Building the Efficiency Workforce

Preprint

Sarah Truitt,[1] Juliana Williams,[1] and Madeline Salzman[2]

1 National Renewable Energy Laboratory
2 U.S. Department of Energy

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Building the Efficiency Workforce

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ABSTRACT

Demand for high-performance homes and buildings is growing due to their marketability, environmental benefits, and increasing affordability. Growth for energy-efficient technologies and building upgrades has driven expansion across many traditional industries, including construction and architecture according to the U.S. Energy Employment Report (USEER). As buildings become more automated, digitized, and interconnected, the workforce that supports the design, build, operation, and maintenance of these buildings must also evolve.

The U.S. Department of Energy (DOE) Building Technologies Office (BTO) has engaged the National Renewable Energy Laboratory (NREL) to provide a framework upon which BTO can develop its next-generation workforce development strategy. The strategy will be designed to increase the quantity of workers with the skills to adequately design, install, maintain, and operate high-performance buildings across all building sectors (residential, commercial, and industrial). This paper discusses recent trends impacting the energy efficiency sector, identifies challenges facing the energy efficiency workforce, and closes with an opportunity to join BTO in addressing the challenges through the Better Buildings Workforce Accelerator.

Introduction

Building efficiency is central to a clean energy future, and the nature of the built environment is changing as demand for energy-efficient technologies and high-performance buildings gains ground. To make energy-efficient buildings the standard, the United States not only needs a workforce that can design, build, and operate high-performance buildings, but also a robust network of professional service providers who are competent and comfortable with selling, insuring, and financing high-performing buildings with energy-efficient technologies.

The growing complexity of the building sector and the pace of technological innovation require rethinking how training and education are provided to the workforce. To capitalize on the market opportunity that high-performance buildings present, a wide range of professions must integrate building science and energy efficiency knowledge into their standard practice—from manufacturing and construction to architecture and real estate.

This paper discusses recent trends impacting the energy efficiency sector, identifies challenges facing the energy efficiency workforce, and closes with an opportunity to join BTO in addressing the challenges.

Increasing Interest in Energy Efficiency

Interest in energy efficiency is steadily growing. It is seen as a competitive advantage for many contractors and architects and is becoming embedded into the existing regulatory and financial structures that support the construction industry. Workers across a range of professions will need to understand energy efficiency and building science concepts as efficiency becomes more ubiquitous and mainstream.

Contractors Showing Interest in Energy Efficiency and Resilience

The second quarter (Q2) 2018 Commercial Construction Index states, “Sustainable building appears to be an emerging area of opportunity,” with almost half (45%) of respondents reporting that sustainable building gives them a competitive advantage, and four out of five stating that that their customers request energy-efficient materials for their projects (U.S. Chamber of Commerce 2018). Demand for resilience is also strong in the commercial building sector. Sixty-four percent of general contractors surveyed indicated a strong desire to learn more about resilience to create a competitive advantage for their firms, indicating that resilience is becoming an important driver in the market (U.S. Chamber of Commerce 2019).[1]

The growing importance of resilience in the market presents an opportunity for improving the energy efficiency of the built environment overall. However, the synergies between efficiency and resilience are complicated. Although there are many instances of efficiency measures complementing and bolstering resilience, drawbacks also exist where efficiency and resilience goals are at odds. Different building types, different climate zones, and many other factors can affect the interplay between these two essential building characteristics (Ott et al. 2019). Increasing demand for resilience and efficiency, as well as the intricate relationships between these two characteristics, intensify the need for a more highly skilled workforce that can integrate new technologies into the built environment.

Growing Importance of Sustainability within the Architectural Profession

Since 2006, the American Institute of Architects (AIA) has promoted the 2030 Commitment, a voluntary pledge for architectural firms to meet incrementally increasing targets for energy reduction in the buildings they design, with an eventual goal of zero net carbon buildings by 2030. AIA’s 2030 Commitment is based on the 2030 Challenge issued by Architecture 2030, which has also been adopted by ASHRAE, the U.S. Green Building Council (USGBC), and the National Governor’s Association, among other organizations (Architecture 2030). In 2018, 252 architectural firms reported data to AIA’s Data Design Exchange (DDx), a reporting platform that integrates with common energy modeling programs, such as Autodesk and Sefaira (AIA 2019). The average predicted energy use index (pEUI) of buildings reported in the DDx in 2018 was 46% less than 2030 baseline-equivalent buildings. Although this is a substantial achievement, the current target is 70% pEUI reduction, a level that only 16 firms were able to achieve across their portfolios. AIA acknowledges more work is needed both to increase the energy savings of reported buildings and expand participation in the 2030 Commitment. To expand the program, AIA recognized the need to train workers on how to measure pEUI and use the reporting platform. A partnership with the Energy Trust of Oregon resulted in an internship program with five architectural firms to assist in reporting projects in DDx and meeting the energy targets. The internship program resulted in tripling the number of projects reported to DDx and increased pEUI reduction by 2% in one year.

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[1] Energy resilience refers to the ability of energy-related systems of a building or community of buildings to predict and prepare for, withstand, recover rapidly from, and adapt to major or unanticipated disruptions.

Increasing Adoption of Efficient Building Codes and Energy Benchmarking

There is a dynamic relationship between the jurisdictional energy codes or incentives and the number of individuals obtaining "green" credentials and designing to high-performance building standards. States that have adopted more stringent energy codes or benchmarking ordinances (Figures 2 and 3) have significant overlap with the states with high participation in the AIA 2030 Commitment (Figure 4) and independent certifications. For green certifications to have broader appeal, a market demand is needed for high-performance buildings.

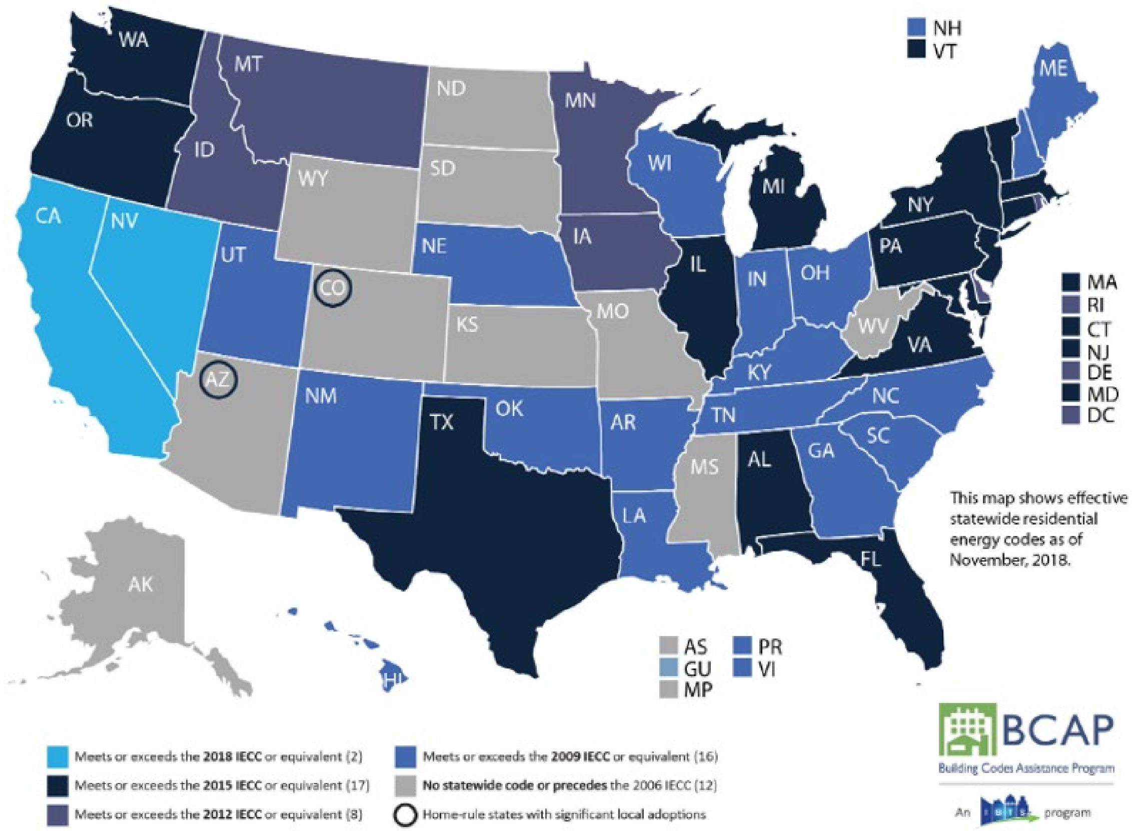

Figure 1. Residential energy code adoption across the U.S. *Source*: Building Codes Assistance Project 2020.

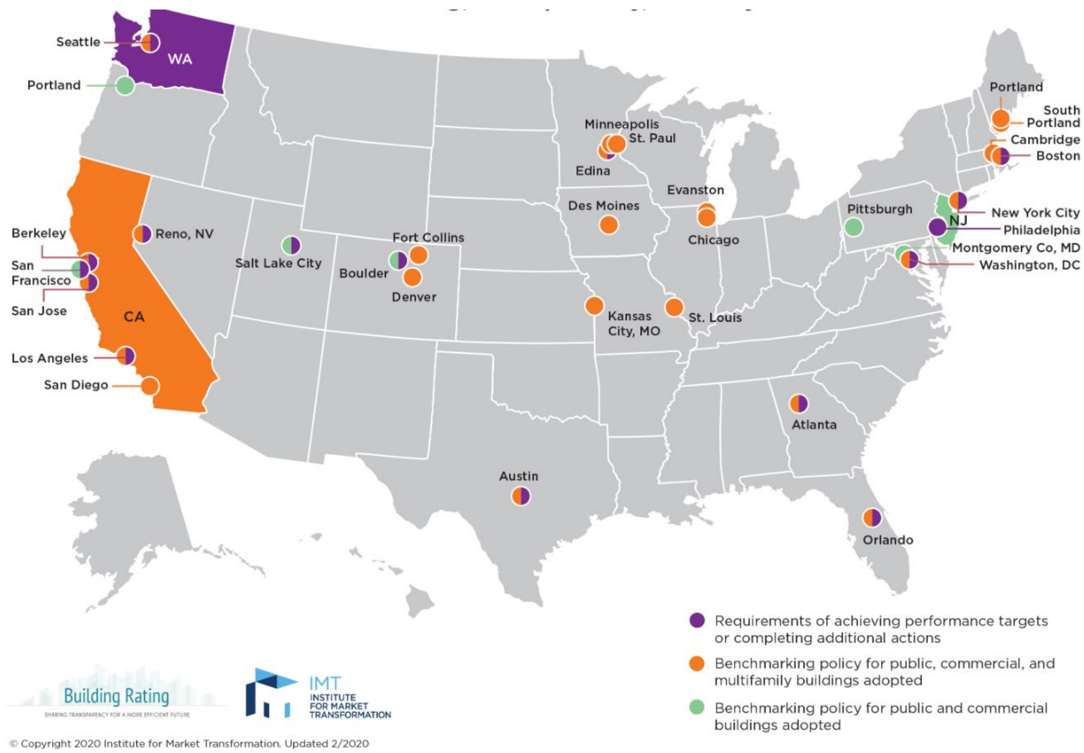

Figure 2. State and local energy benchmarking policies for existing buildings across the U.S. *Source*: Institute for Market Transformation (IMT) 2020.

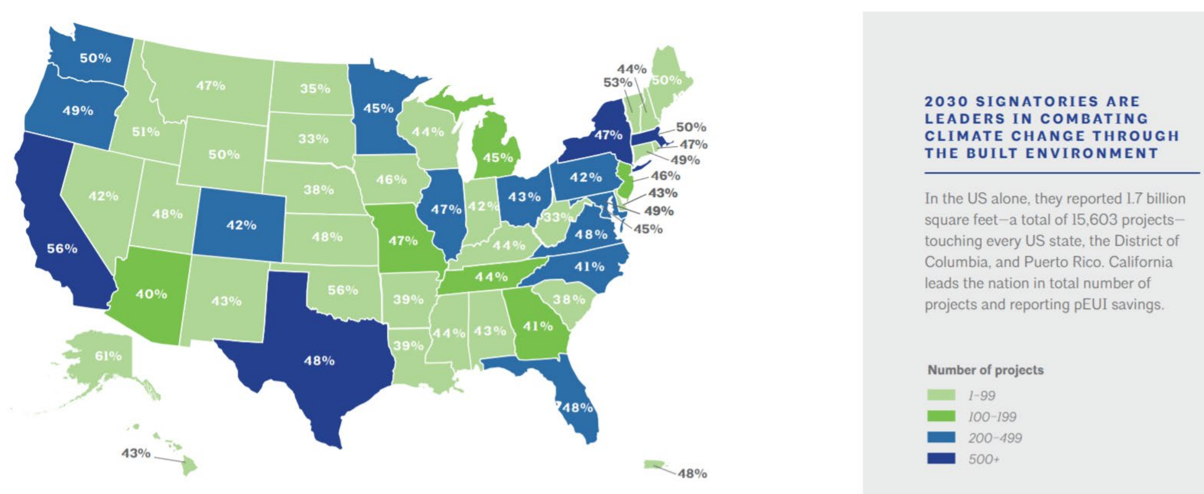

Figure 3. Projected Energy Use Intensity (pEUI) savings, number of projects, and gross square footage reported under the AIA 2030 Commitment in 2018. *Source*: AIA 2019.

Jurisdictional support for high-performance building standards influences the desirability of green certifications. Several interviewed design professionals identified the need for jurisdictional policies (mandatory codes, standards, or incentives for high-performance building, incentives for professional certifications) to create demand for high-performance building and the services provided by high-performance building design professionals. As an illustrative example, an incentive created by the Pennsylvania Housing Finance Authority (PHFA) in 2014 for affordable housing developers to build to passive house standards resulted in Pennsylvania leading the nation in the number of passive house residential units by 2016 (Legere 2018). Developers were concerned that building to passive house standards would cost 15% to 20% more than conventional construction. To the contrary, PHFA has found that passive house project costs have decreased over the years, from having a 5.8% premium over conventional construction in the first year to 1.6% the second year and minus 3.3% the third year (Semke 2020). Therefore, PHFA has concluded passive house projects cost roughly the same as conventional construction, both in terms of proposed cost per square foot and the difference between a project's proposed and final costs (Legere 2018).

Philadelphia-based architect Tim McDonald, whose firm designed the first certified passive house in Pennsylvania in 2012, says "Passive house is not some insanely difficult standard to meet, but it has to be executed well. If air-sealing is done improperly, buildings can develop issues with moisture buildup and mold" (Legere 2018). This illustrates the importance of a trained workforce across a range of professions, from architects and engineers to construction laborers. The PHFA example also highlights the role of policy decisions in creating greater demand for high-performance building.

Growing Support for Energy Efficiency in Financial and Regulatory Structures

Building codes and utility regulations have proven to be effective catalysts of energy efficiency in buildings. The DOE Building Energy Codes Program recently assessed the impact of energy codes in residential and commercial buildings from 2010 to 2040. DOE's website states that building energy codes are responsible for $126 billion in energy cost savings, 841 million metric tons of avoided carbon dioxide emissions, and 12.82 quads of primary energy saved over the 30-year period (U.S. DOE 2017).

Since 2008, customer-funded utility energy efficiency program expenditures in the United States more than doubled, increasing from $3.4 billion to $7.2 billion in 2017 (Cooper and Watkins 2019). Lawrence Berkeley National Laboratory published a report in November 2018 projecting ratepayer-funded energy efficiency programs through 2030 (Goldman et al. 2018), as shown in Figure 4.

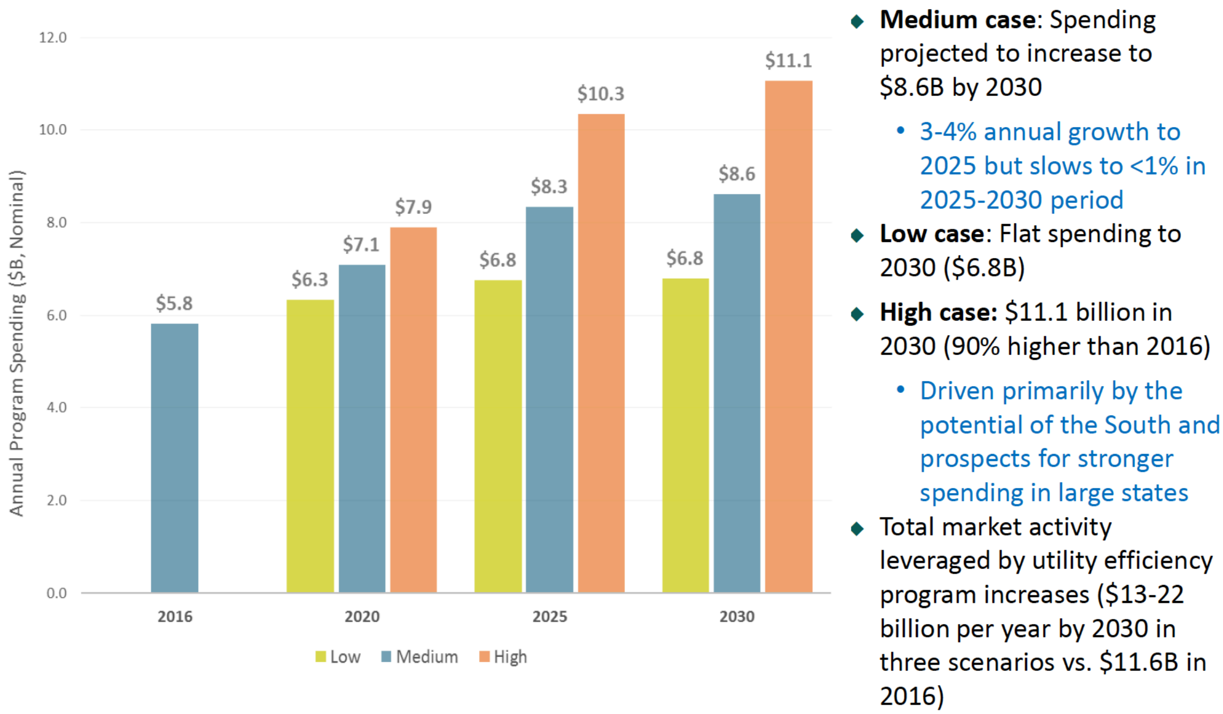

Figure 4. Projected electricity efficiency program spending through 2030 under three scenarios.
Source: Goldman et al. 2018.

A driving force behind energy efficiency programs are state-mandated Energy Efficiency Resource Standards. The Database of State Incentives for Renewables and Efficiency (2019) shows that energy efficiency resource standards are in place across half of the country—25 states as of June 2019. Although energy efficiency can make homeownership more affordable, this cost—an estimated $2,000 per year according to DOE—is not typically factored into traditional mortgage underwriting methods (Freddie Mac 2018).

An emerging trend is the growth of energy-efficient mortgage (EEM) programs, which are supported by the same entities that back the majority of residential mortgages in the United States (Federal Housing Administration, U.S. Department of Veterans Affairs, and Fannie Mae/Freddie Mac [MortgageLoan.com 2019]). EEMs increase borrowing power by 2% to 5% by factoring in the lower annual operating cost (lower utility bills), allowing EEMs to underwrite a higher debt-to-income ratio than would be acceptable under traditional residential mortgage terms (Green Communities website).

EEM lenders typically require a home energy assessment to complete the underwriting process. The assessment must be performed by a credentialed home energy assessor such as a Building Performance Institute Building Analyst Professional, Building Performance Institute Home Energy Professional Energy Auditor, or Residential Energy Services Network Home Energy Rater.

Freddie Mac is assessing sales statistics between homes with and without energy-efficient enhancements. The report, *Energy Efficiency: Value Added to Properties & Loan Performance*, shows that new homes with home energy ratings sold for 2.7% more than comparable unrated homes on average, and better-rated homes sold for 3%–5% more than lesser-rated homes (Argento, Bak, and Brown 2019). The higher price associated with energy-efficient features could be offset by future utility bill savings and resale value (Argento, Bak, and Brown 2019).

The research will help design valuation guidance and uniform data collection tools and develop underwriting guidelines to account for energy-efficient features. The establishment of underwriting guidelines provides a strong catalyst for increasing the use of EEMs, which will subsequently increase the need for energy auditors and raters and informed real estate professionals.

Technological Advancements in Building Technologies Embed Efficiency

Scientific discovery continues to push new, more efficient technologies into the market. Internet connected "smart" devices bring a new level of functionality and convenience to building occupants. BTO estimated that approximately 200,000 smart devices were connected worldwide every hour in 2017 and that the United States has four times more market demand for these devices that any other area of the world (U.S. DOE). In addition, distributed energy resources (DERs) continue to be adopted by residential and commercial customers across the United States. Today's behind-the-meter DERs (energy efficiency, demand response, solar photovoltaics, electric vehicles, and battery storage) are typically valued, scheduled, implemented, and managed separately. Through its Grid-Interactive Efficient Building (GEB) initiative, BTO is funding research to achieve a future where buildings operate dynamically with the electricity grid to integrate DERs and smart devices while meeting the needs of building occupants.

Buildings can provide flexibility by reducing energy waste, helping balance energy use during times of peak demand or plentiful renewable generation, and reducing the risk of frequency deviations. BTO's vision is to integrate and optimize smart devices and DERs for the benefit of building owners and occupants, as well as the grid.

Demand for GEBs will increase as costs come down and benefits are documented in field validations and real-world demonstrations. Greater emphasis on cross-disciplinary teams and multidisciplinary degrees is needed to facilitate adoption of GEBs, particularly among engineering and architecture/design disciplines.

The Need for Workers with Building Science Knowledge Will Grow

Increasing demand for efficient and resilient buildings, financial and regulatory support for energy efficiency, and technological innovations are pushing the current building and building-related workforce to need at least a minimum level of building science education and training. As high-performance buildings become more ubiquitous, building science knowledge will not be viewed as an optional feature that provides a competitive business advantage; it will become essential to a company's survival.

High-performance buildings and energy-efficient technologies are poised to make significant improvements in the energy efficiency of our nation's building stock, and the market is ready to adopt these technologies. However, without addressing the shortage of skilled workers equipped to design, manufacture, install, and operate them, high-performance buildings will not achieve their potential.

Employment in the Efficiency Sector

It is difficult to define and track the energy efficiency workforce because energy efficiency is often part, but not all, of a worker's job. There are no codes in the U.S. Department of Labor's industry classification system to identify efficiency jobs, and therefore, the Bureau of Labor Statistics does not track or report on the sector of the workforce involved with efficient building technologies. To fill this void, the Energy Efficiency and Renewable Energy Office within DOE commissioned the first U.S. Energy and Employment Report (USEER), published in 2016.

The National Association of State Energy Officials (NASEO) and the Energy Futures Initiative (EFI) have been publishing data on the energy efficiency workforce since 2016 in the USEER. Now in its fifth year, the 2020 USEER provides year-over-year statistics on "energy efficiency" jobs.[2]

Before COVID-19, the energy efficiency sector had been growing at an astonishing rate, 10.4% since 2015 (E2 2020)—totaling nearly 2.4 million workers across a range of professions in construction, manufacturing, wholesale trade, business, and other services early in 2020. Figure 5 shows growth in various subsectors of the energy efficiency industry over the past two years.

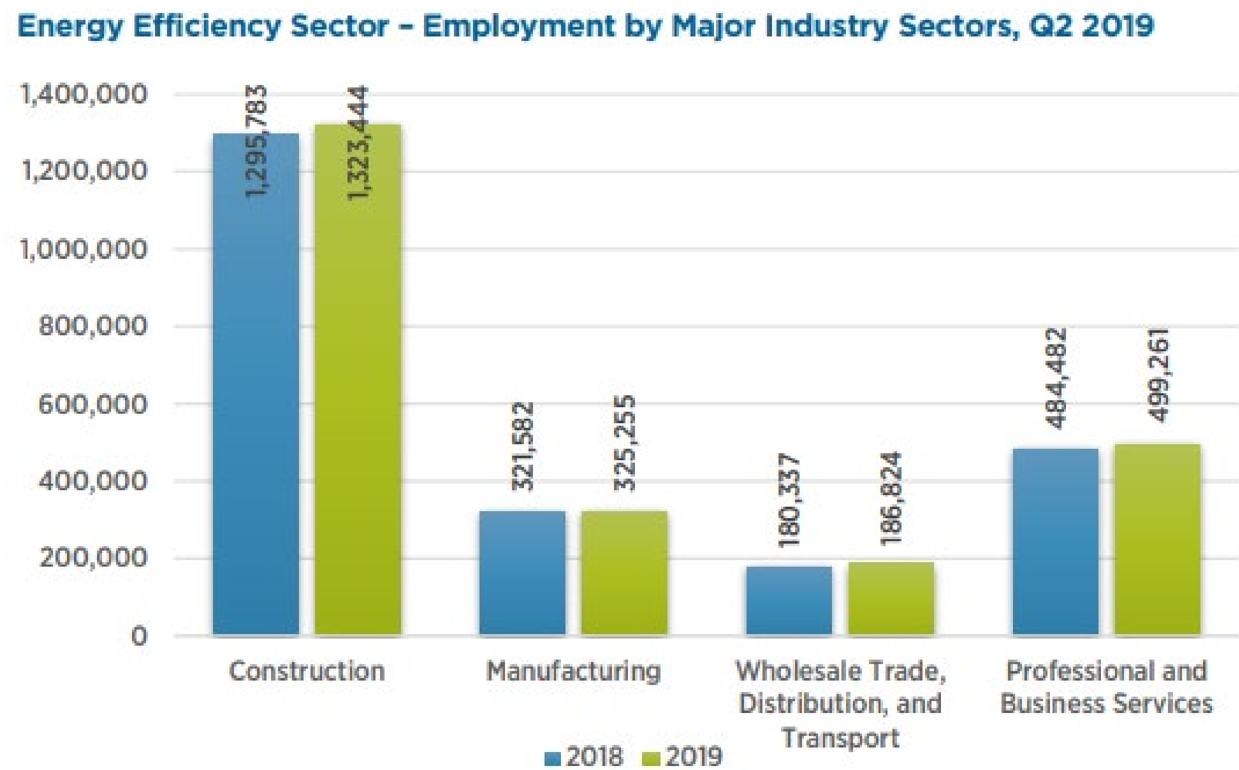

Figure 5. Energy efficiency sector employment 2018–2019. *Source*: NASEO and EFI 2020.

Because more than half of the workers identified in the energy efficiency workforce are in the construction field, data about the construction industry overall is used to draw some conclusions about the energy efficiency sector.

[2] The energy efficiency workforce is defined as "employment [that] covers both the production and installation of energy-saving products and the provision of services that reduce end-use energy consumption" (NASEO and EFI 2020).

Challenges Facing the Energy Efficiency Sector

The USEER found that a large majority of energy efficiency employers had difficulty finding qualified candidates due to a lack of technical skills, small applicant pool, and lack of industry-specific knowledge (NASEO and EFI 2020). The USEER shows that hiring difficulty is fairly consistent across energy-efficient technologies. Figure 6 shows that 35% to 44% of USEER survey respondents reported severe hiring difficulty across all energy efficiency technologies included in the USEER survey.

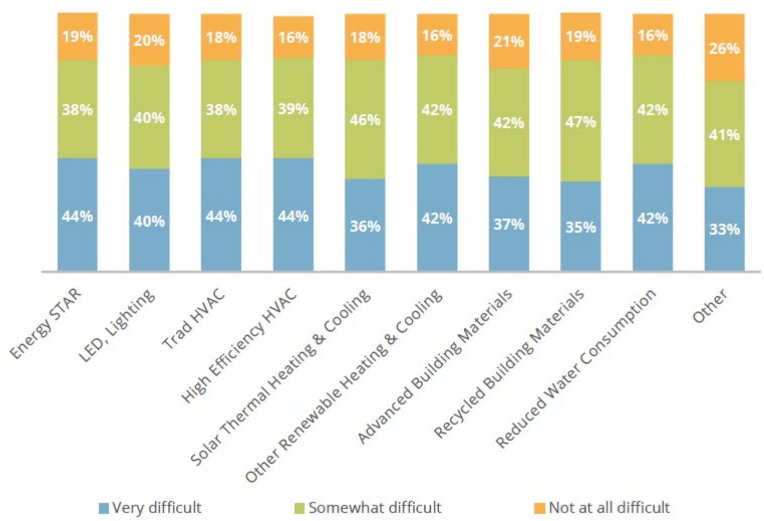

Figure 6. Hiring difficulty across technology types. *Source:* NASEO and EFI 2020.

When comparing construction sector surveys, including the U.S. Chamber of Commerce Commercial Construction Index (CCI), Associated General Contractors of America (AGC), and the USEER surveys, we see that hiring difficulty is more pronounced in the energy efficiency sector than in the construction industry at large. Ninety-one percent of USEER respondents reported moderate to severe hiring difficulty, while 78% of AGC respondents and 61% of CCI respondents reported moderate to severe hiring difficulty in 2019 (NASEO and EFI 2020; U.S. Chamber of Commerce 2019; AGC 2019).

Lack of Technical Skills and Industry-Specific Knowledge

Lack of technical skills and lack of industry-specific knowledge were two of the top three reasons energy-efficient employers cited for their hiring difficulty. There are many options for professionals to obtain technical skills and industry-specific knowledge. A wide variety of professional organizations offer "green" credentials for construction workers, architects, designers, and the real estate professions (real estate, mortgage, insurance, and appraisal). Some of these credentials are not job-specific and are applied to many professions, while others are job-specific. Figure 7 includes a sampling of credentialing programs that provide specialized training designed to expand worker knowledge of high-performance building practices or energy-efficient technologies.

"GREEN" CERTIFICATION OR DESIGNATION	GENERAL AUDIENCE	BUILDER/ CONSTRUCTION WORKER	ARCHITECT/ DESIGNER	REAL ESTATE (AGENT, LENDER, APPRAISER)	INSPECTOR/ AUDITOR/ RATER
Blue House Energy Building Science Basics Certificate	●				
ASHRAE Certified Professional		●	●		
Building Performance Institute Professional Certifications		●			●
Building Performance Institute's Building Science Principles Certificate	●				
BuildIt Green Certified Green Lender, Builder, Real Estate Professional		●		●	
EarthAdvantage Accredited Green Appraiser and Green Broker				●	
EcoBroker				●	
Green Advantage Certified Associate or Practitioner		●			
Green Professional Building Skills Training		●			
GreenPoint Rater or Advisor	●				●
Home Energy Rating System (HERS) Index Rater					●
National Assoc. of Home Builders (NAHB) Certified Green Professional		●			●
National Assoc. of Realtors (NAR) Green Designation				●	
North American Technician Excellence (NATE)		●			
Passive House Certifications	●	●	●		●
USGBC LEED Green Rater, Accredited Professional, Fellow					●

Figure 7. Sampling of green credentialing programs. *Source:* graphic courtesy of NREL.

While there are plenty of green credentialing programs, there is no single location to go to online to navigate all of the various options, understand which competencies each program provides, and recognize the competencies needed for each profession within the energy efficiency workforce.

Trade organizations such as the AIA provide some clarity when courses satisfy their continuing education unit requirements. Architects must complete continuing education credits to maintain their licensure. Requirements vary widely from state to state, from none in Connecticut to 36 hours per year in New York. To maintain AIA membership, members must complete 18 hours of continuing education each year, of which 12 must be related to health, safety, and welfare. AIA has approved more than 3,000 continuing education providers and directly provides over 140 courses online, including a large selection of courses on building science and high-performance design (AIA 2020).

Credentials and certification programs provide effective pathways for workers to enter or advance within the high-performance building sector. These certifications allow individuals to distinguish themselves among the workforce. However, additional effort to build awareness of green credentials and help new entrants navigate the many options for obtaining credentials is needed to grow the efficiency workforce.

Small Applicant Pool

The second most-cited reason for hiring difficulty among USEER respondents was a small applicant pool. Attracting more people to the energy efficiency industry requires intentional outreach to a broader base of applicants and attracting students to the field.

The USEER workforce demographics survey, as shown in Figure 8, indicates that women and Black Americans are notably underrepresented when compared to national workforce averages, with Black workers representing 8% of the efficiency workforce, compared with 12% of the national workforce; and women representing only 25% of the efficiency workforce, compared with 47% of the national workforce (NASEO and EFI 2020).

Energy Efficiency Sector – Demographics, Q4 2019

Demographic	Employees	Percent of Sector	National Workforce Averages
Male	1,795,634	75%	53%
Female	583,258	25%	47%
Hispanic or Latino	367,790	15%	18%
Not Hispanic or Latino	2,011,103	85%	82%
American Indian or Alaska Native	32,334	1%	>1%
Asian	135,445	6%	6%
Black or African American	189,413	8%	12%
Native Hawaiian or other Pacific Islander	26,461	1%	>1%
White	1,835,594	77%	78%
Two or more races	159,647	7%	2%
Veterans	224,223	9%	6%
55 and over	320,884	13%	23%
Union	241,353	10%	6%

Figure 8. Energy efficiency workforce demographics. *Source:* NASEO and EFI 2020.

Beyond the imbalanced demographics of the energy efficiency sector broadly, the demographics can be even more divergent for specific careers within the workforce. For example, although women comprise 47% of the total U.S. workforce, they make up less than 10% (Barbosa et al. 2017) of the construction workforce and only 1.7% of the HVAC workforce (Electric & Gas Industries Association 2018).

McKinsey & Company (2017) writes, "The shift from manual labor, which is typically male-dominated, to new technology-enabled ways of working could mean increased interest from women. Construction needs to diversify its sources of talent to attract the best people, and higher female participation is a large opportunity" (Barbosa et al. 2017).

Students considering various career paths or fields of study are generally unaware of the benefits of an energy efficiency career or the fact that many energy efficiency jobs are high-tech jobs requiring a foundation in science, technology, engineering, and math (STEM). To obtain high-paying energy efficiency jobs, students need a solid foundation in STEM subjects.

Even with the promise of higher wages, many students are not pursuing STEM degrees. A 2017 Pew Research survey sheds some light on the reasons behind this counterintuitive predicament. Respondents believe that STEM subjects are not useful for their careers or that these subjects are too boring to pursue as a course of study (Kennedy, Hefferon, and Funk 2018).

McKinsey & Company (2017) reports, "The [construction] industry has an image of being dull among the latest generation of top-talent engineers and interdisciplinary managers who can run projects of substantial complexity." The report highlights the approach Germany has taken to publicize apprenticeships and provide students with information to generate enthusiasm. Germany's approach has resulted in two-thirds of German high school graduates choosing vocational programs (Barbosa et al. 2017).

A White House task force on expanding apprenticeships noted that "a key facet of developing a revitalized apprenticeship approach is changing the ingrained societal mind-set that a traditional four-year baccalaureate degree is the only pathway to success," and suggests that because high schools are measured by the number of graduates entering college, high school counselors tend to focus on students getting into four-year college degree programs (Task Force on Apprenticeship Expansion 2018). Emulating Germany's approach to vocational programs and generating enthusiasm about efficiency careers among students will help increase the applicant pool for energy efficiency employers.

Conclusion and Opportunity

To fully realize the potential of high-performance buildings and efficient technologies, the future workforce will need more building science knowledge across a wide range of professions. Addressing energy efficiency employers' challenges in finding skilled workers will take an intentional effort to attract more people to the field, improve their skills, and make entry to the field more straightforward.

BTO is leading an effort to address hiring challenges faced by energy efficiency employers by facilitating a range of activities that will expand the pool of skilled workers interested in energy efficiency. One effort is the Better Buildings Workforce Accelerator. This Accelerator, launched in June 2020, is a three-year effort that brings like-minded organizations together to work toward common goals that improve the energy efficiency workforce. The Workforce Accelerator has three broad objective areas:

- **Build Interest**: Increase the awareness and diversity of the energy efficiency field. Showcase building energy efficiency careers as welcoming, impactful, and rewarding. Build awareness of these careers.
- **Streamline Pathways**: Clarify the pathways for building energy efficiency careers. Incorporate efficiency education into established programs.
- **Improve Skills**: Update continuing education modules. Improve building science curricula. Increase training on digital tools to manage performance and fault detection.

Accelerator partners gain access to subject matter experts to help embed more building science into training and education programs, upgrade laboratory or training facilities, and learn from successful approaches and programs. This three-year effort supports BTO's vision of the U.S. building workforce as a global leader in delivering quality efficiency products and services to American residents and businesses, thereby increasing energy affordability across the economy. Organizations can learn more and join the effort at by going to the Better Buildings Workforce Accelerator web page.

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