Technology Developments in Building Electrification

A California Perspective

Ken Rider
Chief of Staff to Commissioner Hochschild
November 8, 2018
California Energy Commission

The Energy Commission

5 Commissioners, appointed by Governor and confirmed by the Senate

Bob Weisenmiller
Chair

Karen Douglas
Siting & Compliance

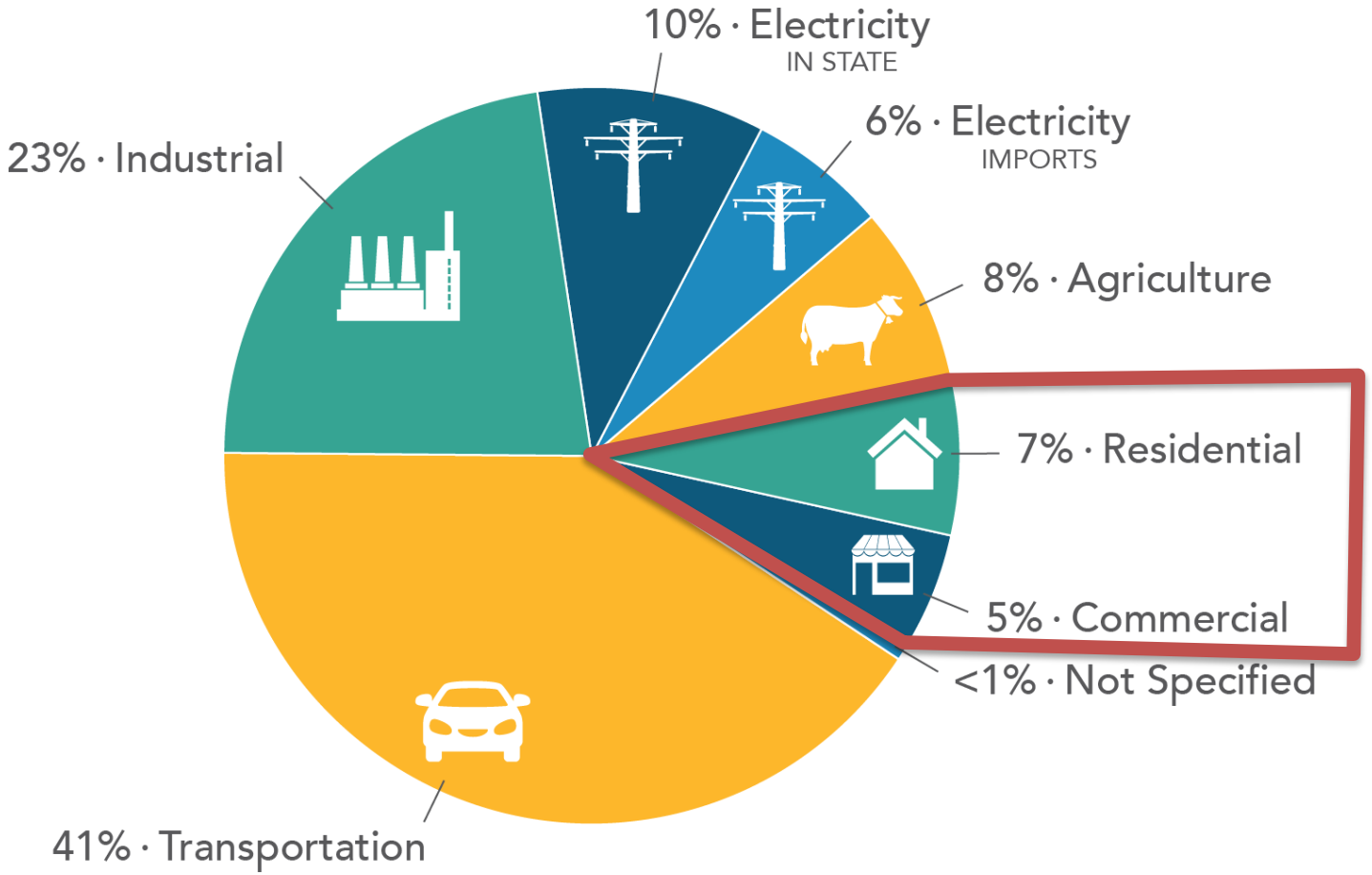
David Hochschild
Renewables

Andrew McAllister
Energy Efficiency

Janea Scott
Transportation

"We must map out, in a strategic and thoughtful way, a path to electrify almost everything from transportation to heating to industrial equipment and then transition our electricity portfolio to 100 percent renewables." -David Hochschild

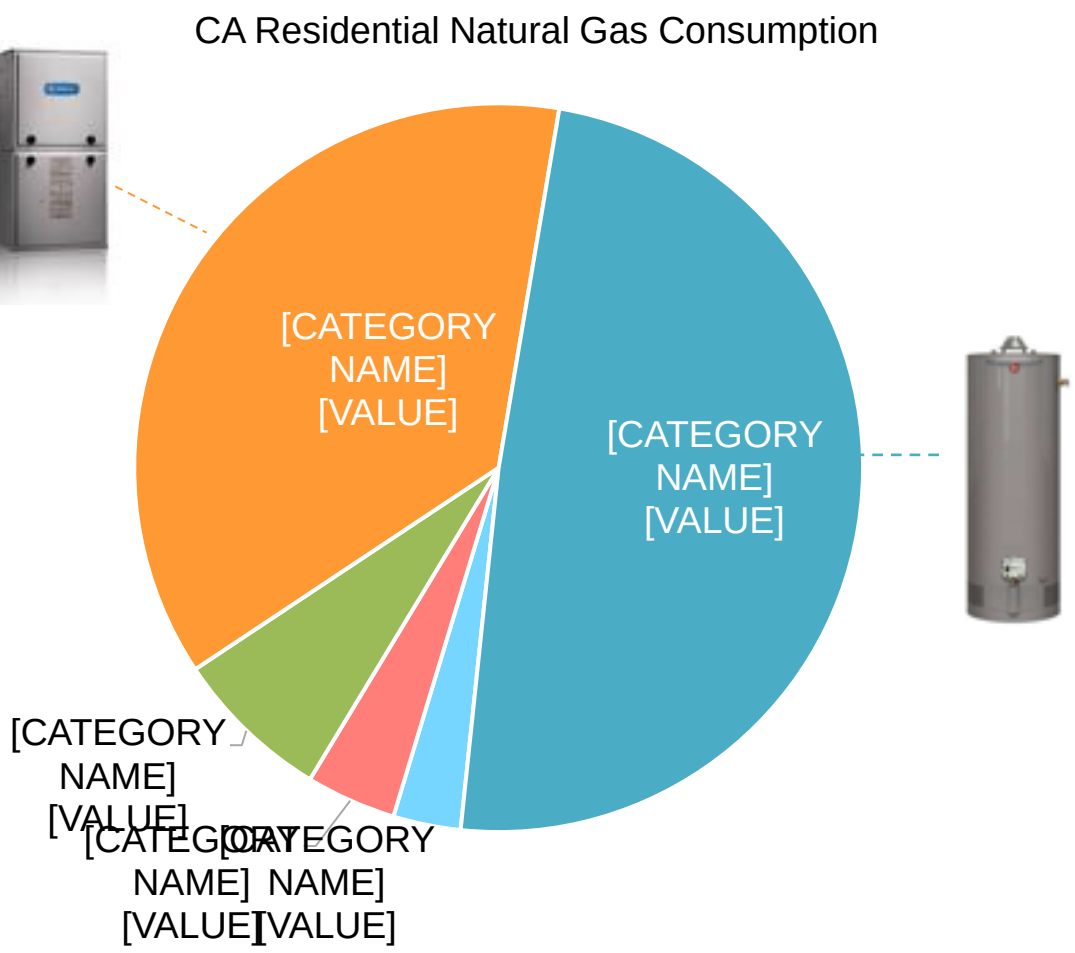
California Greenhouse Gas Emissions



429.4 $MMTCO_2e$
2016 TOTAL CA EMISSIONS

How Natural Gas is Used in California Homes

86% of direct residential emissions are from water and space heating



Source: 2009 California Residential Appliance Saturation Study

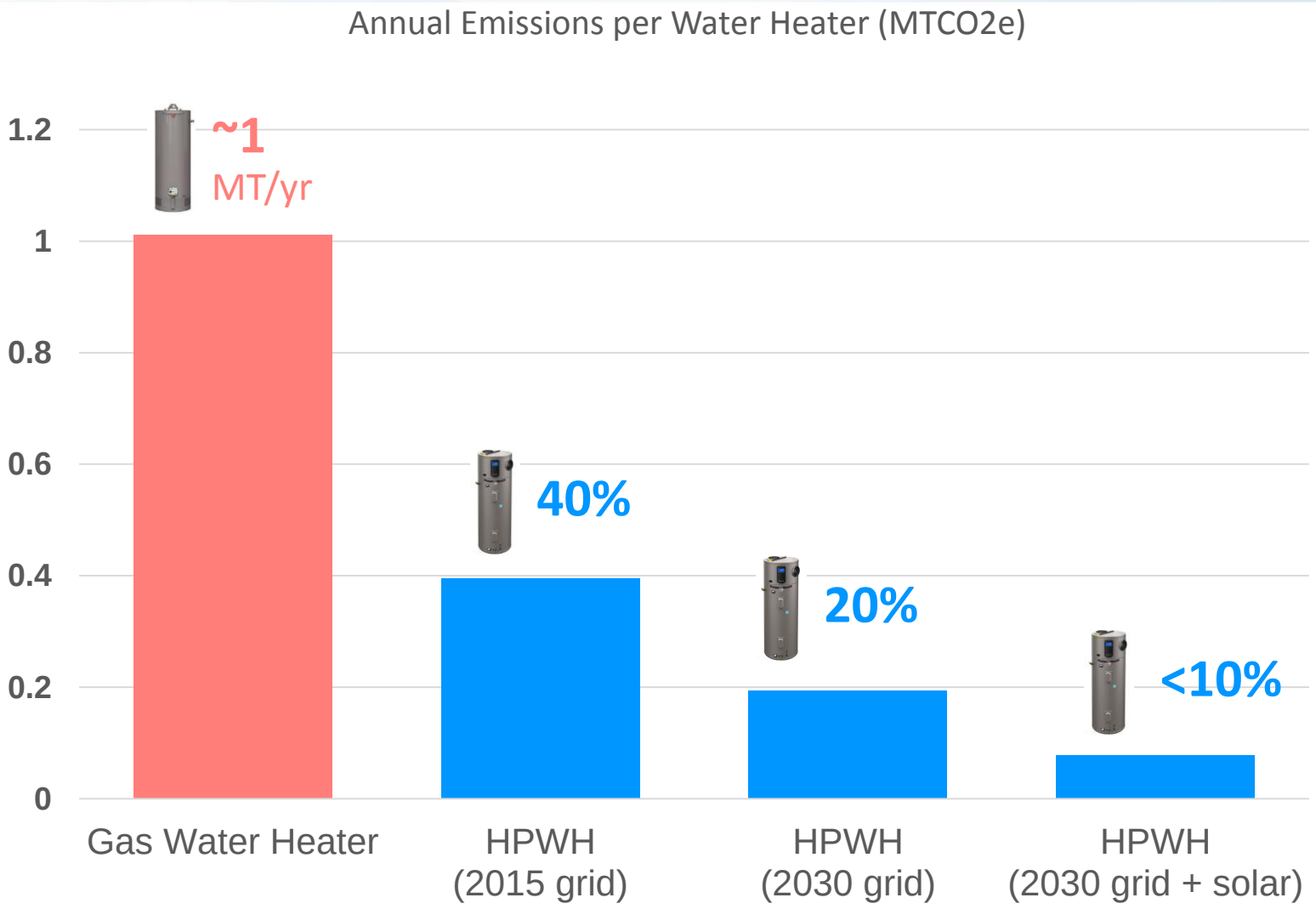
Electrification Technologically Feasible Today

Heat pumps can be **up to 6x as efficient** as conventional heating technologies

Water Heating			Space Heating		
Natural Gas Water Heater		Heat Pump Water Heater	Natural Gas Furnace		Heat Pump Space Heater
	Swap for →			Swap for →	

Source: Currently available products at Home Depot

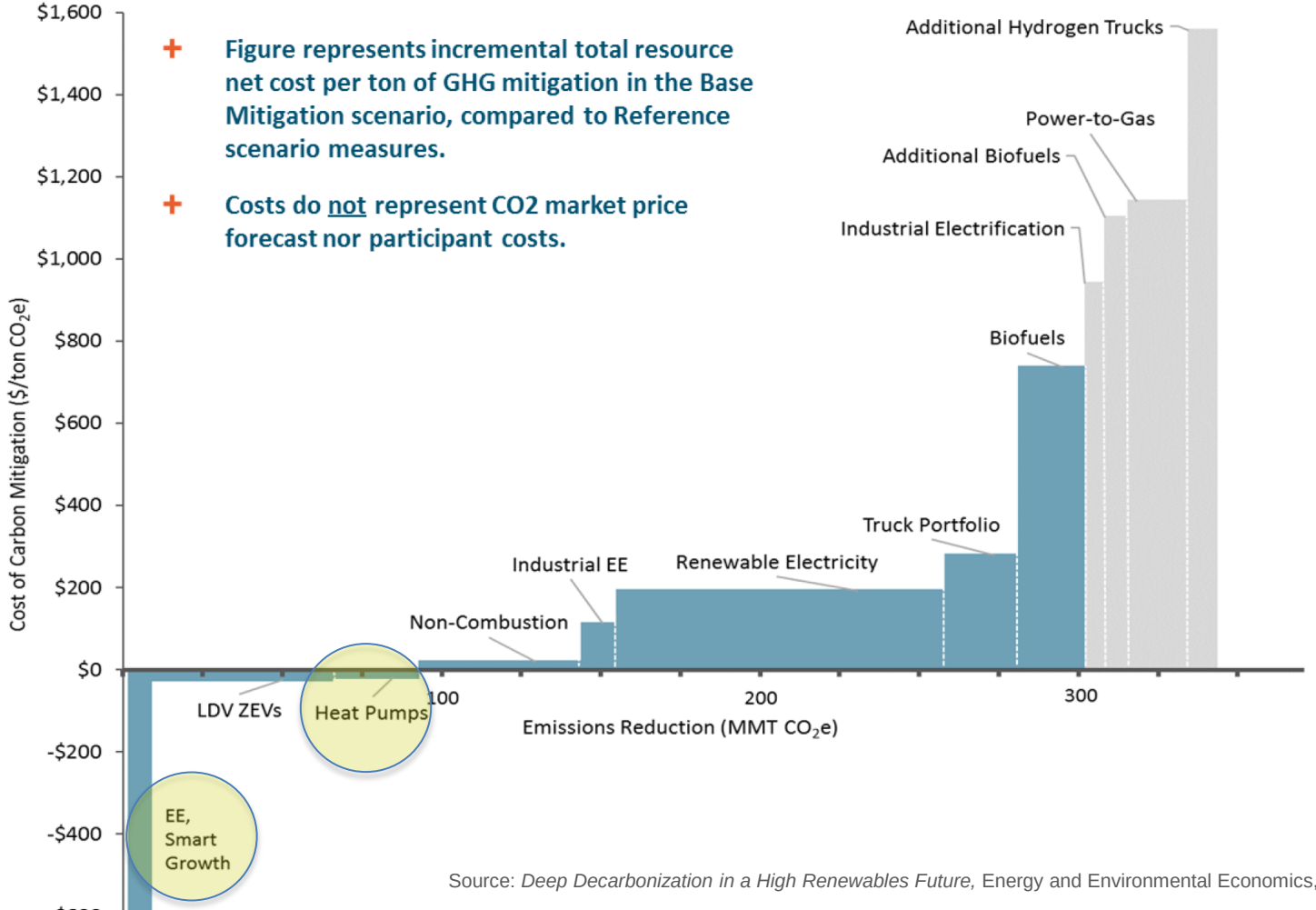
Water Heater Emissions



Source: ARB Emissions Inventory and CEC electricity consumption data

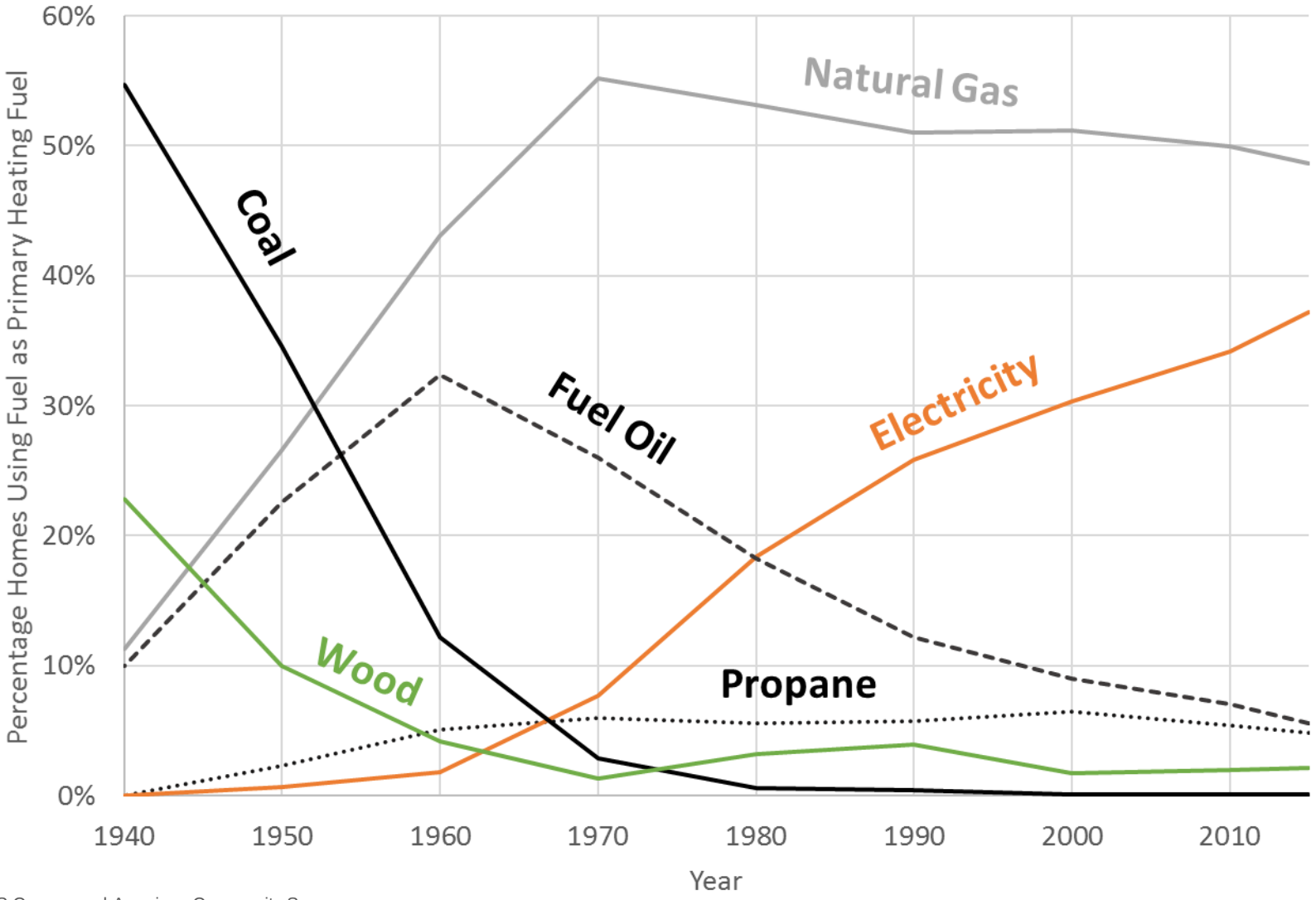
E3 Cost Modeling

Figure 26: 2050 Incremental Carbon Abatement Cost Curve (Total Resource Cost per Ton of GHG Reduction Measures, Net of Fuel Savings), in the High Electrification Scenario



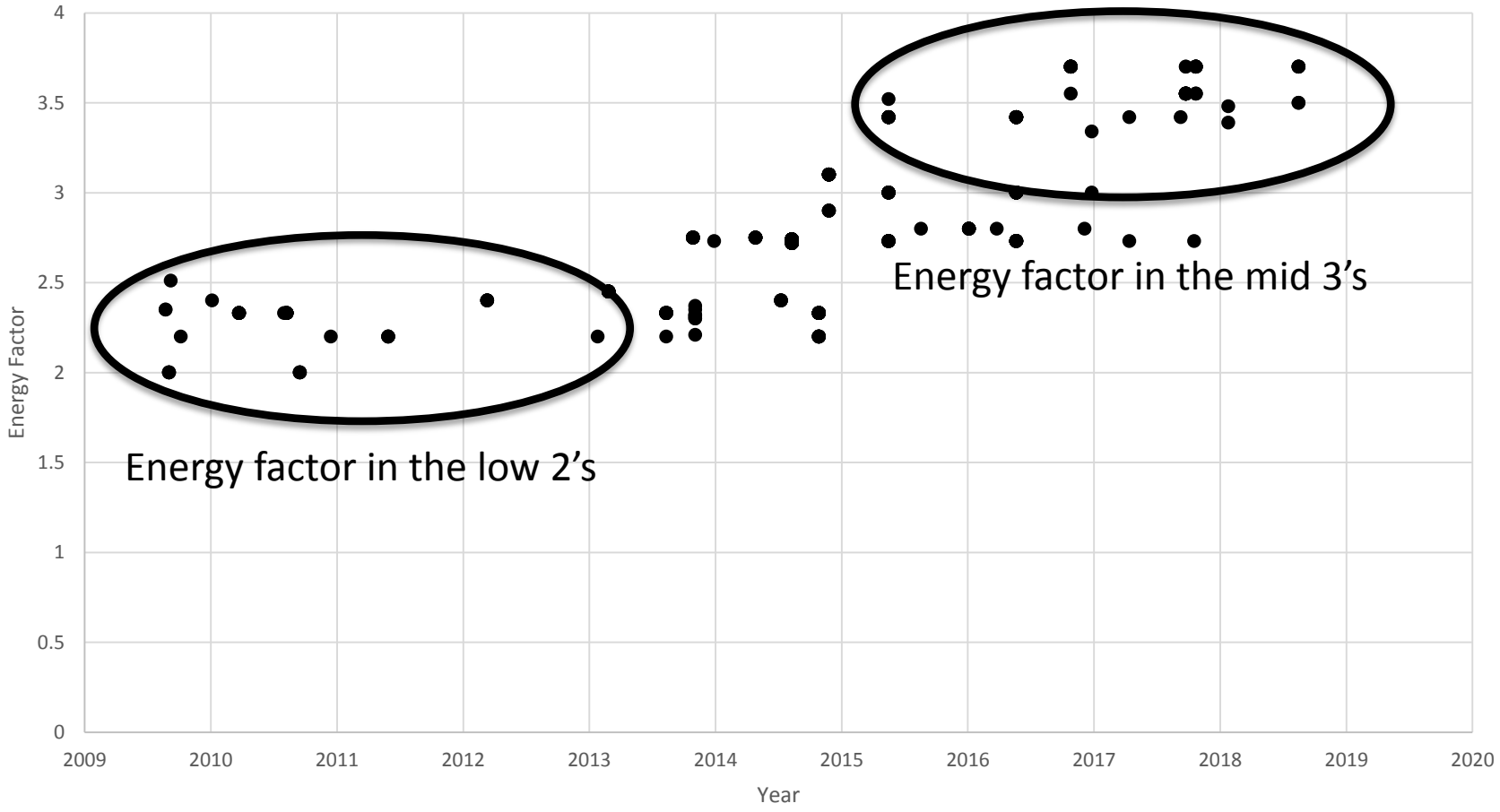
Source: *Deep Decarbonization in a High Renewables Future,* Energy and Environmental Economics, Inc.

Fuel Switching is Normal



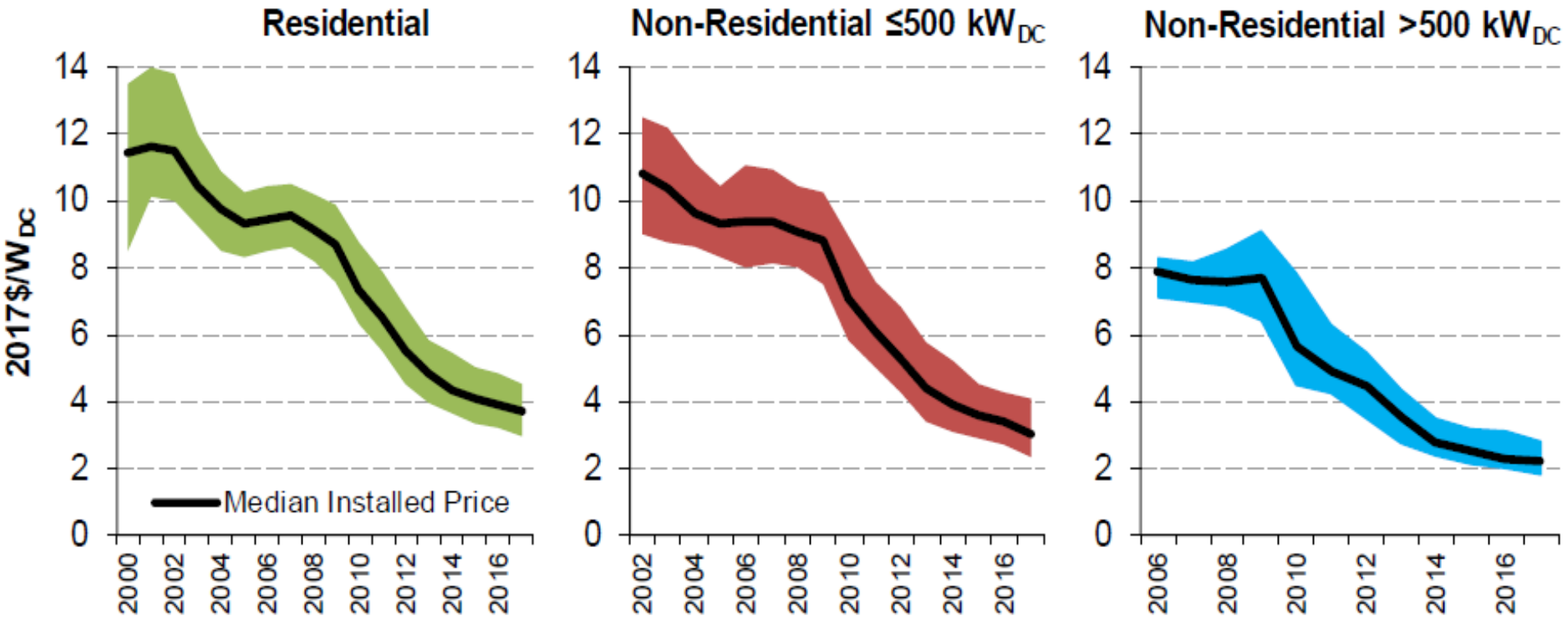
Source: US Census and American Community Survey

Heat Pump Water Heater Performance Advances



Source: Analysis of ENERGYSTAR qualified product lists

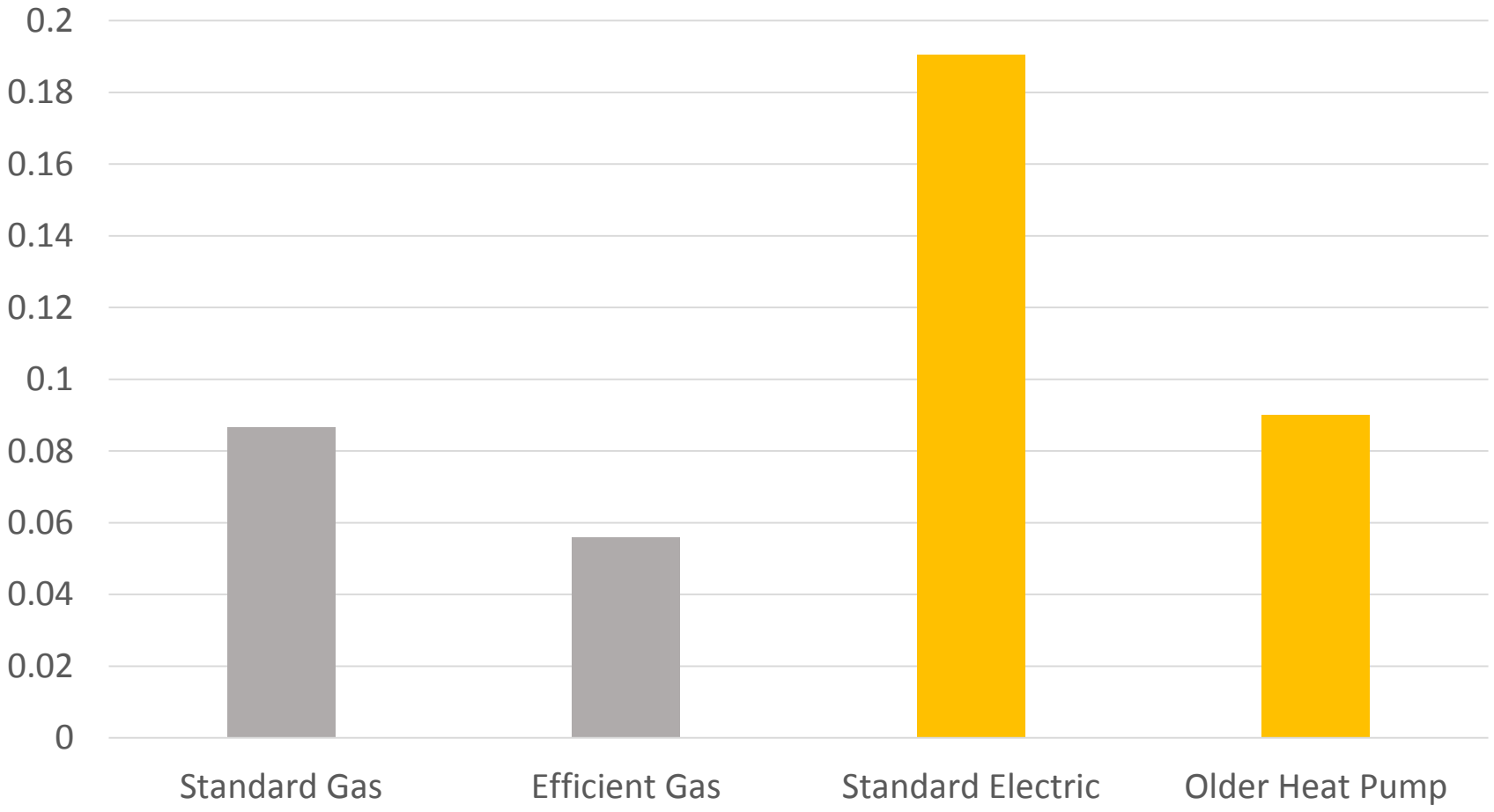
Photovoltaic Advances



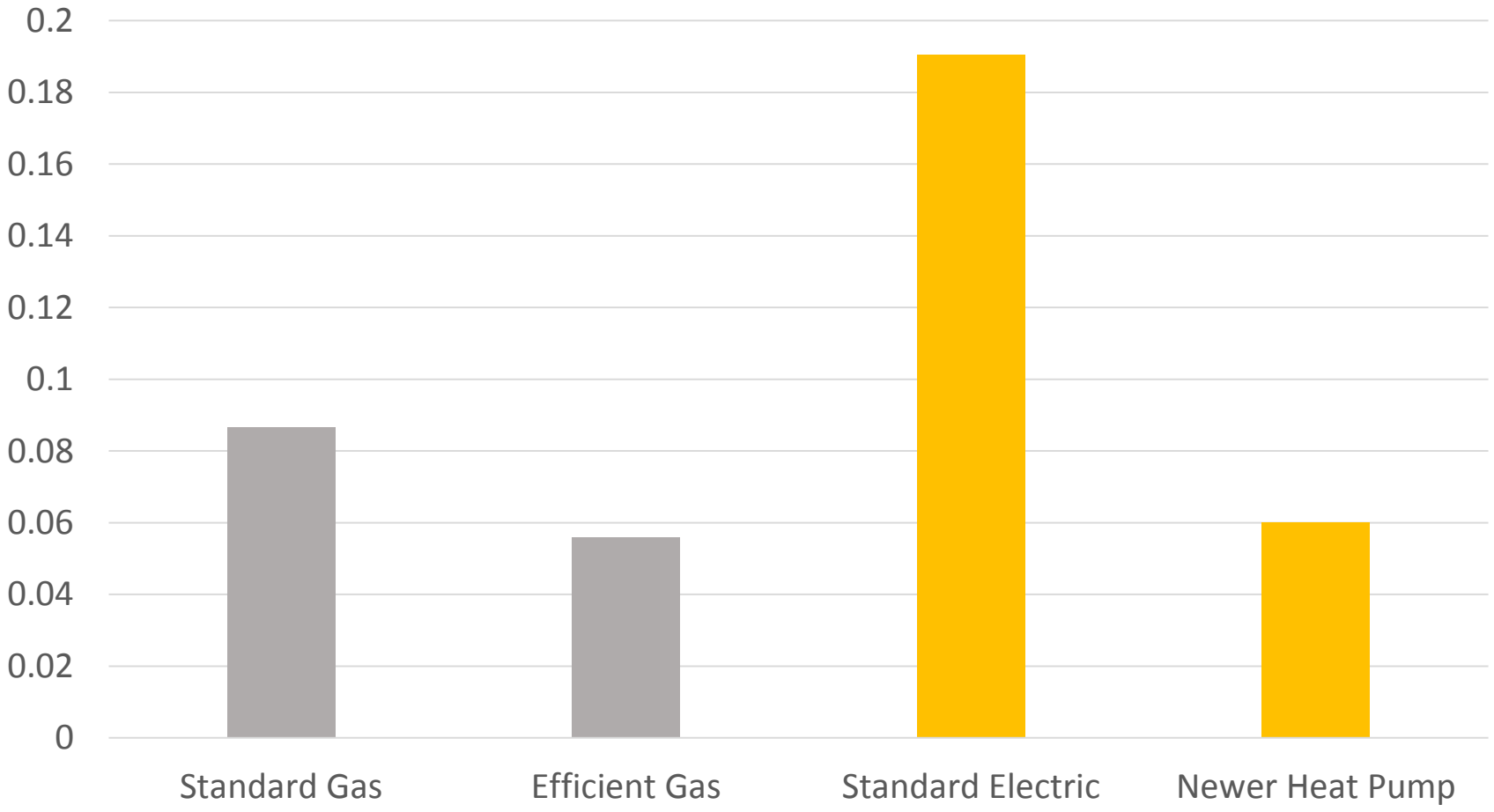
Notes: Solid lines are median prices, and shaded areas are 20th-to-80th percentile ranges. Statistics shown only if at least 20 observations are available for a given year and customer segment. See Table 1 for annual sample sizes.

Source: *Tracking the Sun: Installed Price Trends for Distributed Photovoltaic Systems in the United States – 2018 edition*, September 2018, Lawrence Berkeley National Laboratory
https://emp.lbl.gov/sites/default/files/tracking_the_sun_2018_edition_final_0.pdf

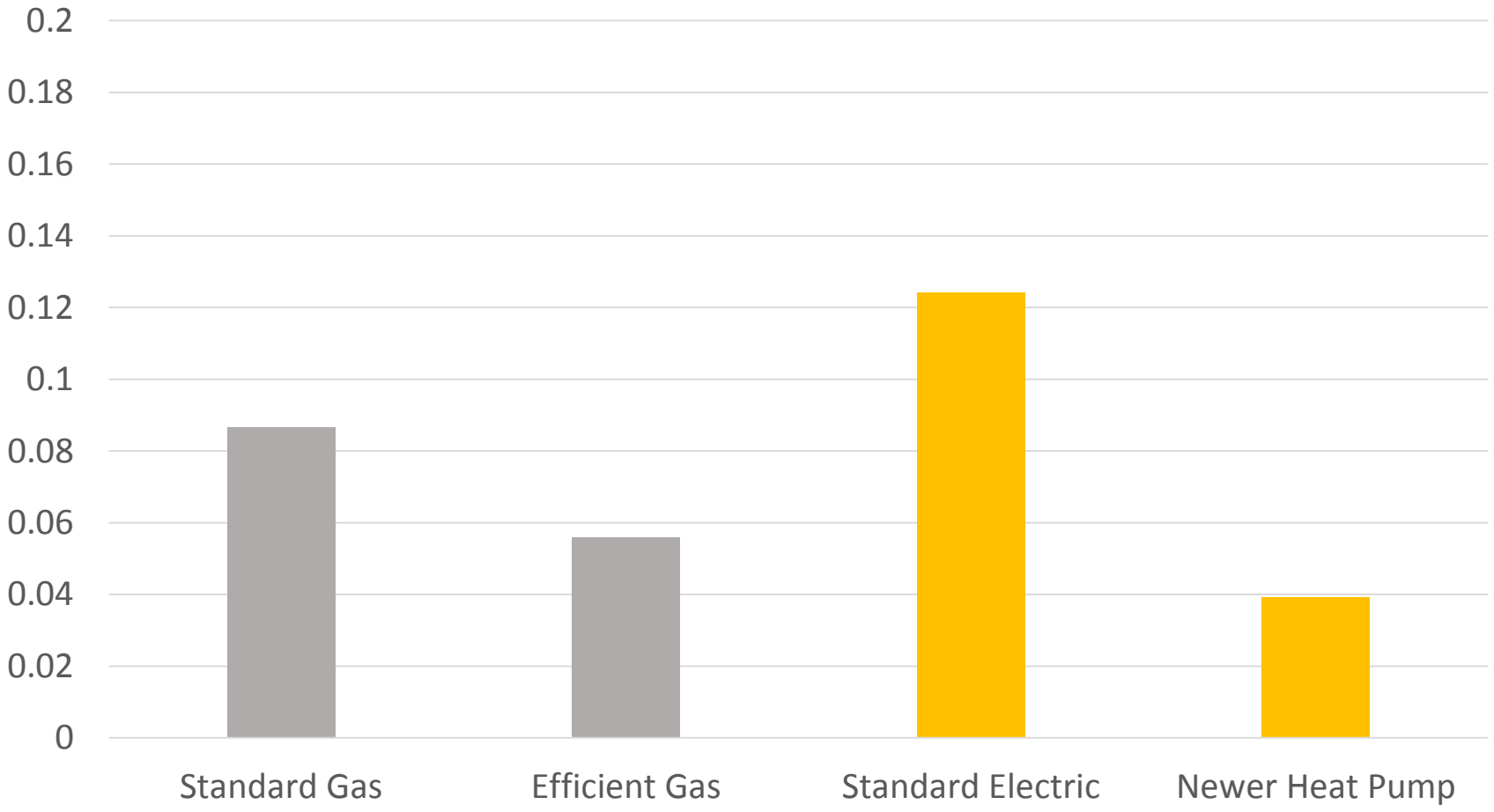
Operating Cost Comparison



With Better Heat Pumps



With Inexpensive Rooftop Solar



Synergy with the Grid

- Heat pumps can be combined with thermal storage to:
  - Decrease carbon intensity by running when renewable energy is abundant
  - Increase grid reliability by shedding load when critical

The Time Crunch

- Water heaters and furnaces have long lifetimes
- Even if 100% of new sales were heat pumps, would take decades to fully electrify
- Need to begin process now to reach significant decarbonization by 2050

Places to Start

- Economics of electrification are particularly attractive in:
  - New buildings
  - Buildings that utilize propane for heating
  - Solar PV retrofits

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Great Policy for the Past

Burn natural gas at a power plant or in the home?

50%

97%

Natural Gas
(CH4)

94%

95%

60%

System Efficiency

45% 303 Therms/yr

58% 235 Therms/yr

Two Factors Change the Math

1) Renewable energy
   a) 50 percent RPS
   b) The price of renewable energy is competitive with conventional energy.
2) Heat pump technology
   a) Can achieve coefficients of performance that exceed 3 (analogous to 300% efficiency).

Electrification Case

Electricity has energy and emission advantages

Renewable Electricity

94%

300%

Natural Gas (CH4)

97%

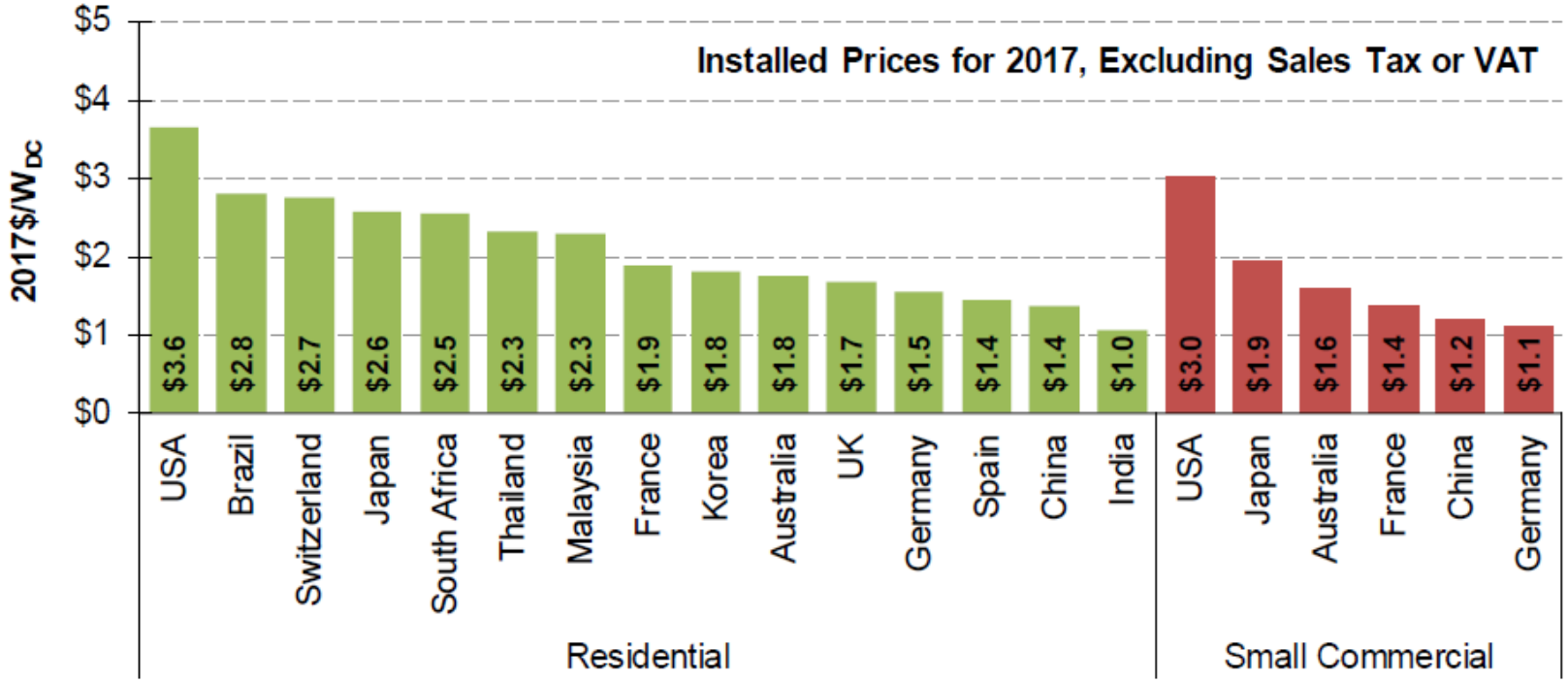
60%

System Efficiency

282% 48 Therms/yr

58% 235 Therms/yr

International PV Install Cost



Notes: Installed prices for countries other than the United States are primarily from IRENA (2018) and refer to average prices in either Q1 or Q2 2017; the one exception is the value reported for small commercial systems in France, which comes from de L'Epine-Hespul (2018) and is an annual number for all of 2017.

Figure 17. Comparison of Installed Prices in 2017 across Countries (Pre-Sales Tax/VAT)

Source: *Tracking the Sun: Installed Price Trends for Distributed Photovoltaic Systems in the United States – 2018 edition*, September 2018, Lawrence Berkeley National Laboratory
https://emp.lbl.gov/sites/default/files/tracking_the_sun_2018_edition_final_0.pdf