Energy Skilled: Preparing the Workforce for a Clean Energy Future

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ABSTRACT

Empowering building professionals to efficiently and effectively upgrade homes is an essential piece of the decarbonization puzzle. However, for many students and workers who want to capitalize on the career opportunities in the clean energy transition, identifying training programs that teach the requisite skills can be an added burden. In some cases, there are too few training programs offering the correct skills, knowledge, and hands-on application that is needed for quality work to be performed and efficiency measures to be successful. To address these needs, the Department of Energy (DOE), in coordination with Pacific Northwest National Laboratory, created the Energy Skilled recognition program with open-source curricular resources to increase the number and visibility of training programs that include modern building science topics. DOE provides Energy Skilled recognition for training programs, certifications and degrees that equip workers to conduct home energy audits, heat pump installations and home comfort advising, and heat pump water heater installations. By establishing skill standards and recognizing credentials that meet or exceed those standards with high-quality content, DOE is fostering a workforce able to meet the demands of today's and tomorrow's home improvements. In the future, these resources can be used to establish minimum skill standards for workforce training and hiring for federal-, state-, or utility-funded programs.

Since program launch, leading heating, ventilation, and air conditioning (HVAC) and plumbing organizations have used the published skill standards and open-source training resources to update their technician certifications, textbooks, and training programs and become Energy Skilled recognized. These efforts increase installer and contractor understanding and comfort with new and more efficient home improvements and are therefore critical to increasing market adoption of home energy upgrades. This paper focuses on efforts for heat pump and heat pump water heater adoption and summarizes the background and methodology for establishing the Energy Skilled program. It describes how programs can update their credentials to become Energy Skilled recognized, and how Energy Skilled recognition aligns with Inflation Reduction Act (IRA)-funded programs so that federal incentives support strong training programs.

Background

The Department of Energy (DOE) Office of Energy Efficiency & Renewable Energy (EERE) is committed to making sure that buildings in the United States are built, remodeled, and operated to be more energy and water efficient, healthier, and resilient against natural disasters. Within EERE, the Residential Building Integration team collaborates with home builders, energy professionals, state and local governments, utilities, product manufacturers, educators, and researchers to improve the energy efficiency of both new and existing homes.

DOE understands a highly skilled construction workforce is key to creating more high-performance homes. For decades, the DOE Building America Solution Center (BASC) has been a national online resource for industry-developed high-performance home information. Since 2017, the BASC platform's companion site for educational content, the Building Science Education Solution Center (BSESC), has provided a growing repository of trusted, open-source

curricular material covering topics from heat pumps to codes and standards. All BSESC educational materials are peer reviewed, meet DOE's rigor for high-performance homes, and meet guidelines for building science education (Metzger et al. 2017).

From 2010 to 2015, DOE led an effort to understand the needs of training organizations that wanted to drive the industry toward creating more comfortable, durable, and energy-efficient buildings. The effort included collaboration with dozens of universities, community colleges, research organizations, training organizations, manufacturers, industry consortiums, government agencies, and builders (Metzger et al. 2015, updated 2017). One major takeaway from industry engagement was the need for a central repository of trusted, open-source information that could be quickly integrated by these organizations into existing programs. At the time, DOE's Commercial Buildings Integration team established the Better Buildings Workforce Guidelines for four key job titles focused on commercial building audits, commissioning, and operations. That effort was built with the goal of supporting high-quality credentials in those focus areas—however, it did not include equipment replacement aligned with residential work scopes (DOE n.d.c).

Despite a growing repository of information about high-performance homes and educational materials to support students in learning this information, DOE sought ways to accelerate adoption of curricula about home energy upgrades into educational programs and career pathways. From 2020 through 2023, DOE ran the Better Buildings Workforce Accelerator, which worked with more than 40 partner organizations to raise the level of building science and energy-efficiency knowledge in the nation's buildings workforce (DOE n.d.a). Analysis of the existing workforce and market conditions found that training pathways for workers in home energy services were confusing and opaque in terms of the knowledge, skills, and abilities (KSAs) a student may expect to achieve through participation (Truitt, Williams, Salzman 2020). Students and workers may struggle to identify training certificates and credentials that meet their needs or career interests in green home construction. Similarly, funders looking to support workforce training programs lacked insight into which programs might deliver the best outcomes for workers that can support the clean energy economy. In 2022, DOE published a website and fact sheet detailing workforce development priorities that include integrating "energy efficiency technology skills and competencies into standard education and training programs" (DOE 2022, DOE n.d.b). Based on the limited engagement that Better Buildings efforts had with priority training organizations and residential contractor networks, it was determined that alignment with the residential resources within BSESC was the best method for training recognition of targeted professions.

As a result, in 2023 the Energy Skilled program was launched to recognize training programs that meet minimum skill standards aligned with a clean energy future and help these programs grow in enrollment and funding. The Energy Skilled program promotes comprehensive training aligned with priorities for energy-efficient, healthier, and decarbonized homes by recognizing organizations that update their credentials accordingly. In fall of 2023, DOE announced that projects funded through the Inflation Reduction Act (IRA) Training for Residential Energy Contractors grant should demonstrate that proposed programs meet energy workforce demands by achieving Energy Skilled recognition in relevant, available job categories (DOE 2024).

Any workforce training program, certification body, or curricula provider may seek DOE Energy Skilled recognition based on training content related to heat pump installation, heat pump

comfort advising, heat pump water heater installation, or home energy audits. Because the Energy Skilled skill standards are publicly available, any federal, state, or private funder of workforce training programs can also leverage DOE's Energy Skilled recognition program to set minimum educational requirements for funded training providers. Finally, any program hiring workers to conduct home energy upgrade projects can refer to the Energy Skilled website to verify if worker credentials are Energy Skilled recognized to confirm competency for the job. Next steps for the program include expanding the number of job types that have Energy Skilled skill standards identified for recognition and working with more training providers, credentialing bodies, and curricula providers on updating existing curricula to become Energy Skilled recognized.

Establishing a System for Identifying and Sharing Building Science Education Content

For many building trade training program instructors, revising curricula is a daunting task that is often crowded out of priority lists by routine planning tasks. Revising curricula is a task that requires researching new content, adjusting existing content to free up space within an established program schedule, and creating proper homework or exam problems based on learning objectives. Even when instructors are interested in updating curricula to reflect the latest research and technologies, they will often encounter the hurdle that "green" (new) construction topics may not be included in curricula requirements for program accreditation. Furthermore, information about green home technologies is a rapidly changing area, which can make it challenging for instructors to prevent curricula content from becoming stale. For these reasons along with the common requirement of advisory committee/board reviews, obtaining authorization for curricula updates often takes multiple years.

Instructors and training providers across community and technical colleges, certifying bodies, union trades schools, and others need sufficient motivation to improve curricula. This can be encouraged by tying program recognition and access to federal funds to program updates. This effort remains important to DOE because curating open-source materials and adopting them into existing curricula are key first steps that DOE has taken in the large-scale effort to transform the workforce (Figure 1).

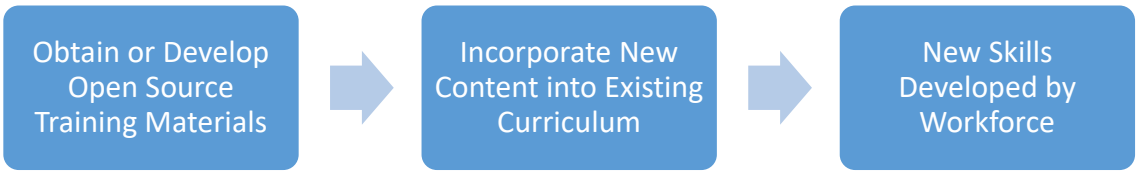

Figure 1: High-Level Steps Toward a More Skilled Workforce

Actions DOE and Pacific Northwest National Laboratory (PNNL) have taken to address barriers to including new building science curricula in education and training programs are detailed in the following sections. PNNL manages the BSESC for DOE's Building Technologies Office as a collaborative library of open-source training materials. Figure 2 depicts the BSESC homepage, including the primary ways in which to navigate to the core content.

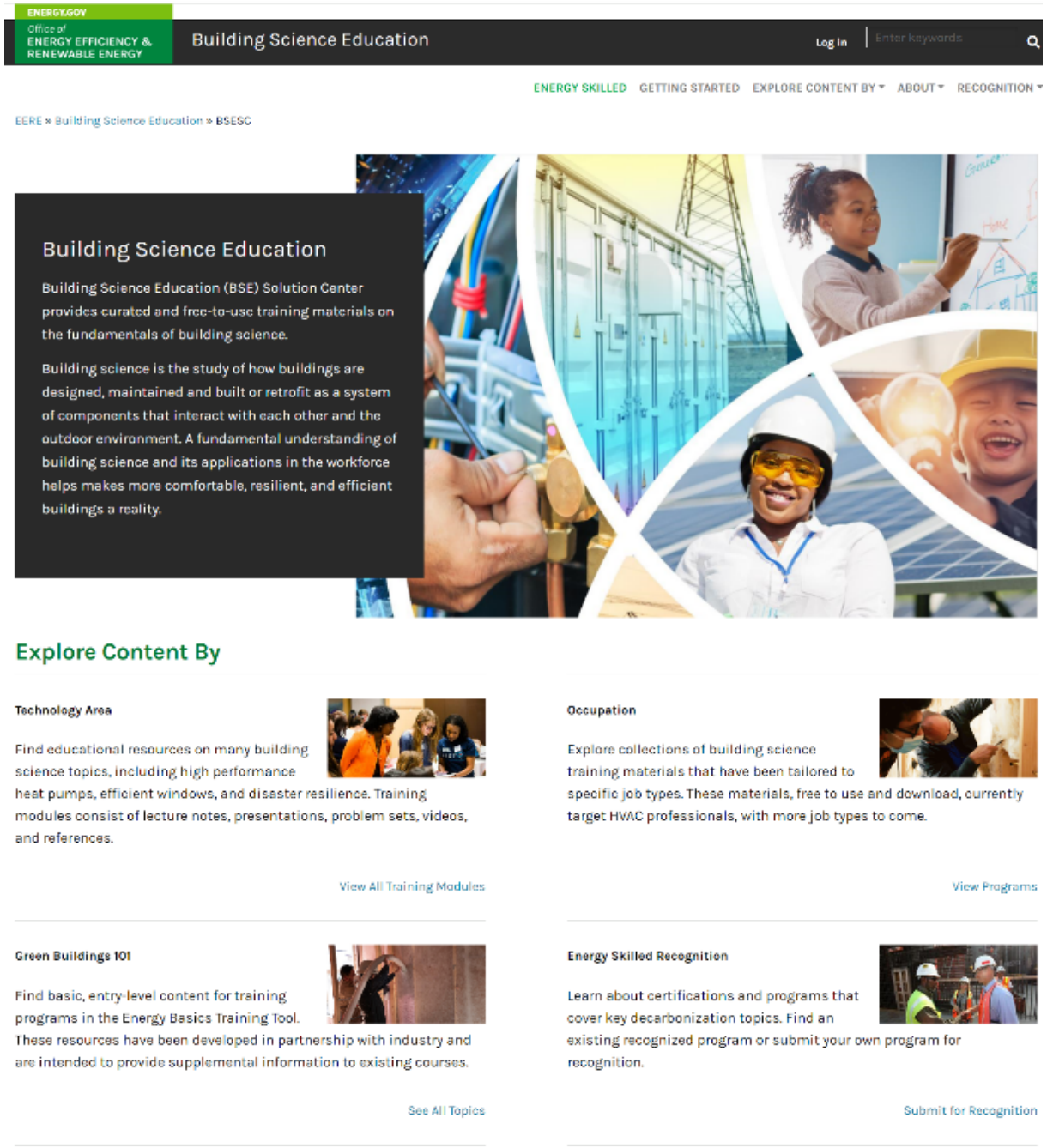

Figure 2: Building Science Education Solution Center

Open-Source Training Materials

As part of its ongoing efforts to build a stronger, energy-efficient building workforce under the direction and guidance of the DOE Building Technologies Office, PNNL curated open-source instructor resources that are currently organized into topical modules. Resources in each module include learning objectives, lecture notes, problem sets, PowerPoint presentations, handouts, demonstrations, videos, books, and more. Training resources are developed from existing national and local government open-source resources, national laboratory staff expertise, and curricula from partner organizations to be used freely. Content continues to be added and new industry partners have emerged, contributing to the 31 training modules developed from 2022 to 2024, with continual revisions to make sure resources are up to date.

In parallel to curating content for the BSESC, the PNNL team worked with national training providers and textbook publishers to encourage incorporation of new content into their materials. This has been a multifaceted effort to incorporate content for future professionals entering training and to develop course extension offerings to reach seasoned professionals. Gaining an audience with established professionals for upskilling is significantly more challenging because they are generally busy with an established career and resistant to changes. Participation and support from existing professionals are critical components of bolstering the workforce. Those currently established in the profession are crucial to the adoption of cold climate heat pump systems and emissions reduction aligned with the 2035 goals that DOE is targeting for the building sector.

Because roughly 75% of home energy use is driven by space heating, space cooling, and water heating, two of the most critical strategies for residential energy savings are widescale adoption of efficient heat pumps and heat pump water heaters. These are also two residential building technologies that are highly susceptible to sizing and installation challenges. PNNL and DOE determined that prioritization of heat pump and heat pump water heater content would increase familiarity, improve installations, and lead to higher customer satisfaction, enabling the uptake of these technologies in the market. With extensive expertise curating content for the Building America Solution Center and supporting workforce training programs, PNNL understands critical aspects of educational content. In recent years, the lab has conducted research projects to validate heat pump technologies. Based on identified deficiencies in training curricula, staff at PNNL developed the lesson plans, lecture notes, and problem sets and curated open-source resources specific to heat pumps and heat pump water heaters that contribute to the training modules. Materials for heat pump education were curated into 10 modules, and materials for heat pump water heaters were curated into five modules (Figure 3). The intent of the modules was to fill knowledge gaps specific to modern variable-speed heat pumps that could affect the technology's performance and operating efficiency.

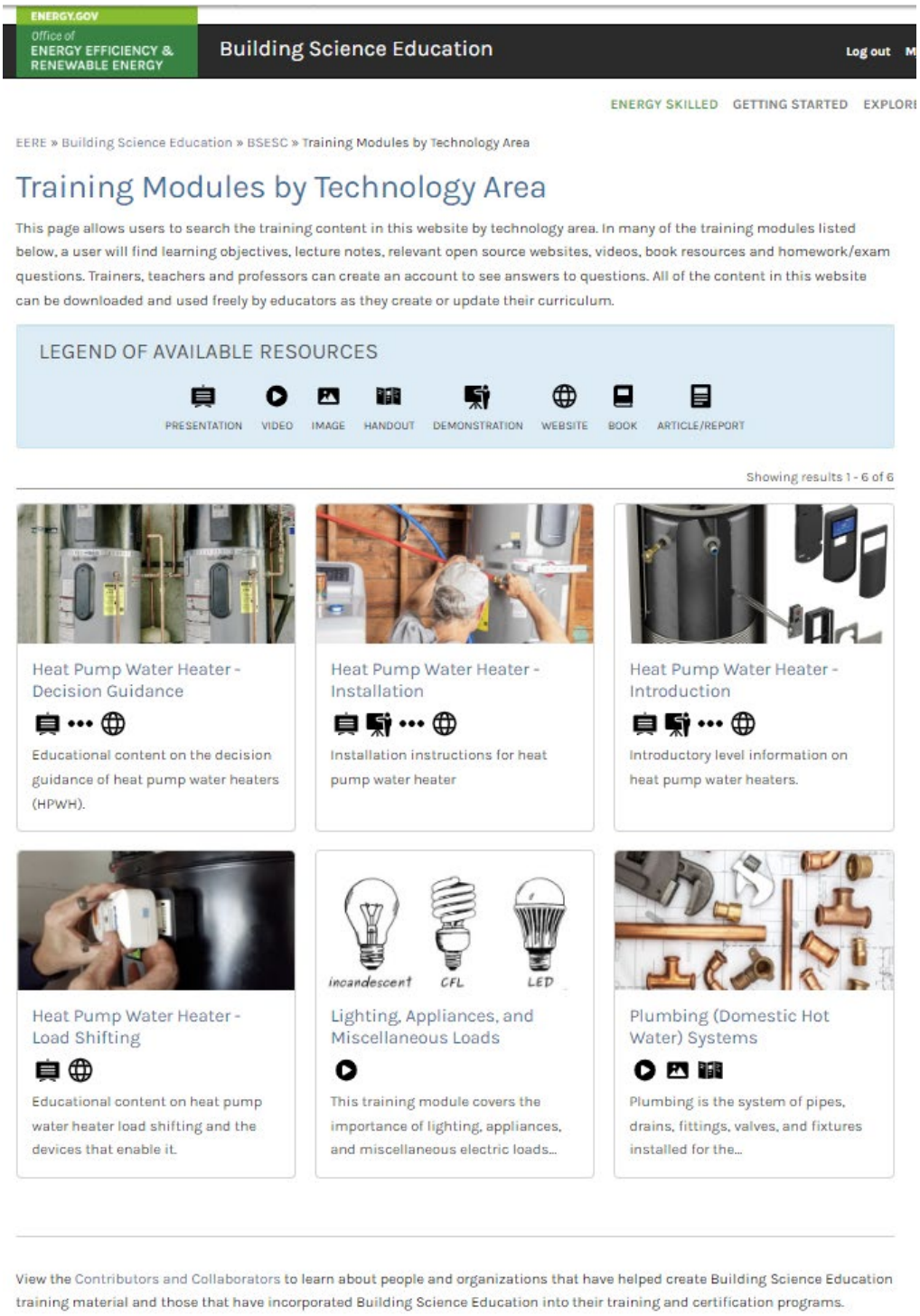

Figure 3: The screenshot above depicts the four heat pump water heater modules. These open-source resources and the ten focused on HVAC heat pumps are all available at https://bsesc.energy.gov/training-modules.

Energy Skilled Recognition

While the BSESC reduced the barriers instructors and programs may face to incorporating modern building science curricula in training programs, additional efforts are necessary to increase incentives for these curricula updates. The Biden Administration—through the Bipartisan Infrastructure Law (BIL) and IRA—has established the largest-ever funding resources to support green home technology investments and workforce upskilling, presenting a unique opportunity to align worker skills with in-demand jobs. These laws have generated more than $20 billion in spending on home energy-efficiency technologies, and more than $300 million in funding for residential energy workforce training (CCBO 2022). This combination of funding lowers barriers and increases incentives for workers across the country to gain the skills that allow them to participate in the clean energy economy. The Administration has also established goals to decarbonize the building industry by 2050, including the identification of energy skills for jobs today and those in the coming decades. The new Energy Skilled recognition program is positioned to bridge these funding programs with market transformation, enabling students and professionals to prepare them for job scopes in future home upgrades.

Program Goals

Recognizing the transformative opportunity of BIL and IRA, the Energy Skilled recognition program was launched to make sure that workers supported through federal funds—either as trainees in workforce development programs or as employees in efficiency deployment programs—have the science-based skills necessary to accomplish high-quality work. This effort is intended to minimize risk of government funds being deployed on poor-quality educational programs and installations. Beyond the near-term need for high-quality BIL and IRA projects, broader goals for Energy Skilled include:

- Establishing transparent skill standards for specific job scopes that are necessary to decarbonize U.S. housing as part of the clean energy economy.
- Supporting education, training, and credentialing organizations in adopting curricula that trains workers for a clean energy future.
- Creating a system that enables funders of residential energy workforce programs and home energy upgrades to verify funds are spent on high-quality offerings aligned with a clean energy future.

After establishing
With a library of the open-source educational content included in BSESC, the goal of Energy Skilled was developed to encourage all training programs to align their content with the skills critical for residential building improvements.

Methodology

To launch Energy Skilled, DOE and PNNL worked together with industry partners and building science experts to identify key KSAs for workers to successfully complete specific work scopes that are needed to meet DOE's 2050 decarbonization goals for buildings (EERE Buildings Blueprint). While there are many job scopes that are necessary to decarbonize U.S. housing, review of projects likely to be supported through BIL and IRA funding, aligned with DOE priorities, and informed by industry input identified key job scopes: (1) heat pump installation, (2) heat pump comfort advising, (3) energy auditing, and (4) heat pump water heater installation. Additional job scopes may be added to the Energy Skilled program over time.

To recognize a training program, credential, or set of curricula (e.g., in a course textbook) for aligning with Energy Skilled, DOE and PNNL identified specific KSAs based on the Guidelines for Building Science Education, existing BSESC open-source content, Better Buildings Workforce Guidelines, and expert input. For each identified job scope, the team sought to identify KSAs that support the workforce to:

- Successfully complete high-quality work on present-day jobs for existing, commercialized technologies.
- Be aware of concepts that prepare workers to take on jobs as new technologies enter the marketplace (e.g., technologies with smart controls).
- Understand the benefits of energy-efficient technologies that can accrue to customers and their businesses.

Because not all training programs are established with the same goals or needs in mind, Energy Skilled allows for some flexibility by requiring some foundational skills and then allowing different programs to achieve recognition through points for including recommended-but-not-required KSAs. Rooted in common terminology used in the education sector, those KSAs are considered Key Concept Knowledge Areas for recognition submissions. Educational framework from Blooms Taxonomy was leveraged in the development of this rubric and the included content areas. PNNL worked with internal and industry-based building science experts to establish the Key Concept Knowledge Areas and point values for the Energy Skilled recognition program scoring system.

Under the banner of Energy Skilled, DOE and PNNL developed a recognition process that was deemed the best way to encourage existing training programs to incorporate content including heat pump and high efficiency technologies. The following steps were published for credentialing bodies and training organizations to use:

1. ***Review*** *the relevant materials on the Building Science Education website and the Key Concept Knowledge Areas for each job type eligible for recognition.*
2. ***Download*** *the relevant Scoring Tool file. This Excel file contains required and optional competencies that are used to determine whether a program includes the proper concepts. Review the Key Concept Knowledge Areas and compare with your program offering.*
3. ***Score*** *your program using the scoring tool by following the instructions provided in the Excel file. You will be asked to provide documentation of the supporting material.*
4. ***Prepare*** *your submission. Gather the materials that support self-scoring, which could include the syllabus, examination outline, learning objectives, course outlines, certification requirements, training presentation slides, or other materials relevant to your program's offerings.*

5. ***Submit*** *the completed scoring tool and supporting materials to the email address energy.skilled@pnnl.gov along with the following information:*
    - *Organization name*
    - *Credential program name*
    - *Which Energy Skilled category are you submitting for?*
    - *How long has the program been offered?*
    - *Do you provide a certification or certificate? Do you incorporate other certification bodies?*
    - *How many individuals have been trained through this program?*

There are currently four types of offerings that can become recognized as Energy Skilled, a *certification, certificate, degree,* or *license*. A certification is defined as an organization that provides an official document that attests to a level of achievement, as proven through an examination or demonstration. Certificates, degrees, and licenses are credentials generally offered through an individual's participation in a defined course of study or training program. Entities offering these programs directly train people and typically do not provide a certification under their own banner. Frequently, training programs offer training that leads to a certification or "attestation document" from a higher-level organization that can be more recognizable by the industry rather than one single training center.

Heat Pump Credential Recognition

In heating, ventilation, and air conditioning (HVAC) fields, professional trades are well-established formal training paths for individuals entering the profession and continuing education. Many trade schools and community colleges have developed HVAC/R (R being refrigeration) educational programs that teach the hands-on trade, leading to many potential careers. There are also multiple professional training organizations and unions that provide training for HVAC assessment, installation, and maintenance, providing a strong foundation for the profession. The Energy Skilled focus in this sector is encouraging training programs to add content that teaches students about appropriate heat pump installation and commissioning practices, particularly when sizing a heat pump for both heating and cooling loads in a building. Recognition categories were created for training related to two residential HVAC roles: (1) installation of the equipment, and (2) sizing and selling of heat pump systems. Heat pump installation is critical to make sure that proper functional performance and equipment set up is completed to meet space condition requirements.

A rubric of the content expectation that a credentialing body or training organization incorporates to achieve Energy Skilled recognition for heat pump installation is used to review submissions. Those seeking recognition must include all "required" Key Concept Knowledge Areas and enough of the "non-required" topics to score >70% of possible points. Table 1 shows an excerpt from the scoring tool for the heat pump installation recognition.

Table 1: Scoring Tool for Heat Pump Installation

Topic Area	**Key Concept Knowledge Area**	**Points Possible**

Space Conditioning Heat Pump Types and Applications	**Knowledge of ducted/ductless/packaged terminal air source heat pumps (ASHPs)**	**Required**
	Knowledge of ground source and water source heat pumps	2
Compressor Stages and Sequences of Operation	Knowledge of variable-speed compressors	5
	Knowledge of minimum and maximum system capacity in variable-speed systems	5
	Understand the difference between constant speed supply fans and variable-speed supply fans	5
	Systems with variable-speed supply fans	5
Installation	**Charge refrigerant and prevent leaks (include proper flaring tools, best practices with brazing to prevent oxidation, etc.)**	**Required**
	Knowledge of proper refrigerant system evacuation procedure (include digital micron gauge)	**Required**
	Understand Quality Installation Standards and Specifications (ACCA QI5)	10
System Commissioning	**Understand prevalence of faults and the importance of commissioning for system performance**	**Required**
	Understand Quality Installation Verification Protocols (ACCA QI9)	**Required**
	Use digital and connected measurement equipment (refrigerant pressure, refrigerant temps, DB/WB temps, airflow estimation or measurement methods, power/electrical)	**Required**
	Use smart diagnostic and commissioning smartphone/tablet applications	**Required**
	Airflow estimation or measurement methods	**Required**
	Verify refrigerant charge	**Required**
	Test duct leakage and conduct system performance testing (delivered cooling/heating, and energy efficiency ratio (EER)	**Required**
	Support documentation, reporting, and QI certificates	**Required**
Smart Thermostats	Install, evaluate, and properly set smart thermostats for heat pumps	5
Dual fuel heat pump systems	**Knowledge of dual fuel heat pump system operation**	**Required**
	Install and service smart thermostats in a dual fuel pump system	5
	Derive and program a dual fuel system balance point temperature	**Required**
Additional Considerations when Retrofitting Fossil Fuel Systems	Evaluate electrical panel capacity to account for a heat pump's electrical load, both for adding heating to a system or for conversion	5
	Understand strategies for avoiding electrical panel upgrades	5
	Communicate operation and temperature differences between heat pumps and fossil fuel systems	**Required**
Sales / Customer Interactions / Decision Guidance	Explain differences between standard-efficiency and high-efficiency heat pumps	2
	Communicate the business case for quality installation	2
	Understand the market trends for heat pumps and the benefits of switching to heat pumps in existing homes	2
	Understand the climate impacts of installing a heat pump	6
	Understand operating cost differences between different electric and fossil fuel heating systems	6
Preventative Maintenance	Use smart diagnostic tools to test system performance	10
	Use smart diagnostic tools to troubleshoot system issues	10
	Install and use add-on fault detection / monitoring equipment	5
	Clean and maintain equipment on a regular schedule	5

Another barrier to market transformation involves bettering the customer's understanding of heat pumps. If the functional performance and efficiency of a heat pump are not properly communicated to a customer, the customer may not choose that option, especially in climates

where other HVAC technologies have a more established market. Along with equipment sizing, those are the skills and role of a heat pump comfort advisor. It is critical that a heat pump comfort advisor considers existing characteristics of the home for their design and sizes the desired heat pump system to handle both winter heating and summer cooling loads (in most of the country, heating loads will govern equipment sizing, which will be a change for many professionals in this field compared to legacy uses for cooling only).

To achieve recognition for heat pump comfort advising, a credentialing body or training organization would have to include all the topics labeled as required below and to value >70% of possible points. A similar table with recognition requirements was developed for this recognition area, which can be found on the program website (https://bsesc.energy.gov/recognition/heat-pump-programs).

As of June 2024, certification exams offered by two *certification* bodies are recognized as meeting the criteria for both heat pump installation and heat pump comfort advising.

Within the North American Technician Excellence (NATE) organization, the following certifications are recognized:

- NATE Certification with Heat Pump Service Specialty
- NATE Certification with Heat Pump Installation Specialty.

Within the HVAC Excellence organization, the following certifications are recognized:

- HVAC Excellence Heat Pump Service
- HVAC Excellence Heat Pump Installer.

Additionally, the following programs are recognized:

- Sheet Metal Air Rail Transportation (SMART) Local Union Number 265 Training Program (Heat Pump Installation and Comfort Advising)
- Sheet Metal Worker's Local 104 & Bay Area Industry Training Fund – Building Trades Service Apprenticeships Program (Heat Pump Installation and Comfort Advising)
- Truckee Meadows Community College: Climate Control Systems, Air Conditioning Technology (Residential/Lite Commercial Track), Associates of Applied Science with AC 106 (Heat Pump Comfort Advising)
- Mitsubishi Electric Trane HVAC US (METUS) Residential Heat Pump Installation and Comfort Advising Training Program (Heat Pump Installation and Comfort Advising)
- Western Washington Sheet Metal Joint Area Training Committee (JATC) Service and Residential Apprenticeships (Heat Pump Installation)
- Arizona Heat Pump Council Master Heat Pump Installer Program (Heat Pump Installation).

Many conversations are underway to recognize more credentials and programs, including manufacturer training programs similar to METUS. As of June 2024, there are 10 more programs currently under review for heat pump installation/heat pump comfort advising recognition. From interviews conducted when scoping, most training coordinators support incorporating updated content and high-efficiency heat pump training into their curriculum. There are both procedural and resistive delays to adopting updated content. Procedural delays are common, with requirements for demonstrating merit, committee, or board reviews, and for modifying existing content to fit training into an established program duration. Resistive delays refer to instructor/program apprehensions toward adopting new content and specifically content focused

on heat pumps. Cold climate heat pump systems are relatively new to the market and for many instructors these units are outside of their personal expertise. Additionally, past performance issues of less-efficient heat pumps from two decades ago leave an erroneous impression of heat pumps being unable to work effectively in cold climates, affecting their judgment even as newer heat pumps that can work effectively in cold climates are entering the market. These ongoing challenges require hands-on experience to dispel legacy understandings that PNNL's Building Science Education team encounters at most HVAC trainer and industry events they attend. In the absence of opportunity to provide that direct hands-on experience, the Energy Skilled team is encouraging manufactures of heat pumps to get their training recognized and facilitating connections to networks of educators they may partner with to increase adoption.

Training for this trade is a multi-year curriculum with a relevant breadth of knowledge to complete projects. Because one of the primary foci of Energy Skilled is encouraging training for HVAC professionals who are currently working in the field, programs that extend to base knowledge with upskilling that includes variable-speed heat pumps is viewed as critical. The Energy Skilled recognition criteria was developed with upskilling in mind to motivate training providers to prioritize offering continuing education on heat pumps. Upskilling can be challenging because the intended audience generally works a full-time job where training affects their schedule. To address that barrier, certification providers are encouraged to design upskilling extension courses packaged in ways that working professionals can more easily fit into their daily schedule.

Heat Pump Water Heater Training Program Recognition

Plumbers are typically trained in how to confirm pipes are the right size for the job, the proper slopes are used for drainpipes, and other aspects that apply to most water heater installs. The common pathway for a plumbing credential is through on-the-job apprenticeships. While apprenticeships are an effective method of passing down skills and completing projects, this type of training is based on historical knowledge and best practices, therefore providing limited exposure to training on new technologies or advanced methods. Residential water heaters are frequently replaced by individuals who have not received a formal education in heat pump water heater installation. The various and fragmented pathways into this profession warrant a multifaceted approach to disseminating training content and providing education.

A similar scoring rubric with recognition requirements was developed for heat pump water heater training that includes expected Key Concept Knowledge Areas. This was developed from a landscape analysis of existing standard practices for plumber training and knowledge areas specific to heat pump water heaters. As with the heat pump categories outlined above, achieving recognition for heat pump water heater installation requires a credential that includes all subject matter labeled as "required" and sufficient content to value >70% of possible points. Table 3 below includes the first few rows of the scoring tool—the full version can be found on the BSESC website (https://bsesc.energy.gov/recognition/heat-pump-water-heater-programs).

Table 3: Scoring Tool for Heat Pump Water Heater Installation

Topic Area	Key Concept Knowledge Area	Possible Points
Introduction to Heat Pump Water Heaters	How a heat pump heats water	5
	Role of the major components of a heat pump water heater	5
	Common modes of operation for heat pump water heaters	4
	Consumer expectations of heat pump water heaters compared to conventional water heaters	Required

	Switching from gas vs. switching from electric	6
	Explain how energy efficiency is determined (Uniform Energy Factor)	3
	Calculate yearly operational cost estimates	10

PNNL has been working through existing training channels to make sure that heat pump water heaters are incorporated into training programs so that this technology becomes a common business offering for manufacturers, trade unions, and technical colleges. PNNL developed relationships across those channels to encourage adoption of new curricula to incorporate these technologies. The following *programs* are recognized for their heat pump water heater installation training:

- Sheet Metal Air Rail Transportation (SMART) Local Union Number 265 Training Program
- Sheet Metal Worker's Local 104 & Bay Area Industry Training Fund – Building Trades Service Apprenticeships Program
- Energy STAR Heat Pump Water Heater Manufacturers Action Council (ESMAC) Heat Pump Water Heater Education for Your Program
- TECH Clean California and ESMAC Heat Pump Water Heater Education
- Barnett Plumbing & Water Heaters Training Program
- AO Smith – Voltex® AL Smart Heat Pump Certification
- State Water Heater – Premier® AL Smart Heat Pump Certification
- American Water Heaters – Proline XE® AL Smart Hybrid Electric Heat Pump Water Heater Certification
- Urban Green – Heat Pump Water Heating Systems Installations for Plumbers.

ESMAC education is a unique training program that has been recognized as Energy Skilled, this is spearheaded by the Environmental Protection Agency's ENERGY STAR program and was developed by a consortium of manufacturers. ESMAC training is available through deployment organizations like TECH Clean California, in central California, that incentivize contractors with free equipment to bolster their support for the technology. This is an example of manufactures willingness to collaborate on mutually beneficial objectives, having a well skilled and confident workforce installing their equipment.

Lessons Learned from Recognition and Increasing Training Adoption

While there is a growing market for energy-efficiency upgrades to homes, upskilling existing and upcoming residential building efficiency contractors to meet that market opportunity requires focused programs and methods of differentiating comprehensive training. Energy Skilled recognition and curated instructor resources is an attempt to reduce barriers that training institutions and instructors encounter when considering program improvements.

Resistance to New Technology. Federal incentives are creating a market where more consumers are requesting high-efficiency heat pumps for water and space conditioning upgrades. However, contractors are often reticent to work with new technologies and applications of heat pumps. Without a clear value proposition and direct experience with variable-speed heat pumps or heat pump water heaters, including that equipment in a project scope has significant risk and little upside for an installer. Individuals in these professions, especially those with significant expertise, can be reluctant to change product offerings and transition to a new technology whose performance they are unfamiliar with.

To aid the workforce in becoming comfortable with making those upgrades and servicing equipment into the future, it is critical to foster upskilling programs. The preferred method for doing this is working through networks trusted by today's and sought by tomorrow's workforce. That includes formal educators like technical colleges and trade schools, curriculum developers and certification organizations, unions, manufacturers, and distribution suppliers.

Incorporating updated training content into established training programs requires the buy-in of the trainers. In plumbing and HVAC fields, trainers are commonly retired professionals with decades of experience. It requires significant effort and learning for them to be supporters of training for a technology they never used in the field. Manufacturers and supply houses generally have strong relationships with large training organizations, and alumni frequently remain in contact with programs as a pipeline for future staff. Engaging those various entities that may nudge a training provider toward updates can increase their potential for adopting updated content. This is particularly true if employers in the field are demanding these skills from future hires.

Limited Resources. Instructors who are interested in updating their curriculum often have limited ability to modernize their labs, attend training, or fit the new content in their existing training. One HVAC instructor reached out because he had new heat pumps donated by a manufacturer that could not be hooked up in the lab because there was not enough electrical capacity on the existing electrical panel. Instructors, especially those serving disadvantaged communities, may not have funds or time to attend necessary training so that they understand the newer technology and applications. While federal incentive money and other educational grants can help address this problem, connecting these individuals with funds can be a time-consuming effort because many are not familiar with funding opportunities available to them.

Conclusions and Next Steps

The development of a third-party recognition mechanism has the potential to greatly transform the market. Without this mechanism, a contractor in any given location is just lucky if they happen to live near or find an HVAC training center that happens to be using state-of-the-art training materials. With the announcement of the Energy Skilled recognition, PNNL has received many more applications in HVAC and plumbing training that are being reviewed. Additionally, PNNL is promoting those recognized to other industry-wide partners who could leverage the recognized training programs.

Soon after the launch of the Energy Skilled program in 2023, DOE's Contractor Training Grants through the IRA referenced the Energy Skilled recognition (DOE 2023). This program encourages state energy offices to fund training initiatives that culminate in a credential that is Energy Skilled recognized. Utilizing credentials that are Energy Skilled recognized allows states to leverage federal incentives more swiftly, and also distinguishes them as ahead of the curve when it comes to efficiency and newer technologies.

Going forward, this Building Technologies Office, Residential Building Integration led effort to upskill the workforce could expand to the Commercial Building Integration program to support workforce needs specific to commercial buildings. PNNL is also taking the lessons learned from the development of this process for heat pumps and heat pump water heaters and assessing the opportunity to encourage adoption of improved training content for other professions to improve residential energy efficiency. In many construction trades and the workforce that completes home improvements, existing training is fragmented with on-the-job

training that plays a much larger role—this presents different challenges to increasing adoption. There is value for home owners and overall energy savings that can result from increasing adoption of training related to energy-efficient and resilient envelope improvements (window replacement, sealing, and insulating). Particularly with funding available through the Bipartisan Infrastructure Law, IRA, and local incentives, there is an increased priority to make sure that upgrades meet performance and marketed expectations.

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