Better Buildings®
U.S. DEPARTMENT OF ENERGY

Better Buildings Residential Network
Peer Exchange Call Series

The Age of Workforce Challenges – How is Residential Efficiency Responding?

January 25, 2024

U.S. DEPARTMENT OF ENERGY

Agenda and Ground Rules

- Moderator
  - **Jonathan Cohen,** Better Buildings Residential Network, U.S. DOE Residential Buildings Integration Program (RBI)
- Agenda Review and Ground Rules
- Residential Network Overview and Upcoming Call Schedule
- Opening Poll
- Featured Speakers
  - **Jenny Wiedower,** U.S. Department of Energy (DOE)
  - **Larry Zarker,** Building Performance Institute (BPI)
  - **Christian Valoria,** Pacific Northwest National Laboratory (PNNL)
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.

Join the Network

Member Benefits:

- Recognition in media, social media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

Upcoming Calls (2nd & 4th Thursdays):

- *2/8: How is Artificial Intelligence's Use and Rapid Growth Impacting Energy Efficiency?*
- *2/22: TBA*

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call



Jenny Wiedower

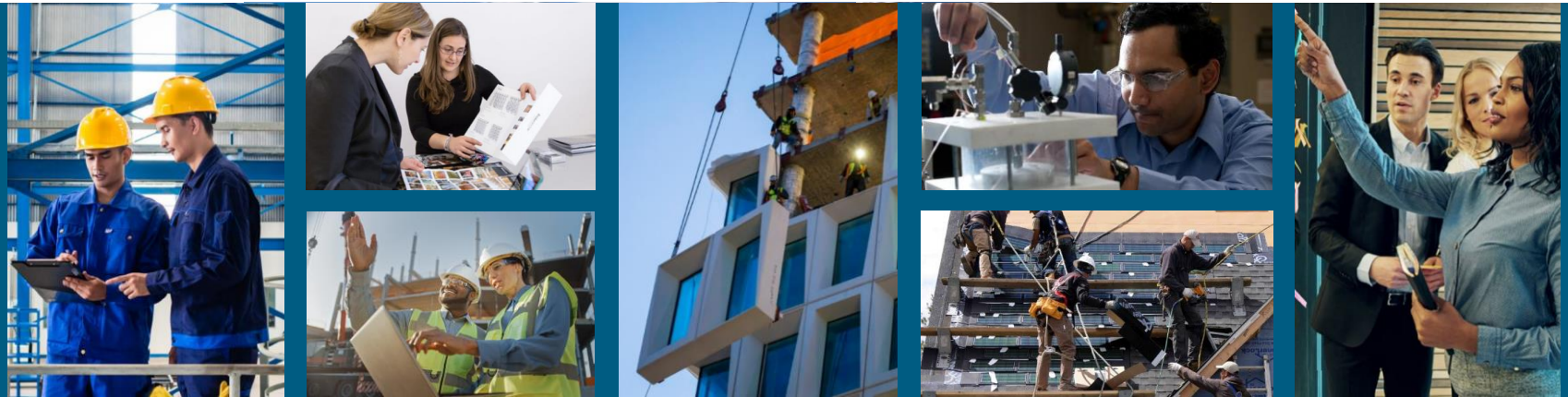
U.S. DOE

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Building Good Jobs in Building Efficiency

Jenny Wiedower
ORISE Fellow
Building Technologies Office
January 2024



Who is the Building Efficiency Workforce?

Building Efficiency Technology & Product …

Development	Design	Deployment	Diffusion
			
Research & Manufacturing	Architecture & Engineering	Construction & Operations	Services & Programs

2.3+ Million Workers Across These Industries in Efficiency Alone

Residential jobs needed to support BIL/IRA implementation

Trainers in building science, energy efficiency, codes, and installation
Energy auditors
Energy modelers
Electrical engineers
Mechanical engineers
HVAC installers/professionals
Appliance installers
Solar installers and technicians
Plumbers
Lighting technicians (installers)
Architects
Building scientists
Electricians
Construction and Buildings Inspectors (includes code officials)
Construction managers (with understanding in building science, energy efficiency, codes, and installation)
Insulation workers, floor, ceiling, and wall
Air sealers and duct sealers (home performance contractors)
Ventilation and clean air contractors
Window installers

Energy auditors

HVAC technicians

Plumbers

Electricians

Envelope retrofits

Clean energy workforce projections

Bipartisan Infrastructure Law, Inflation Reduction Act and CHIPS and Science Act:

- Will support nearly 3 million jobs per year and 19 million job-years over their lifetime
- Equal to nearly 2% of current U.S. workforce
- A significant share of jobs created by these investments are within reach for workers without a college degree
- Pay higher median wages on average than jobs in the U.S. workforce overall, making them a lever to help alleviate the United States' unacceptably high levels of income inequality

The economic sectors slated to see the largest relative growth in jobs include:

- Construction (4% growth, relative to 2021 employment levels, and 467,000 jobs annually);
- Manufacturing (3% growth, 336,000 jobs annually);
- Transportation and warehousing (2% growth, 257,000 jobs annually); and
- Utilities (2% growth, 15,000 jobs annually).

Source: *Employment Impacts of New U.S. Clean Energy, Manufacturing, and Infrastructure Laws*, University of Massachusetts Amherst, 2023

Challenges to residential building workforce

Employer perspective

- Shrinking labor pool (retiring baby boomers)
- Confusing career pathway and credential landscape
- Technical skills and soft skills deficiencies

Table 34. Energy Efficiency Hiring Difficulty Reasons

Industry	Most Common Reason	Second Most Common Reason	Third Most Common Reason
Construction	Competition/small applicant Pool (44%)	Lack of experience, training, or technical skills (36%)	Insufficient non-technical skills (work ethic, dependability, critical thinking) (26%)
Manufacturing	Competition/small applicant pool (57%)	Lack of experience, training, or technical skills (29%)	Insufficient non-technical skills (work ethic, dependability, critical thinking) (19%)
Wholesale Trade	Competition/small applicant pool (56%)	Insufficient qualifications (certifications or education) (14%)	Insufficient non-technical skills (work ethic, dependability, critical thinking) (30%)
Professional and Business Services	Competition/small applicant pool (45%)	Lack of experience, training, or technical skills (29%)	Cannot provide competitive wages (24%)

Source: U.S. Energy and Employment Report (2023)

Existing challenges to residential building workforce

Lacking Interest and Awareness of Careers Among Young People

*71% of students are **"definitely" or "probably not" interested** in HVAC careers*

Source: Electric & Gas Industries Association (2018)

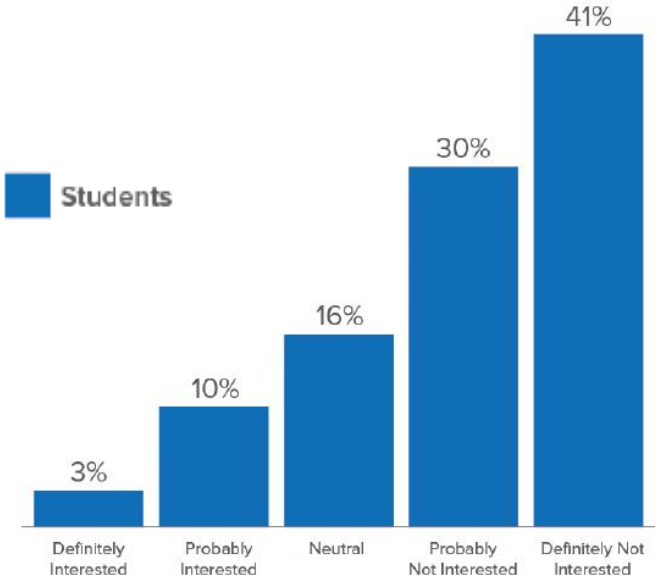
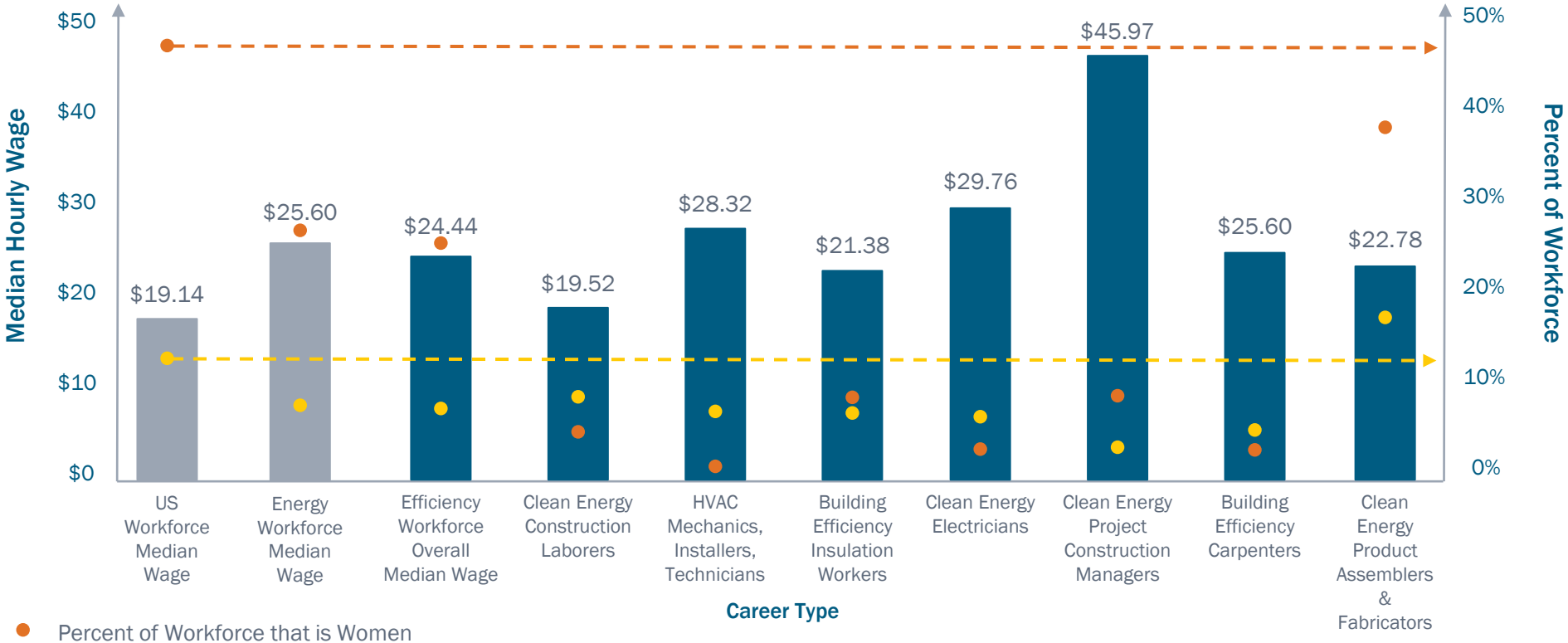


Fig. 6

Interest in Pursuing/Level of Support for HVAC Career Field

Existing challenges to residential building workforce



Sources: E2, 2020, Clean Jobs, Better Jobs Report & 2020 USEER

Existing challenges to residential building workforce

Worker perspective

- Underrepresentation of women and black Americans
- Boom/bust nature of residential construction
- Lack of competitive wage and benefits

Federal programs will be creating additional demand for an already tight labor market in clean energy sector

Strategy to Address Challenges

Goal: Ensure career pathways for a diverse and qualified building efficiency workforce that enable high performance buildings nationwide.

Low/Negative Perception	Confusing Pathways	Poor Quality Installation	Lacking Market Stability
Build Interest » Showcase careers in building efficiency as welcoming, impactful, and rewarding.	**Streamline Paths** » Clarify pathways from education and training to entry-level and long-term careers.	**Improve Skills** » Enhance continuing education. Include building science competencies in existing training pathways.	**Support Demand** » Support durable market demand growth for skilled workers, including by showcasing value of green building skills.

Early Career Exposure & Education | Apprenticeships & On-The-Job Training | Mid- and Late-Career Workers

A Complete Workforce System



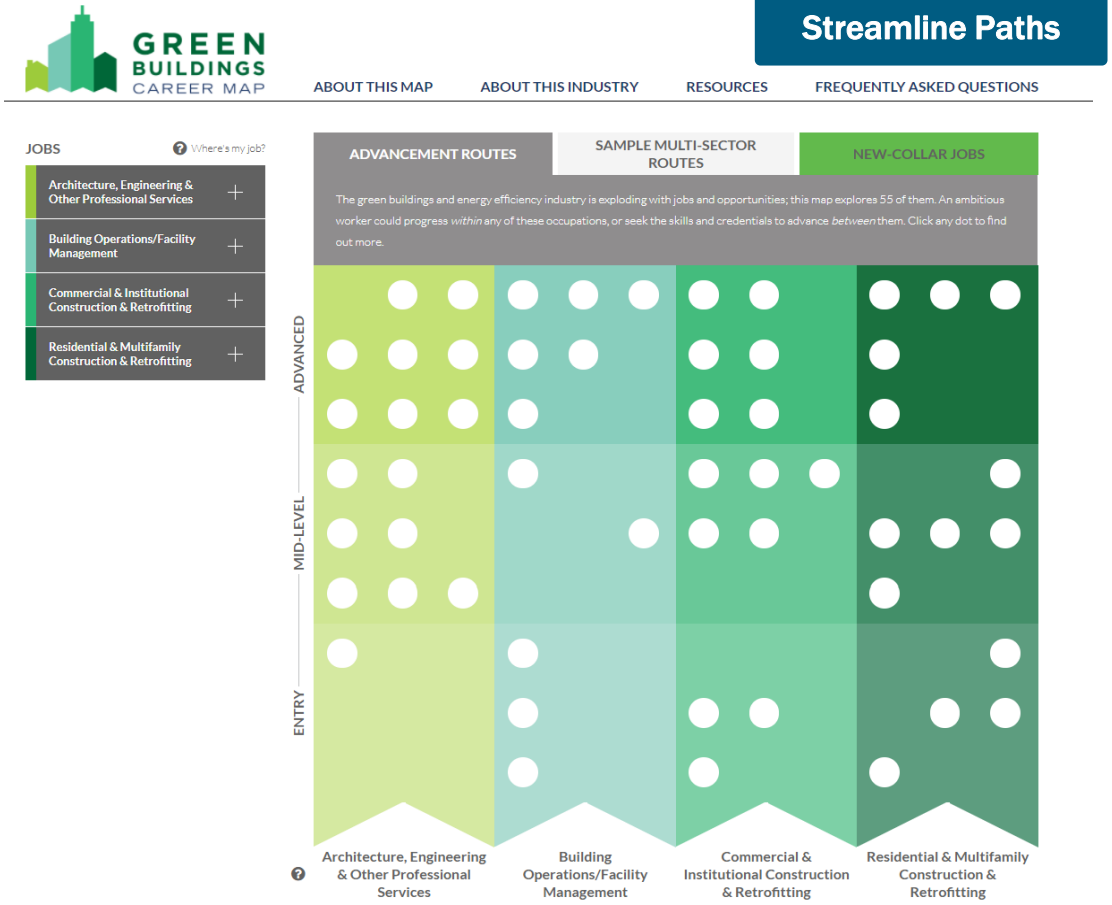
Tools, education and training

Build Interest

Streamline Paths

Green Buildings Career Map

- Information on 50+ careers across various sectors supporting green buildings
- Interactive webpage featuring career pathways, salary information, and educational requirements
- Developed by IREC as part of Advanced Building Construction funding award
- https://greenbuildingscareermap.org/



Support for workforce programs

Streamline Paths

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WORKFORCE DEVELOPMENT PORTAL





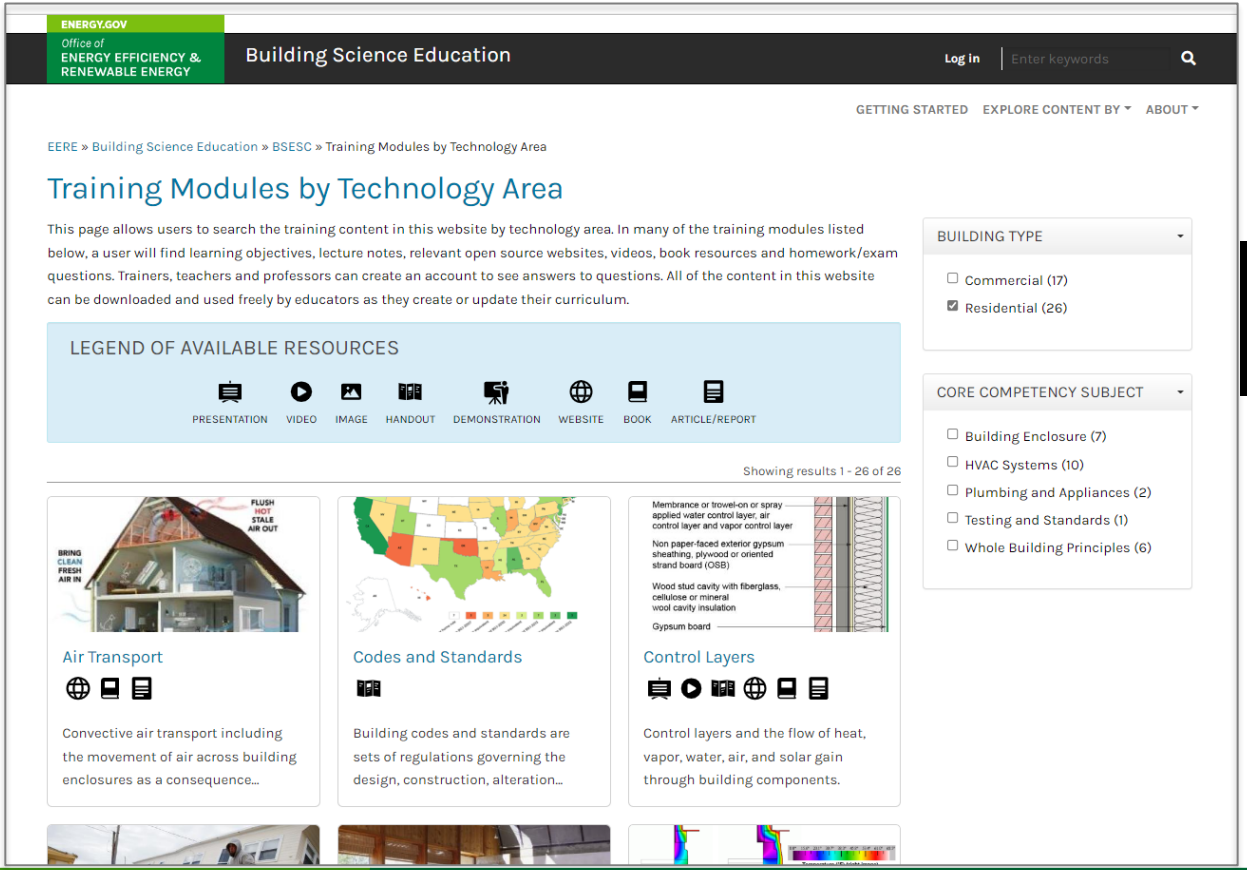






betterbuildingssolutioncenter.energy.gov/workforce-development

Tools, education and training for *educators and instructors*



Build Interest

Improve Skills

Building Science Education Solution Center

https://bsesc.energy.gov

Tools, education and training for *educators and instructors*



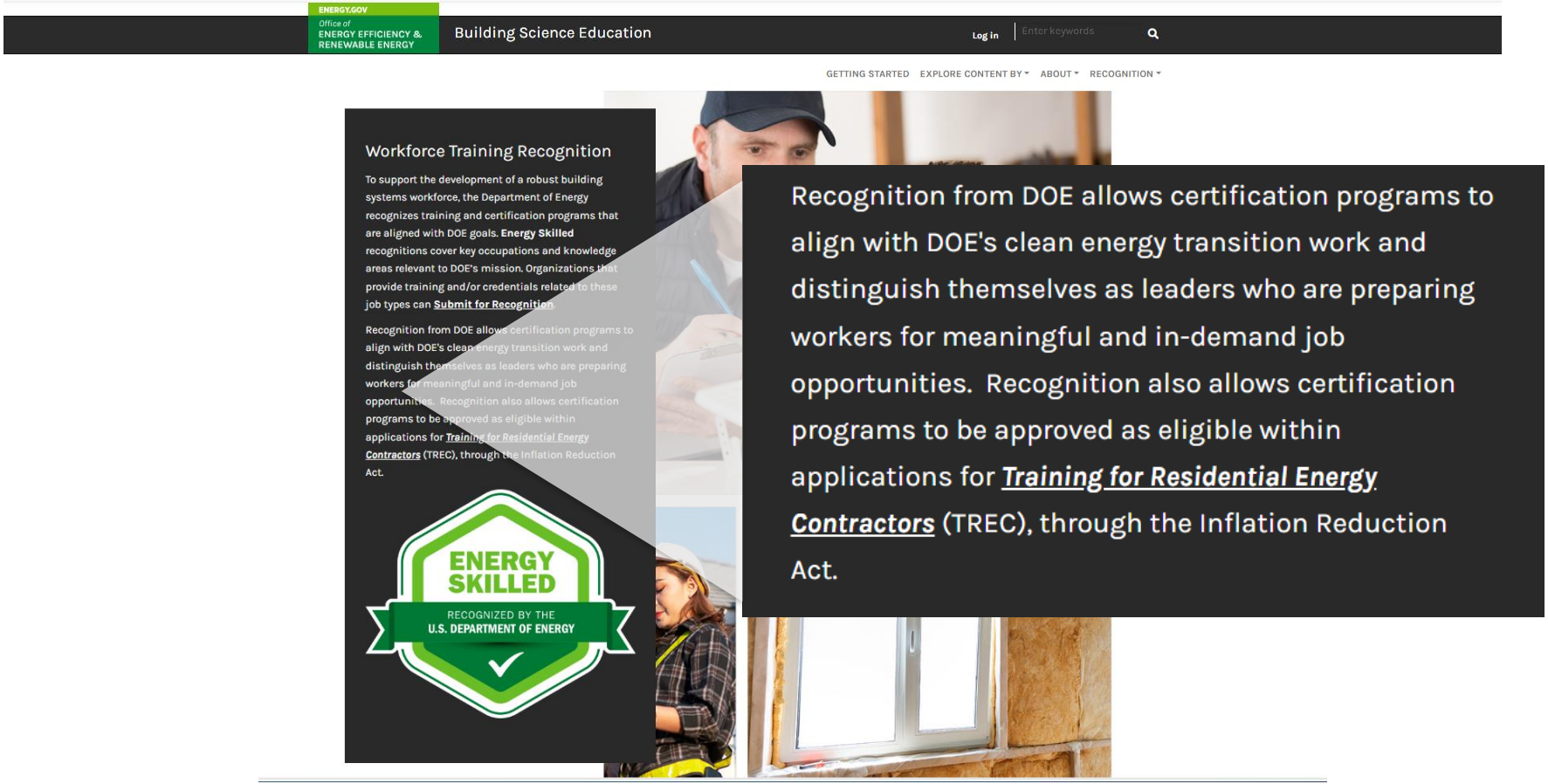
Build Interest

Improve Skills

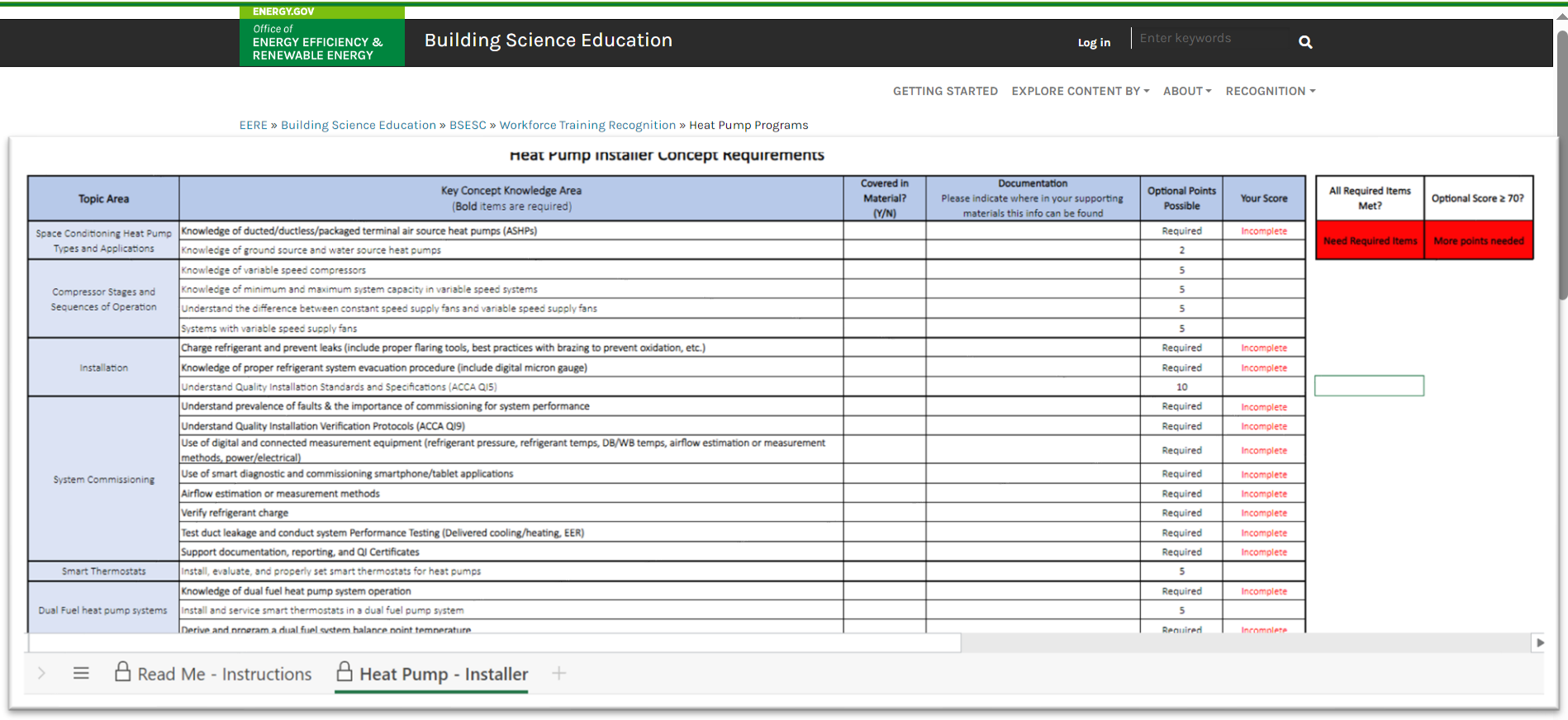
Building Science Education Solution Center

https://bsesc.energy.gov

Resources and recognition for *credentialing and training*



Skill standards for in-demand BIL/IRA jobs



Topic Area	Key Concept Knowledge Area (Bold items are required)	Covered in Material? (Y/N)	Documentation Please indicate where in your supporting materials this info can be found	Optional Points Possible	Your Score
Space Conditioning Heat Pump Types and Applications	**Knowledge of ducted/ductless/packaged terminal air source heat pumps (ASHPs)**			Required	Incomplete
	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	Incomplete
	Knowledge of proper refrigerant system evacuation procedure (include digital micron gauge)			Required	Incomplete
	Understand Quality Installation Standards and Specifications (ACCA QI5)			10	
System Commissioning	**Understand prevalence of faults & the importance of commissioning for system performance**			Required	Incomplete
	Understand Quality Installation Verification Protocols (ACCA QI9)			Required	Incomplete
	Use of digital and connected measurement equipment (refrigerant pressure, refrigerant temps, DB/WB temps, airflow estimation or measurement methods, power/electrical)			Required	Incomplete
	Use of smart diagnostic and commissioning smartphone/tablet applications			Required	Incomplete
	Airflow estimation or measurement methods			Required	Incomplete
	Verify refrigerant charge			Required	Incomplete
	Test duct leakage and conduct system Performance Testing (Delivered cooling/heating, EER)			Required	Incomplete
	Support documentation, reporting, and QI Certificates			Required	Incomplete
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	Incomplete
	Install and service smart thermostats in a dual fuel pump system			5	
	Derive and program a dual fuel system balance point temperature			Required	Incomplete

All Required Items Met?	Optional Score ≥ 70?
Need Required Items	More points needed

Open-source education for in-demand BIL/IRA jobs

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Building Science Education

Log in | Enter keywords

GETTING STARTED | EXPLORE CONTENT BY | ABOUT | RECOGNITION

EERE » Building Science Education » BSESC » Workforce Training Recognition » Heat Pump Programs

Heat Pump Programs

Featured below are the occupations that are available for DOE-recognition, the related open-source content that any program is able to use, and the materials associated with submitting for recognition.

Job Scope	Related BSE Content	Prerequisite Knowledge	Recognition Materials
Heat Pump Installation	Introduction to Heat Pumps Cold Climate Heat Pump Sizing Smart Diagnostic Tools Thermostats for Heat Pumps and Dual-Fuel Heat Pumps Preventative Maintenance	Heat pump specialty	Key Concept Knowledge Areas BSE Recognition Form Scoring Tool
Heat Pump Comfort Advising	Introduction to Heat Pumps Cold Climate Heat Pump Sizing Thermostats for Heat Pumps and Dual-Fuel Heat Pumps Business Development Preventative Maintenance	Heat pump specialty	Key Concept Knowledge Areas BSE Recognition Form Scoring Tool

To submit for recognition of a training or certification program please download and complete the BSE Recognition Form and Scoring Tool linked in the last column of the table above. More detailed directions on how to complete these are provided on the How to Become DOE-Recognized Page.

Recognition for aligned credentials and training

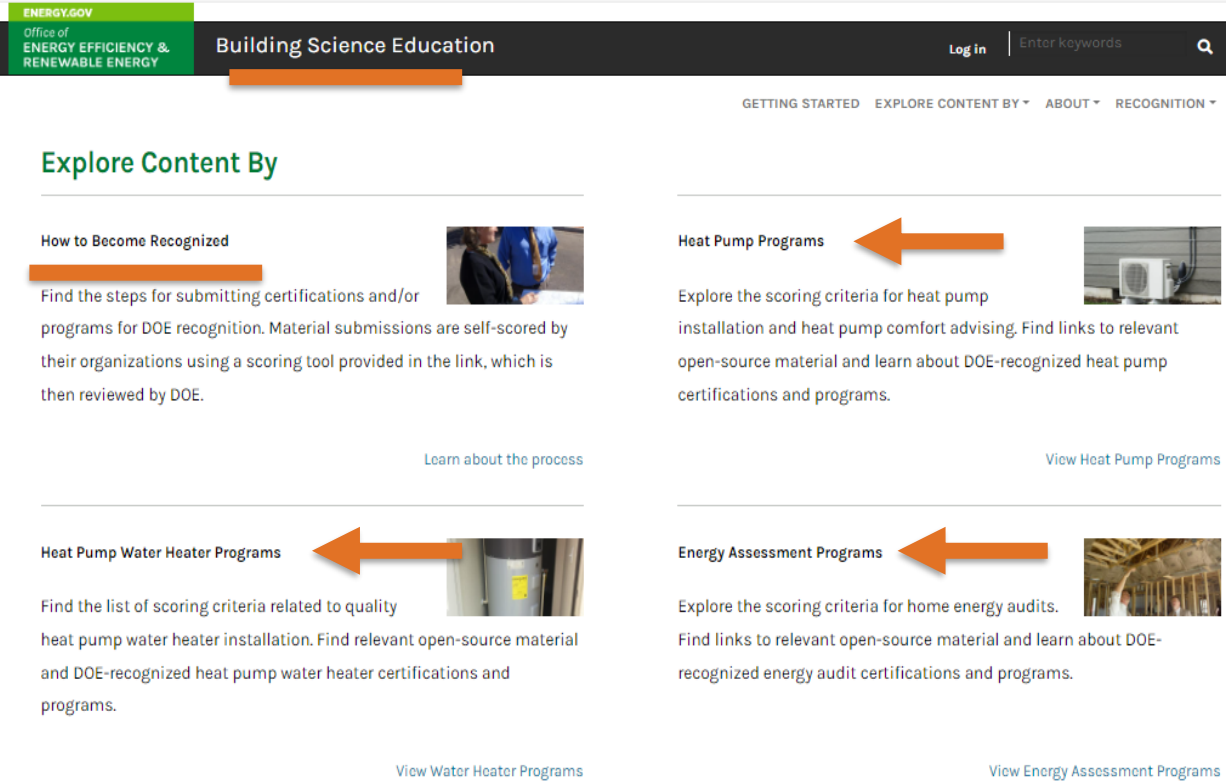
RECOGNIZED CERTIFICATIONS:

Logo	Recognized Program	Recognized For
	NATE Certification with Heat Pump Service Specialty NATE Certification with Heat Pump Installation Specialty	HP Installation and Comfort Advising
	HVAC Excellence Heat Pump Service HVAC Excellence Heat Pump Installer	HP Installation and Comfort Advising

RECOGNIZED PROGRAMS:

Logo	Recognized Program	Recognized For
	SMART Local Union No. 265 Training Program	HP Installation and Comfort Advising HPWH Installation

Energy Skilled recognition program



https://bsesc.energy.gov/recognition

Energy Skilled vision

1. Skills for key home energy upgrade tasks are defined.
2. Related credentials include skills.
3. Workers are incented to obtain credentials.
4. Credentialing and skills training is accessible to workers.
5. Supply of skilled workers meets demand.



Residential workforce vision

*The United States has a **nationally-representative** workforce of **sufficient size, skill, and compensation** to carry out an equitable transition of America's energy infrastructure to achieve net-zero greenhouse gas emissions no later than 2050.*





Larry Zarker

BPI

The Age of Workforce Challenges – How Is Residential Efficiency Responding?

January 25, 2024

Presenter:

Larry Zarker, CEO

LZarker@bpi.org

Building Performance Institute, Inc.



BPI's Role in Workforce Development

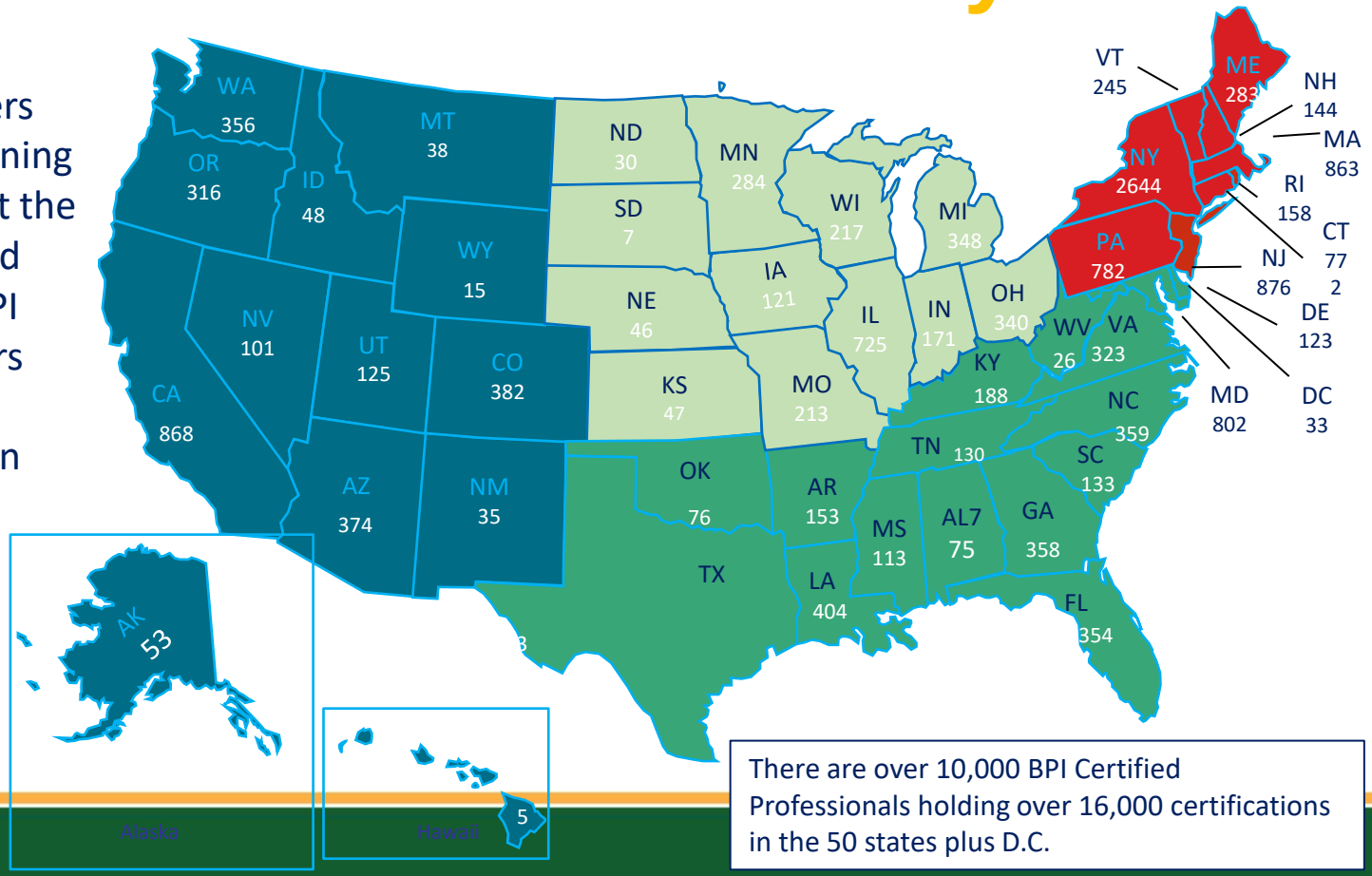


BPI, now in it's **31st year**, sets national standards for improving comfort and energy efficiency and for creating and maintaining safe and healthy home environments. From these standards, BPI develops professional certifications and certificates for home contractors to ensure quality service and workmanship.

BPI is a national 501(c)(3) nonprofit organization.

BPI Certifications by State

107 partners deliver training throughout the country and serve as BPI Test Centers for certification exams.



There are over 10,000 BPI Certified Professionals holding over 16,000 certifications in the 50 states plus D.C.

Building Analyst and Envelope Certification Revisions

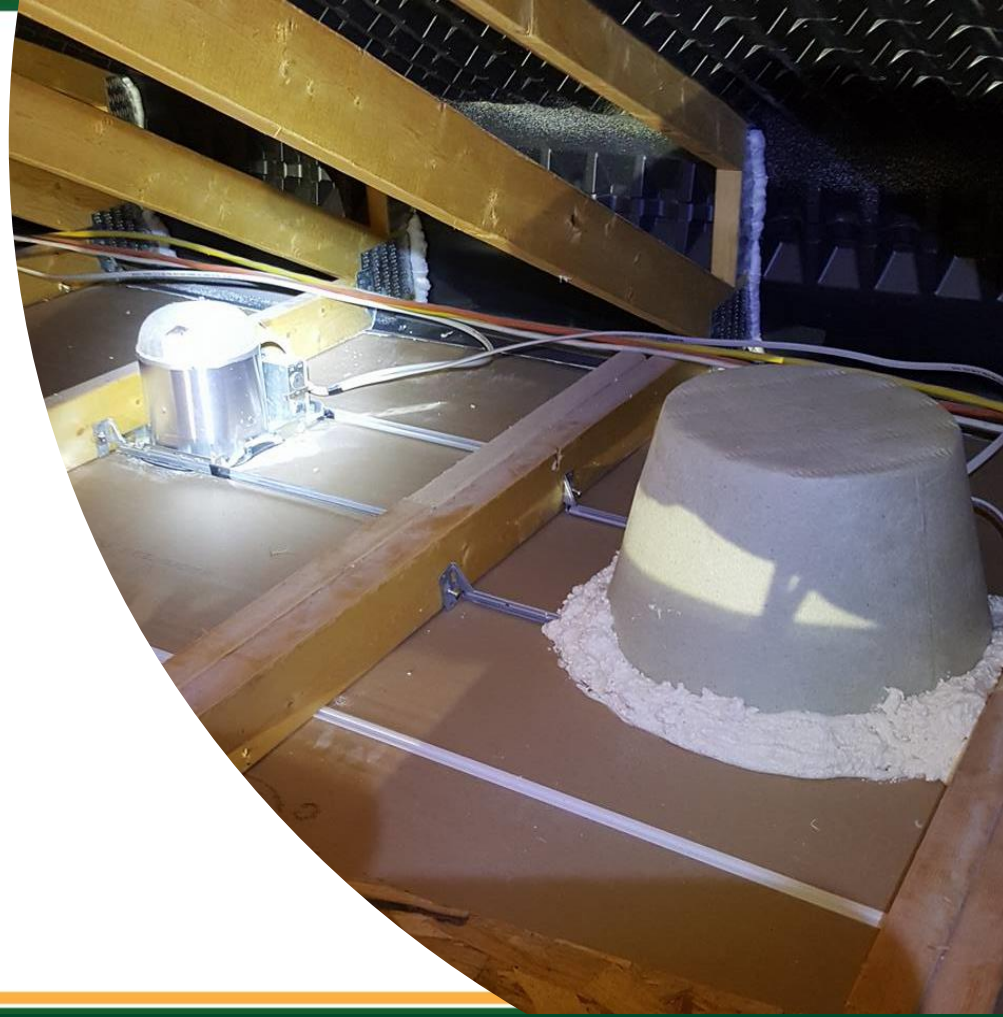
- Subject Matter Experts reviewed overlaps in the two certifications
- Upgraded the Job Task Analyses and Knowledge, Skills, and Abilities
- Upgrade resulted in a new credential specific to diagnostic testing and data collection
- New designations create a stronger career path



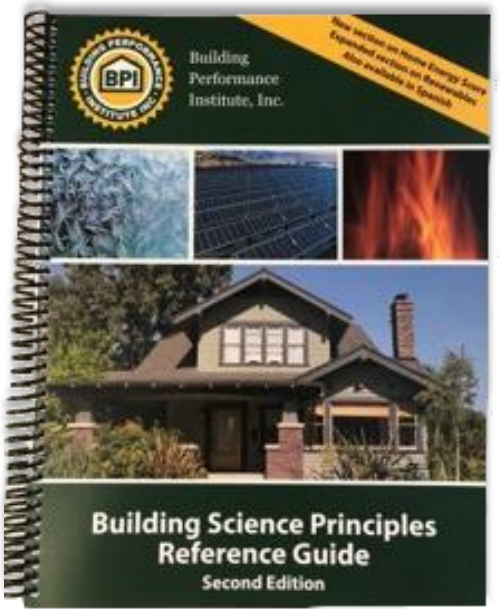


What are the objectives of the Building Science Principles Certificate of Knowledge?

- Learn the fundamentals of building science and the related terminology
- Learn about the relationships between the building envelope, heating, A/C, insulation, mechanical ventilation, lighting, appliances, and other systems
- Understand how these systems affect the comfort, health, and safety of residents and the durability of the home



BPI's Building Science Principles





Building Analyst Technician (BA-T)

Scope

A Building Analyst Technician conducts residential building science-based diagnostic tests and home performance data collection.



Building Analyst Technician

- Field Exam only
- Verbal questions during field exam
- Building Science Principles Certificate of Knowledge prerequisite
- Does not include work scope development
- Does not include energy modeling

Updated Building Analyst Professional (BA-P)

Scope

A Building Analyst Professional is a certified Building Analyst Technician who also conducts energy modeling, building analysis, and data evaluation in order to provide a comprehensive report with a list of prioritized home performance recommendations.

Updated Building Analyst Professional

- Less of an experience requirement compared to the HEP Energy Auditor
- Written only exam with BA-T as a prerequisite
- Exam focuses on analyzing data, modeling, and work scope development

BUILDING PERFORMANCE ASSOCIATION CAN HELP BUILD A CERTIFICATION PATHWAY



Provide no-cost, high quality technical assistance for employers and other potential sponsors throughout the process of designing, registering, implementing, and scaling Registered Apprenticeship programs aligned with national standards and industry-recognized credentials.

- Industry lead
- DEI & safety standards
- Related Technical Instruction, O-T-J
- Paid training with wage progression
- Mentored job shadowing
- Credentials that build on each other

ACE APPRENTICESHIPS IN CLEAN ENERGY NETWORK™

BUILDING PERFORMANCE ASSOCIATION

National Grid/NYSERDA $700K Investment in Workforce Development

Up to 225 Individuals will receive training and certification exams at an out-of-pocket cost of $150.

- Minority and Women Owned Business Enterprises (WMBE) and their employees
- Indigenous-owned energy services companies and their employees
- Veteran Owned Businesses (VOB) and
- Service-Disabled Veteran Owned Businesses (SDVOB)
- Individuals living in Disadvantaged Communities (DACs) within National Grid service territory

BPI New York Test Center Eligibility

To qualify to participate in this program, NY Test Centers must offer training leading to one of the Core BPI Certifications:

- Multifamily Building Analyst (MFBA)
- Air Leakage Control Installer (ALC)
- Infiltration and Duct Leakage (IDL)
- Building Analyst Technician (BA-T)
- Building Analyst Professional (BA-P)


GREEN
GENERATION

Leadership and Sustainability Advocacy





Summer KSA Development

- Year 1
  - **Infiltration/Duct Leakage (IDL)**
  - **Air Leakage Control Installer (ALCI)**
  - Cool Tools
  - Learning to Know/Do
  - Sustainability Advocacy
- Year 2
  - **Building Science Principles (BSP)**
  - **Healthy Housing Principles (HHP)**
  - Administration
    - Learning to Be/Live Together
    - Sustainability Advocacy
- Year 3
  - **Building Analyst - Technician (BA-T)**
  - Program Management/ Implementation

First Cohort

- 9 students have BPI's IDL, ALCI, BSP, and HHP
- Some also have BA-T
- 100% of students returned each year

- See greengen2.com







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Efficiency For All

M=POWER

Paving the Way to Equity and Opportunity

www.efficiencyforall.org

EFFICIENCY FOR ALL



Lack of Qualified workers for Open Jobs

Our nation as a whole is facing a lack of qualified workers for available energy efficiency jobs and clean energy jobs. These Energy Efficiency (EE) career paths include entry level and building science certified insulation, energy auditors, EE support techs, insulation installers and insulation support techs, office administrators, window installers, electricians, heat pump installers, ALM/mold remediators, customer service representatives, and office billers. Many job seekers are unaware of the growing energy efficiency and clean energy career industries. While others lack the proper skill sets needed to apply for the local and growing energy efficiency roles in our great state.







How Can one be involved in something they do NOT know exists?

EMPOWERMENT through Knowledge is Key to Engagement !



Certified - Workers

- **BPI Building Analyst** – Learn how to perform comprehensive, whole-home assessments, identify problems at their root cause, and prescribe and prioritize solutions based on building science.
- **BPI Envelope Professional** – Learn to prescribe improvements to tighten the building envelope (shell), stop uncontrolled air leakage, and optimize comfort, durability, and HVAC performance.
- **Infiltration and Duct Leakage** – Gain the skills needed to offer duct leakage and blower door tests, in compliance with IECC codes for new home construction or existing home remodels.
- **Healthy Home Evaluator** – Healthy Home Evaluators assess home-based environmental health and safety hazards and provide a prioritized list of recommendations to address those hazards.

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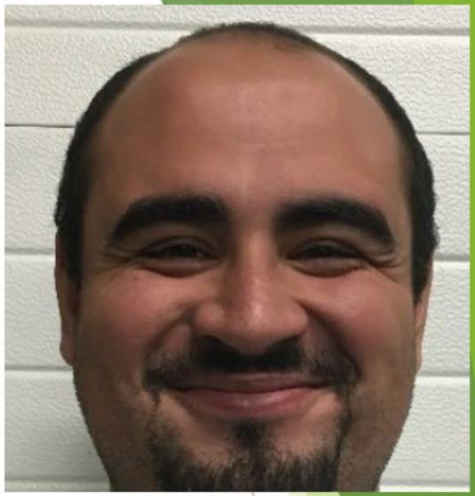
Real Careers

"Thank you EFA for teaching me new skills that have lead to a great career at Harisi Energy. My career has helped me become financially stable and finally accomplish a life long dream of owning a motorcycle!" - Andrew G.



- Achieved Lead Technician Status in under a year
- Has a car that works
- Increased his family's economic mobility
- Has stable housing
- Leads a team
- Bought a motorcycle

Real Progress



"This is not just a job; it's a career. I love hearing the customer leave good compliments; they are so happy when we leave. Sometimes they tell you that their home feels comfortable as we leave. That is a good feeling!"

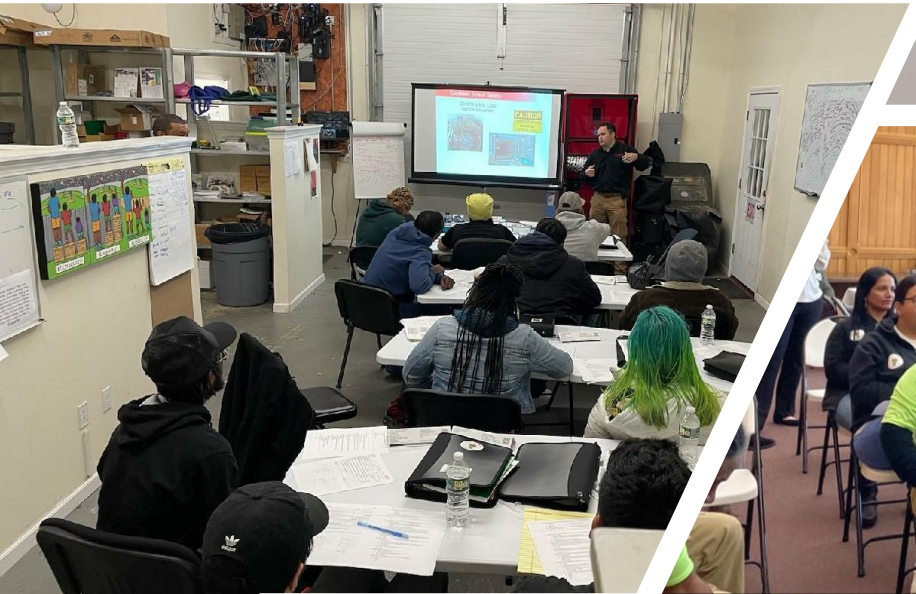
"Thank you Leticia and Edgardo from EFA for starting this program and for being there for those who need help!" - Francisco



- Achieved Lead Technician Status in under a year
- Leads a crew at one of the largest Energy Efficiency Contractors in the Nation
- Increased his family's economic mobility
- Has stable housing









EXAMPLE





HOME PERFORMANCE CONTRACTOR INCUBATOR PROGRAM

Mark Kravatz
Partner
Alidade Consultants

Adam Feldman
Executive Director
Habitat for Humanity of Saratoga, Warren, and Washington Counties

THE PROGRAM

At the end of the thirty-six month program, contractors will have the skills, knowledge, experience, network, and financing necessary to thrive as new independent home performance contractors.

HIGHLIGHTS

YEAR 1

- Classroom training/certs
- Field experience
- Financial savings plan

YEAR 2

- Manage construction jobs w/ assistance
- Develop essential construction mgmt. knowledge & skills
- Hone essential administrative skills

YEAR 3

- Contractors work independently but under Habitat NSWW's fiscal agency
- Business and marketing plans complete
- Secure startup financing

YEAR 4+

- Continuing education credits
- Professional Networking



EXAMPLE

Alidade CONSULTANTS

Habitat for Humanity® Northern Saratoga, Warren and Washington Counties

YEAR ONE AT A GLANCE



Classroom Training

- ❑ 11+ Industry Recognized Trainings & Certifications
- ❑ ***Primary areas of study include***: Building Science ● Building Safety ● Building Codes ● Critical Home Repairs ● Hazard Mitigation ● Healthy Housing ● Energy Efficiency ● Universal Design ● Green Building Standards

Field Training

- ❑ 1500+ hours
- ❑ ***Field experiences include***: Home Repairs ● Hazard Mitigation ● Integrated Pest Management ● Weatherization ● Home Modifications
- ❑ Build construction team ● Team gets trained & certified
- ❑ ***Purchase Equipment:*** Truck and Tools

Organize Finances

- ❑ Establish Savings Account ● Credit & Debt Repair ● Financial Literacy

Alidade CONSULTANTS

Habitat for Humanity® Northern Saratoga, Warren and Washington Counties

EXAMPLE

YEAR TWO AT A GLANCE

Construction Management

- ❑ 1750+ work hours
- ❑ Scoping ● Pricing/Bidding ● Coordinate Subcontractors ● Budgeting ● Scheduling ● Quality Control
- ❑ ***Software Applications***: Procore

Business Management

- ❑ General Bookkeeping (Account Receivables & Deliverables) ● Purchasing Materials ● Supplies Management ● Human Resources ● Marketing
- ❑ ***Software Applications***: QuickBooks ● Google Workspace ● Social Media ● Webpage



Alidade CONSULTANTS

Habitat for Humanity® Northern Saratoga, Warren and Washington Counties

EXAMPLE

YEAR THREE AT A GLANCE



Independent Contracting

- ❑ Full management of construction jobs
- ❑ 2000+ hours

Business Planning

- ❑ Business Plan & Pro forma

Networking

- ❑ Collaborations with other contractors in the home performance sector

Financing

- ❑ Local community financial institution partners to provide startup financing

Alidade CONSULTANTS

Habitat for Humanity® Northern Saratoga, Warren and Washington Counties

EXAMPLE

YEAR FOUR+

Networking and Continuing Education

- We will provide regular programming (e.g., monthly mentoring check-ins, networking events, guest speakers, etc.) to ensure that participants remain connected and supported as they venture into business independently.
- Additional continuing education opportunities for contractors to maintain their credentials and provide more in-depth technical training.

Continuing Education Partners

BPI CERTIFIED PROFESSIONAL

BUILDING PERFORMANCE ASSOCIATION

LEAD-SAFE EPA CERTIFIED FIRM

IREC INTERSTATE RENEWABLE ENERGY COUNCIL Independent leadership. Trusted clean energy expertise.

NEW YORK STATE OF OPPORTUNITY. NYSERDA

US DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

DEPARTMENT OF ENERGY UNITED STATES OF AMERICA

Alidade CONSULTANTS

Habitat for Humanity Northern Saratoga, Warren and Washington Counties



EXAMPLE

GREEN WORKFORCE CONNECT

Cultivate a New Generation of Diverse **Weatherization Assistance Program** Professionals and Contractors







PROBLEMS

- Job seekers don't know about opportunities in the Weatherization Assistance Program (WAP).
- Workforce development resources are fragmented.
- Employers need help connecting to potential employees.
- Contractors don't know how to connect to WAP opportunities.

SOLUTIONS

- **Green Workforce Connect** provides job seekers with a WAP career exploration tool and connects them to their local WAP employer.
- Employers access workforce development resources and technical assistance.
- Contractors access program information and resources to connect them to WAP contracting opportunities.

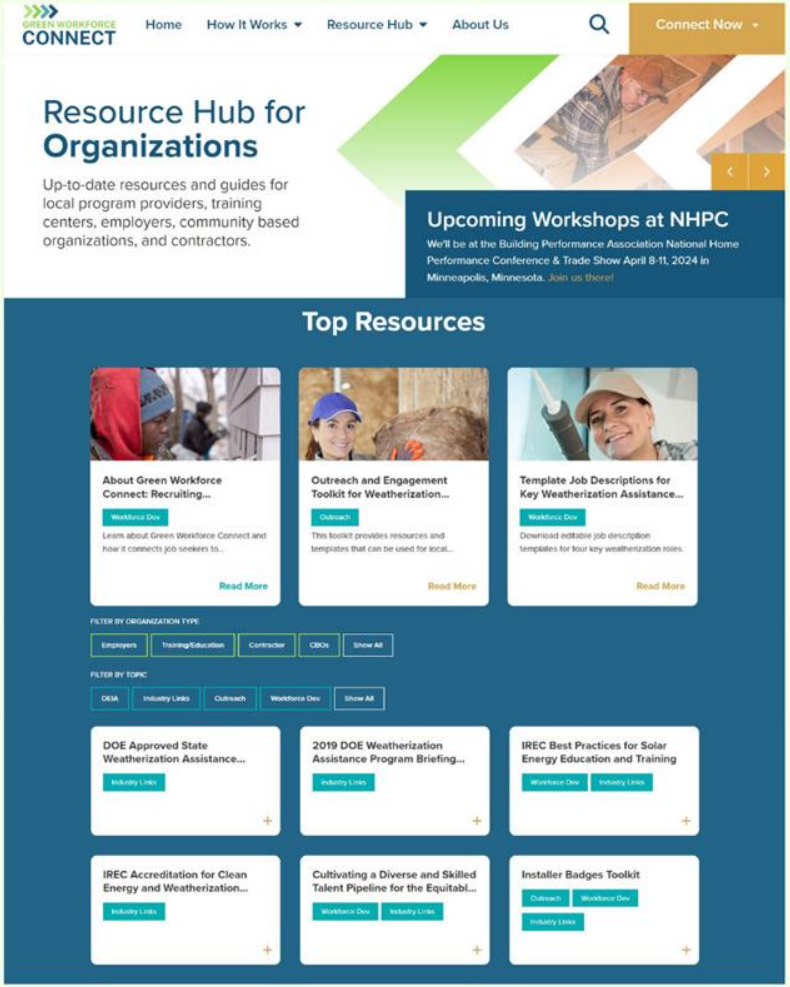
Take advantage of our...

GREEN WORKFORCE CONNECT

Resource Hub!

Access workforce development resources on the Green Workforce Connect platform! Find up-to-date resources for local program providers, training centers, community based organizations, and contractors.

- Career exploration information for job seekers
- Job description templates for key roles
- Recruitment and outreach messaging to reach underrepresented populations, including youth
- Links to commonly requested program resources
- Project information and upcoming events
- “Contractor’s Guide to Success”



Take advantage of our...

GREEN WORKFORCE

CONNECT

Outreach Toolkit!

Raise awareness of WAP careers and invite job seekers to visit the Green Workforce Connect platform! The outreach toolkit includes dozens of template options for multiple audiences, including:

- Printable Flyers
- Printable Postcards
- Social Media Toolkit
- Radio Ads/PSA Language
- Slideshow Presentations
- Videos Featuring Real Weatherization Professionals



Workforce Recruitment Materials

- Themed messages demonstrated to resonate with target audiences
- Customizable graphics for print and social media
- Sample copy to use in recruitment
- Strategies & shared wisdom from around the country
- Survey data from real recruitees on what works
- Modern design values



Total Building Performance (TBP) Certificate of Knowledge

BUILDING PERFORMANCE ASSOCIATION

BUILDING PERFORMANCE INSTITUTE INC

ENERGY FUTURES GROUP



Toward Net Zero Energy in Existing Homes

Earn the Total Building Performance (TBP) Certificate of Knowledge



TBP SCOPE

- Exam is free until March 31
- Earn 10 BPI CEUs
- 8 Free online training modules
- Online exam can be taken anytime
- Scores available after cut scores are determined

Certificate

Training

BPI Credentials on the Horizon

- **Cold Climate Air Source Heat Pumps Sizing, Design and Equipment Selection (Certificate)**
- **Heat Pump Water Heater (Certificate)**
- **Residential Electrification Energy Audit Protocol (Certificate)**
- **Multifamily Building Analyst Certification (Updating)**

Links to Workforce Development Resources

- BPA – https://building-performance.org/registered-apprenticeships-building-career-pathways-in-energy-efficiency/
- National Grid/NYSERDA – https://www.nationalgridus.com/Long-Island-NY-Business/Energy-Saving-Programs/BPI
- Green Generation (G2) – https://www.energy.gov/scep/articles/eere-success-story-building-green-generation-chicago
- Efficiency for All – www.EfficiencyForAll.org
- Alidade Consultants – mark@alidadeconsultants.com
- IREC – https://greenworkforceconnect.org/
- BPI – https://www.bpi.org/certified-professionals

Workforce Development Contacts

- BPA – Xavier Walter (xwalter@building-performance.org)
- National Grid/NYSERDA – Lynn Franz, BPI contact (lfranz@bpi.org)
- Green Generation (G2) – Paul Francisco, Darnell Johnson, John Pady (pdfgm3@gmail.com, darnelljohnson@urbanefficiencygroup.com, jpady@cedaorg.net)
- Efficiency for All – Leticia Colon de Mejias (lcolonees@gmail.com)
- Alidade Consultants – Mark Kravatz (mark@alidadeconsultants.com)
- IREC – Pagan Paggione (paganp@irecusa.org)
- BPI – Nancy Kaplan (nkaplan@bpi.org)

Discussion? Questions? Ideas?

Larry Zarker, **CEO**
BPI
lzarker@bpi.org
(202) 256-3893 direct

Building Performance Institute, Inc.
63 Putnam Road, Suite 202
Malta, NY 12866
1-877-274-1274
www.BPI.org



Christian Valoria

PNNL

Pacific Northwest
NATIONAL LABORATORY

Heat Pump Workforce Challenges

Quality Installation and Commissioning

January 22, 2024

Christian Valoria, P.E.
Pacific Northwest National Laboratory



U.S. DEPARTMENT OF ENERGY BATTELLE
PNNL is operated by Battelle for the U.S. Department of Energy

Agenda

- Residential building decarbonization landscape
- Heat pump challenges
- Need for residential commissioning
- Smart commissioning tools
- Other PNNL-managed workforce initiatives and tools

Residential Building Decarbonization Landscape

- IRA Home Energy Rebates
  - High-Efficiency Electric Home Rebate Program
  - Home Energy Performance-Based Whole-House Rebates
- Key technology: Heat Pumps
- Workforce challenges
  - Workforce shortage
  - Upskilling
  - Contractor resistance
- Training for Residential Energy Contractors (TREC) Grants



Quality Installation: A Key Workforce Challenge to HP Deployment

Impact of Improper Installation

Improper installations reduce system performance, resulting in energy waste and comfort issues:

- One or more energy-wasting HVAC fault in 70–90% of homes[1]
- Nationally, estimated 9% residential HVAC energy waste due to installation faults in CAC/ASHP, compared to no-fault condition[2]

If you don't test it, how do you know?

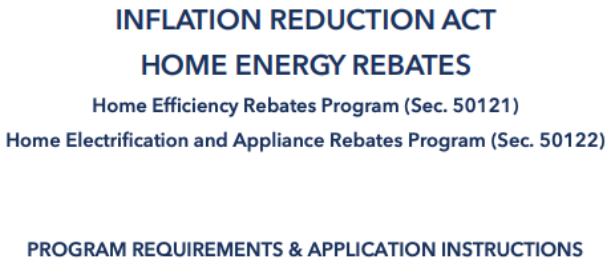
Quality assurance through residential HVAC commissioning

Fault Type	% of Systems Testing Higher than Recommended Range	% of Systems Testing Lower than Recommended Range
Equipment Sizing	31-93%	0-9%
Airflow	8-29%	50-93%
Refrigerant Charge	4-50%	29-78%
Duct Leakage	67-100%	N/A

Figure: Field Measured Data by Fault Type (truncated table from Ref [1])

1. DOE EERE, 2019. Residential HVAC Installation Practices: A Review of Research Findings
2. Winkler et al. 2020. Impact of installation faults in air conditioners and heat pumps in single-family homes on U.S. energy usage. Applied Energy, Volume 278

Quality Assurance in Home Energy Rebates



§3.2.5 – Program Requirements: Consumer Protection through Quality Assurance
[Home Efficiency Rebate Programs]
§ 4.2.5 – Program Requirements: Consumer Protection through Quality Assurance
[Home Electrification and Appliance Rebates State Programs]

- *Post-installation photos of major upgrades for all homes.*
- *Proof of commissioning testing on HVAC equipment in all homes where HVAC systems are installed.*

Source:
https://www.energy.gov/sites/default/files/2023-10/home-energy-rebate-programs-requirements-and-application-instructions_10-13-2023.pdf

Limited Adoption of Residential HVAC Commissioning

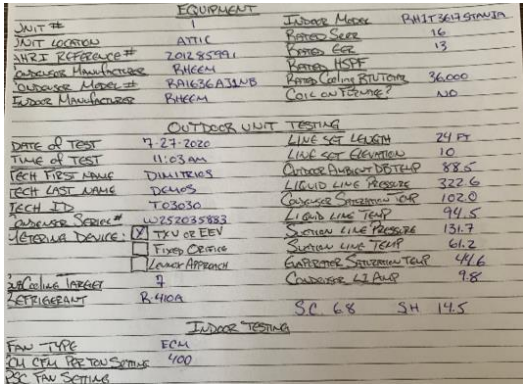
HVAC Installer / Start – up Technician Responsibilities:

- Complete the Installation and applicable Distribution Aspects portion for each system that is installed[41].
- Visit www.gacontractors.org/qa/existing-homes for more information.

3. INSTALLATION		
3.1 Installed Equipment		
3.1.1	INSTALLED equipment and control are SAME as specified in Section 2: DESIGN: ☐ Yes ☐ No	
3.1.2	Furnace Brand:	☐
3.1.3	Furnace Model Number:	☐
3.1.4	Furnace Serial Number:	☐
3.1.5	Condenser Brand:	☐
3.1.6	Condenser Model Number:	☐
3.1.7	Condenser Serial Number:	☐
3.1.8	Coil/ Fan Coil Unit Brand:	☐
3.1.9	Coil/ Fan Coil Unit Model Number:	☐
3.1.10	Coil/ Fan Coil Unit Serial Number:	☐
3.2 Airflow[42]		☐
3.2.1	System must be tested in the mode with highest design airflow?[43] ☐ Heating ☐ Cooling	☐
3.2.2	Fan Speed[44]: ☐ Hi ☐ Med- Hi ☐ Med ☐ Med-Lo ☐ Lo ☐ Variable-Speed	☐
3.2.2.a	Airflow Procedure: ☐ ESP – Furnace, Fan Coil Unit, or Package Unit ☐ PD – Evaporator Coil Only	
3.2.3	Return / Entering Air Static Pressure[45]: _____ IWC	☐
3.2.4	Return / Entering Air test port location[46]: ☐ Return air plenum (pre-filter) ☐ Equipment cabinet (post-filter) ☐ Return air (filter) grille ☐ Before the coil (furnace–coil transition)	☐
3.2.5	Supply / Leaving Air Static Pressure[47]: _____ IWC	☐
3.2.6	Supply / Leaving Air test port location: ☐ Furnace limit switch sensor port ☐ Supply air plenum ☐ After the furnace (furnace – coil transition)	☐
3.2.7	External Static Pressure (ESP)[48]: _____ IWC	☐
3.2.8	Determine airflow using ESP and OEM performance data[49]: _____ CFM	☐
3.2.9	Return and Supply Test Hole Locations marked and sealed: ☐ Pass ☐ Fail	☐
3.3 Refrigerant Charge – *Run system for a minimum of 10 minutes or until system operation is stable* [50]		☐
3.3.1	Refrigerant type: ☐ R-410A ☐ R-22	☐
3.3.2	Outdoor Temperature: _____ °F DB	☐
3.3.3 Subcooling: Test[51] DO NOT TEST COOLING MODE BELOW 60°F *outdoor air (OA) temperature*		☐
3.3.3.a	Measured Liquid Line Saturation Temperature: _____ °F DB	☐
3.3.3.b	Measured Liquid Line Pressure: _____ psig	☐
3.3.3.c	Liquid Line Temperature for the Corresponding Saturation Pressure 3.3.3.b[52]: _____ °F DB	☐
3.3.3.d	Calculated subcooling (3.3.3.a – 3.3.3.c): _____ °F DB	☐
3.3.3.e	OEM subcooling target[53]: _____ °F DB	☐
3.3.3.f	Subcooling deviation (3.3.3.e – 3.3.3.d): _____ °F DB	☐
3.3.4 Superheat Test:[54] DO NOT TEST COOLING MODE BELOW 55°F *OA temperature*		☐
3.3.4.a	Measured DB Temperature (taken at condenser)[55]: _____ °F DB	☐
3.3.4.b	Measured WB Temperature (as air enters evaporator)[56]: _____ °F WB	☐
3.3.4.c	Measured Suction Line Saturation Temperature (at condenser): _____ °F DB	☐
3.3.4.d	Measured Suction Line Pressure (taken at condenser): _____ psig	☐
3.3.4.e	Suction Line Temperature for the Corresponding Saturation Pressure 3.3.4.d[57]: _____ °F DB	☐
3.3.4.f	Calculated superheat (3.3.4.c – 3.3.4.e): _____ °F DB	☐
3.3.4.g	OEM superheat target[58]: _____ °F DB	☐
3.3.4.h	Superheat deviation:(3.3.4.g – 3.3.4.f): _____ °F DB	☐
3.3.4.i	Value 3.3.3.f is ≤ 3°F OR Value 3.3.4.h is ≤ 5°F ☐ Pass ☐ Fail	☐
3.3.4.j	OEM approved test procedure was used[59]: ☐ Pass ☐ Fail	☐
3.4 Electrical Measurements		
3.4.1	Indoor fan motor: _____ amperage _____ line voltage	☐
3.4.2	Inducer fan motor: _____ amperage _____ line voltage	☐
3.4.3	Condenser / Heat pump: _____ amperage _____ line voltage	☐
3.4.4	Outdoor fan motor: _____ amperage _____ line voltage	☐
3.4.5	Electrical measurements within OEM-specified tolerance of nameplate value ☐ Pass ☐ Fail	☐
3.5 On Rate Combustion[60] (When Fossil Fuel Equipment Is Installed)		☐
3.5.1	Combustion Appliance Startup Testing (All Appliances): Altitude De-rating Factor: _____	☐

HVAC Quality Installation Verification Protocols – 2016



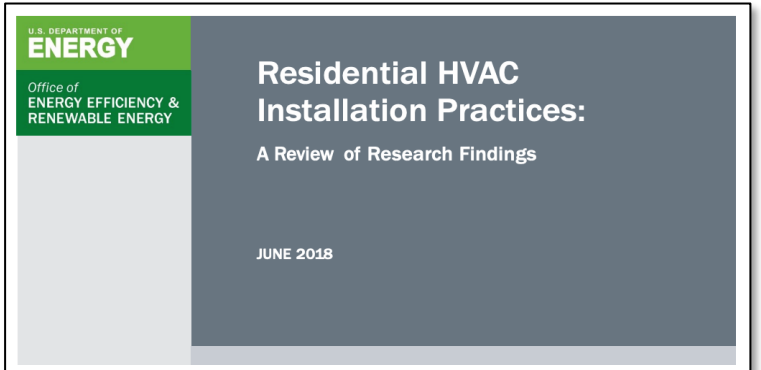


- ACCA Quality Installation Specification (QI5) and Verification Protocols (QIvp)
- ACCA / RESNET Standard 310
- ASHRAE Standard 221
- Manufacturer Requirements
- Utility programs may require Verified Quality Install

Increasing Uptake of Residential HVAC Commissioning

Smart Diagnostic and Commissioning Tools!

- Calculate HVAC system performance, Capacity, EER
- Detect faults, suggest corrective actions
- Workflows for consistent practices
- Third-party verification
- Provide feedback loop for technician, leading to continuous improvement

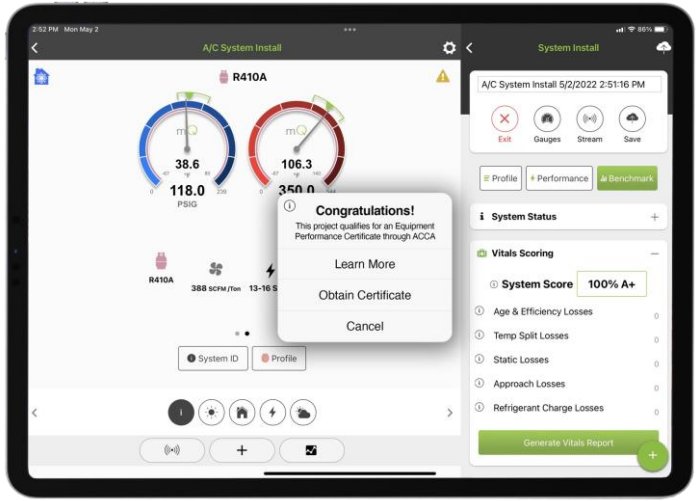


… recommendations to advance high performance HVAC installation practices.

- ***Promote technologies and processes*** *that reduce deployment and implementation costs and make improved installation practices more accessible and cost-efficient (e.g., automated verification systems and on-board monitoring and fault detection)*
- ***Develop Quality Control protocols*** *to detect and minimize the opportunity for gaming of data inputs when using automated verification tools. At a minimum, ensure data checks exist to identify patterns indicating improper use of tools and intentional gaming.*

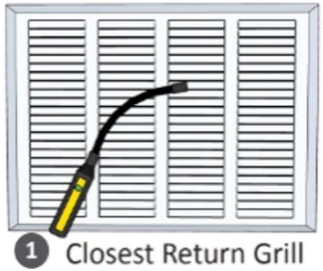
Smart Tool-Assisted Commissioning

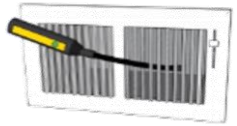
Quality Install Certificates

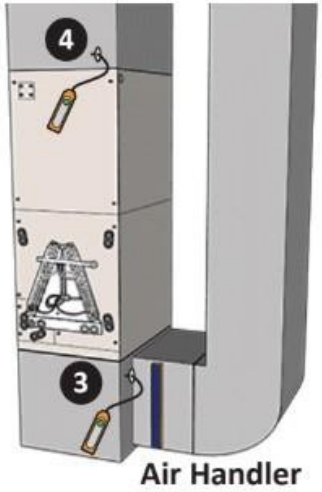


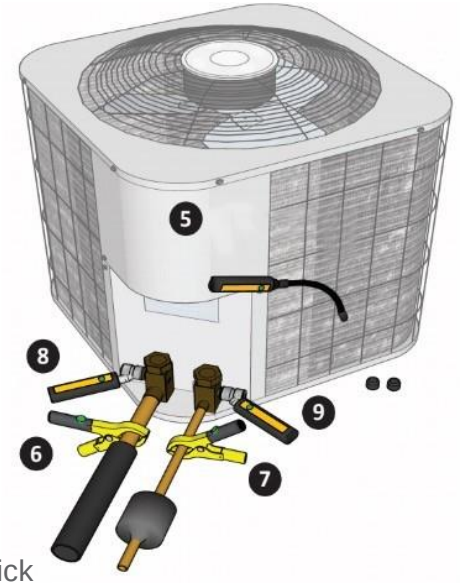


https://www.acca.org/qa/prove-it









Illustrations courtesy of measureQuick

*PNNL does not specifically endorse specific smart tool products

Smart Tools for Efficient HVAC Performance (STEP) Campaign

Goal: increase adoption of **smart tools** to streamline HVAC system commissioning and troubleshooting and improve residential HVAC installation quality

Campaign Functions:

- ✓Raise awareness
- ✓Develop resources
- ✓Technical assistance
- ✓Recognize partner achievements

In search of campaign partners …

- Training Providers
- HVAC Contractors
- Utilities and Energy Efficiency Orgs



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

SMART DIAGNOSTIC TOOLS

Smart Diagnostic Tools take SMART Training from Classroom to Customer Satisfaction

STEP Campaign Case Study

Several studies have found that at least one energy-wasting fault exists in 70–90 percent of residential HVAC systems.[1] Smart diagnostic tools can help HVAC technicians prevent, identify, and fix such issues.

Smart diagnostic tools are a suite of digital probes that transmit key HVAC system measurements to smartphone applications that enable commissioning and diagnostics. This ensures air source heat pumps, central air conditioners, and other residential HVAC equipment are installed and operating correctly.

Quality training on the use of smart diagnostic tools is critical in empowering technicians to provide this level of service—and ensures all parties involved are set up for success. When technicians have the skills and tools they need to maximize an HVAC system's capacity, performance, and longevity, the result is improved customer satisfaction, contractor profitability, distributor sales, and manufacturer reputation.

Plus, with demand for heat pumps at an all-time high, and with an influx of federal incentives becoming available for heat pump installations, it is critical that these systems be installed correctly the first time. Smart diagnostic and commissioning tools can help technicians during the installation and system performance verification process, but few organizations currently provide training on these tools. SMART Local 265 is leading the way by implementing smart diagnostic tools in their training and helping to upskill the HVAC workforce.

Figure 1. A SMART Local 265 instructor demonstrates the use of smart diagnostic tools to verify proper refrigerant charge on a test system in the program's in-house laboratory. (Photo courtesy of Joseph Carone; SMART Local 265)

Once a system is verified, a technician can easily capture system data and save it to a customer's file. If there is a problem in the future, the team can more easily troubleshoot by comparing past readings. The tools make data collection easy, enabling contractors to better prepare for service needs or potential issues that may arise in future service visits.

Smart Diagnostic Tools

Smart diagnostic tools combine digital HVAC diagnostic or commissioning applications and wireless probes to enable real-time fault detection and diagnostics during installation or maintenance of residential HVAC systems. Technicians place smart probes on different components of HVAC systems to collect key measurements, such as air temperature and flowrates, refrigerant temperature and pressure, and electrical readings.

These measurements conveniently synchronize with the diagnostic application, which synthesizes the data to calculate system performance, run real-time diagnostics, and identify potential system faults. The smart diagnostic tools can also narrow down points of failure and recommend suggested adjustments or repairs. These tools check that the HVAC system measurements are within industry standard tolerances and that the system is performing optimally.

Benefits in the Classroom

SMART Local 265 recognizes that smart diagnostic tools are the way of the future—and for its students to be prepared for careers in the HVAC field with rapidly advancing technology, its curriculum needs to stay up to speed.

"Our leadership team is committed to being on the cutting edge of technology," Carone said. "As soon as a new innovation that could be valuable to our membership comes into the marketplace, they support us in adding it to our training center as soon as possible."

When smart diagnostic tools were new to the market, SMART Local 265 staff saw smart gauges at a trade show and knew their potential. Despite the expense at the time, the organization decided they were worth the investment—and their benefits were immediately apparent in SMART Local 265's apprentice training program.

Training Organization Quick Facts

SMART Local 265
SMART Local 265 (Sheet Metal, Air, Rail, Transportation Local Union No. 265) serves nine counties in Illinois. As a sheet metal union, SMART Local 265 provides apprenticeship programs for two HVAC career paths: system installation and HVAC service. The latter includes commissioning new equipment and troubleshooting operational issues in existing HVAC systems.

Joseph Carone, senior apprentice and journeyperson service instructor
Location: Carol Stream, Illinois
Founded: 1913
Website: smart265.org



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

SMART DIAGNOSTIC TOOLS

From Data to Decision-Making: Smart Diagnostic Tools Linked to Business Growth

STEP Campaign Case Study

Several studies have found that at least one energy-wasting fault exists in 70–90 percent of residential HVAC systems.[1] Smart diagnostic tools can help HVAC technicians prevent, identify, and fix such issues.

Smart diagnostic tools are a suite of digital probes that transmit key HVAC system measurements to smartphone applications that enable commissioning and diagnostics. This ensures air source heat pumps, central air conditioners, and other residential HVAC equipment are installed and operating correctly.

With demand for heat pumps at an all-time high, and with an influx of federal incentives becoming available for heat pump installations, it is critical that these systems be installed and operate correctly from the start. Smart diagnostic tools can help contractors achieve this goal—and help training organizations upskill the HVAC workforce. This case study provides an example of how one company's implementation of smart tools led to optimal system performance and customer satisfaction, along with significant business growth. It also highlights how the company is helping increase awareness across the industry by providing training on smart tools and preparing technicians for the growing HVAC field.

Figure 1. HVAC technicians learn about smart diagnostic tools at the Fast Track Learning Lab, Simpson Salute's 5,000 square foot training facility. (Photo courtesy of Steve VanHorn / Simpson Salute Heating and Air)

Smart Diagnostic Tools

Smart diagnostic tools combine digital HVAC diagnostic or commissioning applications and wireless probes to enable real-time fault detection and diagnostics during installation or maintenance of residential HVAC systems. Technicians place wireless probes on different components of HVAC systems to collect key measurements, such as air temperature and flowrates, refrigerant temperature and pressure, and electrical readings.

These measurements conveniently synchronize with the smart diagnostic application, which synthesizes the data to calculate system performance, run real-time diagnostics, and identify potential system faults in existing systems or commission newly installed systems. The smart diagnostic tools can also narrow down points of failure and recommend suggested adjustments or repairs. These tools check that the HVAC system measurements are within industry standard tolerances and that the system is performing optimally.

Once a system is verified, a technician can easily benchmark system performance and save it to a customer's file. If there is a problem in the future, the team can more easily troubleshoot by comparing to the benchmarked data. The tools make data collection and reporting easy, enabling contractors to set up a replicable commissioning process, and better prepare for service needs or potential issues that may arise in future service visits.

A Smart Pivot

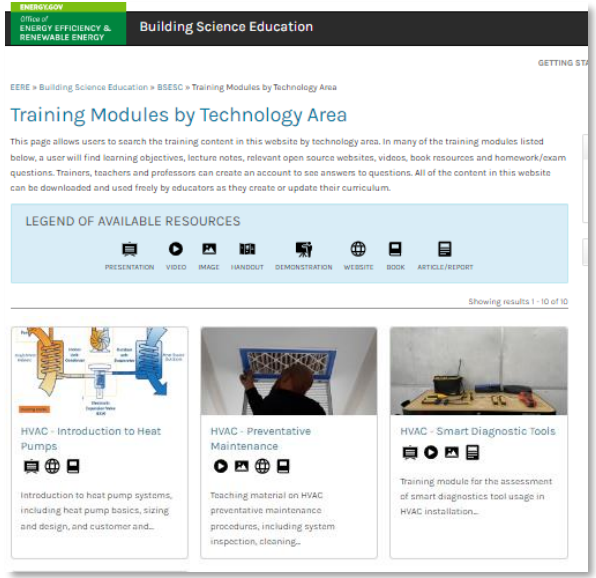
Simpson Salute Heating and Air had been growing steadily over the years when suddenly in 2021, its trajectory changed. During a period of rapid growth in terms of the number of installations completed, the company started noticing a drop in installation quality and an increase in customer call backs. Profits decreased by four percent, and there was a clear negative impact to staff morale and customer satisfaction. "Then in 2022, we were introduced to measureQuick, a popular smart diagnostic platform, which turned everything around," said Simpson Salute owner, Chad Simpson.

Organization Quick Facts

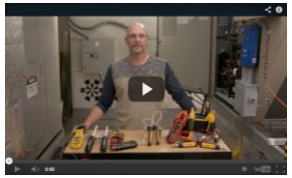
Simpson Salute Heating and Air
Founded on more than 100 years of combined experience, Simpson Salute is committed to setting new standards for reliable, superior service in northeast Ohio. Simpson Salute installs and services systems of all types, including gas furnaces, heat pumps, boilers, and more. The company's 5,000 square foot training center ensures its technicians and other local industry members are on the cutting edge of HVAC technology.

Chad Simpson, owner
Location: New Philadelphia, Ohio
Founded: 1999
Website: simpsonheating.com

Smart Tool-Assisted Commissioning Training





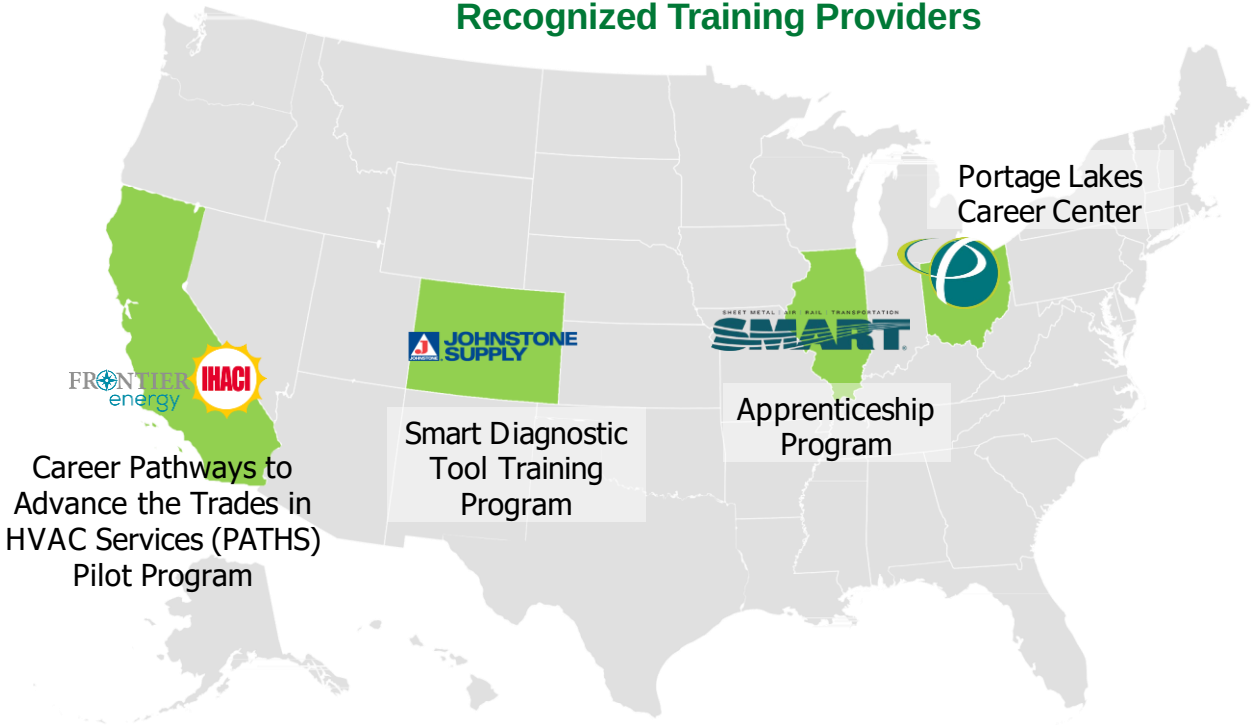


Collaboration with **Building Science Education Solution Center** Team

- Developed Intro to Smart Tools Module
- Smart Tool-Assisted Commissioning module in development
- STEP Campaign looking for interested training providers to pilot curriculum

STEP Campaign Recognized Partners in 2023

Recognized Training Providers



Recognized Contractors

eco PLUMBERS ELECTRICIANS HVAC TECHNICIANS

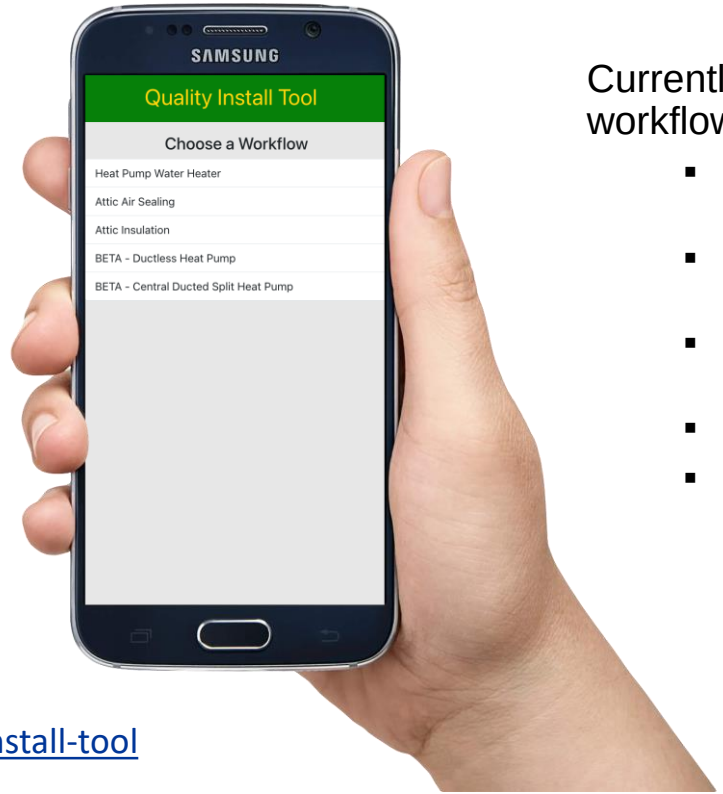
JACKSON COMFORT Services
HEATING • COOLING • PLUMBING

RAY O. COOK HEATING & AIR SINCE 1947

SIMPSON SALUTE HEATING & AIR

PNNL Quality Install Tool

- Free to use
- Easy to use
- Photo driven
- Automatically generates formatted PDF reports
- Contractor retains a copy on their work phone
- Contractor emails a copy to the customer
- The PDF can be attached to rebate submission portal



Currently available workflows:

- Central ducted split heat pump
- Ductless heat pump
- Heat pump water heater
- Attic insulation
- Attic air sealing

https://www.pnnl.gov/projects/quality-install-tool

PNNL Quality Install Tool
Example Photo Prompt & Resulting Photo

Vacuum Decay Test Results – Photo

Take a photo of the vacuum decay test results. Use a digital micron gauge. The system must be isolated from the vaccum pump. The vaccum must not rise above 500 microns in 15 minutes.

Add Photo

- The photo is automatically placed into a PDF alongside text that allows a customer or a quality assurance verifier to understand what they are looking at and what to look for in the image to determine quality.
- The app records the photo's timestamp and geolocation

Edward Louie
Edward.Louie@pnnl.gov

Vacuum Decay Test Results – Photo

A passing vacuum decay test is one where the system's vacuum does not rise above 500 microns in 10 minutes with the vacuum pump and vacuum hose isolated from the system. This indicates the system contains no moisture and is leak free.



Timestamp: August 25, 2023 at 10:00 AM PDT

Geolocation: 45.5118,-122.5809

Other PNNL Activities to Address Workforce Challenges

Address **skilled labor shortage**

Curate residential HP/HPWH **pre-field training** for installers & service technicians

Curate residential HP/HPWH in-field **on-the-job training** for installers & service technicians

Curate residential HP/HPWH **training for distributors & sales representatives**

Provide resources to **ensure contractor comfort** with HP technology in any climate (especially cold climates)

Kieren McCord
Kieren.mccord@pnnl.gov

Pacific Northwest
NATIONAL LABORATORY

Thank you

Christian Valoria
Christian.Valoria@pnnl.gov



Announcement:
Building America Retrofit Solutions Teams!

Team Leads and Locations:

Team Lead: Frontier Energy – Building Research and Consulting Business Unit
Location: Southwestern U.S.

Team Lead: Center for Energy & Environment
Location: Midwest U.S.

Team Lead: Enterprise Community Partners Inc.
Location: Western and Central U.S.

Team Lead: Steven Winter Associates
Location: Northeastern U.S.

Team Lead: EXP
Location: Eastern U.S.

Team Lead: Cycle Architecture, PLLC
Location: Northeastern U.S.

Team Lead: Syracuse Center of Excellence in Environmental & Energy Systems
Location: Northeastern U.S.

Team Lead: Earth Advantage
Location: Pacific Northwest U.S.

Team Lead: Southeast Energy Efficiency Alliance
Location: Southeastern U.S.



Building America Retrofit Solutions Teams

A portfolio of field demonstration projects leading to de-risked, equitable, and scalable technical retrofit solutions in the existing U.S. housing stock

Nine Multi-Disciplinary Teams Each Consisting Of:



Scan QR code to learn more about the teams!

Key Objectives:

- **Reduce risk** of retrofits to end-user, utilities, contractors, financiers.
- **Improve value proposition** of retrofit improvements to end-user, utilities, regulators.
- **Develop, disseminate, and promote** use of best retrofit practices.
- **Inform** technology development to meet end-user/contractor needs.



Teams will engage directly with communities to identify retrofit needs and develop best practice guidance for broader, scalable retrofit implementation (timeline: 1–3-year projects)

Smart Tools for Efficient HVAC Performance (STEP) Campaign

Pacific Northwest NATIONAL LABORATORY

STEP CAMPAIGN

Scan this QR code to visit our website

Contact: christian.valoria@pnnl.gov

The STEP Campaign aims to increase adoption of smart diagnostic tools to streamline HVAC system performance testing and troubleshooting, reducing energy-wasting faults and improving occupant comfort.

To join the STEP Campaign, visit: bit.ly/3DFmEaE



HVAC Contractors and Technicians

- Reduce callbacks, improve consistency and quality, streamline processes
- Find out where to get training on smart diagnostic tools
- Be recognized for successful adoption of smart diagnostic tools!



Utilities and Program Implementers

- Streamline quality installation and quality maintenance programs
- Improve engagement with your contractors
- Be recognized for programs that utilize smart diagnostic tools!



HVAC Training Organizations

- Offer qualified training on System Performance with smart diagnostic tools
- Promote your training events
- Be recognized for providing training!



Weatherization Organizations

- Ensure your ASHP/CAC installations are operating at optimized efficiency
- Develop pilot with PNNL team
- Be recognized!

ORGANIZING PARTNERS

ACCA · BUILDING PERFORMANCE ASSOCIATION · CEE Working Together, Advancing Efficiency · HVAC Excellence · NATE · neea · U.S. DEPARTMENT OF ENERGY

Explore the Residential Program Guide

Resources to help improve your program and reach energy efficiency targets:

- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.
- Health + Home Performance Infographic – spark homeowner conversations.



https://rpsc.energy.gov

Health + Home Performance Infographic



DOE's Health + Home Performance Infographic reveals the link between efficiency and health – something everyone cares about. Efficiency programs and contractors can use the question-and-answer format to discover a homeowner's needs.

The infographic is ideal for the "kitchen table" conversations where people decide what to do – and who they want to do it. It also has links for homeowners to find a qualified contractor if they do not already have one.

Download this infographic from DOE's Better Buildings Residential Network.

Looking for photos to help tell your energy efficiency story? Visit our image libraries: https://www.energy.gov/eere/better-buildings-residential-network/articles/image-libraries

Thank You!

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Please send any follow-up questions or future call topic ideas to:
bbresidentialnetwork@ee.doe.gov