acting as subcontractors (e.g. lighting, HVAC contractors)

- **Insulation workforce**, both envelope and mechanical

- **Federal and state energy efficiency programs,** including the state energy office workforce

We believe that these sub-sectors capture the bulk of the policy-driven and market activity in the EESS for which it is relatively easy to characterize energy efficiency investment and spending (and derive employment). However, we acknowledge that our approach is not comprehensive and does not fully account for energy efficiency-related market activity and investment in a number of areas, including.

ENERGY STAR® appliances and equipment –

Our approach captures energy efficiency spending (and EESS workforce) involved in the high-efficiency appliances market that participate directly in ratepayer-funded energy efficiency programs. We have not tried to estimate current spending on all ENERGY STAR® appliances and equipment. This spending is significant; Ehrhardt-Martinez and Laitner (2008) estimate market investment for energy efficient appliances and electronics at approximately $88 billion in 2004, with additional spending on energy efficient equipment for residential and commercial buildings. Laitner (2008) estimates market activity at X billion in 200X [need to add Revenue and YEAR]. The market for high-efficiency appliances is larger than we have captured. However, otherwise

[4] See Chapter 3 for a more detailed description these sub-sectors.

High-efficiency windows – Our approach captures energy efficiency spending (and EESS workforce) for high-efficiency windows that are installed through either ratepayer-funded, state energy, or low-income weatherization programs.

Industrial Energy Efficiency – Our approach is limited to the energy efficiency spending (and EESS workforce) for industrial customers that participate in ratepayer-funded energy efficiency programs. According to Ehrhardt-Martinez and Laitner (2008), domestic and international competitiveness is a huge driver of efficiency in the industrial sector, especially in energy-intensive manufacturing industries, and spending by industry on energy efficiency was roughly $75 billion in 2004. Our approach only partially captures energy efficiency market activity among industrial customers; further study is required to understand the full job impacts.

2.2.1 Regions of the Country Included in the Study Used to Develop Spending to Employment Ratios

To get employment numbers for some of the sub-sectors, we needed the field of investigation to be something less than the nation as a whole to keep the scope manageable.

2.2.2 Study Focus on Eleven States

Having selected a bottom-up approach, we needed the field of investigation to be something less than the nation as a whole. We decided to focus on a subset of states currently active in energy efficiency. We used three criteria to inform our sampling strategy to select the states on which to focus data collection:

1. Energy efficiency program spending, based on CEE's analysis of 2007 energy efficiency program expenditures (CEE 2007a),
2. The activity of energy service companies (ESCOs), selected as a proxy for market spending on retrofit energy efficiency activity (Hopper and Goldman 2007), and
3. Geographic balance to ensure that each region of the country was represented.

These sampling criteria lead us to narrow our focus to 11 states, illustrated in Figure 2-1. California, Connecticut, Illinois, Iowa, Maryland, Massachusetts, New Jersey, New York, Texas, Washington, and Wisconsin. These 11 states represent: roughly 75% of all 2008 ratepayer-funded energy efficiency (CEE 2008), about 45% of the ESCO-reported activity (Goldman 2009), and 40% of the U.S. population of the U.S. (U.S. Census Bureau 2009).

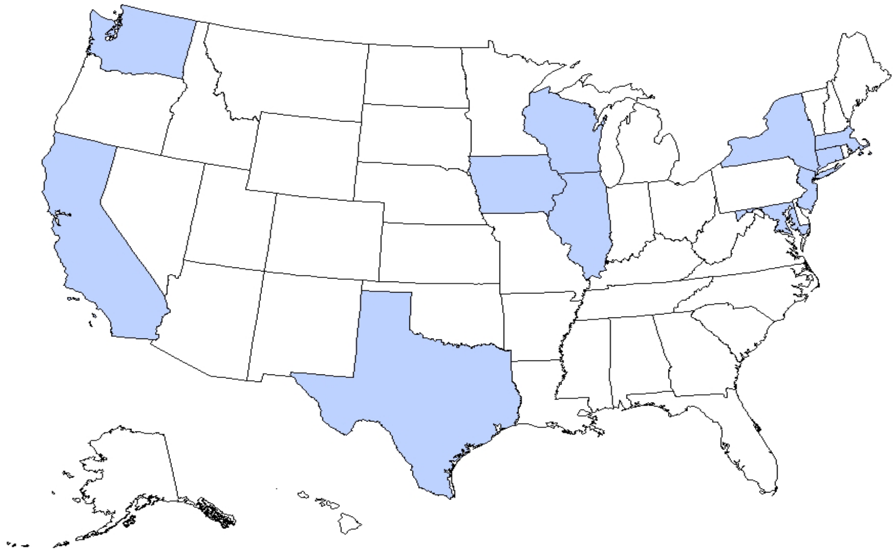

Figure 2-1. The Eleven States Examined in the Study

We describe in the next section when we use numbers based on the 11 state group data and when we use national numbers, depending on what is available for each sub-sector.

2.3 Methods for Estimating Current and Future Employment

It is important to note that this study estimates **person years of employment** (PYE), which equals one person working full time in the EESS for a year. This is different than total number of employees, which can include people who either work part time or just work part time on EESS-specific activities. For example, employees of a heating contractor may spend 20% of their time installing high-efficiency furnaces and 80% of their time installing conventional furnaces. We only count the fraction of that person-year that is spent on installing high-efficiency products in our estimates of EESS workforce size.

Using PYE, two half time employees working on EESS-specific activities equal one PYE.[5] In our surveys, it made sense to ask the PYE involved in energy efficiency because so much of the EESS workforce only works part time on EESS-specific activities.

To determine current and future employment we go through a set of steps to estimate spending and employment for each of the targeted sub-sectors within the EESS. These steps vary slightly between sub-sectors, but they follow the general process represented in Figure 2-2. First, we estimate the spending and person years of employment (PYE) for a sample of the sub-sector, usually from the 11 state sample (unless national data is available). Second, we calculate the PYE per million dollars of spending for that sub-sector. Third, we find the total U.S. spending within the sub-sector and use the PYE/$ spending ratio from the 11 state sample and extrapolate

[5] Full-time equivalent (FTE) may be a more familiar acronym used to describe workforce staffing levels. FTE does not explicitly include a duration; for our purpose, FTE should be understood as referring to full time employment over one year's duration given one year's funding. We use the terms PYE and FTE interchangeably.

in order to estimate the current employment nationally in that sub-sector. Fourth, we then develop two scenarios of future energy efficiency spending in 2010, 2015 and 2020 and then use the PYE/$ spending ratio to estimate future employment.

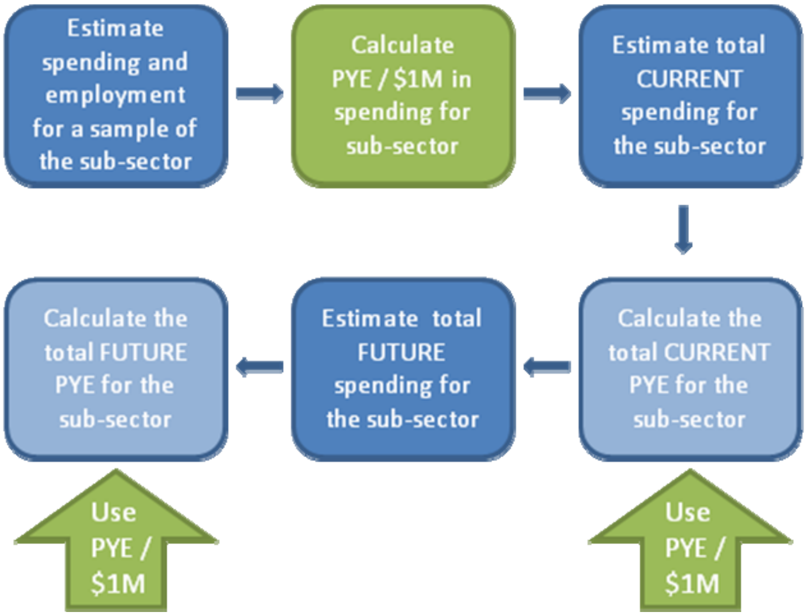

Figure 2-2. Method for estimating current and future PYE

2.3.1 Current Employment

Our estimates of current size of the EESS workforce are based on:

- Self-reported workforce data by managers of organizations implementing energy efficiency (e.g., program administrators, energy services companies);
- Interviews with representatives of trade and professional organizations and associations whose members design, install, operate and maintain energy efficient solutions; and
- Data obtained from public sources (e.g., state regulators, EIA, CEE, and prior LBNL research).

We described the specific sources of data for each sub-sector in Table 2-2 below. We also include the employment to spending ratios for each sub-sector in Table 2-3. These vary from a high of 8.9 PYE for weatherization to a low of 2.5 PYE for ESCOs per $1 million in spending.

Table 2-2. Sources of data for estimating current workforce size

Sub-sector of the EESS	Current Spending Estimates	Person-Years of Employment per $1M spending
Ratepayer-funded efficiency activity	**Program Administrators**[6] - Obtained 2007 budget data from interviews with	**Program Administrators** – Workforce data for 2007/2008 provided by interviewed program

[6] For definitions of Program Administrators, Program Implementation Contractors, and Program Support Contractors see Chapter 3.

	38 PAs. Aggregated administrator data by state for 11 states. Budgets for non-respondents in the 11 states estimated as difference between surveyed responses for a state and CEE 2007 state totals. Obtained budgets for remaining 39 states from CEE (2007). **Program Implementation Contractors** – Used PA budgets as described above. **Program Support Contractors –** Used PA respondents' estimates of incentive budgets. Calculated unweighted average of proportion of budget going to incentives and all other costs. **Building and Construction Trades conducting ratepayer-funded activity** – Used PA total and incentive budgets reported by PA respondents. Interviewed key informants on average proportion of incentive cost to total EE project cost. Estimated ratio to convert from incentives to total project costs. Used Connecticut data (Navigant 2009) and key informants for allocating project costs into labor and equipment components. Estimated labor's share of total project cost.	administrators. Conducted regression analysis of workforce on budget. Used regression to estimate workforce of nonrespondents. For 39 non-surveyed states, assumed FTE in relation to budget is low; proxied with data from the surveyed states with the lowest FTE to budget ratio. **Program Implementation Contractors** – Workforce data for 2008 provided by 23 interviewed program implementation contractors and 11 efficiency program planning and evaluation consultants. Used respondents' estimates of percent of work done in each of 11 states to allocate staff by state. **Program Support Contractors –** Workforce estimates for CA, IA, NY, and WA based on prior program evaluations conducted by Research Into Action. Estimated for remaining states as equal to one-half program implementation contractor workforce. Corroborated validity of assumptions by estimating total PA budget needed to cover PA, PIC, and PSC and verified outcome was consistent with survey data on proportion of budget *not* allocated to incentives. **Building and Construction Trades conducting ratepayer-funded activity** – Used Connecticut data (Navigant 2009) and BLS Occupational Code 472130 (insulation) data on average organization revenues per FTE. Re-analyzed Navigant data, corroborated with BLS data, and estimated average revenues per FTE. Estimated person-years of B&C trades employment associated with labor's share of total project cost, as driven by PA budgets.
Low income weatherization	Obtained 2007 budget data (NASCSP 2007) for 11 states and national for DOE, LIHEAP, and "other." Removed estimates of the low income program administrator budgets from the "other" category (CEE 2007).	Developed an estimate of PYE per $ million spending from an analysis of detailed survey data collected on Massachusetts low income weatherization activity (New England Clean Energy Council 2009).
ESCOs	Used Goldman and Hopper (2007) estimates of 2006 ESCO EE revenue and respondents' forecast of growth in revenues to estimate 2008 revenues.	Workforce data for 2008 provided by 9 interviewed ESCOs (over 50% of market as defined by 2006 revenues). Used interview data to re-analysis Goldman and Hopper (2007) data to estimate 2008 workforce for entire ESCO market, including contractors to ESCOs.
Insulation	Applied to the workforce estimate (see next column) the average revenue per insulation worker as reported by the 2002 Economic Census (US Census Bureau), escalated for inflation.	Used Bureau of Labor Statistics data on number of workers in occupational codes 472131 (insulation workers: floor, ceiling, and wall) and 472132 (insulation workers: mechanical) working in five industry codes (2361-Residential Building Construction; 2362-Nonresidential Building Construction; 2382-Building Equipment Contractors; 2383-Building Finishing Contractors; 2389-Other Specialty Trade Contractors). Added to insulation workers estimated overhead workers of administrative support occupations (Occ. Code 43-0000) and management, business, and financial occupations (Occ. Code 11-1300).
Federal and state govt	Obtained 2008 budget data from EERE	Used FY 2010 Federal Budget for DOE-EERE actual

EERE offices	website, selecting EE program components and excluding low income weatherization	FTE and applied percent of programs that were EE to total FTE. Obtained 2008 efficiency workforce data for state energy offices from a 2009 NASEO study.

Table 2-3. PYE and spending for each sub-sector

Activity	Estimated 2008 Spending (in $M)	Person-Years of Employment per $1M
Ratepayer-funded efficiency activity	$5,224	6.2
Low income weatherization	$528	8.9
ESCOs	$4,957	2.5
Insulation	$7,091	8.9
Federal and state govt EERE offices	$243	6.5

2.3.2 Future Employment

Our estimates of the future size of the EESS assume that similar types of trades and occupations will persist and grow among similar types of organizations that currently pursue energy efficiency (see Figures 3-2, 3-3 and 3-4). To estimate the size of the EESS workforce in the future we project future spending on energy efficiency, and then apply each sub-sector's PYE/$ ratio to get the projected future PYE. We develop a low and high scenario of energy efficiency spending over several time periods: near-term (2010), intermediate-term (2015), and long-term (2020). Table Table 2-4 describes the sources of data for the spending of each sub-sector. Further details behind these projections are included in Appendices C and D.

Table 2-4. Sources of data for estimating projections of future spending

Sub-sector of the EESS	Basis for Future Spending Projections
Ratepayer-funded efficiency activity	Recent study by Barbose et al 2009 which provides low and high estimates, see Appendix D.
Low income weatherization	Created scenarios for high and low projections: ***Low*** – Drop after ARRA funds run out, then only modest increase in spending through 2020. ***High*** – Ongoing aggressive spending after ARRA funds run out, increasing through 2020.
ESCOs	We developed estimates of future spending on ESCO activity by drawing upon several sources: 1) results of the 2006 ESCO survey (Hopper and Goldman 2007) that provided ESCO projections for the near-term, 2) interviews with representatives from nine ESCOs, and 3) a Delphi process that involved discussions with several experts who consult on the ESCO industry. We developed two scenarios to project future ESCO revenues: ***Low*** – A "business-as-usual" scenario with spending on ESCO activity increasing by 8% per year to 2020. High – A "high growth" scenario with spending on ESCO activity increasing by 12% per year to 2020.
Insulation	We used two sources for high and low projections: ***Low*** – Growth forecast published by the Bureau of Labor Statistics.

	High – Used the same rate of growth as the high scenario for ratepayer-funded programs of 12%.
Federal and state govt EERE offices	**For 2010**: Assumed additional budget over 2008 by summing the DOE EERE non weatherization ARRA funded programs, plus the ARRA funds for DOD, GSA, and VA programs, and dividing by 3 years to get one year of spending for 2010 **For 2015 and 2020:** ***Low*** – Took proportion of DOE EERE programs that were EE only in 2008 (excluding weatherization); multiplied by total federal forecast budget for 2015 ***High*** – Estimated that the 2008 budget devoted to EE (excluding weatherization) would increase 5% per year.

3. Characterizing the Energy Efficiency Services Sector

In this section, we provide an overview of the market supply chain for energy efficiency and describe the types of firms and institutions that provide various types of energy efficiency-related services in specific end user markets (e.g. commercial, residential, and industrial). We then describe the structure of several types of organizations in the EESS (e.g. Program Administrators, Program Implementation Contractors, ESCOs) and describe how they establish and utilize various occupational categories to deliver services.

3.1 Energy Efficiency Market Supply Chain

The market supply chain for energy efficiency spans product development, manufacturing, wholesale and retail distribution, deployment (e.g., project design, construction, evaluation) and operations/maintenance (see Figure 3-1) [CCEF 2009]. In this study, we limit our scope primarily to estimating workforce size and needs of that portion of the EESS market supply chain that focuses on deployment and installation of energy efficiency products and measures (e.g., planning and project management, consulting & auditing, construction & installation and evaluation, monitoring and verification). Operations and maintenance of high-efficiency equipment is often provided by in-house employees that work for large end users or outsourced to a third party service O&M provider.[7]

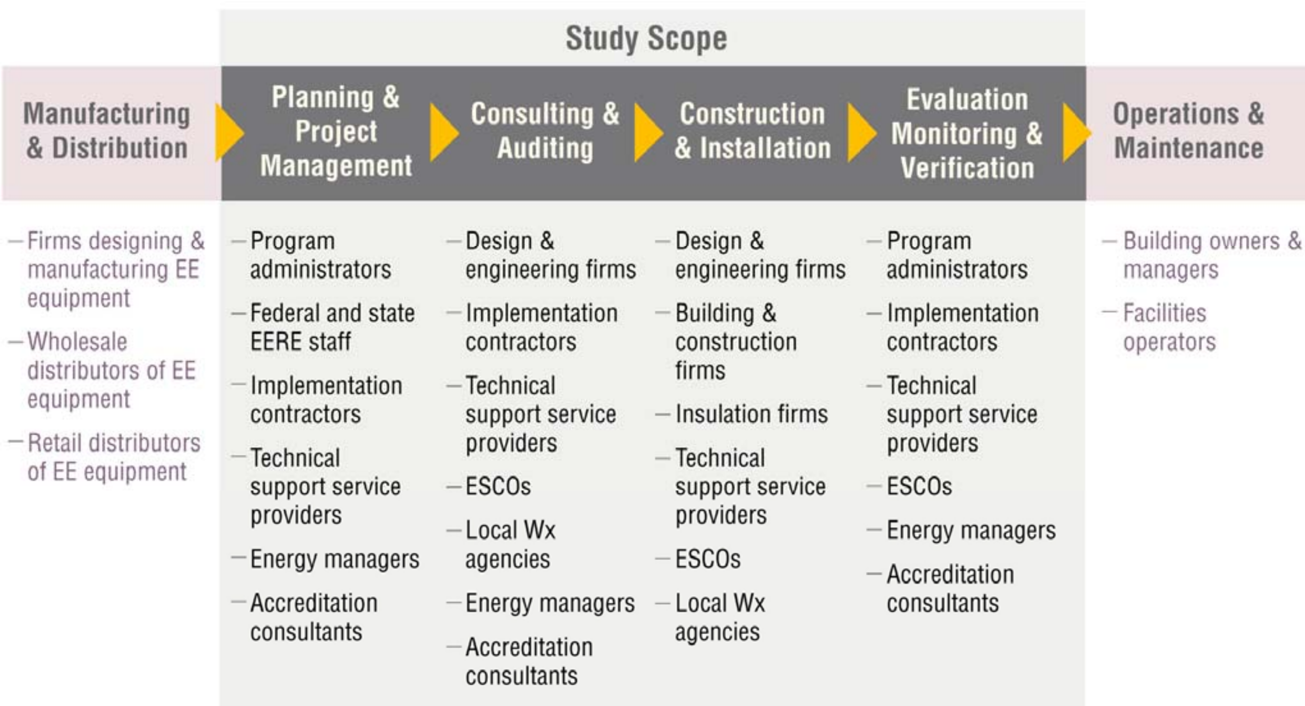

Figure 3-1. Energy Efficiency Market Value Chain

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[7] Our workforce size estimates do account for O&M services provided by ESCOs, but not other types of firms that provide O&M services related to energy efficient equipment.

Source: adapted from CCEF, 2009

3.2 Structure of Energy Efficiency Services Sector and Types of EE Service Providers

It is also useful to characterize the types of firms that are involved in providing energy efficiency products and services in key markets: commercial/institutional (Figure 3-2), residential (Figure 3-3), and industrial (Figure 3-4Figure 3-4). These market characterization diagrams highlight a number of themes about the structure of the energy efficiency services sector (EESS).

- For some companies and organizations, energy efficiency is their primary business or activity (e.g. Federal and State EE Administrators, Program Implementation Contractors, some ESCOs).
- For many of the firms involved in the EESS, energy efficiency may not be their core business, but comprises a business line or service offering (e.g., design/engineering firms, equipment providers). Utility program administrators also fall into this latter category as energy efficiency departments typically account for a small portion of utility revenues and employees.
- We use the convention of lighter-colored boxes with dotted outlines for job categories that have emerged primarily as a result of the development of the EESS and darker-colored solid boxes for firms and job categories that also exist outside of the EESS.
- The market characterization diagrams utilize a somewhat, "top down" view of the market from a Program Administrator's perspective.[8] Program Administrators rely heavily on various types of market actors and trade allies to design, deliver, and implement high efficiency products and services to facility and building owners. Thus, the bulk of the employment and jobs created from EE programs typically occur among these market actors and trade allies.
- In Figure 3-3, we provide a "top down" view of the residential energy efficiency marketplace, including program administrators, key trade allies and service and equipment providers. We explicitly include "local weatherization agencies" to highlight the fact these community-based organizations typically administer and implement low income and limited-income weatherization programs using WAP, LIHEAP, and other funding from states and private sources.[9]

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[8] We take this approach, in part, because historically, our view is that a significant amount of energy efficiency investments have been driven by various types of public policies (e.g. Federal & state programs). Federal and state EERE administrators include the staffs of state energy offices. Program administrators oversee ratepayer-funded efficiency programs which can be administered by utilities, state agencies, or third-party firms; hence we use the broader term "program administrator" in lieu of "utility."

[9] Program administrators also contribute to WAP funds. We tally the workforce associated with these rate payer WAP funds as part of the program administrator workforce and exclude them from our tally of the WAP workforce estimates.

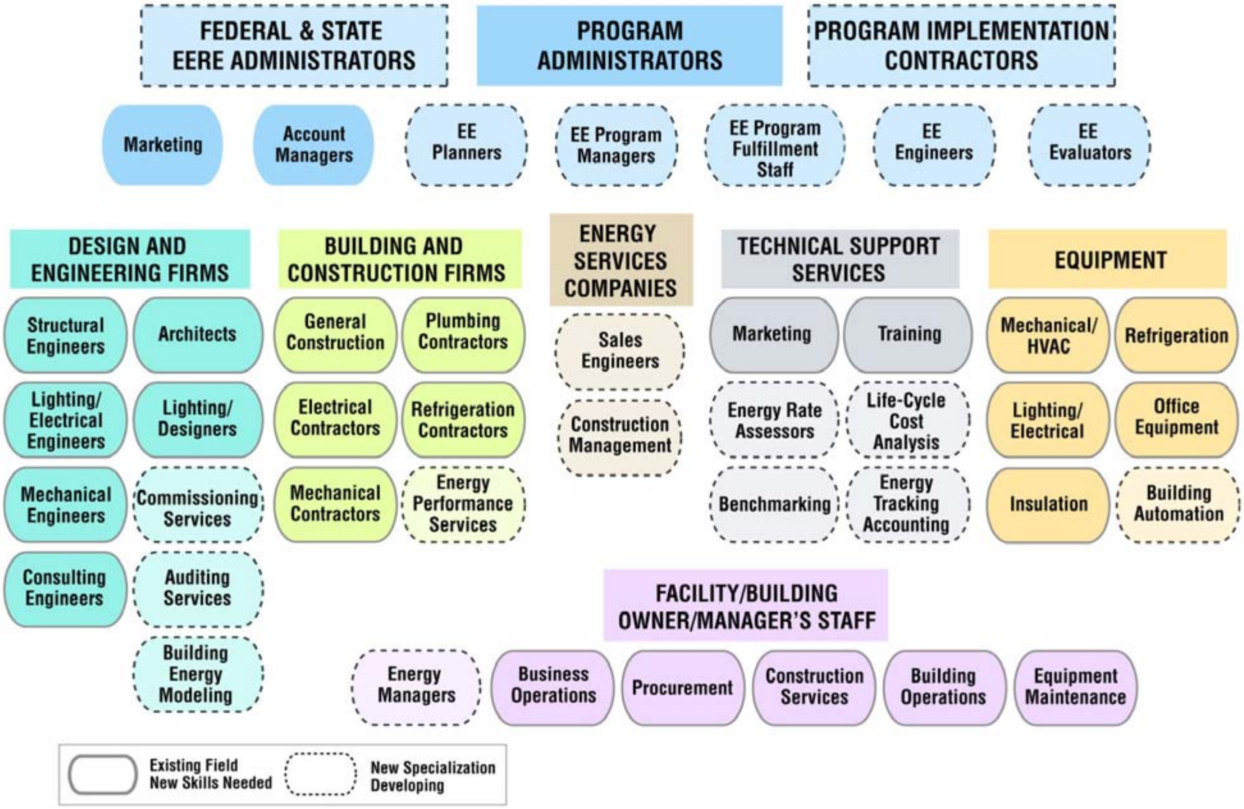

Figure 3-2. The Commercial-Institutional Energy Efficiency Services Sector

- The proportion of lighter dotted-line boxes in Figures 3-2 to 3-4 also illustrates the emergence of a variety of new skill-sets and new professional categories specific to energy efficiency that involve tasks and activities that were not commonly addressed within the traditional building design, construction, equipping, and operations professions and trades. These new job occupations include:
  - auditing to identify energy savings opportunities
  - energy modeling to analyze the savings opportunities
  - commissioning to ensure equipment is installed and operated as designed
  - training in home energy efficiency retrofit services
  - installation of new equipment such as industrial energy management and building automation systems
  - various types of analysis services including benchmarking, life-cycle cost assessment, and energy rate analysis, and
  - staff positions among the various types of Program Administrators and Program Implementation and Support Contractors.[10]

[10] The staffs of these organizations plan, design, manage, and evaluate energy efficiency programs and in some cases are the field crews that install and/or inspect energy efficient projects.

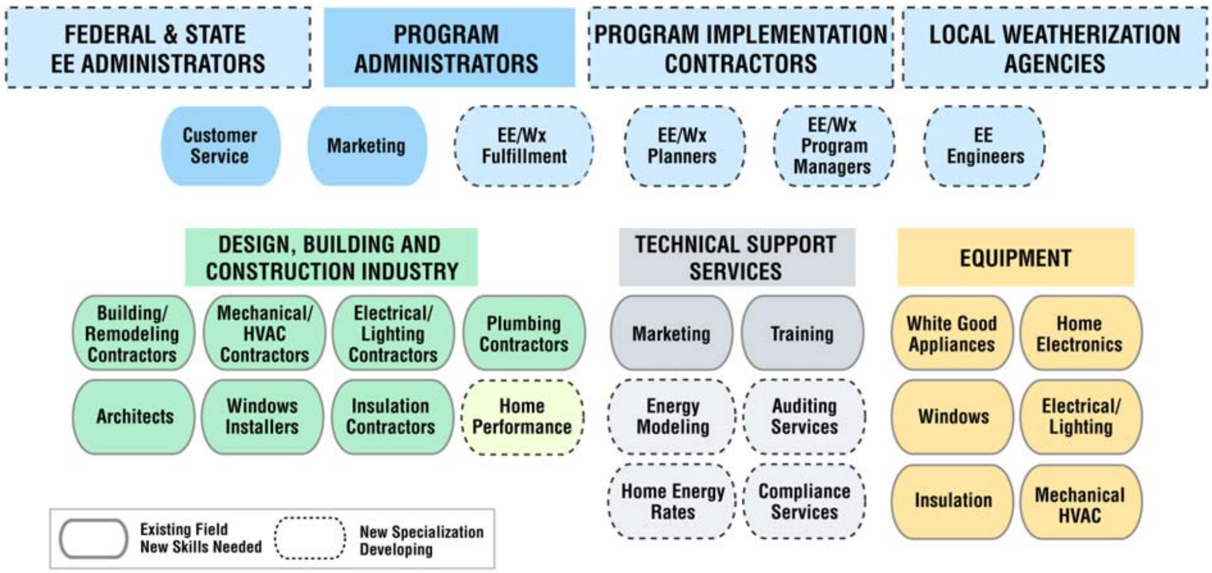

Figure 3-3. The Residential Energy Efficiency Services Sector

- Program Implementation Contractors (PIC) are often responsible for the day-to-day management of energy efficiency programs and include consulting firms that provide energy efficiency program design and planning, program implementation, and program monitoring, verification, and evaluation services. Program Implementation Contractors have the ability to scale up or down quickly – for individual programs or for large programmatic efforts and typically work for multiple Program Administrators. PIC often have teams of specialists in various program areas that can work part- or full-time as programs ramp up; thus providing additional flexibility to Program Administrators in managing work load and staffing.

- Organizations that are Program Administrators and Program Implementation Contractors typically include many occupational specialties, which are illustrated in Fig. 3-2 to Fig. 3-4 by the oval boxes in the second column from the top of each figure. These job specialties include marketing and customer service managers; jobs now devoted to energy efficiency but that use the same basic tools-of-the-trade of non-EESS marketers and managers (thus the darker-colored oval boxes). Specialties involving skills or tasks unique to energy efficiency program implementation are lighter-colored and include EE planners, evaluators, program managers, engineers, and program fulfillment staff. Note that these job specialties vary somewhat across the three customer markets.

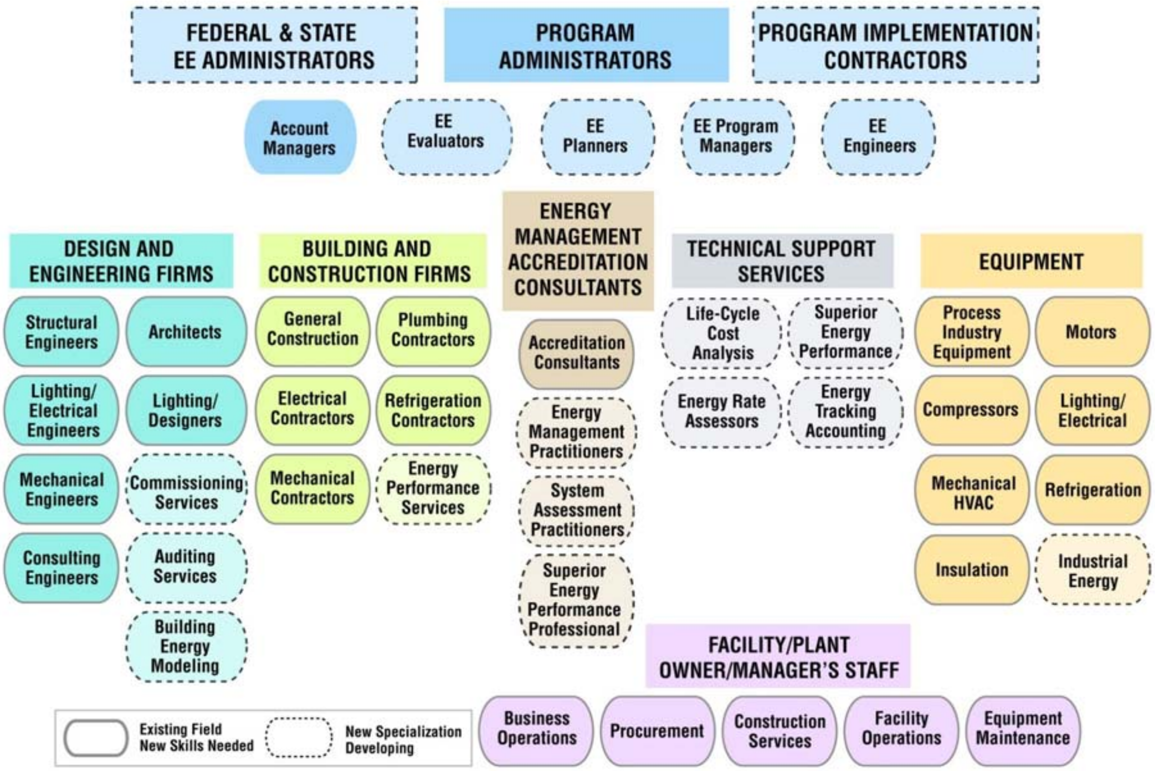

Figure 3-4. The Industrial Energy Efficiency Services Sector

- Program Administrators typically augment their staff through contracts with individuals and small firms with energy efficiency specialties, which we classify as “Program Support Contractors." These contractors are the primary providers of the new and emerging activities shown in the lighter-colored dotted-outline boxes in the second tier of the diagrams (see Technical Support Services).[11] They provide such specialty services as reviewing project energy savings calculations and estimates, calculating customer incentives, running cost-effectiveness models, conducting field inspections, assisting with program planning, and providing regulatory support. These firms have the ability to quickly add or reduced staffing capability and often have experienced professionals that have worked for program administrators; thus, providing additional flexibility to Program Administrators in managing work load and staffing.

- The second tier row of Figures 3-2 to 3-4 includes firms that provide more specialized services in the areas of design and engineering, building and construction, ESCOs (in the institutional/commercial market), energy management accreditation consultants (in the industrial market), technical support contractors, and equipment manufacturers. For these companies, energy efficiency-related jobs are created due to several factors: business-as-usual market demand for energy-saving equipment and services (i.e. not driven by government policy or ratepayer funding) and jobs that result from supporting EE policies

[11] Programs Support Contractors can also include engineers, architects, economists, and energy efficiency generalists that serve as business and management consultants.

(e.g., building codes that require certain construction standards, industrial standards for energy efficiency management (ISO 50001) and system assessment (ANSI-ASME)). Jobs are also created through funding (i.e., financial incentives for implementing energy efficiency projects) received from programs offered by Program Administrators.

- Program Administrators and Implementation Contractors also offer resources – often financial incentives, but sometimes training, technical assistance, product development expertise, or other information-based resources – that support the components of EESS found in the second tier in other ways. In both the commercial and institutional (Figure 3-2) and industrial markets (Figure 3-4), Program Administrators provide financial incentives to firms (design and engineering, building and construction, technical support services or equipment vendors) who deal directly with customers, or to the customers themselves who seek these services from the market. For the residential sector (Figure 3-3), the Program Administrators or local weatherization agencies facilitate the installation of energy efficient products and services. Implementation Contractors often use design and engineering and/or construction firms to facilitate the deployment of products and services. Technical services jobs that support residential energy efficiency have also emerged such as auditing and energy modeling.

> *The Energy Efficiency Services Sector does* not *constitute an independent industry, since the activities of the EESS typically consist of a shift from standard practice to a more energy-efficient approach to the design, construction, equipping and operating of buildings.*

It is clear from the market characterization diagrams that the EESS is a multi-disciplinary sector that addresses the design and construction of homes and buildings, and the installation, use, and maintenance of high-efficiency equipment in homes, buildings, and industrial processes. The EESS includes engineers, designers, economists, marketers, and trades people. At present, it does *not* constitute an independent industry, since the activities of the EESS, rather than being new efforts, typically consist of a shift from standard practice to a more energy-efficient approach to the design, construction, equipping, and operating of buildings. Hence, this is our rationale for using the term “energy efficiency services sector” rather than “energy efficiency industry.”

> *Many jobs in the Energy Efficiency Services Sector are not new jobs, but rather evolving jobs which provide more energy efficient versions of current products and services.*

Finally, these market characterization diagrams also highlight the point that there is potentially a high degree of substitution in the EESS for many services and products that are similar to existing services in the building and construction industry (as illustrated by the solid boxes). The focus of the EESS is on the most energy-efficient product or service. These products and services exist in the market place and are, through the efforts of tax payer- and ratepayer-funded programs, supported in order to gain an increased share of the market, displacing less efficient products and services.[12] Thus, many jobs in the EESS are not new jobs, but rather jobs that are evolving to improve the energy efficiency of the product or service provided. To recall the comment by Hendricks (2009) on

[12] There are always new entrants of high-efficiency items to the market. Some public policy programs, especially those of the federal government, provide support for R&D and commercialization of new technologies.

green jobs: there are created jobs, transformed jobs, and retained jobs. Those in the light colored boxes are created. Those in the solid boxes are retained or transformed. A significant expansion of the EESS will necessarily involve the creation of a transformed building and construction industry, which will be at the core of the EESS.

3.3 Job Categories and Roles within EESS Organizations

Growth of the Energy Efficiency Services Sector will involve transformation of the construction industry, which will be core to the EESS.

We are also interested in characterizing how organizations involved in the EESS establish and utilize various occupational categories to deliver services. In this section, we describe the job categories and roles found in Program Administrator and Program Implementation Contractor organizations, ESCOs, low income weatherization programs, and the design, engineering, building, and construction industries, drawing from our survey responses. Prior to fielding the surveys, we developed occupational categories for each type of organization in the EESS. We asked respondents to identify their staffing mix across the various categories and describe the key skill sets and training for major occupations.

3.3.1 Program Administrators and Implementation Contractors

The occupational categories that make up Program Administrator, Program Implementation Contractor, and Program Support Contractor organizations range from management to planning to implementation (e.g. technical services, training, marketing) to evaluation (see Table 3-1).

Table 3-1. Job categories: Program Administrators and Program Implementation Contractors

Job category	People in this category …
Senior management	…provide the senior level of management to the EE organization. In the case of a large utility or private firm this is the EE department; in the case of smaller organizations that solely focus on energy efficiency this could be the senior management of the entire organization.
Program planning, design, and budgeting	… conduct activities that get an EE program into the overall program portfolio of an organization.
Program management and administration	…provide leadership for a specific program such as a commercial lighting or new construction program.
Program technical services and field staff	…provide technical services in the field such as auditors, installers, and verifiers.
Program training and marketing	…work with trade allies and others to train them in new programs and market the EE programs.
Program support and incentive processing	… provide overall administrative support to EE programs, including incentive processing and data entry.
Program evaluation and market assessment	…conduct research aimed at improving the design and implementation of EE programs and assessing their impacts on end use and product markets.

The job categories are similar among Program Administrators and Implementation Contractors, although we found some differences in staffing patterns and organization among these two types of firms (Figure 3-5). For example, we found that Implementation Contractors have more staff in their organization that provide technical services and field support (37% vs. 22%), program support and incentive processing, and program evaluation and market assessment (12 vs. 4%) compared to Program Administrators.

Implementation Contractor organizations also have relatively more senior management staff than do Program Administrators (12% vs 7%). This is likely because utilities have less management directly assigned to energy efficiency efforts, which are typically a department within a large corporation rather than an entire business unit or company as with Implementation Contractors. In contrast, Program Administrators have more positions for training and marketing, program planning and design, and program management and administration, reflecting their active role in trying to plan and design programs to influence market response.

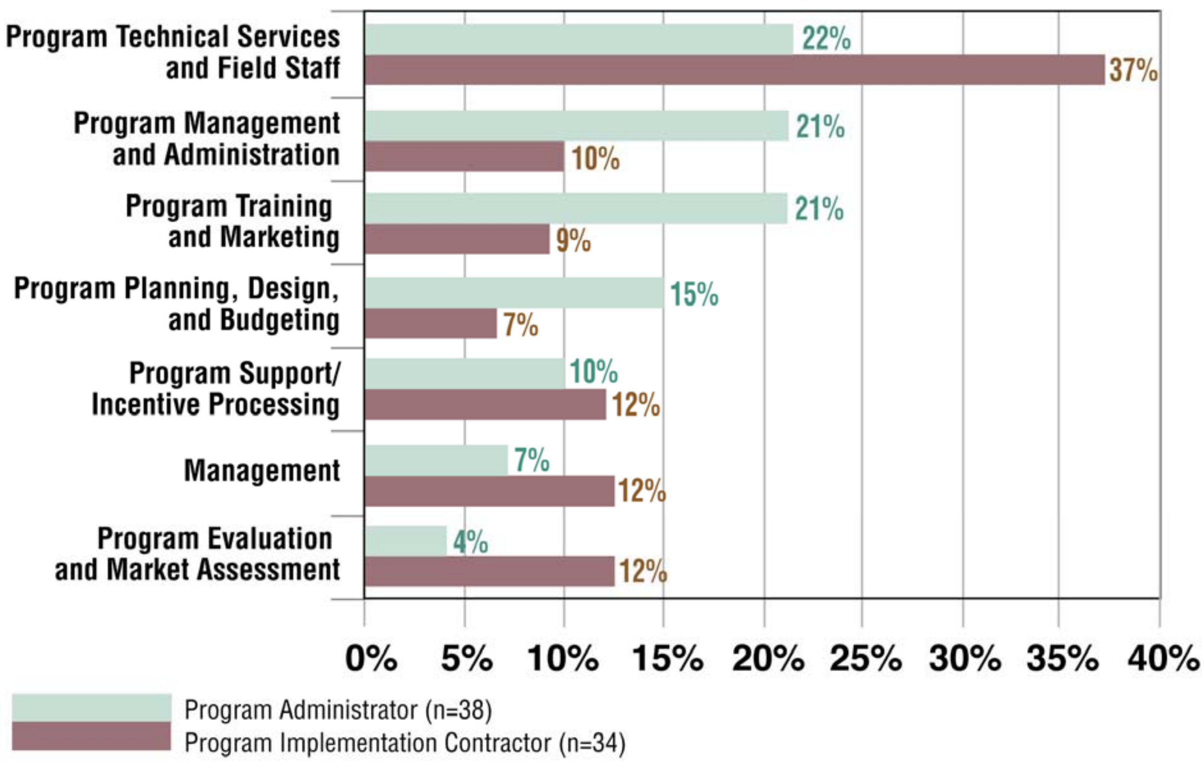

Figure 3-5. Distribution of Program Administrators and Implementation Contractors workforce by job category

3.3.2 Energy Service Companies

Energy service companies (ESCOs) develop and implement turnkey, comprehensive energy efficiency projects and provide other value-added services; ESCOs offer performance-based contracts (*i.e.*, contracts that tie the compensation of the ESCO to the energy savings generated by the project) as a significant part of their business. About 80% of the ESCO market activity is targeted to public/institutional market and their projects tend to be relatively large and complex (e.g. the typical ESCO project size is ~$1.7M in institutional customers; see Goldman et al 2005). Key job categories include sales and marketing, project design and engineering, construction management and project maintenance and savings verification (see Table 3-2).

Table 3-2. Job categories in ESCO organizations

Job category	People in this category …
Senior management	…provide the senior level of management to the organization.
Sales and marketing	… staff develop business leads and projects; work with customers to make project happen; participate in investment-grade audits.
Project design and engineering	…conduct investment-grade audits; design and engineer projects, develop project costs and budgets, develop construction drawings and specifications.
Construction management	…provide leadership on site for installations and retrofits, ensure projects are completed on budget and to design requirements.
Project maintenance and savings verification	…oversee project-related operations & maintenance after project is accepted by owner; gather field and billing data to verify savings; prepare reports on project savings and performance.

The distribution of staff across these categories is consistent with the ESCO role as project developer; staffing within ESCO organizations is dominated by sales and marketing (28%) and project design and construction management (44%) (Figure 3-6). Like program administrators, ESCOs tend to contract installation and maintenance activities to the building and construction industry (e.g. HVAC and lighting contractors). These field positions therefore are typically not found on ESCO staff.

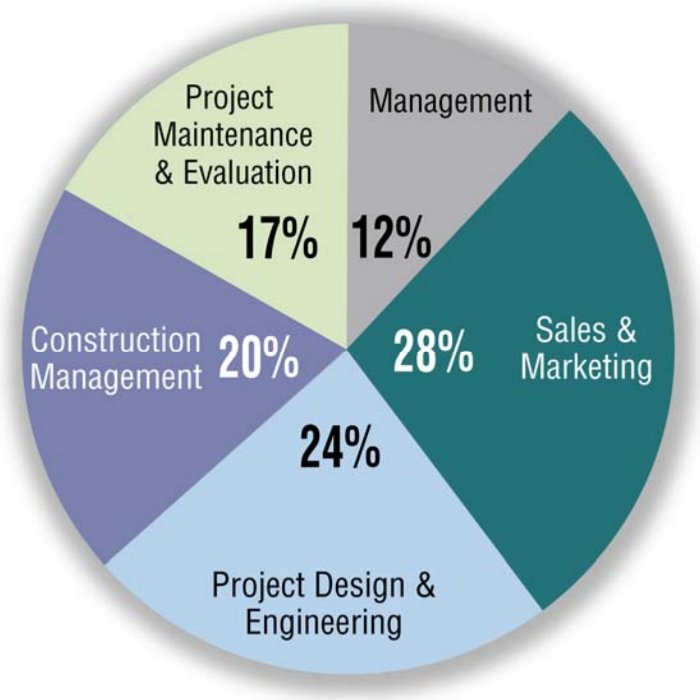

Figure 3-6. Distribution of staff within ESCO organizations

The allocation of work between Program Administrators, Implementation Contractors, and ESCOs leads to different needs for staff skills. In terms of staffing, the respondents for ESCO organizations reported that their staffs are dominated by engineers (60%) (see Table 3-3). While both program administrators and implementation contractors have engineers on staff, respondents reported that staff engineers comprise a larger share of the total organization for Implementation Contractors (26%) compared to Program Administrators (17%).

Table 3-3. Engineers as percent of staff

Organization type	Engineers as percent of total staff (est.)
Program Administrators	17%
Program Implementation Contractors	26%
ESCOs	60%

3.3.3 Low Income Weatherization

The distribution of jobs is somewhat different among organizations that provide energy efficiency services in the residential market. For example, job categories in organizations that manage and deliver weatherization services targeted to low income customers as part of federal and state weatherization programs are shown in Table 3-4. The program planning and design function is conducted by designated state and federal agencies (e.g. DOE) and the local weatherization agency staff act in a manner similar to the management and administrative staff of Program Administrators and Implementation Contractors. Unlike administrators of ratepayer-funded programs, local weatherization agencies use a substantial amount of in-house field and technical staff: crew leaders and crew members do audits and installations of weatherization measures in low-income households.

Table 3-4. Job categories in Low Income Weatherization programs (Adams 2009)

Job category	People in this category …
State and National program staff	… provide overall management and administration of weatherization funds, coordinate large scale training efforts, and stay abreast of technological developments in the field.
Local program management and administration	…account for local program resources, coordinate local training efforts, and manage multiple crews in a defined region.
Crew leader	…oversee a crew that implements weatherization activities in homes.
Crew members	…audit, weatherize (e.g. insulate building shell, windows), and install high-efficiency equipment in homes making them more energy efficient.

Engineering skills are much less in demand for residential and low income weatherization programs. Though engineering technician skills are desirable for certain functions associated with building analysis and program design, engineering skills in the residential sectors primarily support the development of tools for technicians and contractors.

3.3.4 Design, Engineering, and Building and Construction Industries

The professionals, contractors, and trades people working in the design, engineering, and building and construction industries support and implement energy efficiency projects that are managed and partially funded by various Program Administrators, projects developed by ESCOs, and projects that occur as a result of their own market-driven business activities (see Table 3-5).[13] New job categories related specifically to energy efficiency services are being created in the design, engineering, and building and construction industry; examples include auditors, commissioning agents, and compliance services.

In order to provide the needed energy efficiency solutions, standard occupations in the building and construction industry will need to be transformed through energy efficiency training—by retraining current workers and adding energy efficiency to existing design, engineering and construction education programs.

The building and construction industry provides the largest share of jobs in the EESS (see section 4). However, in order to effectively provide energy efficient solutions, the services provided by architects, electricians, mechanical contractors, insulation contractors, and other standard occupations in the building and construction industry need to be transformed and enhanced through energy efficiency training. This transformation of occupations will come about through retraining current industry members and by incorporating energy efficiency training in the education and training programs that already

[13] In some states, local weatherization agencies increasingly rely on contractors to install selected equipment measures as a way to scale up the workforce as needed.

exist for design and engineering professionals, and the rest of the building and construction industry.

Table 3-5. Job Categories in Design, Engineering and Building and Construction Industry that provide Energy Efficiency Services

Job category	People in this category …
Architects	....design buildings, develop drawings and specifications for construction.
Engineers	....design energy using systems for new and existing buildings; prepare drawings, specifications for construction; develop software and analysis tools for building modeling and simulation of energy consumption; and commission new buildings and high-efficiency projects.
General contractors, builders, remodelers	....create the team that constructs or renovates the building, solicits bids from equipment contractors, and structural and construction specialties, coordinate with design team and owners.
Equipment (e.g., mechanical, electrical, lighting, and refrigeration)	....install specified products, systems, and equipment consistent with design specifications
Building envelope contractors (e.g. insulation, windows)	…install specified products consistent with design specifications

4. EESS Workforce Size: Current and Projected

In this chapter, we present our estimates of the aggregate size of the current EESS workforce as well as projections of the EESS workforce in the near and longer term (i.e., 2010, 2015, and 2020) under low and high energy efficiency spending scenarios. Results are expressed in terms of the total number of person-years of employment (a PYE is one person working full-time for one year). Our estimates of EESS workforce size are driven by two key factors: (1) person-years of employment per million $ of EESS activity and (2) estimated EESS spending. We then discuss and describe our "bottoms-up" approach that was used to develop estimates of future energy efficiency spending/revenues and direct employment from EESS activity for major programmatic areas (e.g. ratepayer-funded EE, state/federal EE programs, low-income weatherization, ARRA funds) and market-driven activities (e.g. ESCOs, insulation).
See Appendix A for a more detailed discussion of data and assumptions used to derive these workforce and spending estimates.

4.1 Total EESS Workforce

Figure 4-1 and Figure 4-2 provide a high-level summary of our estimates of current and projected workforce size (expressed both in terms of person-years of employment (PYE) and estimated number of individuals involved in the EESS) under the high efficiency spending scenario. The stacked bar graphs in each figure show estimated person-years of employment for major EE program areas or market-driven activity: (1) Ratepayer-funded EE includes Program Administrators, Program Implementation and Support Contractors, and building/construction industry employment induced by ratepayer-funded energy efficiency, (2) Low-income weatherization, (3) Other energy efficiency programs funded under ARRA, (4) ESCO market activity, including contractor employment induced by ESCO projects, and (5) market activity among building and mechanical insulation contractors.

In 2008, the EESS workforce comprised about 114,000 person-years of employment (see Figure 4-1). Figure 4-2 provides an illustrative sketch of what the total efficiency employment in terms of individuals might be. We estimate that 380,000 individuals are employed in EESS activities in 2008, or over three times the estimated EESS workforce in person-years of employment (see Appendix A.13 for details). We estimate that the building and construction industry in 2006 was 4.2 million PYE (Bureau of Labor Statistics 2006) and the current 114,000 PYE of the EESS workforce comprises about 3% of that workforce.[14]

[14] We identified the 48 Occupational categories in the 6 NAICS industries most closely aligned with the EESS (see Tables A-16 and A-15 respectively) and tallied how many PYE they represent We had data for 2006 and 2016 from the BLS , calculated an average growth rate, and we then carried the growth rate out to 2020 to calculate the size of the building and construction industry for 2020.

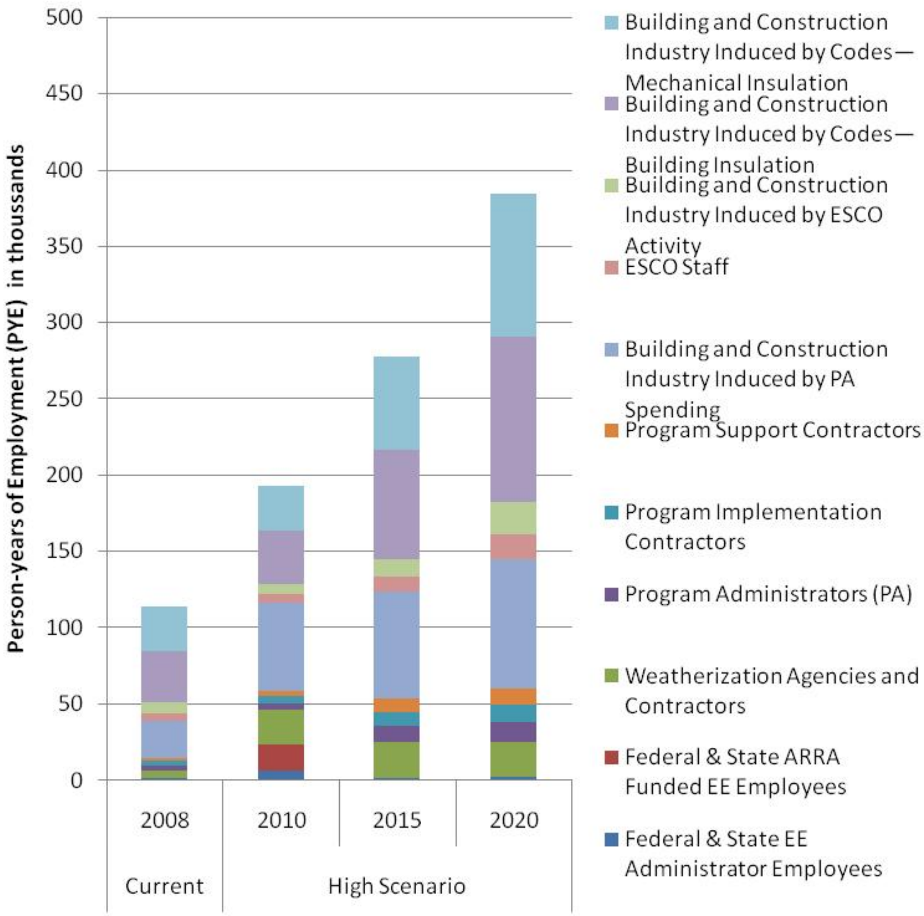

Figure 4-1. Current and Projected EESS Person-Years of Employment (PYE) – High Growth Spending Scenario

Ratepayer-funded energy efficiency efforts currently constitute about 30% of estimated EESS person-years. This employment includes the staffs of program administrators (PAs), the program implementation contractors (PICs) and program support contractors (PSCs) they hire, and the building and construction professionals and trades people that design and install the equipment that ratepayer funds subsidize. ESCO efforts constitute about 10% of the total person-years, including ESCO staff and the contractors they hire among the building and construction industry. The weatherization assistance efforts of the federal and state governments constitute about 5% of the total EESS person-years. Finally, the professionals and trades people responsible for building envelope insulation and those responsible for mechanical insulation each comprise more than one quarter of the 2008 EESS person-years of employment.

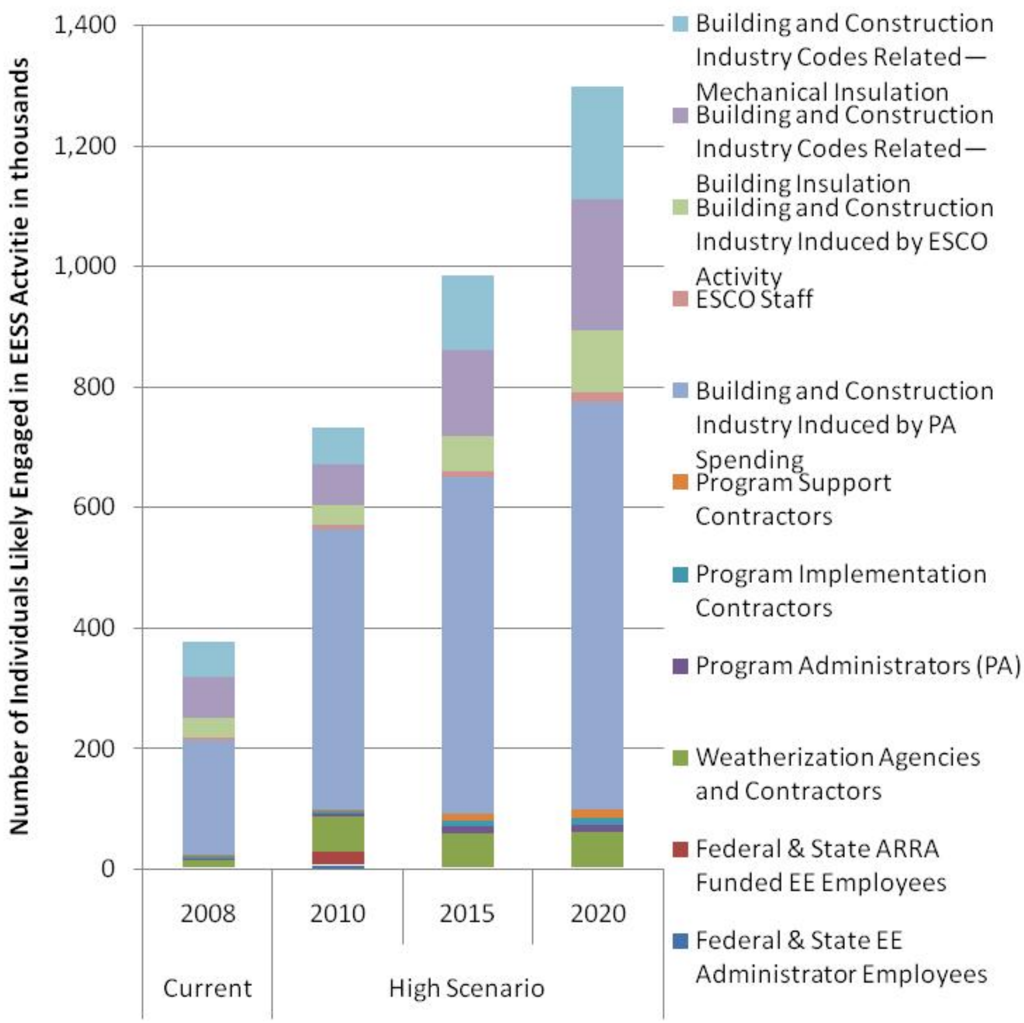

Figure 4-2. Illustrative Sketch of Number of Individuals Likely Engaged in EESS Activities

The workforce estimates presented here are in person-years of employment and do not necessarily represent the number of *individuals* employed. Based on our interviews, we found that staffs of PAs, PICs, and ESCOs are likely to be employed full-time or nearly full-time in energy efficiency; thus for these groups, the person-years of employment provides a rough approximation of the number of individuals employed. Not so for the other groups. The building and construction trades-people that support PA and ESCO activities conduct various types of work in their business, of which a fraction involves developing and installing high-efficiency measures and equipment. Weatherization assistance employs many part-time workers. Even the person-year counts for building and mechanical insulation likely understates the total number of individuals employed, as insulation may be just one aspect of the on-the-job activities of these trades people. For each of these groups (other than PA, PIC, and ESCO), the number of individuals employed doing any energy efficiency work could easily be three to five times the estimated person-years of employment.

Figure 4-2 provides an illustrative sketch of what the total efficiency employment in terms of *individuals* might be. We estimate that 380,000 individuals likely are employed in EESS activities in 2008, or over three times the estimated EESS workforce in person-years of employment (see Appendix A.13 for details).

Figure 4-1 also depicts high growth scenarios to 2020 and suggests that the EESS may grow to just under 400,000 person-years of employment by 2020. Over the same period, the Bureau of Labor Statistics (BLS) forecasts the workforce size of those occupations and trades potentially associated with energy efficiency to be almost five million (Bureau of Labor Statistics 2007; see Appendix A.10). Thus, in the high growth scenario, by 2020 the EESS may comprise as much as 8% of the relevant building and construction industry. As many as 1.3 million individuals could be employed in EESS activities in 2020 under our high growth spending scenario (see Figure 4-2).

Our high growth scenario includes a few key assumptions:

- A quick ramp-up by 2010, reflecting the commitment of American Recovery and Reinvestment Act (ARRA) funds to weatherization assistance and other efficiency activities.
- Significant increases in spending on energy efficiency over the next dozen years resulting from governmental policy and market investment in efficiency.

We believe a high growth scenario is likely due to the current political will to implement policies that address energy security, global climate change, and job creation in activities that cannot be moved overseas.

In contrast to these high-growth trends, we think it possible, but unlikely, that fuel prices will decrease – reducing the impetus for market investment in efficiency – and that political support for efficiency initiatives will wane. We captured these possibilities in a low growth scenario that assumes future energy efficiency spending simply mimics the past, increasing at the same rates as the historic trends in some subsectors or holding constant in real terms and increasing nominally as a result of inflation (see Figure 4-3).

Even under a low growth scenario, we estimate that in 2020 the EESS will comprise over 200,000 person-years of employment, or about twice the current level. (This level of activity might involve about 750,000 individuals.) Our 2010 low-growth scenario depicts the EESS in the absence of ARRA spending. The ARRA allocations represent a very ambitious ramp-up in efficiency activity to levels that may or may not be attained. Our low and high spending scenarios reflect the significant uncertainties regarding deployment of ARRA funds and represent different near-term paths for energy efficiency: the low growth scenario includes a relatively modest ramp up in the ability of state and local governments and federal agencies (and EE services contractors) to develop and implement energy efficiency projects *by 2010* using ARRA funds while the high scenario assumes that the EE programs supported by ARRA funds are very successful and able to rapidly ramp up energy efficiency activities by 2010.

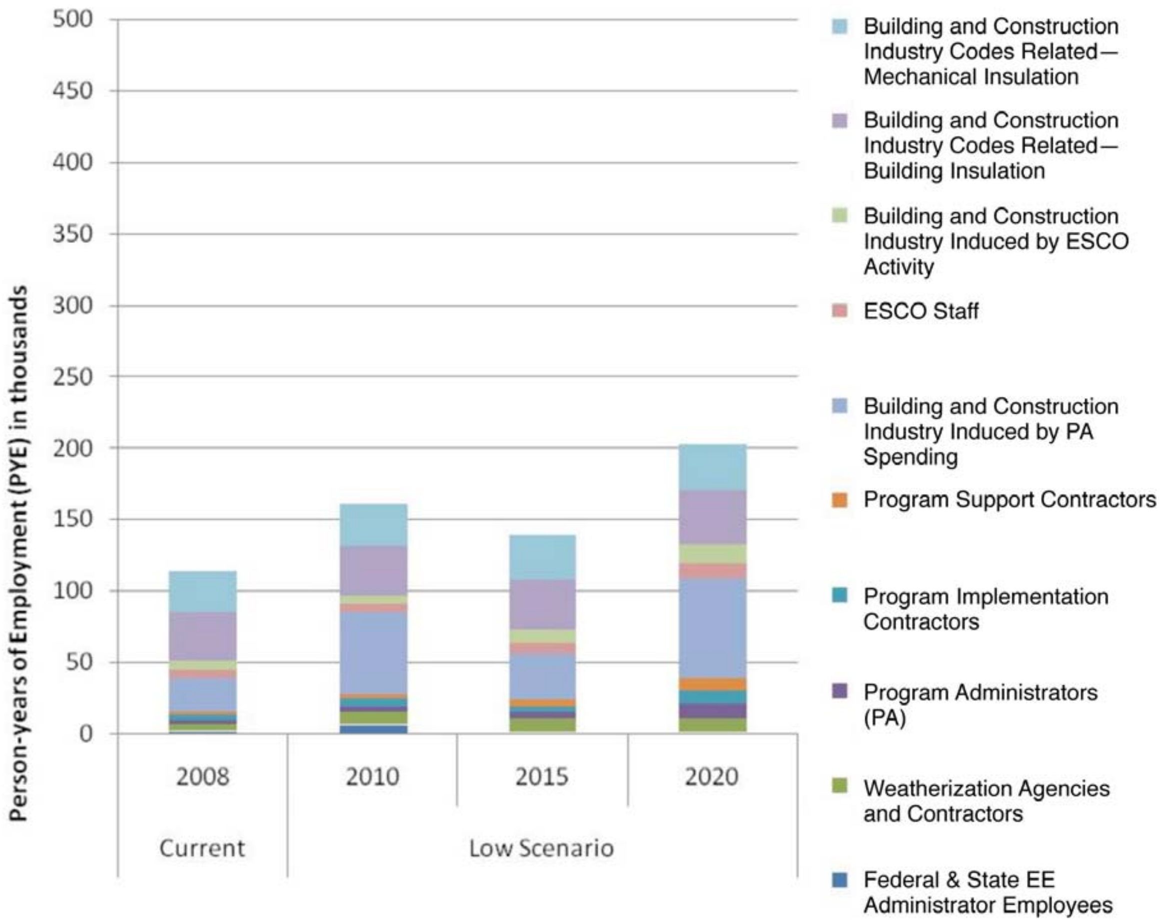

Figure 4-3: Current and projected EESS person-years of employment – low growth scenario

While we believe the high-growth scenario to be most likely over the longer term (e.g. 2015-2020), given either scenario we believe the EESS workforce will grow by a multiple of two to four between 2008 and 2020. This increase means people currently employed in the EESS will need additional energy efficiency-specific training to keep abreast of developments in the field and new people will need to be introduced to the sector and adequately trained to implement energy efficiency in a reliable and cost-effective manner.

One potential pitfall of rapidly expanding energy efficiency funding can be the attraction of "fly-by-night" operations that are hungry for energy efficiency incentives and credits but are not properly trained to optimize efficiency, thus undermining the effectiveness of the efficiency investment. Poorly trained workers that do not deliver the promised energy savings could undermine the public commitment to, and market interest in, energy efficiency. Such a backlash might reduce the long term employment prospects of people in the business of providing energy efficiency services. The sections below describe several key drivers of our projections in greater detail.

4.2 National Spending on EESS Activity

The nation's current spending on EESS activity is just over $18 billion (Figure 4-4). The market-based activities of energy consumers and building owners constitutes over 75% of this efficiency spending, while less than 25% comes from direct tax payer and ratepayer spending. A relatively small public investment nationwide of approximately $4 billion leverages about $14 billion of private investment and generates about 85,000 person-years of employment out of the total of about 114,000 person-years. Figure 4-4 gives our forecast through 2020 under the high-growth scenario for spending on EESS activity. We forecast that spending on EESS will increase more than four-fold by 2020 (high growth), to over $80 billion dollars.

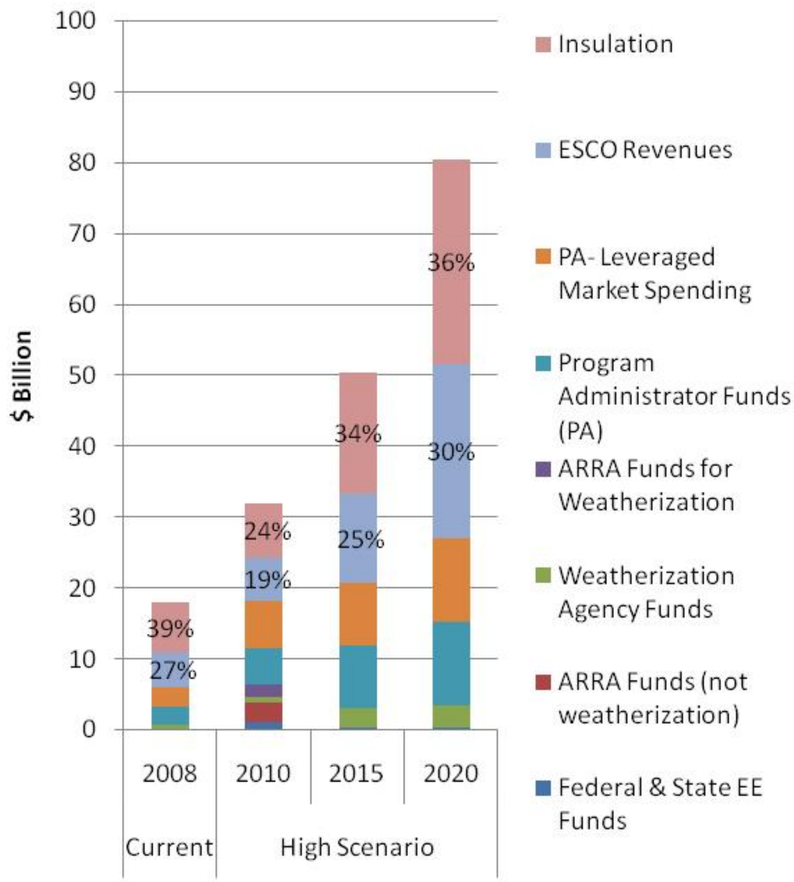

Figure 4-4: Current and projected spending on EESS activity—high growth scenario

Figure 4-5 gives our forecast under the low-growth scenario for spending on EESS activity. We forecast the low-growth increase to 2020 to be a little more than two-fold, to about $37.1 billion dollars.

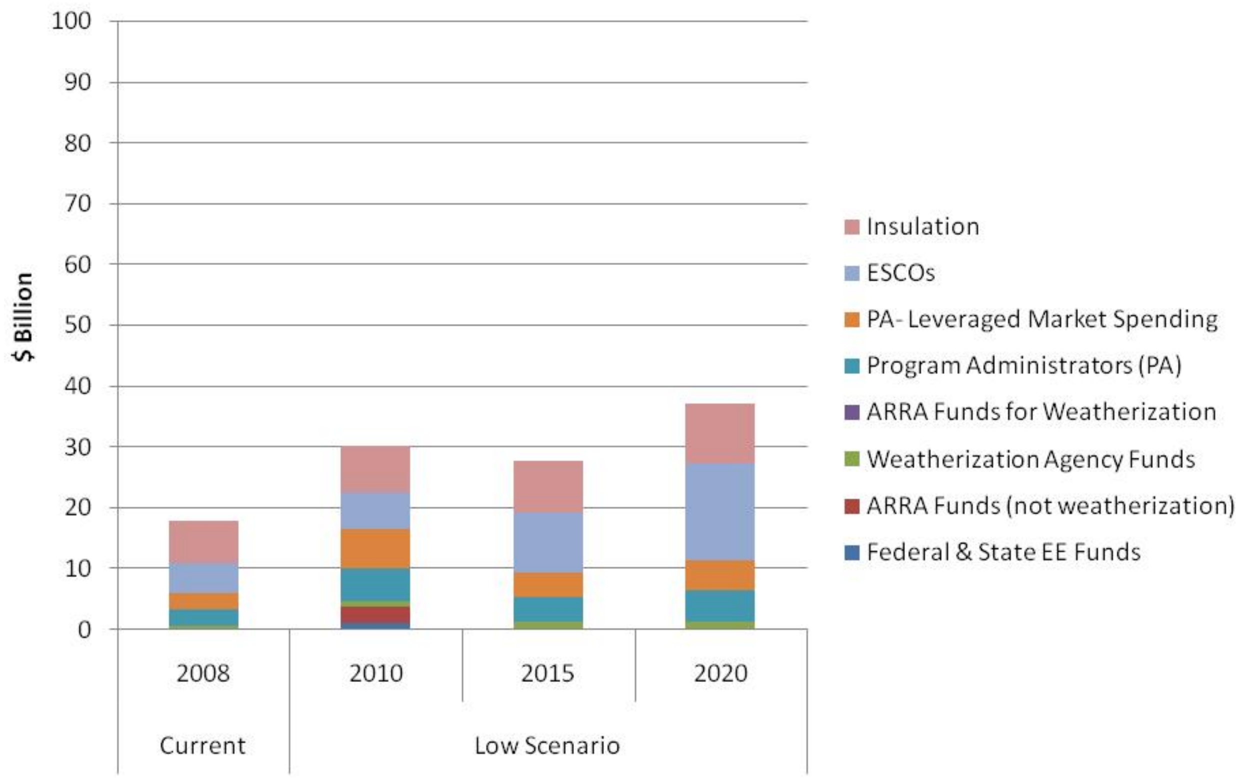

Figure 4-5. Current and projected spending on EESS activity—low growth scenario

4.3 Weatherization Assistance

Federal and state policies provide weatherization assistance to low-income households. At the federal level, the Office of EERE within U.S. DOE administers the Weatherization Assistance Program (WAP). EERE works directly with the states, the District of Columbia, the U.S. Territories, and several Native American Tribal Governments. These governments contract with roughly 900 "sub-grantees" to deliver weatherization services, comprising about 700 community action agencies and 200 units of local government and other non-profit organizations (Adams 2008). DOE EERE sets national guidelines of eligibility, establishes the technical merit of energy efficiency measures, documents energy savings, and provides technical training and assistance to weatherization service providers. The states make the rules and set eligibility standards for their residents, contract with weatherization agencies (typically community action agencies and community-based organizations), and monitor agency work to ensure quality.

The weatherization agencies take applications from families in their service area, determine eligibility, and prioritize based on relative need; perform an energy audit and determine the most cost-effective weatherization measures for each dwelling; install those measures and inspect all work; and meet with family members to review the energy efficiency improvements. The funds can be used for energy efficiency measures, key health and safety improvements, and minor repairs that protect energy efficiency measures. Measures address the building envelope, its heating and cooling systems, its electrical system, and electricity consuming appliances.

States can augment the DOE WAP funds by allocating to weatherization up to 15% of their LIHEAP (Low Income Home Energy Assistance Program) Block Grant, received from the U.S. Department of Health and Human Services (DHHS) or use Petroleum Violation Escrow Account funds.[15] In the 2007 program year, 44 states and the District of Columbia transferred LIHEAP funds into WAP. LIHEAP transfers vary from state to state, from a low of $200,000 in Nevada to a high of over $35 million in New York (NASCSP 2008). Some WAP offices may also access state-funded companion low-income programs and other public and private funding sources. The National Association for State Community Services Programs (NASCSP) reports these other funds have grown steadily since 1989 and in 2007 totaled about $200 million, or 30% of total WAP monies (NASCSP 2008). Finally, many electric and gas utilities also provide weatherization services in ratepayer-funded energy efficiency programs targeted at low-income consumers; we account for ratepayer-funded energy efficiency efforts, including low-income programs, in section 4.3.1.

The average cost per home weatherized varies widely across states. Climate, of course, influences the optimum level of weatherization activities; state differences also reflect state policies regarding eligible activities, equipment installation, and home repairs. Average cost per home weatherized ranged from about $2,000 to over $8,000, with a national average of just under $4,000 (NASCSP 2008). It is unclear from the source materials whether these averages include program overhead costs; in our opinion, it is likely that each state categorizes its expenditures somewhat differently and thus some of the variation in average cost per state reflects different reporting procedures.

4.3.1 Weatherization Assistance Budgets

Of all the EESS categories included in our study, we generate both low and high 2010 funding scenarios for only two in order to illustrate the effect of the ARRA funds. These categories are weatherization assistance and non-weatherization ARRA spending. For all the other EESS categories, we generate a single 2010 funding scenario. Also, PVE funds are being exhausted and the current study simplifies by assuming zero PVE funds going forward.

In program year (PY) 2007, DOE funding for WAP totaled $204 million; LIHEAP funds administered by WAP totaled $256 million; PVE funds totaled $2 million (NASCSP 2008). To bring our analysis of weatherization assistance funding into alignment with our broader methodology, we subtracted from the NASCSP estimates of “other funding” the Consortium for Energy Efficiency numbers for program administrator low-income budgets per state (CEE 2008), leaving $66 million in other funding (that is, non-DOE, non-LIHEAP) for WAP in 2007. At an average cost of $4,000 per home, the PY 2007 funding would have weatherized over 130,000 homes with a total budget of almost $530 million.

[15] In past years, states have also allocated Petroleum Violation Escrow Account (PVEA) funds to weatherization. States first had access to these funds in 1983, which resulted from settlements associated with violations of Federal oil pricing controls of 1973-1981. In 1997, PVEA funds comprised nearly 10% of total WAP resources, yet by 2007 PVEA comprised only ~0.5% of total funding (~$2M) (NASCSP 2008).

Our 2010 low scenario for weatherization assistance funding uses the FY 2009 DOE WAP appropriation of $450 million, the LIHEAP FY 2009 transfers for weatherization of $400 million, and other funding for weatherization at the inflation-adjusted 2008 value. At an average cost of $4,000 per home, about 230,000 homes can be weatherized with a total budget of about $920 million. Our 2010 high scenario assumes one-third of the ARRA appropriation for weatherization assistance of $5B (that is, $1.66B) in addition to the funding assumptions of the low scenario. At $4,000 per home, about 646,000 homes can be weatherized with a total budget of about $2.6 billion. The ARRA legislation increases the cap on spending for a single home at $6,500.

Our low scenarios for 2015 and 2020 for DOE funding of WAP assume the number of houses weatherized each year will be 50% more than in 2008, on the assumption that the increased weatherization capacity stimulated by ARRA will persist to some extent but not fully. We forecasted DOE WAP funding to reflect this increase in activity (and inflation). For LIHEAP and other funding sources, we assumed 2008 funding levels, escalated for inflation. We assumed the same average cost per house of $4,000 (as denominated in constant 2008 dollars).

Our high scenarios for 2015 and 2020 assume federal policy makers commit to a high level of weatherization assistance. To represent this scenario, we assumed that DOE WAP spending in 2015 and 2020 maintains much of the impetus from the ARRA and continues at roughly the magnitude achieved in 2010. For LIHEAP, we assumed 2010 funding levels (PY 2009), because the latest LIHEAP budget appropriation for WAP represents an infusion of money. We hold “other” funding constant in real terms at its 2008 level. At an average cost of $4,000 per home (constant 2008 dollars), about 650,000 homes can be weatherized per year in the high scenario. Yet such a public commitment to weatherization might translate into higher spending per house; about 520,000 homes can be weatherized in the 2015 and 2020 high scenarios at an average cost per home of about $5,000.

Figure 4-6 illustrates projected 2010 funding for weatherization assistance and projected 2015 and 2020 funding under low and high funding scenarios by funding source.

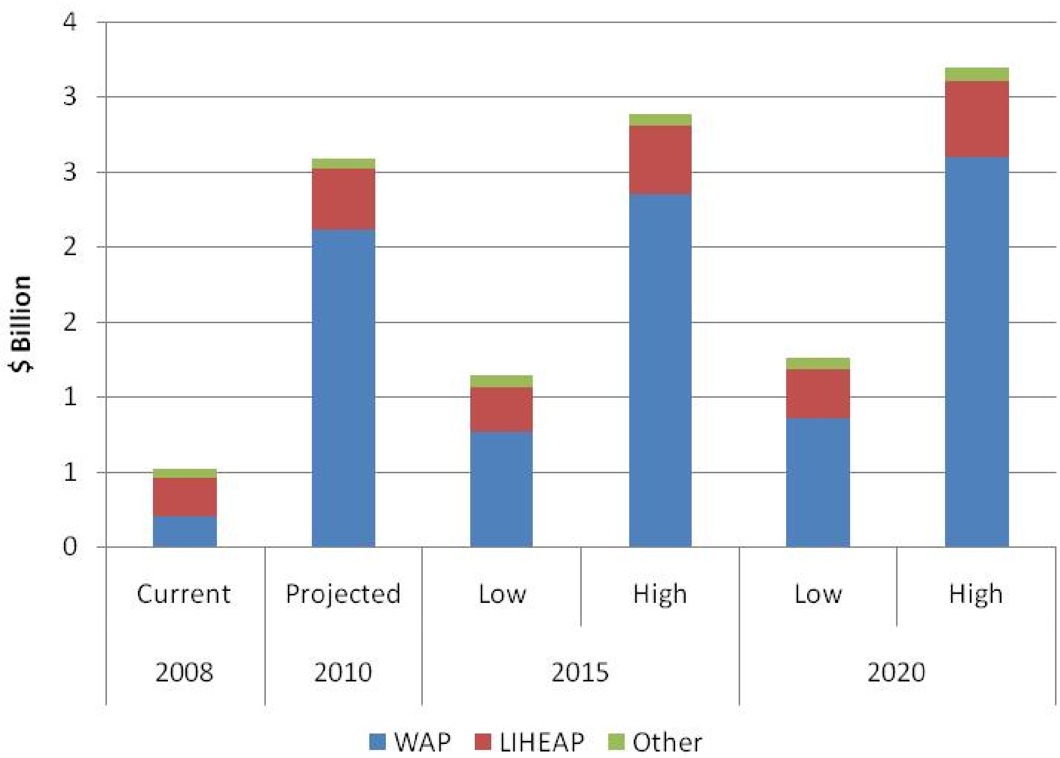

Figure 4-6: Projected 2010, 2015, and 2020 Weatherization Assistance Funding

4.3.2 Weatherization Assistance Leveraged Private Sector Efficiency Spending

The weatherization assistance efforts leverage market spending on efficiency, although to date these leveraged monies are not large. While some sources consulted for this study refer to the leveraging of DOE monies by supplements from LIHEAP and state programs, from a societal perspective, these supplements are transfers of tax payer money between governmental organizations and do not constitute leveraging of market spending.

The private sector contributes to low-income weatherization when building owners decide to use their own funds to buy-down the cost of measures that otherwise would not pass the implementer's cost effectiveness criteria. The study by the National Association for State Community Services Programs includes leveraged private sector money in its estimates of "other funds," which also includes ratepayer funding and funds from state agencies and programs; consequently the current study likewise includes private sector contributions in the category of "other" in tallies of weatherization assistance monies and associated workforce.

4.3.3 Weatherization Assistance Workforce Estimates

We relied on research conducted by New England Clean Energy Council (NECEC) for our weatherization workforce estimate. The study used a bottom-up methodology similar to our own and developed estimates of person-years of employment per $1 million in funding for low-income weatherization from analyses of detailed survey data it collected (NECEC 2009). The study determined total funding for WAP in Massachusetts and the number of homes that could be weatherized for the funding. Working from survey data, the study estimated the number of WAP managers needed to supervise this level of activity, as well as the number of administrative assistants, auditors, and contractor field workers needed. The study considered a mix of WAP activity – such as window replacement, equipment replacement, and home repairs – and the implications for staffing.

The study's director, Kevin Doyle, provided us the workforce data. We analyzed this data and conducted sensitivity testing assuming different proportions of the various measures installed for the funding. From this sensitivity testing, we calculated and then rounded the result to obtain a value of nine person-years of direct employment per $1 million in WAP funding.

Using this figure, we estimate the current weatherization assistance workforce (excluding ratepayer-funding activities, which are included in the program administrator analysis in Section 4.6) at 4,676 full time equivalent (FTE) workers. When ratepayer funding is included in the tally, the team estimates the total workforce at 5,848 FTE. This figure is roughly comparable to the figure cited by a DOE website, which reads: "Weatherization is responsible for creating some 8,000 jobs in building energy science that provide weatherization and other energy services to homeowners" (EERE 2009). It is possible the figure of 8,000 jobs includes part-time positions.

We estimate the standard appropriation for weatherization in 2010 (that is, in the absence of ARRA, which our 2010 low growth scenario represents) will generate about 8,150 person-years of employment. Given our assumptions of the rate at which ARRA funds for weatherization will be expended (see the discussion of our 2010 high growth scenario), the funding will generate about 22,913 person-years of employment.

Our low funding scenarios generate about 9,200 person-years of employment in 2015 and 2020, and our high funding scenarios generate about 23,000 person-years of employment. Thus, our low growth longer-term scenarios represent a doubling of the weatherization workforce while our high scenarios represent an increase of nearly five-fold.

4.4 ARRA Funds for Federal and State Efficiency through EERE

The American Recovery and Reinvestment Act of 2009 provides a large infusion of money into energy efficiency projects in 2010 across several federal agencies. Section 4.3 discusses the ARRA funding for weatherization assistance. ARRA also provides the Department of Energy with other funds for energy efficiency efforts including $3.1 billion for the State Energy Program, $3.2 billion for Energy Efficiency and Conservation block grants, and $300 million for energy efficiency appliances. Appendix Table A-5 gives our assumptions for the proportion of these funds that will be allocated to energy efficiency in buildings (as opposed to efficiency in transportation, renewable energy, or other projects) and the proportion to be spent in 2010.

We also included in our 2010 high funding scenario estimates of person-years of employment that will be generated by ARRA funds allocated to energy efficiency projects conducted by the Department of Defense ($3.69 billion), General Services Administration ($4.5 billion), and the Department of Veterans Affairs ($1 billion). We do not assume these allocations will persist into

2015 and 2020 as these funds target projects to increase the energy efficiency of existing facilities and for the completion of deferred maintenance.

We assume that a total of approximately $5.53 billion in ARRA funds will be spent on energy efficiency in 2010, of which $1.6 billion is included in our weatherization assistance analysis and $3.9 billion is additional energy efficiency spending. While other government agencies have also received some ARRA funding for energy efficiency, such as the Department of Housing and Urban Development, we limited our analysis of employment effects to the aforementioned programs. We do not provide ARRA estimates for 2015 or 2020 because the legislation requires these funds be spent by March 2012.

4.4.1 ARRA Workforce Assumptions

For lack of better information, we proxied the employment associated ARRA funds with the average person-years of employment per million dollars in funding across all the other EESS sectors in our analysis. Using this method, we assumed six jobs are created per $1 million of ARRA investment. We calculated this number by taking the total amount of EESS spending in 2010 from our program administrator, implementation contractor, ESCO, building trades, insulation, and weatherization assistance analyses divided by the total 2010 PYE we estimated for these groups. The calculations are: 193,235PYE / $32 billion = 6 PYE on average per $1 million. Using this approach, we estimated the non-weatherization ARRA-funded workforce in 2010 to be about 23,200 person-years of employment.

4.5 Federal and State Energy Efficiency (Independent of ARRA and Weatherization)

4.5.1 Federal and State Energy Efficiency Spending

We examined the FY 2010 DOE EERE budget data and determined that energy efficiency programs comprised 14% of the budget, exclusive of weatherization assistance, or $243 million out of a total budget of $1,780 million. Such activity spans the DOE offices, national laboratories, and federal support for state energy offices. We derived low scenario funding estimates for 2010, 2015, and 2020 using the federal budget forecasts through 2019 as published in the FY 2010 Federal Budget for DOE EERE and assuming energy-efficiency-related activity continues at 14% of the total budget.

It is important to note that our low funding estimates for both weatherization assistance and for DOE EERE *inclusive* of weatherization do not match the federal forecast total budgets for 2015 and 2020. Our estimated funding levels are higher because we assume that continued efforts to increase funding for weatherization efforts in the coming years will supplant the current federal forecast. Our low scenario estimates for non-weatherization DOE EERE programs do not include a similar assumption of increasing funding levels. For our high estimates, we assumed DOE EERE funding will increase at 5% per annum from 2008 onward.

4.5.2 Federal and State Energy Efficiency Workforce

The same federal budget data source from which we derived energy-efficiency spending provided an estimate of 479 employees. We assume that 14% of that employment is in energy-efficiency, as reflected by the distribution of budget across activities. For the forecast years, we assume that PYE will grow proportional to the funding increase.

4.6 Public Utility Commissions, Program Administrators, Implementation Contractors, and Support Contractors

State public utility commissions regulate essential utility services, such as electricity, gas, telecommunications, water, and transportation. We conducted brief interviews with contacts at the utility commissions in the 11 states for which we conducted in-depth research. The contacts estimated relatively few staff (typically, less than a dozen full-time equivalents) dedicated to energy efficiency. We included these staff estimates in our estimates of program administrator staffing; we did not attempt to estimate commission spending on energy efficiency.

We base our estimates of staffing for program administrators and implementation contractors on in-depth interviews we conducted with 39 program administrators our targeted 11 states and 34 program implementation contractors whose activities span program planning, implementation, and evaluation and who typically work in multiple states. We augmented our survey samples for missing data, as described in Appendices A.5 and A.6, and believe our final samples capture virtually all program administrator activity within the 11 states and all implementation contractors that have a national presence, as well as most of the largest remaining contractors (roughly those with ten or more employees). As mentioned in Section 2.3, the program administrators in the targeted 11 states comprise roughly 70% of all 2008 ratepayer-funded energy efficiency (CEE 2008).

Program administrators reported their 2007 spending on energy efficiency; our interviews were in 2008 and, as we sought actual rather than projected values, 2007 was the year most recently available. In interpreting the findings of our study, the reader should understand that the dollars associated with program administrator spending on energy efficiency cover all aspects of program delivery: administration, contracting, and incentives. It would be a misinterpretation to assume the funds we identify in this study as “program administrator” refer simply to the activity of administration; administration is only one component.

Program administrator respondents estimated the size of their staffs on a full-time equivalent basis and provided, as they were able, an estimate of how much they expected the size of their staffs to increase in the near-term, which we interpret for the purposes of our study as 2010. On average, program administrators reported an expected near-term growth in staffing of 16%. Program implementation contacts also provided estimates of their staff size on a full-time equivalent bases and their near-term expectations for growth in staff. Implementation contractors reported an average expected near-term growth in staffing of 48%.

Based on these expectations, it appears that for every one full-time-equivalent program administrative position that opens, three implementation contractor positions will open. This finding is consistent with the trend we have seen in the most recent wave of expansion of ratepayer-funded activity: program administrators turn to program implementation contractors to enable them to quickly ramp-up program activity, provide skills on a flexible basis, and enable administrators meet restrictions on staff sizes or staffing to budget ratios.

Using regression analysis, we found a strong relationship between program administrator spending and administrator staffing levels. Appendix A.5 provides details on the program administrator analysis, including the regression parameters and goodness-of-fit statistics. Using the estimated regression parameters, we forecasted program administrator person-years of employment for the projected low and high 2015 and 2020 program administrator budgets, as developed by Goldman and Barbose (2009).

We did not ask implementation contractors for revenue estimates because their aggregate revenues are equal to total program administrator spending on these contractors. Aware that the implementation contractors typically work in multiple states, we asked the contractor respondents to estimate the proportion of their firms' activities in each of the 11 targeted states. Assuming their workforce in a given state is proportional to their activity in that state, we estimated for each respondent the full-time-equivalent staffing in each of the 11 states. Thus, we were able to estimate for each of the 11 states the total number of implementation contractor staff employed by the state's program administrators.

Using regression analysis, we found a strong relationship between program administrator spending and implementation contractor staffing levels. The findings confirmed our underlying model that implementation contractor staffing is driven by program administrator spending. While this finding is not surprising on conceptual grounds, we were pleased we could demonstrate it by regressing data obtained from one survey (that of implementation contractors) on data obtained from another (that of program administrators). Using the regression parameters, we forecasted implementation contractor person-years of employment per million dollars of program administrator spending in the same manner we forecasted program administrator employment.

We are aware from our prior professional work that program administrators also hire self-employed contractors and small contracting firms, typically local to the administrator, to expand their capabilities and augment their staffing resources in such areas as analyzing the cost-effectiveness of custom projects, conducting direct installations, conducting field verifications, and so on. As described in Chapter 3, we refer to these individuals and small firms as program support contractors.

Through our survey with program administrators, it quickly became apparent that these program support contractors typically are numerous and work for individual program managers. Our contacts were unable to estimate the numbers of these small firms, nor the number of individuals they employed, or even identify these contractors with enough specificity that we might be able to conduct follow-up interviews with them. Yet in aggregate, the program support contractors comprise a substantial group involved in ratepayer-funded energy efficiency.

Unable to estimate the number of program support contractors through survey research, we used a case study approach and extrapolated the findings across our 11 targeted states. Through prior professional work, we had detailed knowledge of the use of program support contractors in California, Iowa, and New York. We used this information, plus the information for each state on total administrator budget, administrator staffing, and implementation contractor staffing, to estimate the number of program support contractors for each state.

Figure 4-7 shows the estimated person-years of employment among program administrators, implementation contractors, and support contractors for the 11 targeted states. The figure uses a dotted-outline bar for the support contractors to indicate that those estimates are less reliable than our estimates of administrator and implementation contractor employment.

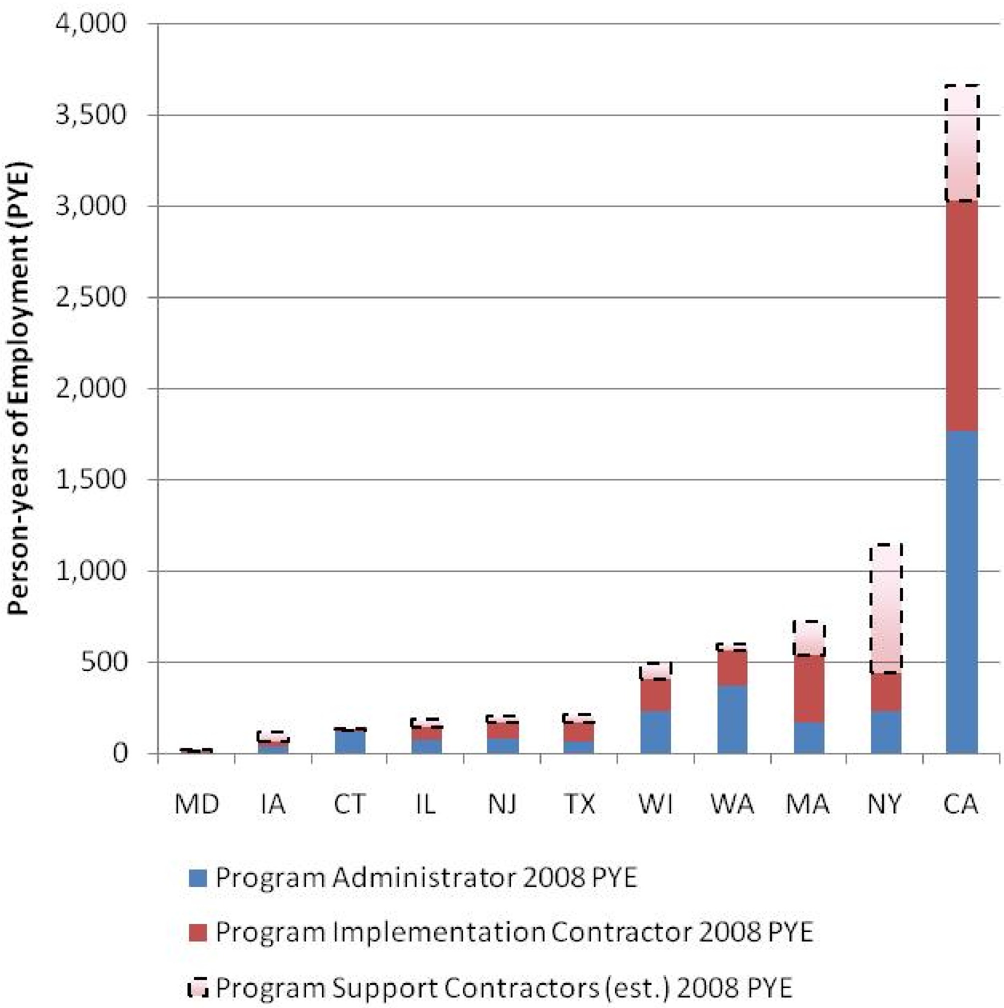

Figure 4-7. Person-years of employment for 2008 program administration and implementation

As Figure 4-7 illustrates, the states vary in their organization of program administrator and implementation staff. For example, the Washington program administrators include many municipal utilities, which typically conduct the majority of program activities using in-house staff. The 2008 activity in New York is dominated by NYSERDA, which has a very lean organization. NYSERDA relies heavily on program support contractors, working closely under NYSERDA staff direction, to extend the hours and capabilities of the in-house staff. Massachusetts similarly has a lean administrator staff in relation to total administrator/contractor workforce, while Wisconsin and California operate with roughly equal proportions of administrator staff and contractor staff of both types.

4.7 Building and Construction Industry Workforce for Ratepayer-Funded Activity

Ratepayer-funded energy efficiency activity employs many professionals and trades people in the building and construction industry to design and construct energy-efficient buildings and to specify and install energy-efficient equipment. The program administrators buy-down the cost of this efficiency activity by providing rebates and incentives to building owners and energy consumers. The building owners and energy consumers also invest their own money, paying the difference between the total project cost and the incentive.

Based on our consultations with experts in the field, we assume that the average incentive covers one-third of the *total* project cost (not the *incremental* cost of efficiency). We estimated from our survey data of 39 program administrators the average proportion of total administrator budget used for incentives (53%) and then estimated the total cost of the efficiency projects this amount of incentive spending would stimulate. We applied to the total project cost estimate a factor (60%) for the proportion of total project cost comprised by labor and from that derived an estimate of the leveraged market (that is, building owner and energy consumer) spending on energy efficiency.

Figure 4-8 illustrates the program administrator spending on all activities – administration, contractor, incentives – and the induced market spending currently and through 2020 under the high funding scenario. Induced market spending on energy efficiency matches administrator spending roughly one-for-one.

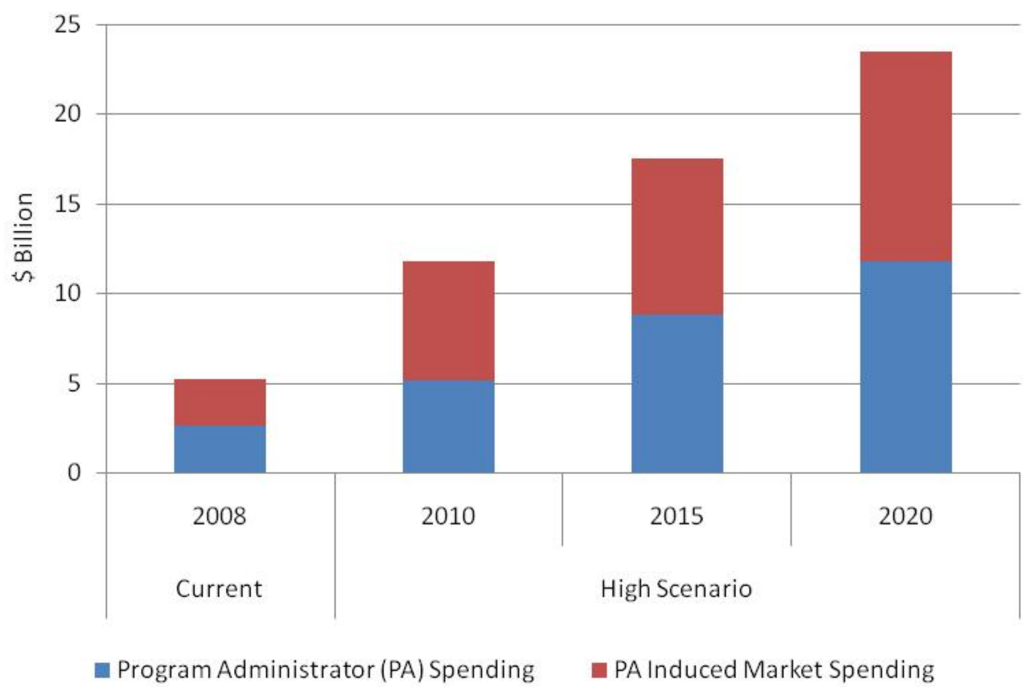

Figure 4-8. Program Administrator funding and leveraged market spending

4.8 Energy Service Companies

To update a 2006 LBNL survey of 46 ESCOs whose revenues the study authors estimated comprised over 97% of the 2006 market (Goldman and Hopper 2007), we interviewed nine large ESCOs whose revenues comprise more than 50% of the market. Based on this effort, we estimated that ESCO staffs grew by 33% from 2006 to late 2008, which is a little over 10% per year for a three-year period. Based on the surveys, we estimate ESCO revenues for 2008 at just under $5 billion. Energy efficiency performance contracting accounts for about three quarters of this revenue, or about $3.75 billion (Goldman and Hopper 2007).

ESCO spending constitutes market spending on efficiency – ESCO revenues come from work they do for the market, including governmental and nongovernmental clients. Comparing the total efficiency spending of ESCOs and program administrators, the ESCO activity is roughly 70% of the program administrator-induced activity (both administrator spending and leveraged market spending). As another comparison, when jointly considering the program administrator and ESCO efficiency efforts, ESCOs drive about 40% of that activity and program administrators drive 60%.[16]

Again using data from Goldman and Hopper (2007), we estimate that ESCO activity in the 11 targeted states comprises 47% of total ESCO activity nationally (see Figure 4-9).

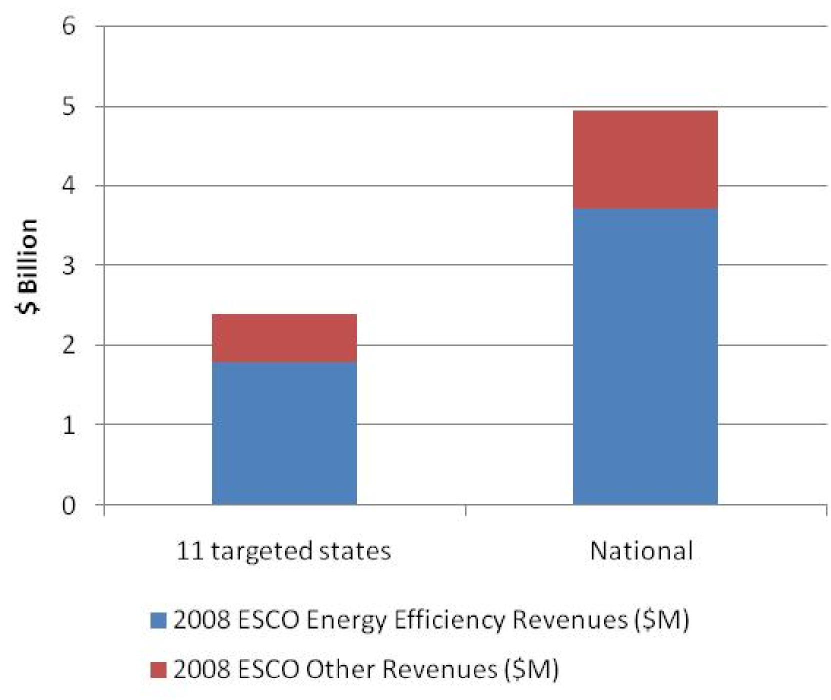

Figure 4-9. Current ESCO energy efficiency and other revenues

[16] ESCOs report they conduct about 10% of their efficiency work for program administrators. Our analysis does not adjust the data for this small double-counting bias.

In the near term, there are contradictory forces at work that increase uncertainty in projecting ESCO revenues. The deep economic recession could dampen ESCO market activity because of additional constraints for customers and ESCOs to obtain financing for projects, risk aversion by ESCOs trying to ensure adequate working capital, and tightening lending standards. On the other hand, ARRA provides a significant increase in spending on public sector energy efficiency for “shovel ready” projects that could lead to large increases in near-term ESCO revenues, subject to constraints on available workforce capacity among state agencies that need to contract with ESCOs and workforce constraints faced by ESCOs.

We developed estimates of future ESCO revenues in energy efficiency performance contracting drawing upon several sources: 1) results of the 2006 ESCO survey (Hopper and Goldman 2007) that provided ESCO projections for the near-term, 2) interviews with representatives from nine ESCOs completed in December 2008, and 3) a Delphi process that involved discussions with several experts who consult on the ESCO industry.

Our low growth scenario represents business-as-usual. We forecast that ESCO energy efficiency revenues increase between 8% per year to 2020 based on the following market drivers:

- Continued expansion of the federal market with the recent award of new energy service performance contracts,
- Ongoing need for facility improvements and equipment replacement in public sector markets,
- High energy prices,
- Increasing momentum for performance contracting as a strategy that allows states to “lead by example” by retrofitting public sector buildings, and
- Near-term momentum and increased funding for state and local government markets created by ARRA.

Our high growth scenario forecasts that ESCO revenues grow by about 12% per year to 2020, due to the combined impact of existing market drivers plus other factors. These other factors include:

- A long-term, aggressive commitment by the federal government to energy efficiency that could involve national federal legislation that aggressively promotes energy efficiency (examples: an Energy Efficiency Resource Standard, carbon legislation),
- Ongoing funding and larger programs administered by state energy offices, and
- Greater market penetration of performance contracting in several market segments (examples: private universities, Section 8 housing, owner-occupied commercial buildings, large-scale energy efficiency initiatives sponsored by local government).

Based on these assumptions, we forecast that energy efficiency revenues among ESCOs revenues will range between $15.8 and $24.5 billion in 2020.[17]

[17] Projected revenues are in nominal dollars. See Appendix A.1 for the assumed inflation rate. In our revenue projections for 2015 and 2020, we assume that energy efficiency projects continue to account for about 75% of total ESCO revenues.

4.9 Building and Construction Trades Conducting ESCO Activity

Data from Goldman and Hopper (2007) enabled us to estimate the number of building and construction professionals and trades people with whom ESCOs subcontract (see Appendix A.8 for methodology). We estimate that for every ESCO full-time-equivalent employee, ESCOs subcontract with about 1.25 FTE of labor by building and construction contractors.

4.10 Building and Construction Trades Conducting Code-Related Activity

Insulation workers are a distinct occupation that is tracked by the Bureau of Labor Statistics (Occupational Code 472130). BLS further segments these workers into those installing building envelope insulation ("insulation workers, floor, ceiling, and wall"; Occupational Code 472131) and mechanical insulation ("insulation workers, mechanical"; Occupational Code 472132).

According to insulation industry professionals interviewed for this study, building envelope insulation refers primarily to residential applications, with some small commercial, while mechanical insulation includes primarily insulation on pipes and equipment internal to the building, but also includes the envelope insulation for large commercial structures. Building energy codes set minimum insulation requirements for various regions of the U.S., inducing the bulk of the spending on building envelope insulation. Commercial establishments tend to install mechanical insulation to optimize equipment performance as well as to reap energy savings.[18]

We obtained revenue and employment data for the insulation market from the U.S. Economic Census. Given the strong relationship between envelope insulation activity and building energy codes, we were disappointed when our analysis revealed little variation across states when revenues and workers were normalized by state population. This finding is suspect because the states vary widely in energy codes, climates, building stock characteristics, and rates of new construction – all drivers of the quantity of insulation installed.

Industry contacts that were interviewed provided estimates of the national market size, however, interviewees may have been citing information gleaned from the Economic Census.[19] The BLS 2006 data includes a forecast of industry employment in 2016. We used the implied annual growth rate (just under 1%) for our low growth scenario. For our high scenario, we used the growth rate implied by the high-scenario growth in program administrators, as estimated by Goldman and Barbose (2009).

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[18] Regardless of the benefit explicitly recognized, the performance and energy benefits of mechanical insulation are hard to disentangle. Typically, excess heat energy is a culprit in low equipment performance. While energy codes have less influence on total spending on mechanical insulation than on building envelop insulation, efficiency codes and standards nonetheless play a role in inducing installation of mechanical insulation

[19] As our interviews preceded our analysis of the census data, we did not think to ask the respondents the basis of their market size estimates. Thus, while we lack confidence in the Economic Census data on insulation workers, it remains our best source of information.

4.11 Summary of Person-Years of Employment Per Million Dollars of EESS Activity

Table 4-1 summarizes our findings of person-years of employment per $1 million dollars in spending on EESS activity. Note that these figures capture direct employment in the activities of designing and installing efficiency measures (refer to Chapters 2 and 3 for definitions of terms and EESS activities). We explicitly have excluded from this analysis manufacturing and retail jobs because we believe those jobs substitute for standard efficiency jobs and require little new training or knowledge for staff. Furthermore, we did not capture jobs that indirectly result from EESS activity.

Table 4-1. Person-years of employment per million dollars in EESS activity

Activity	2008 Spending (in $M)	2008 Person-Years of Employment	Person-Years of Employment per $1M
Weatherization assistance (excluding program administrator assistance)	$528	4,676	8.9
Government (federal and state)	$243	1567	6.5
Program administrators, implementation contractors, support contractors, and associated building and construction industry	$5,224	32,596	6.2
ESCOs and associated building and construction industry	$4,957	12.205	2.5
Building and construction industry influenced by codes and standards (insulation)	$7.091	62,948	8.9
Total	**$18,043**	**113,857**	**6.3**

On average, we find that per $1 million of investment in EESS activity, 6.3 jobs are created with a range of 2.5 jobs created per million dollars in ESCO activity to 8.9 jobs in weatherization and insulation activity. As Table 4-2 illustrates, our estimate falls between that of the American Solar Energy Society (ASES 2007) – 3.8 jobs per million dollars investment – and that of the American Council for an Energy Efficient Economy (ACEEE 2009) – 9.8 jobs per million dollars of investment.

Table 4-2. Person-years of employment per million dollars in EESS activity

Study	Job Type	Total Investment (in $M)	Person-Years of Employment per $M
UMASS-PERI and CAP (2008)	Green Jobs (direct)	$100,000 (hypothetical scenario)	9.4
Apollo Alliance (2004)	Energy Efficiency	$90,000 (hypothetical scenario)	9.2
ACEEE (2008)	Energy Efficiency (efficiency premium)	$24,000	9.8
ASES (2007)	Energy Efficiency (direct)	$932,600	3.8
Connecticut Clean Energy Fund (2009)	Energy Efficiency	$565	4.7

Energy Efficiency Services Sector: Workforce Size

5. Regional Surveys of Energy Efficiency Employers

In this chapter, we provide a comparative review and analysis of four recent studies that surveyed employers offering various types of energy efficiency services in California, Massachusetts, the Pacific Northwest, and Connecticut. In some cases (California and Massachusetts[20]), LBNL developed a partnership with the organization conducting the employer surveys which meant that we provided some input on the design of the survey instrument (e.g. questions asked) and had access to the raw data to analyze results.

These surveys of individual employers reveal the types of energy efficiency services offered, employers' expectations about revenue and job growth, barriers to hiring qualified employees, and training needs. The samples surveyed do not represent the entire population of a state or region. The survey results complement our interviews with representatives of building and construction trade and professional associations by providing more detailed information about the types of firms in a state or region, firm size distribution, and the market sectors served by these firms.

It is also worth noting where the respondents of these studies differ from the market segments we target in our study. In some cases the types of employers interviewed included entities such as equipment manufacturers or distributors, and/or large customer facility or energy managers that were not included in the LBNL study (see Figure 5-1). Three of the four case studies did not survey program administrators (e.g. utilities), although program implementation contractors that provide EE services to utilities were included.

Figure 5-1. Segments of energy efficiency value chain covered by employer surveys

[20] LBNL was a technical advisor to the San Francisco Bay and Greater Silicon Valley Centers of Excellence (COE) that designed the California survey, and to the New England Clean Energy Council that conducted the Massachusetts survey.

5.1 California Employer Survey

The Centers of Excellence (COE) across the state, which serve the California Community Colleges, used a survey designed by the San Francisco Bay and Greater Silicon Valley Centers of Excellence to conduct an employer survey in California between December 2008 and July 2009. Drawing from a wide array of lists of employers provided by partner organizations, they received responses from over 1,100 businesses in the state.

5.1.1 Employer Characterization

The services offered by California businesses are similar to those offered by businesses in other regions, with consulting, construction, HVAC, project management, engineering, and lighting topping the list. When given a narrower list of "industries" to identify with, the responses reveal a more descriptive picture of existing employers. As seen in Figure 5-2, almost 50% of the firms are involved in the design and construction of new buildings and homes, whereas 34% work on improving existing buildings, and 39% work on improving existing homes. In addition, building operations and maintenance is performed by 17% of firms, and 8% offer services for utilities or are energy resource managers. Many of the firms work in multiple sectors: 76% of firms reported that they serve commercial sector customers, followed by 70% serving the residential sector, 50% serving the public or institutional sector, and 47% serving the industrial sector. Activity in the residential sector in California is significantly higher than seen in the Pacific Northwest or Massachusetts employer surveys, which are discussed later in this chapter.

These firms employ almost 45,000 people, with an average of 31 employees per business; only about a quarter of these employees perform energy efficiency-specific work (see Figure 5-4). The highest percentage of businesses have 10 or fewer employees, with 55% of firms in this category (see Figure 5-3). Over 95% of firms have 100 or fewer employees.

Table 5-1. Types of energy efficiency services offered by California employers

Services Offered	
Consulting	51%
Construction	33%
HVAC-R	29%
Project management	28%
Engineering	26%
Electrical	23%
Lighting	22%
Controls	17%
Architecture	16%
Commissioning	15%
Marketing and sales	14%

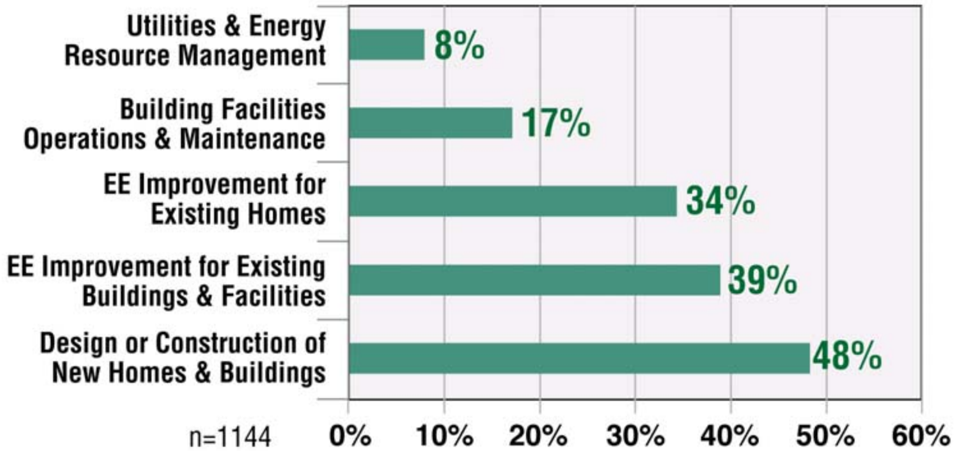


Figure 5-2. Industries identified by California businesses, multiple responses allowed

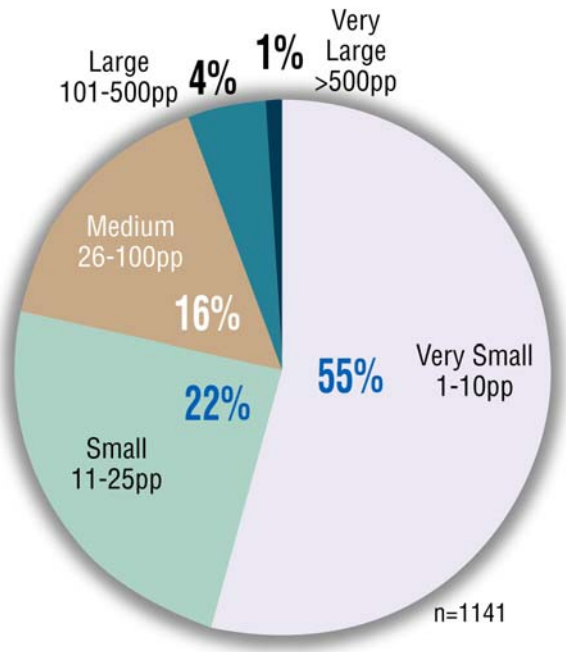


Figure 5-3. Distribution of firm size among energy efficiency service providers in California

The COE survey also asks about eight specific energy efficiency occupations (see breakout in Figure 5-4). One important observation is that only 28% of the 44,700 employees work in these eight specific energy efficiency occupational categories. There may be other energy efficiency-focused jobs not included in these eight categories, but it is clear that many jobs at firms in the energy efficiency services sector do not require energy efficiency-specific skills. Among the eight energy efficiency occupations, the largest category by far is project managers for construction or design work; 69% of the firms surveyed have at least one position that fits this description. Project managers for construction and design work account for 9% of all jobs and 31% of the energy efficiency-specific jobs at thefirms surveyed.

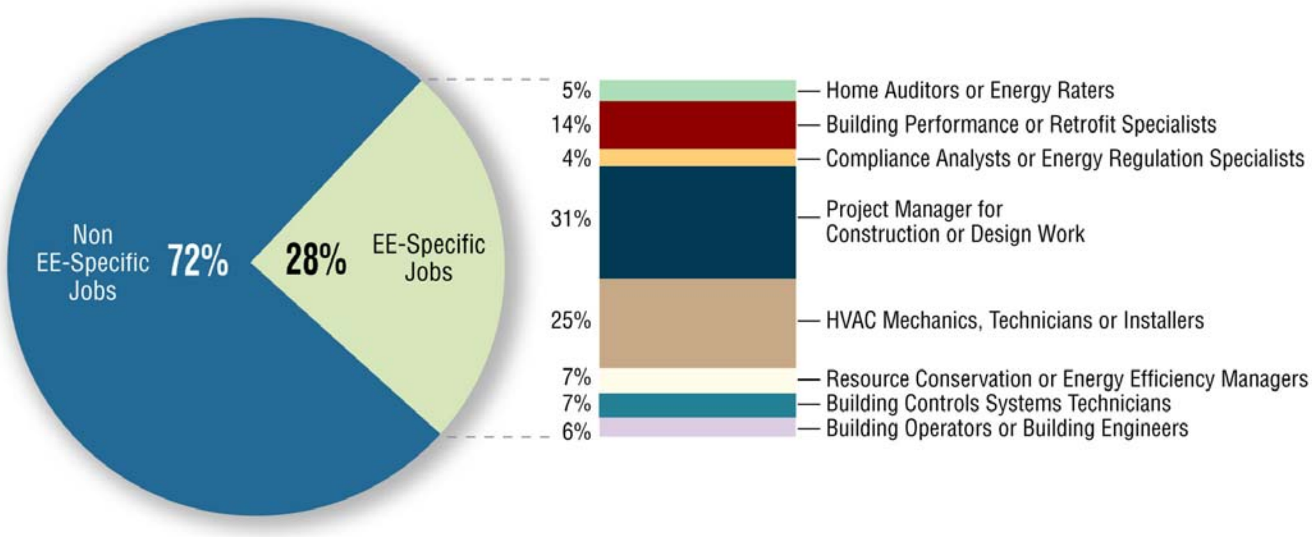


Figure 5-4: Employer data for eight specific energy efficiency occupations

5.1.2 Expectations for Growth

The COE asked survey respondents to forecast job growth in the eight efficiency occupations over the next 12 months and 3 years; results are shown in Figure 5-5 along with the percentage of jobs in each category to add perspective. For example, firms project a 158% increase in the number of building operators and engineers and a 112% increase in the number of energy auditors over the next 3 years; note however that these are some of the smaller job categories (i.e. 6% and 5% respectively) among the eight efficiency occupations. In contrast, employers project a growth of 59% for project managers over the next 3 years; this is the largest job category so the total number of jobs added is greater. In general, the 12-month job growth projections are between 13% and 39% and the 3 year projections are between 59% and 158% for the eight energy efficiency occupations. The survey also reveals much higher growth expectations for these job categories compared to the other jobs at these firms. The average 12 month expectation for growth in all job categories is 2% versus 20% on average for these eight EE categories.

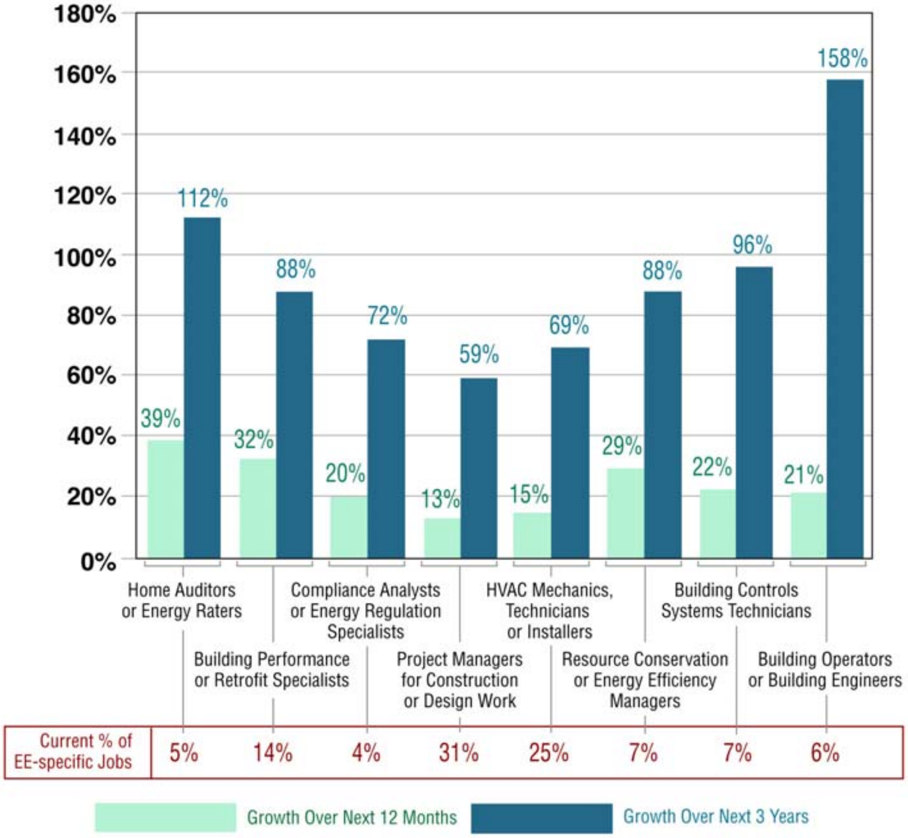


Figure 5-5. Job growth expectations in 12 months and 3 years for California employers

5.1.3 Workforce Development Needs

The businesses surveyed expressed a surprisingly high level of difficulty in hiring for the eight energy efficiency occupations (see Figure 5-6). The percent of employers experiencing “some” or “great” difficulty in hiring range from 56% to 73%, depending on the occupational category. The most difficult categories are building operators/engineers and EE managers, but all categories seem to have significant difficulty in hiring qualified employees. Employers across all job categories also identified three important skill areas for potential employees: 1) the ability to communicate in writing and in person, 2) understanding of state and local energy efficiency requirements and incentives, and 3) general understanding of the mechanics of energy systems, including HVAC, lighting, and renewables. The COE survey also ask questions specific to the offerings of community colleges, and the employers responded positively;73% were interested in an internship program, 64% were interested in a one-year certificate in energy auditing and retrofitting, 62% were interested in onsite training for their current employees, and 60% were interested in an Associates degree in resource and conservation management.

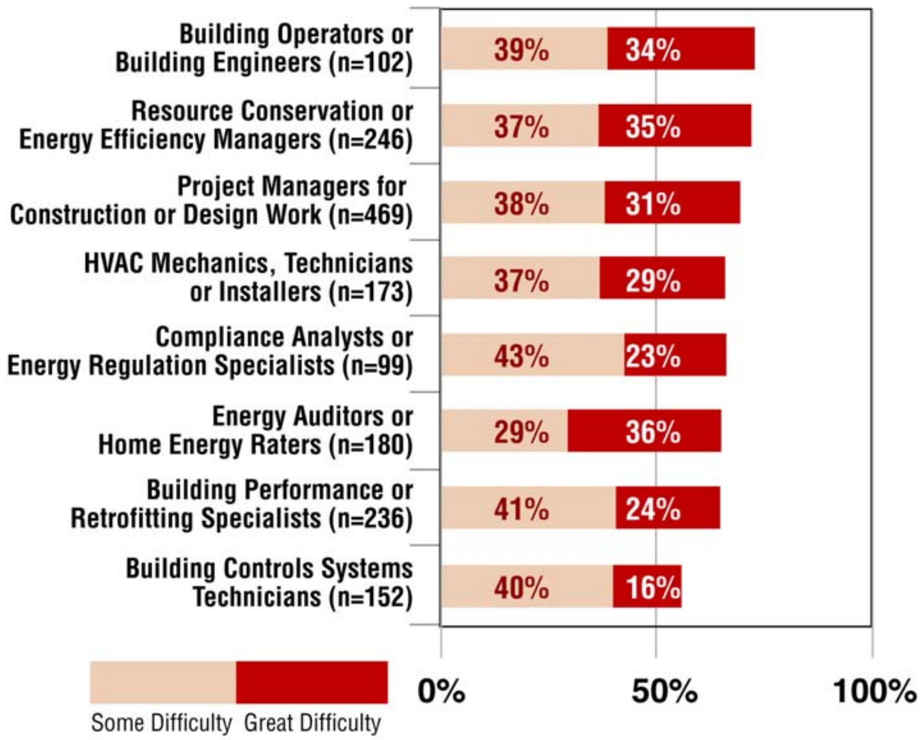


Figure 5-6. Difficulty in hiring for the eight efficiency occupations

5.2 Massachusetts Employer Survey

In January 2009, the UMass Donahue Institute, the New England Clean Energy Council (NECEC), and the Massachusetts Renewable Energy Trust collaborated to conduct the Massachusetts Clean Energy Industry Census. Of the almost 400 responses from a range of firms in the clean energy sector, our team deemed that at least 76 provide energy efficiency services; results for this energy efficiency cohort are summarized in our case study.[21]

5.2.1 Employer Characterization

The vast majority of the firms surveyed offer services related to building efficiency with 67% offering residential or commercial building system services, followed by lighting (43%), weatherization (16%), information systems (16%), and consulting (16%) as seen in Table 5-2. These firms employ over 9,500 people, with an average firm size of 128.

[21] Due to the overlapping categories included in the survey, it was difficult to isolate the energy efficiency employers from other clean energy firms; thus our sample of the number of employers that provide energy efficiency services is a lower bound.

Table 5-2. Types of energy efficiency services offered by Massachusetts employers

Services Offered	
Residential/Commercial Building Systems	**67%**
Lighting	**43%**
Weatherization/Insulation	**16%**
Information Systems	**16%**
General consulting	**16%**
Metering	**11%**
Energy Storage and/or Power Electronics	**8%**
Social Marketing	**5%**
Other	**11%**

This employment number includes all jobs within each firm, not just those with efficiency-specific roles. These businesses tend to be small – over half have 10 people or fewer, and 81% have 100 people or fewer (see Figure 5-7).

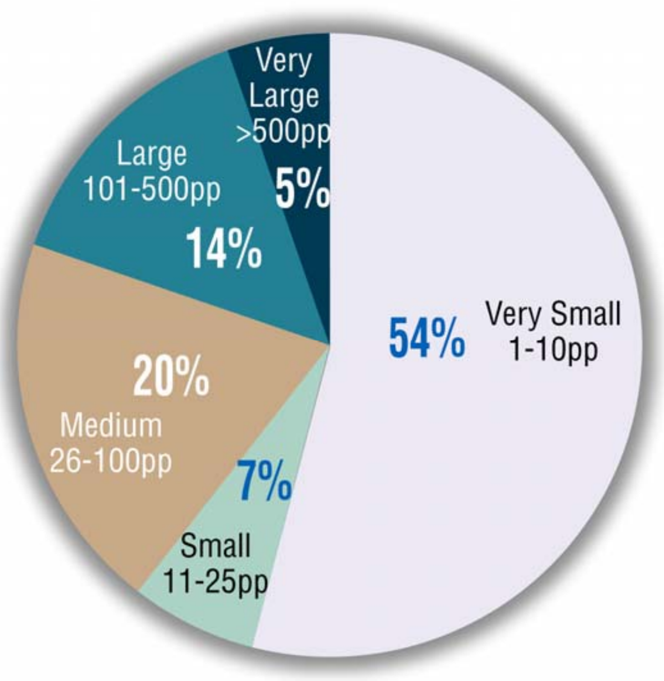


Figure 5-7. Distribution of firm size among energy efficiency service providers in Massachusetts

Unlike the California and Northwest employer surveys, the Massachusetts survey asks how many of the firm's employees are based within the state. The respondents reveal that only 21%

of the employees (2,040 total or 27 per firm on average) work in Massachusetts, suggesting that a majority of the firms have multi-state operations.[22]

5.2.2 Expectations for Growth

These businesses report high rates of revenue growth in 2008, with slightly higher growth projections for 2009. Figure 5-8 shows that 68% percent of firms experienced greater than 10% revenue growth in 2008, and 73% of firms expect this level of growth in 2009. It is important to note the survey particularly asks about growth in the "clean energy sector." These high growth rates can be explained to some degree by the fact that there are a large percentage of small firms; small nominal increases in revenue can easily translate into a 50 or 100% increase in revenues as small firms begin to grow. In terms of growth in employee numbers, firms added 10 people on average in 2008 and plan to add 12 people (a 9% increase on average in total employees) in 2009.

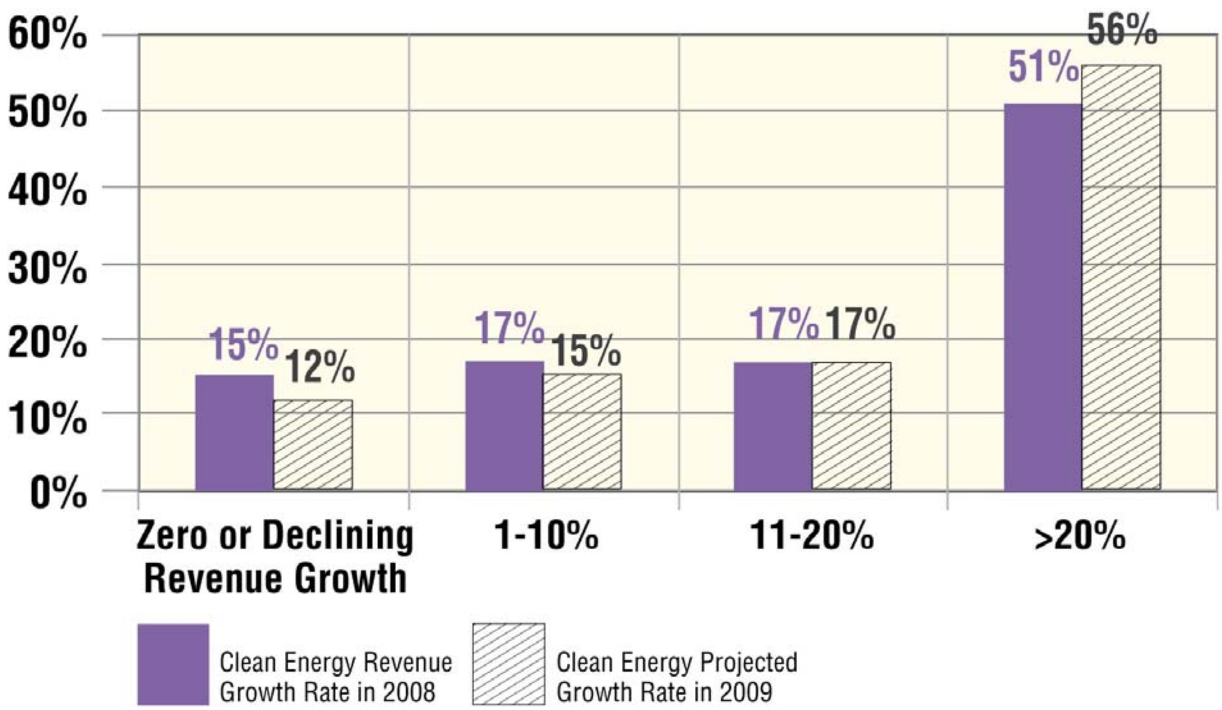


Figure 5-8. Actual and projected growth in "clean energy" revenues for Massachusetts energy efficiency service providers (n=59)

5.2.3 Workforce Development Needs

There is relatively little information available about workforce development needs from this survey, as it was not designed for that purpose. Employees of these firms tend to have high educational attainment levels; 44% have a masters or doctoral degree, 49% have a four-year

[22] This implies that the California and Northwest employee numbers may overestimate the energy efficiency jobs located in their region if employers responded with their total number of employees, instead of just the employees based in the region.

college degree, 4% have an associate's degree, and 3% have high school or less as their highest level of education. When asked if they had any open positions in 2008 that they were ***not*** able to fill in 2008, 24% said yes and 76% said no. The two main reasons that firms were unable to fill positions were 1) that applicants lacked relevant clean energy employment experience, and 2) that applicants lacked necessary formal education or training.

We also reviewed an additional report based on a subsequent in-depth survey of the C/I EE sector employers in Massachusetts, also commissioned by NECEC (NECEC 2009). In this survey, C/I EE employers expressed the sentiment that the market downturn would make it easy to fill certain types of positions such as equipment installers and other roles that require less prior training. Similar to responses from other regions, there was an emphasis on hands-on field experience and many employers believed that potential hires from many backgrounds could obtain the training they needed on the job. In contrast, engineers proficient in energy efficiency strategies were uniformly identified as the most difficult to find, which is consistent with our findings in chapter 6. Senior project developers, project managers, and qualified auditors were also identified as hard to find. To address this need, Massachusetts will soon launch a focused effort to train workers for jobs in the energy efficiency sector. The state's Clean Energy Center has created the Massachusetts Energy Efficiency and Building Science Training Initiative, which will spend almost $1.9 million on a variety of training programs over the next three years.

5.3 Oregon and Washington Employer Survey

The Northwest Energy Efficiency Council (NEEC), a trade association representing companies in the energy efficiency industry, conducted a survey of regional energy efficiency businesses in summer 2008 to better understand the composition and needs of this sector. Over a two-month period NEEC received responses from about 100 of their association members in Oregon and Washington, a 29% response rate.

5.3.1 Employer Characterization

The businesses surveyed offer a wide range of services, as shown in Table 5-3, with most offering more than one service.

Table 5-3. Types of energy efficiency services offered by Pacific Northwest employers that responded to the NEEC survey

Services Offered	
Consulting	**48%**
Engineering	**42%**
Lighting	**32%**
HVAC-R	**29%**
Commissioning	**27%**
Controls	**25%**
Marketing and sales	**24%**
Project management	**23%**
Electrical	**20%**
Non-technical consulting	**18%**

Industry promotion	13%
Product representative	13%
Utility	13%
Construction	12%
Product manufacturing	12%
Architecture	7%
Retail sales	3%

The most common service offered is consulting, followed by engineering, lighting, HVAC, and commissioning. The vast majority of these businesses serve the commercial (86%) and/or industrial (60%) markets. Some of these firms also serve the residential market, but only 6% of firms serve the residential market exclusively.

Collectively these firms employ over 7,600 people, with an average of 80 employees per firm. This employment number includes all jobs within each firm, not just those with efficiency-specific roles. Most of these firms are rather small, with 75% employing under 100 people and 34% employing 10 people or fewer. The firm size varies somewhat by service (see Figure 5-9). Firms offering consulting services tend to be on the smaller end of the spectrum. The other services show a range of distributions in firm size. It is important to note that most firms offer multiple services, so there is significant overlap in these service categories.

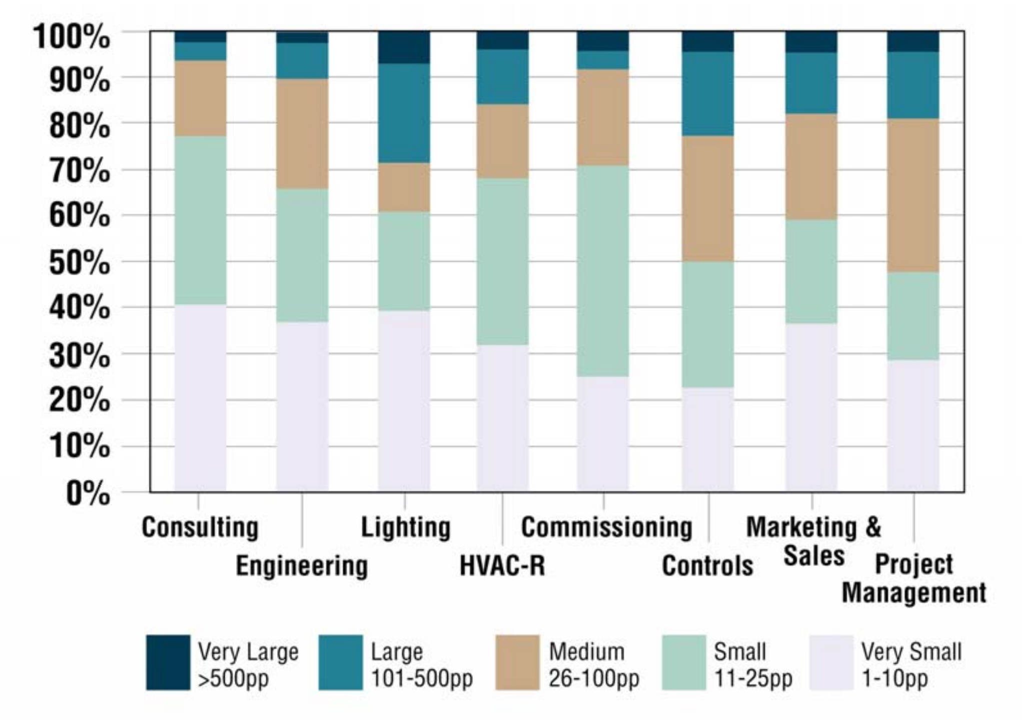


Figure 5-9. Firm size for the top 8 services provided, firms may provide more than one service

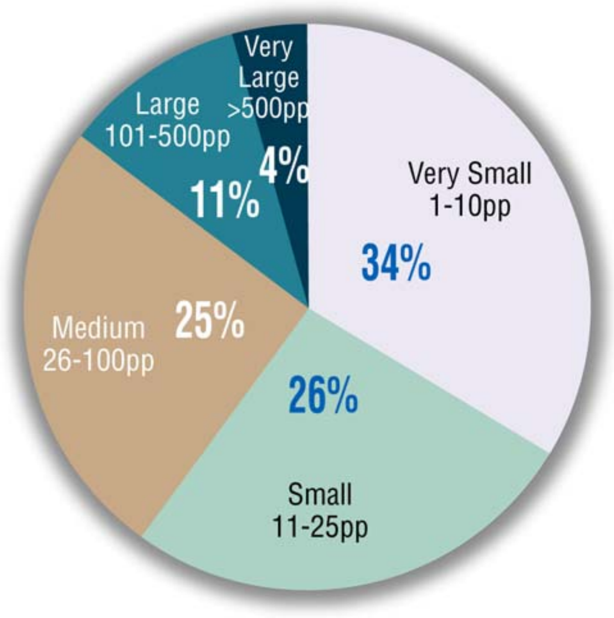


Figure 5-10. Distribution of firm size among energy efficiency service providers in the Pacific Northwest

5.3.2 Expectations for Growth

These businesses report high rates of revenue growth in 2007, and expect growth to continue over the next five years. More than half of the firms report a revenue growth rate of over 5% in 2007, with over 40% of the survey respondents reporting revenue increases of 8% or more (see Figure 5-11). Half of the firms also expect annual revenue increases of over 5% during the next five years, with over 35% expecting annual increases of 8% or more. It is important to note that these projections were made before the economic downturn in October 2008.

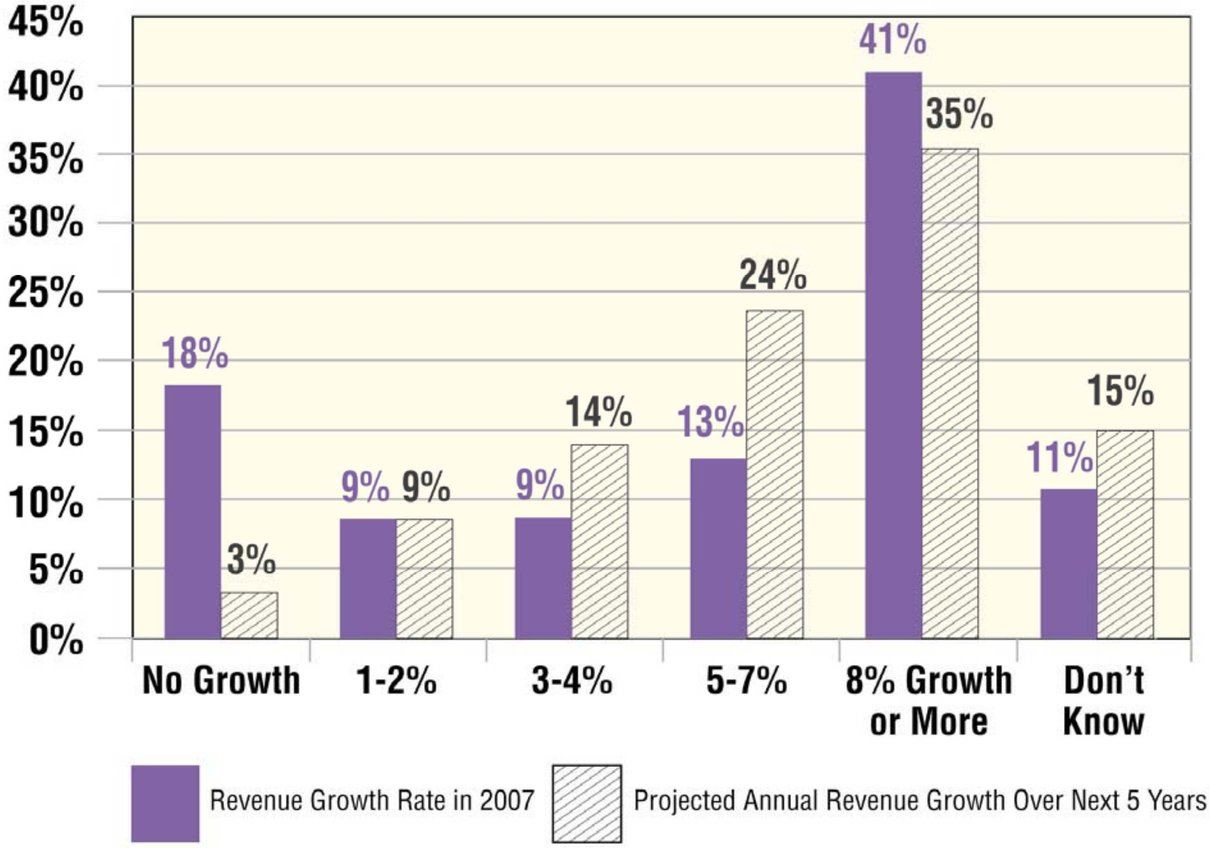


Figure 5-11. Actual revenue growth in 2007 and projected average annual revenue growth over next five years for Pacific Northwest energy efficiency service providers

In 2007, almost 25% of these firms hired more than 10 new employees, and most firms plan to hire many more over the next five years to keep up with their expectations for revenue increases. Respondents indicate the greatest areas of new job growth, listed in order of growth expectations: administrative support, engineering, marketing and sales, project management, and mechanical expertise.

5.3.3 Workforce Development Needs

The businesses surveyed express several common workforce development needs. About 30% of survey respondents indicate that they were able to find skilled applicants in the region, while 64% said that they sometimes could find skilled applicants, and 6% indicated that they could not find skilled applicants. Three key deficiencies in the current pool of job candidates stood out: 82% of respondents cite energy efficiency experience as a deficiency, followed by hands-on experience (56%) and specific technical training (49%). When asked about emerging needs of employers in this sector, many respondents identify the need for good technical abilities in engineering design, HVAC and controls, energy modeling, and industrial processes.

There may be an important opportunity for educational institutions in the region to offer more applicable energy efficiency training. When asked if educational programs are keeping up with changing energy efficiency technology and emerging clean tech fields, respondents gave universities, community colleges, trade schools, and union training programs average scores between 2.5 and 2.8 (1 = strongly disagree and 5 = strongly agree), with a rating of 2 or 3 given by over 70% of employers for every training program type. Employers also express strong interest in internships for students that will soon enter the job market. Over 60% of the firms already sponsor interns, and 70% express an interest in participating in a NEEC internship placement program. Training and other workforce development programs will become increasingly important if the sector grows over the next five years as these companies expect. There will also be new positions open due to retirement of current employees. These firms estimate that almost 14% of their skilled employees will retire in the next five years.

5.4 Connecticut Employer Survey

Navigant Consulting conducted an assessment of energy efficiency employers in Connecticut during the first quarter of 2009 for the Connecticut Clean Energy Fund (CCEF) and the Connecticut Energy Efficiency Fund (CEEF). Navigant identified 97 key businesses in the state; they interviewed 37 directly and researched the others in detail.

5.4.1 Employer Characterization

The businesses in Connecticut generally offer similar products and services to those found in the other three regional employer surveys, but the frequency of each service offered is not reported. Instead, the Connecticut study focuses on types of employees and the sectors served by the firms. The big difference in the Connecticut results is the strong presence of retail and wholesale businesses in the study's results; 20% of jobs were in these areas (see Table 5-4).

Table 5-4. Percentage of jobs by employee job type in Connecticut energy efficiency firms

Job Types	
Retail/wholesale	**20%**
Installations	**18%**
Mgt & Admin	**17%**
Sales & Business Dev	**16%**
Engineering	**9%**
Manufacturing	**6%**
Research	**4%**
Utility	**3%**
O&M	**3%**
Other	**1%**

This is likely due to an emphasis on this sector in the research design of the Connecticut study, which included large retailers such as Home Depot and Walmart in the market assessment, unlike the other regional employer surveys.

In other ways, the Connecticut results mirror those from other parts of the country. The 97 firms employ 2,675 people that are based in-state. This employment number includes all jobs within each firm, not just those with efficiency-specific roles. This is about 28 people per firm, compared to about 27 in-state staff per firm in Massachusetts, and 31 staff per firm on average in California. These firms generate $137 million that goes directly to job employment income, which is about $51,000 per employee. The total revenue for these firms is $565 million, divided up as shown in Figure 5-12**Error! Reference source not found.**.

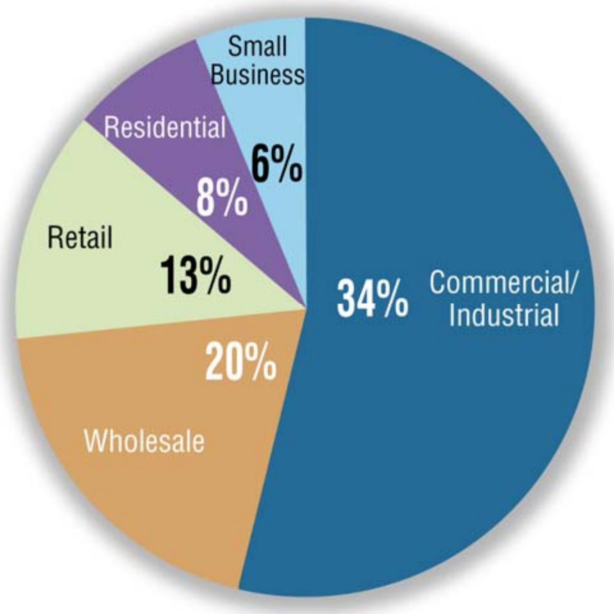


Figure 5-12. Revenue by sector served for Connecticut energy efficiency businesses

Firms that serve commercial and industrial (C&I) clients account for 53% of the revenue earned by energy efficiency firms while firms that serve residential market account for 8% of total revenue. In terms of the number of jobs, C&I firms account for 52% of energy efficiency jobs in Connecticut, versus 16% for firms that target the residential market.

5.5 Comparative Analysis of State or Regional Surveys of Employers on Energy Efficiency Services

We highlight the following trends based on our review and analysis of these four surveys of employers on energy efficiency services workforce size, composition, and training needs:

- **Most firms providing energy efficiency services are extremely small (often under 10 people), with a few very large firms.** For example, well over 75% of firms in California, the Pacific Northwest and Massachusetts have 100 or fewer employees per firm, and ***at least*** 34% of each have 10 or fewer employees. These employers tend to include a large number of small consulting firms and startups, and a few very large engineering firms and ESCOs.

- **These firms' operations appear to frequently span more than one state.** When asked directly how many of their employees are based in-state, the average per firm in Massachusetts is 27 employees (21% of the firms' average total employees) and the average in Connecticut is 28 employees. Most of these multi-state firms are likely the large engineering and energy service companies.

- **The employers often serve multiple customer market segments.** In California, the employers serve the following sectors: 76% commercial, 47% industrial, 50% public or institutional, and 70% residential. In the Pacific Northwest these numbers are: 86% commercial, 60% industrial, and 39% residential (public or institutional not asked). If you look at just the C/I market versus the residential market in Connecticut, revenue is 88% and employment is 76% from C/I (including small business), versus 12% and 24% respectively in the residential market. California is the only state that shows relatively strong activity in the residential sector compared to other market sectors, though this may simply be a result of the types of firms that were targeted and/or responded to each regional survey.

- **Expectations for growth are high, perhaps particularly in the EE portion of a firm's business.** In Massachusetts, most employers expect greater than 10% growth in revenue and an average 9% increase in employees in the next 12 months. In the Pacific Northwest, most employers expect revenues to grow at an annual rate of 5-7% over the next 5 years. In California, employers expect a 20% growth in energy efficiency-specific jobs in the next 12 months, versus 2% growth for all job categories. This distinction is important, and is not captured by the other three employer surveys.

- **"Premium" EE jobs are likely only a fraction of the total employees in many firms.** The eight energy efficiency-specific jobs identified at California firms make up only 28% of the total jobs at these firms. Recognizing the various job types at EE firms, and the fact that not all jobs at these firms require EE-specific skills, is important to inform the estimates of the overall number of EE-specific jobs and the need for training programs in these specific occupations.

- **Additional energy efficiency training is needed.** In California, 56% to 73% of employers (depending on the job category) have "Great" or "Some" difficulty in hiring. In the Northwest, 70% of employers "could not or sometimes could not find qualified applicants." In Massachusetts 24% of employers were not able to fill positions with qualified candidates.

The survey results highlight the makeup and size of the EESS in various states and regions and provide insight into the types of training and support that are valued by employers looking to provide energy efficiency services.

6. Meeting Energy Efficiency Service Workforce Needs

As previous chapters demonstrate, we can expect increased demand for a significantly expanded, well-trained, and experienced EESS workforce. Needs range from engineers and architects to design energy efficient building systems, HVAC technicians to install systems and optimize efficiency, and program and construction managers to administer and oversee development of energy efficiency programs and projects. To understand the gaps in the EESS, we included questions in our surveys to assess the respondents' perceptions of issues their organizations face in hiring, retaining, and training their staff; this chapter summarizes results from our interviews on these topics.

6.1 Is It Difficult to Hire the Right People?

As illustrated by our four case studies of recent state and regional employer surveys on energy efficiency (see Chapter 5), many EESS firms are reporting difficulty in hiring people. Survey respondents reported that during 2007 and 2008 it took two to three months to fill entry-level positions in the EESS. Moreover, management positions requiring at least 10 years experience and positions requiring engineering experience with high-efficiency technologies are the most difficult positions to fill; survey respondents noted that many position take three to five months to fill but that it can take up to 15 months to hire an engineer with managerial skills and energy efficiency experience. One company gave the example of receiving 80 applications for a senior level position only to find that only five applicants could pass the initial screening. Another company noted that they were planning to take several years to find a suitable candidate for a senior position leading their energy efficiency group.

Overall, respondents believe there are challenges hiring into the EESS for any position other than entry level.

Filling experienced positions often occurs by hiring from other firms. Implementation contractors are very concerned about losing experienced staff to competitors and three of the 23 respondents expressed reluctance to provide staffing information for fear that it would somehow be misused. Many respondents believe that hiring from other firms is reaching a limit as the rate of growth increases in the EESS; the total number of experienced personnel needed exceeds the existing workforce needs. While implementation contractors expressed the most concern, the most common examples were implementation contractors hiring from program administrators, which occurs largely because program administrators have less competitive salaries. This phenomenon is most pronounced in regions with high costs of living (e.g.,the Northeast and California).

In contrast, building and construction industry contractors do not hire for energy efficiency skills and report hiring from a variety of sources: former workers in manufacturing facilities, people with military experience, graduates of local community colleges and technical trade schools, various web sites such as Monster.com and CareerBuilder, local building associations, and employment agencies. For residential construction there is no lack of potential employees due to the limited training requirements; residential contractors report that they hire "from anywhere" or "by word of mouth."

General contractors, builders, and remodelers typically come to their positions after working in the industry for some period of time. There is little training available in technical schools or colleges; experience is the primary teacher. Among survey respondents that were members of building associations, several noted that the demand for green building is leading to a change in the industry and that younger contractors are developing more skills associated with "green building" than those who have been in the business a long time. None of the respondents could quantify this rate of change, but the current participation rate in green certification programs among building association members was reported as less than 5% of the industry.

For equipment installation contractors, the experience of hiring is affected by the level of unionization. Those areas with a highly unionized building trades workforce report hiring out of apprenticeship programs. In "open-shop" states or states with a less unionized building trades workforce, employers place ads to find applicants. While general hiring seems satisfactory for building and construction contractors, several respondents from industry associations mentioned anticipated future shortages due to retirements (see Section 6.3).

Union contractors and labor union respondents reported some difficulty recruiting qualified applicants into apprenticeship programs. They have many applicants, but a much smaller number who can pass the basic skills and drug screening tests. In a similar vein, several contractor association respondents expressed dismay over a lack of interest in jobs that are physically demanding, suggesting that the allure of "white collar" service jobs limits the pool of applicants seeking apprenticeships. In New York, the Board of Cooperative Education Services (BOCES) provides training through community colleges, which contractors say helps meet building and construction industry needs. In Connecticut, contractors reported that there was a workforce shortage in the residential construction industry in 2004-2006 that was addressed by workforce development efforts. Such efforts are not found in all states, but do point to a mechanism that could aid the EESS.

6.2 Is There an "Aging Workforce" Issue for the EESS?

At the outset of project, one of our hypotheses was that the EESS workforce was aging and that soon a wave of retirements would leave a void in the EESS workforce. Recent studies of the utility industry reported that 44% of the current utility sector workforce will reach retirement age in the next few years (Stern 2008). Mary Miller, Vice President of Human Resources at the Edison Electric Institute, noted that coincident with these pending retirements, many utilities expect a need to grow staff by 50% to meet increasing demand for power (Stern 2008).

> *Retirement is not currently a concern for program administrators or implementation contractors; however, the building and construction industry is facing substantial changes in the workforce due to retirements between 2015 and 2025.*

Pacific Gas and Electric (PG&E) in California, a program administrator, also identified retirement as an issue. With over 20,000 employees, 42% of their union employees and 50% of their management are eligible to retire by 2014 (Opalka 2008). In response, electric and gas utilities across the United States created the Center for Energy Workforce Development (CEWD) to work with educational institutions, labor groups, and others to identify ways to promote jobs and careers in the utility sector (Center for Energy Workforce Development 2008).

Given these recent studies, it seemed logical that the EESS might more generally face this issue. However, among the 23 program administrators that provided an estimate of the percentage of their workforce projected to retire in five years, the mean percentage was 15%. Among program implementation contractors (n=17) the mean percentage expected to retire in five years was just 6%, while for ESCOs (n=9) less than 5% of their workforce were projected to retire in five years. Respondents in all groups further qualified their responses to retirement questions indicating that retirement was not a big concern. Rather, retaining existing staff, managing the growth of the efficiency department, and finding qualified staff knowledgeable about efficiency were their dominant personnel concerns.

In contrast, aging workforce and loss of large pool of qualified workers due to retirement is viewed as a problem among the building and construction industry. Respondents from building and construction industry association members reported much higher percentages of association members older than 50 and thus nearing retirement in the next five to ten years. Builders/remodelers and mechanical and electrical trades people had the largest share of workers nearing retirement (38% to 44%, see Figure 6-1). At the lower end, our survey found 28% of energy engineers were over 50 years of age.

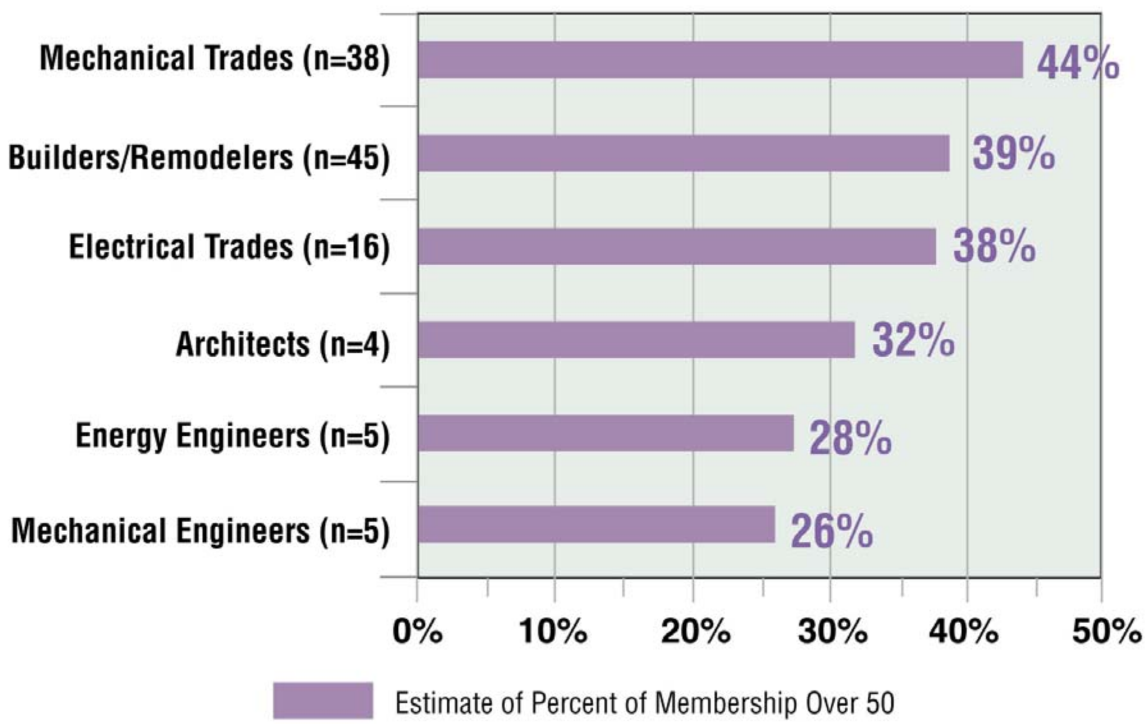
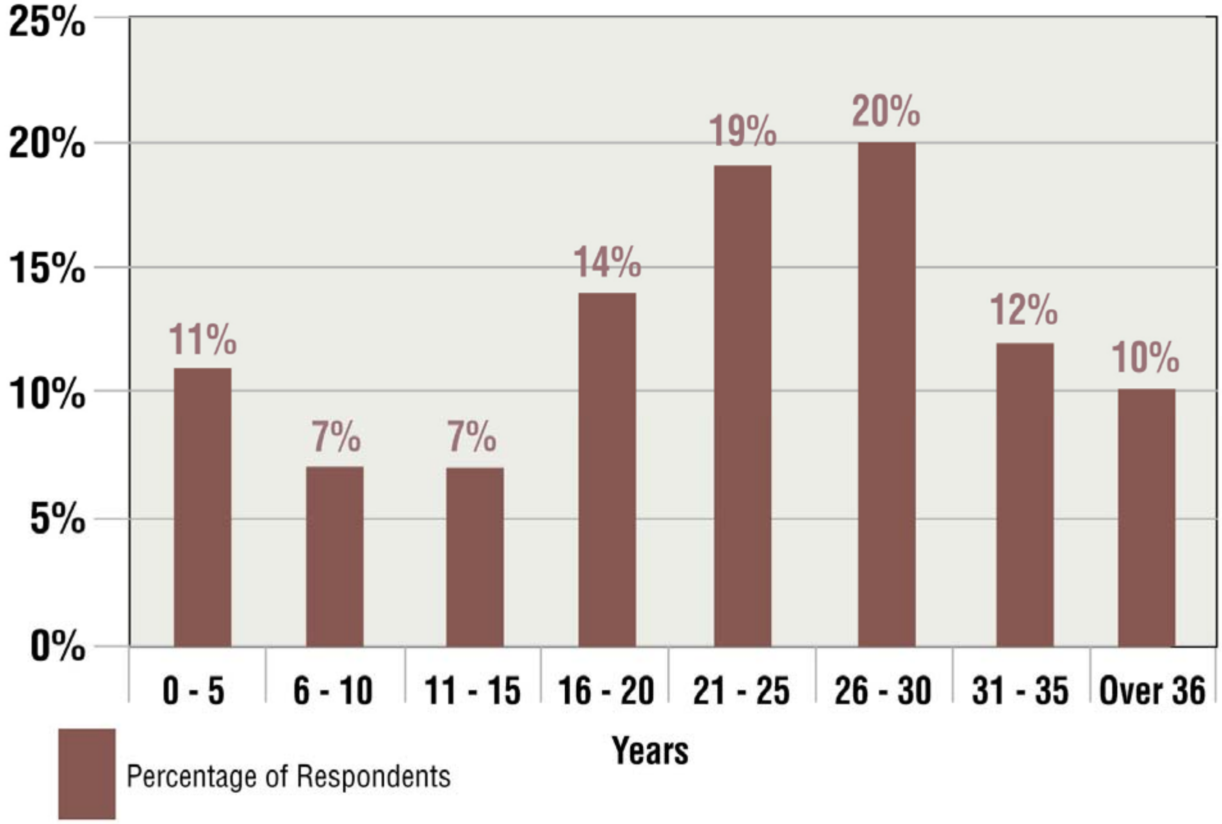


Figure 6-1. Building Industry workforce older than 50

A recent survey of 978 members of the Association of Energy Engineers (AEE 2009a) suggests that retirement could be an even more significant issue than we found in our surveys of professional engineering associations. The AEE survey found that over 61% of the respondents have over 21 years experience in the business while only fourteen percent have 5-15 years of experience (see Figure 6-2). This result indicates a bimodal distribution in the amount of experience of practicing energy engineers. We believe that this phenomenon is driven in part by the influence of policy-driven funding cycles – notably that in the period 1996-2006 there was reduced public policy support for energy efficiency (DOE 2007) resulting in very few mid-career energy engineers who can take over senior positions as those older engineers begin to retire. This distribution and the effect of shifting funding cycles have been noted for EESS occupations in other studies (Peters 2009; Nadel 2009).



Source: Association of Energy Engineers (2009).

Figure 6-2. Energy engineers: Years of professional experience.

> *The bi-modal age distribution of staff for EESS firms, may partially explain the current challenge in hiring experienced managers.*

To summarize, the EE program administrator and implementation contractor organizations interviewed for this study do not view retirement of their existing workforce as a major concern at present or in the next five years. However, the challenge of finding managers and engineers with experience is a significant issue. The bi-modal distribution that is observed in these firms suggests that in the next few years there could be a problem having sufficient staff to train and manage the new entrants especially as those at the upper age of the distribution begin to retire. As that happens, retirement could become a larger concern.

6.3 Are There Enough Engineers for an Expanding EESS Workforce?

Administrators, implementation contractors, and ESCOs who work with commercial and industrial customers indicate that engineering talent is difficult to find. Survey respondents reported that engineers with efficiency knowledge or experience are relatively nonexistent. As a consequence they are often willing to hire any engineer with technical aptitude, communication skills, and some engineering experience. This explains the results of Figure 6-3 which shows that about ~55% of program administrators and implementation contractors indicated that they were most interested in hiring energy engineers. We probed those respondents that didn't check energy engineers as a preferred engineer hire and found that most of these survey respondents were interested in hiring energy engineers, but that they are much harder to find.

Given that reality, program administrators and implementation contractors indicated that their top preference is to hire mechanical engineers (see Figure 6-3), but when not available, respondents indicate they hire from other engineering disciplines including electrical (especially for utility program administrators), chemical, agricultural, or civil engineers.[23] A memo from Johnson Controls Inc. (JCI) to the DOE Industrial Technologies Program also reported a lack of trained energy engineers emerging from engineering schools other than through the Industrial Assessment Centers (DOE Industrial Technologies Program 2008).

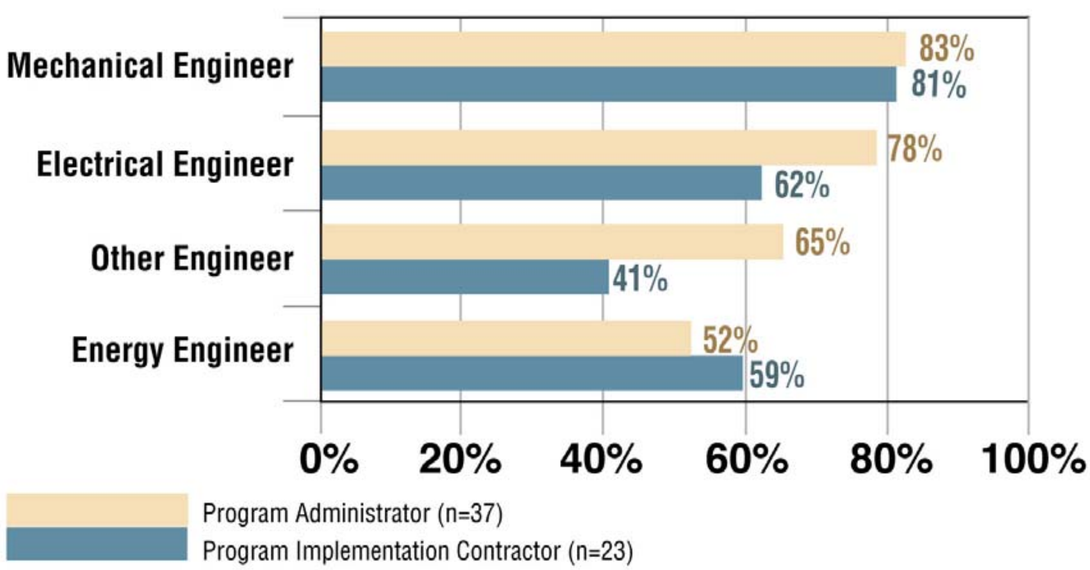


Figure 6-3. Preferred engineers for Program Administrators and Implementation Contractors

The demand for engineers with knowledge of energy efficiency is currently met by hiring other types of engineers and training them on the job. This practice may not be sufficient as the EESS workforce demand increase in the future. Many industries compete for engineering talent and for

[23] We asked the following question. "What types of engineers are you typically most interested in hiring for energy efficiency work? 1) Energy Engineers, 2) Mechanical Engineers 3) Electrical Engineers 4) Other Engineers. Respondents were also asked to comment on other types of engineers they hire.

Until 2009, energy efficiency engineering was not included in the Bureau of Labor Statistics Occupational Handbook as a job category.

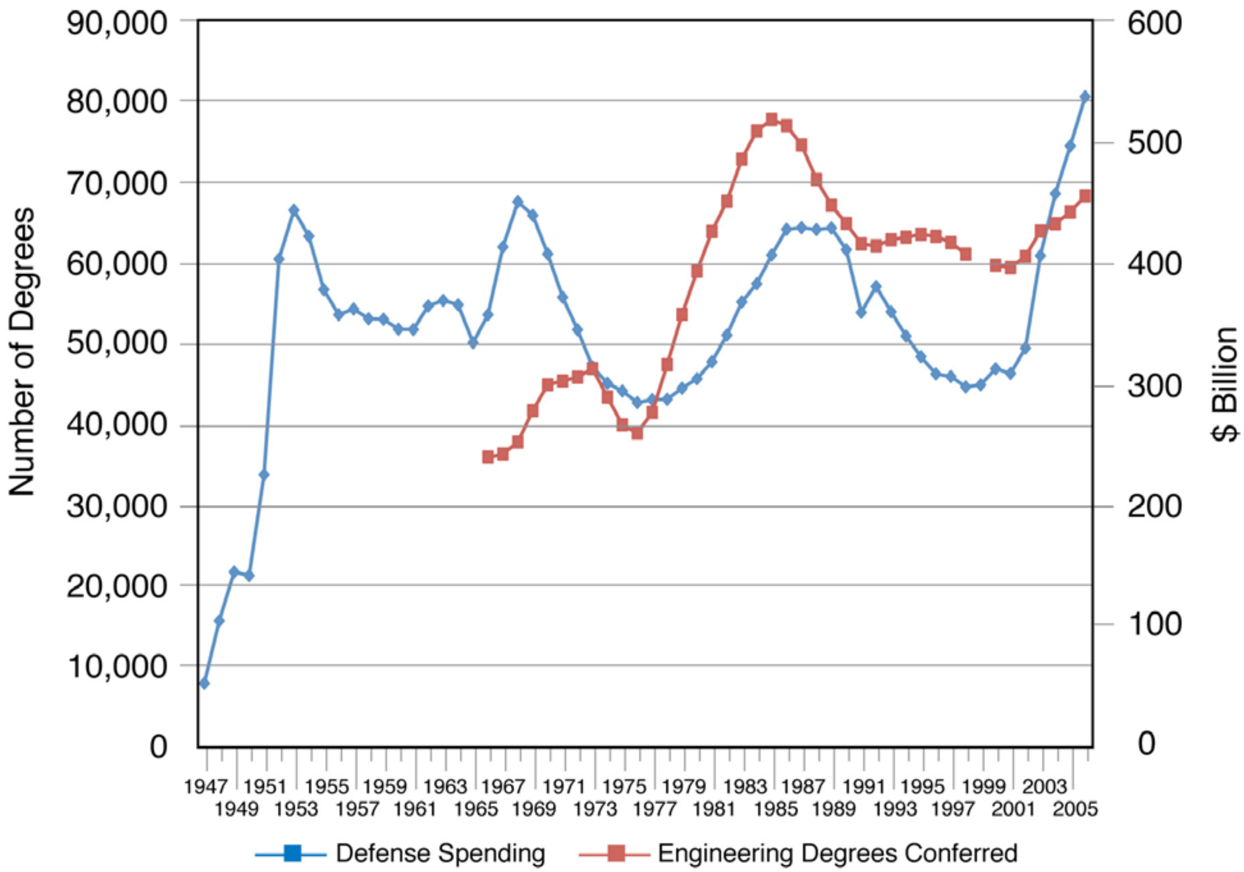
engineers to seek positions in the EESS they need to know the field exists. Table 6-1 displays the engineering disciplines recognized by the U.S. Bureau of Labor Statistics (BLS) as of 2006 and the number of engineers employed in each discipline. Many disciplines align with specific occupations: a degree 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. Energy efficiency is yet to be recognized as an engineering discipline by the BLS, despite the Association of Energy Engineers having over 9,500 members (AEE 2009).

Table 6-1. Number of Employees by Engineering Discipline 2006

Engineer Discipline	Employees (2006)	Percent of Total	Median Salary ($)
Aerospace engineers	90,000	6%	87,610
Agricultural engineers	3,100	0%	66,030
Biomedical engineers	14,000	1%	73,930
Chemical engineers	30,000	2%	78,860
Civil engineers	256,000	17%	68,600
Computer hardware engineers	79,000	5%	88,470
Electrical engineers	153,000	10%	75,930
Electronics engineers, except computer	138,000	9%	81,050
Environmental engineers	54,000	4%	69,940
Health and safety engineers, except mining safety engineers and inspectors	25,000	2%	66,290
Industrial engineers	201,000	13%	68,620
Marine engineers and naval architects	9,200	1%	72,990
Materials engineers	22,000	1%	73,990
Mechanical engineers	227,000	15%	69,850
Mining and geological engineers, including mining safety engineers	7,100	0%	72,160
Nuclear engineers	15,000	1%	90,220
Petroleum engineers	17,000	1%	98,380
All other engineers	170,000	11%	81,660
Total number of engineers	1,510,400		

Source: Bureau of Labor Statistics (2008).

A few of our survey respondents noted difficulty competing for engineers with large international firms or high tech computing and aerospace companies that offer higher salaries and perks such as international travel. At the same time, there is concern that the total number of engineers receiving degrees cannot keep pace with the need. For instance, Leon (2005) reports that U.S. defense spending correlates with the number of engineering degrees conferred in the U.S. Figure 6-4 shows trajectories for defense spending and conferred engineering degrees in the U.S. from 1966 to the 2006. Leon concludes that the total number of engineering degrees being granted is no longer keeping pace with the need and advocates for more investment in research and development and in science and engineering curriculum.



Source: National Science Foundation (2009), Center for Defense Information (2007).

Figure 6-4. U.S. defense spending and conferred engineering degrees

The energy industry generally has also experienced shifts in funding and demand. An Oak Ridge National Laboratory (1982) study of the scientists and engineers working in the energy field from 1976 to 1980 found that as federal funding increased in coal exploration there was an increase in scientists and engineers in that field. Similarly, as fossil fuel prices rose in the 1970s, there was an increase in the number of engineers and scientists employed in the energy field and between 1976 to 1980 there was a 70% increase in the number of bachelor's and master's graduates in energy-related activities (Bell 1982).

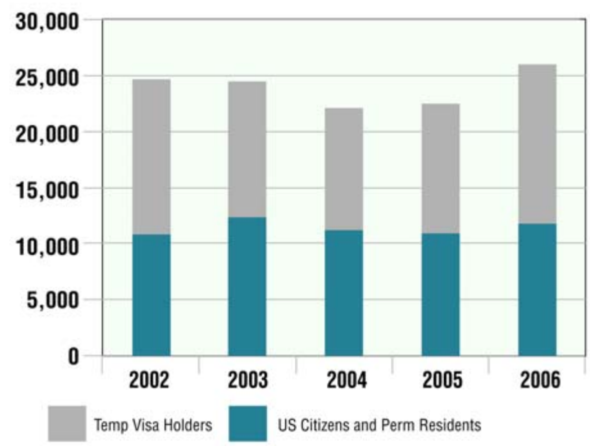
Nuclear engineering has also seen fluctuations in funding, hiring, and demand. A 2008 study found that most nuclear engineers in the field are between the ages of 45 and 65, few nuclear engineers between 32 and 45, and a small peak of nuclear engineers less than 32 years of age. These distributions correlate with funding cycles for nuclear energy (Prelaw 2008).

Bell (1982) reports that the manner by which the energy industry was able to keep up with the demand for engineers was to hire from related fields. Petroleum companies preferred petroleum or geological engineers yet they hired mechanical engineers and trained them in petroleum engineering. Our results and interviews suggest that a similar phenomenon is happening in the energy efficiency services sector. Energy or mechanical engineers are desired but program administrators, implementation contractors and ESCOs hire any engineer with interest in energy efficiency and build upon the engineer's technical aptitude through on-the-job industry-specific training. Several of the larger implementation contractors and ESCOs we spoke with noted that they have no difficulty attracting engineering talent that they could then train. In contrast, smaller firms indicated that they find it more difficult to recruit as they do not have similar resources to recruit or train.

Are U.S. universities are conferring too few engineering degrees? Between 1966 and 2006, the number of engineering graduates increased from 35,826 to 68,121, an increase of 90%. During the same time period, the number of bachelor degrees conferred rose from 524,008 to 1,473,735, an increase of 180% (National Science Foundation 2008). Thus, the relative percentage increase in number of students with bachelor degrees is roughly twice the rate of increase in the number of engineering graduates. However, some studies suggest that it is not possible to conclude that there is a shortage of engineering talent.

Competition for Engineers

The semi-conductor industry employs the largest number of engineers and offers the highest salary range, attracting the largest share of engineers with advanced degrees. Since the mid-1990s, the percent of U.S. citizens pursuing advanced degrees in engineering has steadily declined In the future, the pool of engineers with advanced degrees and good English communication skills may be a challenge for the EESS.



Source: National Science Foundation, 2008.

Figure 6-5. Number of graduate engineering degrees conferred in U.S. by citizenship status

For example, Brown and Linden (2008) concludes that there are insufficient engineers in the United States because salaries are not rising (which would indicate a lack of supply) and because there are more trained engineers than there are employed engineers. They found that the perceived lack of engineering talent occurs for those industries that seek recent graduates with advanced degrees in the newest advances in the field (e.g., semiconductors and computers), or in fields that prefer engineers with advanced degrees and U.S. citizenship (defense). Meanwhile, experienced engineers in these industries are not retained as the technologies they are most experienced with are replaced by new advances, leading to a larger number of trained engineers than positions.

Two implementation contractor respondents mentioned defense, semiconductor, nuclear, and software industries as primary competitors for engineering talent for the EESS because the EESS also needs engineers with advanced degrees and good communication skills.

The most likely source for new EESS engineers is to transition engineers from other fields into energy efficiency. But until energy engineering is recognized as an engineering discipline this may be difficult.

So whether there are enough engineers or not, most survey respondents confirmed that it is hard to find engineers to work in the EESS. To be effective, EESS engineers need training in fluid and thermodynamics, knowledge of building energy systems, an interest in optimizing the performance of existing HVAC or refrigeration or industrial process systems, and good communication skills for working with customers. The most likely source for new EESS engineers is to transition engineers from other fields into energy efficiency. In addition, recognizing energy engineering as an engineering discipline will be helpful to recruiting and tracking engineers with energy expertise.

6.4 Are there Enough Experienced Managers?

Hiring managers that are knowledgeable about energy efficiency is probably the largest potential bottleneck in the EESS workforce. According to most respondents, the challenge of finding experienced managers is more difficult than finding engineering talent. While the EESS has grown significantly in the past four years both in terms of program administrator budgets (CEE2008) and ESCO revenues (Goldman and Hopper 2007), according to our respondents, the number of experienced manager-level staff has not increased at a similar rate.

Respondents commonly stated that the number of management positions in their organizations had stayed constant in recent years while their organizations hired more entry level positions. Some respondents state that 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.

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.

One implementation contractor stated that it is "almost impossible to find someone with energy efficiency program management experience." People with this knowledge and experience are highly valued by the industry. They are also vital mentors for the next generation of managers in the EESS. This issue may become increasingly important in the future as the EESS workforce demand increases because there are few schools and training centers that offer curriculum focused on energy efficiency – on-the-job mentoring currently fulfills EESS training needs.

There is also a gap between senior and entry level jobs throughout the EESS. It is this gap that poses a significant problem because of limited mid-career staff that can both work with recent hires and be groomed into senior positions.

The problem is also relevant for low income weatherization organizations, where, according to Adams (2009) there is limited senior staff: "Due to state budget shortfalls, the existing technical and administrative monitoring capacity at the state level is severely understaffed." Addressing this gap will not be easy. It is difficult to impart years of experience through training. While managers from other industries can provide some capacity, having experience in energy efficiency that is deep enough to provide guidance to others will be necessary for the EESS to remain effective.

6.5 Are There Enough Trainers?

Given the widespread need for additional training activity as the EESS grows in size, a key question to consider is whether there are enough trainers to train the new entrants to the EESS.

The most commonly mentioned certificate that program administrators and implementation contractors ask their staff to pursue is Certified Energy Manager (CEM) training.

Comments from survey respondents who are trainers noted that many trainers are among those who are older than 50. Among trades people we spoke with those who do training, and we heard several comments about the difficulty of recruiting younger trades people because it requires more coursework to obtain and retain certifications. Among program administrators and implementation contractors, the experienced managers are the ones who do the training and also the people who are over 50. While implementation and support contractors rarely have mandatory retirement, the sheer volume of training required could exceed the number of experienced managers available to do the training. As one experienced implementation contractor stated: "This won't be a problem in 10 years, but it is certainly a problem today."

Formal energy efficiency training affects a small fraction of the workforce.

As part of this study, we interviewed 32 contacts involved in two-year, four-year, and specialty training organizations for the building and construction industry and EESS.[24] Our investigation focused on identifying and assessing those programs that currently offered some explicit training in energy efficiency as defined by the Department of Energy's Energy Efficiency and Renewable Energy Program, the International Energy Program Evaluation Conference, the American Society of Mechanical Engineers, and a group of experienced energy efficiency experts;. We attempted to collect information from this group of survey respondents on the number of certificates and degrees currently being awarded to participants in energy efficiency-related training and education opportunities. Our results suggest that there are not enough certificates or degrees being awarded yet to meet the growing need. Our respondents identified twenty certificate or degree programs available that specifically address energy efficiency ranging from two-day training to Ph.D. programs. These twenty programs awarded approximately 3,400 certificates or degrees in 2008 to a range of four and two- year college graduates, builders, mechanical contractors, architects, and engineers. When one considers that the size of the entire building industry is close to seven million people,[25] formal energy

[24] The results of these interviews will be discussed in the second report in this series.
[25] This is the sum of all occupations in the following NAICS codes in 2007: 236100 Residential Building Construction, 236200 Nonresidential Building Construction, 238200 Building Equipment Contractors, 238300

efficiency training affects a small fraction of the workforce. Yet, the news is also good in that training is available and being expanded, educational programs are developing and in the next five years more certificates and degrees will be developed and awarded. In the meantime the need to expand training programs and inform the work force that there are jobs in the EESS should be a key focus of workforce development efforts.

6.6 Near Term Increases in the Energy Efficiency Workforce

An important finding that emerged from our interviews is the need to inform the building and construction industry work force that the EESS is expanding. Administrators and implementation contractors have fairly clear expectations for growth of energy efficiency services, and the likely effect on their workforce needs. For example, in response to a question which asked respondents to estimate the size of their organizations' workforce involved in energy efficiency by 2010, we found that in aggregate, program administrators estimated that their staff will grow about 19% by 2010 and that implementation contractors expect that their staff will increase by about 64%.

In contrast, less than 50% of those in design, engineering, and building and construction industry associations could even estimate the percent of the current workforce affected by energy efficiency. Of those that could, the design and engineering associations perceive energy efficiency to have a dominant or moderate influence on their current activities while other building and construction association respondents see only a moderate or limited level of influence (see Figure 6-5) on their activities.

Building Finishing Contractors, 238900 Other Specialty Trade Contractors, and Architectural, 541300 Engineering and Related Services

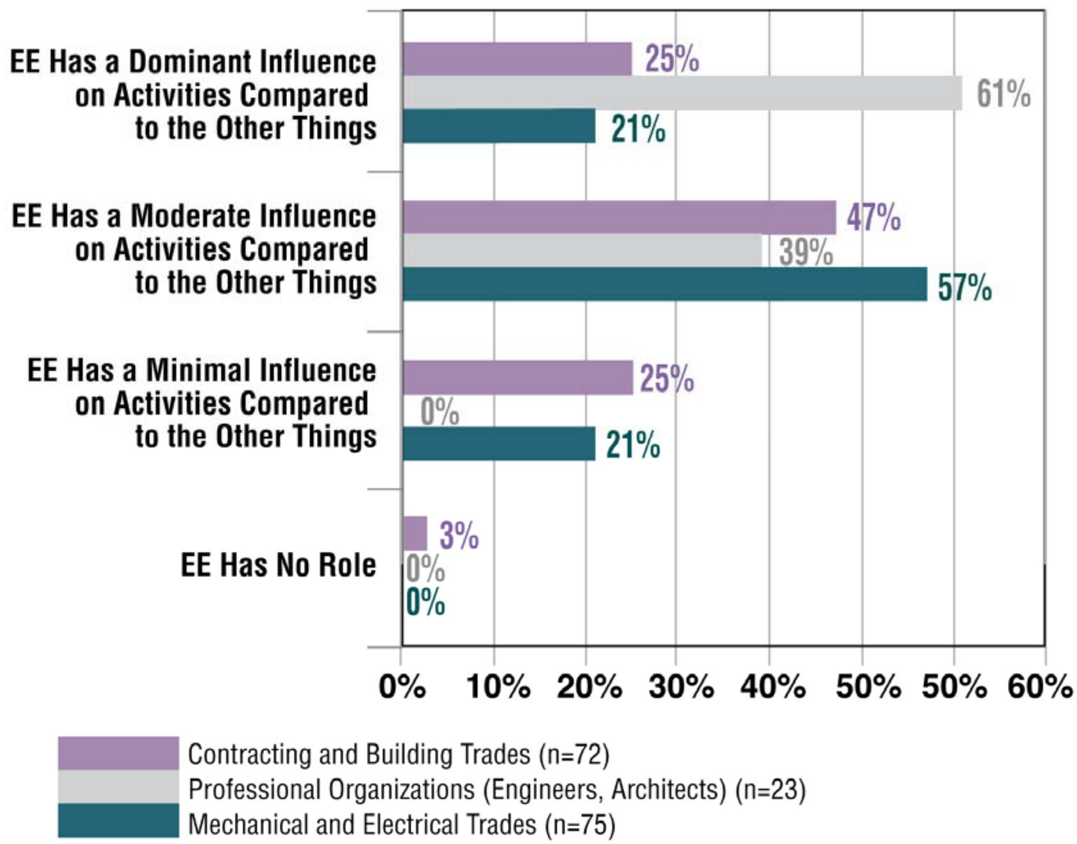


Figure 6-5. The influence of energy efficiency on the building industry

With less than 50% of the building and construction industry association contacts able to estimate the current role of energy efficiency on their business, similarly few could estimate the likely increase in their business given an increase in funding for energy efficiency. For respondents that could make an estimate, those working in the residential sector anticipate a somewhat larger effect on their business than respondents primarily working on commercial and industrial buildings. Yet our analysis suggests that the funding and workforce effects will likely be about equal for the two sectors.

Those building and construction industry associations that were aware of these changes tend to be located in areas of the country with active energy efficiency programs or to be representing a national organization or national labor union rather than a local building and construction association.

We draw the following conclusions from these survey responses:

1) Most firms in the building and construction industry that will be needed to implement energy efficiency solutions are currently unaware of the pending increase in funding for energy efficiency;

2) Not surprisingly, the capacity is not yet developing in the building and construction industry to provide energy efficiency services;

3) National representatives of building and construction industry associations need to educate their state and local organizations on the policy and market drivers that are leading to significant increases in energy efficiency spending so that they can inform their members of the need to develop the necessary skills to provide energy efficiency-related services to meet the coming demand, and

4) Program administrators and implementation contractors are aware of policy drivers that significantly influence spending on energy efficiency and are developing responses and capability to address future growth.

7. Conclusions

There is a growing commitment to reduce energy consumption and address concerns about global climate change in the U.S. This commitment is leading to new policy efforts and funding for improving the energy efficiency of buildings. The energy efficiency services sector (EESS) is that portion of the workforce that implements energy efficiency efforts in response to policy initiatives and market demand for improved energy performance. This report addressed the size and types of jobs in the EESS, projections for growth in response to policy initiatives and market demand, and current perceptions regarding the ability of the EESS workforce people to scale up to meet demand.

7.1 The Current EESS Workforce

We estimate the EESS workforce in 2007 and 2008 comprised 114,000 person years, less than 1/2% of the total U.S. workforce. Ratepayer-funded energy efficiency efforts currently constitute about 35% of the estimated EESS person-years. This employment includes the staffs of program administrators, the program implementation and support contractors they hire, and the building and construction professionals and trades people that design and install equipment, appliances and provide services funded as part of ratepayer-funded energy efficiency programs. The weatherization assistance efforts of the federal and state governments constitute about 5% of the total EESS person-years. Finally, market activity of ESCO constitutes about 11% of the total person-years, including ESCO staff and the professionals and workers they hire from the building and construction industry to implement ESCO projects.

Efficiency activity related to building codes, building envelope insulation and mechanical insulation, comprises just under 50% of the estimated EESS person-years. This brings the total number of workers in building and construction who are involved in energy efficiency to over 93,000 of the national building and construction industry work force. Given that much of the building and construction workforce spends only a fraction of their time on projects that involve installation of high-efficiency equipment or building envelope materials, we estimate that perhaps as many as 397,000 (5%) of the building and construction industry broadly are engaged in EESS activities on a full-time or part-time basis.

7.2 EESS Workforce Growth

To project the requirements for EESS workforce in the future we used an estimate of future spending on energy efficiency based on policies in place at the time of the study (December 2008). The possible effects of federal carbon legislation or energy efficiency portfolio standard were not included in the estimates. Our study concludes that anticipated spending on energy efficiency by 2020 in the high growth scenario will require a workforce four times larger than that in place in 2008.

We believe the high-growth scenario to be most likely; however, given either scenario the EESS workforce will at a minimum grow by a multiple of two-fold between 2008 and 2020 (whether considered in terms of person-years of employment or number of individuals engaged in EESS activities). The anticipated increase means people currently employed in the EESS will need additional energy efficiency-specific training to keep abreast of developments in the field and new people will need to be introduced to the sector and adequately trained to implement energy efficiency in a reliable and cost-effective manner. Clearly, the current workforce is too small and will be challenged even to meet near term needs associated with the ARRA funding package.

In the high growth scenario, by 2020 the EESS could reach nearly 1% of the national workforce and may comprise as much as 3% of the relevant building and construction industry, equivalent to nearly 384,000 person-years of employment and perhaps as many as 1.3 million individuals engaged in full-time or part-time work.

The largest share of EESS workforce growth (fully 78% percent of the 2020 high scenario) will be in building and construction industry, defined as design, engineering, and building and construction firms (including insulation installers). Yet, much of the building and construction industry (outside of the design and engineering community) is unaware of pending growth and is mostly focused on immediate concerns of the economic downturn. Coupled with this lack of awareness is the fact that much of the gains from energy efficient equipment occurs because of correct sizing, design, installation and operation of the equipment – requiring some training and education to get right.

7.3 Preparing for an Expanded EESS Workforce

Program administrators, implementation contractors, and support contractors are aware of the pending growth and are hiring, training, and growing their staff. Program administrators sometimes face restrictions on their ability to rapidly increase their workforce due to company, legislative or regulatory constraints (e.g. hiring freezes with a utility, budget shortfalls in states that lead to hiring freezes, or limits placed by state PUCs on administration budgets). In these situations they turn to program implementation and support contactors who have the flexibility to grow and shrink as needed. Other sectors are less prepared for growth.

7.3.1 Building and Construction Industry

There is a need to inform the building and construction industry of the pending growth in the energy efficiency market. Today the building and construction industry is focused on the effects of the economic downturn, but in the long-term there is a growing need for skilled contractors and trades people generally and specifically with skills and training in energy efficiency solutions. Our interviews with building and construction contractor and trades association contacts suggest that members of these associations are somewhat resistant to training. Hiring is not a problem as there are plenty of people who believe they can do construction work and it is easy to find entry level workers. But getting skilled labor is more difficult, especially in less unionized areas where there are limited apprenticeship programs. The current approach is largely on-the-job training (as it is with all of the EESS), in part because of the resistance to training and in part because there are a limited number of qualified trainers and what the respondents who do training told us is that there are few younger people deciding to take the additional training to become trainers themselves. Industry members attribute this to a combination of the aversion to work that entails manual labor and general lack of awareness of what building and construction work entails.

The building and construction contractor and trades associations have developed training and education programs for energy efficiency but the current number of certified members is typically less than 10% of their memberships. Coupled with this low interest in training, and to some extent limited interest in seeing building and construction contracting or trades as a long-term career, over 35% of the members of the associations are over 50 in the 11 states that were surveyed, thus retirement is a looming issue for the building and construction industry.

7.3.2 Engineers and Managers

The hardest positions to fill according to program administrator, contractor, and ESCO respondents are experienced energy engineers and mid-level experienced managers. While retirement is not considered an issue for any of these types of firms, there is a bi-modal distribution in the age of workers in these firms that means there are limited numbers of staff with 5-15 years experience, just the types of workers who would be seeking promotions to management and supervisory positions.

The need for these experienced staff is very serious as these people provide the training and mentoring needed for on-the-job training, which dominates the EESS. Moreover, shortages of experienced energy engineers and mid-level experienced managers often creates a bottleneck that limits the growth rate in the broader energy efficiency services sector. Program administrators, implementation contractors, and support contractors have no difficulty hiring entry level and early experienced staff but someone has to manage these workers and professionals and ensure that the programs and the projects are well-designed and implemented.

Finding energy engineers even at entry level positions is difficult because there are very few energy engineering degrees, no recognition of this discipline in occupational and census data on engineering discipline and because the types of engineers sought by the EESS (engineers with good foundation in thermodynamics and fluid dynamics with good communication skills to talk to end-users) are among the most highly valued in the engineering field.

Addressing the need for experienced managers will be difficult but certainly seeking managers from other fields and developing training to help them quickly understand the field of energy efficiency could be effective. Another key approach for addressing the need for energy engineers is to work with the BLS to ensure that emerging EESS occupational categories are included in occupational handbook and BLS economic census data.

7.4 Getting the Word Out

As public policies provide the principal drivers of energy efficiency, it is critical for workforce development that policies sustain a long-term commitment to efficiency. The insulation industry comprises over 50% of the EESS workforce estimate, illustrating the effect of sustained and wide-spread building energy codes. Program administrator activity contributes about 30% of the demand for an EESS workforce. The age distribution of administrator staff reflects the policy shift away from ratepayer-funded efficiency that occurred in the mid-1990s. Interviewed administrators report a shortage of skilled staff experienced in energy efficiency suitable to manage large efficiency efforts.

At the root of the EESS workforce challenge is the fact the energy efficiency is not commonly understood in the population at large. Not only is this concept missing from the economic census and the occupational handbook, and from the tool box that contractors and building trades people use every day, but it is not a top of mind concept to the public at large. Today the EESS includes only around 100,000 to 500,000 workers; by 2020 it will be at least 400,000 workers and likely over 2 million workers who spend at least part of their year working on energy efficiency projects. This will be an important activity, one that people think about when they remodel their home or when they look for a new home or place of business.

The next report will focus on workforce training and educational needs and include recommendations to address gaps in the training and education of the current and projected EESS work force.

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