U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

The Intersection of Energy Codes and Electrical Codes on the Road to Decarbonization

Building Energy Code Webinar Series

Building Technologies Office

April 18, 2024

Welcome

Building Energy Code Webinar Series

This webinar is being recorded. The video recording will be available on the webinar webpage next week.

A pdf of the full presentation is available now.

?

Please place all questions for the speakers in the **Zoom Q&A feature**. We will do our best to answer all questions during the Q&A at the end.

Certificates of completion and AIA LUs are available for participating in today's live session. **A link to request a certificate or LUs will be provided at the end of the webinar.**

Building Energy Codes
U.S. DEPARTMENT OF ENERGY

BECP Webinar Series Lineup

Catch the entire lineup of sessions the third Thursday of each month @ 1p ET.

- 9/21/23: How Building Codes Facilitate Resilient Communities
- 10/19/23: Strategies to Equitably Expand the Energy Codes Workforce
- 11/16/23: What You Need to Know About the New Energy Standard for Commercial Buildings: ASHRAE 90.1-2022
- 1/18/24: Best Practices for Understanding and Improving Compliance: Field Studies, Circuit Riders, and More
- 2/15/24: Addressing Existing Buildings: Building Performance Standards and Implementation Support Tools
- 3/21/24: Energy Code Enforcement Challenges and Opportunities in Rural Communities
- 4/18/24: The Intersection of Energy Codes and Electrical Codes on the Road to Decarbonization
- *No webinars in May and June*

> Learn more: www.energycodes.gov/becp-energy-code-webinar-series

Building Energy Codes
U.S. DEPARTMENT OF ENERGY

The Intersection of Energy Codes and Electrical Codes on the Road to Decarbonization

DOE Introduction and Background

DOE Building Energy Codes Webinar

April 18, 2024







Building Energy Codes Program

Mission

To support building energy code development, adoption, implementation and enforcement processes to achieve the maximum practicable, cost-effective improvements in energy efficiency while providing safe, healthy buildings for occupants.

Directive

To participate in industry processes to develop model building energy codes, issue determinations as to whether updated codes result in energy savings, and provide technical assistance to states to implement and comply with the codes.

Connected Communities are helping address modern grid challenges

THE WAY ELECTRICITY IS GENERATED AND CONSUMED IN THE U.S. IS QUICKLY CHANGING

Urgency to decarbonize end uses and the electricity grid

Increasing: deployment of variable energy resources, and efficiency

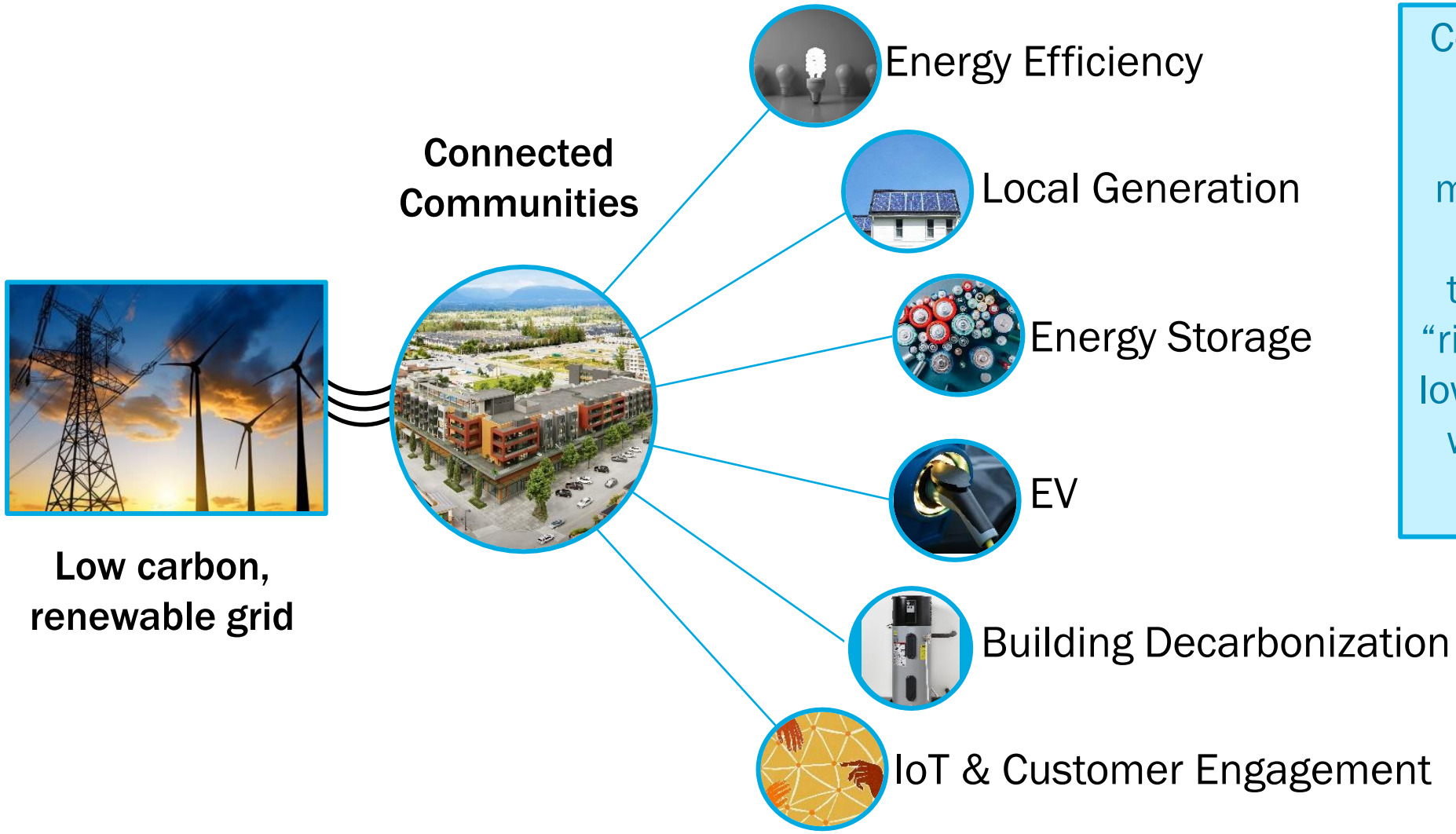
Increasing electrification of vehicles and buildings

Need to modernize fragile electricity system infrastructure

Need to decarbonize buildings, meet customer needs, and save money

Connected Communities envisions the future state of a low carbon grid serving decarbonized end uses using scaled demonstration

The vision of an integrated energy system

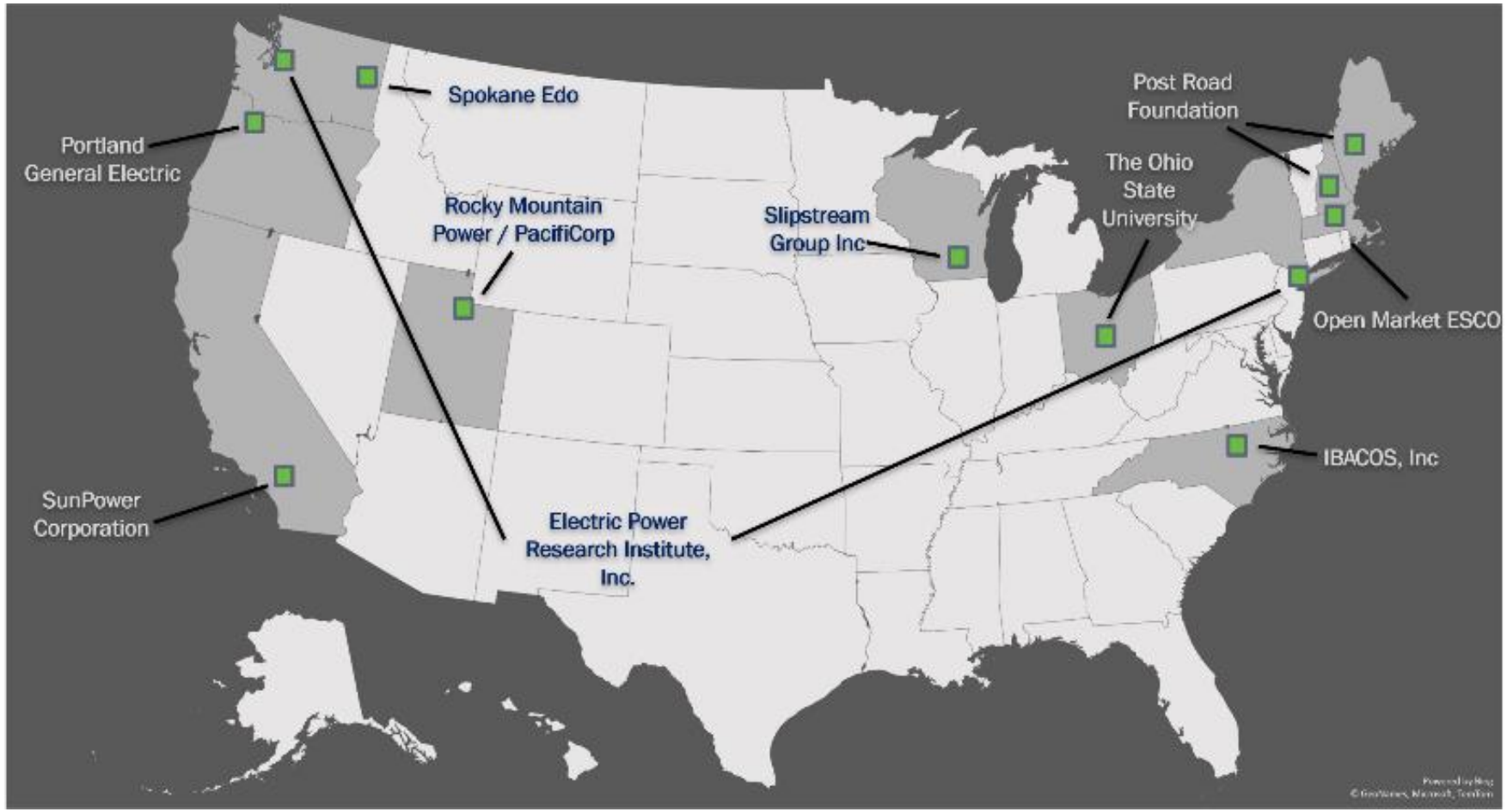


Connected Communities demonstrations are designed to leverage measured data and test grid integration technologies to enable "right sizing" of the future low carbon energy system with decarbonized end uses.

Connected Communities cohort overview

10 Selected Projects

- $61 Million Total funding
- Final Awards made March 2023



Building Types

- Residential
- Commercial
- Multifamily

New build & Retrofit

Diverse DER, DF building loads, & EE upgrades

- All include solar, storage, and EV

Unique business models, motivations, & community types

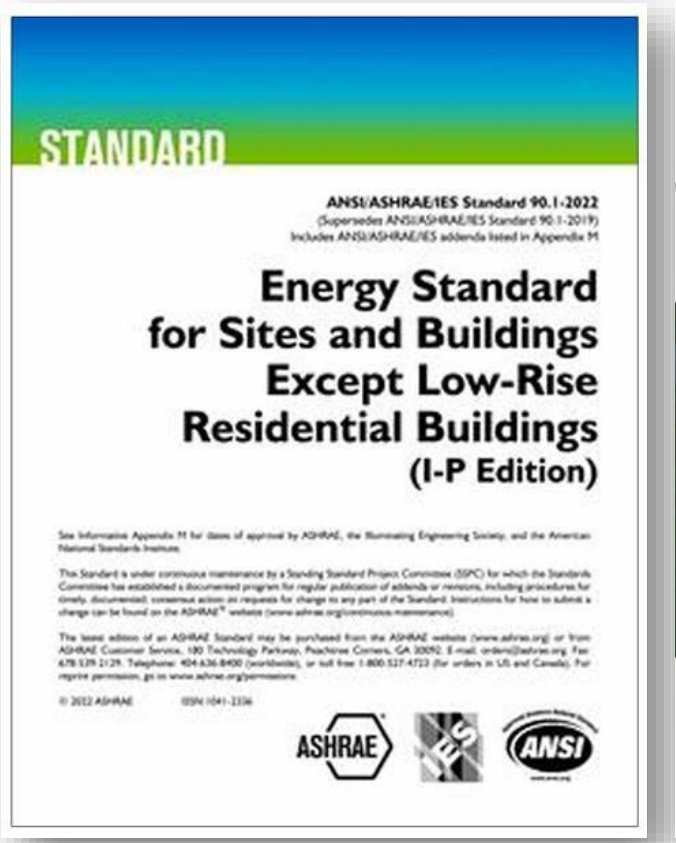
GOALS

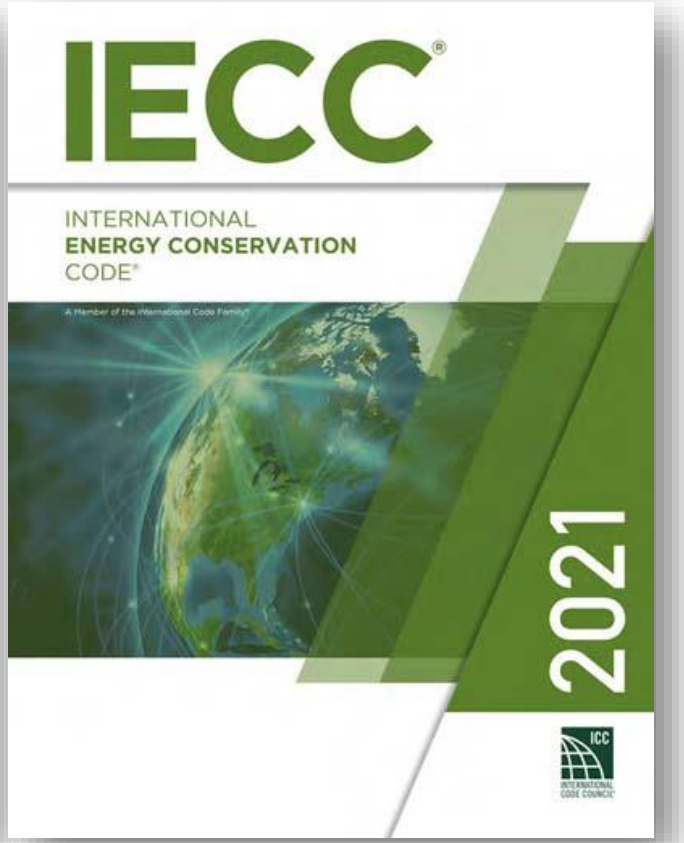
- Produce technology integration solutions and best practices
- Reliable data at scale for grid planners
- Maintain occupant comfort, improve reliability and resilience
- Demonstrate innovative, scalable business models

DER = Distributed Energy Resource; DF = Demand Flexible; EE = Energy Efficiency

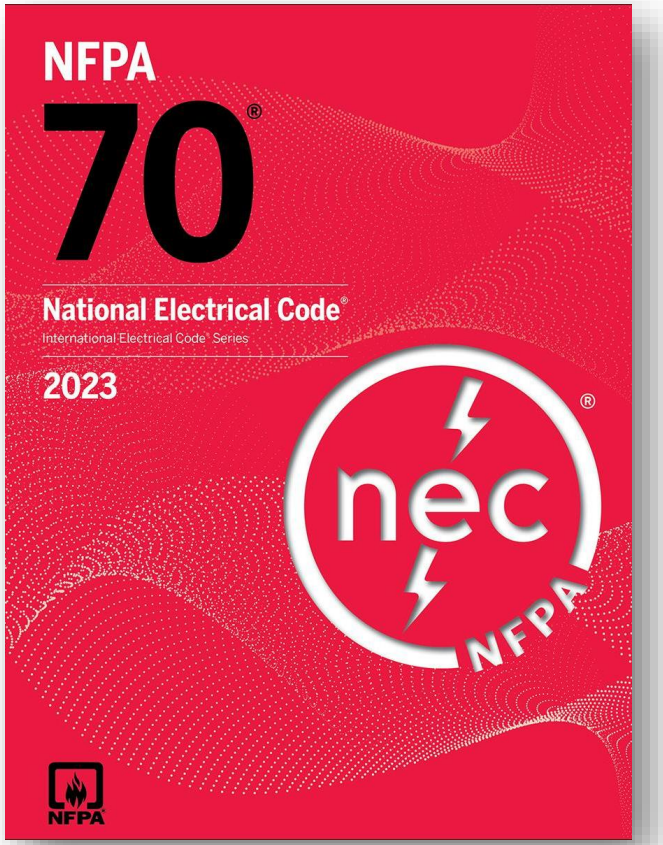
www.energy.gov/eere/solar/connected-communities-funding-program

Building codes are impacted by the changing electricity landscape





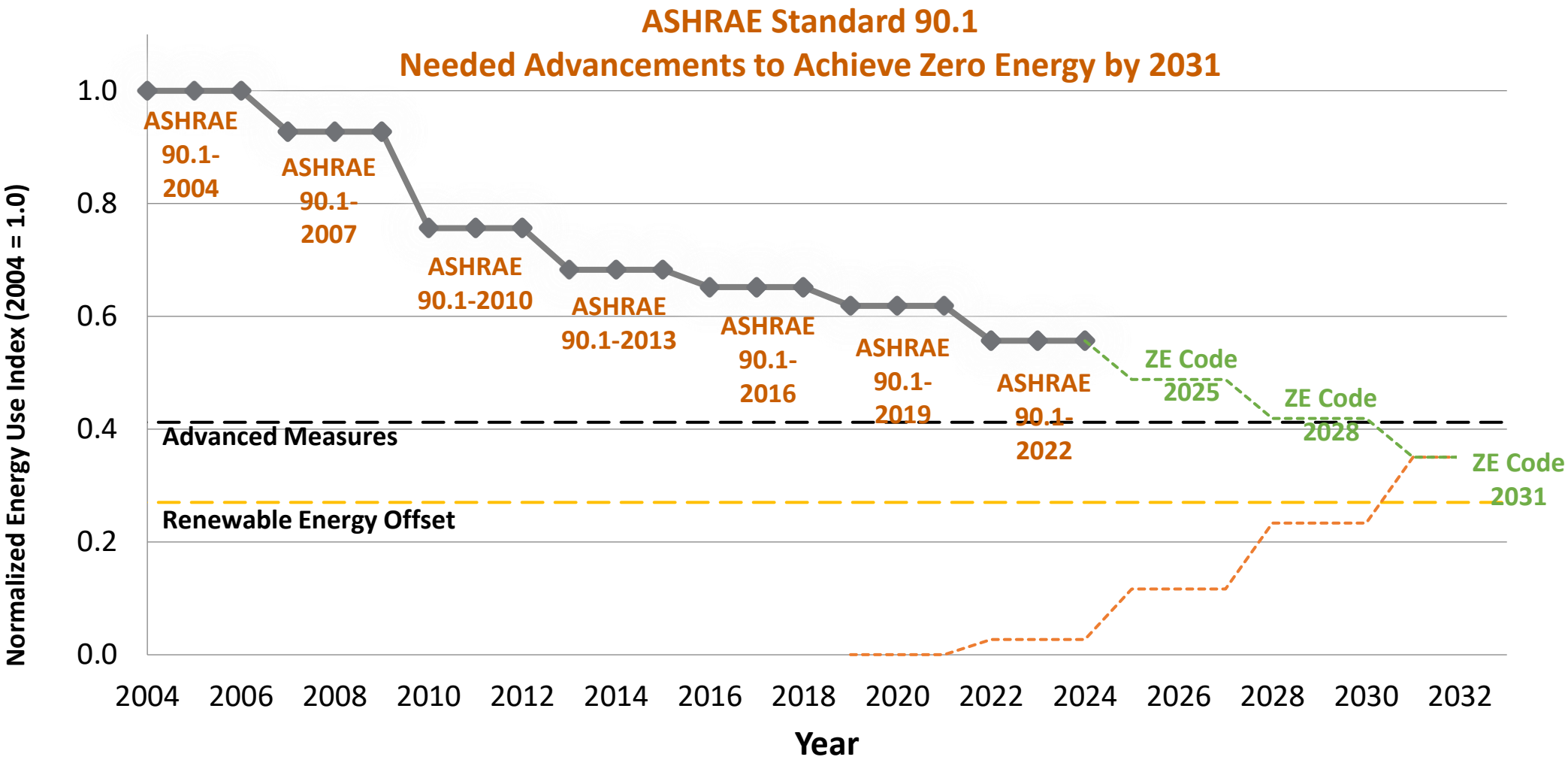
Energy Codes



Electrical Code

(And others like mechanical, plumbing, etc.)

We'll need to be mindful of grid impacts as codes approach zero



DOE developed stretch code language overlays for model codes

A stretch code is a locally mandated code or alternative compliance path that is more aggressive than base code, resulting in buildings that achieve higher energy savings.

For example, DOE has researched and developed code language for:

EV Charging

Solar PV

Simplified HVAC System Performance

Energy Credits

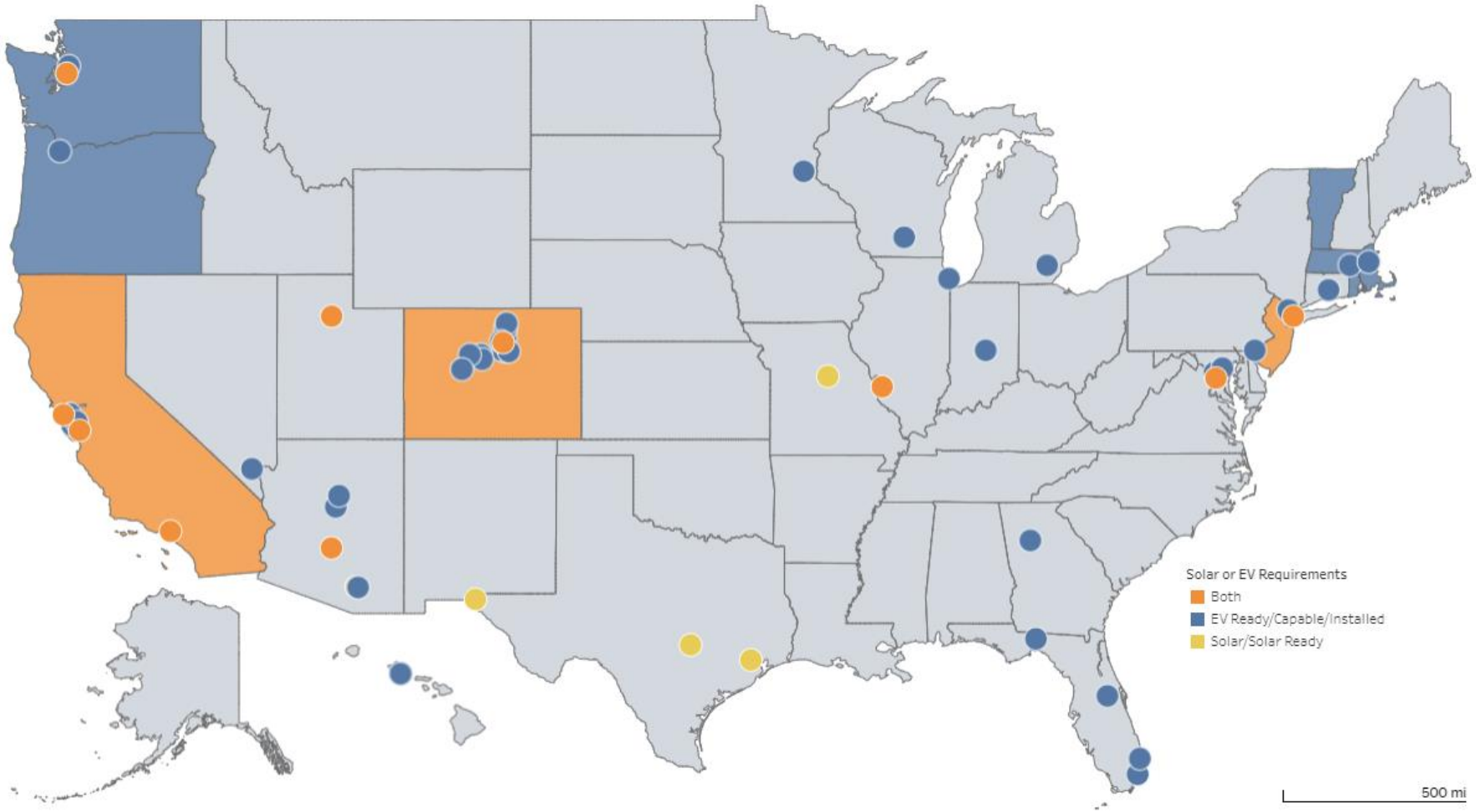
Electric Readiness

Demand Response

Many of these proposals are currently in or may soon appear in model energy codes!

www.energycodes.gov/stretch-codes

DOE tracks state and jurisdiction PV and EV requirements

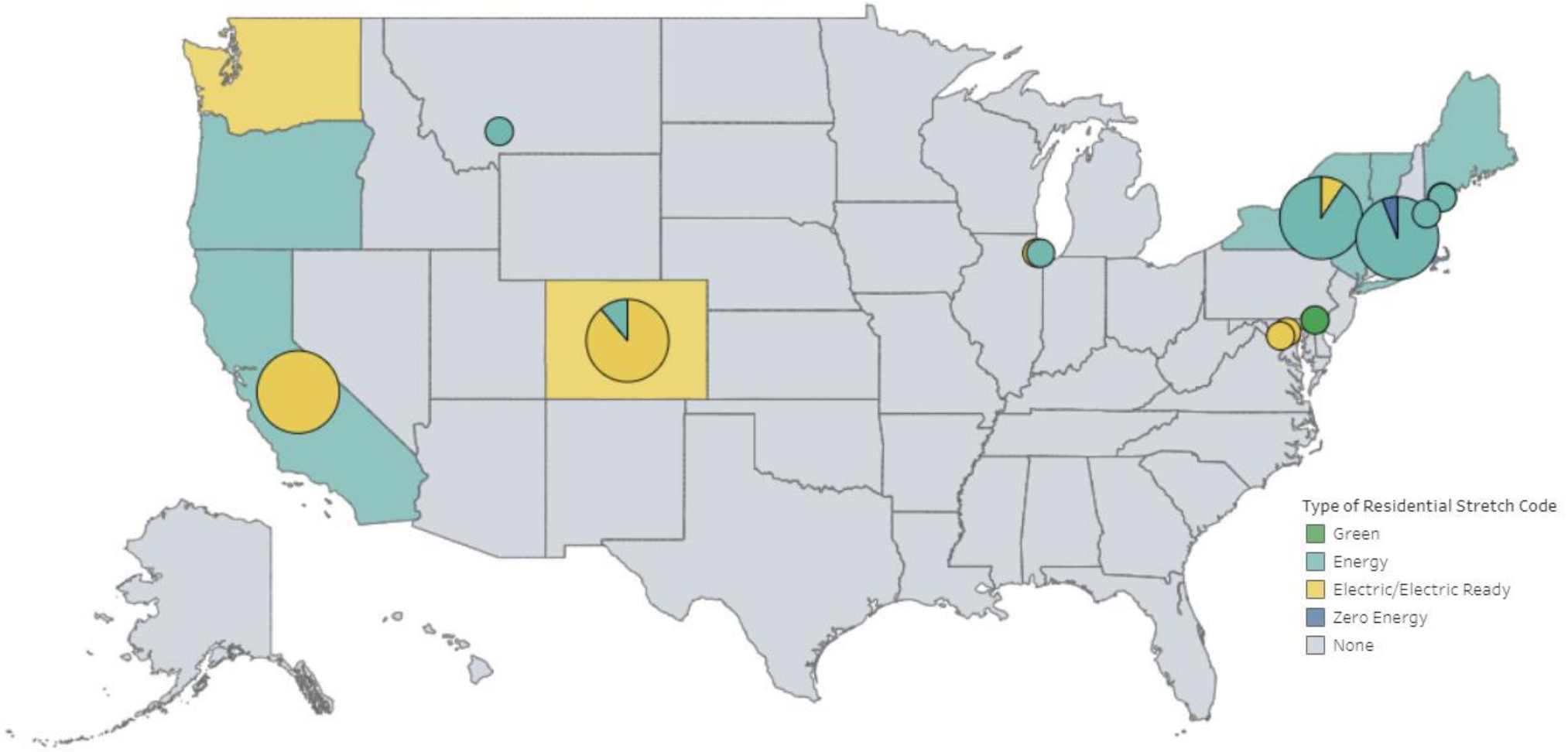


1. Data sources include the Southwest Energy Efficiency Project and Great Plains Institute. Data to support this map is under continuous maintenance. If you know of additional states and cities that should be included, please email becp@pnnl.gov.

Updated as of 03/31/24

www.energycodes.gov/infographics

DOE also tracks state and local stretch code adoption



www.energycodes.gov/infographics

BIL and IRA provide over $1.2 billion for energy codes

BIL and IRA provide over $1.2 billion supporting the adoption and implementation of building energy codes, with emphasis on activities like compliance improvement, workforce education, equity, partnerships, and innovative approaches.

- $225 million BIL Section 40511: Cost-effective Codes Implementation for Efficiency & Resilience
- $1 billion IRA Section 50131: Assistance for Latest and Zero Energy Building Energy Code Adoption

DOE announced initial $90 million in BIL funding awards in July 2023

- Awards support 27 projects across 26 different states and DC
- Wide range of states including Alaska, Colorado, Louisiana, and Ohio

Thank you

Contact

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Building Energy Codes Program

https://www.energycodes.gov/

DOE Codes Webinar: The Intersection of Energy Codes and Electrical Codes on the Road to Decarbonization

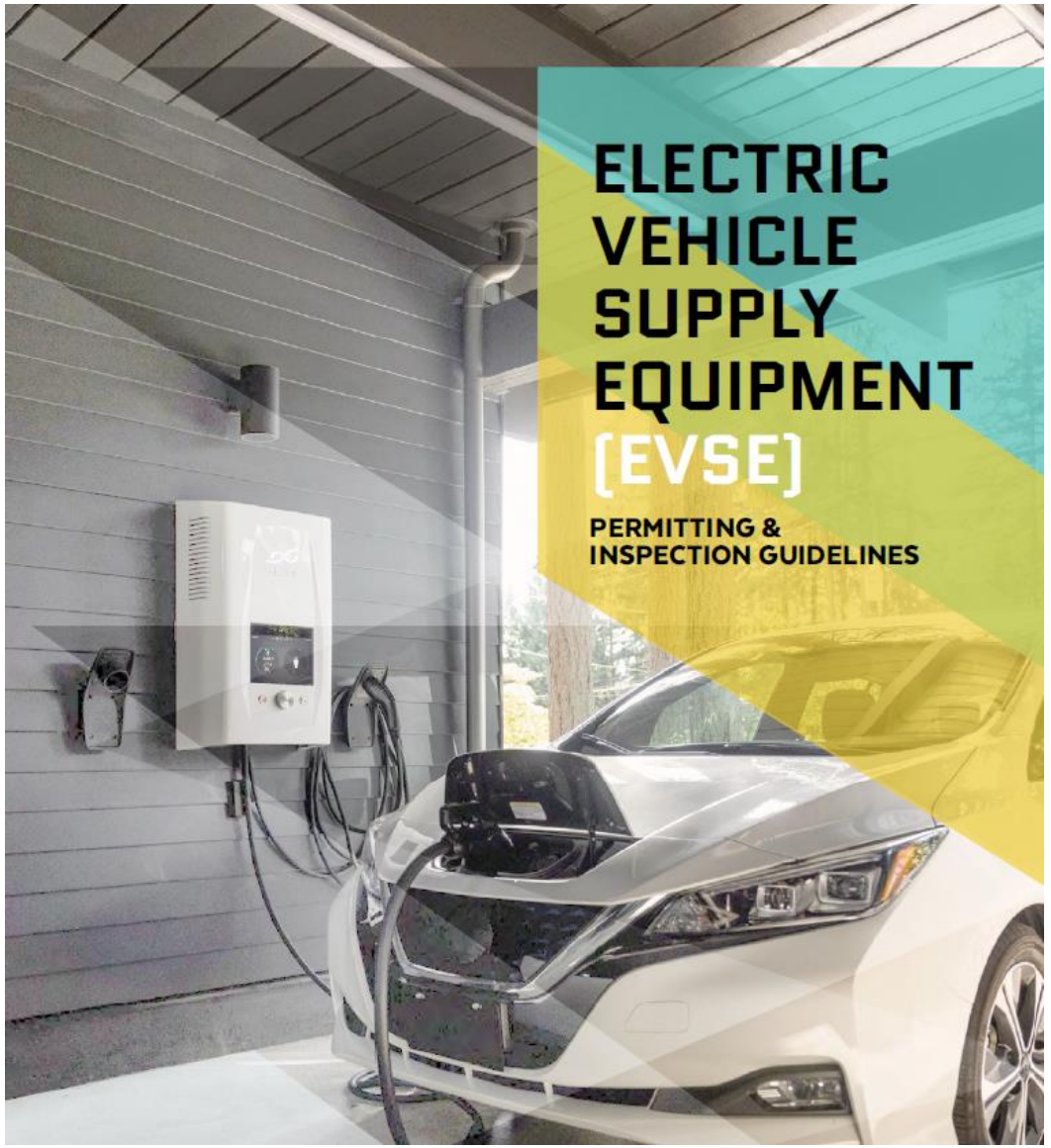
Distributed Energy Resources (DER) Accelerator

April 18, 2024

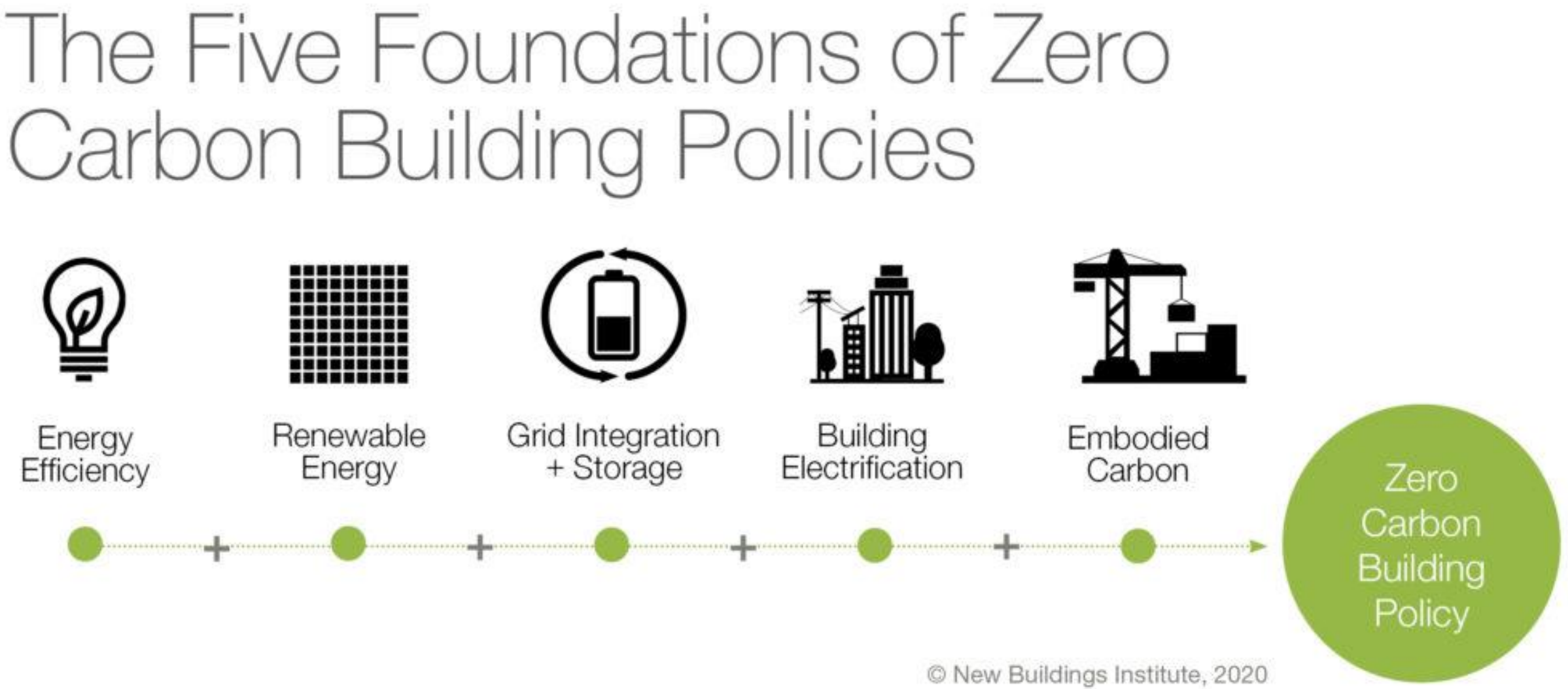
nbi new buildings institute

Agenda

- About NBI
- Program & Partners
- Pilot Process
- Overview of the Guides
- How to Use The Guides
- Best Practices & Lessons Learned
- Where to Find Them
- Q&A



About New Buildings Institute



About the Presenters

Amie Lewis
Associate Director of Codes and Policy
amie@newbuildings.org

Program & Partners

Streamline the design, permitting, and inspections process for Distributed Energy Resource (DER) solutions.

- Electric Vehicle Supply Equipment (EVSE)
- Solar & Energy Storage

FORTH Empowering Mobility

earthadvantage Better Buildings Now

SWEEP SOUTHWEST ENERGY EFFICIENCY PROJECT

MAPC METROPOLITAN AREA PLANNING COUNCIL

ICC

IREC

Southface

SOLSMART NATIONALLY DISTINGUISHED. LOCALLY POWERED.

Funded by the Department of Energy

Guide Development & Pilot Program

- Reviewed existing permitting and inspection guidelines
- Developed guidelines for expedited permit applicability
- Identified barriers & challenges code officials and installers face through interviews, surveys, and pilot program feedback
- Included expert review by technical and jurisdictional partners

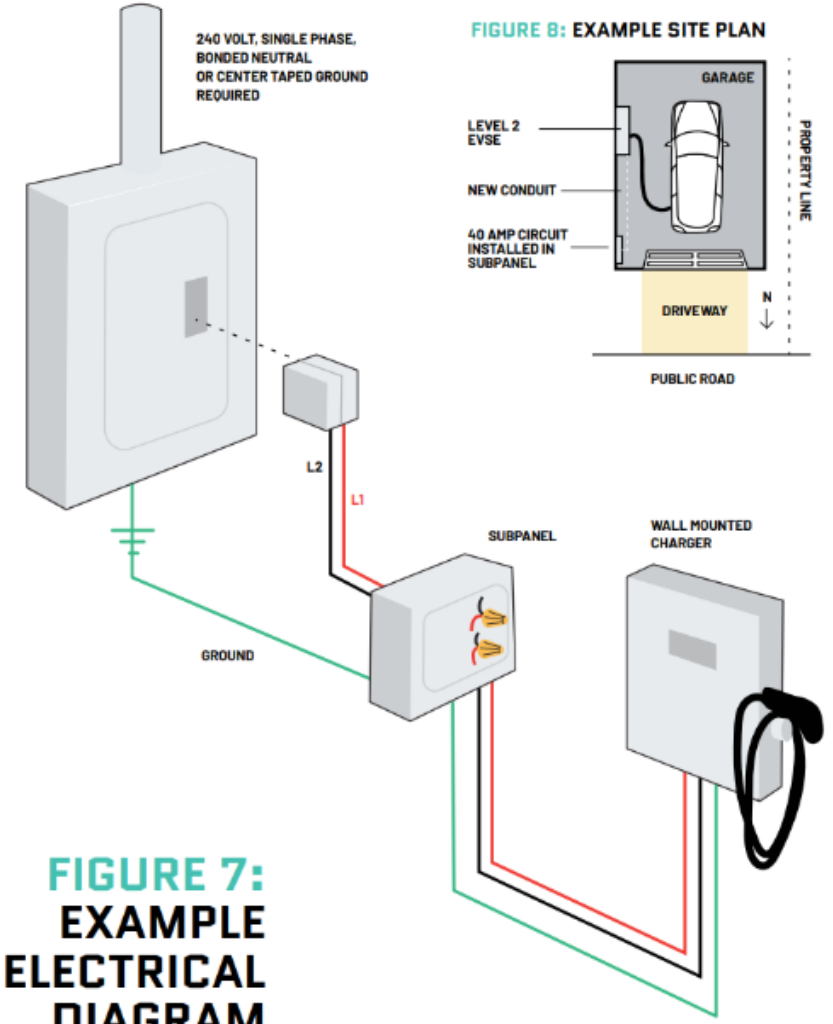


FIGURE 7: EXAMPLE ELECTRICAL DIAGRAM

(Source: SemaConnect)

Pilot Program

Arizona:

- Flagstaff
- Town of Gilbert
- Pima Count

Massachusetts:

- Somerville
- Chelsea

Peer Review

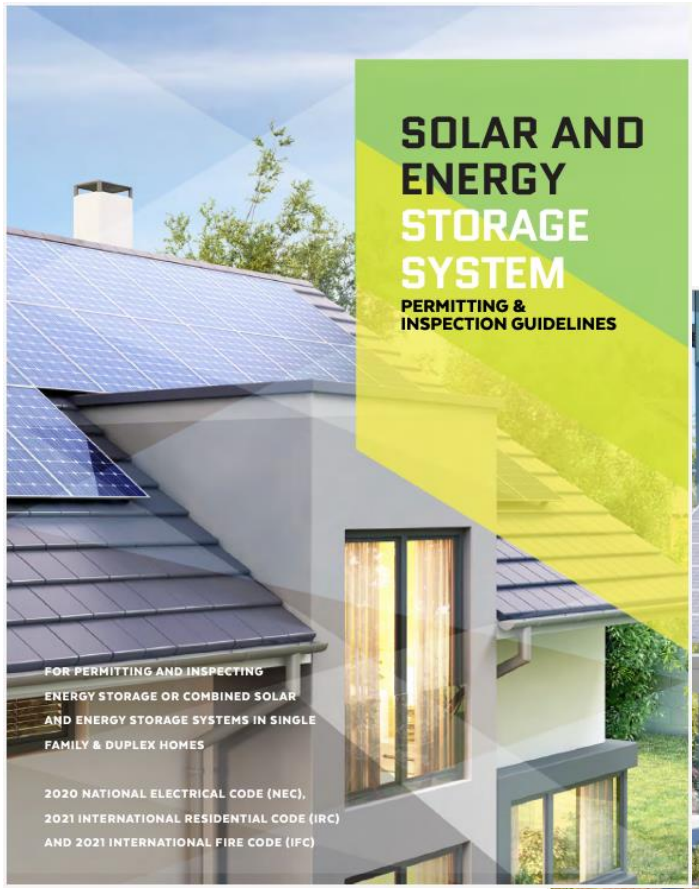
- National Electrical Manufacturers Association (NEMA)
- Sustainable Energy Action Committee (SEAC) EV Working Group
- Dept. of Community and Regulatory Affairs
- Building Officials
- Tesla

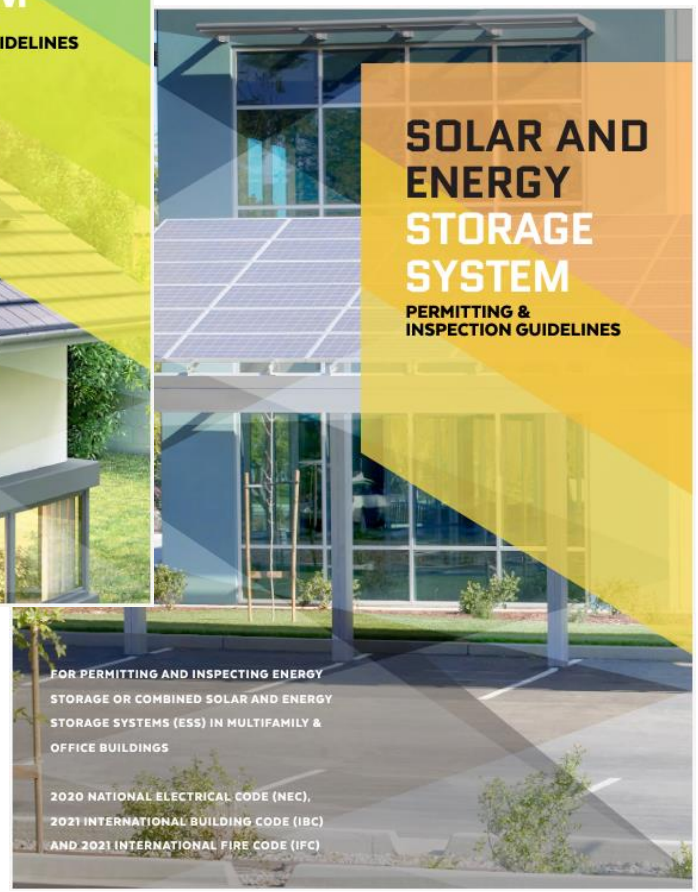

Image credit: Petr Kratochvil

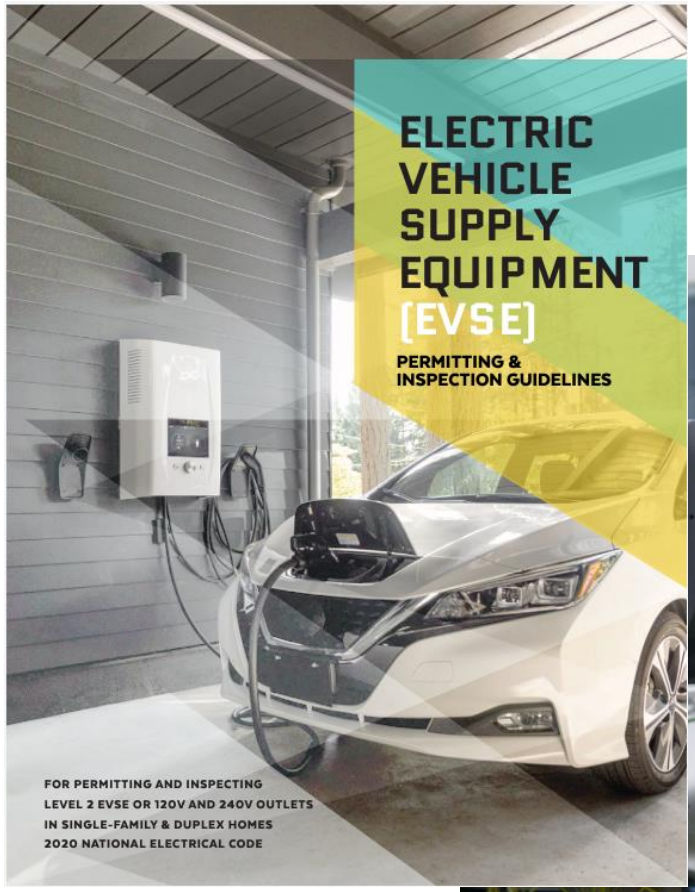
Who should use the guides?

- Building department staff
- Other AHJ's
- Designers
- Builders
- Installing contractors
- Property owners
- Homeowners

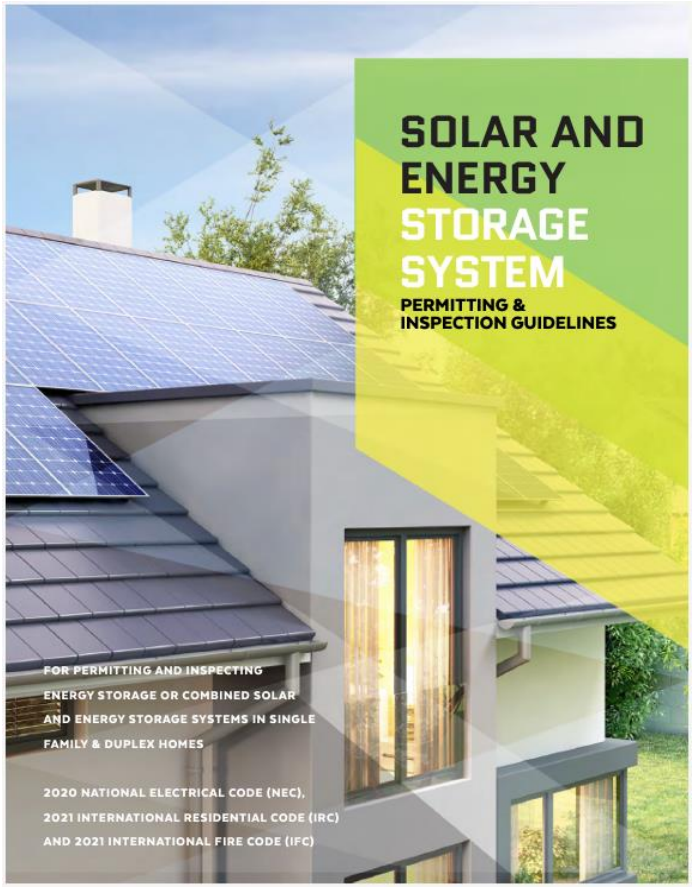
Permitting and Inspection Guidelines







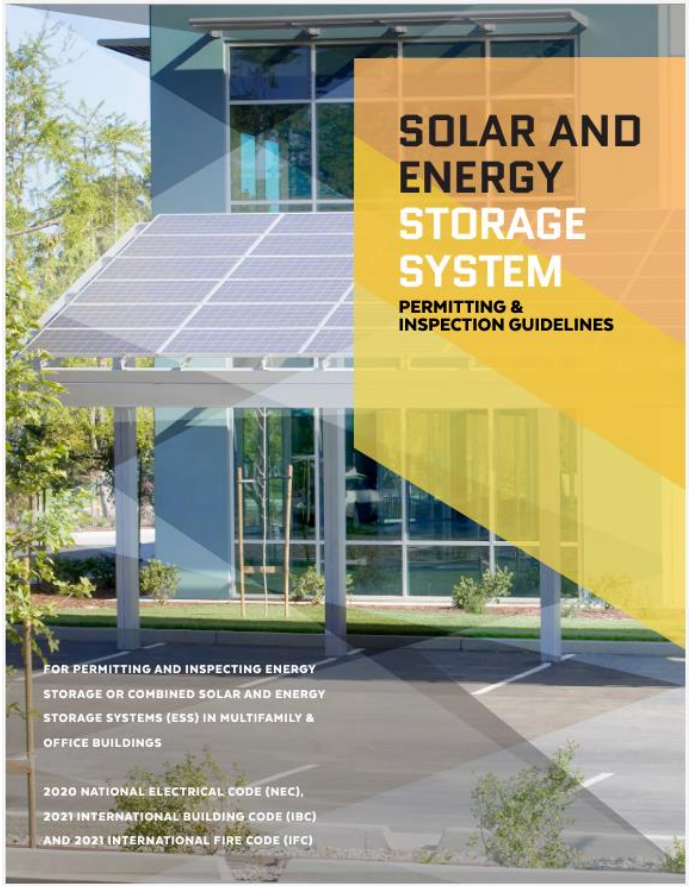
Permitting and Inspection Guidelines



Level 2 EVSE or 120V and 240V Outlets

2020 National Electrical Code (NEC)

Permitting and Inspection Guidelines



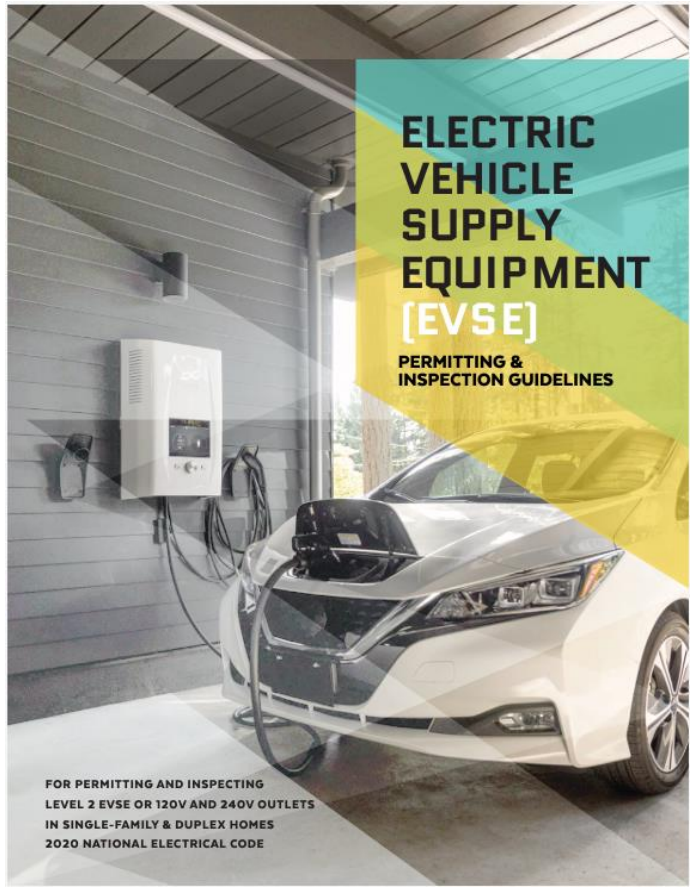
Level 2 EVSE or 120V and 240V Outlets

2020 National Electrical Code (NEC)

2021 International Building Code (IBC)

2017 ICC A11.7.1

Permitting and Inspection Guidelines

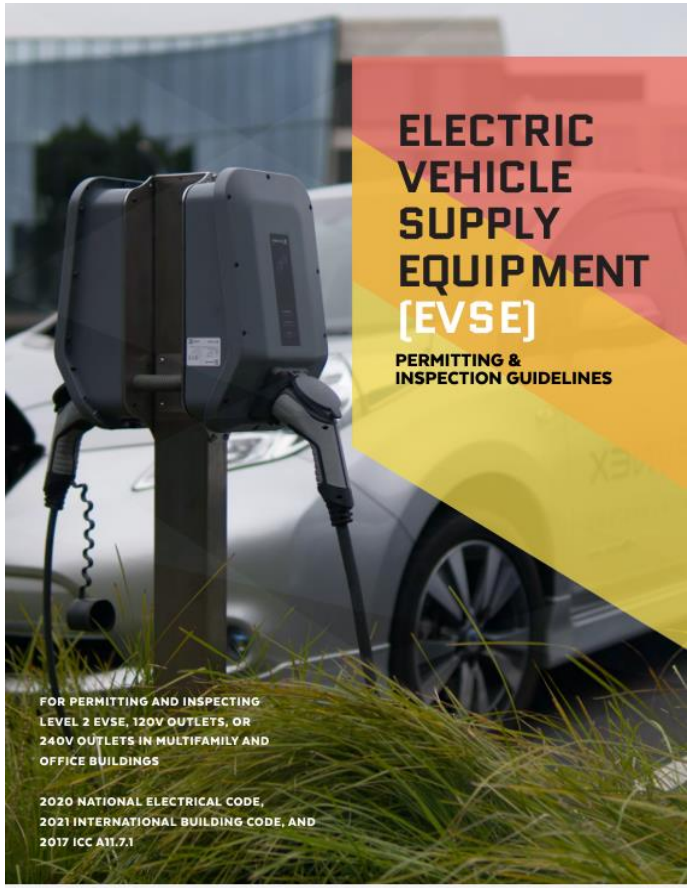


2020 National Electrical Code (NEC)

2021 International Residential Code (IRC)

2021 International Fire Code (IFC)

Permitting and Inspection Guidelines



2020 National Electrical Code (NEC)

2021 International Building Code (IBC)

2021 International Fire Code (IFC)

Guide Contents

- Permit Submission Requirements (list of what should be included on electrical line diagrams or site plans, load calculations, spec sheets)
- General Installation Guide (checklist with example electrical line diagrams/site plans)
- Plan Review and Field Inspection Checklist
- Resources and Agency Contacts
- Sample Permit Application
- Electrical line diagrams for solar & storage

Not included

- Utility-scale solar or energy storage systems
- DC fast charging
- Requirements for electrical service upgrades
  - Where electrical service or metering upgrades are required, another permit may be required before this guide can be followed

This EVSE permitting and inspection guide does not include requirements for any service upgrades or other electrical work. If the required load calculation demonstrates a service upgrade is needed, this streamlined permitting and inspection guide cannot be used to determine code compliance of the service upgrade.

Where electrical service or metering upgrades are required, another permit may be required before this guide can be followed.

This EVSE permitting and inspection guide does not include requirements for indoor installation of infrastructure for EV batteries that require additional ventilation, including flooded lead-acid or nickel-iron batteries.

The electrical requirements in this guide primarily focus on the requirements in Article 625: Electric Vehicle Power Transfer System of the National Electrical Code.

PERMIT SUBMISSION REQUIREMENTS

TO APPLY FOR AN EVSE PERMIT, SUBMIT THE FOLLOWING:

1) Electrical permit application

2) Site plan (see Figure 8) drawn to scale showing:

a) Property lines, adjacent streets, lot dimensions and the north arrow
b) Primary use of the space or area where the EVSE will be installed
c) Location of the proposed EVSE equipment on the property and
d) Number of proposed EVSE chargers

3) Electrical line diagram (see Figure 7) with:

a) EVSE wiring configuration
b) EVSE specifications (manufacturer, maximum kW rating, voltage and ampacity, cable management system, if applicable)
c) Mounting details (e.g., wall, pedestal with footing details)
d) NEMA enclosure type
e) Conductors, cables, and raceway types, sizes, and markings
f) Wiring routes and requirements for their installation (e.g. within framing, mounted to structures, underground, etc.)
g) Type and size rating of overcurrent protection and disconnects and
h) Location of additional meters, main electrical service panel, distribution panels or subpanels

4) Load calculation for EVSE and 240V outlet installations

5) EVSE specification sheets and installation manuals

PERMIT APPROVAL REQUIREMENTS

- This permitting and inspection guide is only applicable to the installation of the following applications:
  - Lithium-ion energy storage systems
  - Energy storage systems with total maximum energy capacity on site of 600kWh
  - Energy storage systems installed with simple solar systems meeting SolSmart criteria that are less than 15kW consisting of no more than 2 series strings per inverter and no more than 4 source circuits in total per inverter.
- Standard electrical diagrams are provided in Appendix B and can be used to accurately represent the ESS or combined ESS and PV installations. If the electrical system is more complex than the standard electrical diagram can effectively communicate, the project does not meet the requirements for a simplified permit application and additional information may be necessary for the jurisdiction to process the permit application.
- This permitting and inspection guide does not include any service upgrades or other electrical work. If the load calculations demonstrate a service upgrade is needed, this permitting and inspection guide cannot be used to determine compliance with code requirements for a service upgrade.

*National Simplified Residential PV and Energy Storage Permit Guidelines. "SolSmart. https://solsmart.org/resources/national-simplified-residential-pv-and-energy-storage-permit-guidelines/

GENERAL INSTALLATION GUIDE

MINIMUM EVSE REQUIREMENTS

1 EVSE installed according to manufacturer's installation instructions. (NEC 110.3(B))

2 EVSE is suitable for the environment (indoor/outdoor) in which it will be installed. (NEC 110.28)

3 EVSE has a Nationally Recognized Testing Laboratory (NRTL) approved listing mark. (UL 2202/UL 2594)(NEC 625.5)

4 If EVSE with adjustable amperage setting is installed, equipment is fixed in place and adjusting means is accessible by qualified personnel with the use of a tool or password protected commissioning software. (NEC 625.42)

FIGURE 1:
EXAMPLE
UL LISTING

LOCATION AND EVSE INSTALLATION REQUIREMENTS

5 Permanently installed EVSE are located at a height of (NEC 625.50):
- a) Indoor location: 1.5 feet or more above floor level
- b) Outdoor location: 2 feet or more above grade level.

6 Charging cord meets one of the following: (NEC 625.17)
- a) Does not exceed 25' in length, or
- b) Is equipped with a cable management system that is part of the EVSE

7 Charging cord length reaches the vehicle's charging inlet without excessive slack. (NEC 625.17)

8 The EVSE is protected from vehicular impact through one of the following:
- a) Installation in a location not subject to vehicular impact such as a side wall or 4 feet or more above floor level,
- b) Wheel barriers,
- c) Bollards, or
- d) Other approved barrier. (NEC 110.27(B))

GENERAL INSTALLATION GUIDE

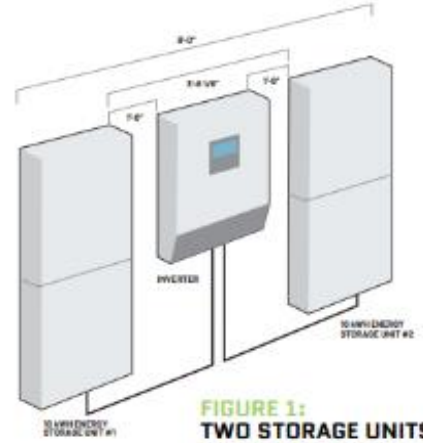


FIGURE 1:
TWO STORAGE UNITS COMPLYING WITH 3 FOOT SEPARATION

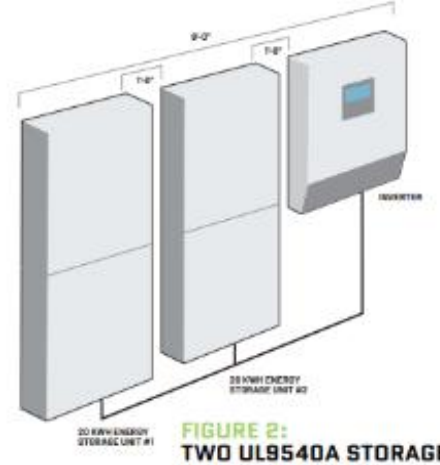


FIGURE 2:
TWO UL9540A STORAGE UNITS COMPLYING WITH MANUFACTURER INSTRUCTIONS

ENERGY STORAGE SYSTEM REQUIREMENTS

1 ESS is listed to UL9540 or UL9540a by a Nationally Recognized Testing Laboratory (NRTL). (IFC 1207.3)

2 ESS is listed to UL1973. (NEC 706.5)

3 Inverters are certified to UL1741. (NEC 690.4(B))

ENERGY STORAGE SYSTEM INSTALLATION REQUIREMENTS

4 ESS is installed according to manufacturer installation instructions. (NEC 110.3(B))

5 All work is done in a neat and workmanlike manner. (NEC 110.12)

6 Access and working space for ESS equipment such as ESS units, battery units, inverters, disconnecting means, and panelboards is adequate. Working space is at least 30 inches in width, 6.5 feet in height and 4 feet in depth or the width, height and depth of the equipment, whichever is greater. (NEC 110.26)

7 Grounding/bonding of ESS units, battery units, inverters, conduit and other electrical equipment according to the NEC and manufacturer's instructions. (NEC 110.14, 250.148(A), NEC 110.3(B))

8 The individual ESS units are no larger than 20kWh. (IRC R328.5)

9 ESS units that are UL9540 certified are separated by 3 feet. (IRC R328.3.1, IFC1207.5.1)

10 Energy Storage Systems that are UL9540a certified are grouped and separated according to manufacturer instructions. (IRC R328.3.1, IFC1207.5.1, NEC 110.3(B))

FIGURE 3:
LARGE SCALE FIRE TESTED LABEL

CERTIFIED TO UL9540 SAFETY TESTED UL9540A

PERMITTING CHECKLIST

MINIMUM EVSE REQUIREMENTS

- ☐ **1** EVSE installed according to manufacturer's installation instructions.
- ☐ **2** EVSE is suitable for the environment (indoor/outdoor) in which it will be installed.
- ☐ **3** EVSE has a Nationally Recognized Testing Laboratory (NRTL) approved listing mark. (UL 2202/UL 2594)

LOCATION AND EVSE INSTALLATION REQUIREMENTS

- ☐ **4** Permanently installed EVSE are located at a height of:
  a) Indoor location: 1.5 feet or more above floor level
  b) Outdoor location: 2 feet or more above grade level.
- ☐ **5** Charging cord meets one of the following:
  a) Does not exceed 25' in length.
  b) Is equipped with a cable management system that is part of the EVSE.
- ☐ **6** The EVSE is protected from vehicular impact through one of the following:
  a) Installation in a location not subject to vehicular impact such as a side wall or 4 feet or more above floor level;
  b) Wheel barriers;
  c) Bollards; or
  d) Other approved barrier.

ELECTRICAL REQUIREMENTS

- ☐ **7** For EVSE and 240V outlets installations, electrical service rating is greater than or equal to the electrical service load as demonstrated by electrical service load calculations.
- ☐ **8** EVSE has a sufficient rating to supply the load served.
- ☐ **9** Service and feeder are sized for EVSE to be considered continuous loads unless an automatic load management system (ALMS) is used. If an ALMS is used, the maximum equipment load on the service/feeder matches the maximum load permitted by the ALMS.
- ☐ **10** The required overcurrent protection for the proposed EVSE are
  a) Sized for continuous duty
  b) Have a rating of 125% or more of the maximum load of the equipment specification based on Table 1 below.
- ☐ **11** If the EVSE is rated more than 60 amps or more than 150V to ground, the disconnecting means is able to be locked in the open position and is in an easily accessible location not protected by locked doors or other obstructions.
- ☐ **12** Circuits serving EVSE do not serve any other end uses.
- ☐ **13** Circuit conductors are sized at 125% or more of EVSE nameplate current
- ☐ **14** Underground conduit meet minimum depth requirements in Table 1 below. Insulated conductors and cables are suitable for use in wet locations and protected from physical damage.
- ☐ **15** Portable EVSE is connected by one of the following:
  a) A nonlocking 2-pole, 3-wire grounding-type receptacle outlet rated at 125V, single phase, 15 or 20 amps
  b) A nonlocking, 2-pole, 3-wire grounding-type receptacle outlet rated at 250V, single phase, 15 or 20 amps
  c) A nonlocking, 2-pole, 3-wire or 3-pole, 4-wire grounding-type receptacle outlet rated at 250V, single phase, 30 or 50 amps
  d) A nonlocking, 2-pole, 3-wire grounding-type outlet rated at 60V DC maximum, 15 or 20A
- ☐ **16** Fastened-in place EVSE are connected by one of the following:
  a) A nonlocking 2 pole, 3-wire grounding-type receptacle outlet rated at 125V or 250V, single phase, up to 50 amps
  b) A nonlocking, 3-pole, 4-wire grounding-type receptacle outlet rated at 250V, three phase, up to 50 amps
  c) A nonlocking, 3-pole, 4-wire grounding-type receptacle outlet rated at 250V, single phase, 30 or 50 amps
  d) A nonlocking, 2-pole, 3-wire grounding-type receptacle outlet rated at 60 V DC maximum, 15 or 20A amps
- ☐ **17** Fixed EVSE are permanently wired and fixed in place to the supporting surface.

INSPECTION CHECKLIST

HELPFUL TIP

Numbers that correspond to the requirement in the permitting checklist are provided next to the same requirement in the field inspection checklist.

MINIMUM EVSE REQUIREMENTS

- ☐ **1** Specifications of EVSE match the approved plans:
  a) Maximum kW rating,
  b) Voltage,
  c) Ampacity,
  d) Manufacturer
  e) NEMA enclosure type.
- ☐ **2** EVSE installed according to manufacturer's installation instructions. (1)
- ☐ **3** EVSE is suitable to for the environment in which it is installed (indoor and outdoor). (2)
- ☐ **4** EVSE has a Nationally Recognized Testing Laboratory (NRTL) approved listing mark. (UL 2202/UL 2594). (3)
- ☐ **5** If EVSE with adjustable amperage setting is installed, equipment is fixed in place and adjusting means is accessible by qualified personnel with the use of a tool or password protected commissioning software.

LOCATION AND EVSE INSTALLATION REQUIREMENTS

- ☐ **6** EVSE installation location matches approved floor plan.
- ☐ **7** Permanently installed EVSE are located at a height of: (4)
  a) Indoor location: 1.5 feet or more above floor level
  b) Outdoor location: 2 feet or more above grade level.
- ☐ **8** Charging cord meets one of the following: (5)
  a) Does not exceed 25' in length.
  b) Is equipped with a cable management system that is part of the EVSE
- ☐ **9** Charging cord length reaches the vehicle's charging inlet without excessive slack.
- ☐ **10** The EVSE is protected from vehicular impact through one of the following: (6)
  a) Installation in a location not subject to vehicular impact such as a side wall or 4 feet or more above floor level;
  b) Wheel barriers;
  c) Bollards; or
  d) Other approved barrier.

ELECTRICAL REQUIREMENTS

- ☐ **11** For EVSE and 240V outlets installations, electrical service rating is greater than or equal to the electrical service load. (7 and 9)
- ☐ **12** Overcurrent protection are the type and size according to the approved plan. (10)
- ☐ **13** For EVSE rated greater than 60 amperes or 150 volts, a disconnecting means is able to be locked in the open position and is located an easily accessible location not protected by locked doors or other obstructions. (11)
- ☐ **14** Circuits serving EVSE do not serve any other end uses. (12)
- ☐ **15** Circuit conductors are the type and size according to the approved plan. (13)
- ☐ **16** All electrical materials, devices, fittings, and associated equipment are listed and labeled.
- ☐ **17** Underground conduit meet minimum depth requirements according to the approved plan. Insulated conductors and cables are suitable for use in wet locations and protected from physical damage. (14)
- ☐ **18** Portable and fastened-in-place EVSE are connected to the wiring system according to the approved plans. (15 and 16)
- ☐ **19** Fixed EVSE are permanently wired and fixed in place to the supporting surface. (17)
- ☐ **20** Receptacles have GFCI protection.
- ☐ **21** All receptacles installed in a wet location for EV charging have a weatherproof enclosure with the attachment plug cap inserted or removed. If an outlet box hood is installed, it is extra duty.

APPENDIX: EVSE PERMIT APPLICATION

FOR OFFICE USE ONLY

Application Number:
Permit Number:
Issued By:
Date Applied:
Date Issued:

SECTION 1 - GENERAL INFO

PROJECT ADDRESS

PROPERTY OWNER'S NAME | PHONE NUMBER | EMAIL

PROPERTY OWNER'S MAILING ADDRESS (IF DIFFERENT FROM PROJECT ADDRESS)

SECTION 2 - PROJECT DETAILS

BUILDING TYPE/EXISTING USE

☐ MULTI-FAMILY ☐ OFFICE ☐ NEW CONSTRUCTION ☐ OTHER: _____

EVSE LOCATION:

☐ GARAGE ☐ EXTERIOR WALL ☐ STREET CURB ☐ OTHER

MAXIMUM RATING OF LEVEL 2 EV SERVICE EQUIPMENT _____ kW

EVSE VOLTAGE _____

MANUFACTURER _____

NUMBER OF EVSE _____

LOAD OF EXISTING PANEL SUPPLYING EVSE _____ AMPS

TOTAL LOAD (EXISTING PLUS EVSE LOAD) _____ AMPS

SERVICE LOAD _____ AMPS

PROJECT DESCRIPTION:

SECTION 3 - CONTRACTOR INFORMATION

CONTRACTOR BUSINESS NAME | CONTRACTOR LICENSE NUMBER

BUSINESS ADDRESS

CONTRACTOR CONTACT NAME | PHONE NUMBER | EMAIL

SECTION 4 - PERMIT FEE

[Include fee schedule/options and/or instructions for calculating fee, directions on how and when to submit the permit fee.]

SECTION 5 - IMPORTANT NOTICE

A permit must be obtained for all installations or alterations of electrical equipment BEFORE WORK STARTS. Refer to EVSE Permitting Checklist for additional documents required. Failure to provide all required documents, including **(1) Site Plan, (2) Electrical Diagram, and (3) Specification Sheets** and Installation Manuals will delay permit approval. All permits expire six(6) months after date of issuance. Failure to start the work authorized by a permit within this six-month period renders the permit invalid and a new permit must be obtained. Once work begins, noticeable progress must continue until completion. All work must be complete within eighteen (18) months of a permit issue date.

Please Submit the following additional documents with the EVSE Permit Application

- **Site Plan**
- **Electrical Diagram**
- **EVSE Specification Sheets and Installation Manuals**
- **Transformer Specification Sheets**
- **Load Calculation**
- **Automatic Load Management System**
- **Specification sheet** if applicable

Submit Permit Application

[Describe the submission process, how should the permits be submitted? In-person, on-line, e-mail, fax, etc.]

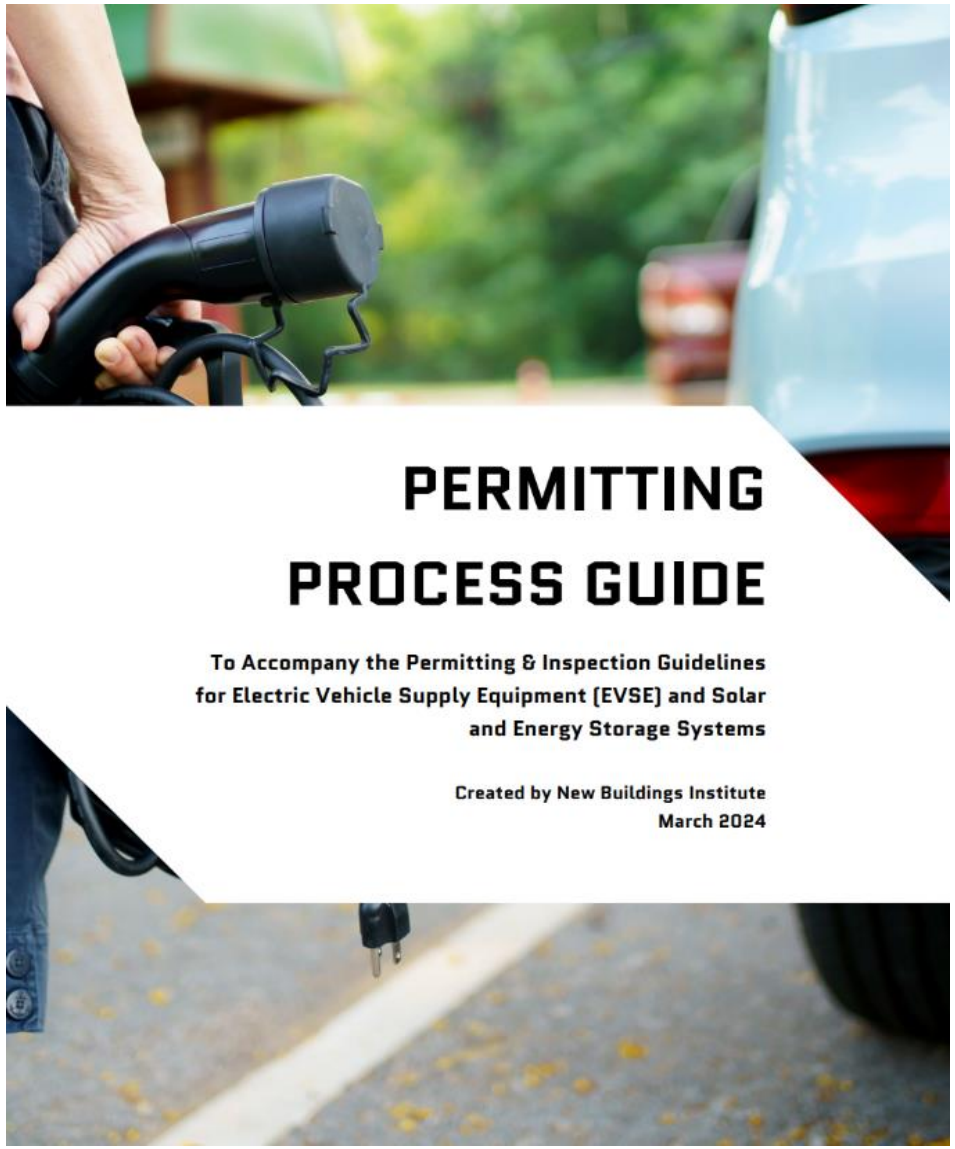
SECTION 6 - APPLICANT SIGNATURE

I, the undersigned, certify that I have proper authority to apply for this permit, that the Contractor has obtained a signed contract from the Property Owner for the specified work, that all contractors have consented to being listed, and that all the information contained on this application is true and accurate to the best of my knowledge.

NAME | TITLE

SIGNATURE | DATE

Permitting & Inspection Process Guide



- Who should use the guides
- How to use the guides
- Best practices & lessons learned

Lessons Learned

- **Communication** with utilities
- **Coordination** with Fire
- **Education** of permit & inspection staff

Communicate with Your Utility

Coordinate with Other Departments

- What other approvals or inspections may be required?
- Planning & Zoning
- Fire Department

Educate Responsible Parties

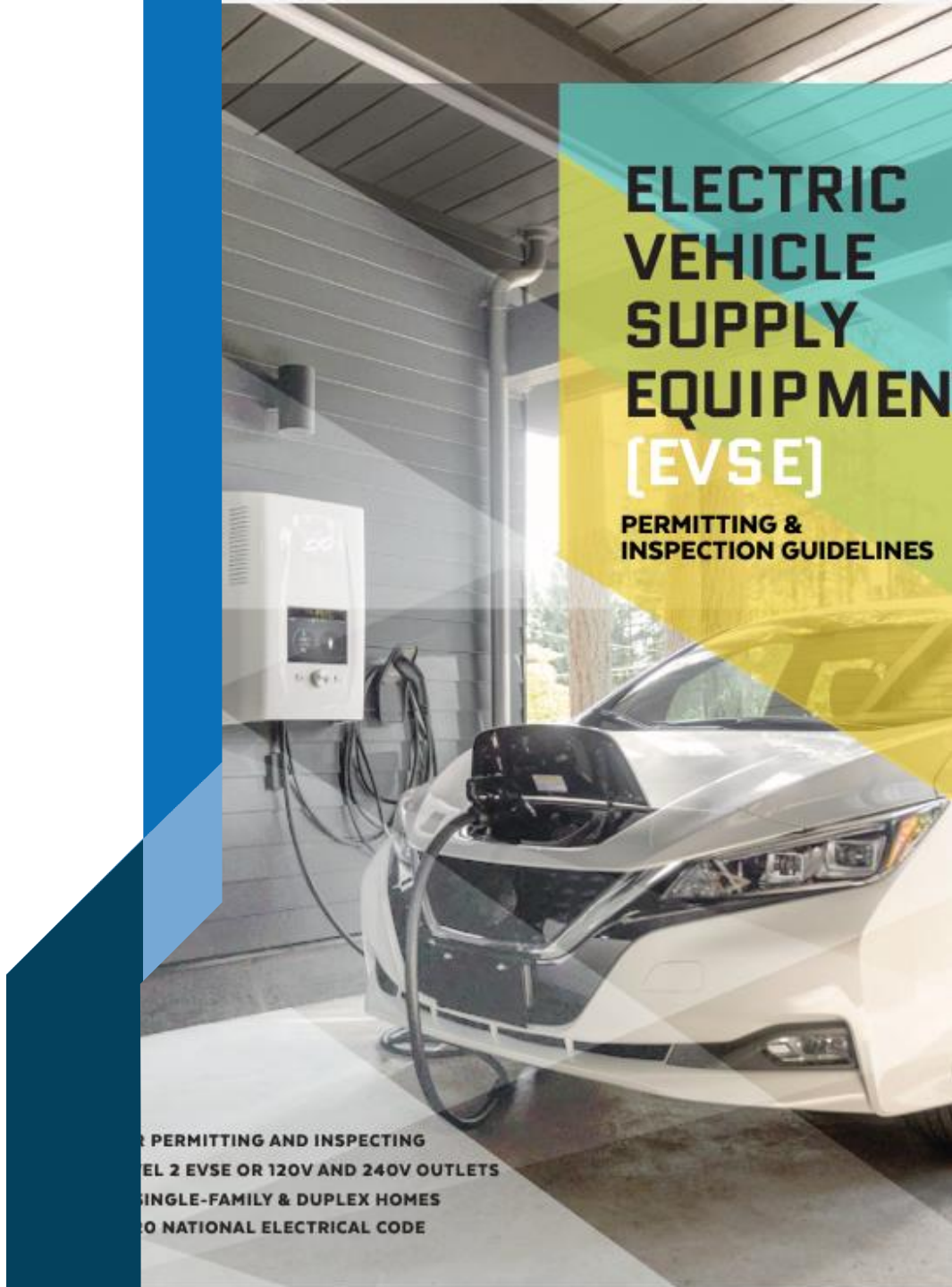
- Plan Reviewers
- Fire officials
- Installers

Educate Plan Review & Inspection Staff

- Notify all impacted scope reviewers
- Communicate to third-party plan review services
- Update technical review requirements
- Consider how to support your staff in taking the time to train

Where to Find the Guides

- NBI's website
- IREC Clearinghouse



• Audience 1: Homeowners and Building Owners

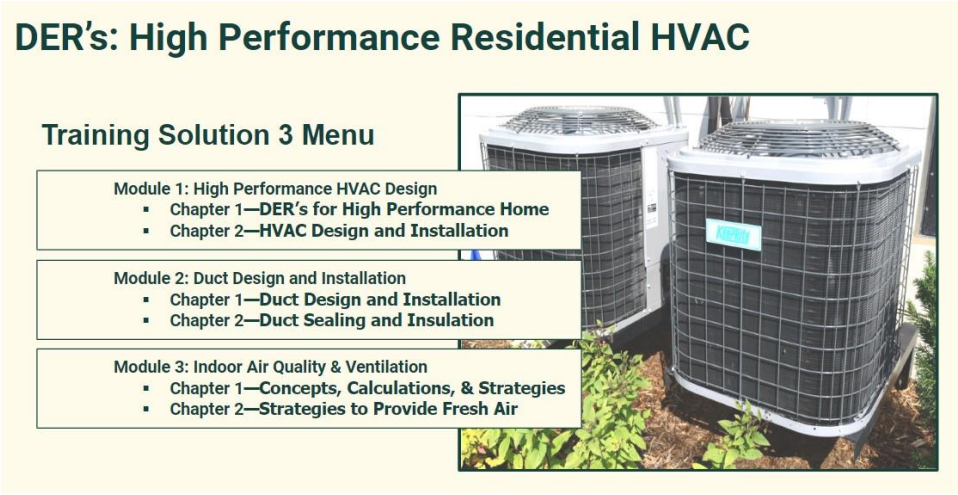
- Introductory Code Training
  - Training Solution 1: *Model Codes and Distributed Energy Resources*

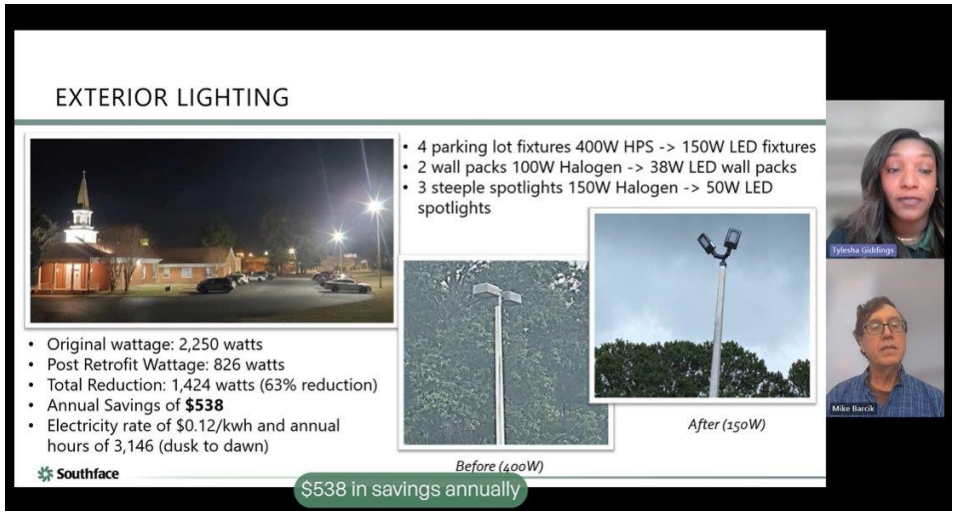
- Introductory Solar Trainings
  - *Training Solution 8:* Introduction to Solar Photovoltaics (PV) - A Training Course for PV Customers
  - Training Solution 2: *Utilities, DERs, and Interconnection*

Southface

• Audience 2: Code Officials

- Introductory Code Training
  - Training Solution 1: *Model Codes and Distributed Energy Resources*
- High Performance Buildings Trainings
  - Training Solution 3: *HVAC Mechanical Code Training*
  - Training Solution 5: *High Performance Lighting 101*
  - Training Solution 6: Building Envelope Code Training
- Solar Installation Code Training
  - *Training Solution 8: PV Installation 101*





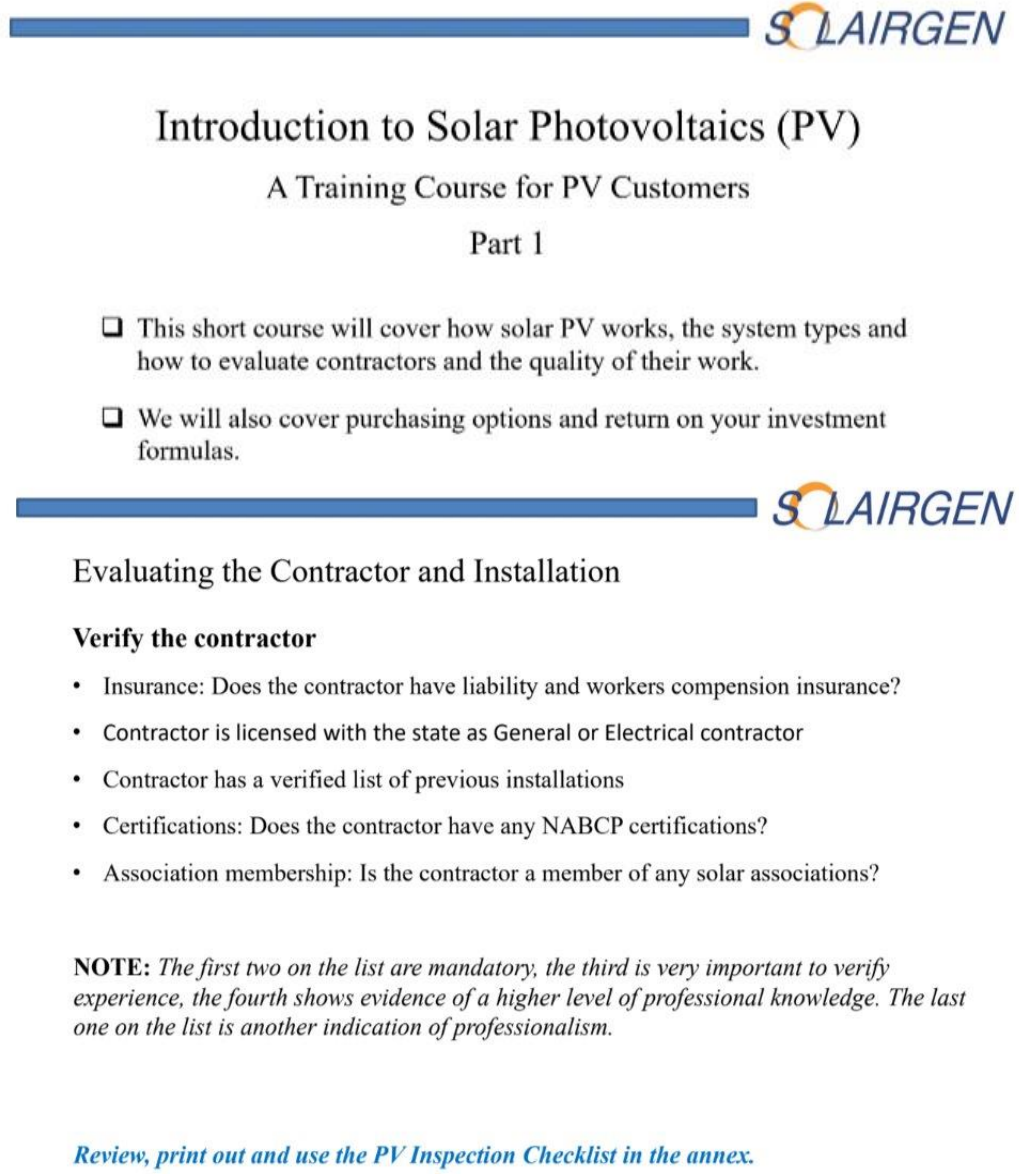
Southface

• Audience 3: Property Managers

- Introductory Code Training
  - Training Solution 1: *Model Codes and Distributed Energy Resources*

- High Performance Buildings Trainings
  - Training Solution 3: *HVAC Mechanical Code Training*
  - Training Solution 5: *High Performance Lighting 101*
  - Training Solution 6: Building Envelope Code Training

- Introductory Solar Training
  - Training Solution 7: *Solar PV: Training for PV Customers*



Southface

• Audience 4: Technicians

- Early Career Solar Trainings
  - *Training Solution 8: PV Installation 101*
  - *Training Solution 7: Solar PV: Training for PV Customers*

- *HVAC Contractor Trainings*
  - *Training Solution 3: HVAC Mechanical Code Training*

- *Electric Bus Drivers and Technicians Training*
  - *Training Solution 4: Electric Bus Ownership – Driver and Technician Training*

Southface

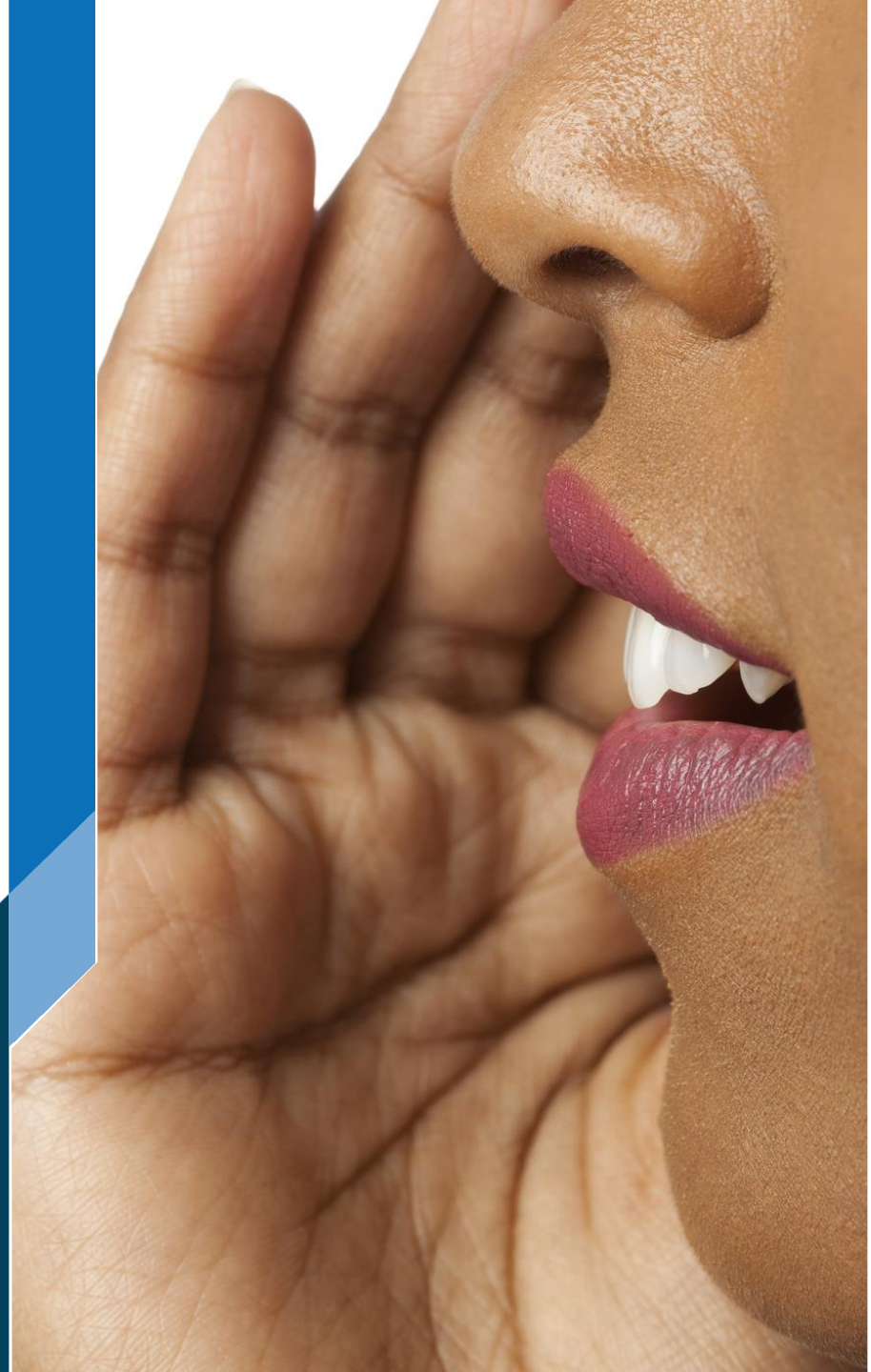
IREC builds the foundation for rapid adoption of clean energy and energy efficiency to benefit people, the economy, and our planet.

Resources

- CleanEnergyClearinghouse.org
- CleanEnergyTraining.org
- Southface.learnupon.com
- NFPA Alternative Fuel Vehicle Training
  - nfpa.org/for-professionals/training-for-me/alternative-fuel-vehicles-training
- NFPA energy storage system training: nfpa.org/ess
- Building America Solution Center: basc.pnnl.gov

Spread the Word

Who should know about these guides?

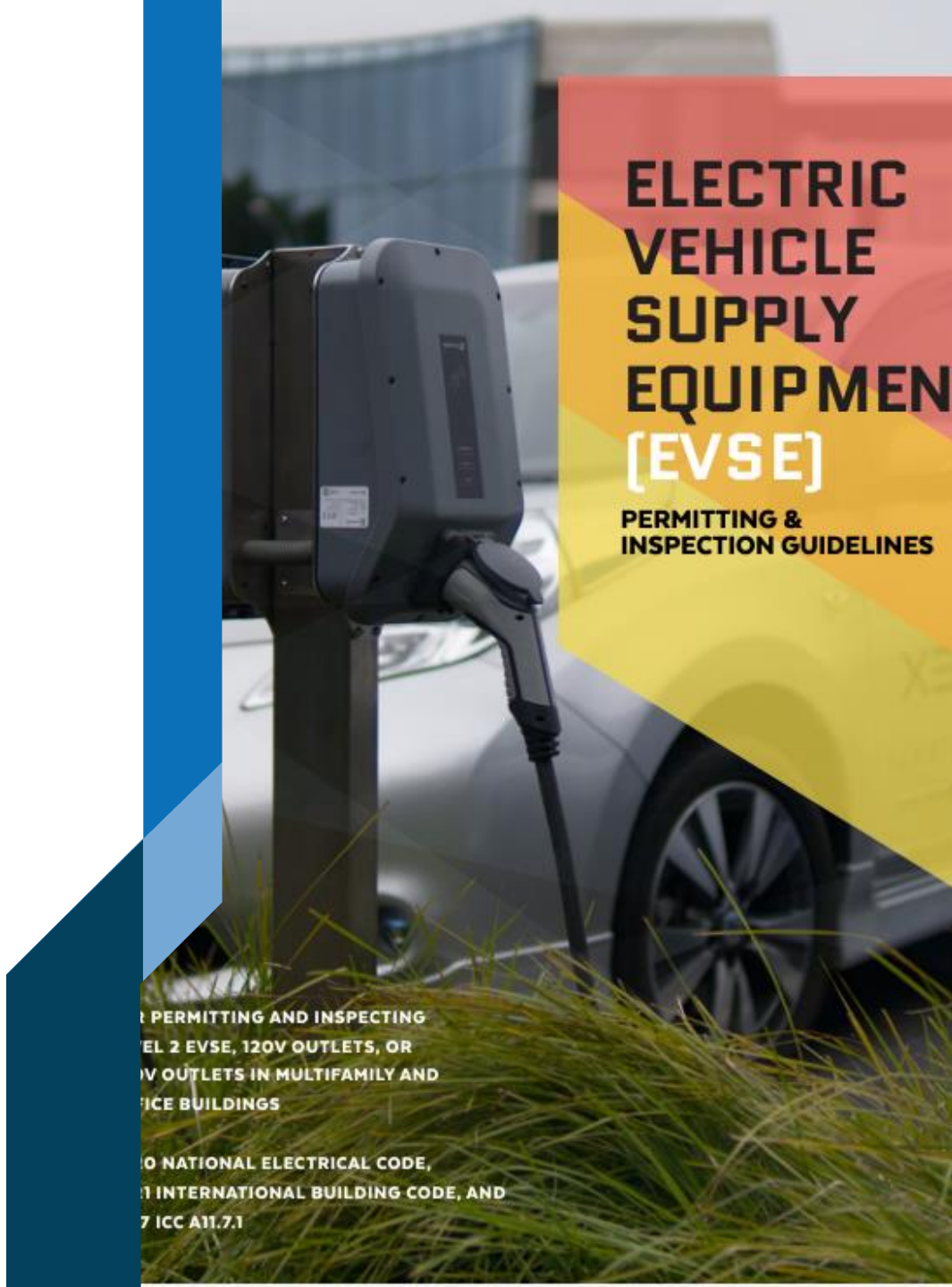


Thank you!

Amie Lewis
Associate Director of Codes and Policy
amie@newbuildings.org

nbi new buildings institute

newbuildings.org



BERKELEY LAB

LAWRENCE BERKELEY NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

Low-Power Electrification, the NEC and Building Energy Codes

Brennan Less

LBNL Residential Building Systems

2024-04-18

DOE Codes Webinar: The Intersection of Energy Codes and Electrical Codes on the Road to Decarbonization

Office of

ENERGY EFFICIENCY & RENEWABLE ENERGY

Energy (*use over time*) vs. Power (*instantaneous demand*)

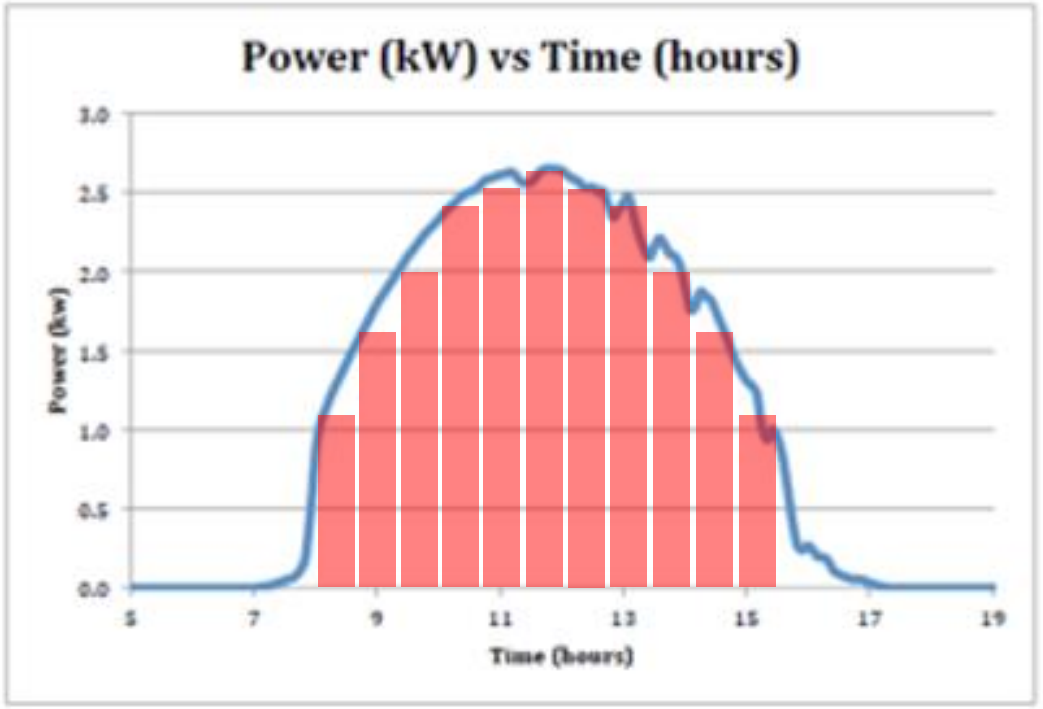


Figure 1. The power (in kW) produced by a solar panel installation at Bryn Mawr College [1] on January 27, 2013.

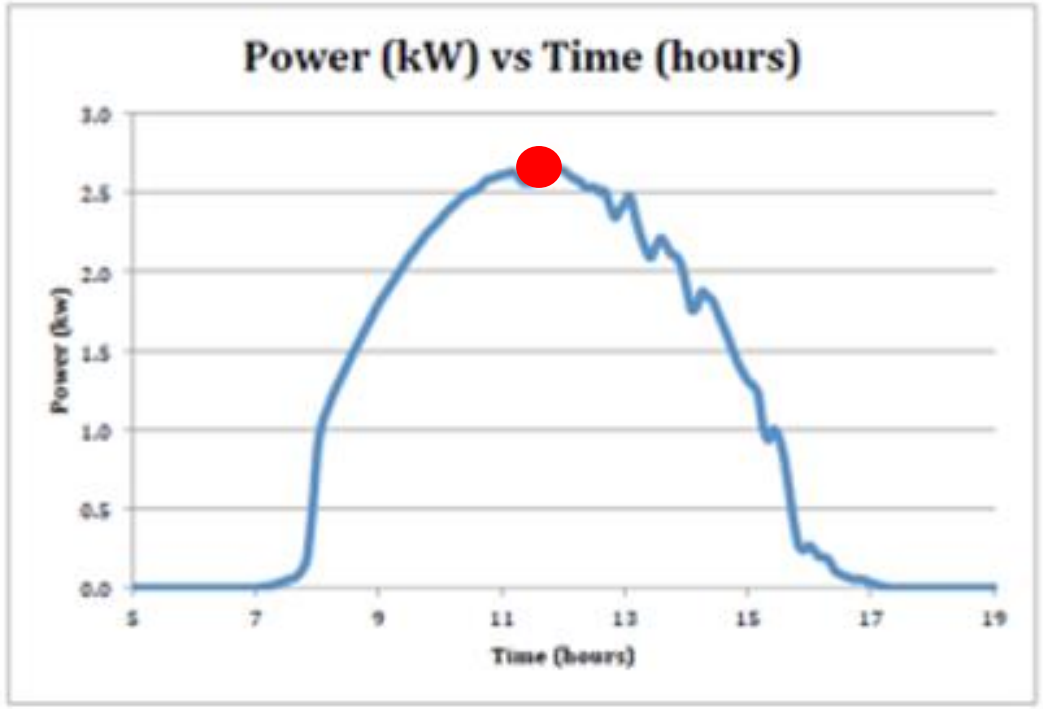


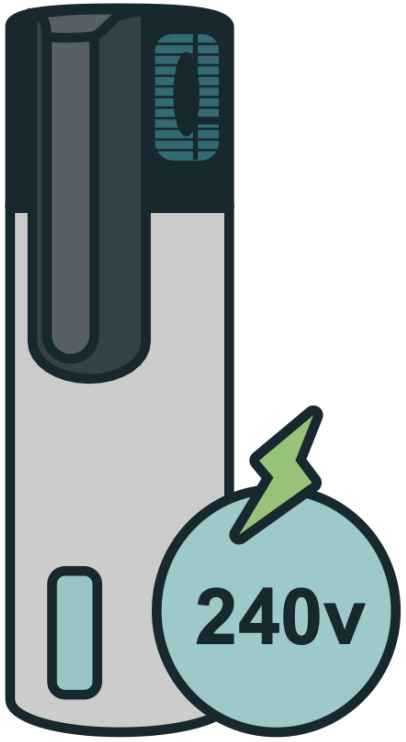
Figure 1. The power (in kW) produced by a solar panel installation at Bryn Mawr College [1] on January 27, 2013.

Building Energy Codes

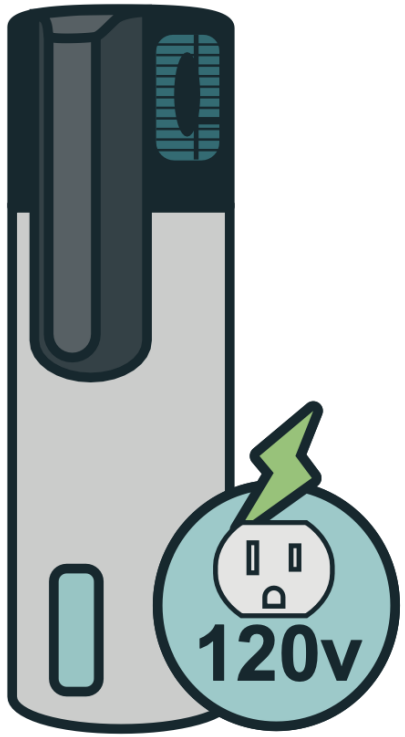
National Electrical Code

Energy Efficiency vs. Power Efficiency

Electric Resistance Water Heater
~3,500 kWh per year
4.5-5.5 kW
Energy and Power Inefficient



240V Heat Pump Water Heater
~1,000 kWh per year
4.5 kW
Energy Efficient, Power Inefficient



120V Heat Pump Water Heater
~1,000 kWh per year
1 kW
Energy and Power Efficient

Why Power Efficiency in Existing Dwellings?

- Massive electrification of US housing
- Majority existing dwellings
- ~1/3 with 100A service and limited breaker slots
- Upsizing panels and service wires is expensive and time consuming
  - >$100 billion for all 100A service panels
- Context: Flexible utility rates, PV, storage, demand response, controls.

Type	Machines (Millions)
Fossil space heating	69
Fossil water heating	63
Clothes Drying	19
Cooking	95
Vehicles	275
Breaker boxes	100
Vehicle chargers	275
Rooftop solar	55
Home battery storage	29
Total Fossil	**980**
Elect. Resist. space heating	29
Elect. Resist. water heating	54
Total Fossil + Elect. Resist.	**1,063**

Table 6: Adding up all the machines.

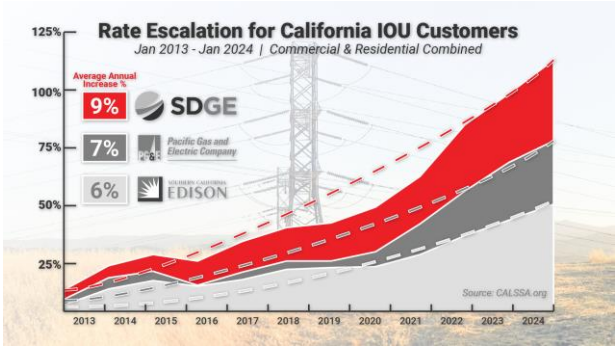
Source: *https://www.rewiringamerica.org/policy/one-billion-machines*

Why Power Efficiency in New Construction?

- Every new load added to the grid can contribute to need for:
  - Utility distribution infrastructure upgrades
  - New power generation facilities
  - Utility staff time for load studies and infrastructure upgrades

- Direct impacts:
  - Infrastructure upgrade costs passed onto homeowners or developers
  - Time-delays for utility interconnection
  - Interconnection denials

- Indirect impacts:
  - Limits ability of other households to electrify
  - Increases utility rates for all ratepayers

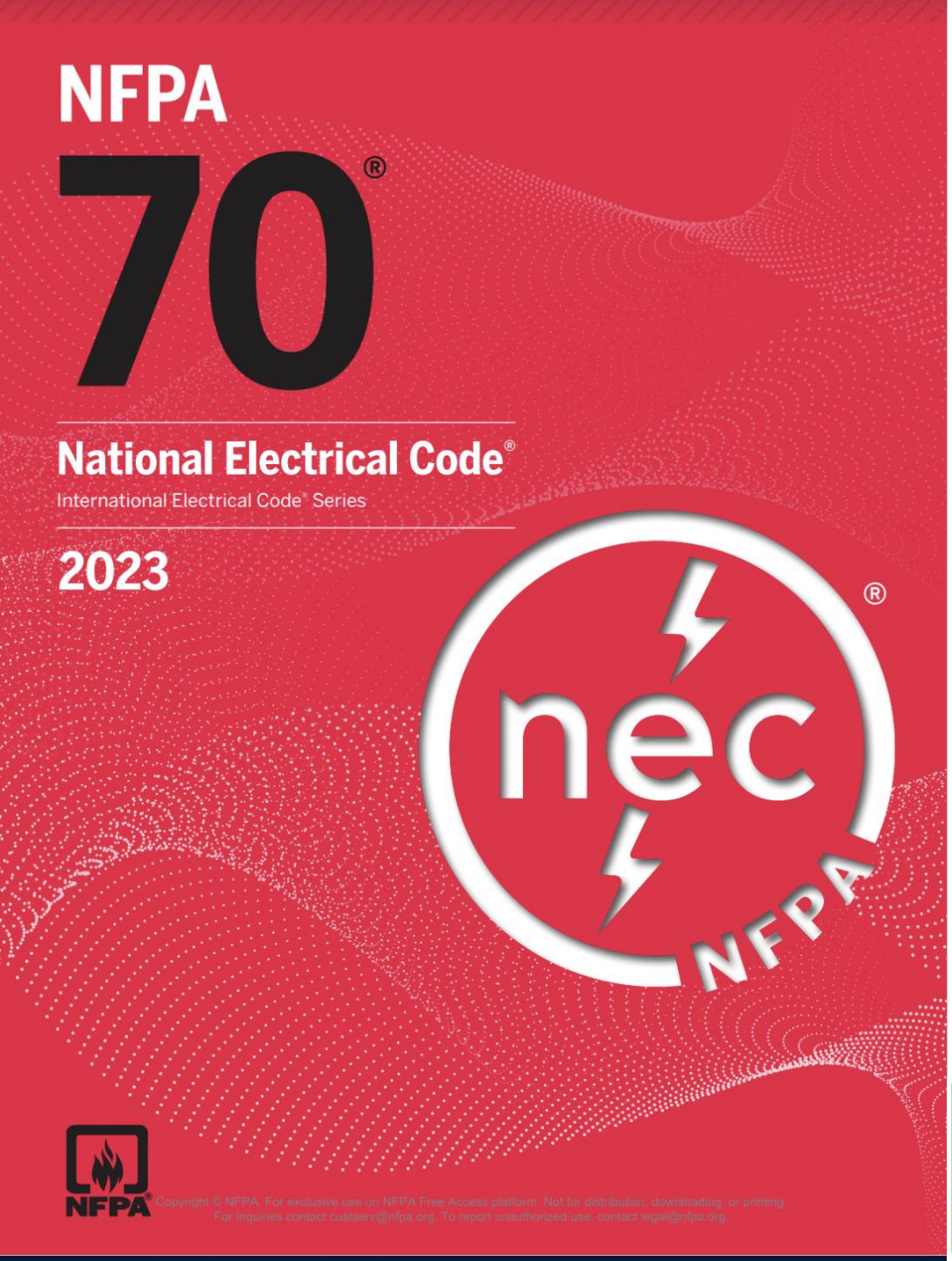


Strategies to Use Today for Low-Power Electrification

1. Pick high efficiency equipment (Heat Pump HSPF > 10)
2. Pick power efficient versions of heat, water heater, dryer, cooking
   - E.g., heat pumps without backup resistance, low amp heat pump water heaters with big tanks
3. Avoid oversizing (heat pump 2- to 3-tons for most homes, low-power level 2 EVSE)
4. Pick multifunction devices (e.g., combo washer/dryer, range)
5. Consider circuit sharing devices (e.g., alternate dryer & EV charger)
6. Consider circuit pausing devices (e.g., pauses EVSE charger or heat pump water heater)
7. Decrease your loads (e.g., improved envelope, use ductless equipment, efficient fixtures)

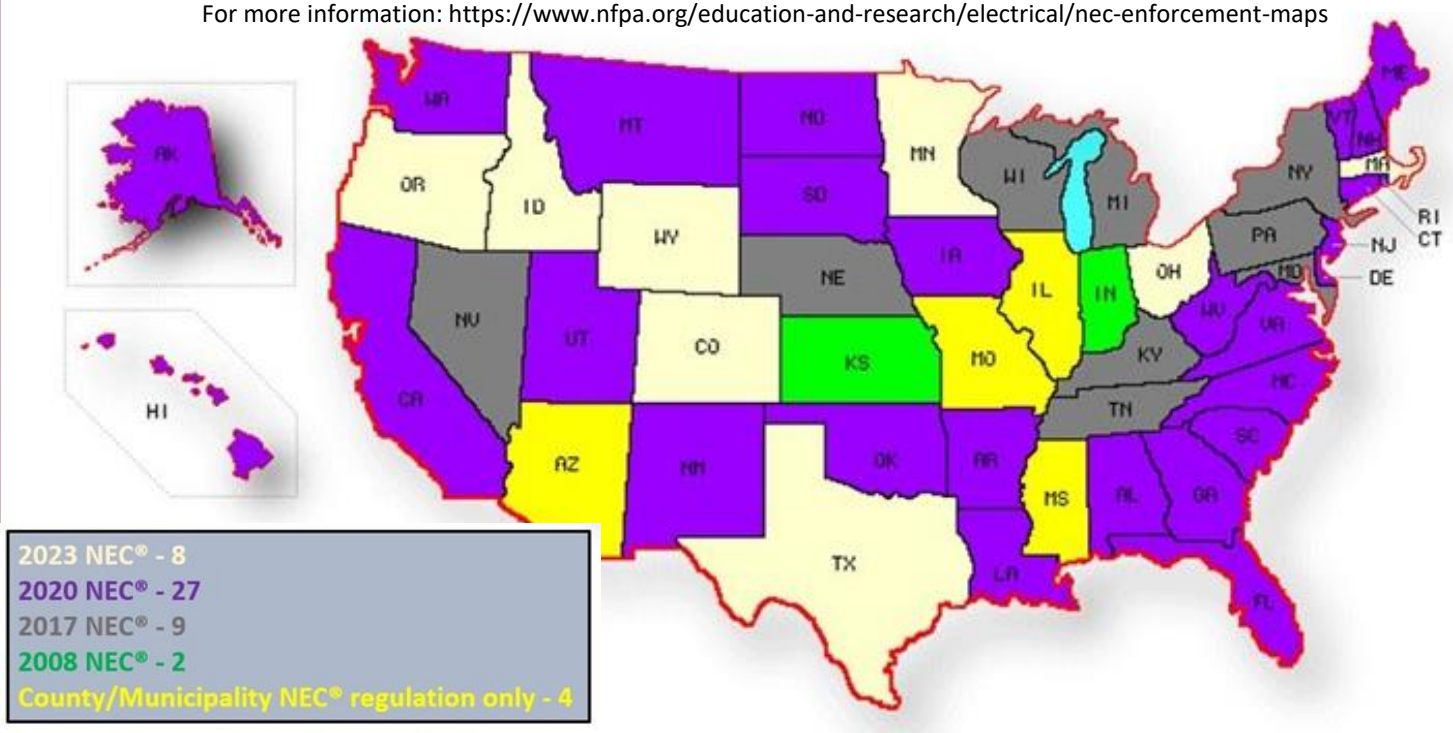
Building Energy Codes vs. Electrical Codes

- Building Energy Codes
  - What loads you must install, their efficiency, etc.
  - Electrification, pre-wiring and sizing mandates
- National Electrical Code
  - How you must safely install and size infrastructure for those loads
  - Circuit requirements, load calculations, conductor and overcurrent sizing, labeling, etc.
- National Electrical Safety Code
  - Addresses grid distribution infrastructure
  - Like the “NEC” for the grid



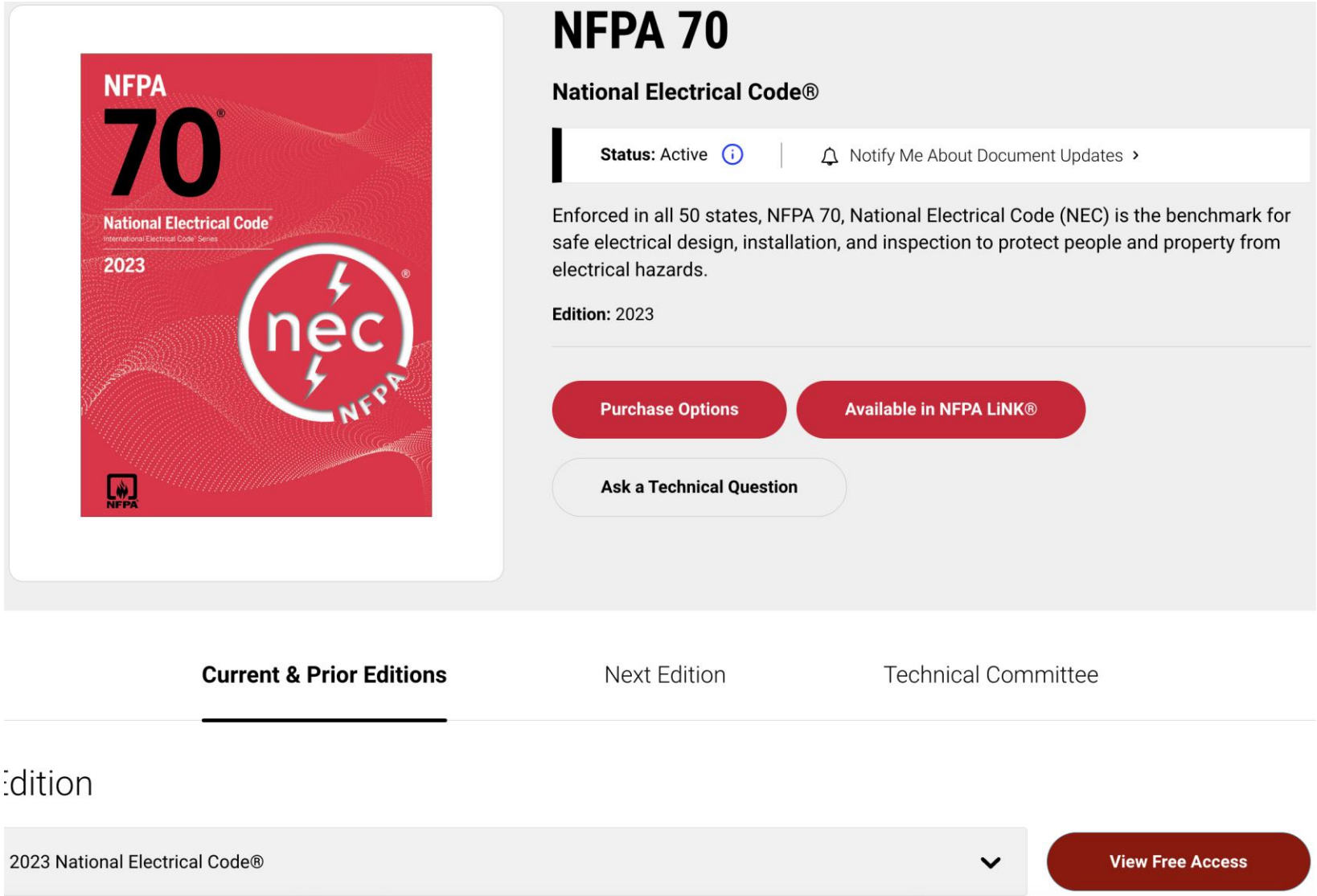
- **National Fire Protection Association (NFPA)** standard addressing electrical hazards and fire safety
- **NOT** a decarbonization or efficiency code
- Adopted and enforced by local jurisdictions, most often at the state-level, sometimes at county or municipal levels

For more information: https://www.nfpa.org/education-and-research/electrical/nec-enforcement-maps



Accessing the NEC for Free Online

- Visit: https://www.nfpa.org/en/codes-and-standards/nfpa-70-standard-development/70



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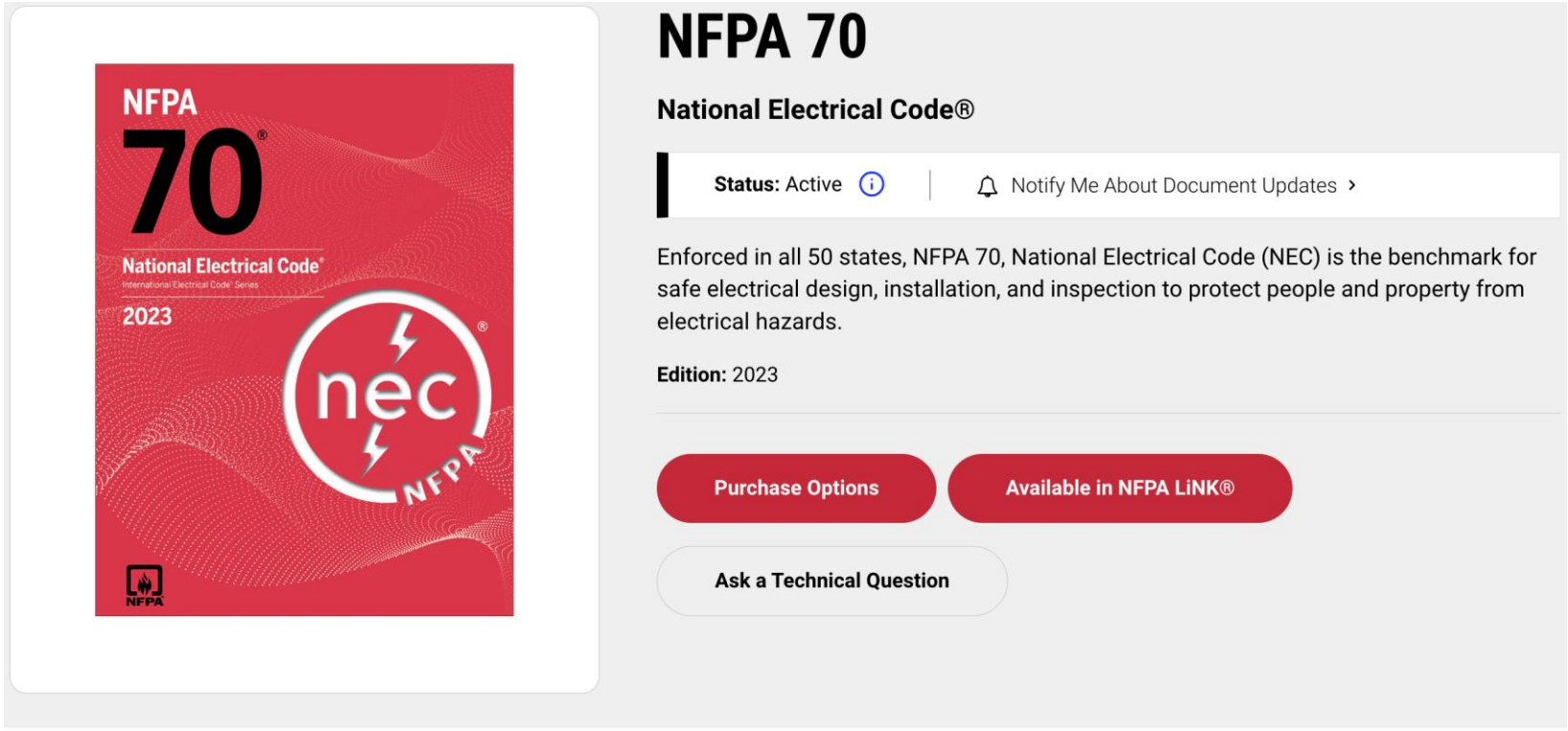


NEC Sections Relevant to Building Energy Codes

- Load Calculations (Section 220)
- Electric Vehicle Power Transfer System (625)
- Solar Photovoltaic (PV) Systems (690)
- Interconnected Electric Power Production Sources (705)
- Energy Storage Systems (706)
- Energy Management Systems (750)

NEC Sections Relevant to Building Energy Codes

- Load Calculations (Section 220) ← **Today's focus**
- Electric Vehicle Power Transfer System (625)
- Solar Photovoltaic (PV) Systems (690)
- Interconnected Electric Power Production Sources (705)
- Energy Storage Systems (706)
- Energy Management Systems (750)

Important Changes 2023 vs. 2020 NEC

- New Electric Vehicle Supply Equipment (EVSE) (220.57) provision for load calculations
  - Must use larger of 7.2 kW and nameplate rating.

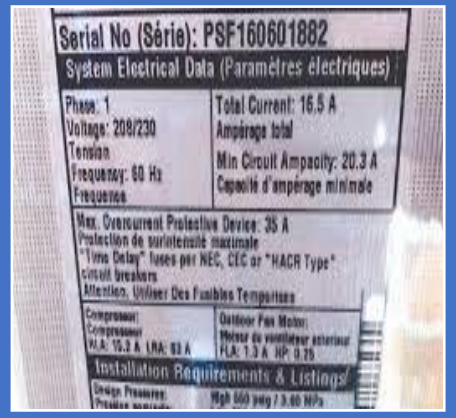
- New Energy Management System (EMS) (220.70) provision for load calculations
  - EMS current set point can be used in load calculations, limited to 80% of panel rating

- Revision of Metering Data method (220.87)
  - Homes with PV systems or demand response can use this method when at least one-year of data is available

- Revision of EVSE Rating (625.42) provision allowing ratings:
  a) Based on use of EMS
  b) Based on EVSE with adjustable settings.

- Revision of Energy Management System (EMS) (750) section:
  - Added listing requirement (750.60) (UL 916?)
  - Added details around current setpoints, labeling requirements, malfunction behavior, and protection from end-user tampering (750.30)

Load Calculations in Dwellings



220.83 Existing Dwelling Units

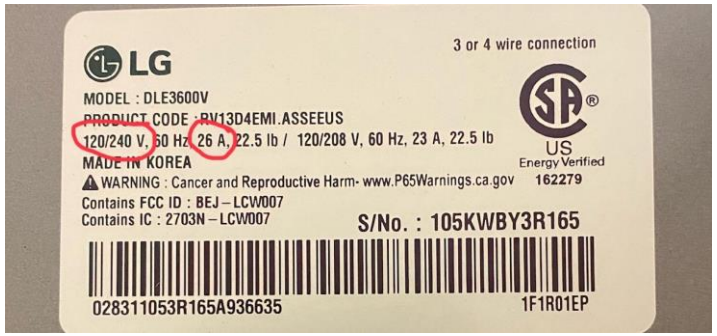
- Asset rating
- Estimates load based on nameplate ratings of installed appliances
  - *No New HVAC: 100% of first 8,000 w + 40% of remaining loads (including hvac)*
  - *New HVAC: 100% of first 8,000 w + 40% of remaining loads + max(heating, cooling)*
- Gives larger existing load but allows more new load
- Best option when adding lots of new loads and/or cannot use metering data
- Requires inspection of home and recording of nameplate values
- Similar sections for new dwellings (220.82) and multifamily dwellings (220.84)

220.87 Determining Existing Loads

- Operational rating
- Estimates load based on metering data plus 25% safety factor
- New loads add at 100% of their nameplate rating
- Gives smaller existing load but allows less new load
- Best option when adding one or two loads, or adding loads over time
- Automated and scalable using smart meter infrastructure

Load Calculation with 220.87

100 A 24 kW → 100 amps X 240 V = **24,000 W Rating**

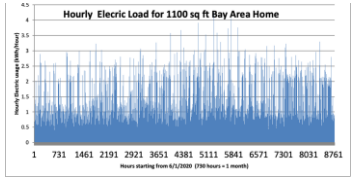


Remaining space available for full nameplates of new equipment:

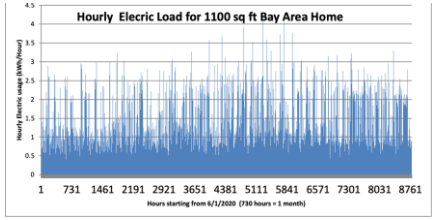
19,000 Nameplate Watts

24,000 W – 5,000 W → 19 kW

4,000 W peak usage measured →



4,000 W peak usage X 1.25 = **5,000 W occupied**



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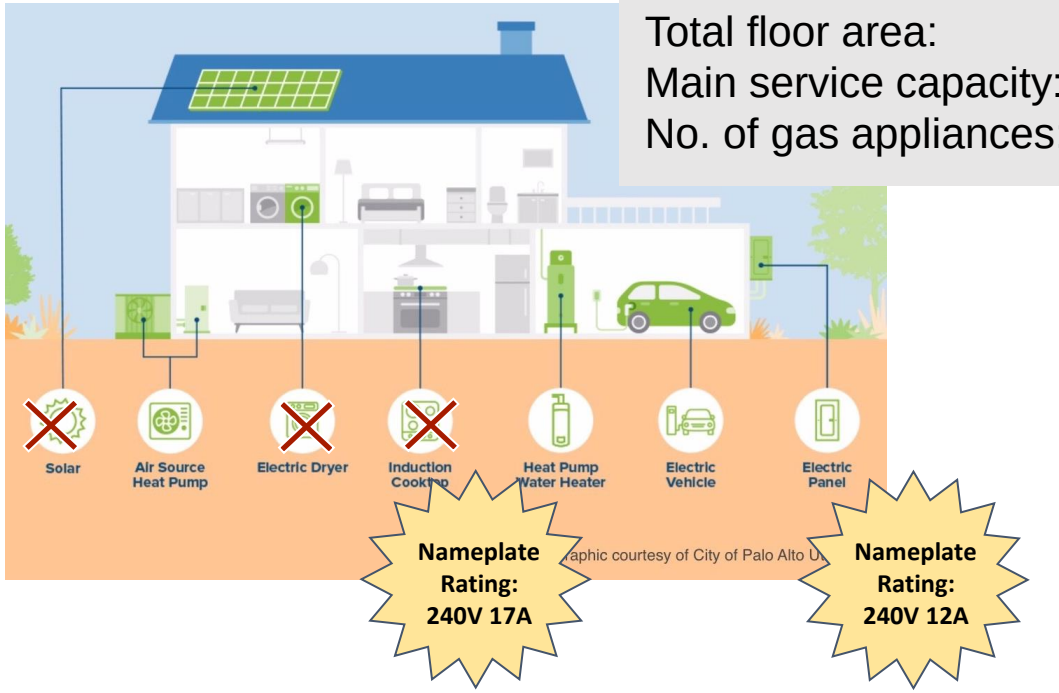
Credit: Tom Kabat

Load Calculation with 220.83

Adding Electric HVAC, Heat Pump Water Heaters

In this example, we use NEC code sections **220.83 (B)**

Home B
Total floor area: 2,000 sq ft
Main service capacity: 100 amps
No. of gas appliances: 2



Load Type	Amps	Volts	Watts
Kitchen Circuit	12.5	x 120	= 1500
Kitchen Circuit	12.5	x 120	= 1500
Laundry Circuit	12.5	x 120	= 1500
Refrigerator	10	x 120	= 1200
Dishwasher	10	x 120	= 1200
Garbage Disposal	5	x 120	= 600
Lights + Plugs	(3 watts / sq foot)		= 6000
First 8,000 watts @ 1.0 coincidence factor			= 8,000
Remaining 5,500 watts @ 0.4 coinc. Factor			= 2,200
HVAC 4,080 watts @ 1.0 coincidence factor			= 4,080
HPWH 2,880 watts @ 0.4 coincidence factor			= 1,152
		Total	**= 15,432**

Amperage = 15,432 with 240V = 65 amps

Credit: Tom Kabat

What New Loads Matter Most?

- **EVSE**: 3 - 12 kW
- **Resistance Heating**: 5 - 20 kW
- **Cooking**: 6 - 13 kW
- **HVAC Heat Pumps**: 3 - 10 kW
- **Clothes Drying**: 4 - 6 kW
- **Water heaters**: 4.5 kW

Working to Make the 2026 NEC Friendly to Home Decarbonization

Two DOE lab teams (**LBNL** and **NREL**) are investigating panel upgrades in the US housing stock, and working with an industry coalition formed under **Build-It Green**'s POWER group (led by Jenny Low and Hannah Bruegmann)

What Did We Do and What Are Our Goals?

- What did we do?
  - Reviewed Section 220 for barriers/challenges to existing dwelling electrification
  - Analyzed metering data to understand dwelling power demand
  - Submitted 17 PIs to NFPA addressing load calculations in Section 220
  - Participated in Task Group 4, attended CMP meetings in Jan 2024

- Our Goals
  - Clear and safe load calculations that support home electrification
  - Assumptions based on actual performance in dwellings based on metered data
  - Accurate, scalable electrical load calculations using nation’s smart meters
  - Apply results to other sections throughout 220, as appropriate

What Data Did We Use?

- **Whole dwelling 15- and 60-minute maximum demand data**
  - 11,750 existing US dwellings
  - 2.7 years per dwelling
  - 32,000 dwelling-years of data

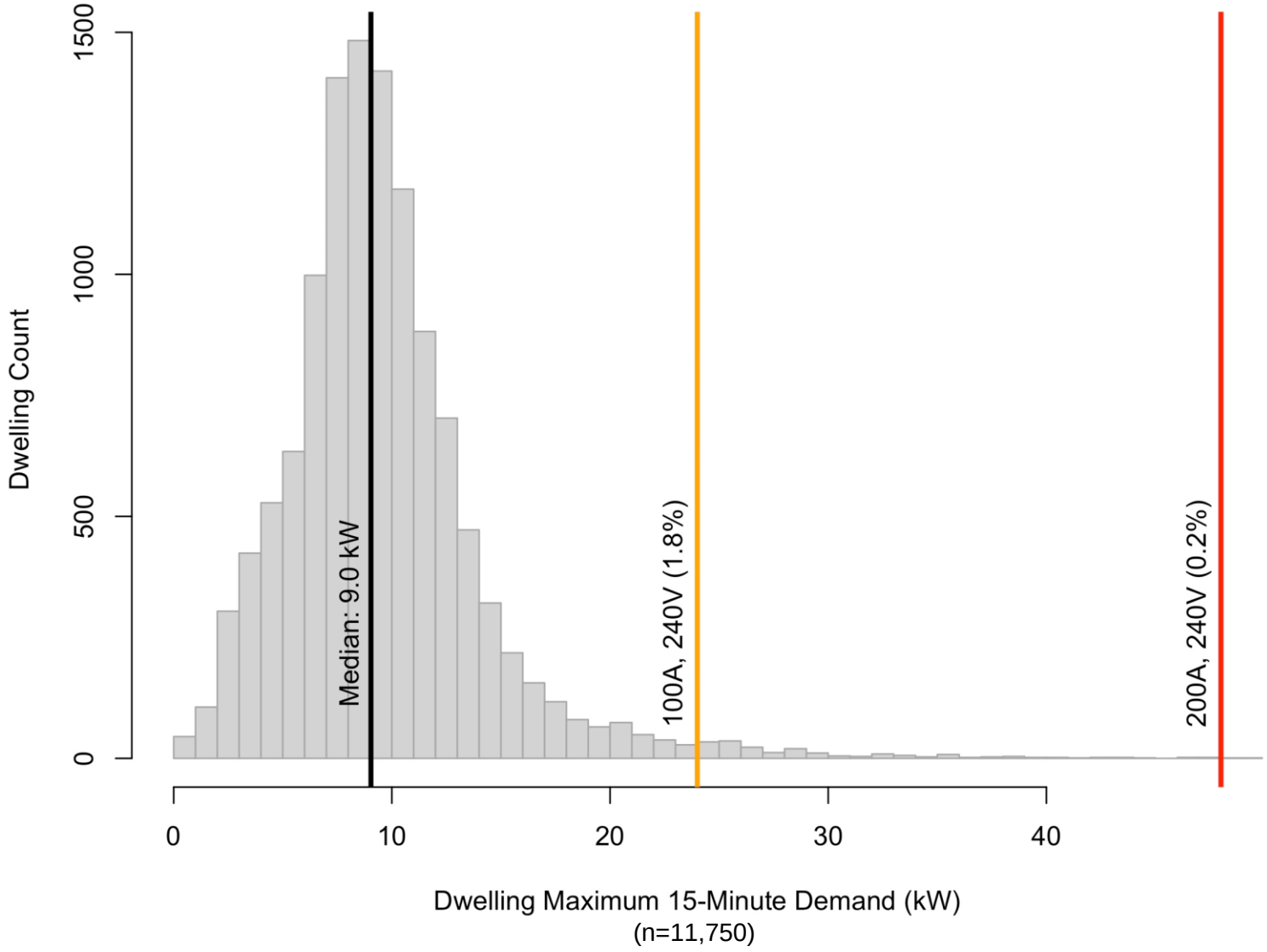
- **End-use sub-metering 15-minute data**
  - 957 existing US dwellings
  - 9,490 branch circuits
  - 3.5 years per dwelling
  - 3,376 dwelling-years of data

- **Lighting audit data**
  - 2,053 existing US dwellings

- States include: **TX**, CA, NY, CO, OR, WA, ID, MT, **VT**
- Housing types: **Single-family**, multi-family and manufactured

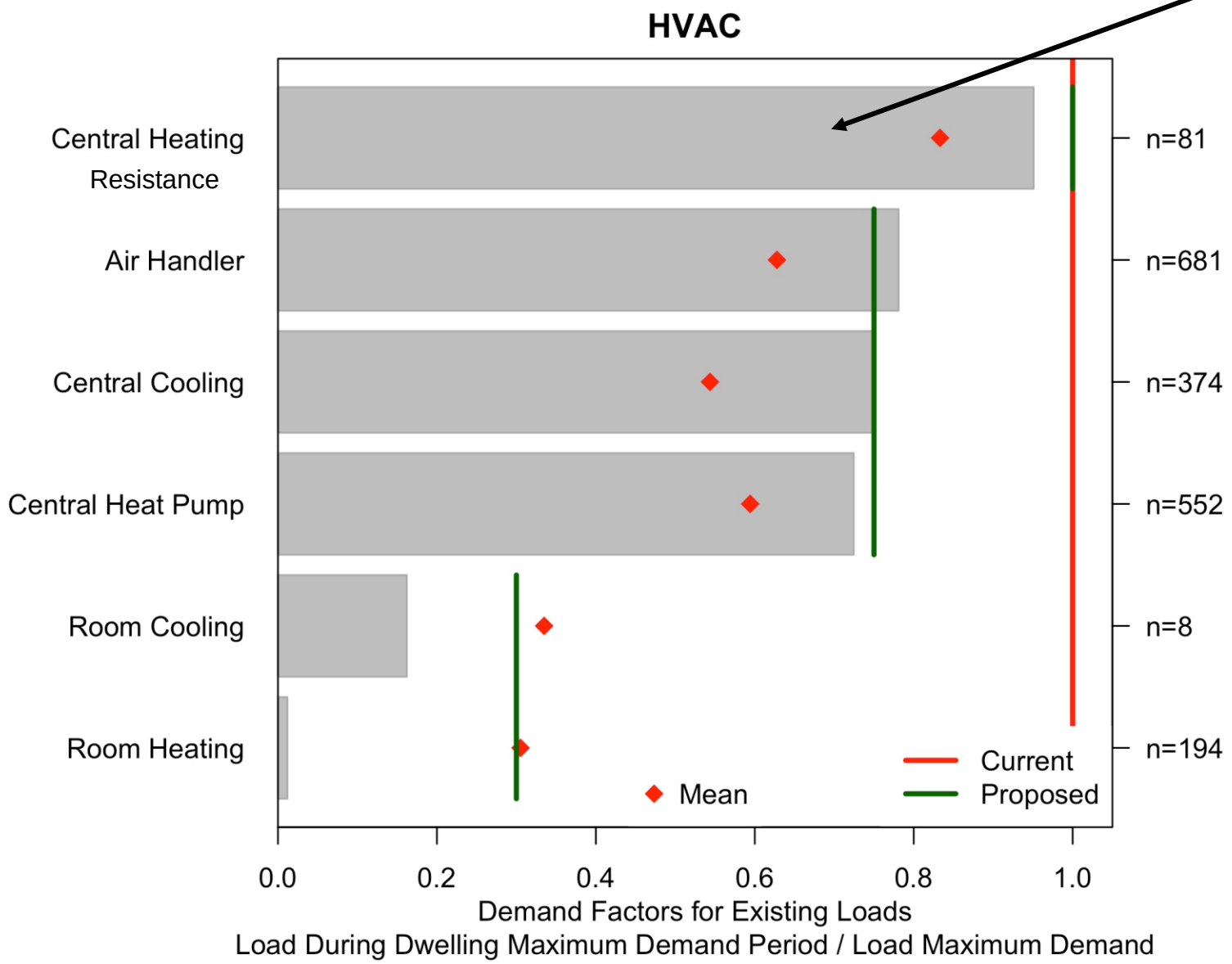
High-Level Learnings for Services and Feeders

- Most dwellings have LOTS of capacity for new loads
- New loads add at <100%
- Lots of load diversity (40-50%), increases with more connected loads
- Never do more than four loads operate at or near 100% together
- Appliance maximum power draw < nameplate ratings

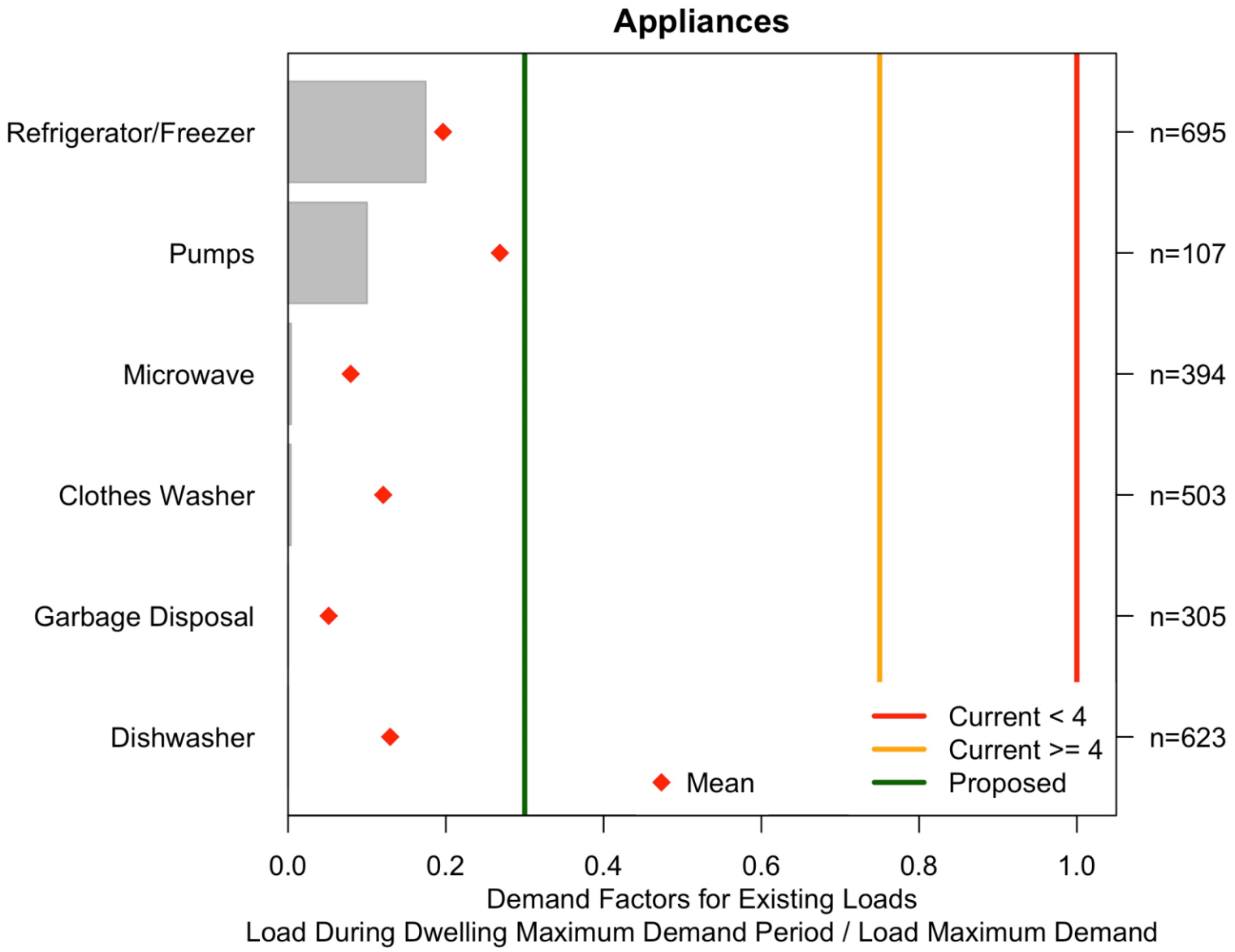


HVAC Loads –220.51, 220.82

Grey bars = median

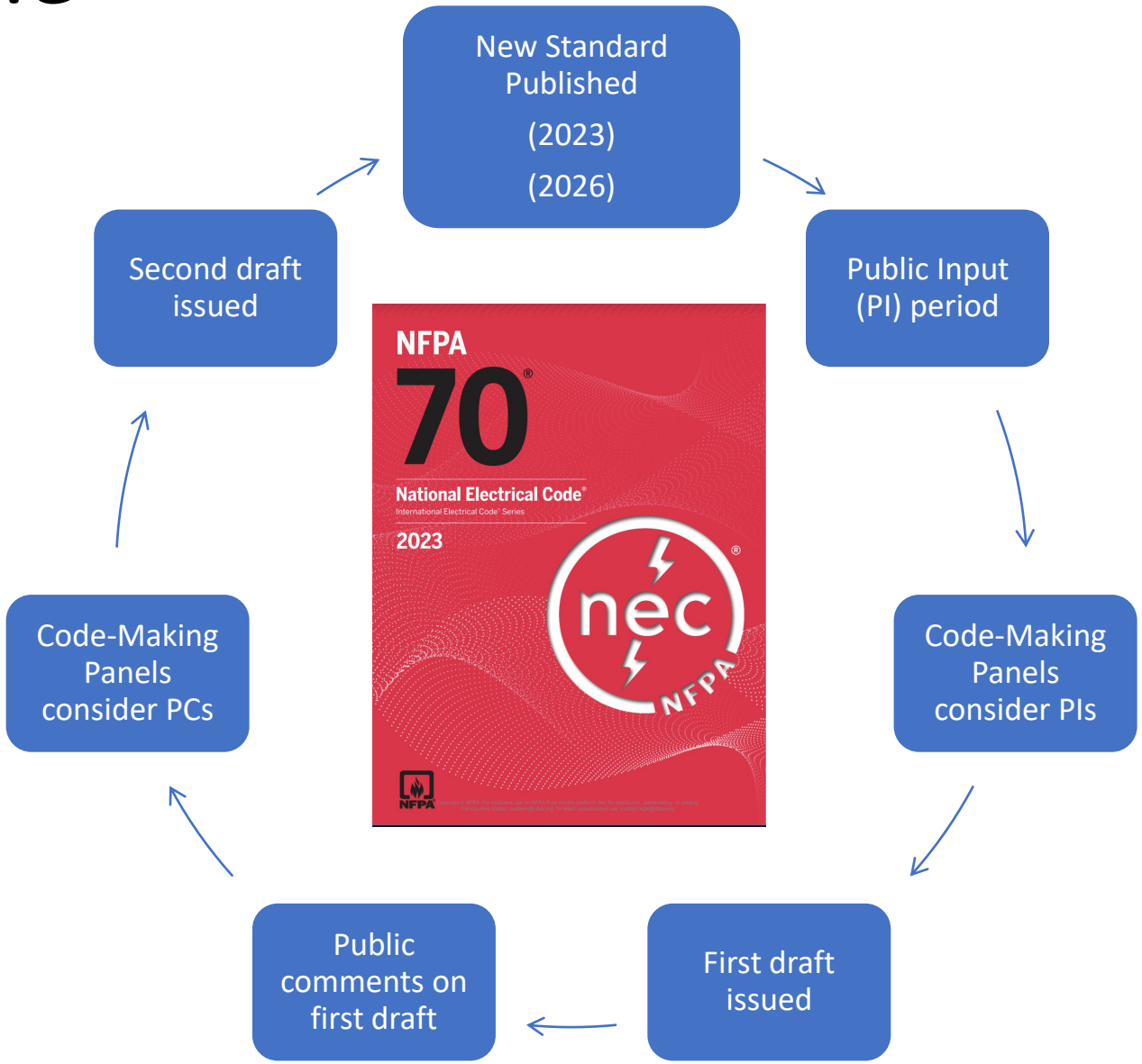


Appliance Loads – 220.53



NEC Revision Cycle

- Revised on a 3-year cycle
- Current edition: 2023
- Next edition: 2026
- Adopted on different timelines across the US



Changes We Proposed for the 2026 NEC

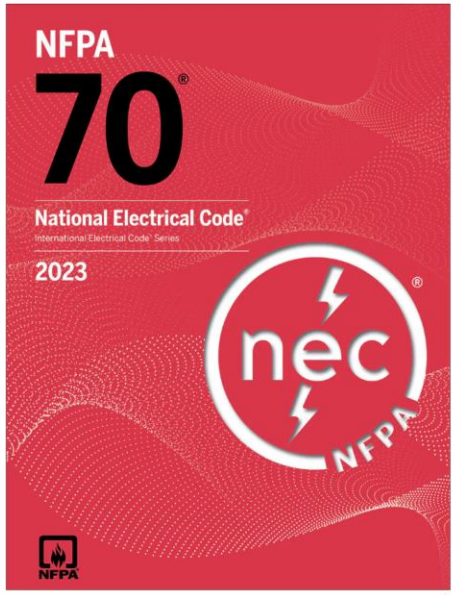
- Changes likely in the pipeline. NOT yet finalized or approved.
  - Reduction in general lights and general receptacles loads, from 3 w/ft^2 to 2 w/ft^2
  - Reduction in baseline kVA for loads in new dwelling units, from 10 kVA to 8 kVA (220.82)
  - Remove differential treatment of new HVAC vs. other new loads in existing dwellings (220.83)
  - Explicit treatment of EVSE in new, existing and multifamily dwelling load calculations (220.82 - 220.84)
  - “Power Control Systems” provide overload protection. New concept to supplement EMS provisions.
  - Expanding ability to take credit for load controls in NEC load calculations
- Changes we are still fighting for. We NEED your help.
  - Re-write of metering data method (220.87) to allow deduction of loads being removed, use of demand factors, and clarification around metering, data interval, time frequency and dwellings with PV.
  - Reduced demand factors for heat pump technologies throughout section 220
  - Allowance to use nameplate ratings for low-power appliances (e.g., clothes dryers, EVSE)

How To Get Involved

Event	***Date***	***Complete***
Public Inputs (PIs) to 2023 NEC	Summer 23’	X
Task groups review/process PIs	Fall 23’	X
Code-making panel meetings, draft 1	January 24’	X
Final, online 1st draft voting. ⅔ majority required for First Revision	Spring 24’	
First draft 2026 NEC issued publicly	**July 10th, 24’**	
END of Public Comment (PCs) period for First Draft	**Aug 28th, 24’**	
Task groups review/process PCs	Sept 24’	
Code-making panel meetings, draft 2	Oct 24’	
Final, online 2nd draft voting. ⅔ majority required for Revision	Winter 25’	
Second draft 2026 NEC issued publicly	March 21, 25’	

Submitting Public Comments on Draft 1

Visit: https://www.nfpa.org/en/codes-and-standards/nfpa-70-standard-development/70



NFPA 70

National Electrical Code®

Status: Active | Notify Me About Document Updates ›

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Next Edition: 2026 | **Revision Cycle:** Annual 2025 NEC

View Public Input Online

Submitting Public Comments on Draft 1

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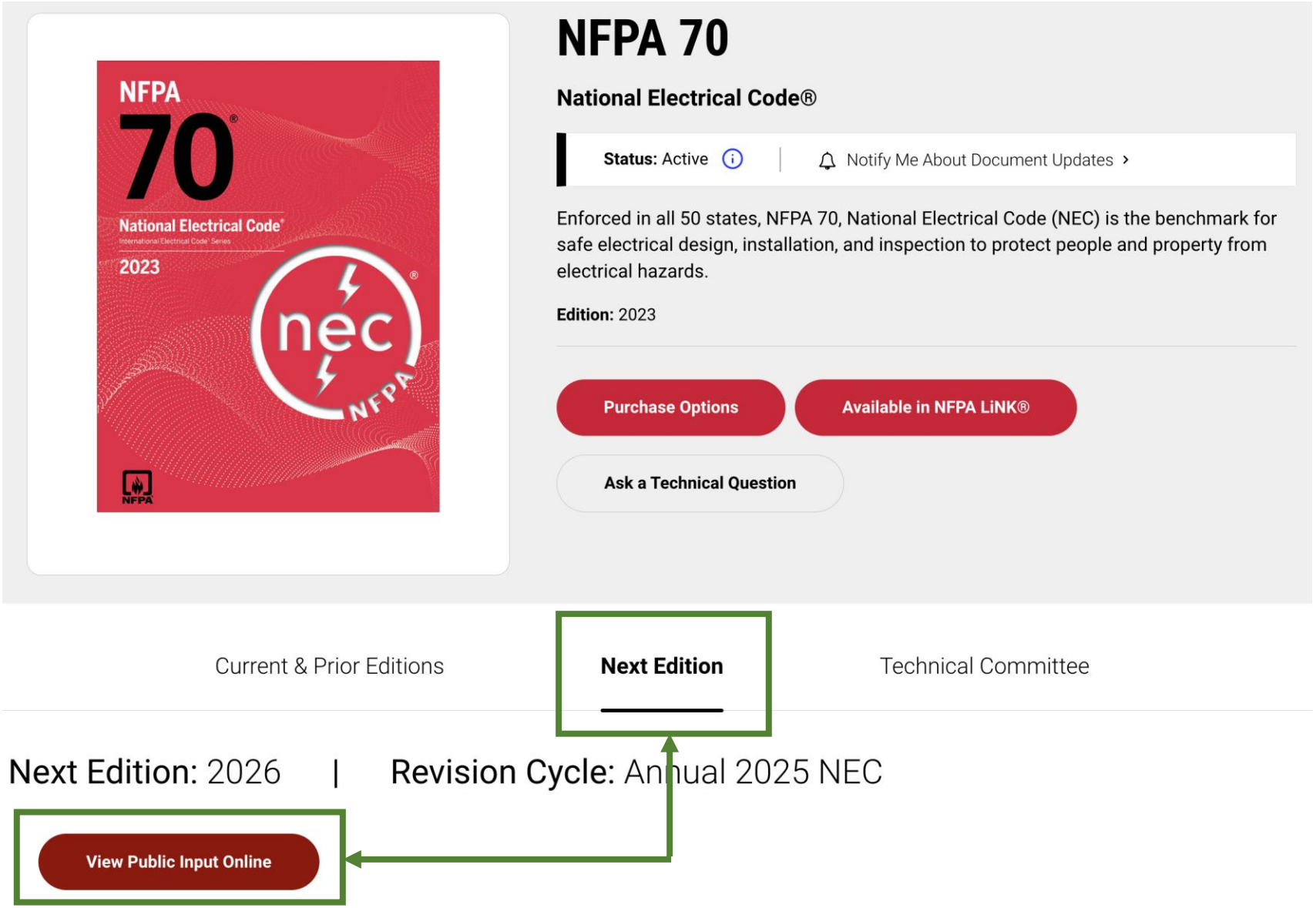


What’s Not In the NEC Yet

- Battery-integrated appliances
- Digital load control (e.g., CTA 2045, smart appliances)
- DC microgrids
- Back feeding power from end-use appliances with batteries
- Required EVSE circuit(s)
- Vehicle-to-Everything

Ways the Energy Code Might Encourage Power-Efficient Electrification

- Large wires, small loads
- Support installation of low-power appliances
- Credit use of load controls
- Envelope solutions that limit HVAC loads and eliminate provision of backup strip heat
- Ban instant electric water heaters
- Require EVSE configured with load control capability
- Consider trade-offs of wiring for 240v electric vs. 120v electric loads
- Encourage use of smart panels and/or smart breakers for future energy management
- Encourage use of equipment with remote control capability for demand response

Other Resources for Power-Efficiency

Redwood Energy Pocket Guides and Watt Diet Calculator

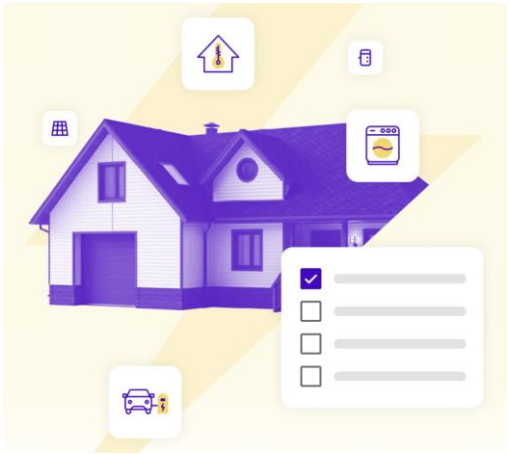
https://www.redwoodenergy.net/research

https://www.redwoodenergy.net/watt-diet-calculator

Rewiring America planning tools

https://homes.rewiringamerica.org/projects/electrical-panel-homeowner

https://homes.rewiringamerica.org/personal-electrification-planner



CalNext Study of Load Control Solutions

https://www.veic.org/Media/Default/Reports/ET22SWE0057%20Market%20Study%20of%20Electric%20Infrastructure%20Upgrade%20Alternatives%20for%20Electrification.pdf

Thanks!

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Thanks!

Building Energy Code Webinar Series

For more information on today's topic, as well as a range of additional training materials and technical assistance resources, visit:

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