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

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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

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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)

Learning Objectives

1. Understand why Building Electrification is Important

2. Understand the Key Technologies of Building Electrification

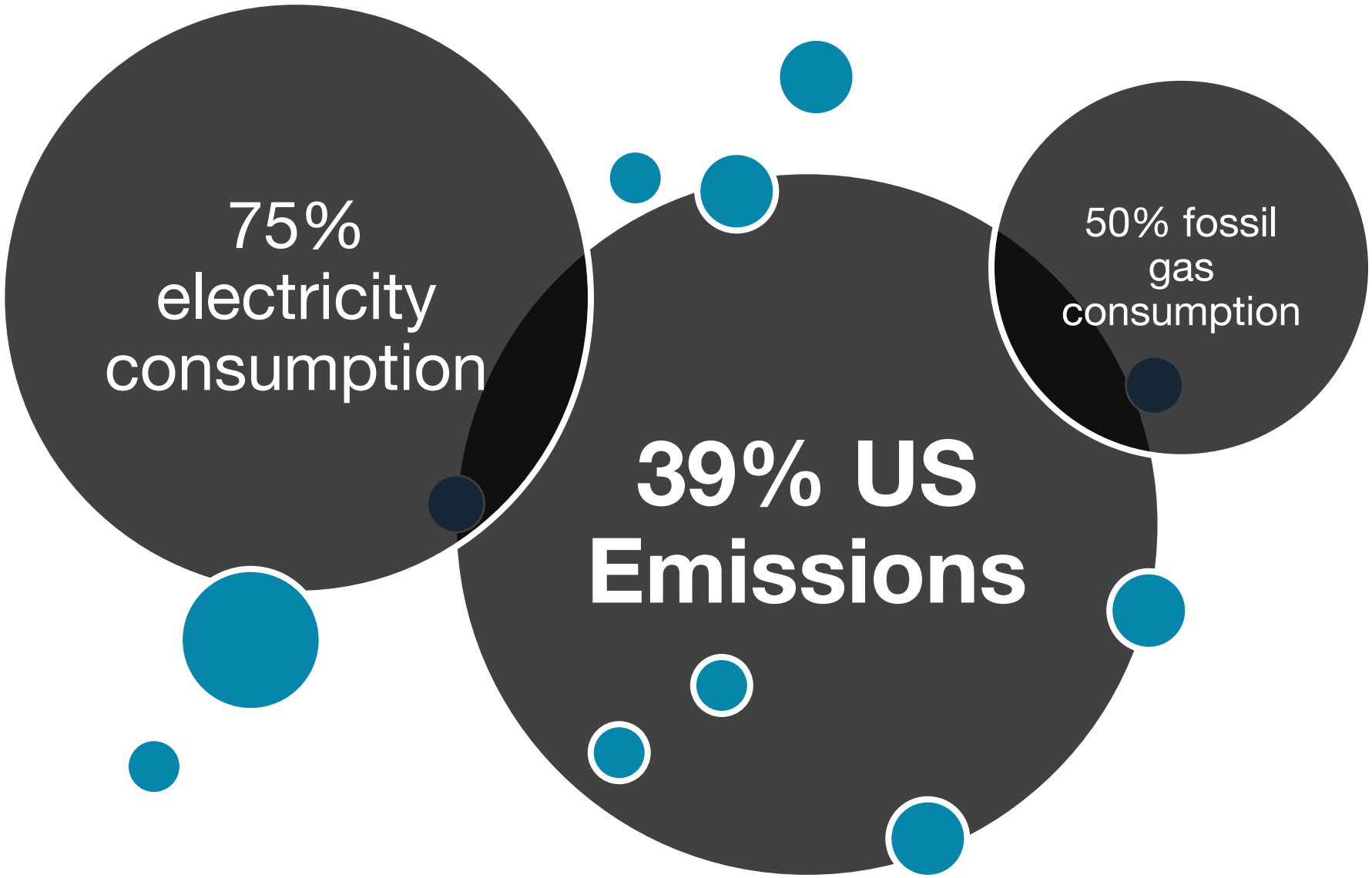
3. Identify Opportunities for Key Stakeholder Groups to Lead Transition

   - State and Local Policymakers
   - Building Code Officials
   - Building Designers
   - Building Contractors

Agenda

- Climate imperative and building electrification
- Building Electrification Technologies
- Market Drivers towards Building Electrification
- Stakeholder opportunities to lead transition
- Close/Take-aways

Climate Imperative and Building Electrification



Todd Quackenbush Unsplash

US getting serious about addressing Climate challenge

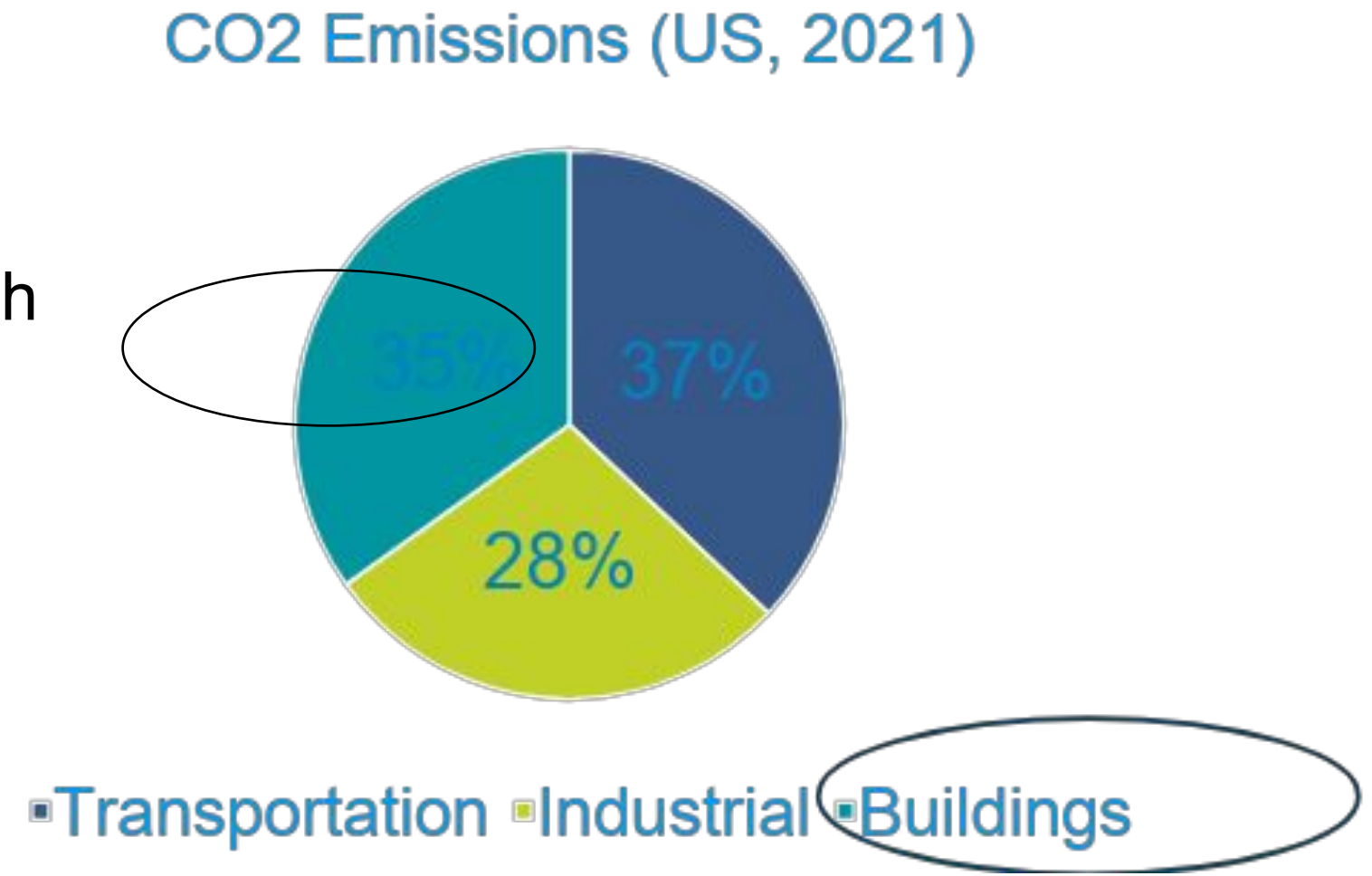
The urgency of climate change necessitates a reevaluation of our energy delivery and usage in buildings to reduce greenhouse gas (GHG) emissions. Buildings account for a significant portion, 40% of energy consumption and 39% of the carbon footprint, in the United States. Taking action in the built environment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

CO_2 Emissions in the US Economy

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



Source: EIA's Monthly Energy Review, April 2022

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

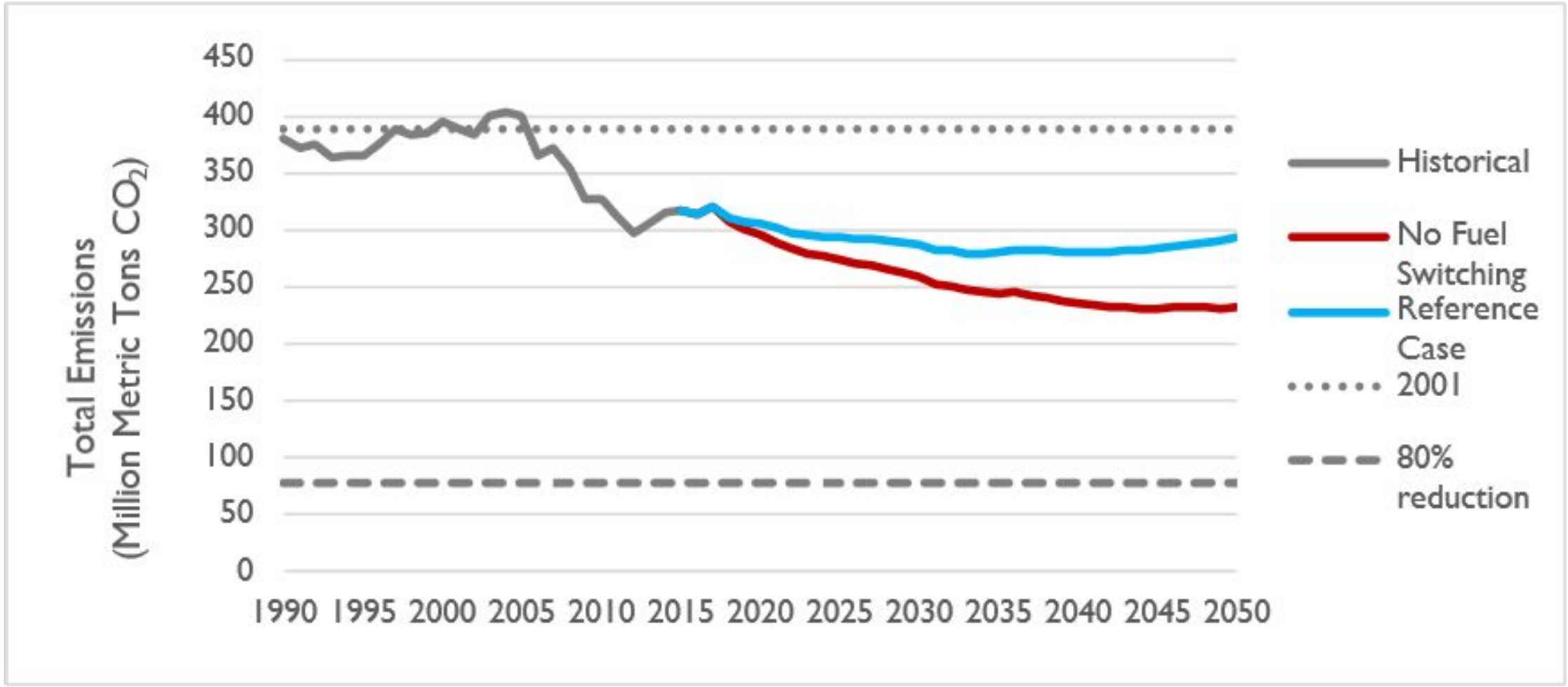
Electricity generation (natural gas, coal, fuel oil, nuclear, hydro, wind, solar)

- 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

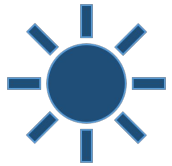
Renewables and Efficiency not close to enough



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

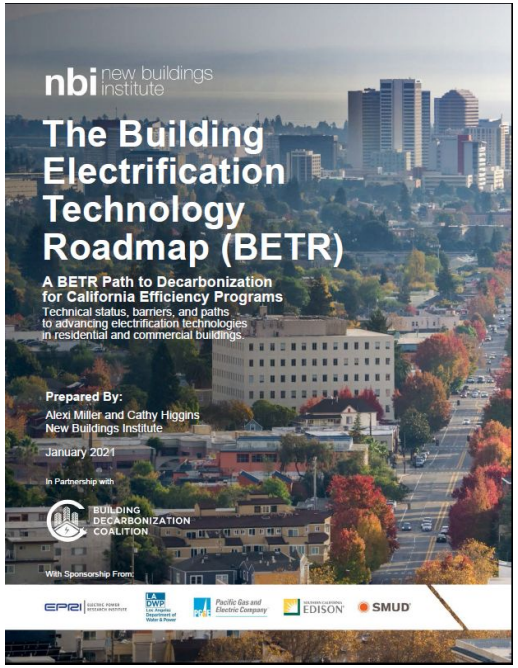
Distribution system "readiness" for Hydrogen

Equipment readiness to operate with alternative fuels

Building Electrification

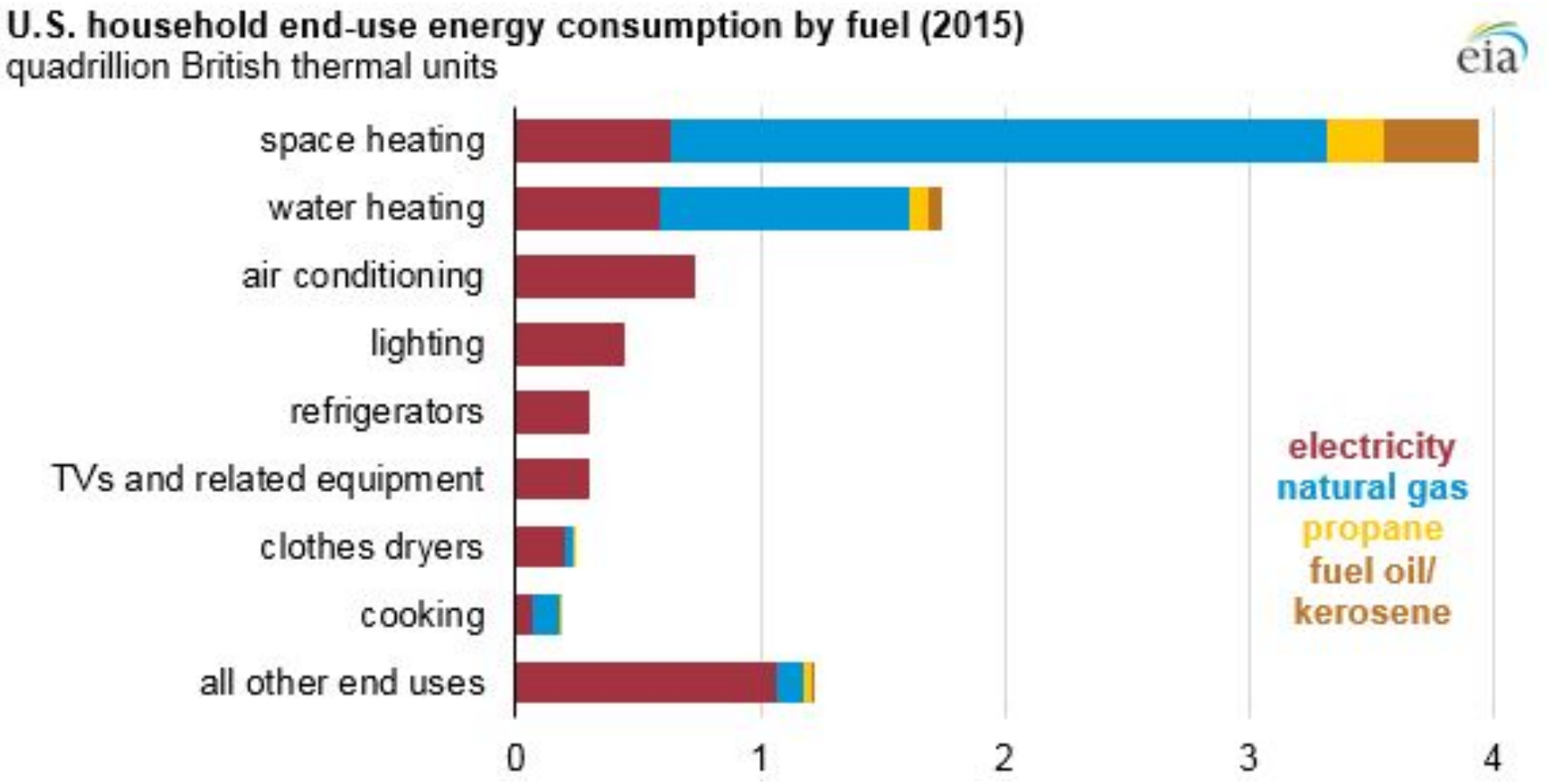
By focusing on building electrification and energy efficiency, these buildings can reduce air pollution, aid in improved grid management, and achieve long-term reductions in utility expenses. This approach promotes the use of clean energy sources and aligns with sustainability goals by reducing reliance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

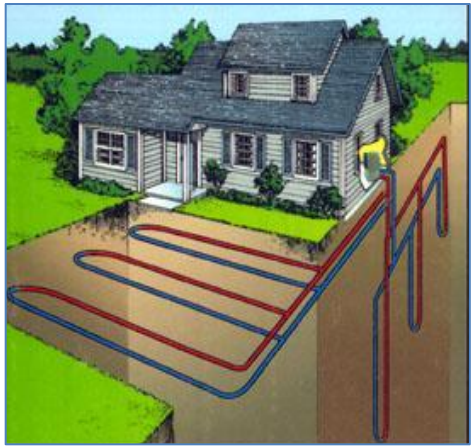
Which end uses to prioritize?



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 Roof-top Units (RTU)
- Reverse cycle chillers (Air-to-water heat pumps)

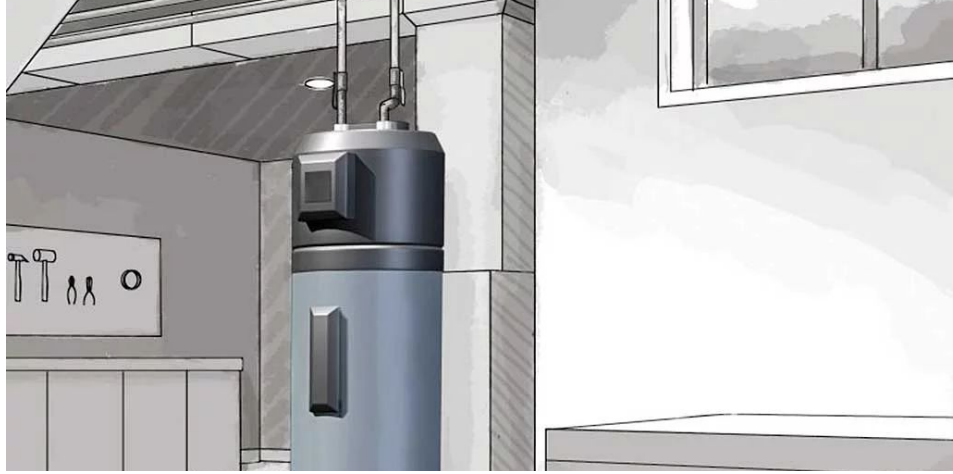
Myth Buster- Air-Source Heat Pump Technology (R)Evolution

- Not your grandparents ASHP
  - 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

State/Local Regulatory Trends

Building Energy codes (New construction)

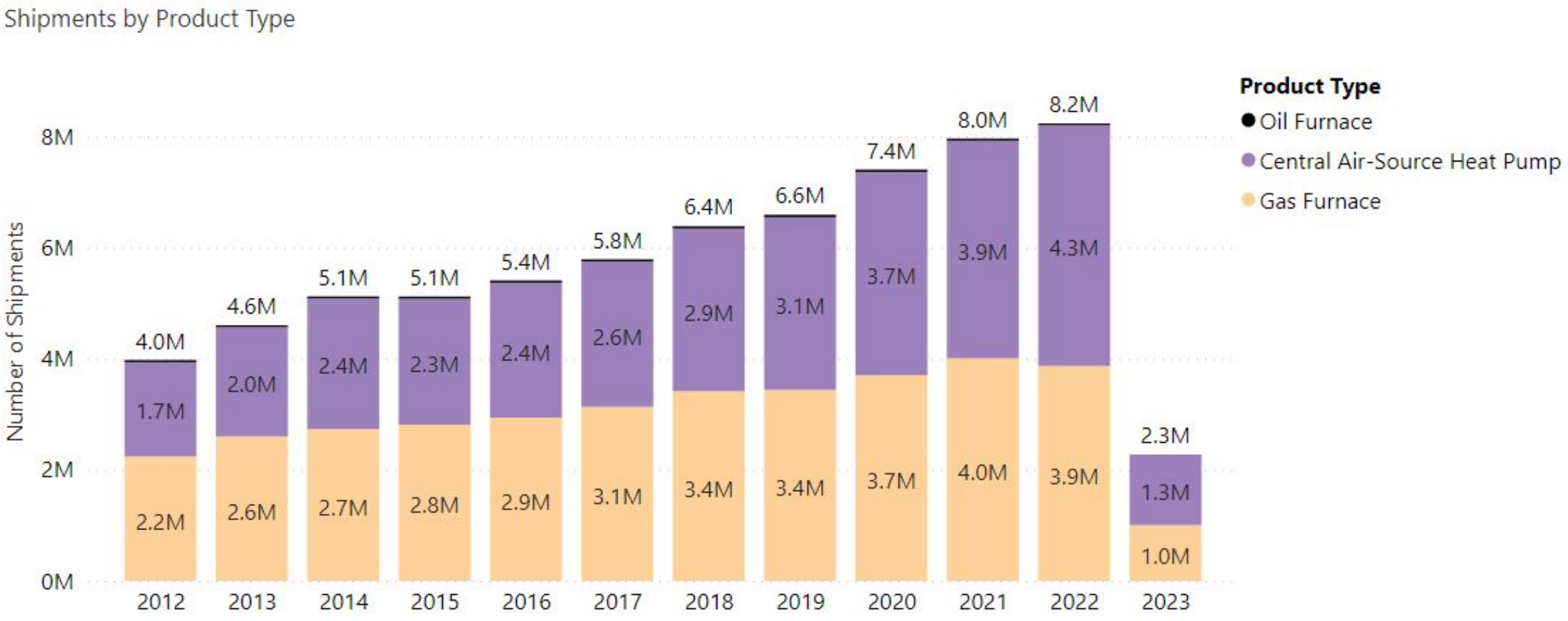
Building Energy Performance standards (existing buildings)

Emissions-based Appliance standards (on system replacement)

Evolving Energy Efficiency program structure

Clean Energy Standards/Alternative Portfolio Standards

Transition is Underway



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.

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

What does an Equitable transition mean?

- 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

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

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

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)

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 leaders hip 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.beicities.org
- Rewiring America
  - www.rewiringamerica.org

Questions?

Section 2

Electrification Checklist for Home Energy Auditors

Education Module

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

Agenda

- Introduction
- Module Goals
- Home Energy Auditors
- How to use the resource
- Questions

Introduction

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Module Objectives

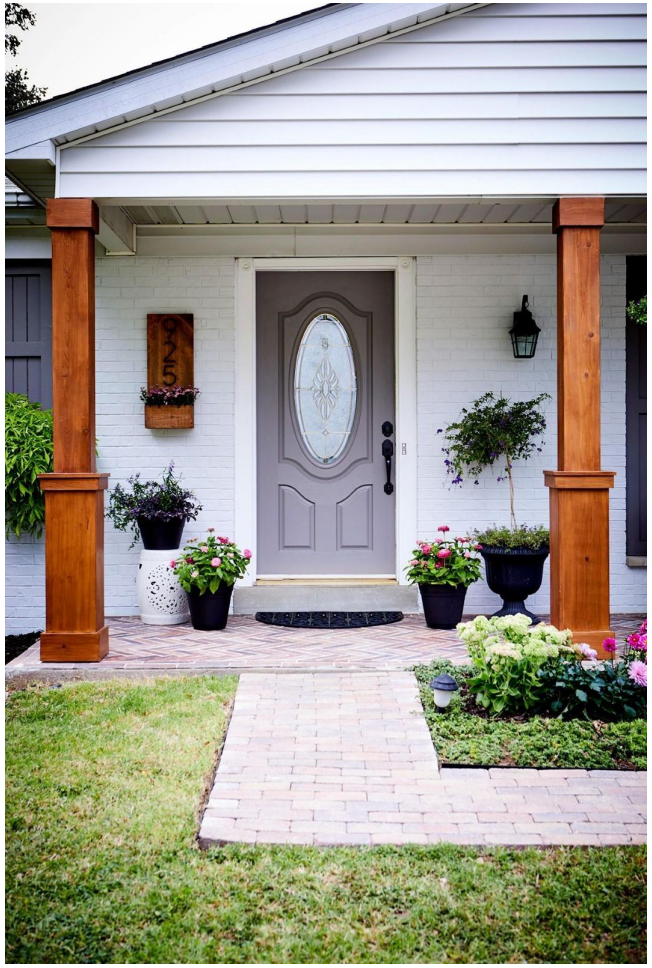
Module Objectives

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

ACCA®

Air Conditioning Contractors of America

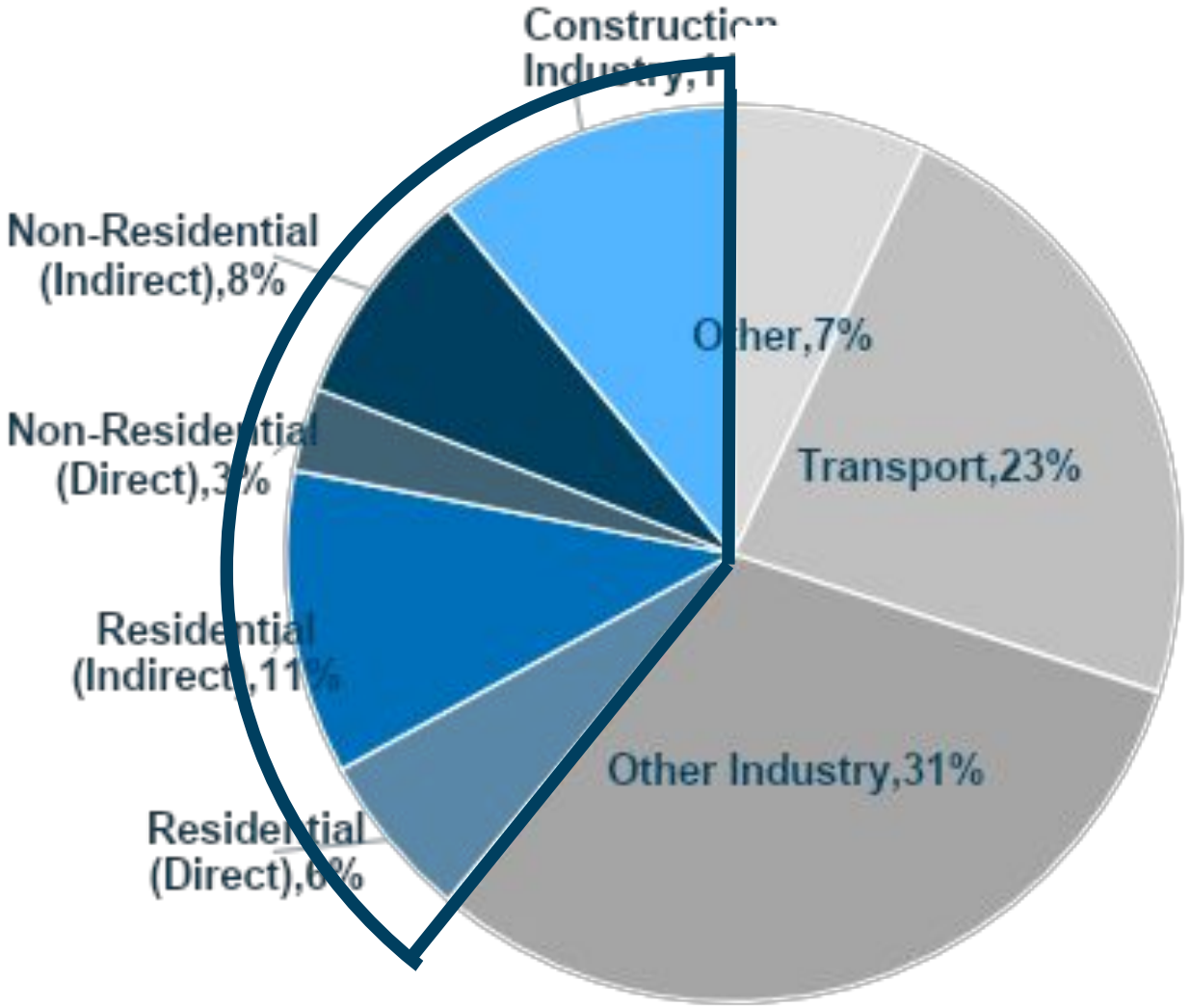
NATE

Certifying the finest in HVACR.

energy

ENERGY STAR

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.

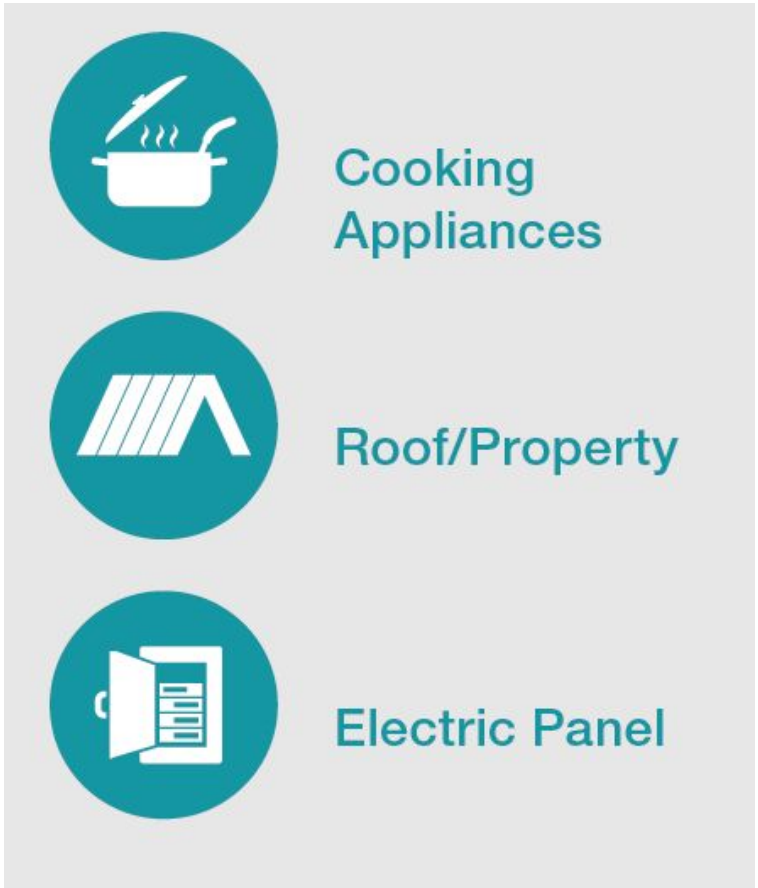
Systems to Inspect

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.

Checklist Sections



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 eectric 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)

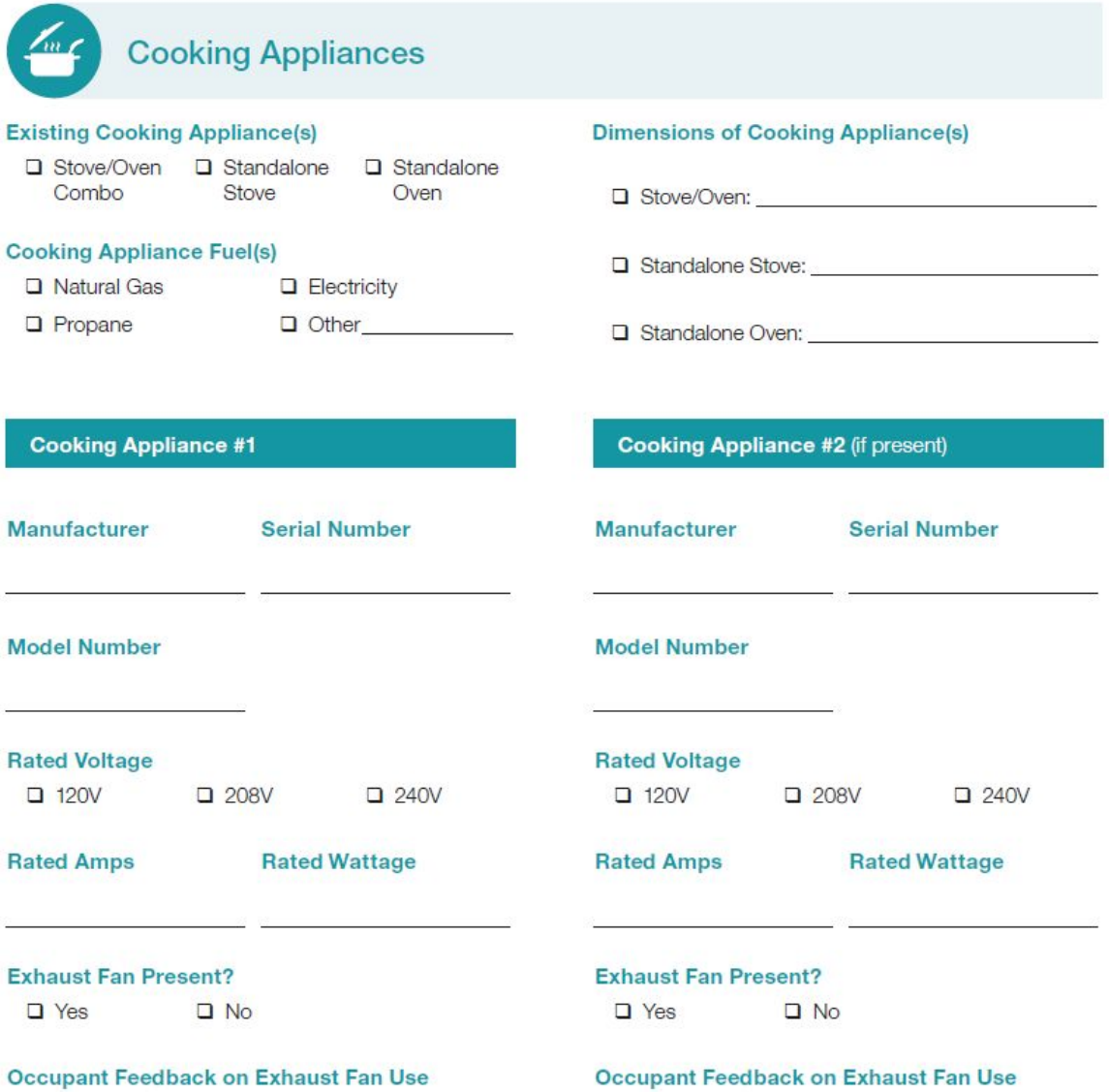
❑ Limited (i.e. in a closet, louvered doors)

❑ 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

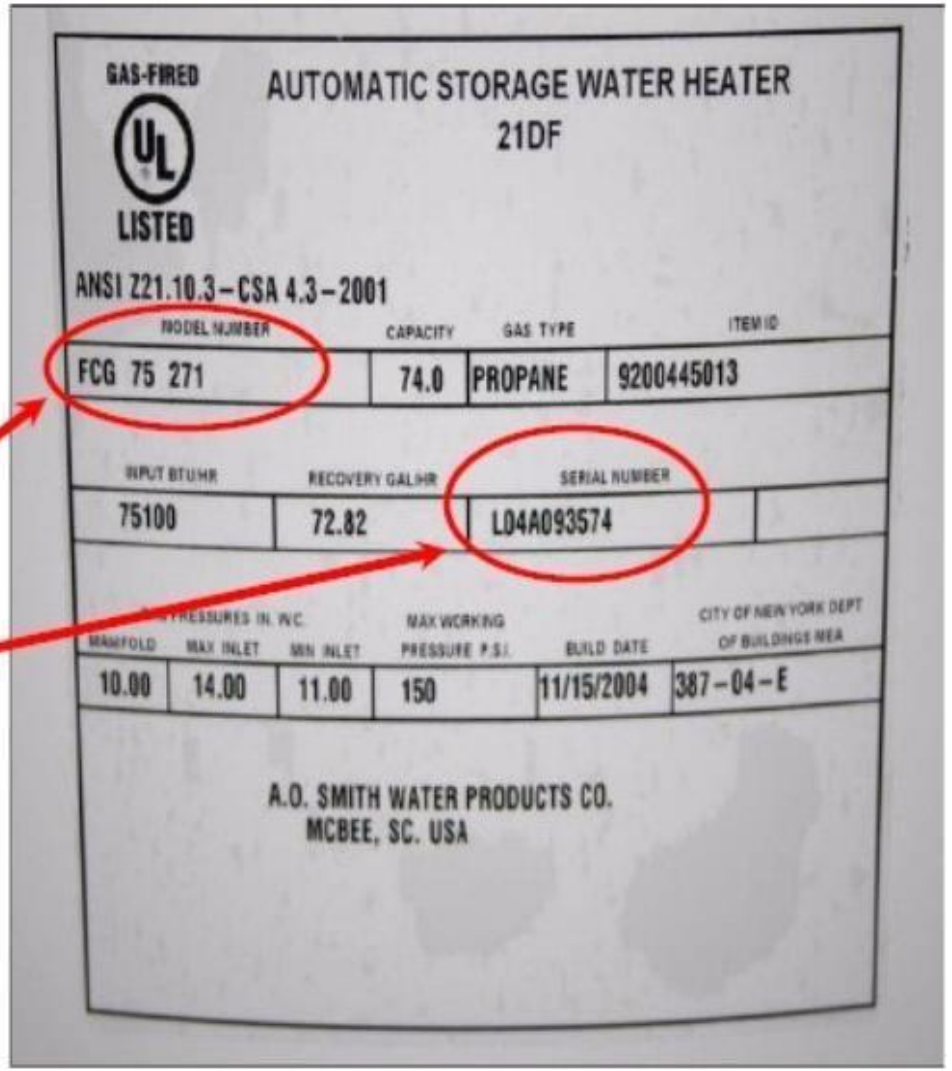
Captured Copy of 12 Months of Utility Bills

❑ Yes ❑ No

Maximum Annual Demand From Utility Bills

_____ (kWh)

“Say cheese”



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?

Section 3

Home Electrification and Electric Panel Upgrades

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

Agenda

- Introduction
- Module Goals
- Electric Panels: Basic Information
- Common Upgrade Triggers
- How to use the resource
- Questions

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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 Panels: Basic Information

Understanding Your Electrical Panel

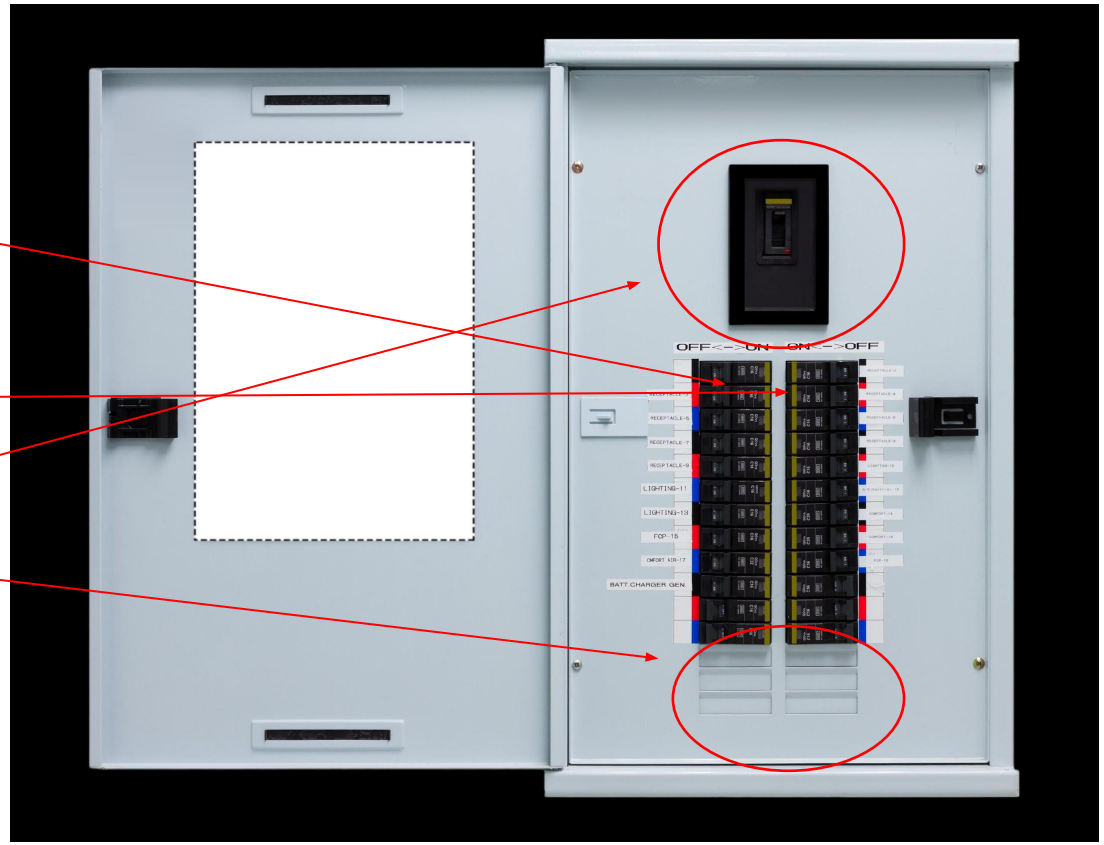
What does my panel do?

- 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

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



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.	• 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.	• 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.	• Energy efficiency • Better air quality	$$
 Electric Space Heating	A heat pump is a single electric appliance that can replace both your traditional air conditioner and home heating system. Heat pumps use electricity to move heat from one place to another. For cooling, a heat pump moves the heat from inside your home to the outside.	• Energy efficiency • Better air quality	$$
 Electric Vehicle Charger	EV chargers pull electricity from your home and delivers it to an electric vehicle.	• 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.

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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.

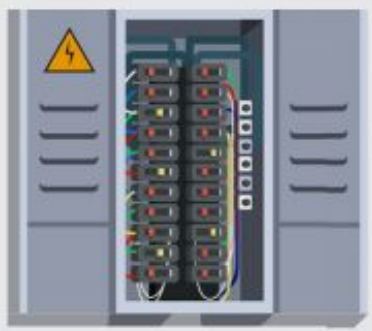
How to Calculate Electrical Capacity?

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.

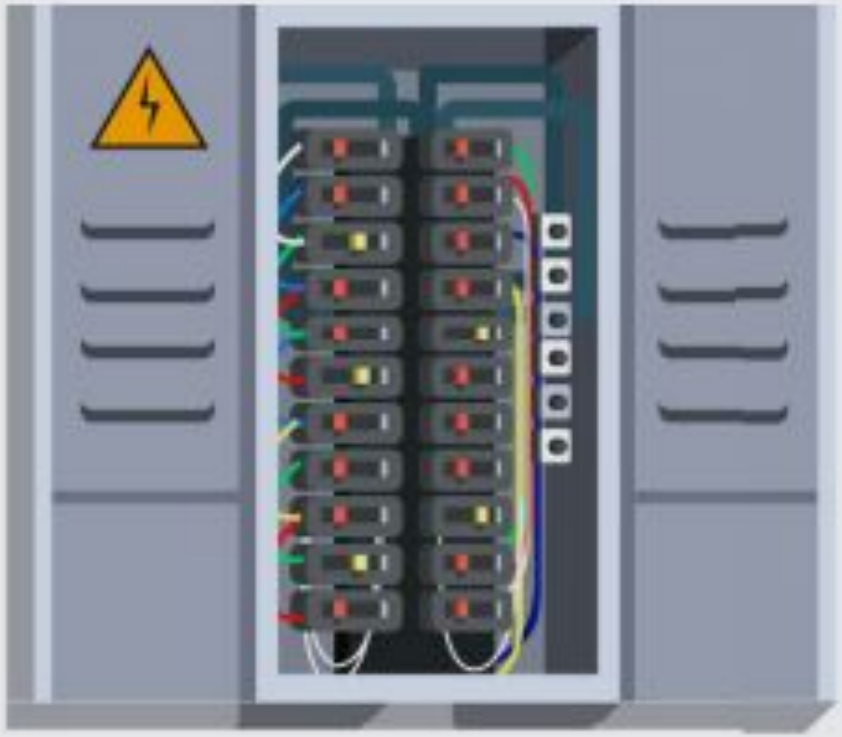


OPTIONAL METHOD ONE

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 VA/ft x _____ = (house finished square footage)	1	
2. 20A small appliance and laundry branch circuits	1500 VA x _____ = (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:	Oven Cooktop Fixed Microwave Dishwasher Disposal Electric Clothes Dryer Electric Clothes Washer Well Pump Sump Pump Garage Door Opener Hot Tub Other **TOTAL:**	3	
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	a. Cooling Load Outdoor Unit Air Handler **TOTAL COOLING:**	5a	
	b. Heating Load Heat Pump Outdoor Unit Air Handler Backup Electric Heat Electric Baseboard/Space Heaters **TOTAL HEATING:**	5b	
6. Add load and divide by 240V (add 4d + 5a or 5b (whichever is greater))	_____ (load total) ÷ 240V = suggested amperage needed to power your home	6	

Other Options Besides Electrical Panel Upgrades When Considering Electrifying

Panel Optimization

Choose power-efficient appliances and circuit-sharing devices.

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 Street

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New Buildings Institute (NBI) is a nonprofit organization working to advance energy efficiency and decarbonization in the built environment. Our efforts are imperative to keeping energy costs affordable, cutting emissions that are fueling climate change, and delivering on improved health, safety, and resiliency for everyone. Throughout its 25-year history, NBI has become a trusted and independent resource helping to create buildings that are better for people, communities, and the planet. Learn more at newbuildings.org.

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Questions?