



Planning a Fuel Transition

Why Electrification?

Questions and Answers

- Ask questions in the chat box
- Use the “raise hand” function

We will answer questions as they come when there is a natural break

About New Buildings Institute (NBI)

We push for **better buildings** that achieve **zero energy, zero carbon, and beyond**—through research, policy, guidance, and market transformation—to protect people and the planet.

NBI's work targets the aspects of the built environment that can make the greatest impact for the climate.



Research and guidance on “best-in-class” measures, practices and technologies



Advanced code and policy approaches



Training and education to build market capacity



Innovative, leading-edge program design and delivery approaches



Updates on issues critical to the utility energy efficiency business models



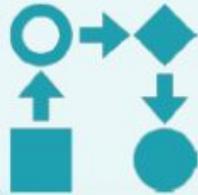
On-call subject matter experts

About Northeast Energy Efficiency Partnerships (NEEP)

Northeast Energy Efficiency Partnerships (NEEP) works to accelerate energy efficiency, electrification, and grid flexibility in the building sector as a core strategy to reduce climate pollution and build an affordable, sustainable, and resilient energy future. NEEP works across the 12 states and the District of Columbia that comprise the Northeast and Mid-Atlantic region.



Events, Stakeholder
Engagement,
Learning Exchange



Regional Market
Transformation
Strategies



Research, Progress
Tracking, Analysis,
Reports, Case
Studies



Best Practice
Guidelines, Tools,
Technical Assistance
and Resource Centers

About BENEFIT



U.S. Department of Energy Funded Project



Started in October 2021 and ends March 2025



Key Partners: Nevada GOE, Northeast Energy Efficiency Partnerships (NEEP), Steven Winter Associates (SWA), and International Code Council (ICC)

Session Agenda

1.

Module 1: Why Electrification?

2.

Module 2: Resource Highlight: Electrification Checklist for Home Energy Auditors

3.

Module 3: Resource Highlight: Electrification and Electric Panel Upgrades



Module Agenda



Climate Imperative and Building Electrification



Building Electrification Technologies



Market Drivers Towards Building Electrification



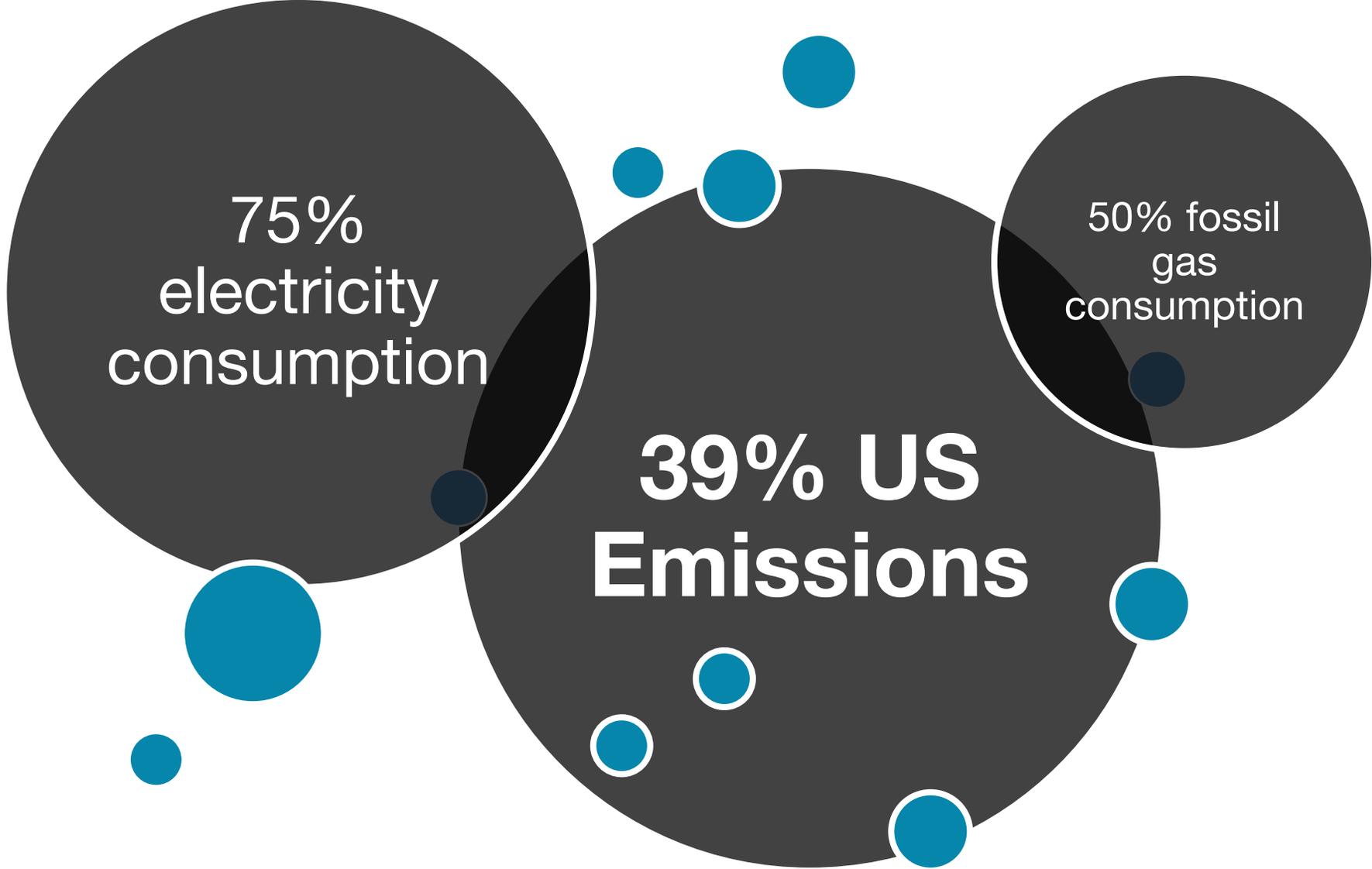
Stakeholder Opportunities To Lead Transition



Close/Takeaways



Climate Imperative and Building Electrification



US getting serious about addressing Climate challenge

The urgency of climate change necessitates a reevaluation of our energy delivery and usage in buildings to reduce greenhouse gas (GHG) emissions. Buildings account for a significant portion, 40% of energy consumption and 39% of the carbon footprint, in the United States. Taking action in the built environment is crucial to effectively address and mitigate the effects of climate change.

Who is involved and why?

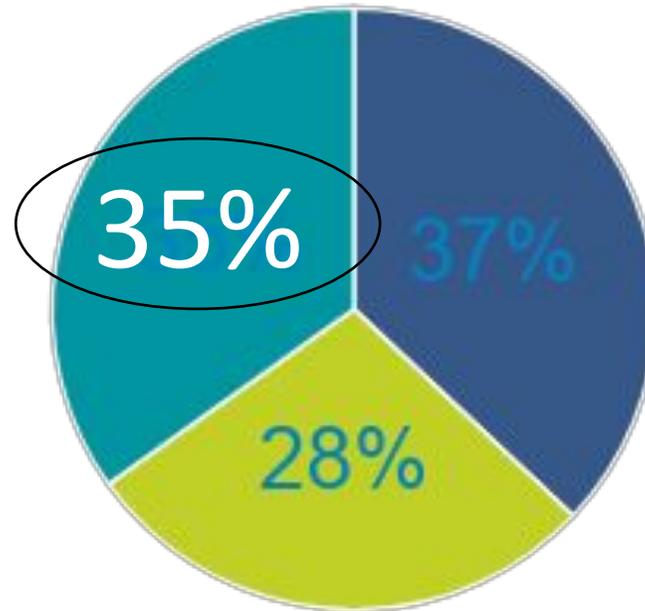
- U.S. Federal Government
- U.S. States
- Business Community



CO₂ Emissions in the US Economy

CO₂ Emissions (US, 2021)

- Decarbonization pathways necessary in each sector, including buildings, to achieve goals



■ Transportation ■ Industrial ■ Buildings

Sources of building sector emissions



Electricity Generation

- Natural gas, coal, nuclear, hydro, wind, solar, etc.)
- Mix of generation sources varies by region
- 75% of electricity used in buildings



Direct use of Fossil Fuels

- Natural gas, propane, fuel oil, etc.
- 50% of gas consumed in buildings

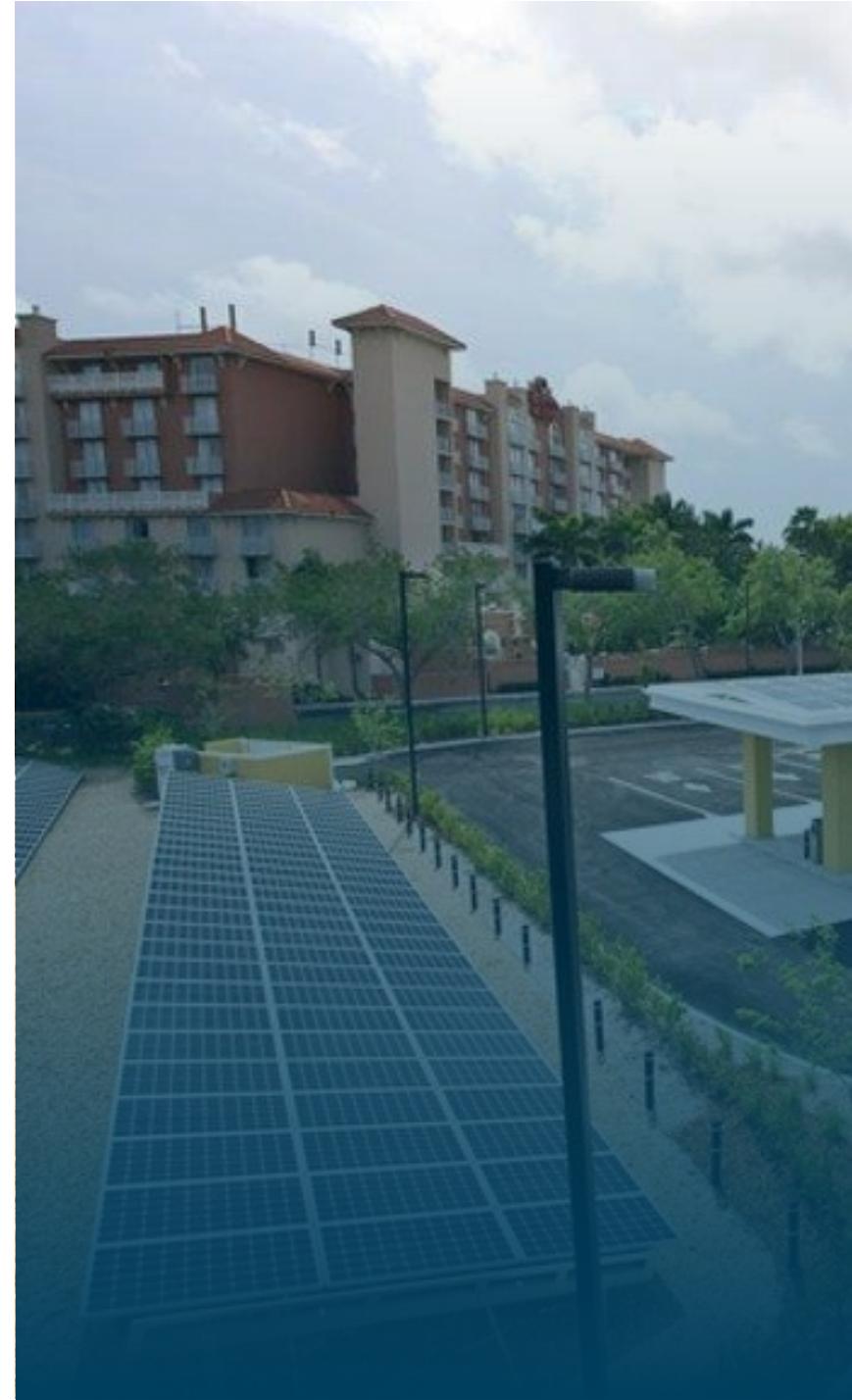
Possible pathways to reduce building sector emissions

Electricity generation (natural gas, coal, fuel oil, nuclear, hydro, wind, solar)

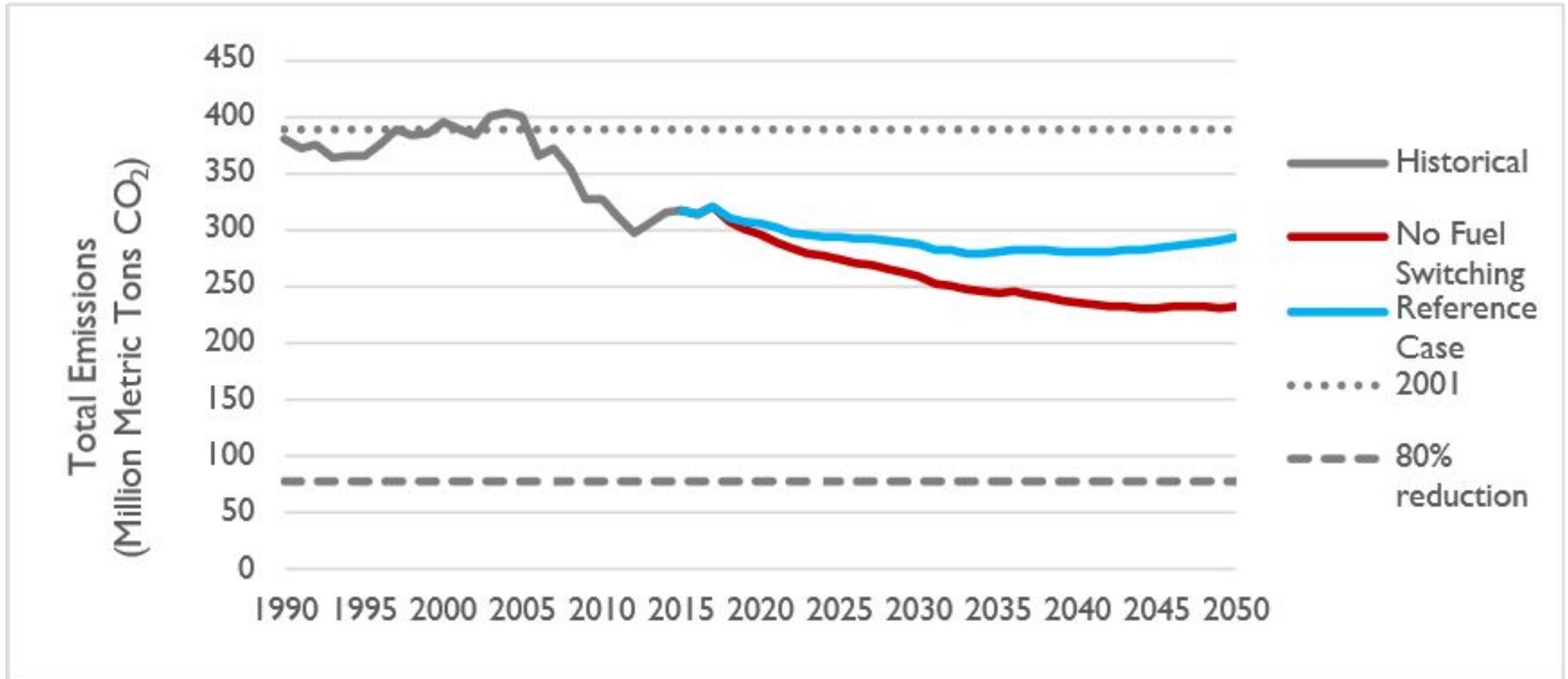
- Decarbonization solutions
 - Increase efficiency of electricity-using equipment/appliances, reducing need to generate grid electricity
 - Increase use of zero-/low- emission generation sources (wind, solar, hydro, nuclear, hydrogen, carbon capture, etc.)
 - Increase distributed generation (i.e. Solar PV), reducing need to generate grid electricity

Direct use of fossil fuels (natural gas, propane, fuel oil, etc)

- Decarbonization solutions
 - Increase efficiency of fossil fuel-using equipment/appliances, reducing use of fossil fuels
 - Increase use of zero-/low- emissions delivered fuels (i.e. hydrogen, “renewable” natural gas, biofuel, etc)
 - Transition fossil fuel-powered systems to efficient electric systems



Renewables and Efficiency not close to enough



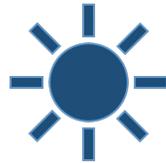
Myth buster: Reality of Zero / low- Emissions Delivered Fuels



Limited life cycle
emission reductions



Lack of robust sources
of renewable natural
gas/Hydrogen



Current/projected cost
of renewable natural
gas/Hydrogen



Distribution system
"readiness" for
Hydrogen

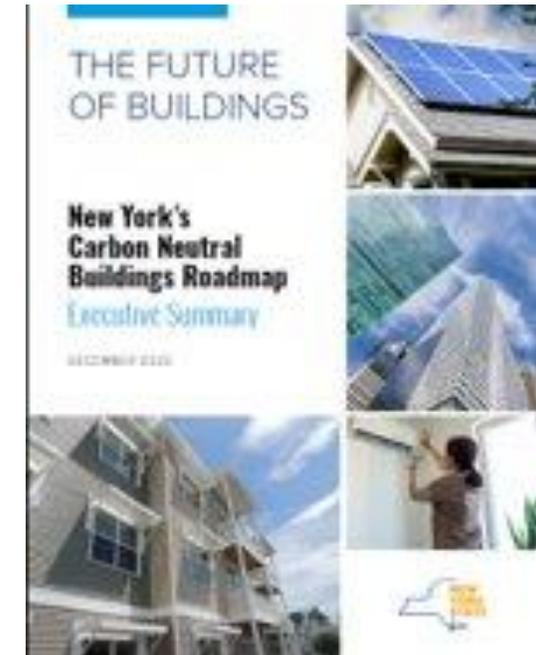
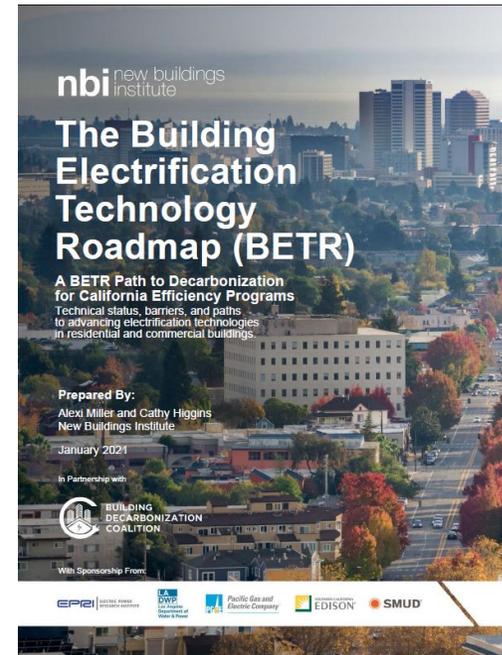


Equipment readiness
to operate with
alternative fuels

Building Electrification

By focusing on building electrification and energy efficiency, these buildings can reduce air pollution, aid in improved grid management, and achieve long-term reductions in utility expenses. This approach promotes the use of clean energy sources and aligns with sustainability goals by reducing reliance on fossil fuel combustion and its associated environmental impacts.

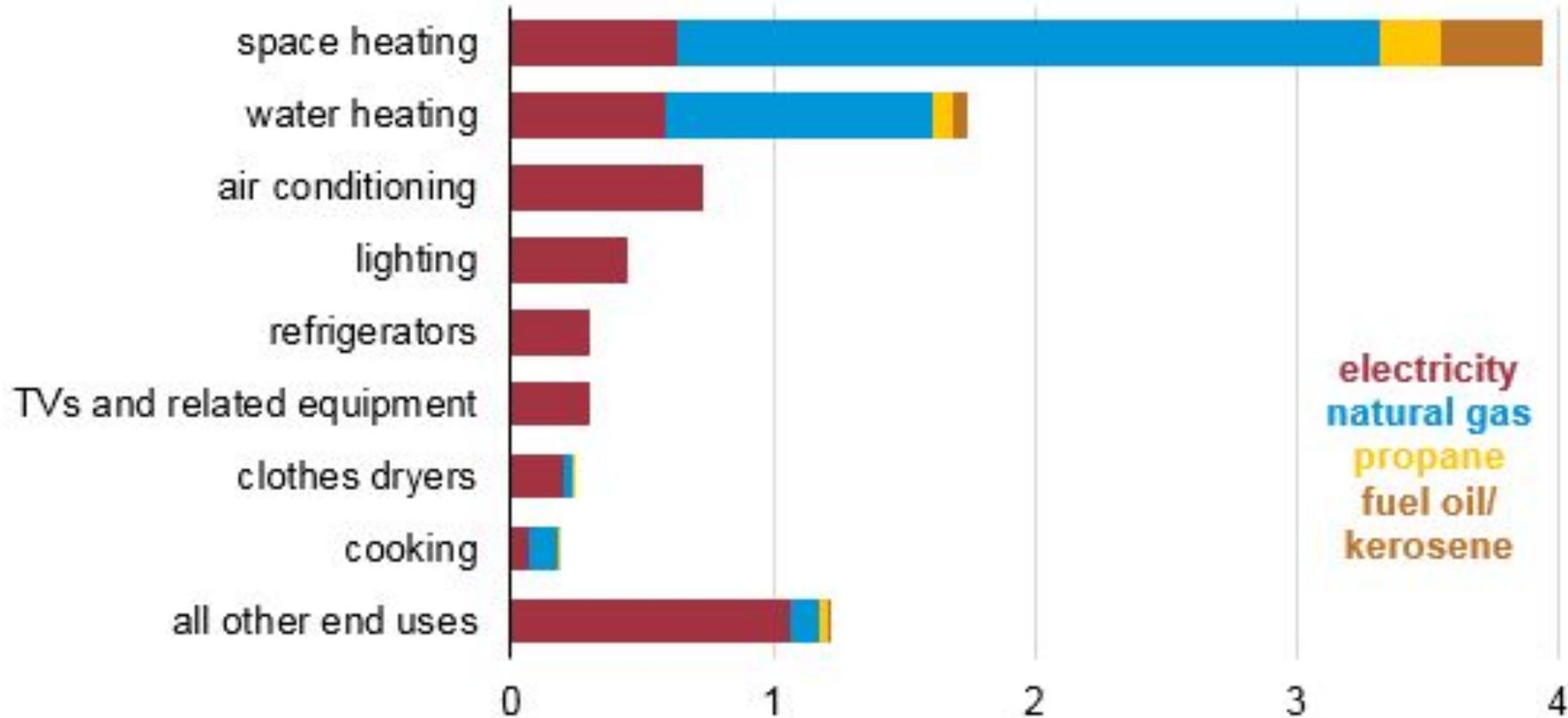
- ✓ Transitioning fossil fuel-powered systems in buildings to efficient electric systems
- ✓ Part of a broader strategy to reduce emissions from buildings
- ✓ Provides clear and technologically feasible pathway to eliminating emissions from buildings (directly and indirectly)
- ✓ Growing consensus that building electrification is key to decarbonization pathways (State and national strategies)



Building Electrification Technologies

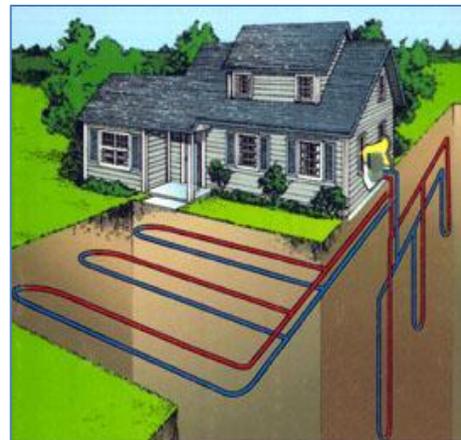
Which end uses to prioritize?

U.S. household end-use energy consumption by fuel (2015)
quadrillion British thermal units



Space Heating Electrification Technologies

- Space Heating
 - Air-Source Heat Pumps
 - Ground-Source Heat Pumps



Available Heat Pump Technology

Air distribution

Water distribution

Air Source

“Air to Air”
(Splits, VRF, PTHP, RTU)

“Air to Water”
(Reverse cycle chiller, Hybrid
VRF)

Ground Source

“Ground to Air”
(GSHP w Forced air
distribution)

“Ground to Water”
(GSHP w hydronic distribution)

Water Source

“Water to Air”
(WSHP)

“Water to Water”
(WSHP)

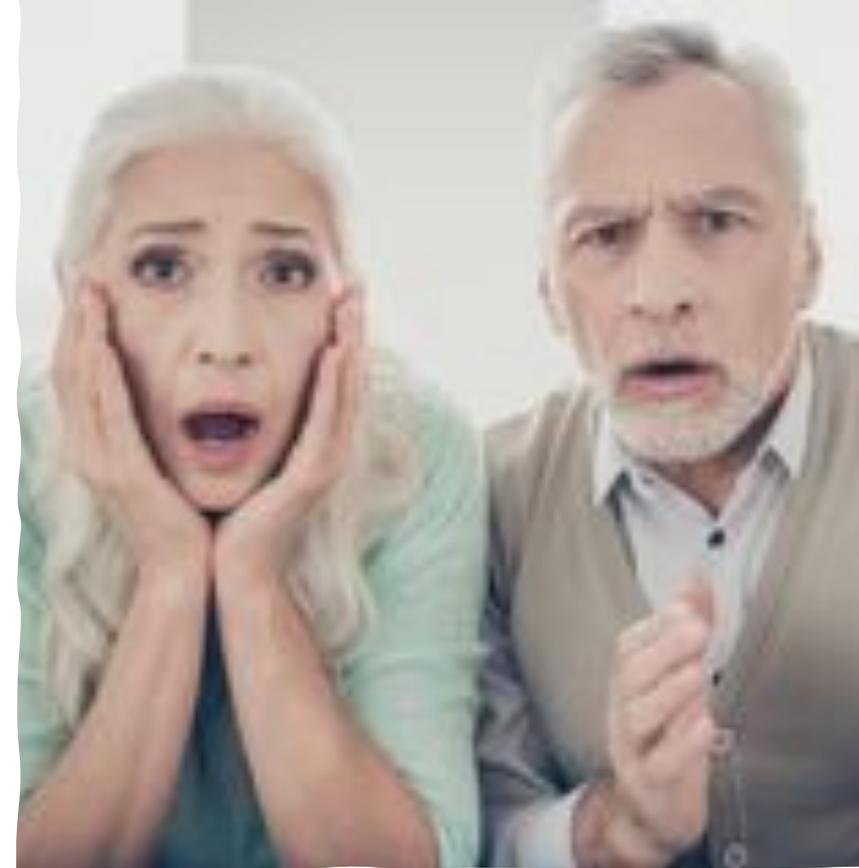
Expanding range of Air-source heat pump configurations

- Packaged Terminal heat pumps
- Window/room heat pumps
- Packaged Rooftop Units (RTU)
- Reverse cycle chillers (Air-to-water heat pumps)



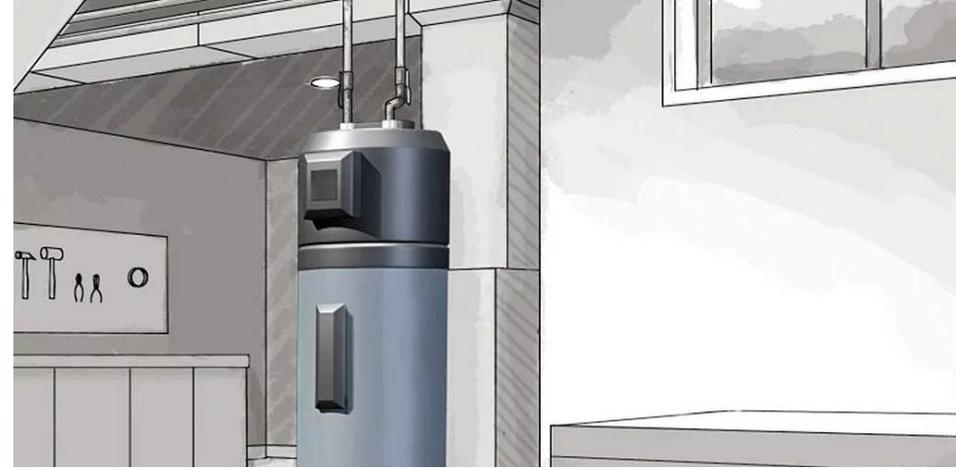
Myth Buster- Air-Source Heat Pump Technology (R)Evolution

- Not your grandparents' heat pump
 - Variable capacity compressors (inverter driven)
 - Sophisticated controls
 - Flash injection
- Delivering capacity and efficiency at low outdoor temperatures
- Air-to-Air- ducted, ductless and everything in between
- Air-to-Water – Variety of distribution options



Water Heating Electrification Technologies

- “Integrated” Heat pump water heaters (HPWH) widely available for residential/small commercial/MF applications
- "Central" HPWHs for commercial/multi-family emerging into the market



“Other” building electrification opportunities



Market Drivers Towards Building Electrification

Market Drivers Towards Building Electrification

- Market transition to building electrification being led by a mix of market forces



Consumer Demand



Program/Regulation

Building Electrification Promotional Programs

State/Utility Programs

- Rebates/Incentives
- Financing

Federal Programs

- Tax credits
- Rebates

More money than ever is being devoted to LMI Customers

- Justice40 Initiative



State/Local Regulatory Trends



Building Energy codes
(New construction)



Building Energy
Performance standards
(existing buildings)



Emissions-based
Appliance standards (on
system replacement)



Evolving Energy
Efficiency program
structure



Clean Energy
Standards/Alternative
Portfolio Standards

The Justice40 Initiative:

Federal Commitment that 40% of the overall benefits of certain Federal climate, clean energy, affordable and sustainable housing, and other investments flow to disadvantaged communities that are marginalized by underinvestment and overburdened by pollution.

Transition is Underway

Shipments by Product Type



Source: Atlas Buildings Hub <https://atlasbuildingshub.com/>

*Data for 2024 is only through September

The Transition Must Be Equitable

- Critically important that electrification benefits all consumers and communities
- Communities to prioritize;
 - LMI/Energy insecure populations- Those that spend higher portion of their income on utility bills and will have a harder time affording new technologies
 - Environmental Justice communities- Those that have born the brunt of local fossil fuel pollution, including from power plants, bus depots and heavy oil boilers
 - Populations vulnerable to heat waves



Health and Safety Benefits

- Replace direct emissions of heating systems with clean, efficient heating helping to improve indoor air quality and eliminate local air pollution in neighborhoods
- Electric systems help eliminate the worry of gas leaks and carbon monoxide poisoning, and can reduce the danger of potential fires or explosion.
- Improving the buildings in LMI and environmental justice communities can reduce energy burden and increases the quality of living

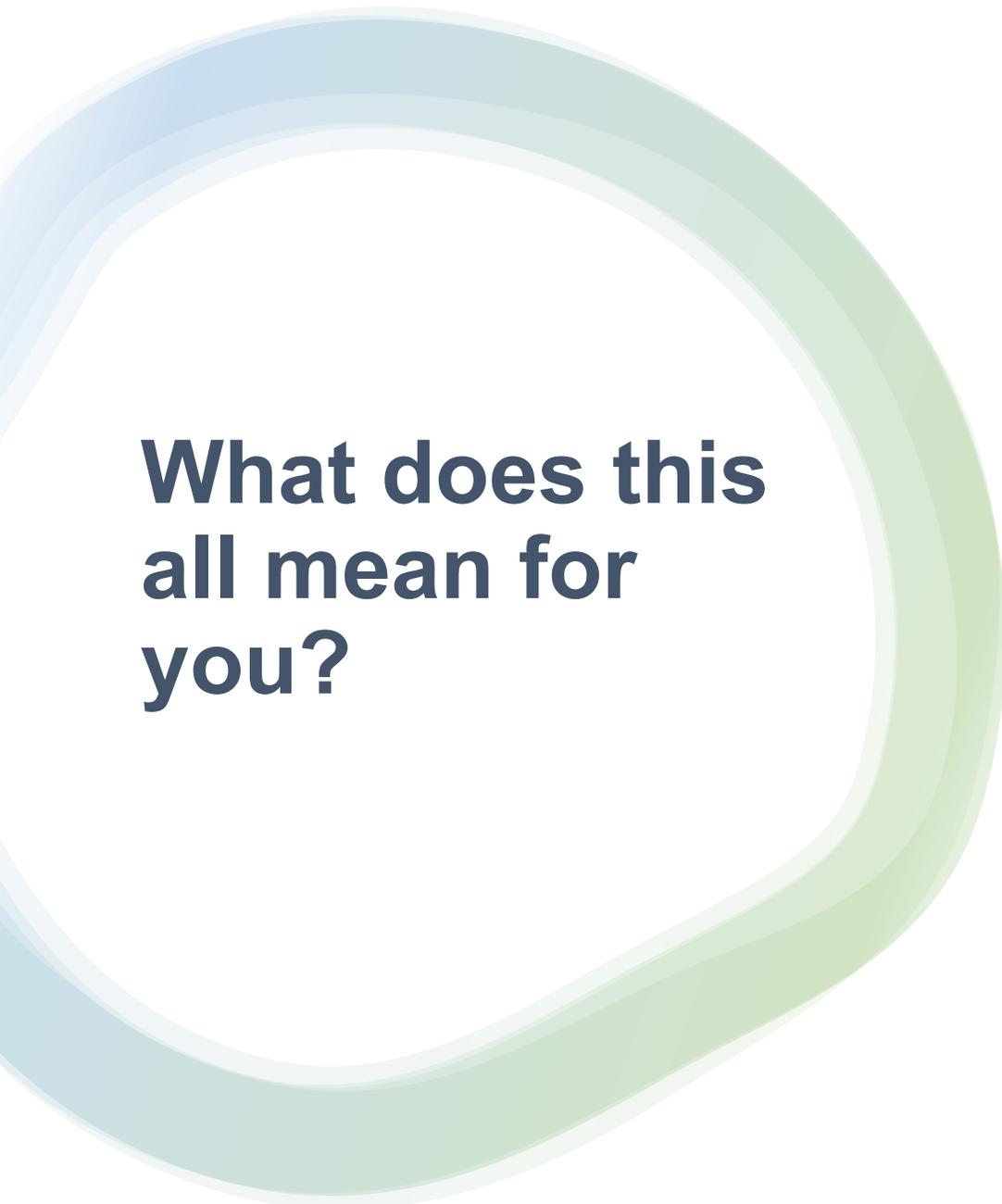


Comfort Benefits

- Heat pumps provide efficient, lower-cost cooling, which makes communities more resilient during heat waves



Market Actor Opportunities to Lead Transition



**What does this
all mean for
you?**

Bring your leadership to the transition..

- Local Policymakers
- Code Officials
- Building Designers
- Contractors

Local/State Policymakers

- Help communicate benefits of building electrification to stakeholders
- Facilitate inclusive processes to inform decision making
- Support community-led initiatives/campaigns
- Promote state-level programs
- Develop/implement/promote supportive policies at the state and local levels
- Ensure that funding flows to Low-to-Moderate Income customers



Local/State Policymakers- Important resources

- U.S. DOE Building Energy Codes Program/NBI/IMT
 - Building Energy codes
 - Building Energy Performance Standards (BEPS)
- NESCAUM
 - Emission-based Standards Resource
- Regulatory Assistance Project
 - Clean Heat Standards
- National Association of State Energy Offices (NASEO)
 - State Energy Planning and more



Code Officials

- Prepare yourself to educate broader building community
- Familiarize yourself with range of electrification technologies, evolving code requirements



Code Officials- Important resources

- NBI Building Electrification Resources
- Local/State Code trainings
- ASHRAE/ICC/IREC
- Energy Efficiency/Utility program code trainings



Building Designers

- Evolve design practices to include electrification technologies
- Develop working relationships with HVAC installers/plumbers to provide feedback mechanisms



Building Designers- Important resources

- U.S. DOE
- ASHRAE
- International Energy Code Council (IECC)
- American Institute of Architects (AIA)
- New Buildings Institute (NBI)
- U.S. Green Building Council
- PHIUS



Contractors

- Familiarize yourself with range of heating electrification technologies and their install procedures
- Understand what works in your area of sale (climate zone, building type, equipment type, etc.)
- Seek training on how to design, size, install, sell electric technologies (Manufacturer, distributor, 3rd party)



Contractors- Important resources

- Manufacturer/Distributor - based trainings
- DOE's Building Science Education
- Air Conditioning Contractors of America (ACCA)
- NATE
- Plumbing-Heating-Cooling Contractors Association (PHCC)
- ENERGY STAR Certified Heat Pumps
- CEE Federal Tax Credit Eligibility List



Closing/Takeaways

Key Takeaways



Building electrification is a critical pathway to reduce GHG emissions from buildings in order to address the climate crisis.



Building electrification can also help improve the health, safety, and resiliency of communities.



Electrification technologies for space and water heating are ready for primetime



From expanding incentive programs to regulatory policies, there are a number of market drivers supporting this transition



State and Local Policymakers, Code Officials, Building Designers and Contractors represent key stakeholders in the building sector.



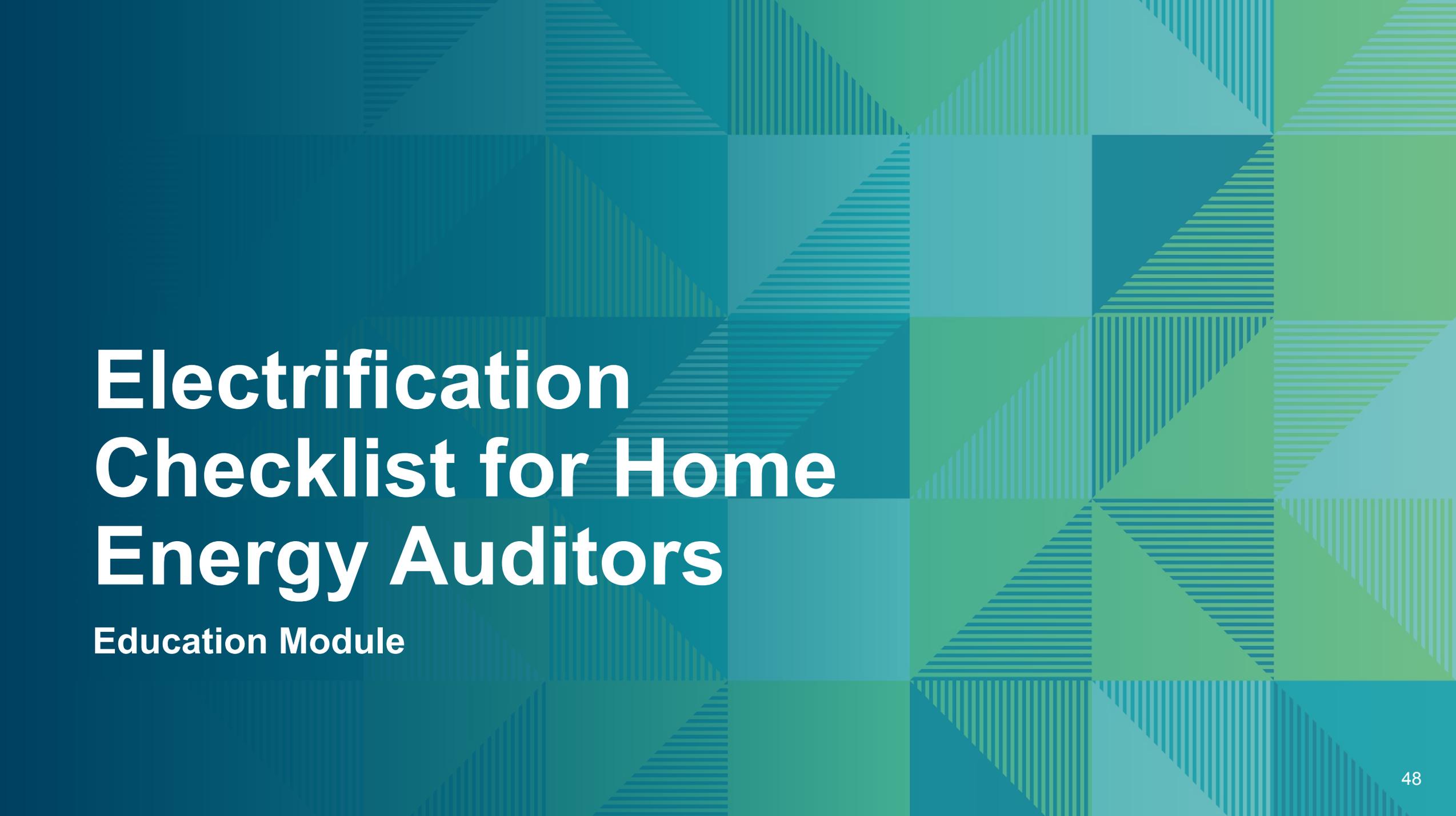
The building electrification transition will be most successful with these groups providing leadership and expertise to the market

Additional Resources

- U.S. Department of Energy (Buildings Technology Office)
 - www.energy.gov/eere/buildings/building-technologies-office
- U.S. EPA (ENERGY STAR)
 - www.energystar.gov
- American Institute of Architects (AIA)
 - www.aia.org
- Air Conditioning Contractors of America Association (ACCA)
 - www.acca.org
- New Buildings Institute (NBI)
 - www.newbuildings.org
- Building Decarbonization Coalition (BDC)
 - www.buildingdecarb.org
- Building Electrification Institute (BEI)
 - www.beocities.org
- Rewiring America
 - www.rewiringamerica.org

Questions?

Module 2



Electrification Checklist for Home Energy Auditors

Education Module

Module Agenda

Module Goals

Home Energy Auditors

How to use the resource

Questions

Module Goals



What we hope folks get out of this module:

- Understanding of why electrification of homes is important
- Understanding of why Home energy auditors are a critical partner in electrification of homes
- Understanding of the contents of the Electrification Checklist
- Understanding of how Auditors can best utilize the checklist to help drive electrification of homes

Home Energy Auditors

Home Energy Auditors



- Home energy auditors are in millions of homes a year
- Auditors offer a unique partner in helping homeowners make smart decisions about home energy upgrades.
- Traditional home energy audits typically assess the thermal performance of the home by measuring insulation levels, air leakage, duct leakage, etc.





SM

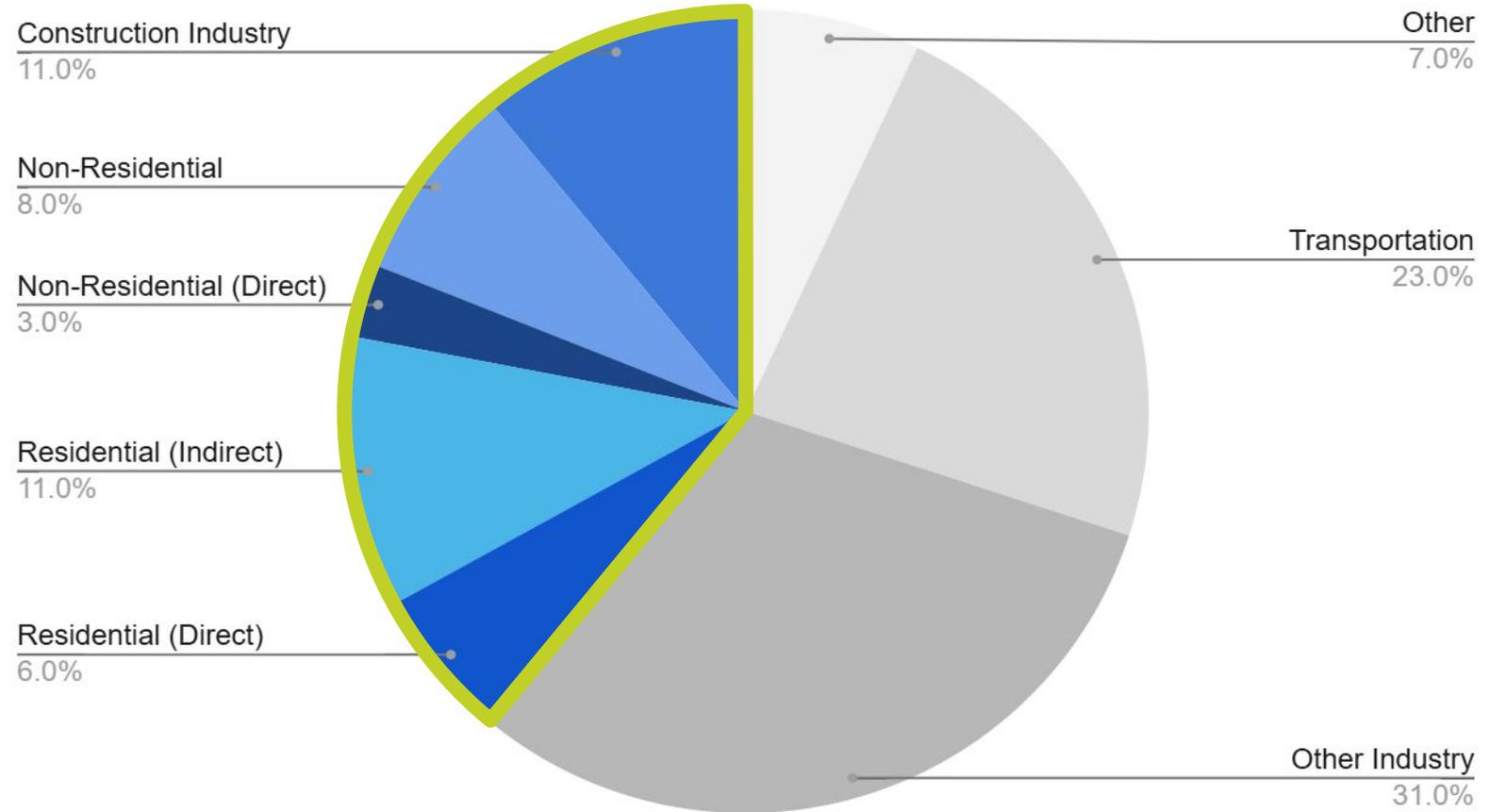


**Certifying the
finest in HVACR.**



Sources of Greenhouse Gas Emissions

Buildings are responsible for 39% of global greenhouse gas emissions.





How To Use The Resource

Electrification Checklist for Home Energy Auditors

This checklist will aid residential energy auditors in assessing opportunities for the electrification of key home systems.

Key systems include space heating, water heating and other fossil fuel-based appliances, as well as readiness for installation of electric vehicle (EV) charging and solar photovoltaic (PV) systems. Many of these end uses provide important opportunities for homeowners to switch from existing fossil fuel-based systems to efficient electric systems. Electrification retrofits provide a host of benefits including financial, health, safety and climate.

The checklist is intended to supplement a traditional home energy audit, which typically assesses the thermal performance of the home (i.e. insulation levels, window efficiency/glazing areas, a blower door test, a duct leakage test, etc.), along with efficiency of primary systems, but ignores comment on the type of fuel used within the home. The checklist is meant to supplement, not replace, existing auditing practices, including those designed by Building Performance Institute, NATE, ACCA, and ASHRAE. As home energy auditors are already in millions of homes a year, this information can easily expand the usefulness, and potential scope, of their work.

Systems to Inspect

This checklist will require the inspection of the following systems:



Space Heating/
Cooling System(s)



Clothes Dryer



Water Heater



Cooking
Appliances



Roof/Property



Electric Panel

Record findings in the following tables.

The checklist is meant to **supplement, not replace**, a traditional home energy audit.

Existing auditing practices ignore important information like type of fuel used

Checklist Sections



Space Heating/
Cooling System(s)



Clothes Dryer



Water Heater



Cooking
Appliances



Roof/Property



Electric Panel

Information captured by Checklist



- » What kind of system is present today?
- » What kinds of fuel do the current systems utilize?
- » What is the current electrical service to those systems?
- » What is the approximate age of the system?

Heating/Cooling Systems Section



Space Heating/Cooling System(s)

Heating System(s)

Existing Heating System(s)

- Forced Air Furnace (with ductwork)
- Boiler (with hydronic radiators/baseboard)
- Electric Resistance (baseboard)
- Forced Air Heat Pump
 - Part of Dual Fuel System
 - Standalone
- Ductless Heat Pump
- Other (e.g. woodstove) _____

Existing Heating System Fuel Source(s)

- Natural Gas
- Propane
- Fuel Oil
- Electricity
- Other _____

Manufacturer

Serial Number

Model Number

Heating Capacity

Rated Voltage

- 120V
- 208V
- 240V

Rated Amps

Rated Wattage

Electric Resistance System Wattage

(If electric resistance is present as primary or supplemental)

Primary: _____ W

Supplemental: _____ W

Age of Heating System

- 1-10 years
- 11-20 years
- 20+ years

Heating System Zoning

- Single zone
- Multi-zone

Water Heating System Section



Water Heater

Existing Water Heater Type

- Storage On-Demand None

Existing Water Heater Fuel

- Natural Gas Electricity
 Propane Other _____

Manufacturer

Serial Number

Model Number

Capacity (if storage)

_____ gallons

Rated Voltage

- 120V 208V 240V

Rated Amps

Rated Wattage

Existing Water Heater Location

Dimensions of Area with Water Heater

Age of Water Heater

- 1-10 years 11-20 years 20+ years

Venting (if fossil fueled)

- Atmospheric Direct

Air Volume Surrounding Water Heater

- Abundant (at least 750 cubic feet)
 Limited (i.e. <750 cubic feet or in a closet, louvered doors)
 Very limited (small closet)

Number of People in Household

- Adults: _____ Children: _____

Temperature Setting

_____ °F

Occupant Feedback on Current Hot Water Supply

- Sufficient Insufficient

Captured Photos of Water Heater, Including Nameplate and Venting

- Water heater Venting

Are Hot Water Pipes Insulated?

- Yes No

Dryer Section



Clothes Dryer

Existing Clothes Dryer

- Standalone Washer/Dryer Combo
 None

Existing Fuel

- Natural Gas Propane Electricity

Manufacturer

Serial Number

Model Number

Drum Capacity

_____ cu. ft.

Is Exhaust Fan Present and Vented to Outdoors?

- Yes No

Rated Voltage

- 120V 208V 240V

Rated Amps

Rated Wattage

Age of Dryer

- 1-10 years 11-20 years 20+ years

Air Volume Surrounding Dryer

- Abundant (at least 750 cubic feet)
 Limited (i.e. in a closet, louvered doors)
 Very Limited (small closet)

Captured Photos of Dryer, Including Nameplate

- Dryer Venting

Cooking Appliances Section



Cooking Appliances

Existing Cooking Appliance(s)

- Stove/Oven Combo Standalone Stove Standalone Oven

Cooking Appliance Fuel(s)

- Natural Gas Electricity
 Propane Other _____

Dimensions of Cooking Appliance(s)

- Stove/Oven: _____
 Standalone Stove: _____
 Standalone Oven: _____

Cooking Appliance #1

Manufacturer **Serial Number**

Model Number

Rated Voltage
 120V 208V 240V

Rated Amps **Rated Wattage**

Exhaust Fan Present?
 Yes No

Occupant Feedback on Exhaust Fan Use

Cooking Appliance #2 (if present)

Manufacturer **Serial Number**

Model Number

Rated Voltage
 120V 208V 240V

Rated Amps **Rated Wattage**

Exhaust Fan Present?
 Yes No

Occupant Feedback on Exhaust Fan Use

Solar PV/Electric Vehicle Readiness



Roof/Property

Solar Photovoltaic (PV)

Does Home Already Have a PV System?

- Yes No

If Yes, Provide Size of System

_____ Watts

Orientation of Roof (degrees of true north)

_____ degrees

Identify Best Possible Array Location

- Roof Mounted Location: _____
- Ground Mounted Location: _____
- No Possible Location (e.g. too shady)

Roof Slope (rise/run)

- _____ / _____ Flat Roof

Maximum Allowable Dead Load and Live Load Ratings of Existing Roof

Dead Load Rating: _____ lbs/sq ft

Live Load Ratings: _____ lbs/sq ft

Is there Conduit From Appropriate Location on Roof to Electrical Panel?

- Yes No

Captured Photos of Possible Siting Location(s)

Location: _____

Age of Roof

_____ years

Age of Building

_____ years

Electric Panel Assessment



Electric Panel

Size of Current Panel (circle or fill in)

- 100A 150A 200A
- Other Size _____ A

Number of Breaker Slots (including subpanel)

Currently Used: _____ Total: _____

Surge Protector

- Yes No

Age of Panel

_____ years old

Condition of Panel

- Good Satisfactory Poor

Captured Photos of Current Panel, Including Nameplate

- Panel Nameplate

Captured Copy of 12 Months of Utility Bills

- Yes No

Maximum Annual Demand From Utility Bills

_____ (kWh)

“Say cheese”



GAS-FIRED		AUTOMATIC STORAGE WATER HEATER			
UL LISTED		21DF			
ANSI Z21.10.3 - CSA 4.3 - 2001					
MODEL NUMBER		CAPACITY	GAS TYPE	ITEM ID	
FCG 75 271		74.0	PROPANE	9200445013	
INPUT BTU/HR		RECOVERY GAL/HR	SERIAL NUMBER		
75100		72.82	LD4A093574		
PRESSURES IN W.C.		MAX WORKING PRESSURE P.S.I.		CITY OF NEW YORK DEPT OF BUILDINGS NEAR	
MANIFOLD	MAX INLET	MIN INLET	PRESSURE P.S.I.	BUILD DATE	
10.00	14.00	11.00	150	11/15/2004	387-04-E
A.O. SMITH WATER PRODUCTS CO. MCBEE, SC. USA					

Nameplates often capture the specific technical characteristics of the appliances, including;

- Model numbers
- fuel type
- Capacity
- Electrical characteristics
- Date of manufacture

Informing home energy upgrades



Informing home energy upgrades



For more information on the specific offerings, visit the white house's clean energy site; <https://www.whitehouse.gov/cleanenergy/>

Questions?

Module 3

Home Electrification and Electric Panel Upgrades

Agenda

Module Goals

Electric Panels: Basic Information

Common Upgrade Triggers

How to use the resource

Questions

Module Goals

Goals



What we hope you will get out of this presentation:

- Inspired to learn more about electric panels and electrical impacts of electrification upgrades.
- Understand how electric panels play a critical role in home electrification.
- Ensure actionable outcomes and best practices.
- Understand the resource and share with others.

Electric Panes: Basic Information

Why Are Electric Panels Important in This Discussion?

- The panel determines what electric appliances can be installed
- Older homes commonly have 100 amp panels which may not be enough for modern electric appliances
- Updating the panel to 150 or 200 amp service is an added cost



Understanding Your Electrical Panel



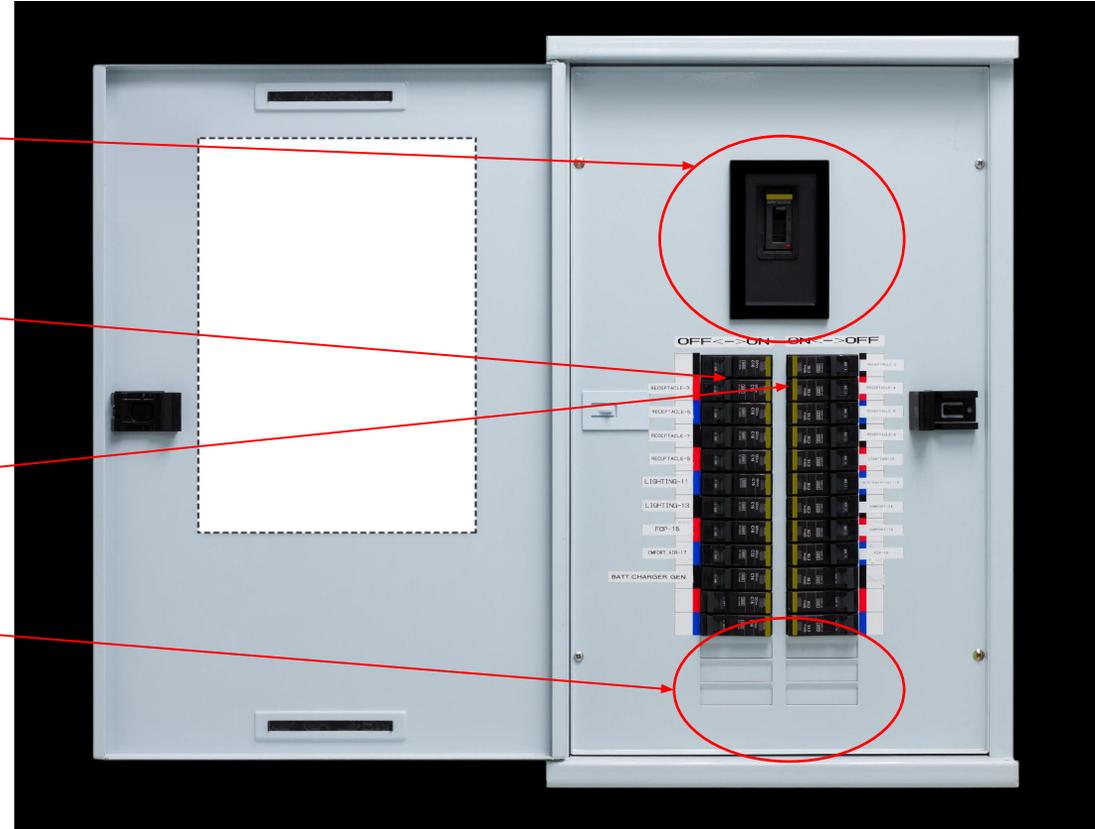
What does my panel do?

- The electric panel controls whether current and power are allowed into the outlets, equipment and appliances in a home.
- The panel capacity determines the maximum amount of power that your lights and appliances can be drawing at any given time.
- The panel serves to limit the amount of electricity entering the residence.
- The panel apportions the electricity into different areas of the home via switches/breakers.

Key Panel Parts & Most Common Types

Key Panel Parts

- Disconnect Switch
- Circuit Breaker
 - Single Pole Breaker (120V)
 - Fuse
 - Double Pole Breaker (240V)
- Expansion Slots



Common Types of Electrical Panels

- Medium Sized Service Panels (100A)
- Large-Capacity Service Panels (150A, 200A)

What is the difference between physical space and electrical space on a panel?



- Electric panel size is determined by the current rating of the main breaker and typically ranges between 100-400Amps.
- A panel is required to be adequate size for a home based on a formula in the National Fire Protection Association's (NFPA) National Electric Code (NEC).
- **Physical space:** How many empty slots there are available and if you need one pole (120 volts) or two poles (240 volts).
- **Electrical space:** Nameplate load for load calculations to calculate maximum amount possible

Common Upgrade Triggers

Common Electrification Upgrade Triggers

Electrification Upgrade	Description	Benefits	Cost
 Electric Dryer	Clothes dryers might be one of the easiest appliances to switch to electric. Electric dryers include ventless heat pump dryers, condensing dryers, and all-in-one washer dryers.	<ul style="list-style-type: none"> • Energy efficiency • Convenience 	\$
 Electric Oven and Cooktop	Moving from a mixed-fuel residential kitchen to an all-electric kitchen is fully achievable today with induction range tops and electric resistance ovens. Induction technology uses a magnetic field to heat pots and pans for cooking.	<ul style="list-style-type: none"> • Better indoor air quality • Reduced asthma risk 	\$
 Electric Water Heating	Heat pump water heaters (HPWHs) use electricity to pull heat from the surrounding air and transfer it into a hot water tank.	<ul style="list-style-type: none"> • Energy efficiency • Better air quality 	\$\$
 Electric Space Heating	A heat pump is a single electric appliance that can replace both your traditional air conditioner and home heating system. Heat pumps use electricity to move heat from one place to another. For cooling, a heat pump moves the heat from inside your home to the outside.	<ul style="list-style-type: none"> • Energy efficiency • Better air quality 	\$\$
 Electric Vehicle Charger	EV chargers pull electricity from your home and delivers it to an electric vehicle.	<ul style="list-style-type: none"> • Reduced operating and maintenance costs • Better for the environment 	\$\$\$

How To Use This Resource

Home Electrification and Electric Panel Upgrades

On August 2022, President Biden signed the Inflation Reduction Act into law marking the most significant action Congress has taken on clean energy and climate change in the nation's history.

One aspect of the Inflation Reduction Act is providing many incentives to support the transition to all-electric homes. A key barrier associated with electrifying is electrical panel capacity. Homeowners need to understand their electrical panel capacity

when considering electrifying. This resource will help individuals gain a deeper understanding of their electric panels and their options to create the easiest path towards electrifying their future.

Common Electrification Upgrade Triggers

Electrification Upgrade	Description	Benefits	Cost
 Electric Dryer	Clothes dryers might be one of the easiest appliances to switch to electric. Electric dryers include ventless heat pump dryers, condensing dryers, and all-in-one washer dryers.	<ul style="list-style-type: none">• Energy efficiency• Convenience	\$
 Electric Oven and Cooktop	Moving from a mixed-fuel residential kitchen to an all-electric kitchen is fully achievable today with induction range tops and electric resistance ovens. Induction technology uses a magnetic field to heat pots and pans for cooking.	<ul style="list-style-type: none">• Better indoor air quality• Reduced asthma risk	\$
 Electric Water Heating	Heat pump water heaters (HPWHs) use electricity to pull heat from the surrounding air and transfer it into a hot water tank.	<ul style="list-style-type: none">• Energy efficiency• Better air quality	\$\$
 Electric Space Heating	A heat pump is a single electric appliance that can replace both your traditional air conditioner and home heating system. Heat pumps use electricity to move heat from one place to another. For cooling, a heat pump moves the heat from inside your home to the outside.	<ul style="list-style-type: none">• Energy efficiency• Better air quality	\$\$
 Electric Vehicle Charger	EV chargers pull electricity from your home and delivers it to an electric vehicle.	<ul style="list-style-type: none">• Reduced operating and maintenance costs• Better for the environment	\$\$\$



Electric Meter

An electric meter is typically located outside and is the device that measures the amount of electric energy consumed by a residence. Electric panel size is determined by the current rating of the main breaker and typically ranges between 100-400 Amps.

Understanding Your Electrical Panel and Its Important Parts

An electrical panel is responsible for safely delivering electricity from the utility's power lines to your home. The electric panel controls how much current and power are allowed in and apportions the electricity into different areas of your home via switches and breakers. The panel capacity determines the maximum amount of power that your lights and appliances can be drawing at any given time.

Circuit Breaker: a switch used in more modern systems.

- **Single Pole Breaker:** a circuit breaker that runs most of your smaller electricity needs as it handles up to 120 amps.
- **Fuse:** found in older systems similar to a circuit breaker.
- **Double Pole Breaker:** a circuit breaker that runs your larger appliances, such as your dryer or water heater, as it handles up to 240 amps.

Expansion Slots: an area where a new circuit breaker can go at a later date, such as when adding an addition to your home.

Service Disconnect Switch: a switch that allows you to turn off all the power to your home.



Most Common Types of Electrical Panel

The size of the panel is usually based on when your home was constructed. Two common types of electrical panel are:

Medium-Sized Service Panel: This is at least a 100 amp service panel and is common in many older homes that have not had a major renovation or home addition. The National Electric Code, or the NEC, requires that a service panel must be at least 100 amps.

Large-Capacity Service Panel: This 150—or 200 amp panel is found in many newer homes and some older larger homes.

The difference between breaker box "sizes"

- The amount of electricity the panel can handle
- The number of circuits a panel can handle

Do I Have Room on My Panel or Do I Need to Upgrade?

Before making any electrification upgrades, it is important to know the amp capacity of your current electrical panel. Many modern homes have 200 amp panels, but it is not unusual for older homes to have 100 amp units. You can tell how many amps of service your panel receives by:

1. Inspecting the utility's meter box for a label with an amperage rating
2. Inspecting your electrical panel for a label with its amperage rating
3. Checking the size of the main breaker on the panel

Physical Space vs. Electrical Space

There are two reasons you may need to increase your electrical panel size. There may not be enough physical space for additional breakers or, there may not be enough electrical space. Breakers will typically add up to more than the capacity of the panel so you cannot add up the breakers and subtract them from the panel rating to determine electrical space. This is because the appliance load is usually less than the breaker load, and not everything in the house operates simultaneously. Electricians use the nameplate load for load calculations to calculate the maximum possible amount an appliance will use. Usually, the actual load from the appliance is significantly lower. For example, properly sized heat pump water heater will never draw full amperage.

How to Calculate Electrical Capacity?

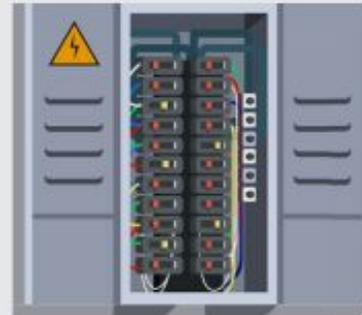
Electrical load capacity is defined as the total amount of power that your main source of electricity provides for your home. This is used by all of your home's circuits and all outlets, appliances, or lights connected to these circuits. The total capacity of your home's electrical system is measured in Amperage or Amps. Calculating how much power your home needs involves calculating the amperage load of all the various appliances and fixtures, then building in a margin of safety. Electricians recommend that the load never exceeds 80 percent of the electrical service capacity.

Relationship between watts, volts, and amps:

These terms have a mathematical relationship that can be expressed in a couple of ways:

- Voltage (Volts) x Current (Amps) = Power (Watts)
- Watt/Volts = Amps

The National Electric Code provides two different methods for calculating the minimum size of residential electric panels, the Standard Method (NEC 220.40) and the Optional Method (NEC 220.80). This factsheet focuses on the two Optional Methods. Optional Method One which utilizes the current utility bill is both easier and more accurate than Optional Method Two which calculates the existing load based on the number and type of appliances and receptacles.

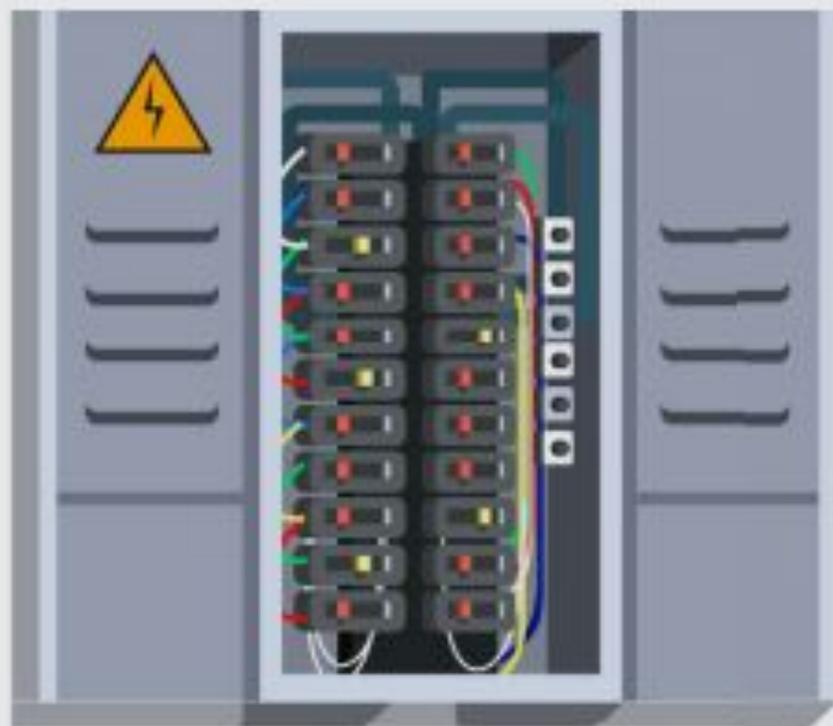


OPTIONAL METHOD ONE

Determining existing loads can be completed by using utility records. Based on the National Electrical Code (NEC 220.87), this code-based method is one of the most accurate ways to calculate the electrical load. The utility record can be used to establish maximum annual demand in kWh and be converted to amps.

Example: Maximum demand in kWh from electricity bill X 125% / (240V X 1 hr) = Ampacity of existing load.

If the ampacity of the existing load plus any new potential loads you may want to add is less than the ampacity of your homes electrical panel, the electrical panel does not need to be upgraded.



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OPTIONAL METHOD TWO

The National Electrical Code (NEC 220.83) describes the steps to determine if an electrical service can safely accommodate new loads.

Calculation to determine the appropriate size for your electrical service:

1. Start by identifying the square footage of the home to determine the estimated lighting and receptacle loads:	$3 \text{ VA/ft} \times \frac{\text{_____}}{\text{(house finished square footage)}} =$	1																																														
2. 20A small appliance and laundry branch circuits	$1500 \text{ VA} \times \frac{\text{_____}}{\text{(20A small appliance and laundry branch circuits (minimum 3))}} =$	2																																														
3. Add in all permanent appliances—Code states 1500 VA per 2-wire 20A small appliance branch circuit and laundry branch circuit, and nameplate rating of all appliances fastened in place:	<table border="0"> <tr><td>Oven</td><td>_____</td><td>_____</td></tr> <tr><td>Cooktop</td><td>_____</td><td>_____</td></tr> <tr><td>Fixed Microwave</td><td>_____</td><td>_____</td></tr> <tr><td>Dishwasher</td><td>_____</td><td>_____</td></tr> <tr><td>Disposal</td><td>_____</td><td>_____</td></tr> <tr><td>Electric Clothes Dryer</td><td>_____</td><td>_____</td></tr> <tr><td>Electric Clothes Washer</td><td>_____</td><td>_____</td></tr> <tr><td>Well Pump</td><td>_____</td><td>_____</td></tr> <tr><td>Sump Pump</td><td>_____</td><td>_____</td></tr> <tr><td>Garage Door Opener</td><td>_____</td><td>_____</td></tr> <tr><td>Hot Tub</td><td>_____</td><td>_____</td></tr> <tr><td>Other</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>TOTAL:</td><td>_____</td><td>_____</td></tr> </table>	Oven	_____	_____	Cooktop	_____	_____	Fixed Microwave	_____	_____	Dishwasher	_____	_____	Disposal	_____	_____	Electric Clothes Dryer	_____	_____	Electric Clothes Washer	_____	_____	Well Pump	_____	_____	Sump Pump	_____	_____	Garage Door Opener	_____	_____	Hot Tub	_____	_____	Other	_____	_____	_____	_____	_____	_____	_____	_____	TOTAL:	_____	_____	3	
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_____	_____	_____																																														
_____	_____	_____																																														
TOTAL:	_____	_____																																														
4. Adjust appliance loads:	a. Sum all above loads	4a																																														
	b. Take the first 8000 VA at 100%	4b																																														
	c. Take the remainder at 40%	4c																																														
	d. Add 4b and 4c to get the general load	4d																																														
5. Add the wattage of your AC or heating appliances (furnace + space heaters), whichever is greater—Don't add both	<p>a. Cooling Load</p> <table border="0"> <tr><td>Outdoor Unit</td><td>_____</td><td>_____</td></tr> <tr><td>Air Handler</td><td>_____</td><td>_____</td></tr> <tr><td>TOTAL COOLING:</td><td>_____</td><td>_____</td></tr> </table> <p>b. Heating Load</p> <table border="0"> <tr><td>Heat Pump Outdoor Unit</td><td>_____</td><td>_____</td></tr> <tr><td>Air Handler</td><td>_____</td><td>_____</td></tr> <tr><td>Backup Electric Heat</td><td>_____</td><td>_____</td></tr> <tr><td>Electric Baseboard/Space Heaters</td><td>_____</td><td>_____</td></tr> <tr><td>TOTAL HEATING:</td><td>_____</td><td>_____</td></tr> </table>	Outdoor Unit	_____	_____	Air Handler	_____	_____	TOTAL COOLING:	_____	_____	Heat Pump Outdoor Unit	_____	_____	Air Handler	_____	_____	Backup Electric Heat	_____	_____	Electric Baseboard/Space Heaters	_____	_____	TOTAL HEATING:	_____	_____	5a																						
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		5b																																														
6. Add load and divide by 240V (add 4d + 5a or 5b (whichever is greater))	$\frac{\text{_____}}{\text{(load total)}} \div 240\text{V} =$ suggested amperage needed to power your home	6																																														

Other Options Besides Electrical Panel Upgrades When Considering Electrifying

1

Panel Optimization

Choose power-efficient appliances and circuit-sharing devices.

2

Technology

(smart panels or smart circuit breakers)

Smart panels or smart circuit breakers that control individual circuits to regulate a home's peak electricity demand.

Additional Sources

1. [Efficiency First CA](#)
2. [Rewiring America](#)
3. [Rewiring America Inflation Reduction Act Calculator](#)
4. [Redwood Energy Watt Diet Calculator: Electrifying the home without upsizing the electric panel](#)
5. [Pecan Steel](#)

nbi new buildings
institute

151 SW 1st Ave., Suite 300
Portland, OR 97204
503 761 7339

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Questions?