Building a Workforce for Energy-Efficient Homes

Rohini Srivastava, Roxana Ayala, and Alex Aquino

February 2025
Research Report

ACEEE

About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

About the authors

Rohini Srivastava conducts research focusing on innovative programs to increase energy efficiency in buildings, the workforce skills needed to advance high-performance building technologies and zero-energy buildings, and the multiple benefits of efficiency retrofits.

Roxana Ayala conducts research, writing, and technical support on local-level energy efficiency policies and initiatives, with a focus on energy equity and workforce development.

Alex Aquino conducts research on residential electrification, workforce development, advanced building technologies, and federal energy efficiency policies, with a focus on equitable program implementation.

Acknowledgments

This report was made possible through the generous support of A. O. Smith, CenterPoint Energy, Commonwealth Edison (ComEd), Northwest Energy Efficiency Alliance (NEEA), Pacific Gas and Electric Company (PG&E), Xcel Energy, and the U.S. Department of Energy's Office of State and Community Energy Programs (SCEP). The authors gratefully acknowledge external reviewers, internal reviewers, colleagues, and sponsors who supported this report. External expert reviewers included Joshua Greene (A.O. Smith), Suzi Asmus (NEEA), Lester L. Sapitula (PG&E), Allison Moe (NREL), Jenny Wiedower (Building Technologies Office at the U.S. Department of Energy), Angela Dayton and Emily Audet (SCEP), and Laure-Jeanne Davignon (LJDMC). Internal reviewers included Forest Bradley-Wright, Steven Nadel, Nora Esram, and Matt Malinowski. External review and support do not imply affiliation or endorsement. Last, we would like to thank the following members of ACEEE's editorial and communications team: Mary Robert Carter, Lynn DeRocco, Kate Doughty, Rob Kerns, Nick Roper, Mark Rodeffer, Ethan Taylor, Roxanna Usher, and Mariel Wolfson.

Suggested citation

Srivastava, Rohini, Roxana Ayalam and Alex Aquino. 2025. *Building a Workforce for Energy-Efficient Homes*. Washington, DC: ACEEE. www.aceee.org/research-report/b2501.

Data and licensing information

Contents

Executive summary

Key findings

- Residential decarbonization projects have the potential to spur job growth, but employers report challenges in finding skilled workers. Without strategies to overcome these challenges, workforce shortages will hinder progress on decarbonization efforts. Common challenges to growing a robust energy retrofit workforce include low awareness of energy efficiency careers, a shortage of training programs that align with market needs, inadequate support for professional development for career advancement or accessing new jobs, and inconsistent contractor licensing requirements.
- This report recommends several strategies to overcome those challenges, such as conducting outreach to increase workforce program participation from underrepresented populations, creating and implementing standardized curricula, partnering with community-based organizations to provide wraparound services in job training programs, and offering and aligning accessible resources to contractors to help meet licensing requirements.
- Collaboration between workforce program administrators, community organizations, and employers can lead to an aligned approach to training on market-informed technical skills, soft skills, and wraparound services that may help to improve worker retention and career advancement.
- Government agencies and trade organizations are helping to standardize training materials. A standardized and industry-informed curriculum enables manufacturers, industry organizations, and training organizations to provide quality training, expand workers' knowledge, and enhance workers' skills to perform energy efficiency projects.
- This report highlights several workforce programs that focus on students, unemployed individuals from communities of color, and workers seeking to upskill and offer them opportunities to acquire new skills, contribute to residential decarbonization projects, and make the workforce more inclusive.
- Some utilities, manufacturers, lending institutions, and nonprofits are investing in career development activities to motivate and support professionals who are interested in upskilling for energy efficiency jobs or contractors who want to grow their businesses. Support may include flexible training (e.g., in-person or hybrid) or financial aid for contractor businesses to allow for completion of trainings.

Growing and training a workforce with the skills to perform residential building decarbonization jobs is necessary for improving the energy efficiency and resiliency of homes in the United States. Recent federal and local building decarbonization commitments and actions are increasing the demand for

energy auditors, HVAC technicians, heat pump installers, electricians, and constructions workers. Between 2022 and 2023, 74,700 new energy efficiency jobs were added, increasing the total workforce in this sector to 2.3 million.[1] However, too few programs help individuals learn about and prepare for these jobs. To respond to this demand and ensure that workforce education and training meet the needs of employers and provide professional development to workers, investments in the energy efficiency workforce development ecosystem are necessary. The ecosystem of interconnected stakeholders—including workforce and education organizations, government agencies, credentialing agencies, policymakers, utilities, lenders, organizations providing wraparound services and soft skills, employers, and the learners—needs to work cohesively to grow a robust workforce that can advance decarbonization efforts.

This report summarizes findings from interviews with 35 workforce experts, provides an overview of common workforce challenges, and profiles programs with demonstrated success in expanding the residential workforce. Additionally, it highlights actions that stakeholders in the energy efficiency workforce ecosystem (e.g., government agencies, utilities, training institutions, and community-based organizations) can consider as they prepare and train workers to deliver decarbonization projects that help homes reduce greenhouse gas (GHG) emissions.

Existing programs demonstrate strategies to grow the workforce

We found five common challenges that hinder the growth of a residential retrofit workforce. Case studies in the report offer strategies that program administrators can consider when designing and implementing programs to overcome existing challenges. For example, an energy auditor pre-apprenticeship program in West Virginia helps overcome negative perceptions about clean energy jobs by offering trainees hands-on experience and exposure to real-life job scenarios. Table ES1 highlights the workforce challenges and the strategies to address them.

Table ES1. Commonly discussed challenges and strategies to grow the workforce from program case studies

Challenges	Strategies
Low awareness and negative perceptions about careers	- Conduct outreach and provide information about energy efficiency jobs to people who may be interested in new career opportunities, including K–12 and career and technical education students, and both unemployed and employed individuals. - Enhance community engagement and connect existing workforce training resources with underrepresented community members to boost workforce diversity. - Braid multiple funding sources to broaden outreach to trainees and expand program offerings to support training of underrepresented populations.
Shortage of programs that integrate technical skills, soft skills training, employer needs, and market demands	- Collaborate with employers, higher education institutions, and community organizations to integrate training on technical and soft skills and provide support services. - Work with employers to develop curriculum and resources based on market needs, recruit participants for trainings, and create career pathways for trainees.

[1] DOE (U.S. Department of Energy) Office of Energy Jobs. 2024. "United States Energy & Employment Report 2024." https://www.energy.gov/sites/default/files/2024-08/2024%20USEER%20FINAL.pdf.

Challenges	Strategies
	- Provide career coaching, employment services, and accessible training (e.g., training in multiple languages) for underrepresented populations to help create an inclusive workforce.
Insufficient skills due to lack of access to standardized technical curricula	- Make standardized curricula widely available that clearly identify the technical skills that are taught to help workers demonstrate that they have acquired skills that align with their new career goals. - Prioritize and widely promote credentials that are stackable and employer recognized, help workers enhance their skills, and enable career advancement. - Offer multiple training options, including online, hybrid, and lab and on-the-job hands-on training with flexible timelines for completion to meet trainee schedules.
Inadequate support for access to new jobs, professional development, and career advancement	- Partner with community organizations to offer wraparound services and personal case management support to encourage underrepresented populations to participate. - Recruit employers in workforce programs committed to hiring training program graduates and offer trainees opportunities to learn from professionals in the field and explore new opportunities and pathways for career growth. - Compensate program participants while they undergo training.
Burdensome contractor licensing requirements and business practices	- Offer accessible and standardized training to contractors to help them acquire skills that employers are seeking and meet licensing and continuing education requirements. - Train contractors on user-friendly tools for designing and implementing technologies. - Provide financial support and financing to cover contractors' upfront costs to incentivize contractors to complete projects.

Stakeholders need to act now to expand the workforce

In addition to the existing strategies modeled by workforce programs, we propose immediate actions for utilities, government agencies, training institutions, and others to develop an effective energy efficiency workforce development ecosystem as they design and implement programs to respond to residential sector decarbonization needs. Employers will play an integral role in growing the workforce as they can advise on designing trainings to meet market demands and help establish pathways to jobs for program graduates. Stakeholders can consider the following to strengthen workforce skills and overcome the five identified challenges:

- ***Standardize knowledge and skills across residential decarbonization occupations***. Government agencies at the federal or state level, employers, and industry and labor organizations can influence the direction and design of training for jobs needed to decarbonize the residential building sector. For example, the Pacific Northwest National Laboratory (PNNL) created training materials for new technologies, such as heat pumps, and has centralized available resources.
- ***Increase awareness of different energy efficiency careers for existing and future workers.*** Government agencies, nonprofits, industry and labor organizations, training institutions, and utilities will need to engage K–12 students and individuals from underrepresented communities to help diversify the workforce, and reach out to incumbent workers to highlight opportunities to acquire new skills and contribute to decarbonization goals.
- ***Integrate technical education, soft skills training, and support services in programs***. Utilities, nonprofits, and labor and trade organizations that provide workforce training must collaborate

with employers and community organizations to offer a balanced approach to technical and soft skills training that reflects the skills needed for the available jobs and serve the prospective employer's hiring needs.[2] Community organizations can provide supportive services for new entrants to join the industry, earn competitive wages, and advance in their careers.

- ***Invest in trainee or employee career development initiatives***. Utilities, manufacturers, lending institutions, and nonprofits should support career development activities that help motivate and support professionals to enhance their skills and career. For example, networking opportunities for trainees can help them learn about industry jobs and their responsibilities, access coaching and employment placement services, or explore training that can help advance their careers or update their skills to maintain their existing employment.
- ***Address contractor licensing and needs through training and financial resources***. Stakeholders, including government agencies, nonprofits, utilities, training institutions, community organizations, manufacturers, and lenders like green banks that finance energy efficiency projects, will need to create resources to prepare contractors and enable them to deliver projects. For example, favorable lending terms to cover the upfront contractor costs can encourage them to accept jobs that accelerate decarbonization efforts or to pursue related training.

[2] Soft skills are competencies often required by employers to help professionals navigate the workplace, such as time management, communication, critical thinking, and teamwork.

Introduction

In recent years, many U.S. cities and states adopted ambitious goals to reduce greenhouse gas (GHG) emissions from buildings, including commitments to ensure that more buildings are energy efficient and use electric space and water heating systems. For example, in September 2023, a bipartisan coalition of 25 governors representing 60% of the U.S. economy and 55% of the U.S. population agreed to collectively install 20 million heat pumps by 2030 (U.S. Climate Alliance 2023).

However, many of these goals will only be achieved with a workforce that is ready to translate these investments into action. Residential decarbonization projects that shift a home's reliance on fossil fuels and reduce GHG emissions have the potential to generate economic development opportunities, including the creation of thousands of jobs, which is likely to increase due to the investments from the Inflation Reduction Act (IRA) and the Bipartisan Infrastructure Law (BIL). If electrification progresses at the pace required to meet the United States' climate goal of achieving net-zero emissions by 2050, over 1.1 million net direct jobs will be created in the residential electrification workforce by 2035. Of these, more than 890,000 will be for electricians and HVAC professionals to install electric appliances and technologies (Herr, Kanj, and Wyent 2024).

Despite these needs and opportunities, employers cite persistent challenges in finding workers to complete residential efficiency and electrification retrofits. Common challenges that employers cite include insufficient skills or experience, small pools of professionals, and professionals lacking industry-specific knowledge or certifications (DOE 2024). Workforce, education, and training programs can help upskill workers and create opportunities for individuals entering a new field. Investments in the energy efficiency workforce development ecosystem can help deliver trainings and resources to prepare individuals and ensure that they are appropriately trained for in-demand jobs. The stakeholders of the ecosystem—workforce and education organizations, lenders, government agencies, credentialing agencies, organizations providing wraparound services and soft skills, policymakers, utilities, employers, and the learners—can work together to address existing challenges and grow a robust workforce.

This report highlights actions that workforce program administrators and other stakeholders can prioritize to prepare workers to deliver residential decarbonization projects. We profile case studies of workforce programs led by training organizations, government agencies, manufacturers, utilities, and community-based organizations and highlight their successes in overcoming market and employment challenges. The key audiences for this report are energy efficiency workforce program administrators or implementers, including government agencies, utilities, training centers, and community organizations.

We conducted a literature review to understand workforce occupations, required skills, and obstacles to filling positions. We interviewed 35 workforce experts to learn how they support workforce growth and training and understand the challenges experienced by job seekers or building retrofit professionals[3] as they navigate training and employment opportunities. Interviewees included workforce program administrators and evaluators, utilities, workforce trainers, contractors, and government offices engaged in workforce development programming, planning, or implementation. The interviews yielded information on the categories of jobs for residential building decarbonization (as shown in figure 1), workforce challenges, and the programs that bridge skills gaps and attract new entrants to the field.

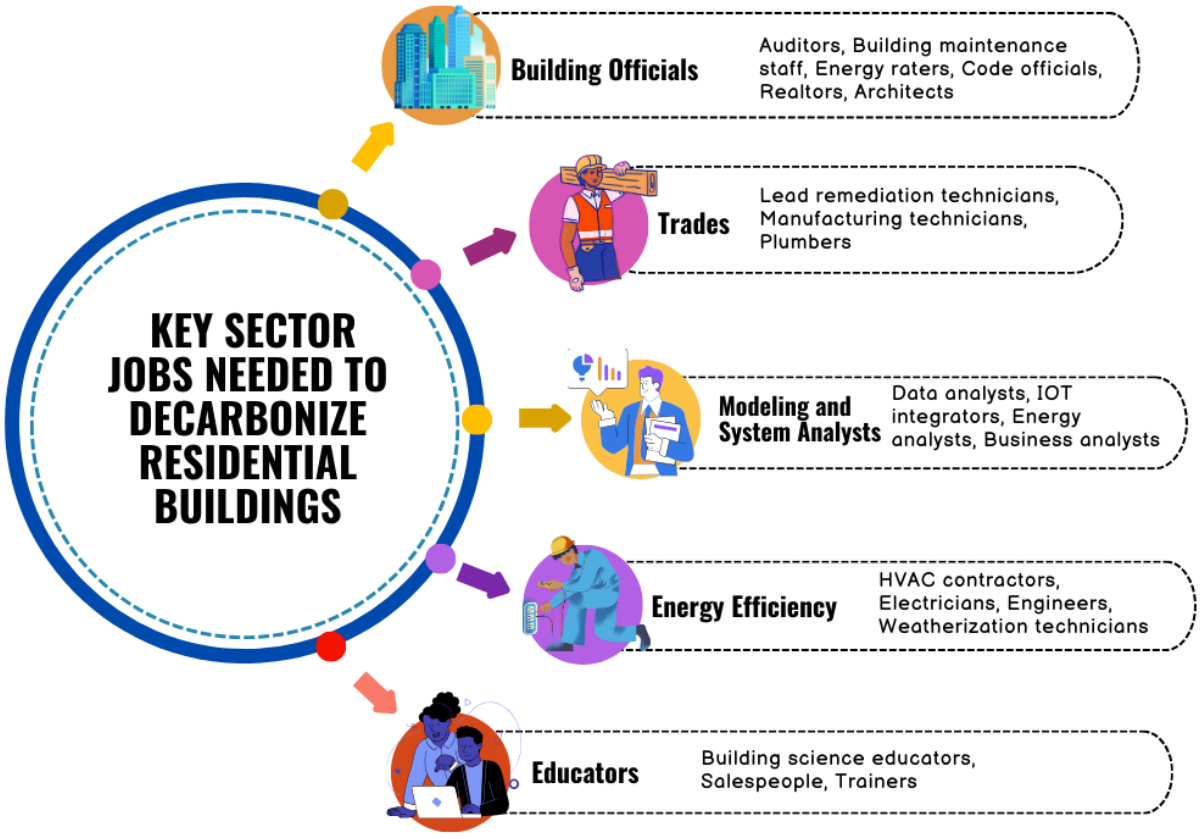
[3] We define building retrofit professionals as individuals who require specific training, education, or skills to perform retrofits.

Residential decarbonization workforce jobs and skills

We define residential decarbonization retrofits as the measures and upgrades that need to be implemented in residential buildings to reduce and eliminate GHG emissions, examples of which include installing efficiency and electrification technologies. The retrofits can include a comprehensive upgrade or replacement of outdated building envelope components; heating, ventilation, air-conditioning, refrigeration (HVACR) systems; and water heating technologies. These retrofits aim to significantly enhance a building's energy performance. By implementing advanced, energy-efficient systems, the retrofits not only reduce carbon emissions but may also improve indoor air quality, occupant comfort, and overall building sustainability (ACEEE 2023).

As federal and state investments scale the number of decarbonization retrofits, many occupations will see growth, including construction workers, energy auditors and others who work on understanding building electricity usage, savings, and optimization; weatherization workers (Brown et al. 2023); HVAC installers and technicians, including heat pump installers (NEEP 2024); skilled tradespeople, including electricians and plumbers; heat pump water heater and heat pump service and maintenance technicians; sales and marketing professionals; and decarbonization project integrators who can oversee project implementation and finances.

In addition to the traditional trade occupations, such as electricians and plumbers, who have always worked on residential buildings, we will need people with new skills for the new technologies. For instance, HVAC engineers, sales and service teams, and maintenance personnel with expertise on heat pump technologies are key jobs needed to ensure the success of projects. Figure 1 highlights the occupations, and the skills needed to decarbonize residential buildings.



Skills category	Proficiencies
Systems design and performance modeling	- understanding of energy performance of existing homes - modeling and designing high-performance systems and demand-side management solution - electrical or codes tracking and compliance - marketing skills to promote and sell decarbonization projects
Systems integration	- sizing and installing heat pumps and ventilation systems according to local adopted building and energy codes, manufacturer specifications, building science best practices, and industry standards - finding appropriate space and electrical and condensate connections for heat pump water heaters and complete electrical upgrades to support home electrification - applying insulation and air sealing materials and other weatherization measures - Integrating new demand response technologies
Systems testing and evaluation	- conducting diagnostic tests, including air leakage and blower door assessments and performing load calculations - analyzing energy use and using basic math to identify savings
Data acquisition and analysis	- computing skills to calculate the energy savings - database management abilities
Operations and maintenance	- commissioning skills to test and adjust installed equipment to ensure that it performs in accordance with manufacturer specs and design goals - maintenance and servicing skills to troubleshoot equipment failures

Figure 1. Sampling of decarbonization retrofit roles and proficiencies based on stakeholder interviews and five categories of buildings-related skills identified in ACEEE's 2020 report (Srivastava, Awojobi, and Amann 2020)

Findings: The roadblocks to workforce development and strategies to overcome them

This report focuses on five common challenges that are preventing the growth of a retrofit-ready workforce. We also present case studies that demonstrate how programs have addressed them. The five categories of challenges are listed below, with specific details for each in the following section. All five are equally important.

- Low awareness and negative perceptions about energy efficiency careers
- Shortage of programs that align technical skills, soft skills training, and market demands
- Insufficient skills due to lack of access to standard curriculum and technical training
- Inadequate support for access to new jobs, professional development, and career advancement
- Inconsistency in contractor licensing requirements and existing business practices

The challenges were identified through a literature review and stakeholder interviews. Overcoming them can prepare the workforce for the decarbonization occupations highlighted in figure 1.

Challenge: Low awareness and negative perceptions about careers

The table below highlights the challenge of individuals not wanting to join the building trades or energy efficiency industry due to low or negative perceptions about the work they will perform. The table summarizes the challenges described by interviewees, actions to prioritize, and the organizations that are best suited to address this challenge. The selected case studies describe how two organizations designed programs to expose participants to residential decarbonization jobs, increase awareness of available jobs, encourage individuals to join the workforce, and support professional development.

Challenges (all equally important)	• Lack of basic information about energy careers and occupations to complete retrofits early on in formal school education and access to a defined network of education and technical resources later to create an effective career pathway (BW Research Partnership 2021) • Lack of educational resources and outreach to non-English speakers (Miniard et al. 2023) • Negative perception and bias of joining the building trades, as they are viewed as less prestigious of a profession (Salzman 2021; Truitt et al. 2022) and there is a stigma of pursuing a trade versus a four-year college education (Gill et al. 2023) • Contractor bias against doing the energy efficiency projects driven by an unwillingness to learn about new technologies because of limited funds to upskill or lack of exposure to technologies or experience with new technology (ICAST 2022; Lis 2023)
Actions to overcome challenges	• Conduct outreach and provide information about energy efficiency jobs to people who may be interested in new career opportunities, especially K–12 and career and technical education students, underemployed people of color, underrepresented communities, and unemployed and employed individuals in efficiency-adjacent trades. • Enhance community outreach and connect existing workforce training resources in languages besides English with individuals looking to join the industry and leverage growth in the residential decarbonization sector to boost workforce diversity. • Braid multiple funding sources to broaden outreach to potential trainees and expand program offerings to support underrepresented populations.
Workforce stakeholders who can act	Local governments, nonprofits, utilities, education and training institutions, green banks, and community-based organizations
Examples of programs that overcome these challenges	City of Milwaukee's Green Jobs Accelerator*; Coalfield Development and Everblue Energy Auditor Pre-Apprenticeship*; Pacific Gas and Electric's and the California Public Utilities Commission's Energize Careers; ComEd's SEM Student Advisor Internship

*Indicates programs profiled in case studies below

We discuss a few of these example programs in the sections below. The programs are classified as either in the planning stage (and looking at new concepts to overcome known challenges) or established within the last five years with results to demonstrate the approaches that have proven to work.

Milwaukee's Green Jobs Accelerator (planning stage)

The Milwaukee Green Jobs Accelerator shows how local governments can build the residential decarbonization workforce through direct community engagement and socioeconomic development. The accelerator supports pathways to various building efficiency occupations, such as electricians, HVAC installers, and weatherization workers. The program markets green careers and raises awareness about overlooked roles by emphasizing quality jobs with competitive salaries and advancement opportunities.

Program description

In June 2023, Milwaukee adopted the Wisconsin State Climate and Equity Plan as part of the city's strategy to reduce GHG emissions by 45% by 2030 and to achieve net-zero emissions by 2050 (City of Milwaukee 2023c). This plan included creating green jobs and improving racial and economic equity through multiple actions. The Green Jobs Accelerator addresses that goal and aims to foster skills and interest in green jobs, increase diversity in the field, provide living-wage employment, establish community benefits agreements for public projects, offer subsidized training, support minority-owned businesses, and identify transitional jobs with career progression opportunities.[4]

The City of Milwaukee and Employ Milwaukee, the Milwaukee County Workforce Development Board, lead the accelerator and collaborate with Milwaukee Public Schools, training providers, employers, and workforce organizations. Training is available for many trades, including electricians and HVAC and building controls; solar, water, and energy technology; and weatherization workers, with a focus on preparing individuals for a wide range of occupations, from engineers to salespeople and support providers (City of Milwaukee 2023b). Support is included for commercial driver license training, coaching on negotiating with employers, implementing Community Benefits Agreements on projects, and career coaching to assist with job matching, training completion, and job retention.

Improving awareness and overcoming perceptions about residential decarbonization jobs

The accelerator focuses on providing multiple resources for green job training with the goals of increasing diversity in the sector and improving awareness and perceptions about careers in the field. To reach minority and underserved populations, the City of Milwaukee will use support coaches to market career and training opportunities at the community level. This approach helps address the lack of basic information about the available careers in the field. Effectively communicating the opportunities and the key skills required for each role and providing resources and support through coaches can impact recruiting, engaging, and attracting new talent. The city plans to collaborate with local workforce institutions and employers to reduce employment barriers by creating a direct employment pathway for Green Jobs Accelerator participants who complete training (City of Milwaukee 2023a).

Program impacts

The Green Jobs Accelerator seeks to support jobs with entry-level salaries of at least $40,000 per year, with a commitment that 40% of these positions will be filled by people of color, using a strategy similar to the Justice40 Initiative. The city's strategy includes subsidizing these jobs through various funding sources, such as federal grants, and providing job-specific training through apprenticeships and internships. These time-limited positions provide valuable experience, helping workers build skills in the energy efficiency sector and secure full-time employment. The city's Environmental Collaboration Office

[4] The Department of Labor defines "transitional jobs" as employment that provides a time-limited, wage-paid, and subsidized work experience for individuals with employment barriers, long-term unemployment, or inconsistent work history. These jobs help build work history and skills for full-time employment.

(ECO) will provide information on local union jobs, technical college training programs, and a range of career and training opportunities for workers across various residential decarbonization roles.

The accelerator will connect national green job pathways illustrated in the Green Buildings Career Map and the Interstate Renewable Energy Council (IREC) Solar Career Map with local training providers. The program will operate neighborhood recruitment centers to provide services to high school students, underemployed people of color, unemployed residents, and incumbent workers, using the growth in residential decarbonization to showcase green careers and help them find jobs. Milwaukee plans to leverage federal funds to further enhance recruitment outreach and expand program resources.

Coalfield Development and Everblue: Energy Auditor Pre-Apprenticeship

The energy auditor pre-apprenticeship program offered a pathway to an energy auditing career, a critical occupation for decarbonizing buildings. A local nonprofit and a nationwide training provider partnered to offer this pre-apprenticeship, through which the participants gained skills and knowledge of building science and increased awareness of clean energy jobs. This approach provided hands-on experience and exposed participants to real-life situations in the field, thus helping overcome negative perceptions about clean energy jobs.

Program description

This pre-apprenticeship program in West Virginia responds to the growing demand for skilled professionals to deliver clean energy projects. The energy auditor pre-apprenticeship was developed through a partnership between Everblue, a nationwide IREC- accredited training provider, and Coalfield Development, a nonprofit organization dedicated to rebuilding the Appalachian economy with direct service work in southern West Virginia (BPA 2024). To reduce economic barriers for people in the pre-apprenticeship, Coalfield offered a $75 stipend for each day participants attended training ($375 per week).

The seven-week pre-apprenticeship offered flexibility and convenience to participants to gain technical skills and train for a career in the energy efficiency sector. In the first four weeks, participants engaged in technical training focused on basic building science principles and took the following courses (Everblue Training n.d.):

- BPI Building Science Principles
- BPI Infiltration & Duct Leakage
- BPI Building Analyst Technician
- Green Building Basics
- Industrial & Commercial Energy Auditor
- BPI Multifamily Building Analyst

Additionally, participants received Occupational Safety and Health Administration (OSHA) and OSHA 10-hour construction safety training to cover the safety basics required before starting new employment. In the remaining weeks, individuals participated in professional development activities (fifth week) and on-the-job training (sixth and seventh weeks). The program offered a mix of classroom, online, and hands-on learning experience to help individuals upgrade their skills to obtain jobs as energy auditors (BPA 2024). In addition to the technical training offered by Everblue, Coalfield worked with participants on personal and professional development skills to enhance their job readiness and help them overcome employment barriers.

During the hands-on learning phase, participants shadowed a building auditor to learn common tasks completed by energy auditors. For example, participants learned how to perform blower door and duct blaster tests and assess duct leakage and infiltration. Upon completing the technical training, participants were encouraged to pursue several certifications. With the knowledge and skills gained under the apprenticeship, participants are qualified to pursue the following certifications: Building Performance Institute (BPI) Building Technician, BPI Building Science Principles, BPI Building Analyst Professional, Home Energy Professional (HEP) Energy Auditor, HEP Quality Control Inspector, and Healthy Home Evaluator (Everblue Training n.d.).

Increasing exposure and overcoming perceptions related to residential decarbonization jobs

The energy auditor apprenticeship increased participants' exposure and helped improve their perceptions about residential decarbonization jobs. The pairing of students with a building analyst expert and job shadowing helped facilitate professional growth as experts share knowledge and expectations about the day-to-day duties and responsibilities of an energy auditor. In addition, the experts offer practical knowledge not often included in standard curricula, such as workplace scenarios and information about potential job wages and benefits. This type of networking and feedback allows participants to better understand and learn about the different careers, especially those in new markets like residential decarbonization. This program structure can increase candidates' understanding of energy efficiency jobs and manage their expectations, which is especially important as employers and trainers seek to fill jobs in the decarbonization sector.

Program impacts

In 2024, 10 people graduated from the program. The program administrators report that four people have successfully obtained jobs as energy auditors and two have obtained jobs in other adjacent fields.

Challenge: Shortage of programs that integrate technical skills, soft skills training, employer needs, and market demands

A persistent issue in the residential decarbonization retrofit sector is the limited number of comprehensive programs that co-deliver technical and soft skills training to meet the needs of the job market. Employers play an integral role in closing this gap as they can (1) advise on programs that use and teach both technical and soft skills, (2) tie market demands to training, and (3) establish pathways to jobs for program graduates. Below the following table, we present a case study that demonstrates how a New Jersey-based utility, PSE&G, successfully integrated on-the-job and soft skills training into its workforce training program.

Challenges (all equally important)	• Failure to integrate up-to-date technical content training with soft skills training (e.g., work ethic, dependability, critical thinking) (Capps et al. 2022). • Absence of family-supporting wages to cover the cost of training for new occupations and lost business due to the time away from projects (for existing workers) (Berkowitz 2019). • Low priority to make the programs more inclusive and representative of the population that they serve (MacPherson and Ayala 2019), including a lack of multilanguage curriculum delivery. • Lack of support for training the trainers and employers to improve the learning experience for adult learners (Berkowitz 2019).

Actions to overcome challenges	• Collaborate with employers, higher education institutions, and community organizations to integrate a balanced approach to training that includes essential technical skills, workforce readiness, financial literacy education, and wraparound services with a provision for initiatives that equip experienced trainers with technical skills to provide an optimal learning experience for participants. • Work with employers to develop curriculum and resources based on market needs, recruit participants for the trainings, and create career pathways for trainees. • Job coaching for participants from underrepresented populations to prepare them for a specific occupations, multilingual training to prepare them to partner with English-speaking crews, and placement services for positions in partnership with employers and suppliers to make the workforce more inclusive.
Workforce stakeholders who can act	Federal and state government agencies, nonprofits, utilities, education and training institutions, and industry labor and trade organizations
Examples of programs that overcome these challenges	PSE&G's Clean Energy Jobs Program*; Emerald Cities Collaborative (ECC) HVACR Training and Career Preparation Academy; East Bay Building Trades Construction Trades Workforce Initiative for union construction careers; Penn College's Residential Building Installer Training program; Louisiana Green Corps; Green Retrofit Immersive Training (GRIT) program

*** Indicates programs profiled in case studies below**

PSE&G: Clean Energy Jobs Program

This program highlights how utilities can expand the residential decarbonization workforce to provide training and support for workers to develop the necessary skills to fill HVAC installer, energy auditor, and building analyst roles. The program offers both current and new workers paid on-the-job training, wraparound services, and access to industry experts to align skills with market demands.

Program description

In 2021, PSE&G partnered with the New Jersey Department of Labor (NJDOL) to launch the Clean Energy Jobs Program, following a state bill mandating utility companies to implement energy efficiency measures. This initiative aims to boost the workforce required for residential decarbonization, with New Jersey needing upward of 41,500 energy efficiency jobs by 2030 to meet its decarbonization goals (E4 The Future 2021). The program prioritizes equity and diversity, striving for a more inclusive clean energy workforce in New Jersey.

The NJDOL provided an initial $1 million for this program, with PSE&G providing grants of $75,000 to $166,500 to nonprofits, governmental agencies, for-profit trainers, and community organizations for training (State of New Jersey 2021) and placing at least 2,000 New Jersey residents in energy efficiency jobs. The program funds multiple activities, including workforce readiness, financial literacy education, and more than 55 wraparound services in partnership with community organizations to overcome participant challenges related to childcare access, transportation to job sites, and job coaching and placement services with PSE&G's contracted suppliers. Monthly training sessions led by industry experts are included to train new employees and upskill current employees. PSE&G collaborates with employers to tailor these trainings to essential industry skills.

Additionally, PSE&G offers a paid four-month on-the-job training (OJT) with utility trade allies and subcontractors, encouraging transitions to full-time roles. Job placements span various energy efficiency

occupations, including HVAC technician, energy auditor, weatherization technician, field technician, and sales representative. The program offers an additional career advancement opportunity through monthly BPI certification sessions. Participants can choose from different vendor-led BPI certifications that cover a wide range of topics, such as building science principles, air leakage control installation, and multifamily building analysis (Mansano 2024).

Inclusive workforce growth with technical training and support services

The program is industry recognized for its focus on strengthening the workforce through comprehensive guidance on careers in energy efficiency and advancement opportunities. It partners with minority-serving and community-based organizations to create a network of robust wraparound services that improve access to jobs and diversify the existing workforce.

PSE&G supports both new and incumbent workers, as well as business owners, offering them different training options with set employment timelines ranging from month-to-month and drop-in sessions that cover relevant technical skills and career enhancement coaching. The program offers technical resources and support for various building decarbonization roles that align the needs of the employers and the market with the skills job seekers require to meet industry demands.

Program impacts

Since creating the program, PSE&G has run multiple on-the-job-training cohorts. By June 2023, the program had exceeded its initial goals, placing more than 2,400 people in energy efficiency jobs and partnering with over 40 organizations (PSE&G 2022). PSE&G has partnered with the African American and Hispanic statewide chambers of commerce to achieve its equity goals and diversify the workforce and benefit underserved communities (Mansano 2024). The program has provided job training to over 700 participants and business development coaching to minority-owned businesses, helping more than 50 become certified minority, woman, or veteran-owned business enterprises (MWVBE).

Challenge: Insufficient skills due to lack of access to open-source standard curricula and technical training

The table below outlines the challenges of fragmented workforce training and credentialing. We indicate the key workforce stakeholders who can overcome this challenge. This case study describes how the DOE created a program to prepare professionals for energy efficiency projects by standardizing the training curriculum.

Key challenges (all equally important)	• Lack of national skill standards for emerging energy-related jobs due to low market demand and uptake; certifications exist but are fragmented and do not build on each other or integrate with existing programs (Guo et al. 2023; Srivastava, Awojobi, and Amann 2020; Grant, Fischer, and Nelson 2017). • Traditional academic training programs focus more on basic academic knowledge than enhancing field skills to size and install new technologies, such as heat pumps (NEEP 2023). • Length of training to achieve certifications varies and can be perceived as being disruptive to business, rather than a key driver of work quality.
Key actions to overcome challenges	• Make open-source standardized curricula widely available and clearly identify the technical skills aligned with different career pathways.

	• Prioritize credentials that are stackable and employer recognized, help workers enhance their skills, and enable career advancement. • Offer multiple training options, including online and hands-on training modules with flexible completion timelines to meet participant schedules.
Workforce stakeholders who can act	Federal, state, and city government agencies, nonprofits, manufacturers, and education and training institutions
Examples of programs that overcome these challenges	DOE's Energy Skilled Recognition*; Arizona Heat Pump Council's Master Heat Pump Technician Program; Efficiency Maine's Heat Pump Installer program; MassSaves Training and Workforce Training Grant Program

* Indicates programs profiled in case studies below

Energy Skilled Recognition

This case study highlights a national program that standardizes training for contractors and HVAC installers to upskill in electric heat pump technology, a crucial technology to decarbonize the residential sector. The Energy Skilled Recognition program can play a key role in standardizing the training curriculum and aligning workforce skills with residential retrofit market needs.

Program description

The DOE launched the Energy Skilled program in 2023 to recognize industry credentialing and training programs that prepare workers for careers in the clean energy sector. The recognition signifies that a training program and its certifications align with clean energy transition goals set forth by the DOE. The program helps promote energy efficiency and standardizes building science education for key occupations and knowledge areas.[5] The initiative recognizes training programs and certifications that align with the DOE's Building Science Education topics of heat pump installation, heat pump water heater installation, and home energy assessments for single-family and multifamily buildings (PNNL 2024). An additional category focused on residential envelope programs is currently under development.

To receive Energy Skilled recognition, programs must incorporate specific topics and key concept knowledge in each training and credentialing program category. For example, under the heat pump installation recognition category, training programs must include training on retrofitting fossil fuel systems, electric panel capacity, and other essential knowledge areas to ensure that participants are well equipped to complete decarbonization retrofits successfully. Organizations must review the criteria for each category to receive recognition and compare the required knowledge areas to their program offerings. Applicants complete a self-assessment of their program using the provided Scoring Tool and submit supporting materials to the Pacific Northwest National Laboratory (PNNL).

Addressing skills gaps and career advancement through standardized training curricula

The Energy Skilled program addresses the need for standardized curricula and training in the residential decarbonization sector. By establishing content and knowledge requirements for training programs and

[5] The DOE's Energy Skilled Recognition is awarded in collaboration with the Pacific Northwest National Laboratory (PNNL), which oversees the program and reviews and approves certification-seeking organizations.

certification organizations, the program standardizes the knowledge that trainees receive and ensures that they obtain consistent and relevant education. The program also benefits the credentialing organization, as it provides increased visibility and credibility through the Energy Skilled logo, which is proof of technical expertise and recognizes participation in a leading credentialing program.

Program impacts

Through the program, DOE and PNNL have recognized various training and credentialing organizations, including technology manufacturers, professional associations, home energy raters, trade unions, community colleges, and others that provide training to workers. For example, this recognition has been extended to the Association of Heating, Refrigerating, and Air-Conditioning Engineers' Building Energy Assessment Professional (BEAP) Certification; Mitsubishi Electric HVAC, Trane U.S. (METUS); and the Local Union No. 265 Sheet Metal, Air, Rail, and Transportation (SMART) labor union programs (DOE Office of Energy Efficiency and Renewable Energy n.d.). As of October 2024, a total of 42 programs have been recognized by the DOE.

In May 2024, METUS became the first manufacturer to receive Energy Skilled recognition from the DOE for its high-efficiency electric heat pump installation and comfort advising training program. This program offers in-person and online training for HVAC contractors with three to five years of experience, covering installation, diagnostics, and necessary skill sets for METUS heat pump technology.

Training is available at 11 company-owned and 112 distributor-owned centers across North America, all meeting technical and training standards for METUS technology. METUS utilized an existing training curriculum that is used across these training facilities. This approach helped the company establish a standard set of skills and knowledge throughout its national workforce. Since May 2024, more than 200 businesses have joined the certified training course, with half already having trainees who completed the course and earned Energy Skilled recognition.

Challenge: Inadequate support for access to new jobs, professional development, and career advancement

The lack of career advancement pathways and support can create challenges for professionals looking to upskill or seeking new job opportunities in the residential decarbonization sector. This table describes the challenges, including the lack of wraparound support, such as for access to transportation and childcare, which can limit additional learning, as well as for access to career planning and advancement opportunities once a participant has trained on new skills. The highlighted case study in this section describes how a Minneapolis-based nonprofit organization, Minnesota Center for Energy and Environment (CEE), provides wraparound services to help participants overcome such participation barriers, thus enabling them to complete training.

Challenges (all equally important)	• Lack of support services, including wraparound services, such as for transportation, childcare, and housing, to support learning (Berkowitz 2019; Madigan and Bonney 2021) and personal case management, including mental health and social service support, to overcome barriers related to access to basic needs • Limited job preparedness, including support for writing a resume, access to work clothing, and preparing for interviews (Lehmann et al. 2021) • Lack of access to career planning and post-training advancement support (e.g., job descriptions, catalog of available jobs for jobs seekers) (Fazeli 2021)

Actions to overcome challenges	• Partner with community-based organizations and enhance their capacity to offer comprehensive wraparound services and personal case management support for trainees to encourage underrepresented populations to participate in trainings, join the field, and advance their careers once new skills are obtained. • Recruit employers in workforce programs that have made commitments to hire training graduates who meet defined criteria and offer networking opportunities with professionals in the field to facilitate knowledge exchange and explore pathways for career growth. • Compensate or offer stipends to participants while they undergo training.
Workforce stakeholders who can act	State and local government agencies, nonprofits, utilities, training institutions, and community-based organizations
Examples of programs that overcome these challenges	Center for Energy and Environment (CEE) and Xcel's Home Energy Career Training* ; Pacific Gas and Electric (PG&E) Workforce Education and Training Resources; Walker Miller's DT, Nicor, and Consumers' Energy program

* Indicates programs profiled in case studies below

CEE/Xcel Energy: Home Energy Career Training Program

For this challenge, we highlight a utility-supported program that helps participants gain an understanding of home energy efficiency approaches and offers a path to energy auditing and HVAC careers. We also describe how this case study offers wraparound services to help participants overcome barriers to participation and navigate employment.

Program description

The energy efficiency industry is a strong component of Minnesota's clean energy economy. A local nonprofit organization, the Center for Energy and Environment (CEE), is contributing to the growth of the industry by helping homes, businesses, and the community improve their energy efficiency and scaling the workforce while diversifying the labor pool. With the surge in decarbonization projects, the demand for workers and contractors in the region has grown, and CEE is responding to this demand by offering comprehensive workforce training programs.

In 2021, CEE launched a paid four-week, in-person home energy career training program to familiarize individuals with energy efficiency careers (Xcel 2023). The program was created to train women and low-income individuals to become energy auditors or HVAC technicians. It includes training in building science (e.g., home energy audits, insulation, and air sealing), jobsite safety guidelines, and basic math skills used in construction work (Xcel 2023). In addition, installation experts teach participants about the benefits of energy efficiency, such as the improved comfort, health, and safety of households. Each participant receives a $2,500 stipend and basic wraparound services, including transportation support. CEE reported that, previously, participants had been unable to attend training because they lacked reliable transportation (Xcel 2023). To address this barrier, CEE sought additional funds to eliminate transit challenges and began to offer aid to help participants obtain a license or automobile repairs and provided bus passes or Uber credits.

Following the completion of the four-week training, participants have the option to gain additional experience through a paid 16-week internship. The program offers two internship pathways that focus on home insulation/air sealing and energy auditing (Xcel 2023). Both pathways offer hands-on

experience completing projects alongside trained professionals and crews, with exposure to workplace cultures.

Addressing employment challenges with wraparound services

Wraparound services are resources or support provided to trainees, job seekers, or workers to promote professional development, improve socioeconomic challenges, or overcome employment barriers. Organizations can offer wraparound services that include but are not limited to assistance with transportation, financial literacy, childcare, and job readiness (e.g., improving skills in communication, problem solving, and conflict resolution) (Ayala 2024). CEE notes that a network of partners, such as community-based organizations, can help provide wraparound services.

Wraparound services were a key component in the program's success. Many participants faced multiple barriers to reliable transportation, workplace readiness, and housing. CEE partnered with local organizations to provide trainees with case management support, transportation assistance, childcare, and job readiness skills to prepare them for work on jobsites. For example, in 2022, CEE paid for the car repairs of two participants, allowing them to complete their internship and retain employment (Xcel 2023). For those without a vehicle, CEE partnered with Uber to provide 174 rides, resulting in high retention rates among participants. Providing transportation and other wraparound services resulted in increased attendance, enabling participants to complete their training and internship, which helped them obtain and retain employment after the end of the program.

Program impacts

In 2023, 39 participants completed the training and pursued different careers, and seven trainees had been placed in training-related jobs. For example, two trainees obtained employment as a carpenter apprentice and an insulation installer. Another two trainees were hired as energy auditors working on income-qualified homes that received services through the weatherization assistance program. Other graduates have entered union pathways in construction or work for Xcel.

Challenge: Burdensome contractor licensing requirements and business practices

State-specific and sometimes jurisdiction-specific licensing requirements for contractors and businesses demonstrate that they have met certain industry standards to perform high-quality work, but that can sometimes hinder contractors from gaining new skills or expanding services. In our interviews, contractors and training providers noted that state-specific licensing requirements can prevent service expansion across geographic regions. Additionally, undergoing training is challenging for small contractors due to lost revenue from time spent away from jobsites. The case study below describes how two organizations' workforce initiatives help contractors grow their businesses and expand their skills through technical training, tailored support, and one-on-one mentorship.

Challenges (all equally important)

- Skilled trades are usually licensed by specific states, and each state has different license and certification requirements that lead to increased burdens on contractors to obtain them (Chaves 2023).
- Lack of internal resources, personnel capacity, and clear guidance on how to upskill on new technologies, access incentives and other revenue streams, and grow business into other sectors. For example, small businesses do not have access to electrification equipment to get trained and grow in this area.
- Lack of incentives for the time taken away from income-earning projects to upskill.

Actions to overcome challenges	• Offer accessible and standardized training resources to help contractors acquire skills employers are seeking and meet licensing and continuing education requirements. • Train residential contractors on user-friendly resources, such as software tools to size heat pumps, to help adoption and implementation of new technologies. • Offer financial support, such as advance financing options for contractors to cover upfront costs and incentivize project uptake and completion.
Workforce stakeholders who can act	Federal, state, and city government agencies, nonprofits, utilities, education and training institutions, manufacturers, lending institutions, and community-based organizations
Examples of programs that overcome these challenges	Nevada Clean Energy Fund*; Elevate Diverse Electrification Contractor Accelerator*; Emerald City Collaborative's Contractor Academy; Michigan Saves Qualified Contractor Network; Wildan Workforce Development Program – Contractor Training program with funding from NYSERDA; Building Futures Minority Contractor Training program sponsored by the Tennessee Valley Authority

*Indicates programs profiled in case studies below

Nevada Clean Energy Fund's Residential Energy Upgrade Program

The Nevada Clean Energy Fund (NCEF) case study showcases how lending institutions support contractor businesses to meet the growing demand for residential decarbonization services. NCEF manages a network of HVAC and electrical contractors across Nevada and offers resources for skill development and business development, such as marketing materials and project lead generation. The program connects contractors to technical training, offers flexible lending terms to support businesses and completion of projects, and prioritizes community engagement to increase uptake of heat pump installation services.

Program description

Nevada aims to meet the decarbonization targets set by Senate Bill 358, which revised the state's renewable portfolio standard to require 50% of electricity sold by utilities to come from renewable energy sources by 2030. The state also targets net-zero emissions by 2050, requiring 45% of residential and 25% of commercial HVAC systems to be electrified (Sullivan et al. 2020). NCEF, as the state's green bank, supports these goals by financing clean energy projects and focusing on underserved market sectors (Nevada Clean Energy Fund n.d.a). Through its Residential Energy Upgrade Program (RE-UP), NCEF provides unsecured loans and technical assistance to Nevada homeowners to complete energy efficiency upgrades and supports contractors that carry out the installations for this program with resources for skills development and business expansion.

NCEF vets contractors before they perform the upgrades and provides them tools to access federal and utility incentives. Contractors can access additional financial and technical resources after they join the certified contractor network. To date 24 contractors, half of which are minority and women-owned businesses, have joined the network. NCEF's relies on engagement with local chambers of commerce, city governments, and contractor trade associations to recruit contractors for their network.

Program impact

NCEF enhances the skills of its network members by offering technical training development benefits. Contractors receive training on electrification technologies, including a 40-hour cold climate air source

heat pump program in partnership with the International Center for Appropriate and Sustainable Technology (ICAST) and Santa Fe Community College (Nevada Clean Energy Fund n.d.b). Additional training on building science principles is also available. This flexible, free training is helpful for upskilling incumbent workers and attracting new people interested in energy efficiency careers. Through the training, NCEF equips the workforce with the skills needed to complete jobs funded by federal rebates while promoting the adoption of more efficient technologies.

Business development benefits include help with identifying potential projects and access to the low-and-moderate income market, NCEF-funded no dealer fee financing to fund projects, and contractor advance financing to cover upfront costs.[6] In an interview with NCEF, dealer fees from traditional lenders, such as banks and credit unions, were identified as a significant barrier to delivering residential decarbonization projects due to the high upfront costs that cut into contractor profits. By eliminating dealer fees, NCEF's network gains significant advantages, increasing profit margins and lowering project costs for consumers.

Contractors can join the NCEF contractor network for free. Using NCEF resources, contractors can establish financing programs within their companies. NCEF supports network-certified contractors by allowing them to start retrofit projects work once their loans are approved and receive payment upon completion. The green bank model increases the demand for contractor services and enables financing for clients who might not qualify through traditional means, thus helping increase the number of retrofit projects. Additionally, NCEF can provide advance financing to cover contractors' upfront costs on a case-by-case basis.

Addressing contractor business model challenges through training and financial resources

NCEF's free resources help contractors receive the necessary tools and training to become proficient in advanced systems. By joining the contractor network, contractors gain understanding of existing financial incentives and access to decarbonization-focused projects. NCEF encourages approved contractors to add an NCEF seal of approval to their marketing materials. This seal signifies their membership in the vetted contractor network, helping to instill confidence in potential customers and borrowers and facilitating discussions about energy efficiency retrofits. In the future, NCEF plans to leverage its lending and technical assistance experience to offer similar support to energy auditors.

Elevate Contractor Accelerator

This case study highlights how a nonprofit organization, Elevate, created a replicable program model that prioritizes collaboration with local community partners to support contractors and provide them with access to training, resources, and employment opportunities. Elevate launched its program in 2018 to prepare contractors for opportunities in the clean energy economy and has held more than 10 Contractors Accelerators offering each cohort a combination of workshops and one-on-one support.

Program description

The Contractor Accelerator program aims to eliminate obstacles that prevent underrepresented contractors from joining the clean energy sector. Each accelerator is customized for a specific region and industry segment, such as solar energy, energy efficiency, or electrification. Elevate works with local utilities, governments, industry groups, and experts to create programs for each area and audience.

[6] A dealer fee is a percentage of a loan contractors pay to lenders to offer homeowners special financing options, like low interest rates or deferred payments. Dealer fees vary widely, ranging from as low as 3% to 45% in some cases.

The accelerators typically run for six to eight weeks and may feature weekly group training sessions, both in-person and online, personalized coaching for contractors to develop an expansion plan that addresses their business and individual needs, and guidance and training on various topics like accounting and finance, incentive stacking, branding, marketing, technical skills, and more. Participants also gain access to mentorship opportunities with local businesses, professional networks, job openings, and ongoing support after completing their accelerator cohort (Elevate n.d.).

Program impact

This approach has been successfully implemented with partners in various U.S. cities, including Chicago and Peoria, Illinois; Portland, Oregon; Kansas City, Missouri; Dane County, Wisconsin; and Detroit, Michigan. From 2022–2024, 40 contractors completed the Contractor Accelerator, preparing them to grow their businesses in the building electrification sector.

Addressing contractor skills and business practices through training and resources

Elevate's Contractor Accelerator program exemplifies how to remove barriers for contractor businesses and overcome inabilities to upskill and expand business services. Contractors join Elevate's accelerator programs at different stages of their business expertise but tend to commonly encounter similar obstacles to accessing decarbonization-focused work. Elevate addresses each contractor's unique circumstances by offering tailored support, including stipends and enhanced operational training. Elevate's partnerships with local organizations is critical for assessing skills and market needs to better support and deliver resources to businesses that participate in the accelerator.

Actions to support workforce development efforts

The energy efficiency workforce ecosystem stakeholders, including federal, state, and local agencies, nonprofits, utilities, and community-based organizations, can play an integral role in meeting the residential sector's decarbonization workforce demands and create a more inclusive and equitable workforce. The program case studies (see Appendix B) highlight how stakeholders employ several strategies to overcome market barriers that prevent individuals from participating in programs or navigate career entry and advancement in the residential retrofit industry. For example, the case studies featuring PSE&G and CEE demonstrate how utilities partner with community-based organizations and nonprofits to recruit trainees, conduct training, and offer wraparound services, thus creating a program that helps new and existing building retrofit professionals learn new skills.

Based on the strategies modeled by workforce programs discussed earlier, stakeholders within the energy efficiency workforce ecosystem can take actions individually and collectively to improve performance of programs to help raise worker proficiency, improve retention, and offer opportunities for career advancement. We acknowledge that several of the stakeholders are also employers, a key group that can influence the workforce development ecosystem by helping develop and prepare their future workforce and promote fair and equitable labor practices to support employee retention. In table 1, we map the stakeholders' actions that can overcome the market challenges we discussed previously and provide details on their roles in supporting the workforce. We categorize the stakeholders by the role they can play in workforce development initiatives—those who can lead, followed by those who should assist, and finally the groups to engage as we focus on growing the decarbonization workforce.

Table 1. Recommended stakeholders' roles in supporting the residential decarbonization workforce based on the case studies

	Create awareness and overcome low perceptions	Develop programs to meet employer and market needs	Standardize curriculum and technical education	Provide career development support	Address contractor business challenges
Lead workforce development efforts based on their ability to influence and implement programs					
Government agencies	√	√	√	√	√
Nonprofits	√	√		√	√
Industry and labor organizations	√	√	√		√
Utilities	√	√		√	√
Education and training institutions	√	√		√	√
Assist with workforce development efforts based on their capacity to provides specific services in a program					
Community-based organizations	√			√	√
Manufacturers and wholesalers			√		√
Engage in workforce development efforts					
Lending institutions (green banks)					√

Government agencies

Authorities having jurisdiction, such as federal and state agencies. (e.g., department of education, department of labor), must play a key role in standardizing knowledge and skills for residential decarbonization jobs. When possible, federal agencies can support and increase the capacity and scale of existing workforce development programs and encourage best practices and coordination across states (Equitable Cities Consulting, C40, and NLC 2024). Together with state governments they can influence program design to require workforce trainers to provide technical, on-the-job training, and integrate innovative approaches to reach a broad range of audiences or standardize content or include relevant certification in the approved lists for workforce education programs. State and local governments can also help build local sectoral partnerships to design programs customized to their unique needs. For example, The Efficiency Maine Trust, an independent, quasi-state agency, has created a standardized list of training resources, with key topics, and a list of registered trainers for professionals seeking to enhance their heat pump-related skills. The Heat Pump Installer training includes both classroom instruction and hands-on training in the areas of installation; sizing, selection, and design; commissioning; service; and incentives.

State and local government agencies can support professional development activities by braiding federal funds such as the Training for Residential Energy Contractor grants and Energy Auditor Training grants

among others, with city or state funds to expand standardized technical training and industry-recognized certification, soft skills training, and to bolster the capacity of community-based organizations to offer support services. For example, the City of Milwaukee sought a Climate Pollution Reduction Grant to help support the Green Jobs Accelerator program's outreach and training activities.

Skilled trades often face challenges transferring or seeking jobs outside of their respective state due to varying licensing requirements imposed by states. State and local governments, especially those in neighboring regions, can minimize challenges faced by businesses or workers moving to seek job opportunities by allowing reciprocity or transferability of credentials or align licensing requirements. Doing so may enable contractors to take on more jobs across jurisdictions and help alleviate labor shortages in key areas. This would also ease job transitioning as well as provide a pathway for businesses to expand their services.

Nonprofits

Nonprofits should address employment barriers by creating awareness among prospective workers about the different energy efficiency jobs available and integrate technical skills training with services to ensure worker's wellness. Nonprofits are in a unique position to establish or invest in programs that support small businesses, minority business enterprises, and women business enterprise participation, or connect with a wider audience of prospective workers such as new career entrant or the youth. Such efforts can prepare underrepresented and marginalized individuals and businesses for retrofit work. For example, Emerald Cities Collaborative, a nonprofit organization, offers a 12-week-long HVAC Career Preparation Academy program to prepare participants for entry-level positions in HVAC or a related field. The program encourages women and underrepresented candidates to apply and includes free technical training, career support including job search, resume writing, and preparation for apprenticeships, and assistance with transportation, housing, childcare, tools, and work clothes, based on participant needs.

Industry and labor organizations

Industry and labor organizations should enable professionals in their network to gain industry-related training and certifications through classroom instruction and on-the-job training to increased adoption of clean energy technologies in homes. These trainings could be developed in-house or offered in partnership with other education and training organizations. Established construction and trade organizations providing training should align their instruction on residential decarbonization with professional development pathways, equipping members with versatile skills needed to participate in the clean energy economy. For example, the Arizona Heat Pump Council, part of the Electric League of Arizona, a statewide nonprofit trade association, offers standardized training materials across a range of continuing education opportunities, including the Master Heat Pump Technician Program (MHPT). The program helps trainees expand their heat pump related knowledge and skills and is recognized by Arizona utilities as an exceptional adult education, certification, and training program model.

Utilities

Many utilities have recognized that labor shortages in the industry's skilled trades could pose challenges to completing projects, thus not allowing them to reach their program goals. By creating jobs that appeal to a diverse audience and providing on-the-job training to help upskill workers, utilities can meet their energy goals and deliver benefits to disadvantaged communities (ICF 2022). Utilities can design programs to train incumbent and new workers to increase the network of skilled contractors available to deliver retrofit projects. These programs can also be designed to target disadvantaged business

contractors, like minority or women-owned businesses, and offer residential energy efficiency program implementation contracts to help them grow their portfolio of work and business.

By partnering with other organizations to provide wraparound services, utilities can offer more comprehensive programs that supplement technical training with services that can support participants with housing, transportation, and childcare needs and enable them to seek professional development activities and advanced career positions. For example, PSE&G partners with trade allies, employers, and additional stakeholders to match program participants in on-the-job training programs to jobs in the field and consults the same industry organizations to develop training programs. Some of these organizations also provide wraparound services for participants while they participate in trainings.

Educational and training institutions

Educational and training institutions, community colleges, and trade associations are critical in creating awareness of energy efficiency careers and providing training for building retrofit and green job opportunities (Equitable Cities Consulting, C40, and NLC 2024). These institutions can provide flexible in-person and virtual technical training resources on efficient technologies, mentorships, and guidance for contractors to help them upskill and expand their businesses. Educational institutions, especially community and technical colleges, are poised to attract young adults into two-year or four-year educational programs and programs can also be created to prepare young people for energy efficiency jobs, such as an energy engineer, and help graduates enter the job field at a higher level. To expand their program impact and elevate trainee knowledge, institutions could integrate building science principles and embed concepts of energy efficiency into existing offerings, instead of creating stand-alone programs.

Education and training institutions can design training length for these programs to match the trainee's skill level and career experience. For instance, new entrants can benefit more from a short-term initial training and get exposure to the field before programs and students commit to multi-month programs. As an example, the Everblue and Coalfield Development's seven-week apprenticeship program uses a two-step training approach to prepare participants for an energy auditor role. In the first four weeks, participants engage in technical training focused on the basic building science principles, and in the remaining weeks, individuals participate in on-the-job training.

Community-based organizations

Community organizations such as minority business associations committed to expanding energy efficiency jobs and experience with providing services in the community are critical to the success of workforce programs. Because of their trusted position in the community, the organizations should assist with program outreach and recruitment, helping connect existing training resources with participants, case management support, business and soft skills training, and job coaching. Community organizations can also facilitate follow-ups and check-ins with participants. For example, Energize Careers, funded through the California investor-owned utility Career and Workforce Readiness Program, partners with community-based training organizations and community colleges to offer energy training and wraparound services. The initiative aims to train and prepare disadvantaged workers for entry-level positions and place them into jobs where they can use the skills they learn. Trainees are offered industry-informed training, preferred consideration for jobs with HVAC and building retrofit contractors around the Bay Area, and support services to prepare them for energy efficiency jobs.

Manufacturers and wholesalers

Given their relationships with contractors, customers, and the broader market, manufacturers are well positioned to offer hands-on low-to no-cost energy efficiency training with content that can increase trainee knowledge and familiarity with new technologies. Their training programs should be tailored to enhance worker competencies related to both installation and maintenance, and address relevant market needs (Roberson 2023). Within their contractor networks and training facilities, technology manufacturers can take actions to standardize the training workers receive and set the requirements needed to complete work and partner with community organizations to offer the trainings.

Manufacturers with multiple training locations and a network of skilled trade professionals can develop curricula that addresses the essential skills for HVAC and heat pump water heater (HPWH) installation and servicing, and train technicians on new technologies and practices. They can tailor the program competencies and requirements to meet the expectations of stakeholders such as the DOE and national laboratories or align with state-level license continuing education requirements. For example, manufacturers can seek accreditation or recognition such as DOE's Energy Skilled Program to ensure that they are teaching up-to-date information and that their program participants are learning about heat pump design and installation, heat pump water heater installation, and home energy assessments. Government-backed certifications are a strong demand signal for future work and standardize the knowledge and skills workers will need and can be supported through manufacturer training.

Lending institutions

Lending institutions, along with more specialized entities like green banks, can help support workforce development efforts by helping implement clean energy projects through their investments. Green banks can leverage their unique industry position to link training providers and existing resources with contractors while supporting the development of new ones. This approach helps upskill contractors and creates opportunities to expand their business. For example, NCEF partners with ICAST and a local community college to provide training and offers tools and resources for contracts to learn about heat pumps and sizing them.

Green banks already provide finances for energy efficiency projects and can offer flexible financing terms for contractors to complete projects and expand their services. The NCEF and other green banks like the Michigan Saves and the Colorado Clean Energy Fund have developed strategies to incentivize contractors by offering financial assistance for upfront costs and immediate compensation upon project completion. They broaden the client base for contractors by offering loans to households that would otherwise not qualify for traditional financing. By participating in green bank qualified contractor lists, contractors gain access to this expanded market, allowing them to increase their sales and take on more residential decarbonization jobs.

Next steps

Given the unprecedented federal funding to decarbonize buildings and state and city goals to reduce building emissions, the residential retrofit sector will need many skilled workers and professionals to design and deliver projects. Increasing awareness and interest in associated careers, addressing knowledge gaps, upskilling the workforce, and scaling best practices will be critical to complete retrofits. The demand for workers also offers opportunities to create partnership models between employers, unions, and other workforce organizations to grow a more inclusive and diverse workforce and develop the energy efficiency workforce ecosystem.

Building industry stakeholders should take actions to develop the workforce and share best practices with others in the workforce ecosystem to enable them to rapidly increase the number of professionals needed to complete building decarbonization projects. This report highlights many innovative program strategies that stakeholders can implement to help overcome workforce growth and training challenges. Investing in them can help expand the knowledge and skills of new entrants and incumbent workers.

Program administrators, community organizations, and employers must collaborate to offer a balanced approach to training, including education on the essential market-informed technical skills, soft skills, and support services. Technical training should focus on equipping workers with knowledge of efficiency measures like weatherization and new electrification technologies, to ensure they are prepared to deliver the services necessary for decarbonizing homes. Community organizations can assist with wraparound services such as childcare, transportation, and mental health services to help professionals join the industry, earn competitive wages, and continue to grow in their careers. These services can improve participant diversity and facilitate recruitment in programs.

Workforce program administrators should focus on engaging new entrants such as K–12 students and underemployed individuals from underrepresented groups to make the workforce more diverse and equitable and incumbent workers, offering them opportunities to acquire new skills and become part of the workforce. Partnering with community-based organizations such as minority business associations and nonprofits can help create awareness of available jobs and program recruitment. After participants are enrolled, community organizations can support case management, business skills training, job coaching, and program follow-ups. Community organizations, as trusted voices in their areas, can lend credibility to the workforce programs.

Government agencies and trade organizations can lead initiatives to standardize training materials for new technologies and ensure they are offered in multiple languages to improve learning environments for multilingual students. Furthermore, organizations administering industry certification exams should take steps to ensure that non-English speakers have the same opportunity to earn career-advancing certifications without barriers. A standardized curriculum can help manufacturers, industry organizations, and nonprofits provide quality education to trainees, expand their knowledge, and signal the need for high-quality services to the market. Instructions on new technologies that are easily accessible at low-to-no cost to participants and user friendly are likely to be more attractive to professionals and contractors wanting to learn new skills and proficiencies.

Utilities, manufacturers, lending institutions, nonprofits, and employers should consider and invest in career development activities to better tailor the training and connect to hiring and placement needs of employers. This can motivate and support professionals interested in upskilling and growing in their careers. For example, reducing participant training expenses and offering compensation for contractors taking time off from existing projects can help overcome fiscal challenges and enable professionals to learn new skills and advance their careers, which, in turn, helps with job retention. Other services, such as networking opportunities with professionals in the field to learn about roles and responsibilities, job coaching, and placement services, can help clarify career pathways and enable participant learning.

Furthermore, offering financial incentives, including favorable lending terms to cover upfront contractor costs, such as those provided by green banks, can encourage contractors to take on jobs involving the installation of new technologies and to pursue related training. Incentives like waived dealer fees, access to a qualified contractor network, and upfront payments can significantly alter the pool of skilled workers available to work on projects, helping scale the number of residential retrofits.

While training grants to advance the residential decarbonization workforce can bridge skills gaps, more intentional and market-informed approaches to energy efficiency workforce development ecosystem are needed. Such a process can better prepare workers and equip them with the skills needed to meet the volume and scale of retrofit projects. It can address regional skills gaps, create local jobs, build public trust, increase awareness of careers, and improve buildings and public health.

References

ACEEE. 2023. "Home Energy Upgrade Incentives: Programs in the Inflation Reduction Act and Other Recent Federal Laws."aceee.org/sites/default/files/pdfs/home_energy_upgrade_incentives_2-1-23_1.pdf.

Ayala, Roxana. 2024. "Case Study: How Philadelphia Is Preparing Its Workforce to Deliver Home Energy Upgrades." https://www.aceee.org/memo/2024/06/case-study-how-philadelphia-preparing-its-workforce-deliver-home-energy-upgrades.

Brown, Mitch, Aaron Lazelle, Bill Prindle, Eliza Johnston, and Ridah Sabouni. 2023. "Clean Energy Employment Impacts and Occupational Analyses: Building Envelope & Electrification Upgrades." NREL/SR-5500-86711, DOE/GO-102023-5940. https://www.nrel.gov/docs/fy23osti/86711.pdf .

Building Performance Association (BPA). 2024. "West Virginia BPA: Energy Efficiency Apprenticeships Webinar." https://building-performance.org/education/resources/west-virginia-apprenticeships-webinar/.

Chaves, Paul. 2023. "Getting the Job Done: Models for Heat Pump Workforce Development." . November 7, 2023. Regulatory Assistance Project presentation. https://www.youtube.com/watch?v=2eotjIl_47A.

City of Milwaukee. 2023a. "10 Big Ideas." https://storymaps.arcgis.com/collections/81e362f32b71421eb572832f3e739074?item=1.

_____. 2023b. "Green Jobs Accelerator." https://city.milwaukee.gov/ImageLibrary/BBC/images/GreenJobsAcclerator.pdf.

_____. 2023c. "Milwaukee Climate and Equity Plan." https://city.milwaukee.gov/climate/Climate-Plan.

Department of Energy Office of Energy Efficiency and Renewable Energy. n.d. "Energy Assessment Programs." https://bsesc.energy.gov/recognition/energy-assessment-programs.

_____. n.d. "Energy Skilled Heat Pump Programs." https://bsesc.energy.gov/recognition/heat-pump-programs.

Department of Energy Office of Energy Jobs. 2024. "United States Energy & Employment Report 2024. https://www.energy.gov/sites/default/files/2024-08/2024%20USEER%20FINAL.pdf.

E4 The Future. 2021. "New Jersey: Energy Efficiency Jobs in America." https://e4thefuture.org/wp-content/uploads/2021/08/New-Jersey_2021.pdf.

Elevate. n.d. "Contractors and Workforce Development."https://www.elevatenp.org/contractor-workforce-development/.

Equitable Cities Consulting, C40, and National League of Cities. "Growing the Workforce Needed for Building Retrofits: A Guide for U.S. Cities." https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/Vo0000002bDB/qpGKZ155V0Y9Fd9f9w2lROtmZFfnazc6oLKSXyWua9k.

Everblue Training. n.d. "Coalfield & Everblue Present: Energy Auditor Apprenticeships." https://everbluetraining.com/get/coalfield-apprenticeship/.

Fazeli, Sandy. 2021. "Energy Sector Workforce Diversity, Access, Inclusion, and the Policy Case for Investment: Recommendations for State Energy Office Action."

https://www.naseo.org/data/sites/1/documents/publications/Workforce%20Diversity%20Report_Final2%5b2%5d.pdf.

Grant, Roger, Liz Fischer, and Matt Nelson. 2017. "Building a Better Clean Energy Workforce." Presented May 16, 2017, DOE Better Buildings Summit. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/Building_a_Better_Clean_Energy_Workforce.pdf.

Guo, Wei, Thomas Wenning, Sachin Nimbalkar, Jennifer Travis, John O'Neill, and Bruce Lung. 2023. "US Department of Energy Better Plants Program's Approach to Manufacturing Workforce Development." *Summer Study on Energy Efficiency in Industry 2023*. American Council for an Energy-Efficient Economy. https:/www.aceee.org/sites/default/files/pdfs/ssi23/4-131-GUO.pdf.

Herr, Alexandra, Wael Kanj, and Cora Wyent. "Electrification That Works: Jobs for a Clean and Healthy Future." *Rewiring America*. https://e4thefuture.org/wp-content/uploads/2023/10/Energy-Efficiency-Jobs-in-America-2023.pdf.

ICF. 2022. "Utility's All-in Approach to Clean Energy Workforce Development Yields Results—and Jobs. *ICF Insights*. https://www.icf.com/insights/energy/clean-energy-workforce-development-program.

International Center for Appropriate and Sustainable Technology. 2022. "Very High-Efficiency Heat Pumps for Multifamily Resource Guide." https://www.icastusa.org/education/heat-pump-resource-guide/.

Kaluthantirige, Piyaruwan, Lahiru Silva, Kasun Hewage, and Aekamjot Gill. 2023. "Construction Labor Shortage, Challenges, and Solutions: A Survey-Based Approach." In *Proceedings of International Structural Engineering and Construction (ISEC-12)*, August 14–18, 2023, Chicago. https://dx.doi.org/10.14455/ISEC.2023.10(1).CON-16.

Lehman, Sarah, Nate Hunt, Cobi Frongillo, and Phillip Jordan. 2021. *Diversity in the U.S. Energy Workforce: Data Findings to Inform State Energy, Climate, and Workforce Development Policies and Programs*. https://www.naseo.org/data/sites/1/documents/publications/Workforce%20Diversity%20Data%20Findings%20MASTER%20Final42.pdf.

Lis, David. 2023. "Heat Pumps—With Unprecedented Incentives, Where Are We Now?". 2023. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. https://www.energy.gov/node/4833248.

MacPherson, Mary, and Roxana Ayala. 2019. "Cities and Clean Energy Workforce Development." ACEEE. https:/www.aceee.org/sites/default/files/pdfs/cities_workforce_development_v2_0_2.pdf.

Madigan, Dana, and Tessa Bonney. 2021. "Reemployment Needs and Barriers of Users of Workforce Development Programs: A Mixed-Methods Study." *Workplace Health and Safety*. 69(11): 494–505. https://journals.sagepub.com/doi/epub/10.1177/21650799211016244.

Mansano, Waltasia. 2024. "Delivering Energy Efficiency Jobs to Underserved Communities." *ACEEE Summer Study on Energy Efficiency in Buildings*, August 4–9, 2022, Pacific Grove, CA. American Council for an Energy-Efficient Economy, Washington, D.C. https://www.aceee.org/sites/default/files/proceedings/ssb24/assets/attachments/20240722163156406_0684ab9d-7b0c-4cd3-a441-e24d4057b556.pdf.

Miniard, Deidra, Whitney White, Nicole Nave, Stephanie Means, Derrick Meeking, and Jonathon Clark. 2023. "Integrating Diversity, Equity, and Inclusion into Workforce Development in Energy Efficiency:

A Case Study in Building Analyst Training." *Summer Study on Energy Efficiency in Industry 2023*. American Council for an Energy-Efficient Economy (ACEEE) https://www.aceee.org/sites/default/files/pdfs/ssi23/4-96%20Miniard.pdf.

Nevada Clean Energy Fund, n.d. "About NCEF." https://nevadacef.org/about/.

_____. n.d. "RE-UP Network." https://nevadacef.org/contractors/.

Northeast Energy Efficiency Partnerships, Inc.. 2024. "Decarbonizing Buildings: How States Can Set the Table for Success." https://neep.org/sites/default/files/media-files/neep_2024_decarbonizing_buildings_table_for_success_final_0.pdf.

_____. 2023. "We Have Energy Efficiency Workforce Funding… Now What?" https://neep.org/blog/we-have-energy-efficiency-workforce-fundingnow-what.

Pacific Northwest National Laboratory. 2024. "Energy Skilled Recognition for Training Programs and Certification" https://pnnl.gov/energy-skilled-recognition.

PSE&G. 2022. "PSE&G Recognized for Helping Advance Energy Equity." https://nj.pseg.com/newsroom/newsrelease299.

Roberson, Emily. 2023. "Utilities and Vendors Can Empower Communities with Workforce Development Solutions". ESource. https://www.esource.com/blog/0012302car/utilities-and-vendors-can-empower-communities-workforce-development-solutions.

Salzman, Madeline. 2021. "Building the U.S. Green Building Workforce." February 12, 2021. Job Creation and Workforce Development for Building Renovation U.S. and EU Exchange on Energy Efficiency in Buildings and Housing presentation. bpie.eu/wp-content/uploads/2021/11/Slide-deck-Webinar-4-SPIPA-US.pdf.

Srivastava, Rohini, and Jennifer Amann. 2020. "Training the Workforce for High-performance Buildings: Enhanced Skills for Operations and Maintenance." *ACEEE Research Report*. American Council for an Energy-Efficient Economy, Washington D.C. https://www.aceee.org/research-report/b2003.

State of New Jersey. 2021. "NJ Department of Labor and Workforce Development Announces $1M Grant for Clean Energy Jobs Training."
https://www.nj.gov/labor/lwdhome/press/2021/20210329_cleanenergygrant.shtml.

Sullivan, Dylan, Arjun Krishnaswami, Priya Sreedharan, and Elspeth Dimarzio. 2020. "Pathways and Policies to Achieve Nevada's Climate Goals." https://gridlab.org/portfolio-item/achieve-nevadas-climate-goals/.

Third Way. 2019. "Credential Hurdles: 6 Things Slowing Workers Down." https://www.thirdway.org/report/credential-hurdles-6-things-slowing-workers-down.

Truitt, Sarah, Jonathan Bean, Julia Sullivan, Gokul Paranjothi, and Allison Moe. 2022. *Completing the Circuit: Workforce Development for Advanced Building Construction and Grid-Interactive Efficient Buildings*. National Renewable Energy Laboratory, Golden, Colorado. http:/www.nrel.gov/docs/fy22osti/80480.pdf.

Appendix A: Summary table of common workforce challenges and program examples

The information below summarizes five challenges that emerged from our research. Through our research, we learned that these challenges often delay workforce growth. We offer program examples that have shown to overcome a respective challenge. The programs with asterisks indicate that the program models are highlighted as case studies in this report.

Overcoming low awareness and negative perceptions about energy efficiency careers

- City of Milwaukee's Green Jobs Accelerator*
- Coalfield Development and Everblue Energy Auditor Apprenticeships*
- Pacific Gas and Electric's and the California Public Utilities Commission's Energize Careers program
- ComEd's SEM Student Advisor Internship Program

Overcoming shortage of programs that align technical skills, soft skills training, and market needs

- PSE&G's clean energy jobs program*
- Emerald Cities Collaborative (ECC) HVACR Training and Career Preparation Academy
- East Bay Building Trades Construction Trades Workforce Initiative for union construction careers
- Penn College's Residential Building Installer Training program

Overcoming insufficient skills due to absence of standard curriculum and technical training

- DOE's Energy Skilled Recognition*
- Arizona Heat Pump Council's Master Heat Pump Technician Program or the HVAC System Consultant Series
- Efficiency Maine's Heat Pump Installer program
- MassSaves Training and Workforce Training Grant Program

Overcoming inadequate support for career development

- Center for Energy and Environment (CEE) and Xcel's Home Energy Career Training*
- Pacific Gas and Electric (PG&E) Workforce Education and Training Resources;
- Walker Miller's DT, Nicor, and Consumers Energy program

Overcoming inconsistency in contractor licensing requirements and existing business practices

- Nevada Clean Energy Fund*
- Elevate Diverse Electrification Contractor Accelerator*
- Emerald City Collaborative's Contractor Academy
- Michigan Saves Qualified Contractor Network
- Wildan Workforce Development Program—Contractor Training program with funding from NYSERDA
- Building Futures Minority Contractor Training program sponsored by the Tennessee Valley Authority