



VanDusen Botanical Gardens Visitor Centre, Vancouver, BC | Credit: Nic Lehoux



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Plugging into Building Electrification

Market, Policy, and Technology Progress

April 21, 2020

Today's Topics – Decarbonizing the Built Environment

1. Market Attention
2. Policies & Initiatives
3. Technologies

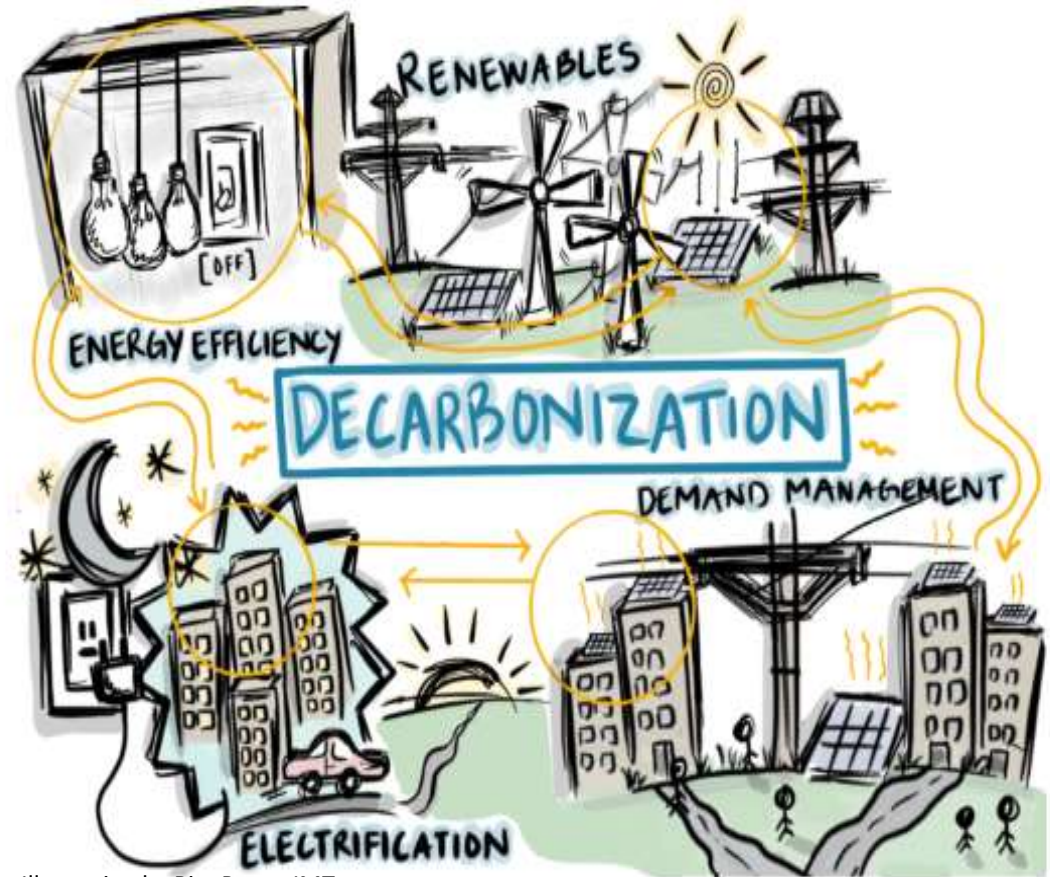


Illustration by Rita Perez, IMT

1) Market Attention

Why go 'low-carb'

Making Headlines



Electrification of buildings: A cornerstone of Canada's low-carbon future

The Electrifying Path to Decarbonization — Part 3

OPED - Jan. 10, 2018 - By Dylan Heerema

PEMBINA
institute

Goodbye, gas furnaces? Why electrification is the future of home heating

CBC

Emily Chung · CBC News · Posted: Jan 20, 2020 4:00 AM ET | Last Updated: February 4

No more fire in the kitchen: Cities are banning natural gas in homes to save the planet

Elizabeth Weise USA TODAY

Published 10:33 a.m. ET Nov. 10, 2019 | Updated 7:47 p.m. ET Nov. 21, 2019

USA
TODAY

Cost, comfort emphasized as building electrification takes off in Colorado

In a first for Massachusetts, Brookline votes to ban oil and gas pipes in new buildings

The Boston Globe

Cities Look to Natural Gas Bans to Curb Carbon Emissions

SCIENTIFIC
AMERICAN

Forward-Looking Cities Lead the Way to a Gas-Free Future

By Matt Gough February 11, 2020

Cities are banning natural gas in new homes, citing climate change

CBS
NEWS

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CarbonPositive'20

You Should Stop Designing Buildings With Natural Gas Because It Is Dirty, Dangerous, Bad For the Climate and Will Trap Your Clients In An Expensive, Embarrassing and Smelly Hell

PANAMA BARTHOLOMY

Director, Building Decarbonization Coalition

Presented by Architecture 2030 & **ARCHITECT**



March 2–4, 2020 | Intercontinental Los Angeles Downtown

The New York Times

Calculating Air Pollution's Death Toll, Across State Lines



"The biggest culprit of dangerous pollutants now is the commercial and residential real estate sector's reliance on heating from fossil fuels. Building emissions accounted for 28,200, or $\frac{1}{4}$, of all premature deaths from air pollution in 2018."

[Dedoussi, I.C., Eastham, S.D., Monier, E. et al. Premature mortality related to United States cross-state air pollution. *Nature* 578, 261–265 \(2020\).](#)

Outdoor Air Quality: Burning Fossil Fuels in Buildings is a Big Part of California's Smog Problem

Nitrous Oxide (NO_x) in California



Source: California Air Resources Board

Cooking with Gas Can Harm Children



Children living in a home with a gas cooking stove have a 42% increased risk of current asthma and a 24% increased lifetime risk of asthma.

[Cooking with Gas Can Harm Children: Cooking with gas stoves is associated with increased risk of childhood respiratory illnesses, including asthma Andee Krasner, MPH* and T Stephen Jones, MD, MPH](#)



METHANE IS

84x more potent
than CO₂ in the short run



Business

Methane leaks offset much of the climate change benefits of natural gas, study says



Natural gas burn off near oil pumps in Watford City, N.D. (Charles Rex Arbogast/AP)

By **Steven Mufson**

June 24, 2018 at 3:00 p.m. PDT

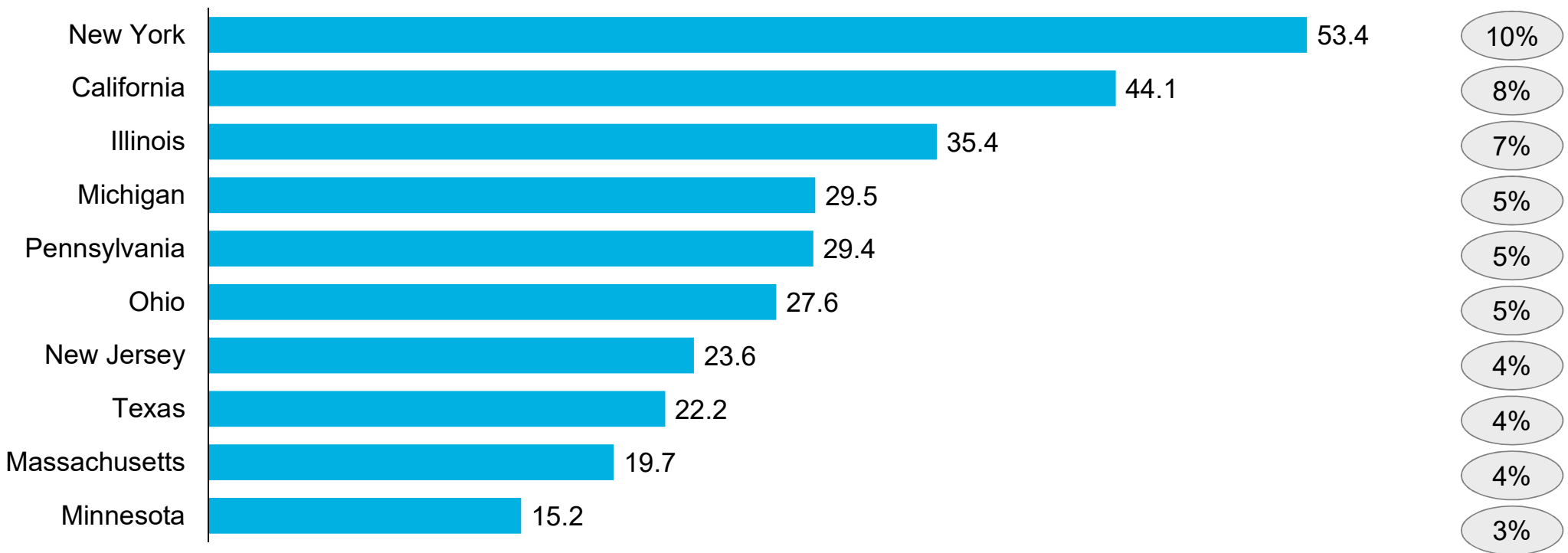


Ten states are responsible for 56% of US direct building emissions

Building greenhouse gas emissions by state

Million metric tons CO₂e, 2017

% of US total



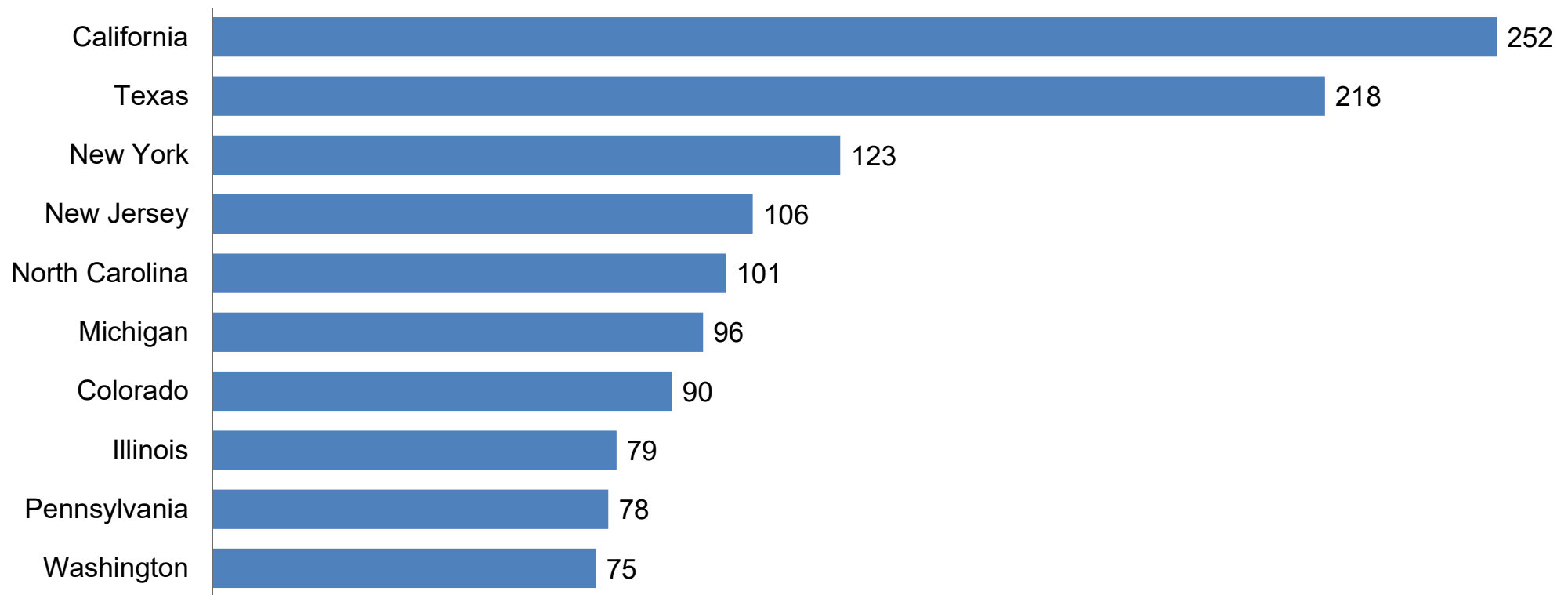
Note: Excludes methane leakage.

Source: EIA 2017

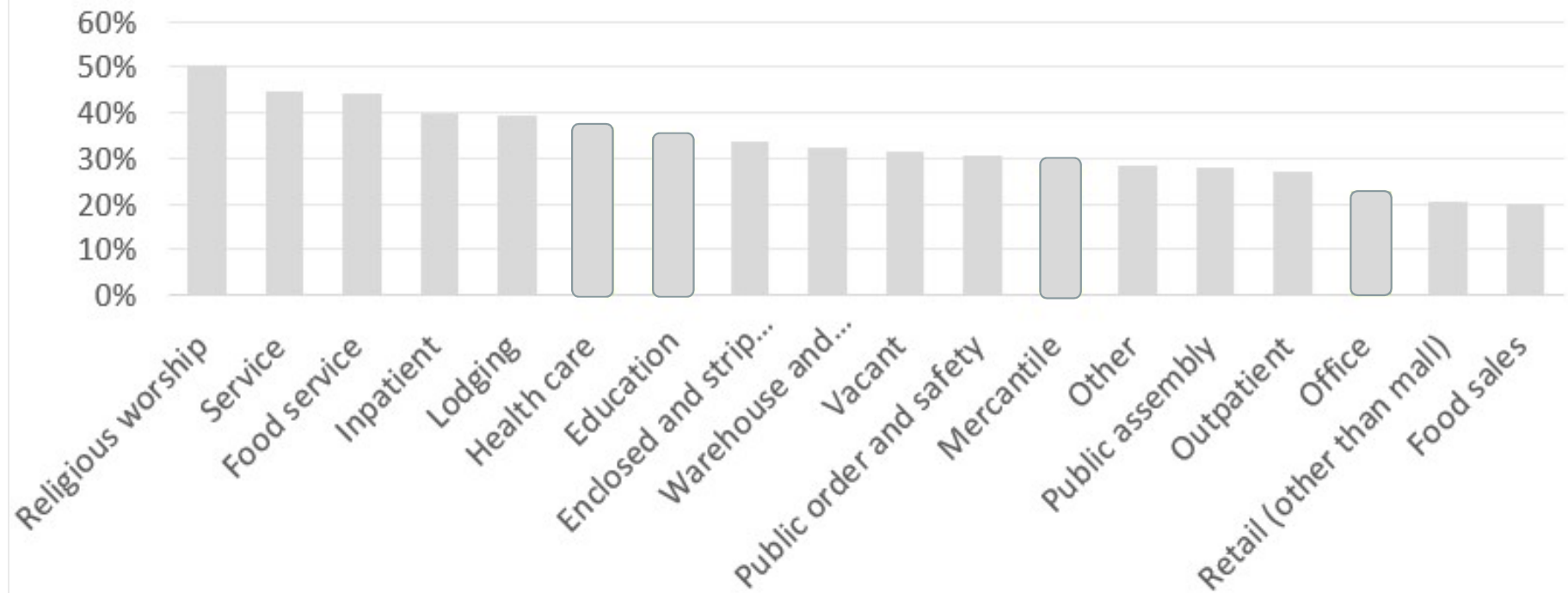
10 states account for 52% of all new gas customers 2013 to 2017

New gas customers, 2013–2017

Thousands of customers, residential and commercial sectors



Natural Gas Site Portion of Commercial Sector Site Energy Use¹

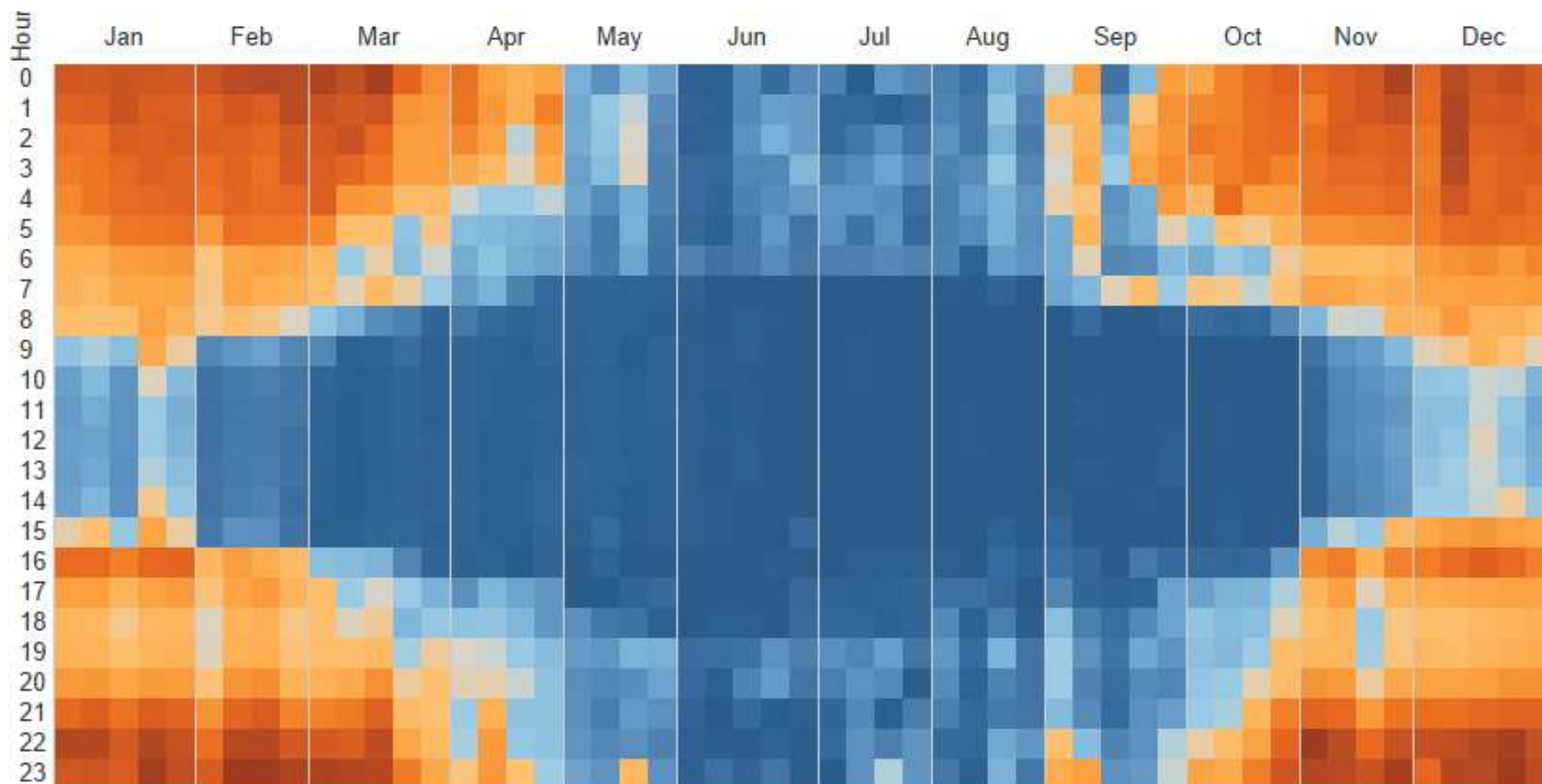


¹ AGA Report 2017, *Uncovering the US Natural Gas Commercial Sector*

Understand the data to set building decarbonization



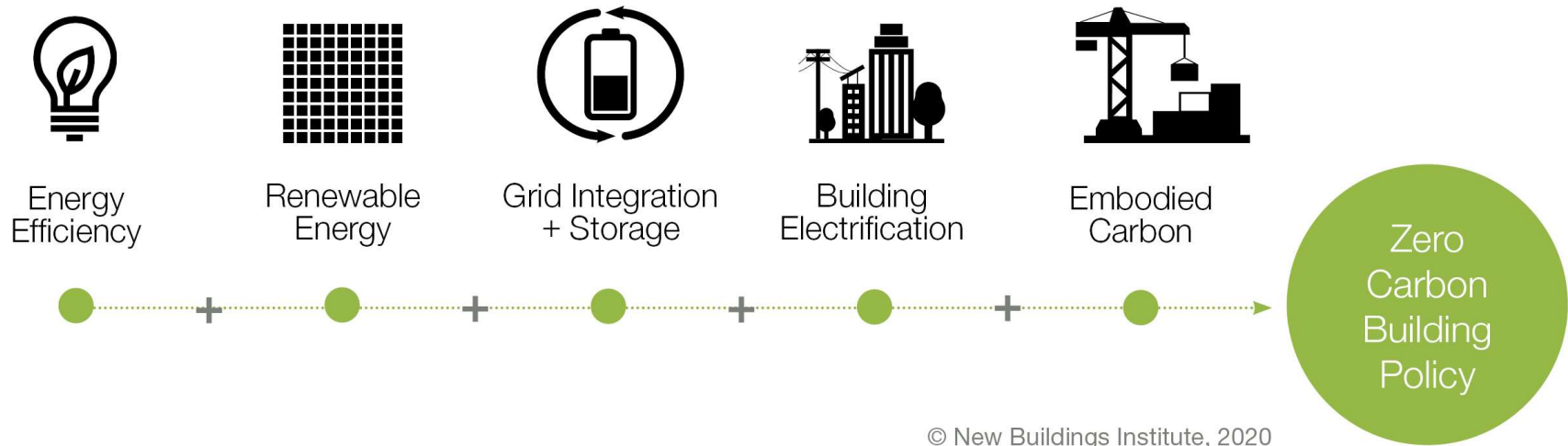
Electricity GHG Emission Intensities Relative to Natural Gas



2) Policies and Initiatives

Building Electrification is growing

The Five Foundations of Zero Carbon Building Policies



Overview of US Electrification Policies

- **30 Total Local Policies**
 - 27 Cities and 1 County in CA
 - 1 City in MA & 1 City Utah
- **3 Policy types:**
 1. Gas Moratoriums
 2. Electric - required Reach Codes – *most with exceptions*
 3. Electric-preferred – *additional requirements for dual fuels*



Gulf Islands National Park Preserve Operations Centre, Sidney BC

- **4 State Policy Examples:**

- CA, NY, MA & VT

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Policy Examples from California

Building Sector	Policy or Measure	Specific Details
All	Statewide emissions target (AB3232)	40% GHG reduction by 2030 over 1990 levels
All	Energy Efficiency Increased Requirements (SB 350)	Doubles building energy efficiency by 2030 through utility Integrated Resource Plans
New Residential and Commercial (varies)	Local Zero-emissions building codes	27 cities and 1 county have various electrification mandates or preferred policies
Existing homes and business	Incentives	\$1 billion self-generation program (includes HPWH) to reduce GHG
New & Existing	Incentives	\$200M over four years for low-carbon space & water heating

Some of the 50+ Leading US Cities


'Bloomberg' Cities working toward accelerating Electrification:

Albuquerque	Minneapolis
Atlanta	Orlando
Austin	Philadelphia
Boston	Pittsburg
Charlotte	Portland
Chicago	St. Paul
Cincinnati	San Antonio
Columbus	San Diego
Denver	San Jose
Honolulu	Seattle
Indianapolis	St. Louis
Los Angeles	St. Petersburg
	Washington, DC

Members of the Building Electrification Initiative:

Berkeley, CA
Boston, MA
Boulder, CO
Burlington, VT
New York City, NY
Salt Lake City, UT
San Jose, CA
Washington DC

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VanDusen Botanical Gardens Visitor
Centre | Vancouver, BC
Source: Nic Lehoux

Local U.S. Electrification Policies

- 27 Cities and 1 County in CA
- 1 City in MA & UT
- **30 Total**

Up to 50 more in consideration

Approved Zero Emission Building Codes in California as of 2/21/2020

Jurisdiction	Approach			Systems			Building Types								Add-Ons		
	Natural Gas Infrastructure Moratorium	All-Electric Reach	Electric-Preferred	Whole Building	Water Heating	Space Heating	Low Rise Residential	City-Owned Properties	High Rise Residential	Hotel	Retail	Office	Restaurant	Life Sciences	Additional Solar	Electric Vehicles	Natural Gas In Lieu Fee
Alameda	X			X				X									
Berkeley	X		X	X			X	X	X	X	X	X	X	X			
Brisbane*		X			X	X	X	X	X	X	X	X	X				
Campbell		X			X	X	X									X	
Carlsbad	X	X			X		X								X		
Cupertino		X		X			X	X	X	X	X	X	X			X	
Davis			X	X			X										
Healdsburg		X			X	X	X	X	X	X	X	X	X	X			
Los Altos Hills		X			X	X	X	X	X	X	X	X	X				
Los Gatos		X		X			X									X	
Marin County			X	X			X	X	X	X	X	X	X	X		X	
Menlo Park*		X			X	X	X	X	X	X	X	X	X		X	X	
Mill Valley			X	X			X		X							X	
Milpitas			X	X			X	X	X	X	X	X	X	X			
Morgan Hill	X			X			X	X	X	X	X	X	X	X			
Mountain View*		X		X			X	X	X	X	X	X	X		X	X	
Pacifica		X			X	X	X	X	X	X	X	X	X		X	X	
Palo Alto*		X	X	X			X	X	X	X	X	X	X	X		X	
Richmond		X		X	X	X	X	X	X	X	X	X				X	
San Francisco	X		X				X	X	X	X	X	X	X		X	X	
San Jose*	X		X	X			X	X	X	X	X	X	X	X	X	X	
San Luis Obispo			X	X			X	X	X	X	X	X	X	X			X
San Mateo			X	X			X					X			X	X	
San Mateo County			X				X	X	X	X	X	X	X			X	
Santa Monica			X	X			X	X	X	X	X	X	X	X		X	
Santa Rosa		X		X			X										
Saratoga		X			X	X	X	X	X	X	X	X	X			X	
Windsor		X		X			X										

Electrification Initiatives and Resources

- Building Decarbonization Coalitions in CA - and new in the Midwest (8 states)
- West Coast Advanced Water Heating Initiative (AWHI) (*NBI Initiative*)
- Electrification Resources
- Electrification efforts in North America
 - Strategy focus
 - Technology focus
 - Market focus



City of Vancouver Zero Emissions Fire Hall
Vancouver, British Columbia
Source: Canada Green Building Council

3) Electrification technologies

PV gets all the attention – ***but heating air and water are the cornerstones of building electrification***



*Solar array with real time generation data public dashboard
UBC Okanagan Campus, Kelowna BC*

Plenty of All-Electric Building Examples

Technologies vary by:

- Application:
 1. Space Heating
 2. Water Heating
 3. Cooking
 4. Clothes Drying
- Sector & Bldg. Type
- Market Status and Maturity
- Refrigerants: Low Global Warming (GWP) potential units



Santana Row Lot 11



Sacred Heart School



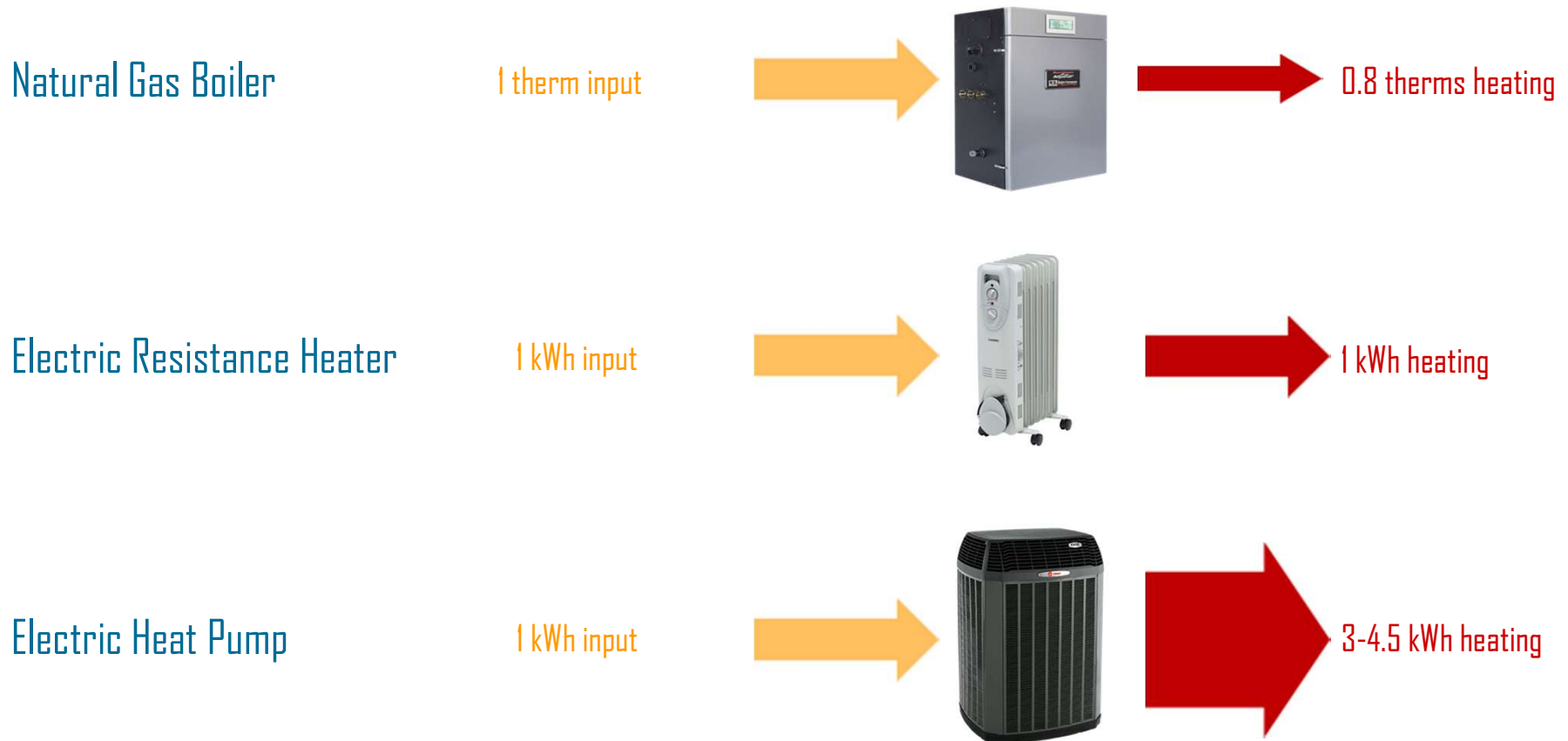
Chatam University Dining



Chatam University Housing

ehdd.

Electric systems provide heat more efficiently



Lots of technologies to electrify space heating

Technology Solutions for Commercial Sector	Technology Solutions for Residential Sector
HVAC	
Air Source Heat Pumps	Air source heat pumps
Low-Temp Heat Pumps	Low/high Temp Heat Pumps
Low-GWP Heat Pumps (CO2, Ammonia, Propane, etc...)	Packaged terminal heat pumps
Water Source Heat Pumps	Ducted Split Heat Pump
Ground Source Heat Pumps	Mini Split Heat Pump
Hydronic Heat Pump (air to water heat pump)	
Radiant Heating Cooling (distribution system)	
Variable Refrigerant Flow Heat Pumps (ductless Heat Pumps)	
Energy and Heat Recovery Ventilation (E/HRV) integration	
Next Generation Integrated Mechanical System	
Magnetocaloric Technology	

Predominantly Heat Pumps






And to electrically heat water

Technology Solutions for Commercial Sector	Technology Solutions for Residential Sector
Water Heating	
Heat pump water heater	Heat pump water heater
Central heat pump water heater	
Solar Hot Water Heating	Solar Hot Water Heating
Grid-integrated heat pump water heater	Flexible water heating sensitivity control technology

Heat Pumps again!
Heat Pump Water Heaters (HPWH)



Even burning gas in a power plant to run a heat pump is more efficient than a gas furnace or boiler

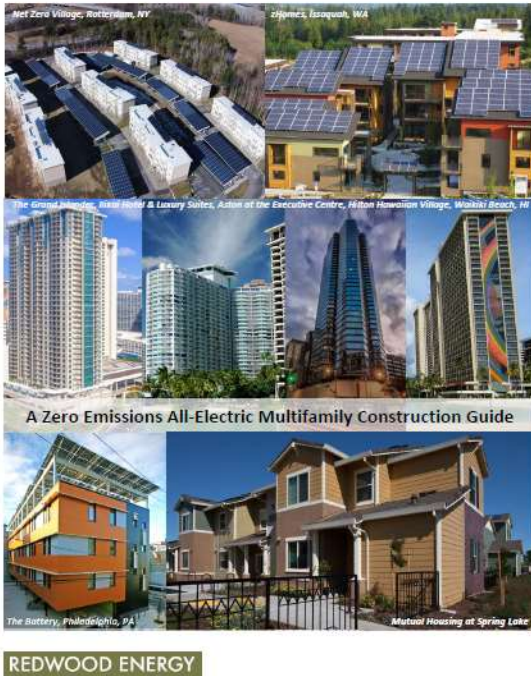
	Gas Consumed	Power Generation	Energy Input to Distribution System	T&D Losses	Energy Input to Appliance	Appliance Efficiency	Thermal Energy Output
Gas Furnace	10.5 MMBTU	n/a	10.5 MMBTU	0.4% Leakage	10.5 MMBTU	0.95 AFUE	
Heat Pump	9.6 MMBTU	 CCGT Heat Rate 7,812 Btu / kWh ~44% efficient	4.2 MMBTU 1,235 kWh	 5% Line losses	4.0 MMBTU 1,173 kWh	2.49 COP	10.0 MMBtu 2,921 kWh

Sources: EIA (average US line loss and gas plant heat rate); EnergyStar (appliance efficiencies benchmarked at EnergyStar qualification level)

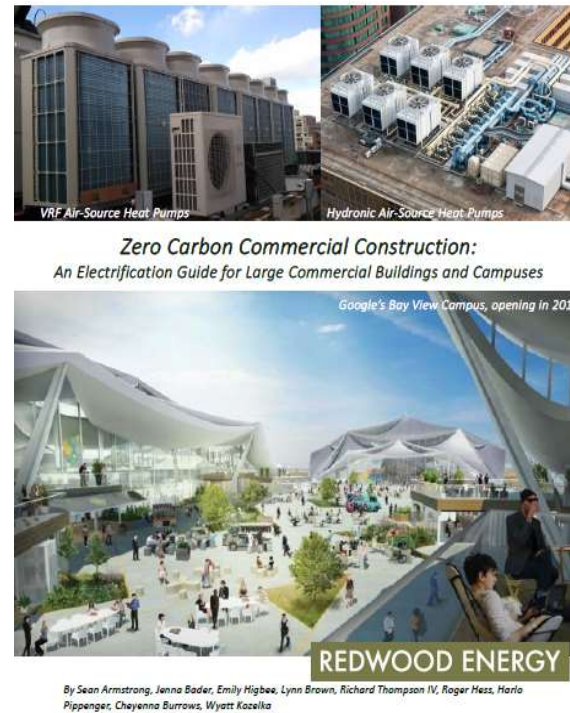
A Growing # of Guides for all Electric Buildings

New construction – the first step for electrification

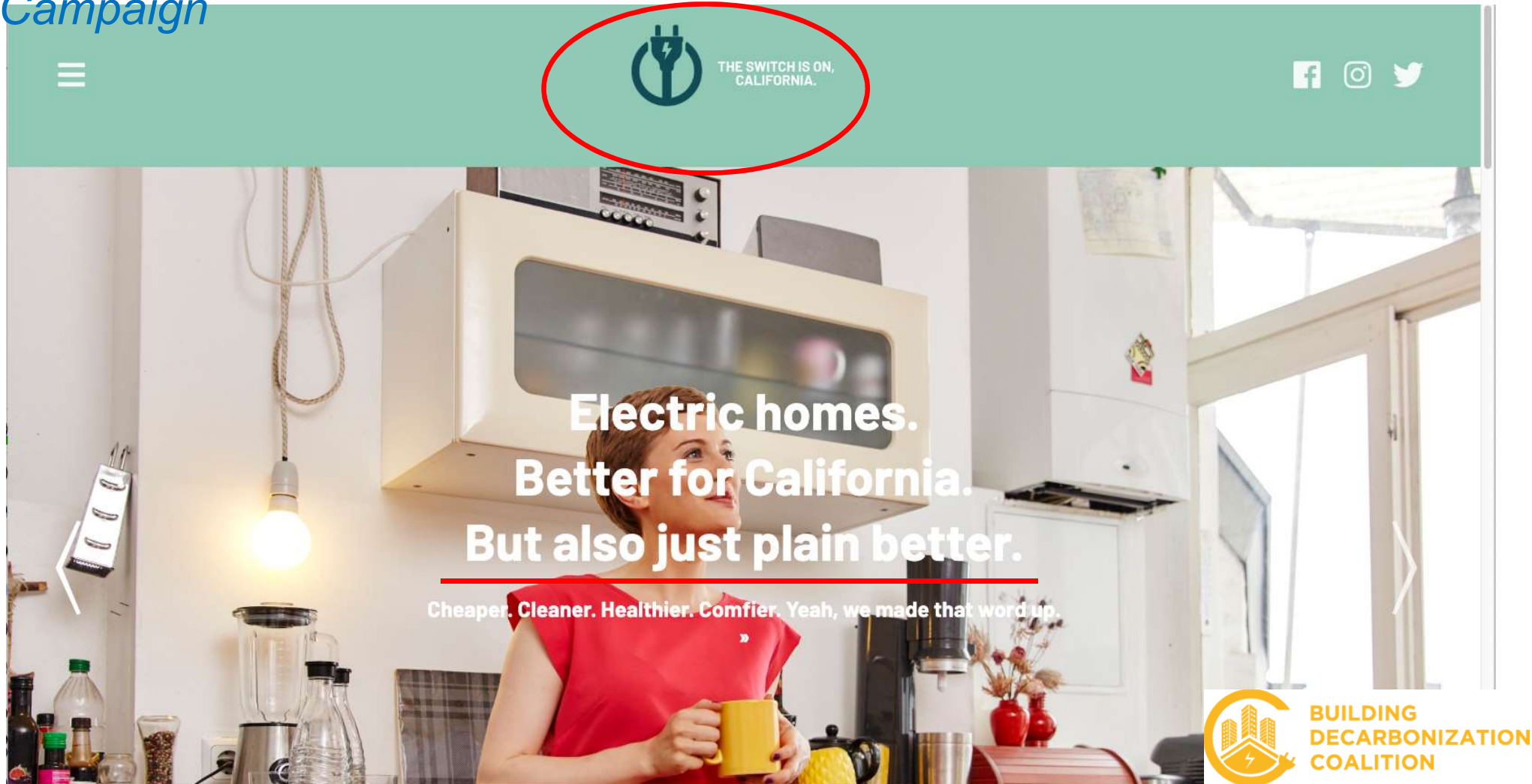
Multifamily New Construction



Large Commercial New Construction



Raising Consumer Awareness – *draft CA Electrification Campaign*



The image shows a website layout for a campaign. The header is a teal bar containing a menu icon, a logo with a plug and the text 'THE SWITCH IS ON, CALIFORNIA.', and social media icons for Facebook, Instagram, and Twitter. The main content area features a photograph of a woman in a red shirt holding a yellow mug in a kitchen. Overlaid on the photo is the text 'Electric homes. Better for California. But also just plain better.' followed by a red line and the phrase 'Cheaper. Cleaner. Healthier. Comfier. Yeah, we made that word up.' with a double arrow icon. The bottom right corner has the Building Decarbonization Coalition logo and name.

THE SWITCH IS ON, CALIFORNIA.

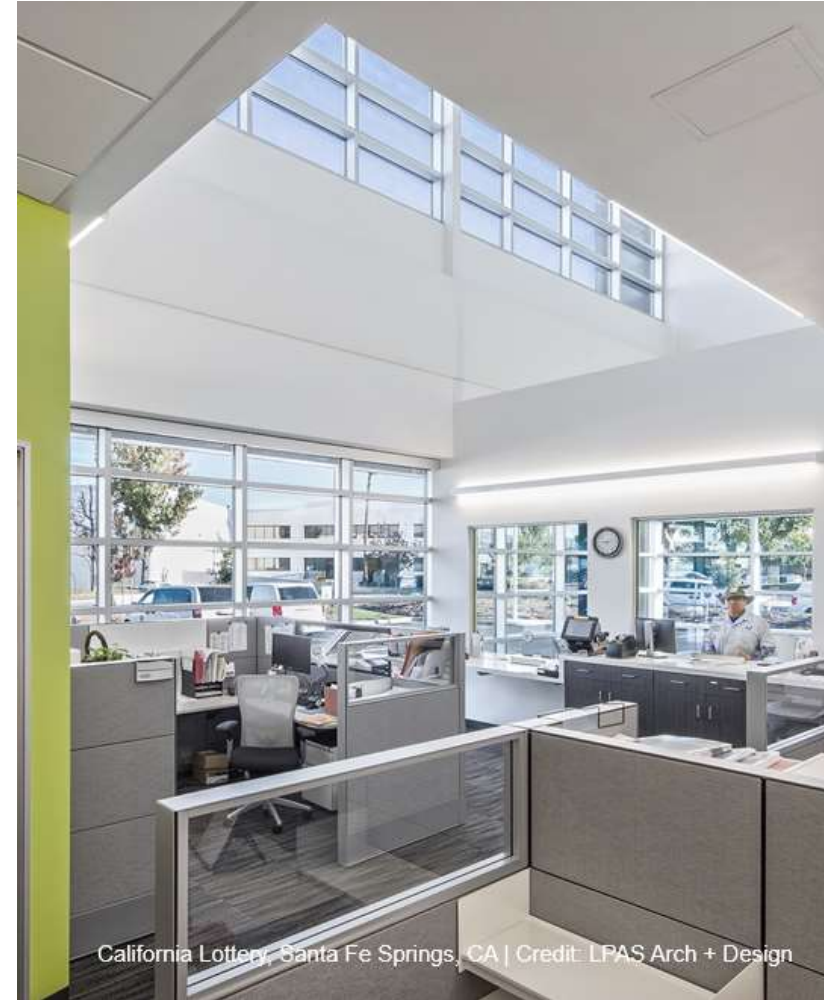
Electric homes.
Better for California.
But also just plain better.

Cheaper. Cleaner. Healthier. Comfier. Yeah, we made that word up.

BUILDING
DECARBONIZATION
COALITION

5 Take Aways

- **Building infrastructure must be decarbonized**
- **Growing market attention**
- **Plenty of Policies** - momentum in CA/ NY plus growing elsewhere
- **Extensive water/space heating options**
- **Low Greenhouse Warming Potential (GWP) refrigerants** are early stage solutions



California Lottery, Santa Fe Springs, CA | Credit: LPAS Arch + Design

Thank You!

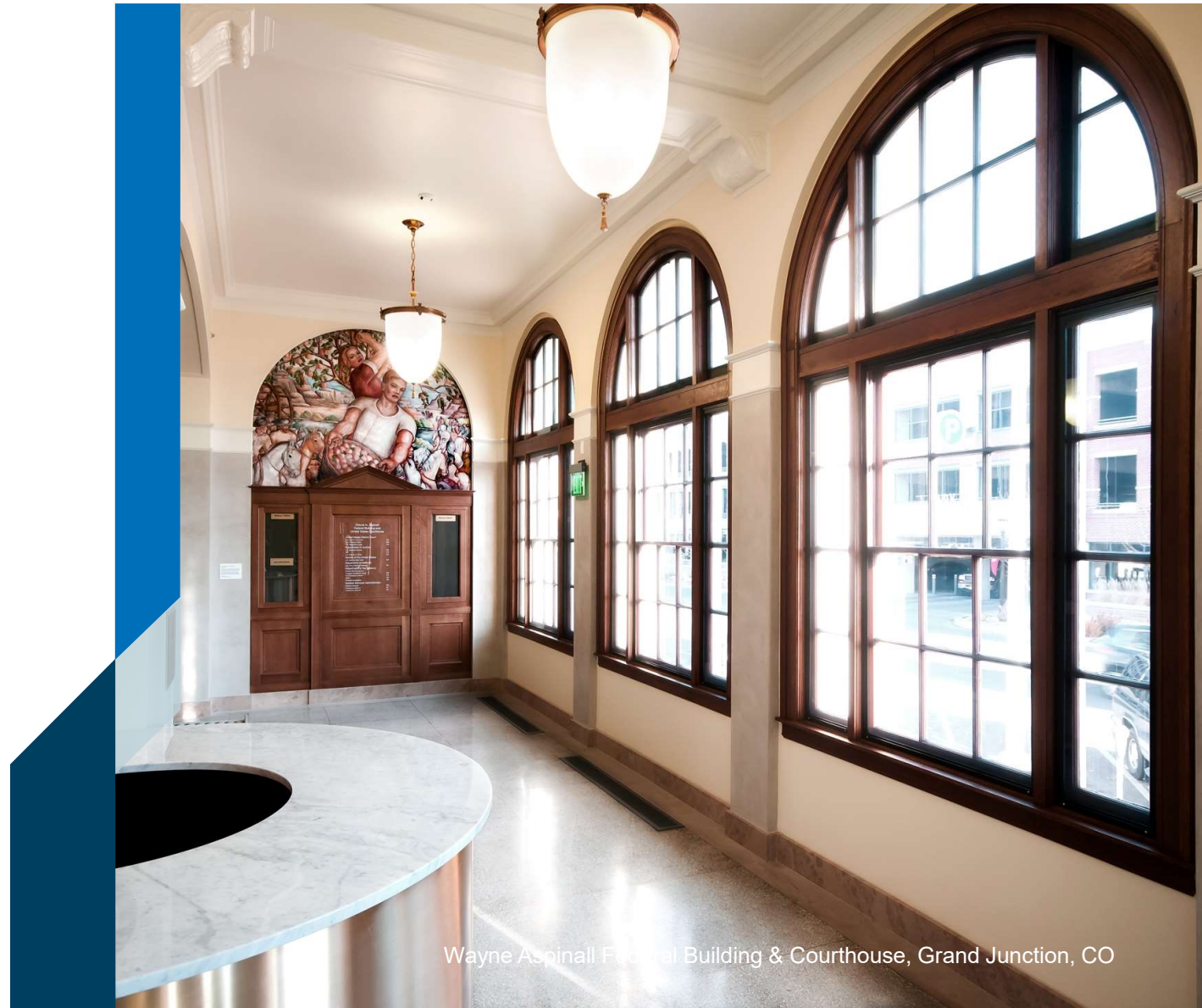
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Wayne Aspinall Federal Building & Courthouse, Grand Junction, CO