Better Buildings Residential Network Peer Exchange Call Series

Decarbonization and Residential Buildings

May 27, 2021

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers
  - **Alejandra Mejia Cunningham**, National Resources Defense Council
  - **Eric Wilson**, National Renewable Energy Laboratory
  - **Smita Gupta**, New Buildings Institute
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

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

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

Better Buildings Residential Network

Join the Network

Member Benefits:

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

Commitment:

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

Upcoming Calls (2nd & 4th Thursdays):

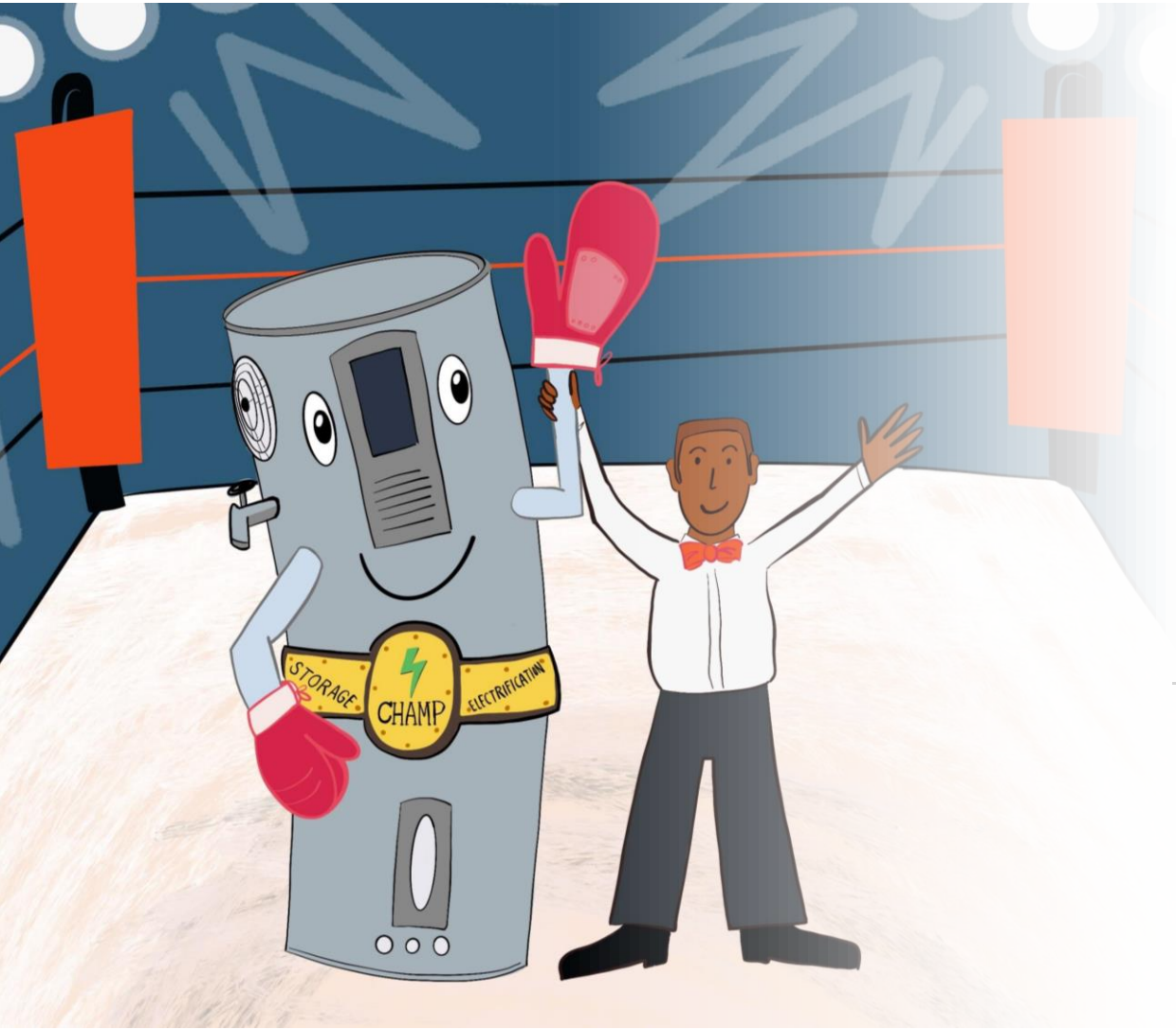
- Jun 10: *Environmental Justice and Residential Energy Efficiency*
- Jun 24: *Residential Energy Efficiency and Jobs: The State of the COVID Recovery*
- Jul 8: *In Hot Water? Residential Efficiency, Affordability & Technology*

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

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join

Alejandra Mejia Cunningham
Natural Resources Defense Council

U.S. DEPARTMENT OF ENERGY



Building Programs that Work

Alejandra Mejia

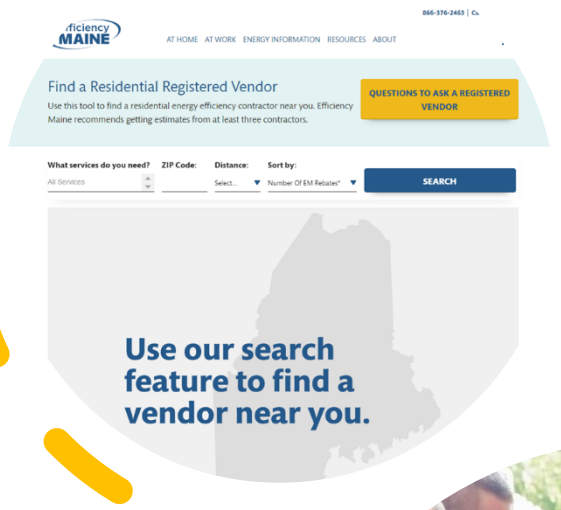
May 27, 2021

Program Design Best Practices

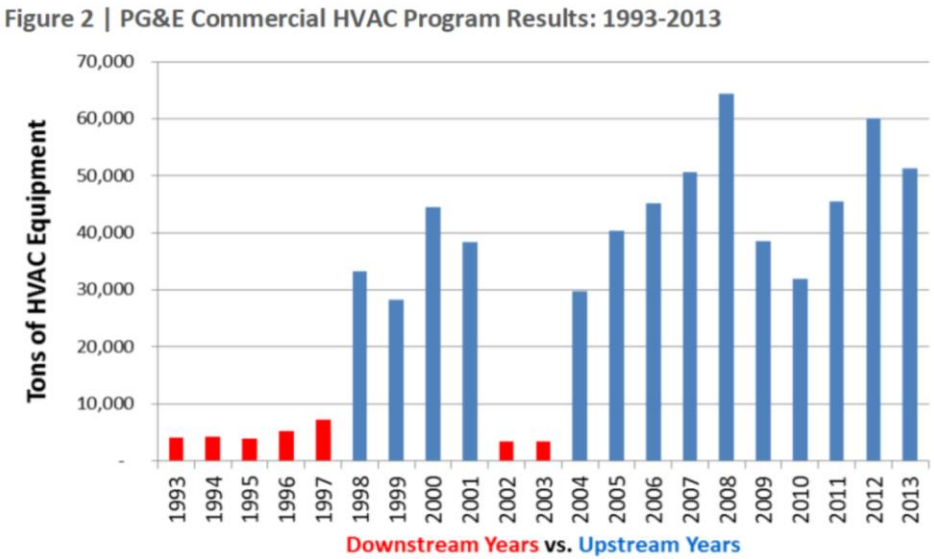
- Meet customers where they are – support and satisfaction
- Deliver streamlined offerings with limited process requirements
- Create an irresistible value proposition for the key actors

Meet customers where they are – Leave them very satisfied

- Impose no requirements outside of normal replacement practices
- Make it easy and risk free to find trusted vendors
- Provide the technical assistance that is needed
- Design realistic incentives
- Build in flexibility



Midstream and Upstream are VIPs



Offer an irresistible value proposition

- Commit to understanding the market, actors, and pain points
  - Delivery mechanisms, timelines
  - Incentive levels
- Fund training components, including on-the-job opportunities
- Support customer acquisition
  - Marketing collateral
  - Qualified vendor portal

Want more?

How to Design Building Electrification Programs that Work

https://on.nrdc.org/3oMM0KQ

Eric Wilson
National Renewable Energy Laboratory

U.S. DEPARTMENT OF
ENERGY

NREL
Transforming ENERGY

Decarbonization of the Residential Building Stock

Eric Wilson, NREL

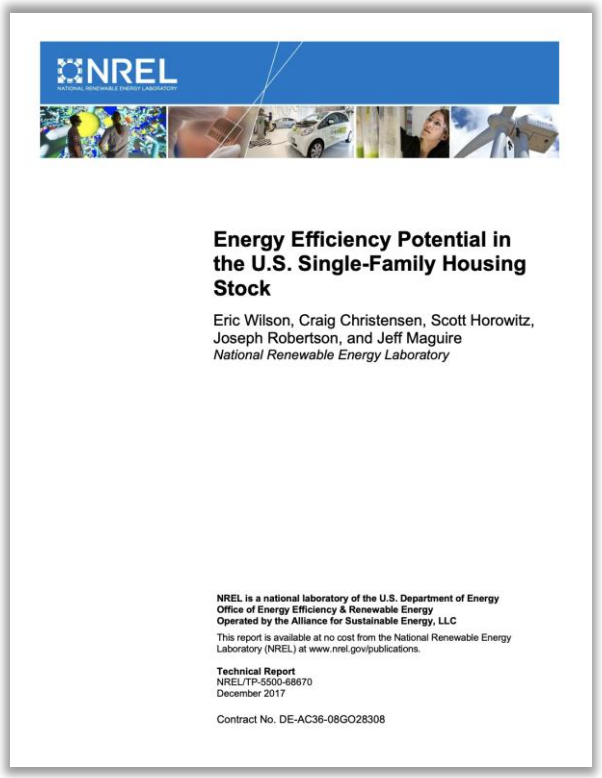
May 27, 2021

Overview

- Building electrification analysis with ResStock
- Using Long-Run Marginal Carbon Factors from Cambium
- What’s on the horizon?

Building electrification analysis with ResStock

ResStock Electrification Analysis (2016)



NREL

Energy Efficiency Potential in the U.S. Single-Family Housing Stock

Eric Wilson, Craig Christensen, Scott Horowitz, Joseph Robertson, and Jeff Maguire
National Renewable Energy Laboratory

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Technical Report
NREL/TP-5500-68670
December 2017

Contract No. DE-AC36-08GO28308

- Technical and economic potential (positive net present value from homeowner perspective)
- Modeled single-family detached housing only
- No future stock projections

https://www.nrel.gov/docs/fy18osti/68670.pdf

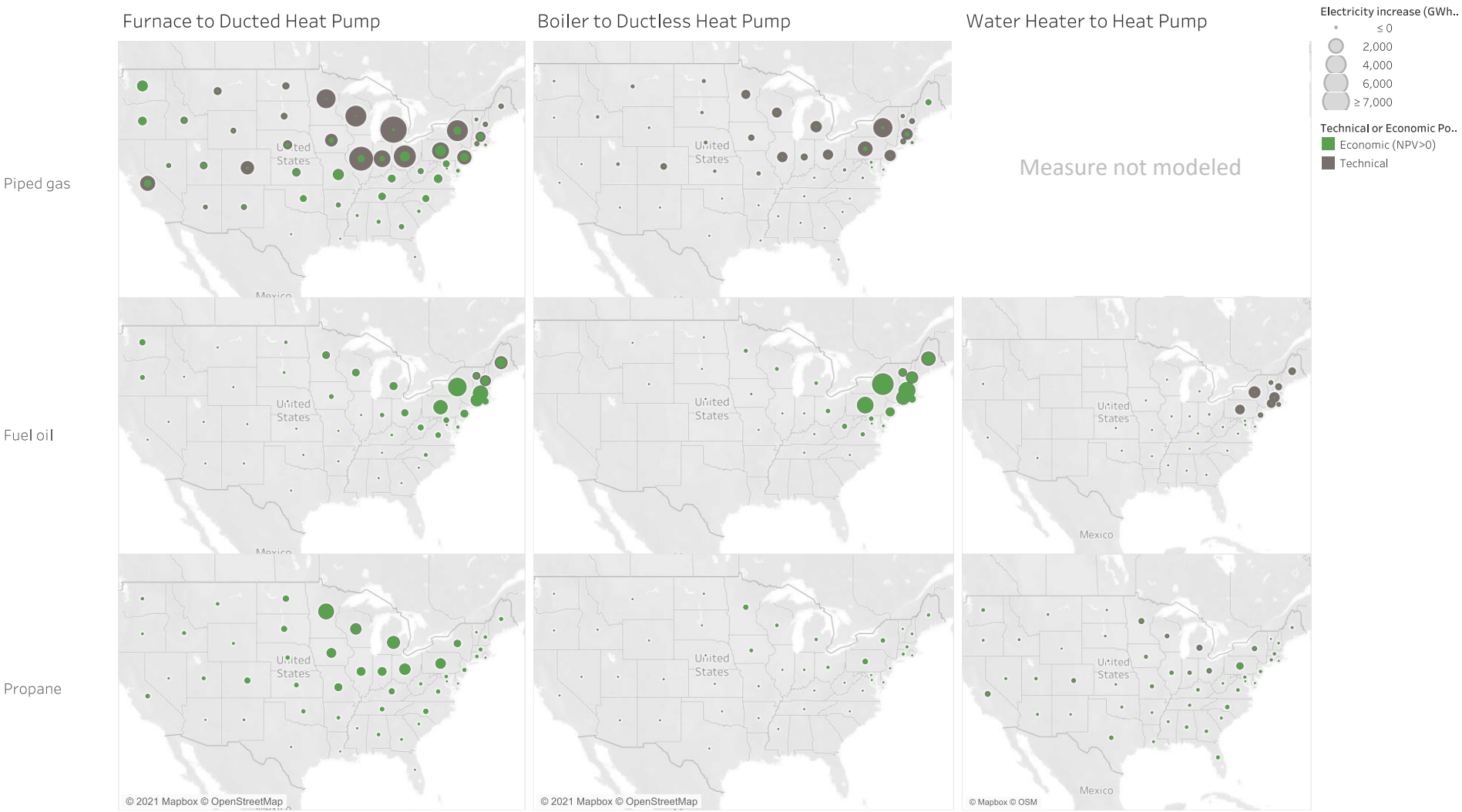
ResStock Electrification Analysis (2016)

Table C-1. Electrification Measures and Packages

End-Use Category	Measure Short Name	Measure Description
Space heating	Replace Gas/Propane/Oil Furnace with VSHP	Replace Gas/Propane/Oil Furnace with SEER 22 HSPF 10 Variable-Speed Heat Pump (VSHP) at wear out
Space heating	DHP (replaces gas/propane/oil boiler at wear out) (60%)	Replace Gas/Propane/Oil boiler with ductless heat pump (SEER 27, HSPF 11.5) at wear out (DHP displaces 60% of space heating load)
Space heating	DHP (replaces gas/propane/oil boiler at wear out) (100%)	Replace Gas/Propane/Oil boiler with ductless heat pump (SEER 27, HSPF 11.5) at wear out (DHP displaces 100% of space heating load)
Water heating	Replace Oil/Propane Water Heater with HPWH (50 gal/80 gal)	Replace fuel water heater (≤55 gal) with electric heat pump water heater (50 gal/80 gal) at wear out
Package	Electrification Package 1	"Synthetic" package combining upgrades related to electrification; assumes DHP displaces 60% of space heating load
Package	Electrification Package 2 (better DHP)	"Synthetic" package combining upgrades related to electrification; assumes DHP displaces 100% of space heating load (no point-source penalty)

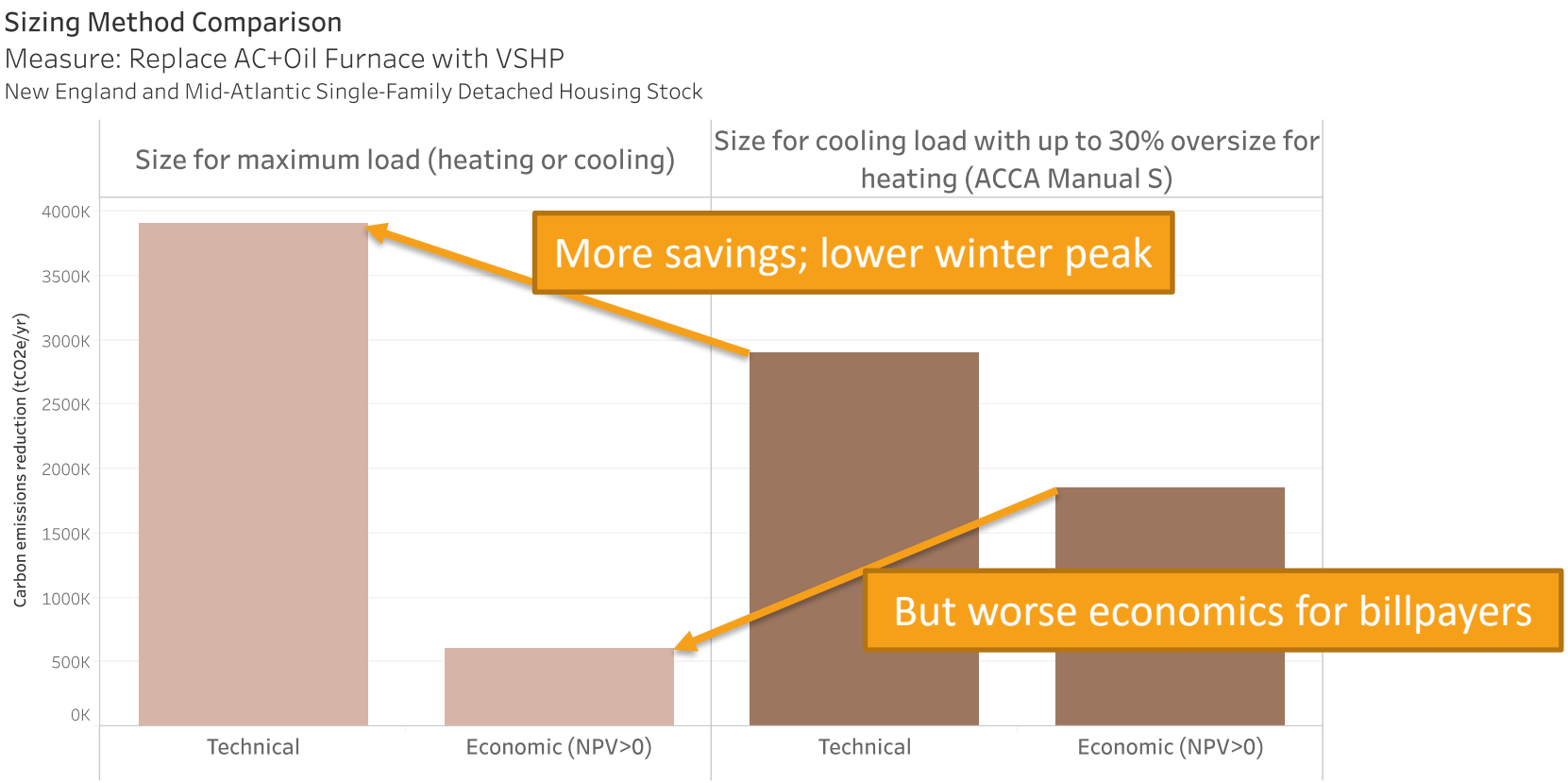
This table describes the measures and packages included in the electrification scenarios.

ResStock Electrification Analysis (2016) - Cost-effective to billpayers

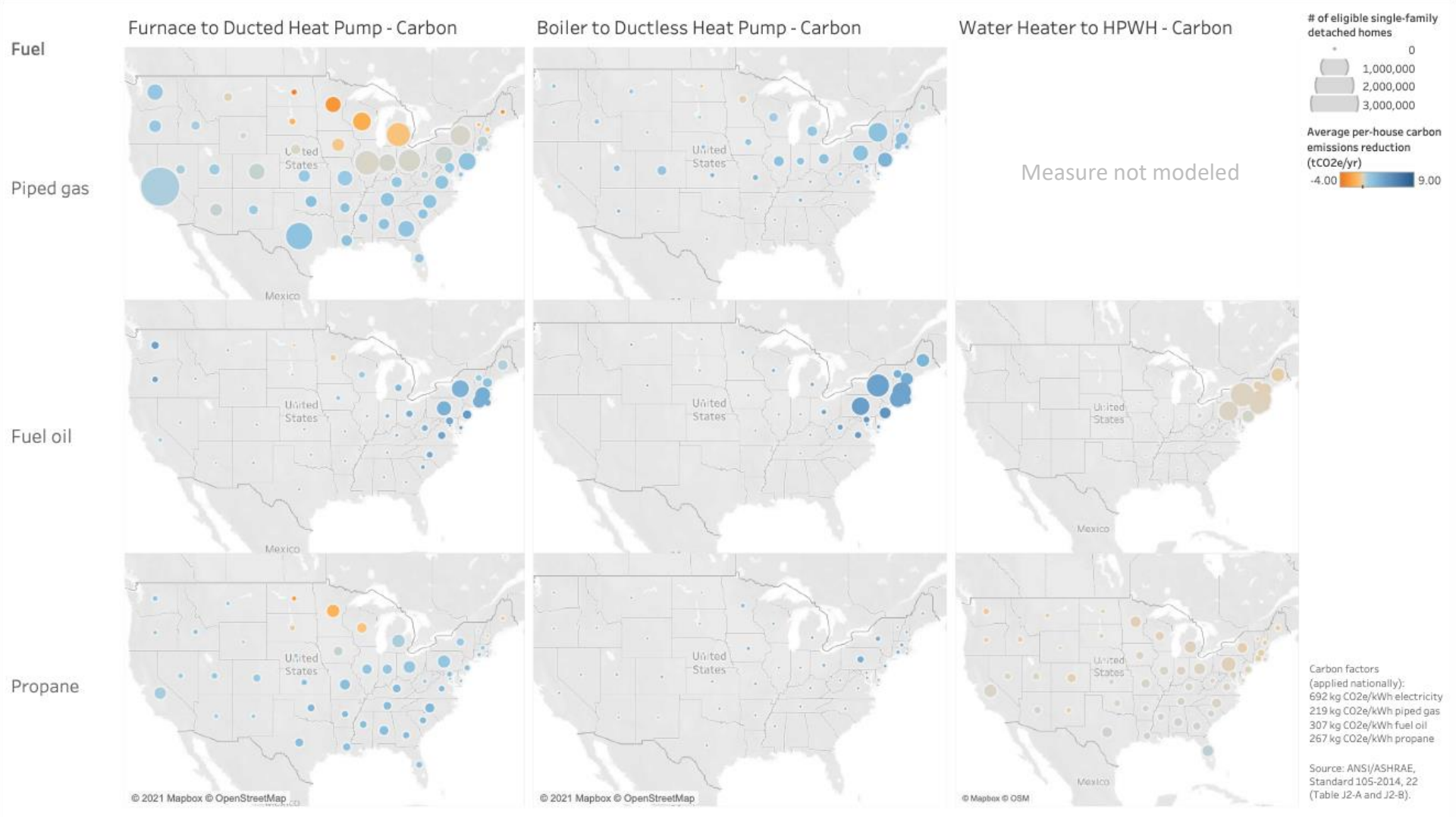


ResStock Electrification Analysis (2016) – Sensitivity to Sizing

If you size for the maximum of heating or cooling load…



ResStock Electrification Analysis (2016) – Est. 2014 Carbon Savings



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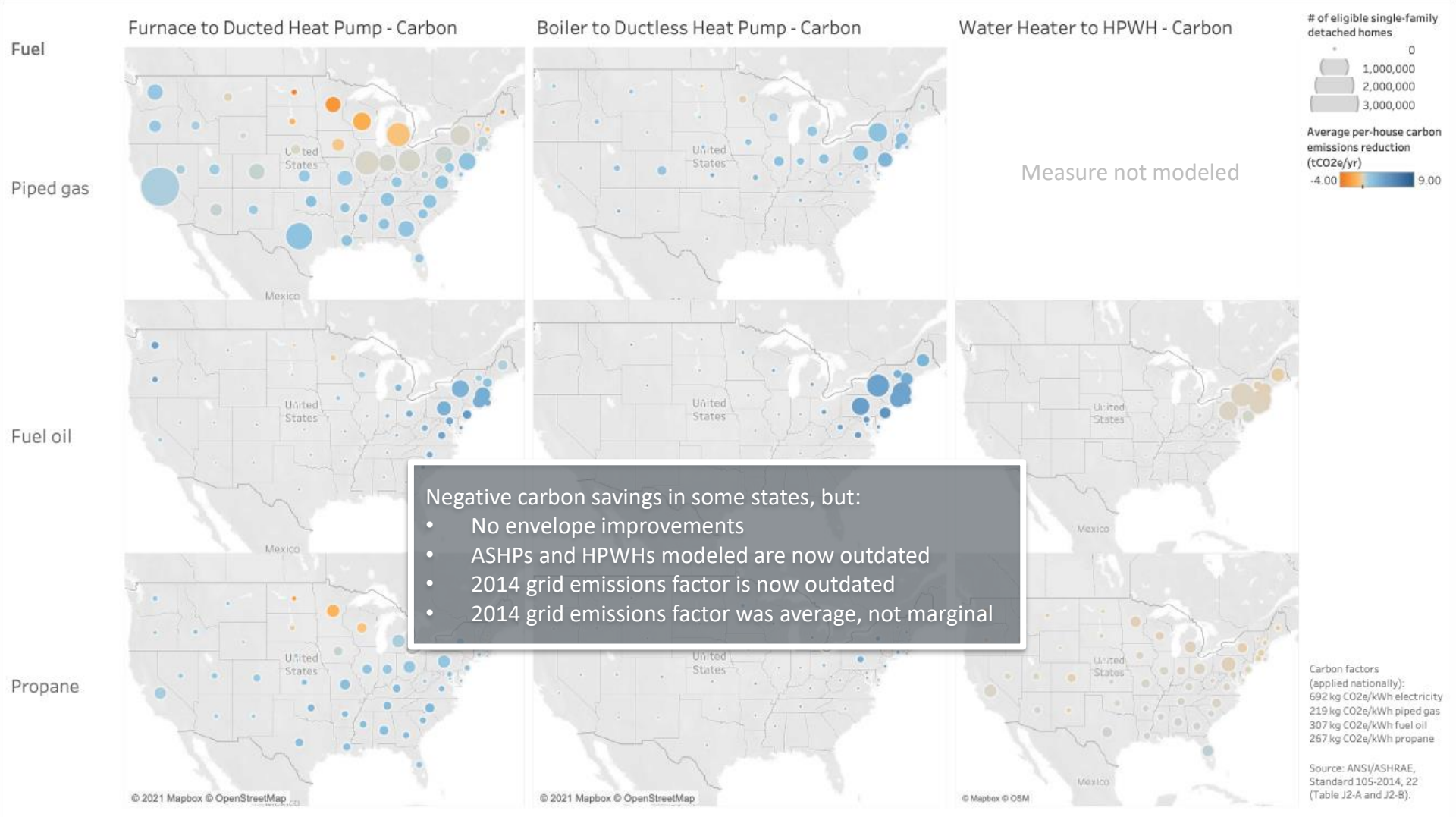


Negative carbon savings in some states, but:

- No envelope improvements
- ASHPs and HPWHs modeled are now outdated
- 2014 grid emissions factor is now outdated
- 2014 grid emissions factor was average, not marginal

Using Long-Run Marginal Carbon Factors from Cambium

Cambium

A public database of hourly emission, cost, and operational metrics for the U.S. electric sector through 2050

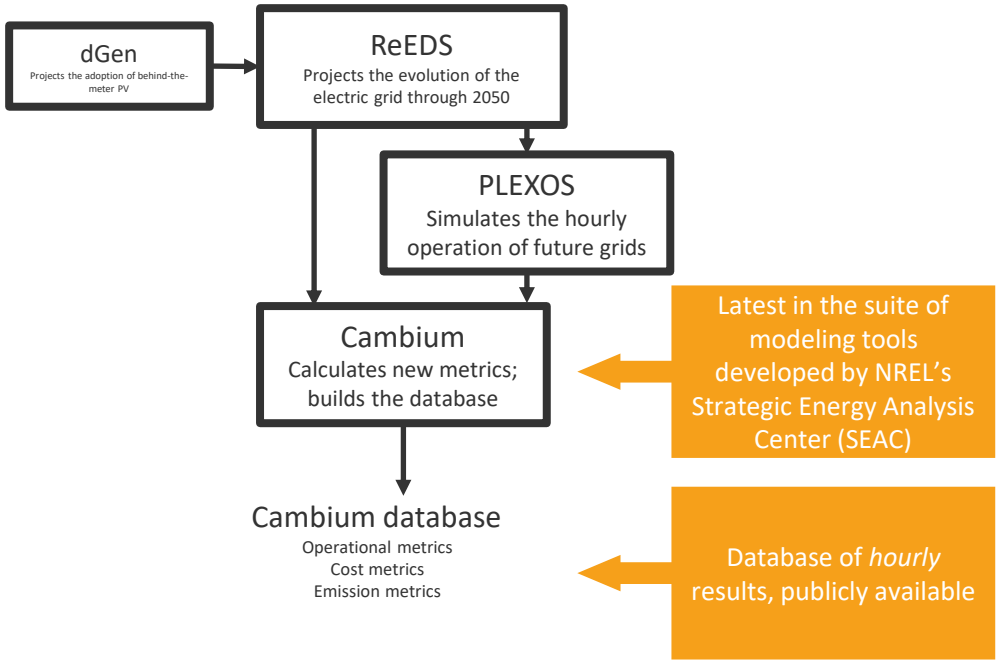
What's the point?

1) The grid is changing

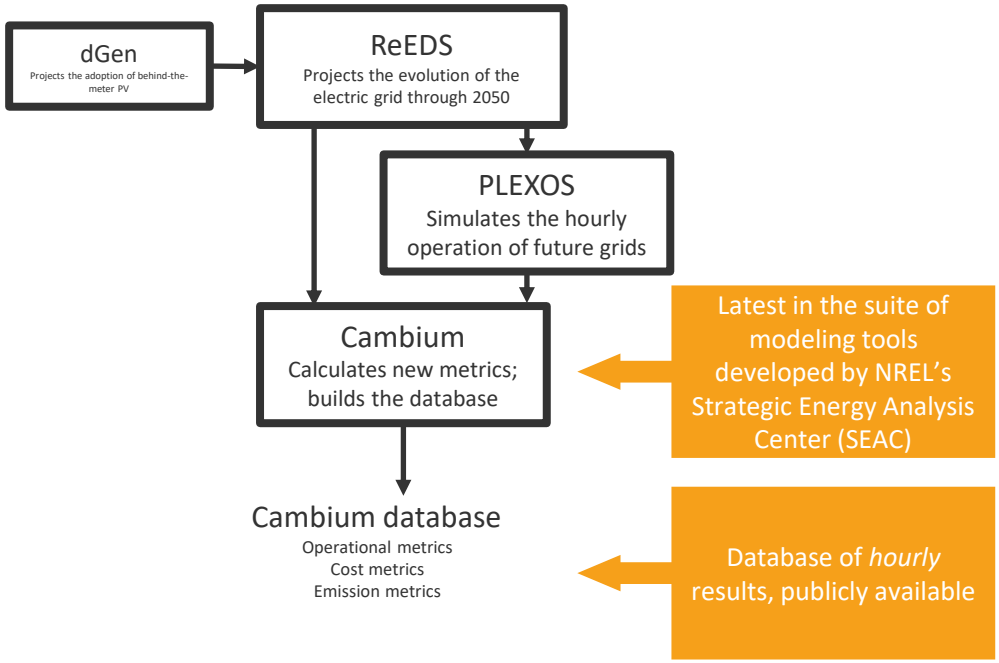
2) Some metrics useful for planning are forward-looking

3) Useful for a fair comparison across technologies

The grid models

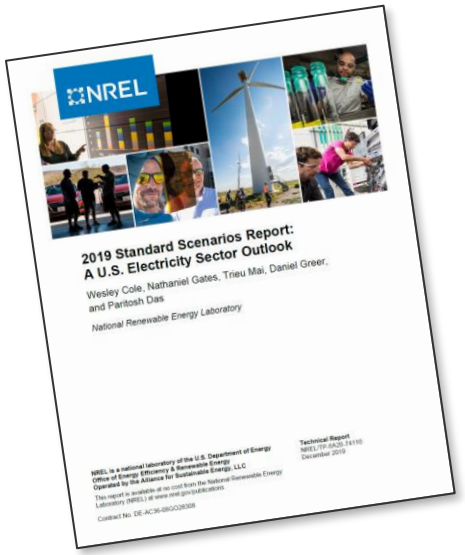


The grid models



NREL Standard Scenarios

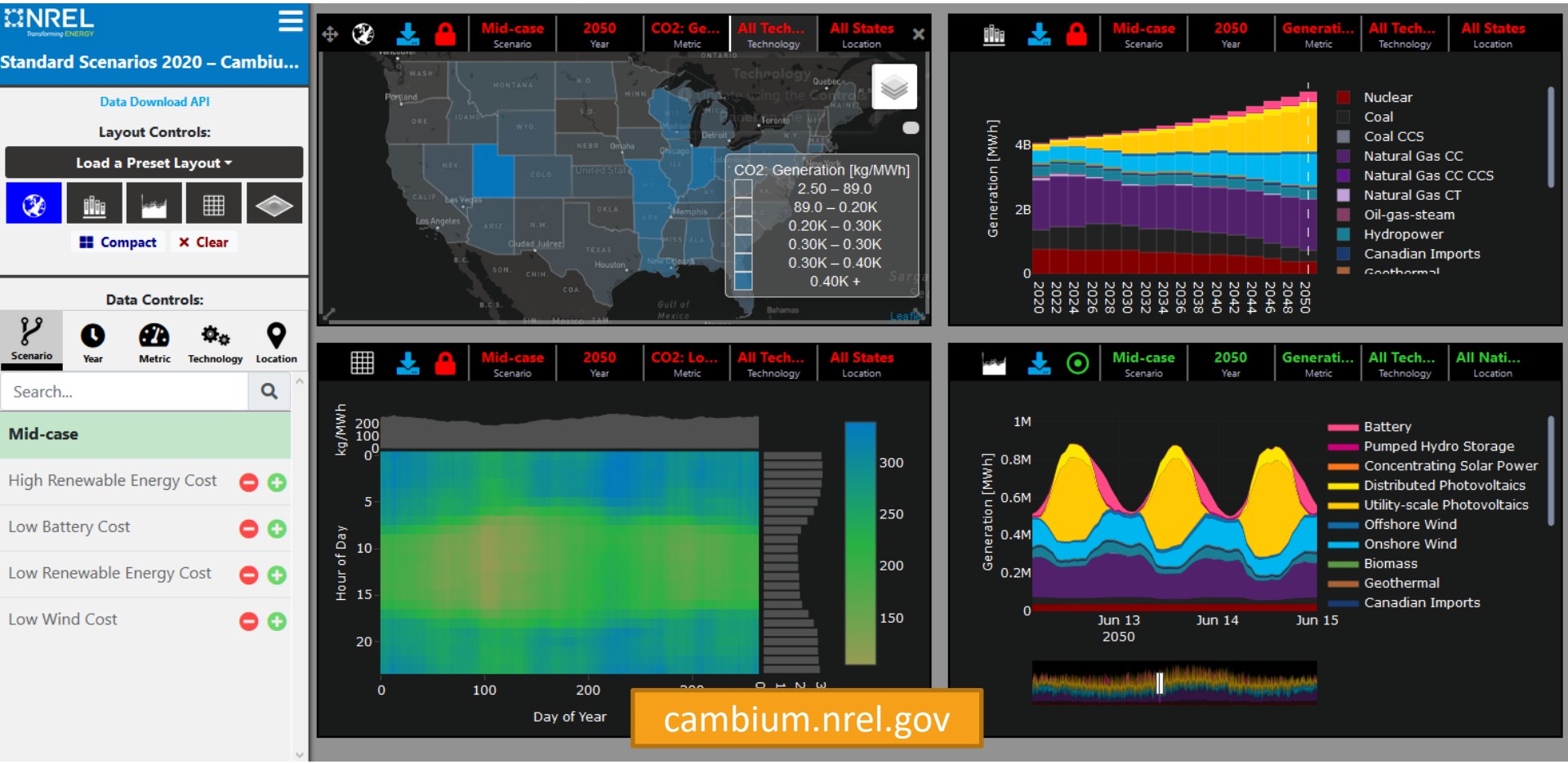
Annually updated set of scenarios produced by NREL



5 scenarios have detailed Cambium data:

- Mid-case
- Low RE Cost
- High RE Cost
- Low Battery Cost
- Low Wind Cost

Scenario Viewer and Data Downloader



Marginal CO_2 Emission Metrics

Short-run marginal emission rate

Emission rate of the generation that would serve a change in electrical load *keeping the capital assets of the grid fixed.*

- Several sources for this (e.g., WattTime)
- Relevant for demand flexibility, batteries

Marginal CO_2 Emission Metrics

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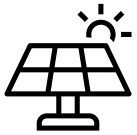
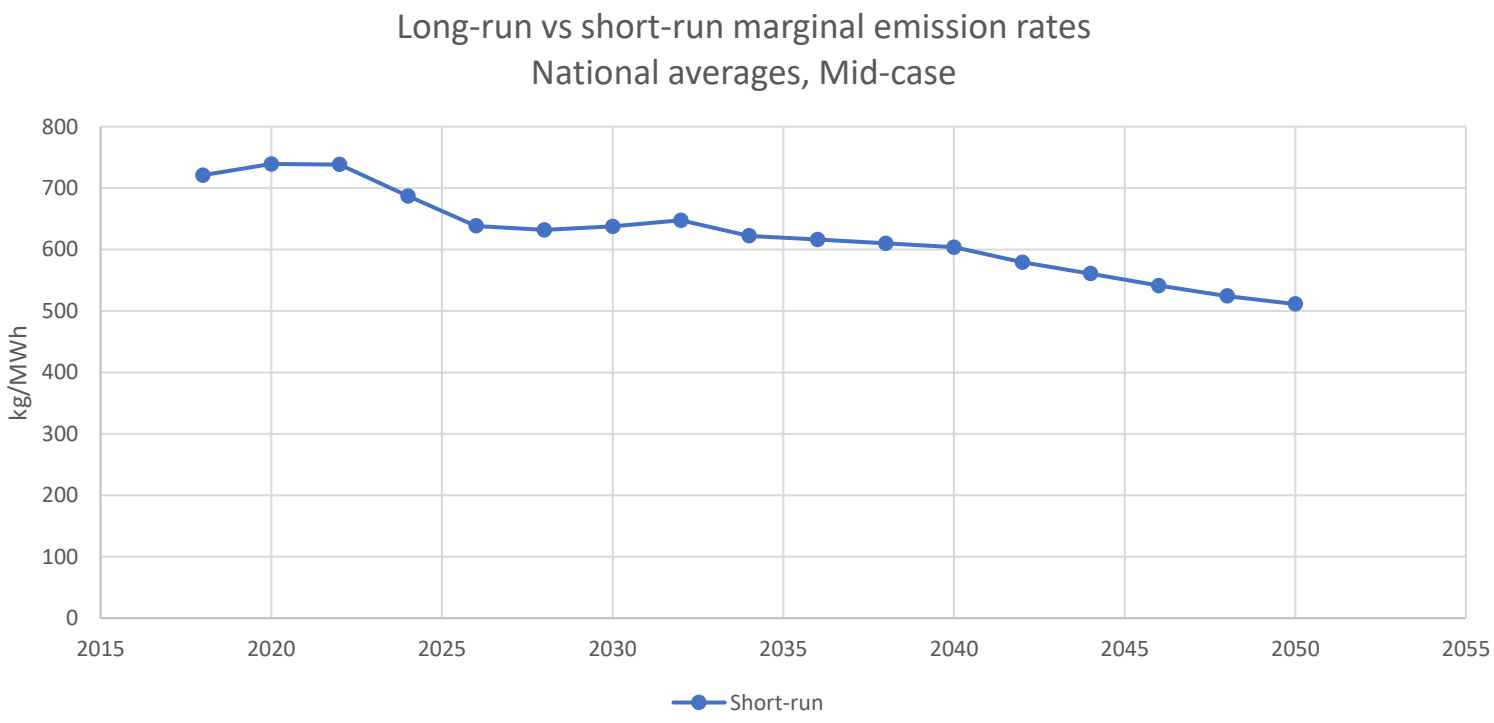


Long-run marginal emission rate

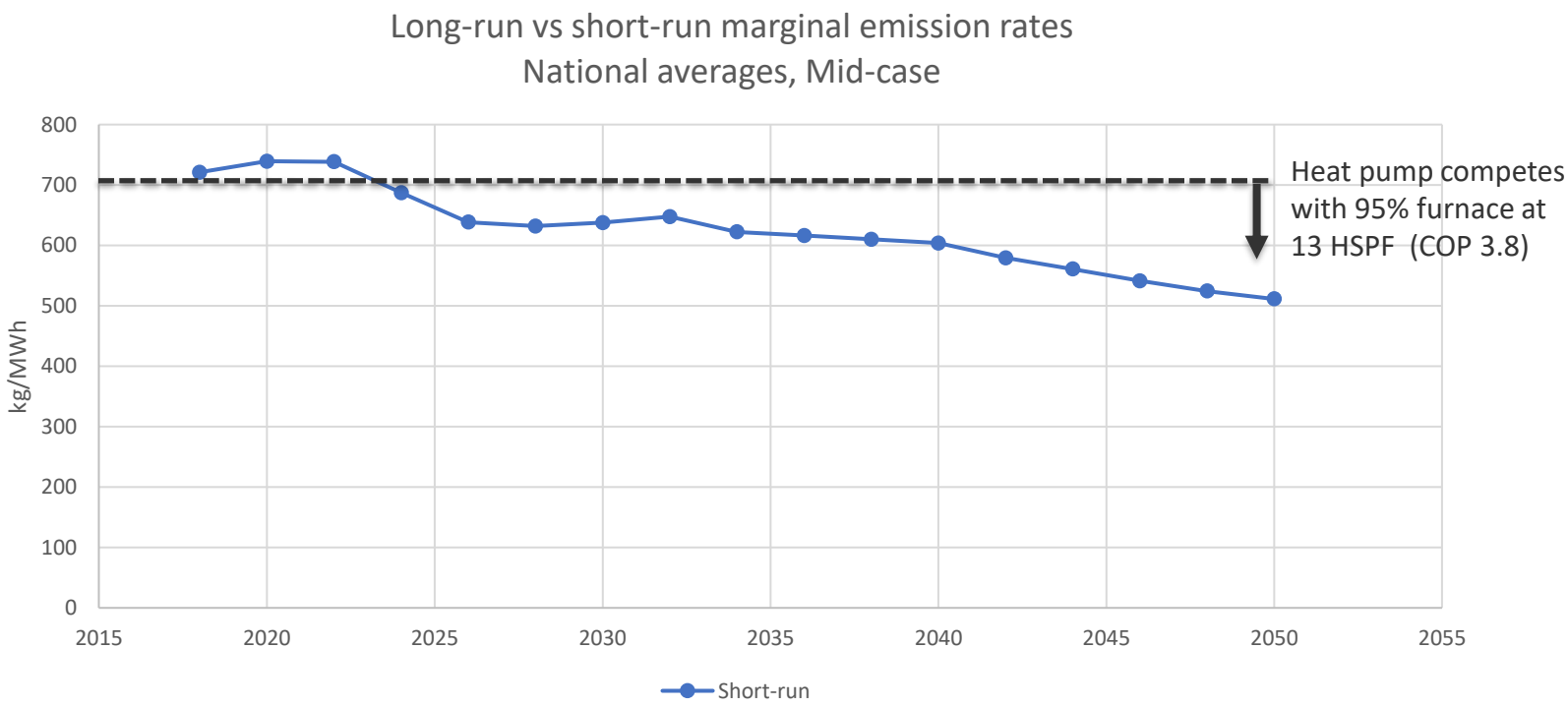
Emission rate of the generation that would serve a change in electrical load *considering the structural changes to the grid that would be induced by a persistent change in load.*

- Unique to Cambium
- Relevant for EE and Electrification

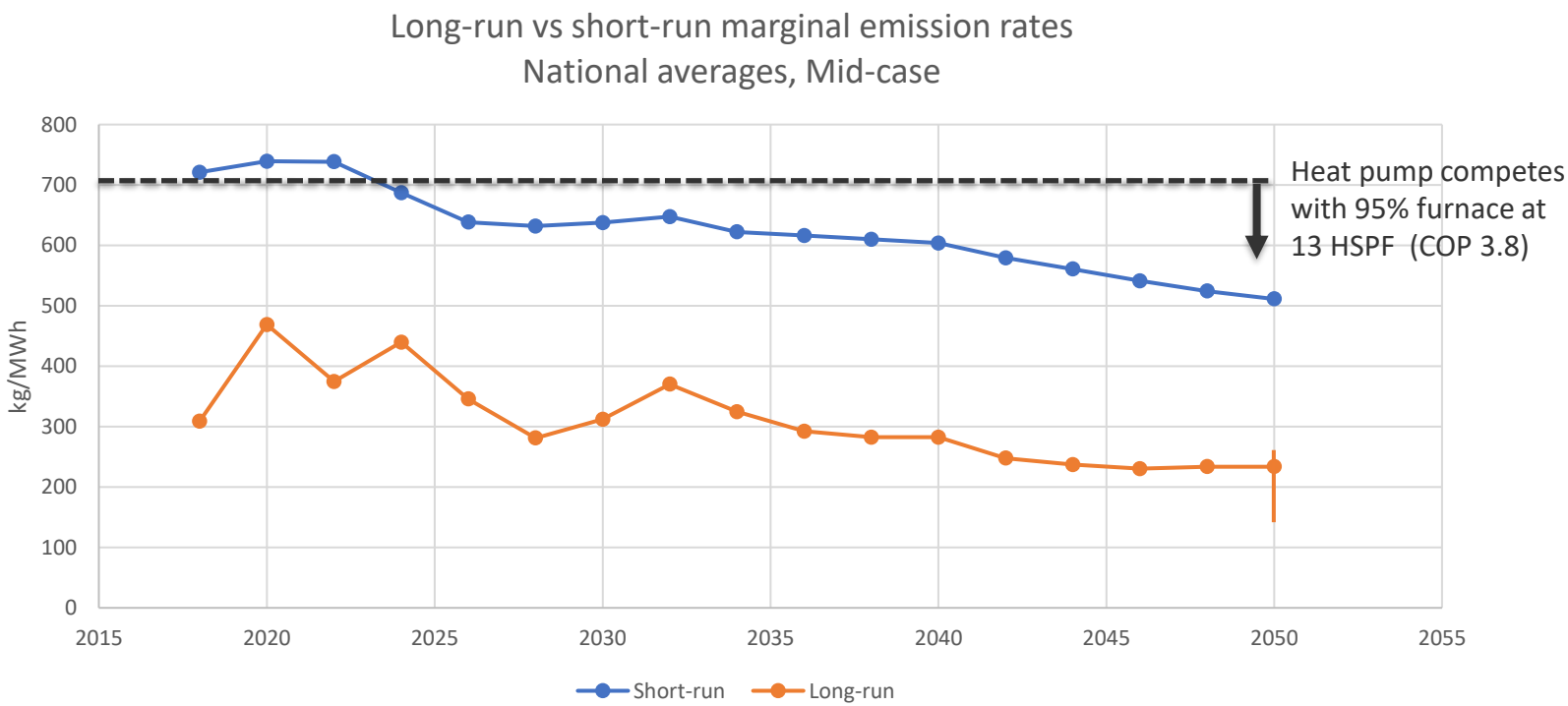
“Mid-case” short-run marginal emissions projected to 2050



“Mid-case” short-run marginal emissions projected to 2050



Long-run emissions rate is about 50% of short-run



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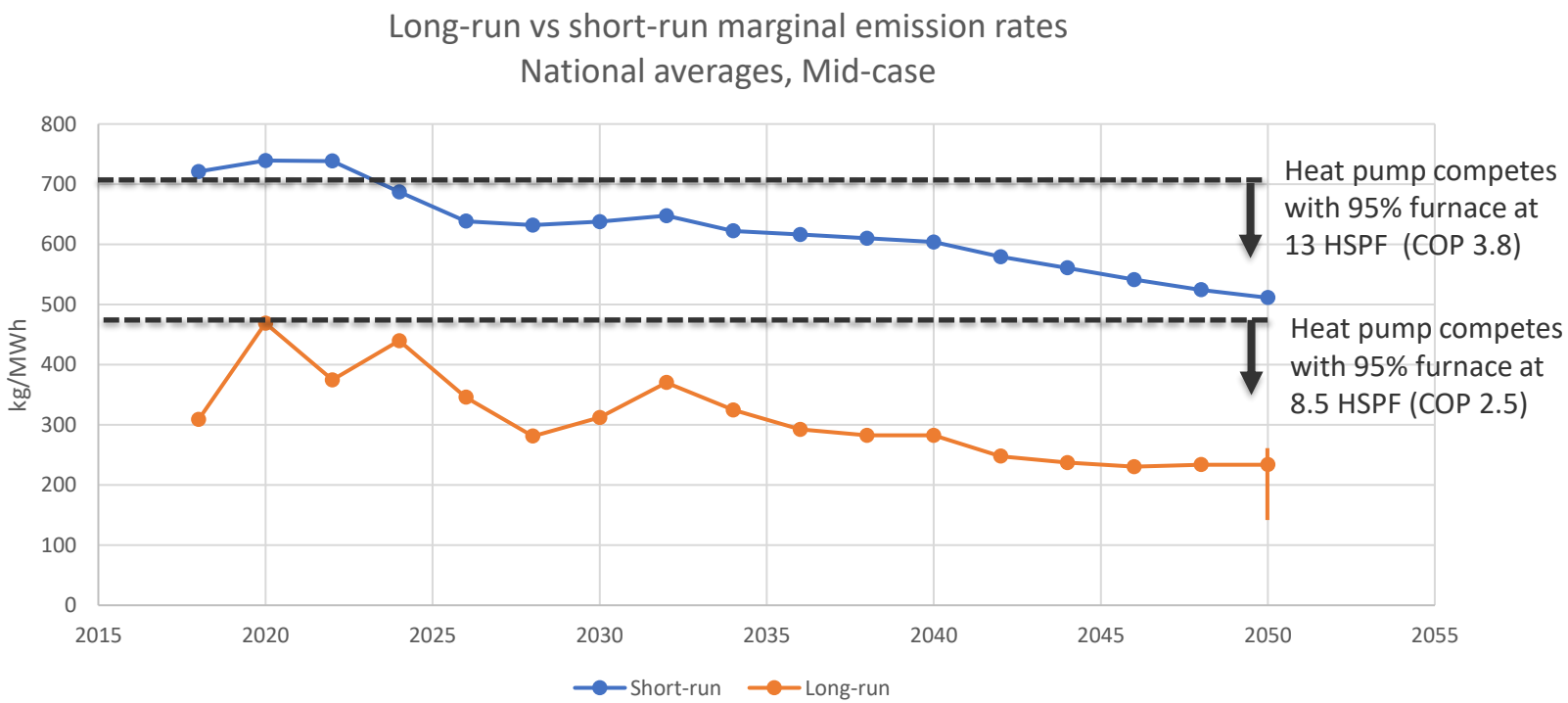
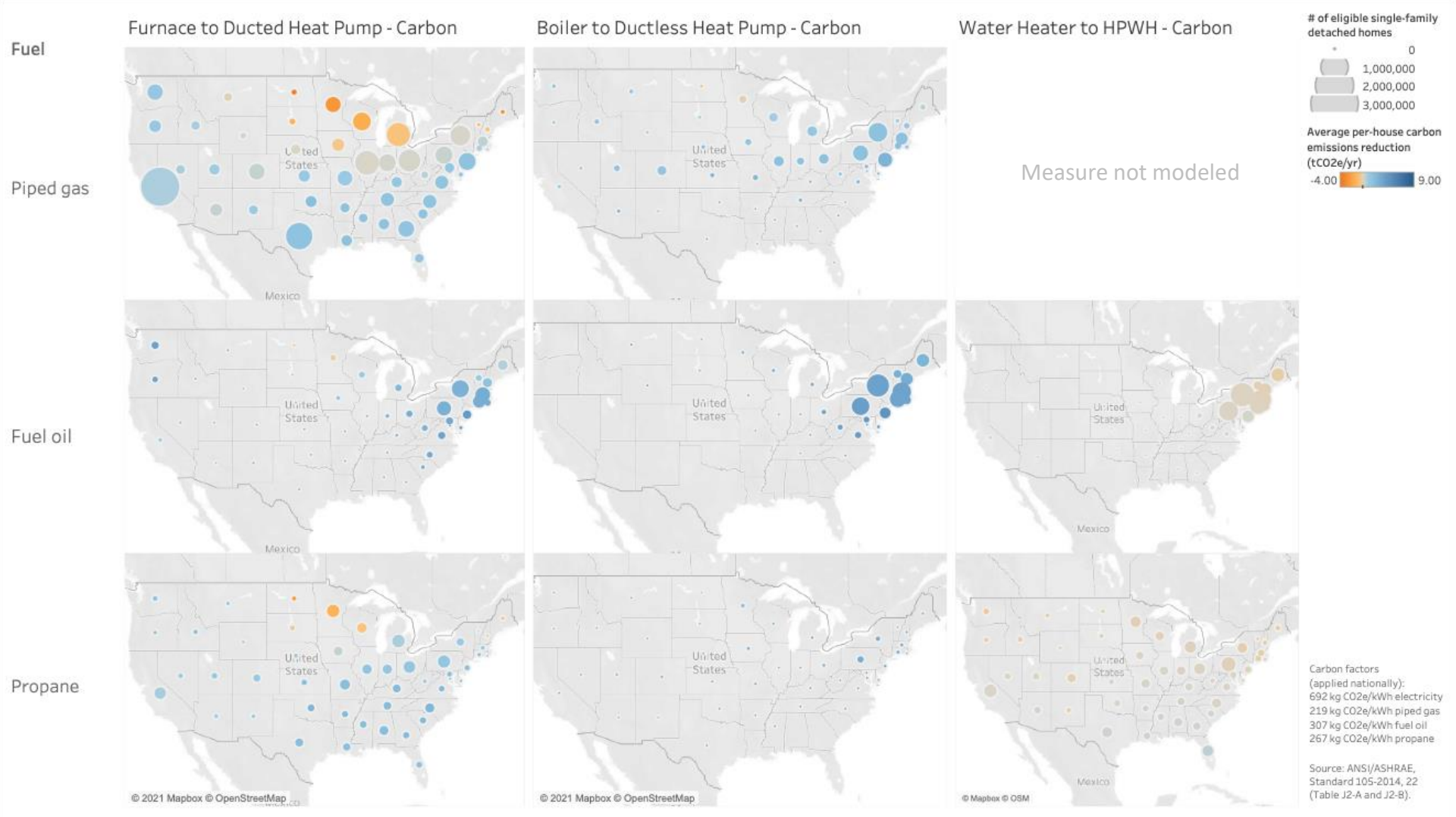
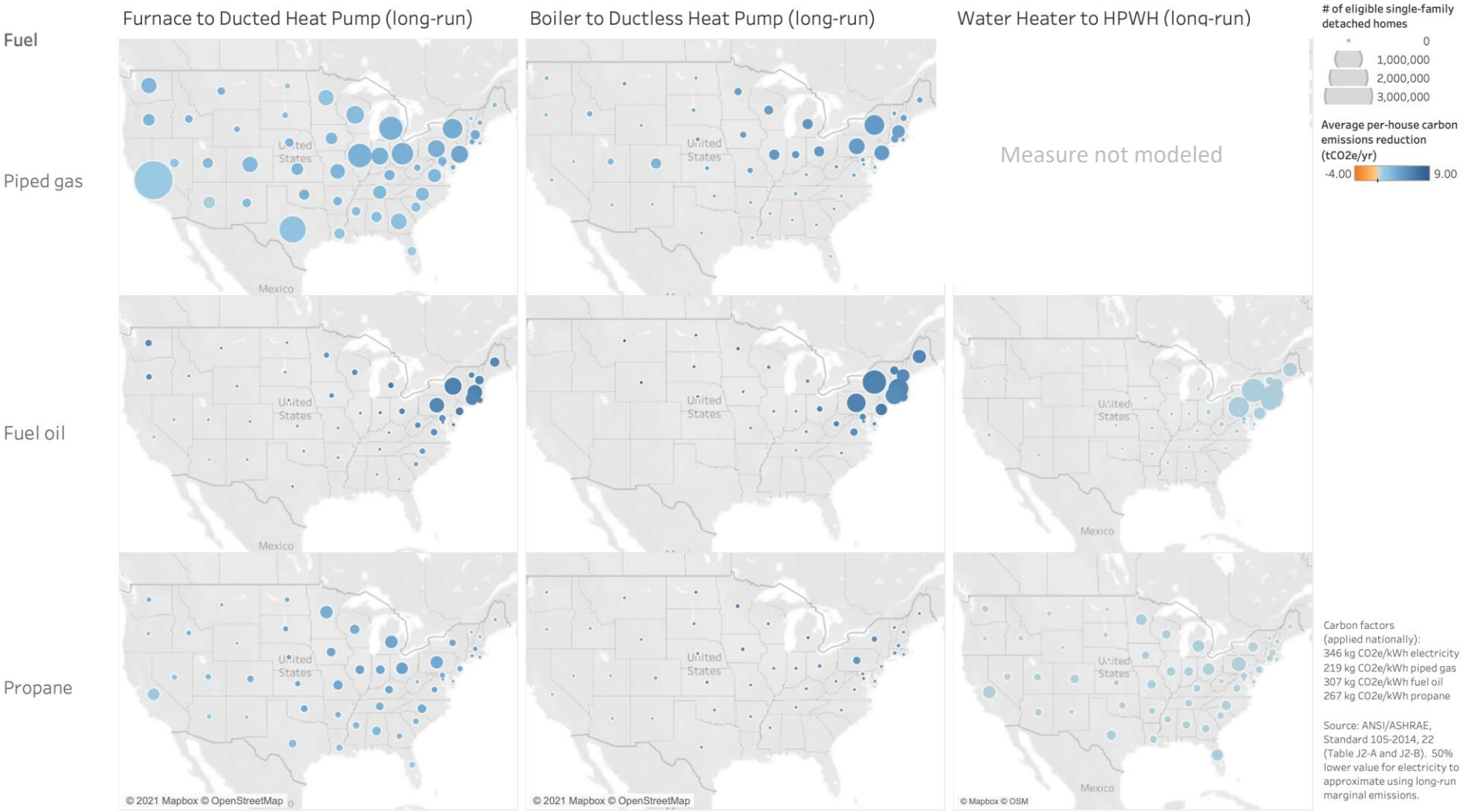


ResStock Electrification Analysis (2016) – Est. 2014 Carbon Savings



Updated Est. Carbon Savings (using Long-Run Marginal Emissions Factors)



Emissions rates will vary by time and location of electrification load

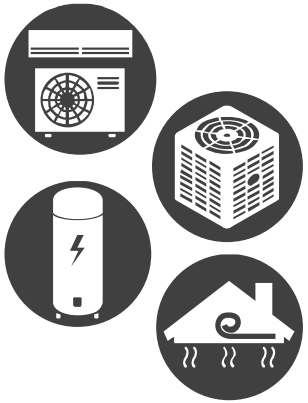
What’s on the horizon?

What's on the horizon?

- U.S. Building Stock Characterization Dashboards – breakdown of thermal energy end-uses by building stock segment

- ResStock analysis of electrification measures for DOE's Advanced Building Construction (ABC) Initiative
  - Where are heat pump swap-outs sufficient?
  - Where are deep envelope retrofits necessary to enable electrification?

- ResStock runs feeding into a Decarbonization Pathways analysis for DOE



Questions?

Eric.Wilson@nrel.gov

www.nrel.gov

NATIONAL RENEWABLE ENERGY LABORATORY

Smita Gupta

New Buildings Institute

U.S. DEPARTMENT OF ENERGY

Decarbonizing Buildings one “Initiative” at a time

nbi new buildings institute

Smita Gupta

Director, Building Innovation

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New Buildings Institute

Vision: We envision a transformed built environment that is carbon-free, sustainable, and energy-efficient and supports thriving economies that benefit all people and the planet.

Mission: 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.

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Program Areas

NBI supports and accelerates an equitable transition to a low-carbon future in all new and existing buildings.

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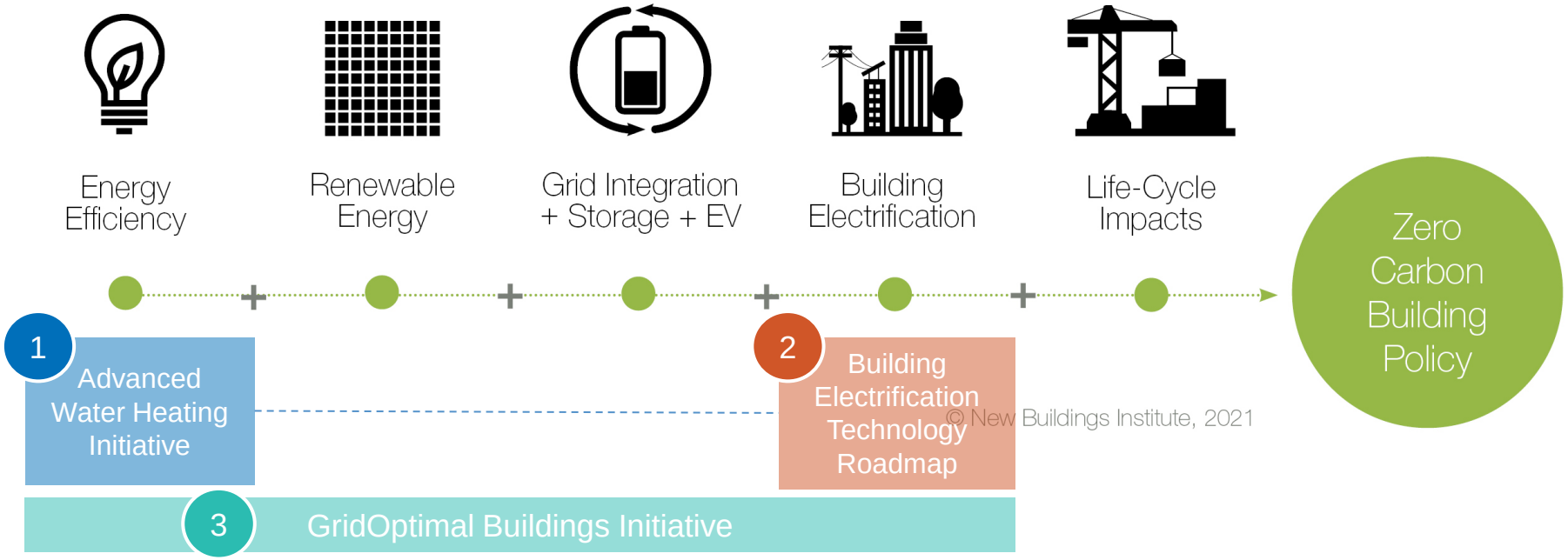
Foundations of Building Decarbonization



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ADVANCED WATER HEATING INITIATIVE

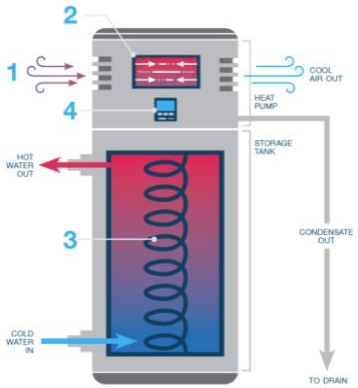
Why Heat Pump Water Heaters?

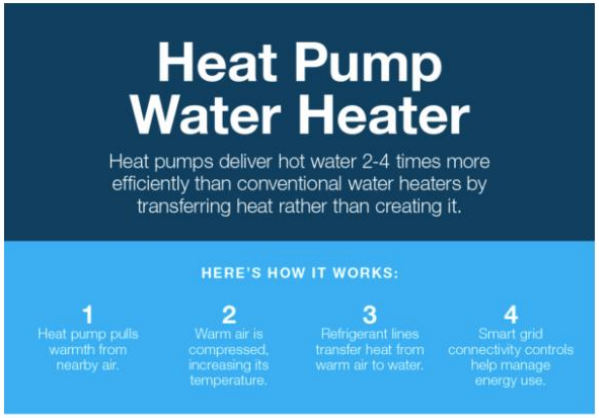
HPWHs – a Climate Solution

How Your Water Heater Can Be a Secret Weapon in the Climate Change Fight

California wants to replace millions of gas water heaters with high-tech electric ones to serve as "thermal batteries" for storing solar and wind energy.

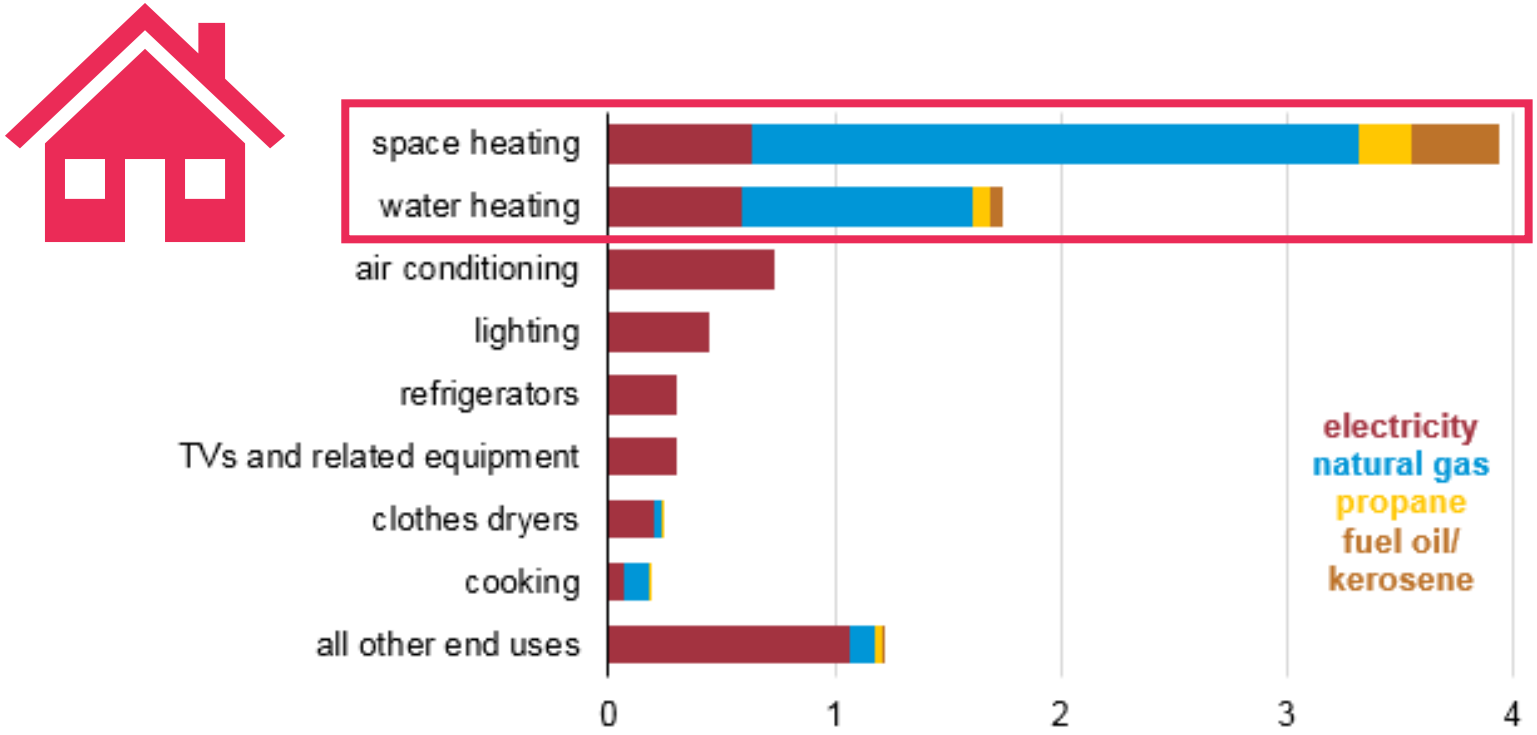
Illustration: Joel Plosz





https://www.bloomberg.com/news/articles/2021-02-11/how-your-water-heater-can-be-a-secret-weapon-in-the-climate-change-fight

Space and water heating = 2/3 of home energy



Source: EIA

Magnitude of the Opportunity

118.2 mil

Residential Buildings

2+ mil

Annual New Home Construction

7.5 mil

Water heaters replaced annually

27 mil

Households w/WH >10 yr old

4.6 mil

Commercial Buildings

100 mil tons

Carbon emissions saved per year

18

Coal fired power plants annually

https://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/water_heater_market_profile_sept2009.pdf

HPWH as Virtual Power Plants

AWHi
ADVANCED WATER HEATING INITIATIVE

Grid enabled (CTA-2045) HPWHs could provide:

Demand Response Potential of 20 - 40 GW

grist

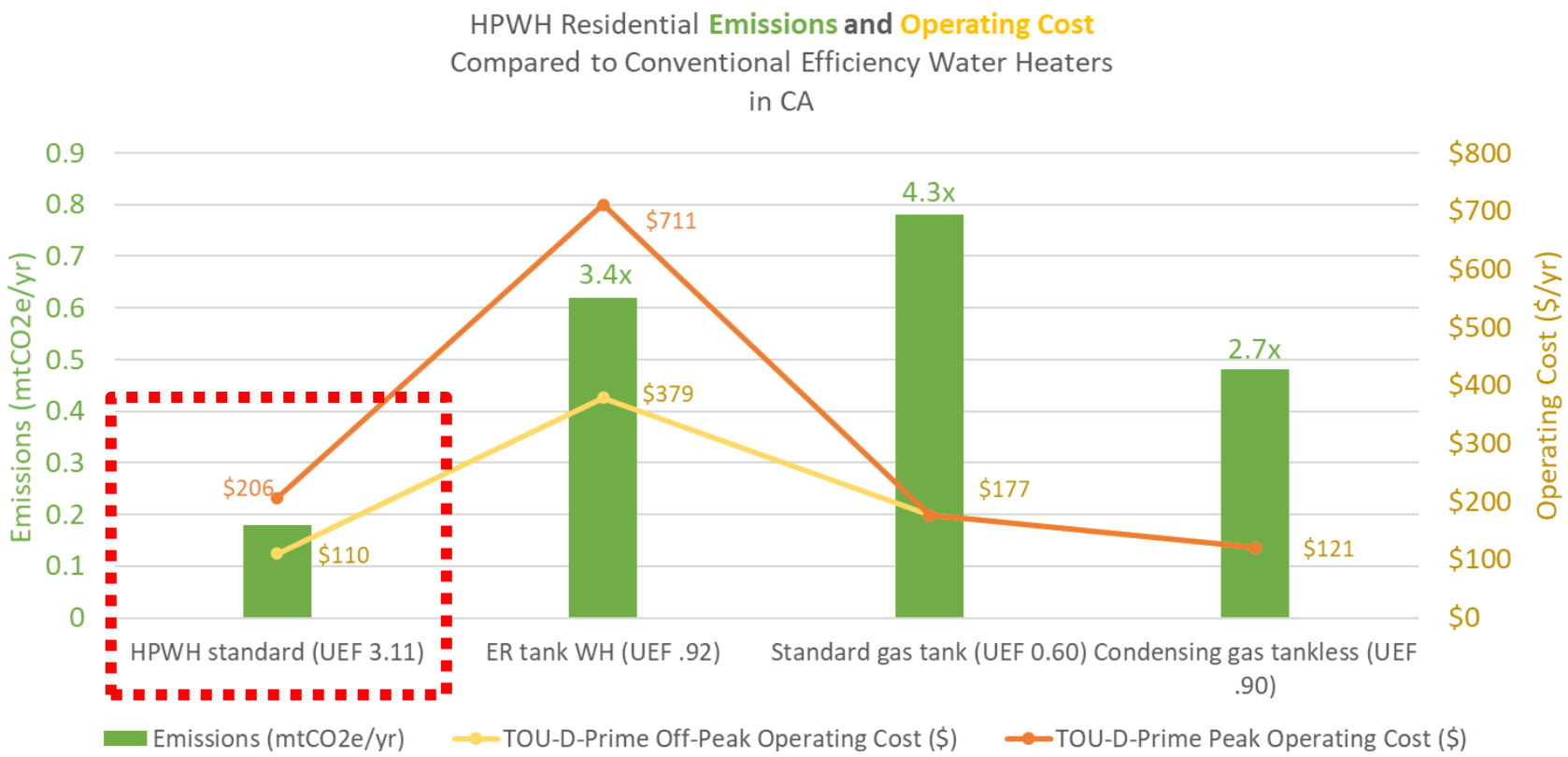
NYC Environmental Justice Alliance

SUMMER SURGES

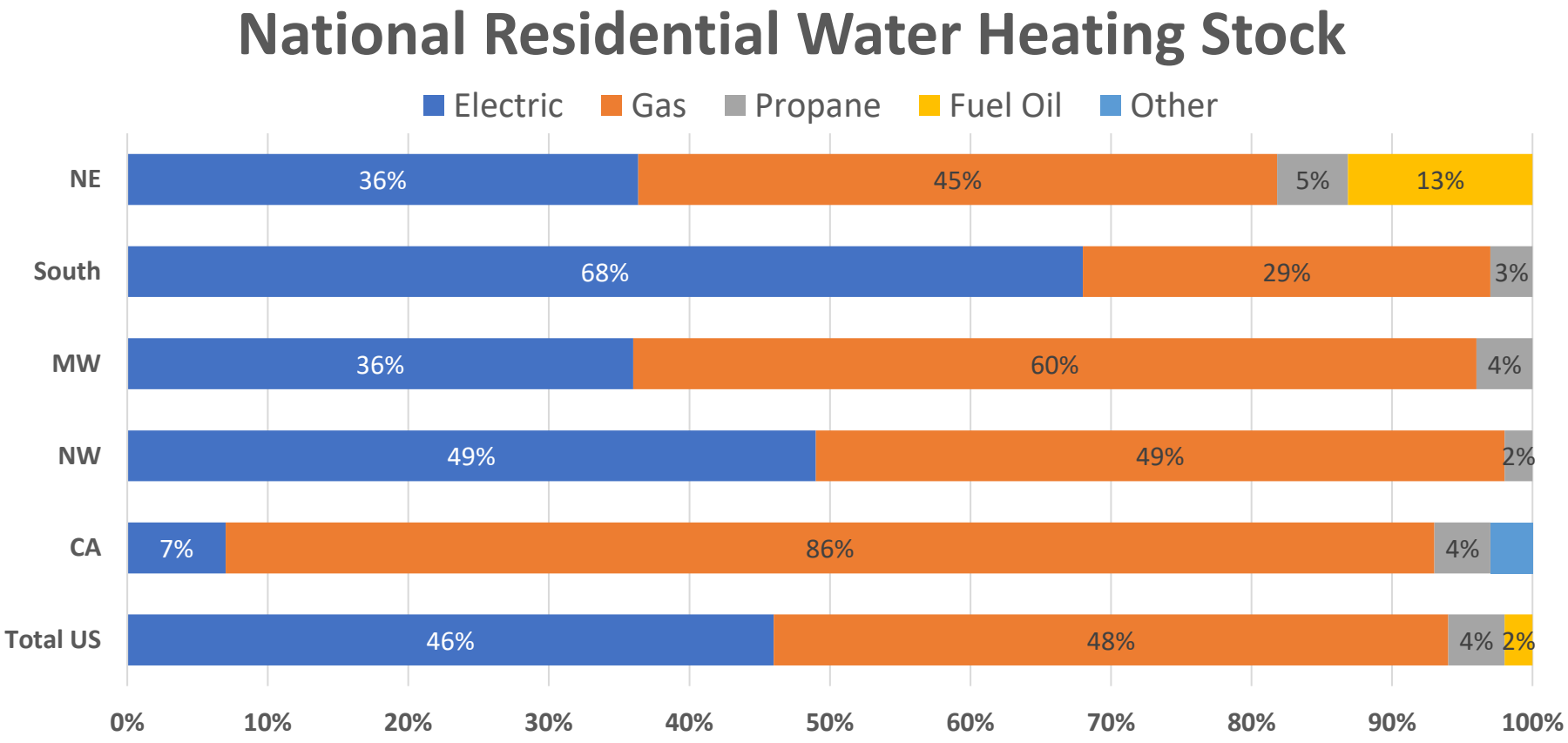
Report: These rarely used, dirty power plants could be cheaply replaced by batteries

By Rachel Ramirez on Jun 11, 2020

HPWHs: Controls and Operating Cost



Water Heating Fuel Mix



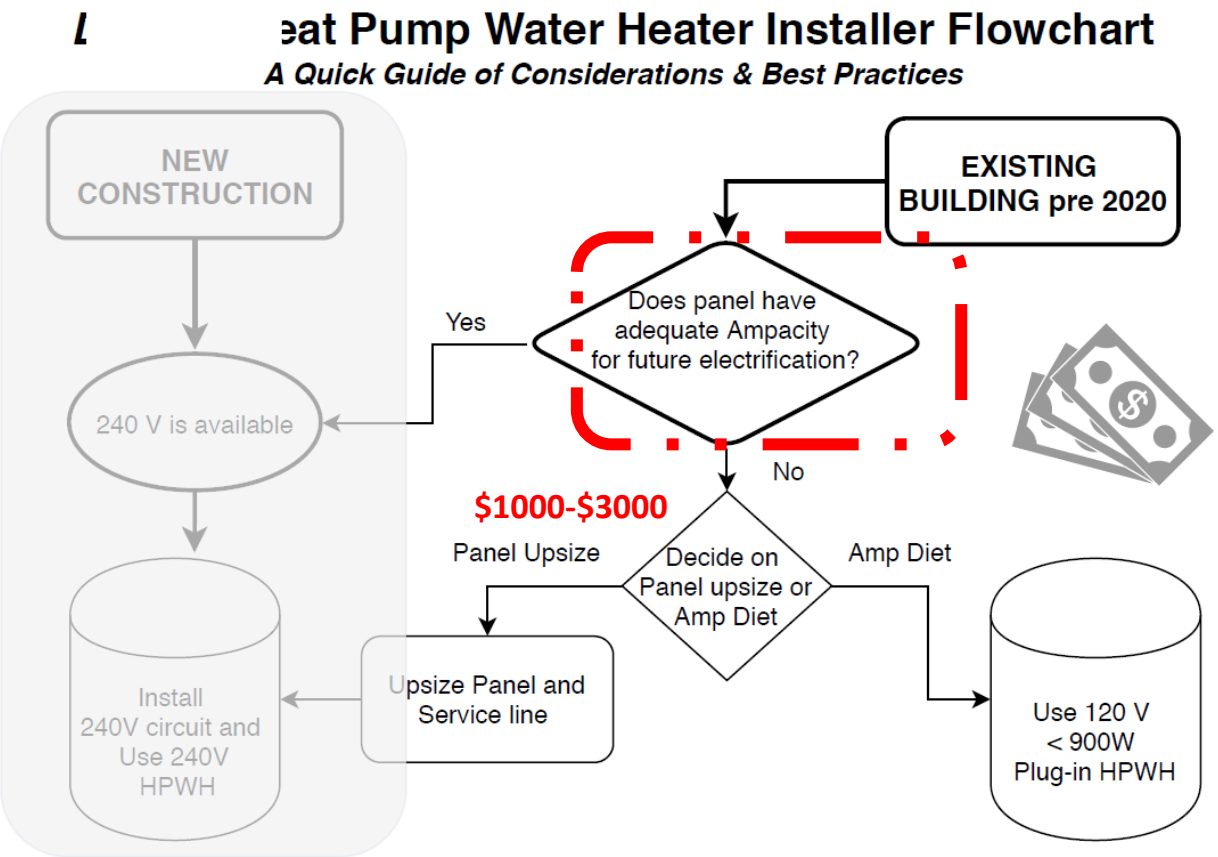
Products for Residential market sector

- **240V product**
  - 50 – 100 gallon
  - UEF 3+
  - Conventional and low GWP refrigerants
  - Applicable in unit installs
  - In garage/basements/attic
  - Grid connectivity CTA 2045

- **120V product**
  - NEW product – retrofit ready – Q3 2021
  - UEF ~2.5 and above
  - No elect resistance heating and bigger tank
  - Avoids expensive panel upgrade
  - Conducive to fuel switch situations

85% of water heater purchases are emergency replacements

Why is the 120V Product Needed?



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120V Field Study Objectives

- Independent field verification to advance market commercialization and program promotion
  - User satisfaction and operating cost
  - Energy and load shifting performance
  - Installer experience

- Demonstration Diversity:
  - Application: single family, multifamily in-unit, manufactured homes
  - Installation location: garage, closet, basement
  - Climate zone

Starting on the west coast this fall – looking for partners to verify performance in cold climates

Photo Credit: NEEA

Advanced Water Heating Initiative

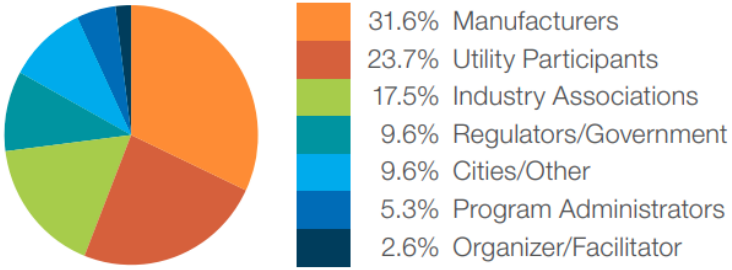
The Future of Water Heating is here

AWHi

ADVANCED WATER HEATING INITIATIVE™

Collaborative started on the West coast – now National

COUNT OF ORGANIZATION TYPES



- Collaborative effort of over 50 organizations, 100+ active members

Key Partners

U.S. DEPARTMENT OF ENERGY

Bonneville POWER ADMINISTRATION

SOUTHERN CALIFORNIA EDISON An EDISON INTERNATIONAL® Company

neea

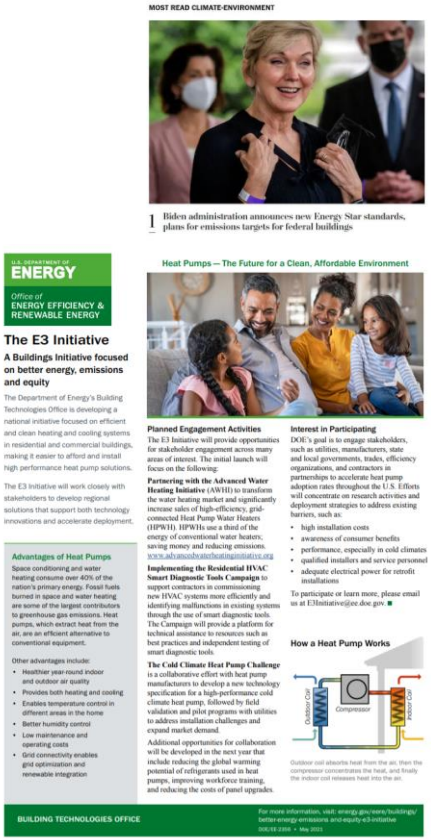
SMUD

nbi new buildings institute

DOE E3 Initiative

May 17, 2021

In partnership with the Advanced Water Heating Initiative, DOE is launching a new initiative to **increase market adoption** of high-efficiency, grid-connected Heat Pump Water Heaters in residential and commercial buildings – which are two to four times more efficient than conventional water heaters – in homes across the country.
www.advancedwaterheatinginitiative.org



MOST READ CLIMATE-ENVIRONMENT

1 Biden administration announces new Energy Star standards, plans for emissions targets for federal buildings

U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

The E3 Initiative

A Buildings Initiative focused on better energy, emissions and equity

The Department of Energy's Building Technologies Office is developing a national initiative focused on efficient and clean heating and cooling systems in residential and commercial buildings, making it easier to afford and install high performance heat pump solutions.

The E3 Initiative will work closely with stakeholders to develop regional solutions that support both technology innovations and accelerate deployment.

Advantages of Heat Pumps

Space conditioning and water heating consume over 40% of the nation's primary energy. Fossil fuels burned in space and water heating are some of the largest contributors to greenhouse gas emissions. Heat pumps, which extract heat from the air, are an efficient alternative to conventional equipment.

Other advantages include:
- Healthier year-round indoor and outdoor air quality
- Provides both heating and cooling
- Enables temperature control in different areas in the home
- Better humidity control
- Low maintenance and operating costs
- Grid connectivity enables grid optimization and renewable integration

Heat Pumps — The Future for a Clean, Affordable Environment

Planned Engagement Activities
The E3 Initiative will provide opportunities for stakeholder engagement across many areas of interest. The initial launch will focus on the following:

Partnering with the Advanced Water Heating Initiative (AWHI) to transform the water heating market and significantly increase sales of high-efficiency, grid-connected Heat Pump Water Heaters (HPWH). HPWHs use a third of the energy of conventional water heaters; saving money and reducing emissions. www.advancedwaterheatinginitiative.org

Implementing the Residential HVAC Smart Diagnostic Tools Campaign to support contractors in commissioning new HVAC systems more efficiently and identifying malfunctions in existing systems through the use of smart diagnostic tools. The Campaign will provide a platform for technical assistance to resources such as best practices and independent testing of smart diagnostic tools.

The Cold Climate Heat Pump Challenge is a collaborative effort with heat pump manufacturers to develop a new technology specification for a high-performance cold climate heat pump, followed by field validation and pilot programs with utilities to address installation challenges and expand market demand.

Additional opportunities for collaboration will be developed in the next year that include reducing the global warming potential of refrigerants used in heat pumps, improving workforce training, and reducing the costs of panel upgrades.

Interest in Participating
DOE's goal is to engage stakeholders, such as utilities, manufacturers, state and local governments, trades, efficiency organizations, and contractors in partnerships to accelerate heat pump adoption rates throughout the U.S. Efforts will concentrate on research activities and deployment strategies to address existing barriers, such as:
- high installation costs
- awareness of consumer benefits
- performance, especially in cold climates
- qualified installers and service personnel
- adequate electrical power for retrofit installations

To participate or learn more, please email us at E3Initiative@ee.doe.gov. ■

How a Heat Pump Works

Outdoor coil absorbs heat from the air, then the compressor concentrates the heat, and finally the indoor coil releases heat into the air.

BUILDING TECHNOLOGIES OFFICE

For more information, visit: energy.gov/eere/buildings/better-energy-emissions-and-equity-e3-initiative
DOE/EE-2356 • May 2021

News: Biden administration announces new Energy Star standards, plans for emissions targets for federal buildings

The Washington Post reported that the White House said that, for the first time, the government will develop "building performance standards" for federal facilities. It will also establish new Energy Star standards for heat pumps and invest in programs meant to boost adoption of the potentially emissions-saving technology. (May 2021) Related Fact Sheet

DOE E3 Website : https://www.energy.gov/eere/buildings/energy-emissions-and-equity-e3-initiative

https://www.whitehouse.gov/briefing-room/statements-releases/2021/05/17/fact-sheet-biden-administration-accelerates-efforts-to-create-jobs-making-american-buildings-more-affordable-cleaner-and-resilient/

Strategies for Market Transformation

HPWHs for every type of building

Programs and policies working together

Create experts along the supply chain

Drive higher consumer demand

We could save **100 million tons** of carbon emissions every year

Create thousands of good-paying **jobs** in the building industry

Promote **equity** through investment in underserved communities

Enable a cleaner, more **resilient** electric grid

The solution is a piece of equipment that every home needs…

AWHi
ADVANCED WATER HEATING INITIATIVE

AWHI is a member-funded initiative, and our work is not possible without the contributions and support of our volunteers, partners, and participating organizations.

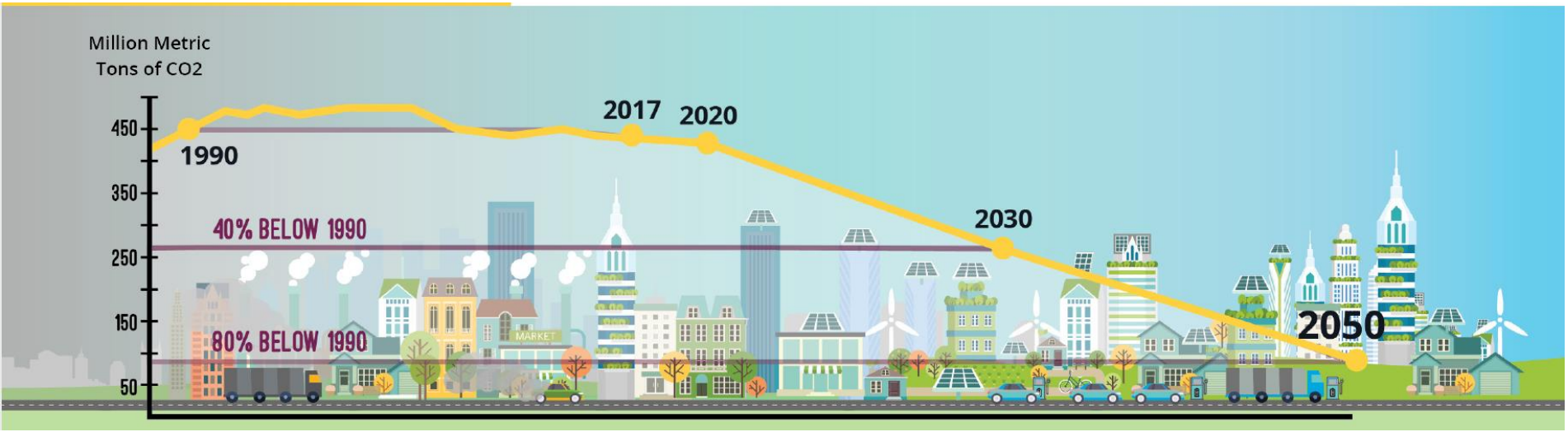
Join the Effort!

https://www.advancedwaterheatinginitiative.org/

AWHi
ADVANCED WATER HEATING INITIATIVE™

The Building Electrification Technology Roadmap (BETR)

Supporting clean energy and electrification goals



BUILDING DECARBONIZATION COALITION

EPRI ELECTRIC POWER RESEARCH INSTITUTE

nbi new buildings institute

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Electrification Technologies, Barriers, and Recommendation

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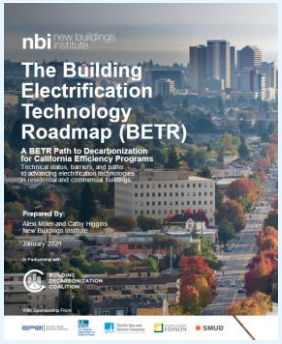

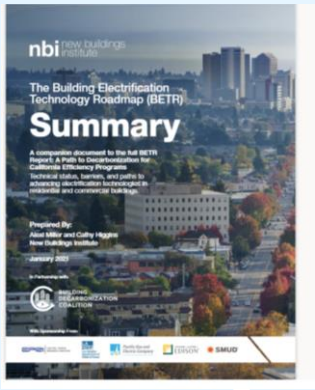

Building Electrification Technology Roadmap
https://newbuildings.org/resource/building-electrification-technology-roadmap/

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GRIDOPTIMAL™
BUILDINGS INITIATIVE

https://newbuildings.org/gridoptimal/

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The GridOptimal Buildings Initiative - Key Themes

- The way **buildings interact with the electric grid** is evolving rapidly.
- Buildings will face increasing **regulatory and economic pressure** to be able to respond to **changing utility rate and delivery structures**.
- Designers will need to **understand and incorporate strategies** that allow buildings to directly interact with the utility grid.
- Adapting to the ***interactive grid*** will be critical to maintaining **building services and comfort** and to **grid dependability**.
- Efforts to **decarbonize the electrical grid** will require **better integration** of distributed energy resources**.**

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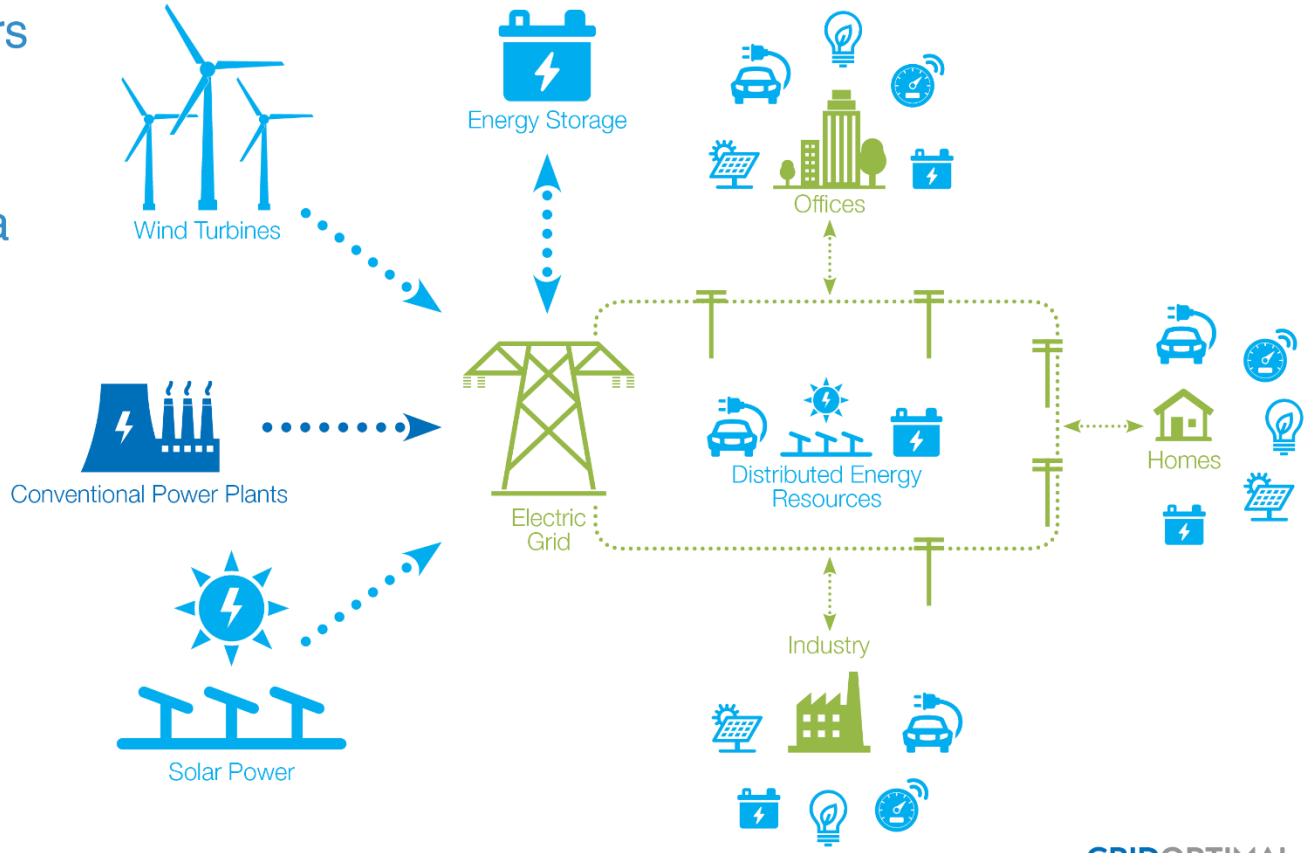
GridOptimal empowers players on both sides of the meter to actively support the transition to a carbon free grid



GridOptimal Technologies and Strategies:

- renewable energy
- energy efficiency
- electric vehicle
- energy storage
- smart connected controls

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	GridOptimal Metric	What it Measures
Load Shape	Grid Peak Contribution	Degree to which building demand contributes to load on the grid during system peak hours
	Onsite Renewable Utilization Efficiency	Building's consumption of renewable energy generated onsite (not exporting to grid) over a year
	Grid Carbon Alignment	Degree to which the building demand contributes to upstream (grid) carbon emissions over a year
	Energy Efficiency vs. Baseline	Percent better than code (annual total energy use)
Asset Capabilities	Short-Term Demand Flexibility	Building's ability to reduce demand (shed) for 1 hour
	Long-Term Demand Flexibility	Building's ability to reduce demand (shed) for 4 hours
	Dispatchable Flexibility	Building's ability to automatically reduce demand (shed) for 15 minutes, controlled by utility/ third party
	Resiliency	Building ability to island from grid and/or provide energy for critical loads for 4-24 hours; motor soft start capability to help grid restart after outage

https://newbuildings.org/wp-content/uploads/2020/11/NewMetricsForEvaluatingBuildingGridIntegration.pdf

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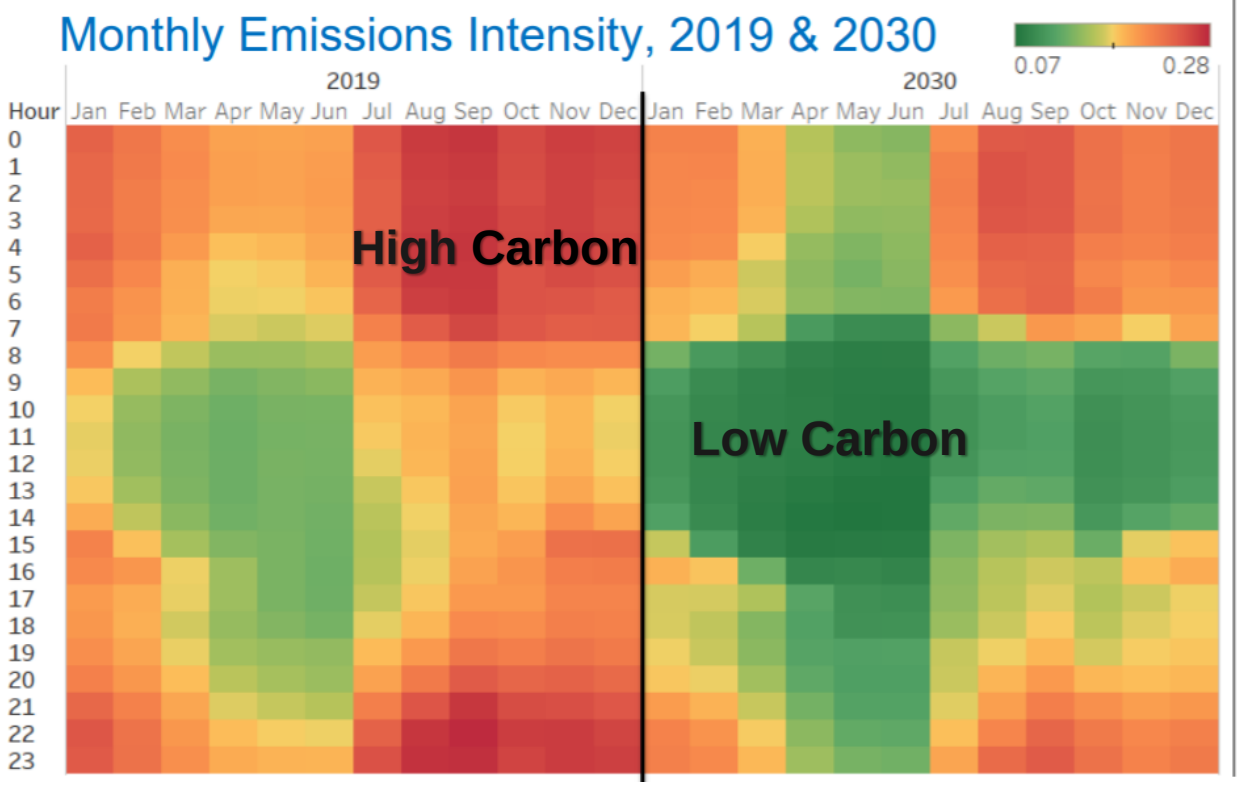
CALIFORNIA ENERGY COMMISSION

Electricity CO_2 Intensity



Electricity will be cleaner than NG 70% of the times by 2030

Brook, M. (2018). Building Decarbonization: 2018 Update Integrated Energy Policy Report. Presentation. Retrieved from https://efiling.energy.ca.gov/GetDocument.aspx?tn=223817&DocumentContentId=54026.

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Our Long-Term Vision

- **Transform the built environment for tomorrow's grid**
- Support development of integrated utility programs
  - Holistic efficiency *and* demand response programs
  - Incentives: new metrics & a fresh framework
- Design guidance and tools for designers
- Program, Rating System, Market, and Policy Deployments

Buildings can be
grid decarbonization enablers

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A Joint Initiative Of:

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Supporting Members:

Southern California Edison

Pacific Gas and Electric Company

SMUD

Austin Energy

Efficiency Vermont

EnergyTrust of Oregon

GRIDOPTIMAL™ BUILDINGS INITIATIVE

Now accepting pilot projects and welcoming pilot buildings + program participants – join us!
https://newbuildings.org/gridoptimal/

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Thank you !

smita@newbuildings.org

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Closing Poll

- **After today's call, what will you do?**
  - Consider implementing one or more of the ideas discussed
  - Seek out additional information on one or more of the ideas
  - Make no changes to your current approach
  - Other (please explain)

STEM
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U.S. DEPARTMENT OF ENERGY
ENERGY.GOV/STEMRISING

Explore the Residential Program Solution Center

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

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

https://rpsc.energy.gov

Thank You!

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Please send any follow-up questions or future call topic ideas to:
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