



# **Clean Energy Employment Impacts and Occupational Analyses: Building Envelope & Electrification Upgrades**

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Mitch Brown, Aaron Lazelle, Bill Prindle, Eliza Johnston, and Ridah Sabouni  
*ICF Incorporated*

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NREL Technical Monitor: Allison Moe

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# Task 2: Occupational Analysis

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## Overview

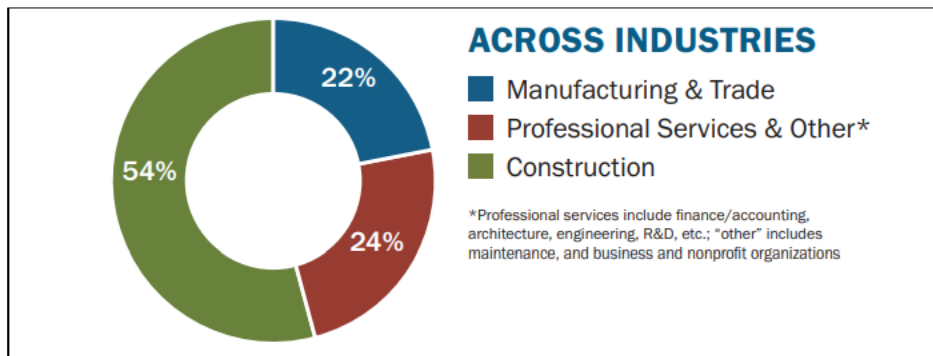
Under the Communities LEAP (Local Energy Action Program) Pilot, the U.S. Department of Energy (DOE) is working with a group of LEAP communities to bolster workforce development initiatives and support the growth of local employment in the clean energy economy. Through this resource, DOE seeks to provide participating communities with an overview of the types of occupations that could be affected by investments in building envelope and building electrification upgrades in existing building stock—differentiating between the residential and commercial sectors. This occupational analysis is intended to be used by communities to inform workforce initiatives (e.g., local training and education programs) as they implement building energy efficiency and electrification projects at scale.

## Methodology

This resource includes occupation lists that follow taxonomies and job naming conventions developed by the Interstate Renewable Energy Council (IREC) and DOE within the [Green Buildings Career Map](#) resource and the [Careers in Climate Control Technology Career Map](#) resource. Occupation titles align with these Career Map resources whenever possible because they are more specific to the work being done; however, additional occupations are listed using job names from the U.S. Department of Labor Bureau of Labor Statistics (BLS). BLS uses generalized occupation titles to measure employment in the US, which does not always reflect the specific duties of workers in the energy efficiency industry. By using the Career Maps and the BLS occupation lists together, this resource captures occupations across the scope of energy efficiency and electrification work, from specialized roles to jobs that are commonly found in the broader economy.

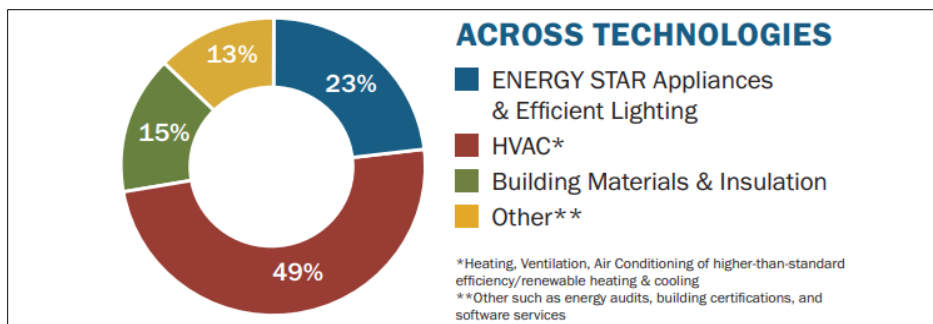
The building envelope and electrification workforce focuses on the design and installation of products that increase energy efficiency and reduce fossil fuel-based energy consumption. The occupations listed in this resource are associated with job functions in specific building envelope and electrification upgrades identified by the Communities LEAP program team using the [NREL ResStock Analysis Tool](#) and the [ComStock Analysis Tool](#). These jobs include building design and contracting services that provide insulation, windows, air sealing, heating and cooling systems, efficient appliances, and other measures that reduce energy consumption in residential and commercial buildings. Electrification upgrades involve the conversion of fossil fuel heating systems to electric heat pumps. Energy efficiency employment is concentrated in the construction industry, with 1,169,407 workers nationwide according to the Department of Energy's [United States Energy and Environment Report \(2022\)](#) employment figures, representing 54% of the energy efficiency industry. Industry breakdowns for all 50 states, plus Washington DC are available through the E4 The Future Report, [Energy Efficiency Jobs in America \(2022\)](#).

Figure 1: Energy efficiency workers by industry (national).



Source: [https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report\\_1.pdf](https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf)

Figure 2: Energy efficiency workers by technologies (national).



Source: [https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report\\_1.pdf](https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf)

## Regional vs. Community-based Workforce

The availability of building envelope, HVAC, and electrification workforce resources will vary depending on the city or region where building upgrades are being made. Construction-related occupations are more likely to be local, community-based jobs. Regions with larger populations may sustain both on-site construction jobs and professional services occupations in fields such as design, engineering, and architectural services that regions with smaller populations may not offer. Depending on the duration of projects and the specific project or job requirements, some workers may travel or work remotely on a project. This resource assumes that communities will be able to access the full spectrum of occupations through both community-based and regional networks.

## Occupations by Energy Efficiency & Electrification Upgrade Type

This section details the types of occupations supported by investments in energy efficiency and electrification upgrades. Occupations are broken out by residential and commercial sectors and mapped to specific building envelope and electrification upgrade types. There is some overlap in occupation types across the residential and commercial sectors, but training and job requirements will be different for each. Additionally, links to the career map and BLS websites are provided for each occupation, which provides detailed information on job descriptions, average salaries, training

pathways, and qualifications. It is important to note that the occupations in this section do not include jobs from the manufacturing or research sectors of the energy efficiency industry.

## Residential

Residential, multifamily, and mobile/manufactured building envelope and electrification upgrades require a wide range of construction industry professionals. These occupations involve many traditional trades that are trained to specialize in energy efficiency, health and safety, durability, and electrification of residential buildings. At the community level, career opportunities range from sales and energy auditing to installation work and energy program management and delivery. Many entry-level jobs found in this industry can be attained with a high school diploma or GED. More advanced positions may require specialized training programs, certifications, job experience, or college education.

Energy efficiency building professionals look at buildings as systems, taking the entire building into account and viewing it, and its components (electrical, heating, plumbing, and envelope components) holistically. A well-insulated and sealed building envelope (walls, windows, attic/roof, etc.) reduces heating and cooling needs compared to drafty, under-insulated buildings that require more energy from the heating and cooling system to maintain temperature settings.

Building electrification requires HVAC, plumbing, and electrical professionals that can replace fossil-fueled technologies with electric alternatives to increase efficiency and reduce greenhouse gas (GHG) emissions, often reducing energy bills for the consumer.

For this resource, occupations are grouped into occupational clusters informed by the IREC Career Maps. The occupational clusters for residential buildings are:

- General Construction
- Energy Services
- Mechanical and Electrification

Within each occupational cluster, specific occupations are mapped to energy conservation measures (ECMs) that are based on upgrade types in the [NREL ResStock Analysis Tool](#). For residential building envelope upgrades, these include:







- **Wall Insulation** – Most typically, insulation is applied to homes with wood stud walls and no existing insulation.
- **Roof/Attic Insulation** – Attic or roof insulation (depending on building type and design) added to meet or exceed required values, depending on climate zone and space configuration.
- **Foundation Measures** – These can include rigid board exterior insulation on foundation walls or slab edges. Interior foundation walls can be insulated with rigid board or cavity-fill insulation.
- **Envelope air sealing** – Air leakage to the outdoors can be reduced by sealing leaks in envelope components, using a blower door to depressurize the home, and reducing leakage rates measured in Air Changes per Hour (ACH).
- **Duct Insulation and Sealing** – Heating and cooling ducts can be insulated when in unconditioned spaces like attics, and all ducts benefit from low air leakage rates. Duct sealing can be guided by instruments like ‘duct blasters’ or can be sealed using approved tape and mastic products at accessible joints.

For residential building electrification, measures can include:

- **Air Source Heat Pumps** – For homes with centrally ducted HVAC systems.
- **Ductless Heat Pumps** – For homes without HVAC ducts.












- **Heat Pump Hot Water Heaters** – To replace existing electric or gas water heaters.
- **Electric service upgrades** – Depending on the equipment installed and the home’s existing wiring, upgrades may be needed, such as additional circuits, or a total electric panel upgrade.

Table 1: Occupation List for Residential Building Envelope Measures

Occupational Cluster	Occupation	ResStock Measures	Career Map Link (click on icon)	BLS Link (click on icon)
General Construction	Residential Energy Efficiency Technician	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing		
	Carpenter Apprentice	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing		
	Carpenter	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing		
	Construction Manager	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing		
Energy Services	Residential Energy Auditor	Air Sealing, Duct Sealing		
	Energy Efficiency Sales Representatives	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing		

The job description and qualifications for someone to perform residential building envelope upgrades are best summarized in the Residential Energy Efficiency Technician job in the Green Building Career Map. This specific occupation title is not tracked by BLS and may not exist in all communities or be listed by local firms. For that reason, we have included occupations like Carpenters and Carpenter Apprentices, which may be the titles posted locally for workers doing residential building envelope upgrade work.

Table 2: Occupation List for Residential Electrification Measures

Occupational Cluster	Occupation	ResStock Measures	Career Map Link (click on icon)	BLS Link (click on icon)
Mechanical & Electrification	HVAC Apprentice	Air Source Heat Pumps, Duct Sealing		
	HVAC Installer	Air Source Heat Pumps		
	HVAC Sales	Air Source Heat Pumps		
	Construction Manager	Air Source Heat Pumps		
	Electrician Apprentice	Electrical for Air Source Heat Pumps, Electric resistance backup heat		
	Electrician	Electrical for Air Source Heat Pumps, Electric resistance backup heat		
	Plumbing Apprentice	Heat Pump Hot Water Heaters		
	Plumber	Heat Pump Hot Water Heaters		
Energy Services	Residential Energy Auditor	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing		
	Salesperson	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing, Air Source Heat Pumps, Heat Pump Hot Water Heaters		
	Energy Efficiency Program Assistants	Air Sealing, Wall, Attic, Foundation Insulation, Duct Sealing, Air Source Heat Pumps, Heat Pump Hot Water Heaters		



## Commercial

Commercial building envelope and electrification upgrades will impact multiple employment sectors. The sector with the largest impact will be construction-related jobs associated with envelope improvements and other building modifications, and equipment installations. Contractors involved in construction in smaller commercial market segments typically differ from contractors serving large commercial and institutional markets. This resource does not differentiate between these two sub-markets. In addition to construction-related jobs, occupations in professional services are included to account for activities such as energy audits and other onsite assessment, verification, and commissioning work, building envelope and mechanical system design, and roles associated with sales and project management.

For this resource, occupations are grouped into occupational clusters informed by the IREC Career Maps. The occupational clusters for commercial buildings are:

- General Construction
- Architects, Engineers, and Other Professional Services
- Energy Services



Within each occupational cluster, specific occupations are mapped to energy conservation measures (ECMs) that are based on upgrade types in the [NREL ComStock Analysis Tool](#). For commercial building envelope upgrades, these include:

- **Wall Insulation** - For buildings with mass, steel-framed or wood-framed walls, products such as foam board can be added to the exterior. Interior cavity insulation may also be applicable. Some construction types will require a more complex recladding approach.
- **Roof Insulation** - Attic or roof insulation (depending on building type) can be added using rigid foam board for built-up roofs, as well as under-deck systems using various products.
- **Window Replacement** - For curtainwall (typically high-rise) buildings, total refenestration may be required. Where windows are manufactured products, replacement is appropriate.
- **Window Film** - Applying solar control film to existing windows.

Commercial building electrification measures include:

- **Air source heat pumps** - This could include ground source heat pumps in appropriate locations. Heat pump designs and specifications depend on existing system characteristics, building construction type, and climate. For example, for buildings with boilers: replacement with air source heat pump boilers, and for small commercial buildings with gas or electric-resistance RTUs: Dedicated outdoor air unit with high efficiency mini split heat pump.

*Table 3: Occupation List for Commercial Building Envelope Measures*

Occupational Cluster	Occupation	ComStock Measures	Career Map Link (click on icon)	BLS Link (click on icon)
General Construction	Carpenter	Wall Insulation, Roof Insulation, Window Replacement		
	Construction Laborer	Wall Insulation, Roof Insulation, Window Replacement		
























Occupational Cluster	Occupation	ComStock Measures	Career Map Link (click on icon)	BLS Link (click on icon)
	Construction Manager	Wall Insulation, Roof Insulation, Window Replacement		
	Insulation Apprentice	Wall Insulation, Roof Insulation		
	Insulation/Air Sealing Technician	Wall Insulation, Roof Insulation		
	Rofer	Roof Insulation		
	Insulation Journeyman/Mechanic	Wall Insulation, Roof Insulation		
Architecture, Engineering, & Other Professional Services	Draftsperson	Wall Insulation, Roof Insulation, Window Replacement		
	Junior Architect	Wall Insulation, Roof Insulation, Window Replacement		
	Architectural Engineer	Window Replacement		
	Registered Architect	Wall Insulation, Roof Insulation, Window Replacement		
	Manufacturer Representative	Wall Insulation, Roof Insulation, Window Replacement, Window Film		
Energy Services	Commercial Energy Auditor	Wall Insulation, Roof Insulation, Window Replacement, Window Film		
	Energy Efficiency Technician (Commercial)	Wall Insulation, Roof Insulation, Window Replacement, Window Film		

Table 4: Occupation List for Commercial Electrification Measures

Occupational Cluster	Occupation	ComStock Measures	Career Map Link (click on icon)	BLS Link (click on icon)
General Construction	Journey-level HVAC Technician	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
	Apprentice-level HVAC Technician	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
	Electrician	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
	Plumber	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
	Construction Manager	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
Architecture, Engineering, & Other Professional Services	Draftsperson	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
	Junior Architect	Air Source Heat Pumps (large commercial)		
	Registered Architect	Air Source Heat Pumps (large commercial)		
	Electrical Engineer	Air Source Heat Pumps (large commercial)		
	Architectural Engineer	Air Source Heat Pumps (large commercial)		
	Manufacturer Representative	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
	Mechanical Engineer	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
Energy Services	Energy Engineer	Air Source Heat Pumps (large commercial)		

Occupational Cluster	Occupation	ComStock Measures	Career Map Link (click on icon)	BLS Link (click on icon)
	Commercial Energy Auditor	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		
	Energy Efficiency Technician (Commercial)	Air Source Heat Pumps (large commercial), Air Source Heat Pump (small commercial)		

There may be additional occupation types required to support building envelope and electrification upgrades that are not listed above. For example, some insulation installations may require drywallers and painters, but these occupations are not required for all jobs and may not be directly related to the ECM installation. Additionally, for commercial building upgrade projects, there will be roles for building operators and facilities management technicians with technical and industry-specific skills related to electrical, HVAC, and energy management software.

## Examples of Occupational Tasks and Activities

Building envelope and electrification upgrades require a variety of skills to operate tools and perform technical tasks. To identify upgrades and build a scope of work, workers must understand electrification and building science principles. They must also develop the skills needed to carry out the upgrades in accordance with applicable energy regulations, codes, or other policies. The skills and activities section below offers insight into the typical tools used and tasks required for a sampling of building envelope and electrification measures.

### Residential

Existing residential buildings vary greatly in construction and system characteristics, and the skills required to perform HVAC, electrification, and building envelope upgrades often overlap. For example, carpenters sometimes install insulation, and weatherization technicians occasionally do light carpentry work. Some HVAC contracting companies employ mechanical engineers who specialize in heat pump design and installation. They may also employ some combination of HVAC technicians, plumbers, and electricians. The tasks and activities below are for general reference.

Table 5: Residential building envelope example skills and activities descriptions

ResStock Measures	Example Tasks and Activities
Air sealing Residential building diagnostics and auditing	<b>Residential Energy Auditors</b> perform air leakage tests such as blower-door-guided assessments to locate air leaks and determine how much energy a home might be losing through the building envelope. Digital thermometers, infrared cameras, air velocity monitors, light meters, and other tools help analyze energy use in a residential building. <b>Residential Energy Efficiency Technicians</b> are often trained to do some of this work as well.
General Air Sealing	Some companies may employ <b>Residential Energy Efficiency Technicians</b> to apply insulation materials, caulking, and seal air gaps. They may also install

ResStock Measures	Example Tasks and Activities
Wall Insulation Attic Insulation Foundation or Crawlspace Insulation	energy efficient windows and doors, but this is more often done by a <b>Carpenter</b> . Insulators use common hand tools, such as knives, measuring tapes, and scissors. They also may use a variety of power tools, saws, staple guns, caulking guns, foam guns, air compressors, and spray insulation machines.
Duct testing Sealing and Insulation	Duct leakage tests locate air leaks and determine the volume of conditioned air a home is losing through leaking ducts. Instrumented testing is performed by a <b>Residential Energy Auditor</b> and typically involves a ‘duct blaster’ type device to pressure-test the system and help locate leak sites. Duct sealing requires screwing ducts together to secure connections and applying mastic duct sealant to seal the seams and connections throughout the duct system. Duct systems outside the conditioned space are typically insulated to R-8 or better by a <b>Residential Energy Efficiency Technician or HVAC Installer or HVAC Apprentice</b> .

Table 6: Residential electrification example skills and activities descriptions

ResStock Measures	Example Tasks and Activities
Air source ducted heat pump installation Ductless, mini-split heat pump installation	<b>Residential HVAC installers and HVAC Apprentices</b> install heat pumps and ventilation systems in single family, multifamily, and manufactured homes following manufacturer specifications, industry codes and standards, and energy program requirements.
Heat pump water heater installation	<b>Plumbers and Plumbing Apprentices</b> repair and install piping for water, wastewater, and gas to and throughout buildings. They work with hand tools and power tools to install and repair sinks, toilets, washing machines, bathtubs, showers, and dishwashers
Electrical power installation heat pump Electrical resistance heat Electrical power installation for Heat Pump Hot Water Heater	<b>Electricians and Electrician Apprentices</b> install and maintain electrical equipment and systems. They use hand tools and power tools, such as conduit benders, to run and protect wiring. Other commonly used tools include screwdrivers, wire strippers, drills, and saws. While troubleshooting, electricians also may use ammeters, voltmeters, thermal scanners, and cable testers to find problems and ensure that components are working properly.

## Commercial

Commercial building envelope and electrification measures create demand for a variety of skilled labor and professional services jobs. Projects require the work of employees in contracting, wholesale, design and engineering, and energy services. Some workers install insulation, windows, and HVAC systems, or work on the design of new solutions for building envelope improvements and whole-building electrification. Service roles include onsite audits/assessments, verification, commissioning, operations, and maintenance. The job tasks and activities listed below align with specific building envelope and electrification upgrades and provide examples to illustrate the occupations needed to build and develop projects.

Table 7: Commercial building envelope example skills and activities descriptions

ComStock Measures	Example Tasks and Activities
Wall Insulation Roof Insulation	<p><i>Commercial Energy Auditors</i> perform an analysis of the building’s thermal envelope using infrared cameras and other methods to assess current insulation conditions. The <i>Manufacturing Representative</i> specifies new insulation and air sealing material to be installed. A team of <i>Roofers</i> and <i>Insulation Journeyman/Mechanics</i> install the new insulation material. The <i>Construction Manager</i> conducts quality control inspection during and after installation.</p>
Window Replacement	<p>The <i>Commercial Energy Auditor</i> completes a visual inspection and inventory of the building’s windows to develop multiple alternatives for upgrading to new window systems. The <i>Architectural Engineer</i> proposes design options for upgraded facades and glazing, with specifications for fenestration type and thermal values. Additional options may include shading systems with variable solar heat gain control characteristics in response to changes in heating and cooling demand, occupancy, and available daylight.</p>
Window Film	<p>The <i>Product Sales Specialist</i> develops a retrofit project scope for adding window film to existing windows using original materials and any other measures to increase the energy efficiency of the existing windows without substantial visual change. They may also provide estimated energy savings impacts. The <i>Construction Laborer</i> installs the window film with minimal disruption to building operation.</p>

Table 8: Commercial electrification example skills and activities descriptions

ComStock Measures	Example Tasks and Activities
Heat Pump (large commercial)	<p>For buildings with boilers, a <b><i>Mechanical, Electrical, and Plumbing (MEP) contractor</i></b> can recommend various heat pump solutions appropriate to the existing systems and loads. The <b><i>Mechanical Engineer</i></b> develops design specifications for the new heat pump system and the <b><i>Commercial HVAC contractor</i></b> will assist with the installation, working closely with an <b><i>Electrician</i></b> to upgrade electrical connections as needed.</p>
Heat Pump (small commercial)	<p>For existing small commercial buildings with gas-powered rooftop units (RTUs), a Variable Refrigerant Flow (VRF) heat pump system requires a significant HVAC redesign and retrofit. The <b><i>Mechanical, Electrical, and Plumbing (MEP) Contractor</i></b> will work with the <b><i>Manufacturer Representative/Product Sale Specialist</i></b> to find a suitable VRF system to replace an RTU system. The <b><i>Commercial HVAC contractor</i></b> will assist with the installation, working closely with an <b><i>Electrician</i></b> to upgrade electrical connections as needed.</p>

# Appendix

Table 9: ResStock and ComStock ECM Summaries

Existing Building Energy Efficiency & Electrification Upgrades		
Upgrade Type	Upgrade Description	Details
<b>Residential Buildings</b>		
Building Envelope Measures	Wall, Attic, and Foundation Insulation	<p>Wall: R-13 drill-and-fill insulation applied to homes with wood stud walls and no existing insulation</p> <p>Attic:</p> <ul style="list-style-type: none"> <li>• R-30 for homes in Climate Zone 1A with <math>\leq</math> R-13</li> <li>• R-49 for homes in Climate Zones 21, 2B, 3A, 3B, 3C with <math>\leq</math> R-30</li> <li>• R-60 for homes in other climate zones with <math>\leq</math> R-38</li> </ul> <p>Foundation</p> <ul style="list-style-type: none"> <li>• Add R-10 interior insulation to foundation walls and rim joists</li> <li>• Seal crawlspace vents</li> </ul>
	General air sealing	30% reduction in ACH50, applied to homes with greater than 10 ACH50
	Duct Sealing	Ducts improved to 10% leakage, R-8 insulation added. Applied to homes with leaker or less-insulated ducts
Electrification Measures	Air Source Heat Pumps	<ul style="list-style-type: none"> <li>• Centrally ducted heat pumps for homes with HVAC ducts</li> <li>• Ductless mini-split heat pump for homes without HVAC ducts</li> <li>• Electric resistance backup heat</li> </ul>
	Heat Pump Hot Water Heaters	<ul style="list-style-type: none"> <li>• 3.45 UEF HPWH, 50-80 gallon depending on unit size</li> </ul>
<b>Commercial Buildings</b>		
Building Envelope Measures	Wall Insulation	Extruded polystyrene foam insulation added to buildings with mass, steel-framed or wood-framed walls, added to meet Advanced Energy Design Guide recommendations
	Roof insulation	Attic or roof insulation (depending on building type), added to meet Advanced Energy Design Guide recommendations
	Window replacement	To meet Advanced Energy Design Guide recommendations
	Window Film	Applying solar control film to existing windows
Electrification Measures	Air Source Heat Pumps	<p>For buildings with boilers: replacement with air source heat pump boilers</p> <p>For small commercial buildings with gas or electric-resistance RTUs: Dedicated outdoor air unit with high efficiency mini split heat pump</p>



