

Distributed Solar 2020 Data Update*

*Based on data otherwise published within Berkeley Lab's *Tracking the Sun* report. Updated data files and data visualizations are available at: trackingthesun.lbl.gov

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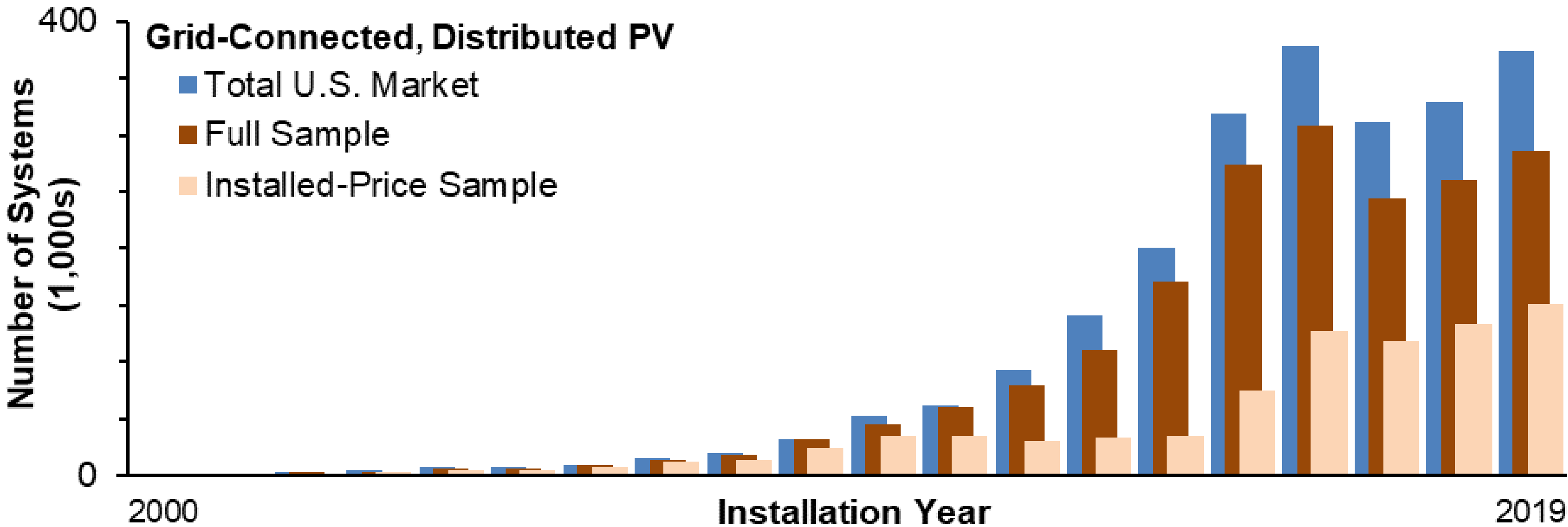
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Overview

- **Covers grid-connected, distributed photovoltaic (PV) systems installed through 2019**
 - “Distributed” PV consists of residential and non-residential systems that are roof-mounted (of any size) or are ground-mounted up to 5 MW_{AC}
 - Ground-mounted projects >5 MW_{AC} are covered in Berkeley Lab’s “Utility-Scale Solar Data Update: 2020 Edition”
- **Includes data on** installed system prices and other project characteristics, including: system sizing, module efficiency, module-level power electronics, inverter-loading ratios, solar+storage installations, mounting configuration, panel orientation, third-party ownership, and customer segmentation
- **Published in conjunction with this slide deck** (at trackingthesun.lbl.gov) **are:**
 - An Excel file containing summary data tables corresponding to each of the figures presented in this slide deck
 - A public data file with all non-confidential project-level data
 - Interactive data visualizations that allow further exploration of the data

Sample Size Relative to Total U.S. Market



Notes: Total U.S. distributed PV installations are based on data from Interstate Renewable Energy Council (IREC) for all years through 2010 and from Wood Mackenzie and SEIA's annual year-in-review Solar Market Insight report for each year thereafter.

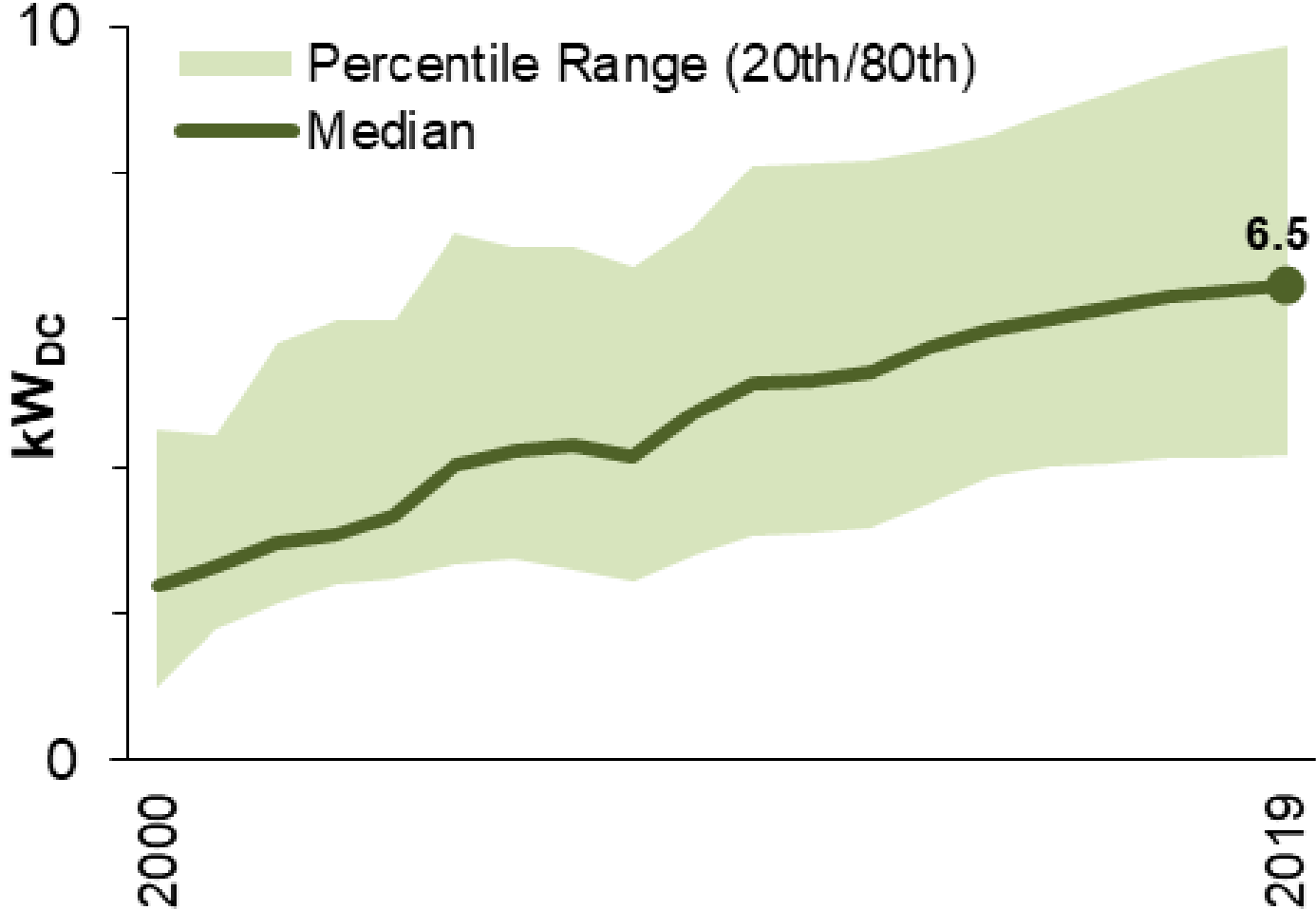
See Appendix for details on data sources, definitions, and data cleaning methods

Distributed PV System Characteristics

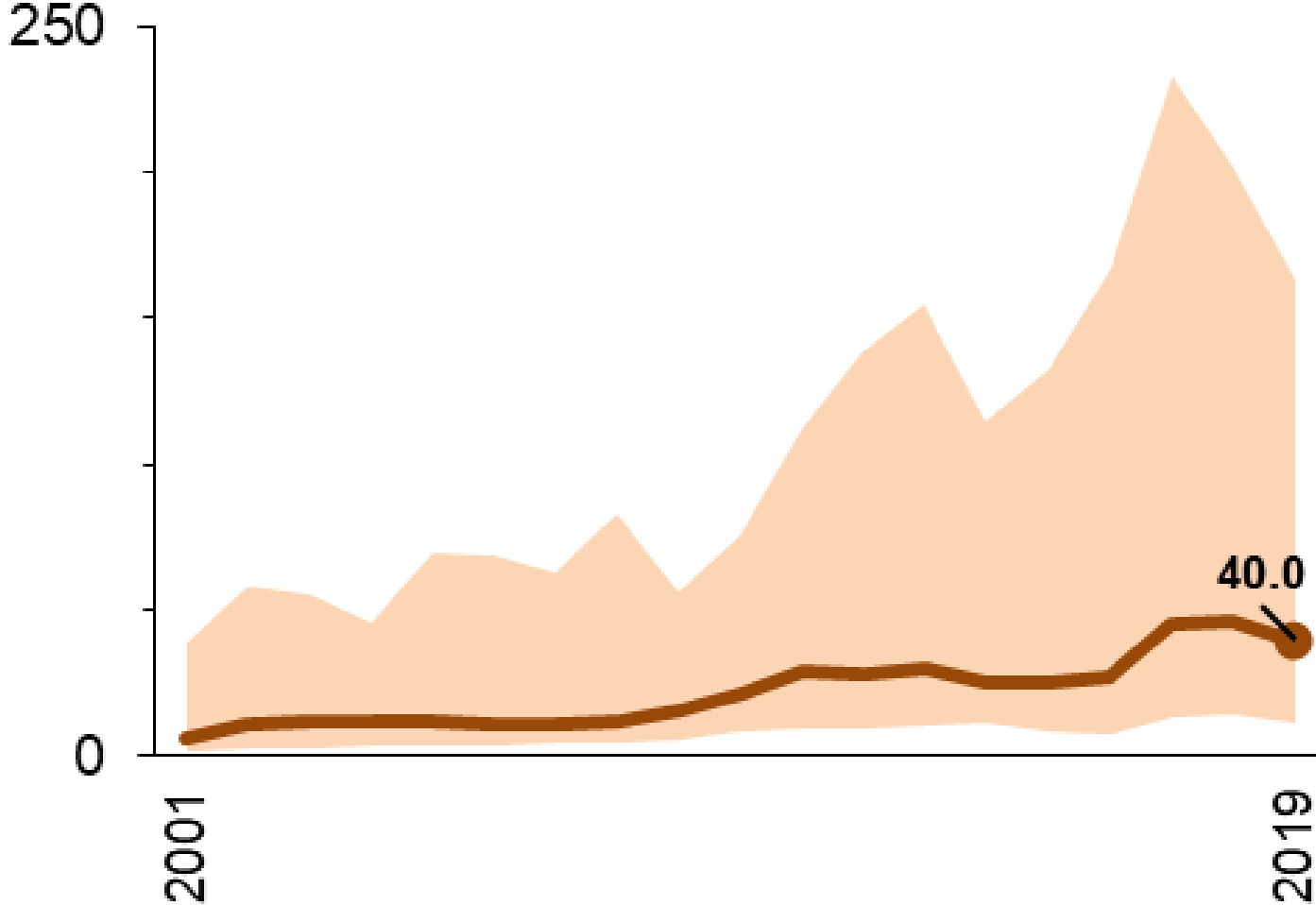
Based on Full Sample

System Size Trends

Residential

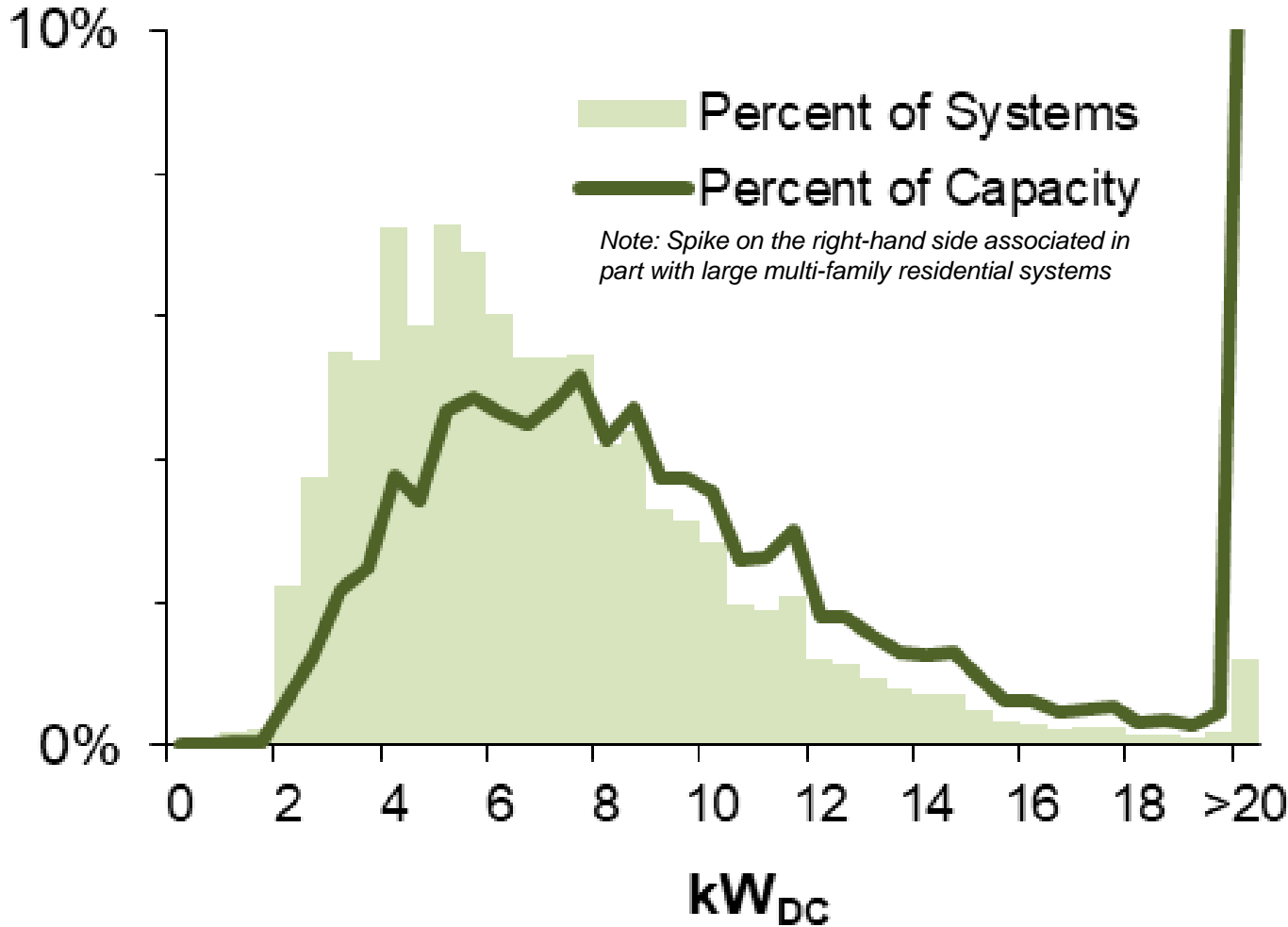


Non-Residential

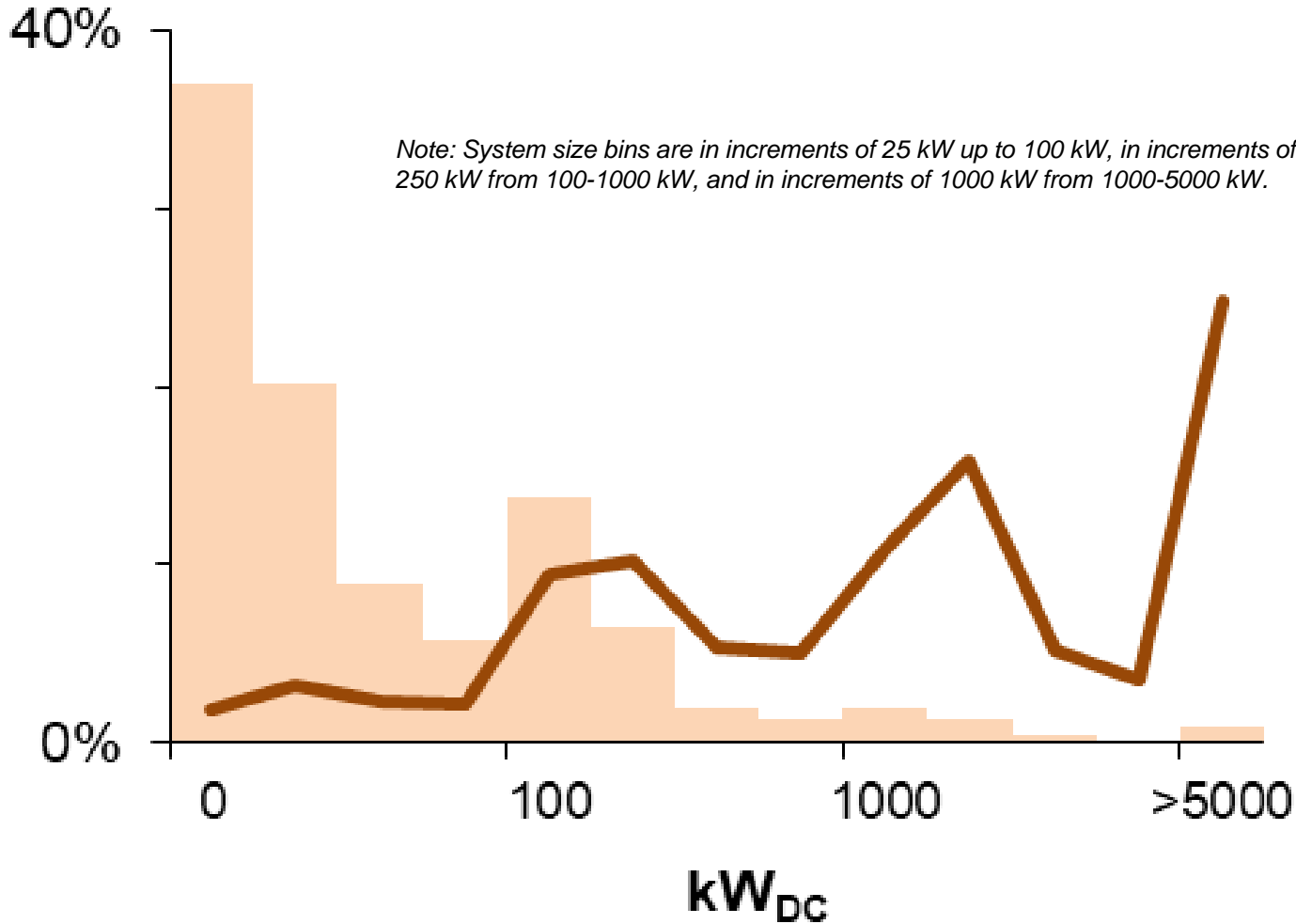


System Size Distribution for 2019 Systems

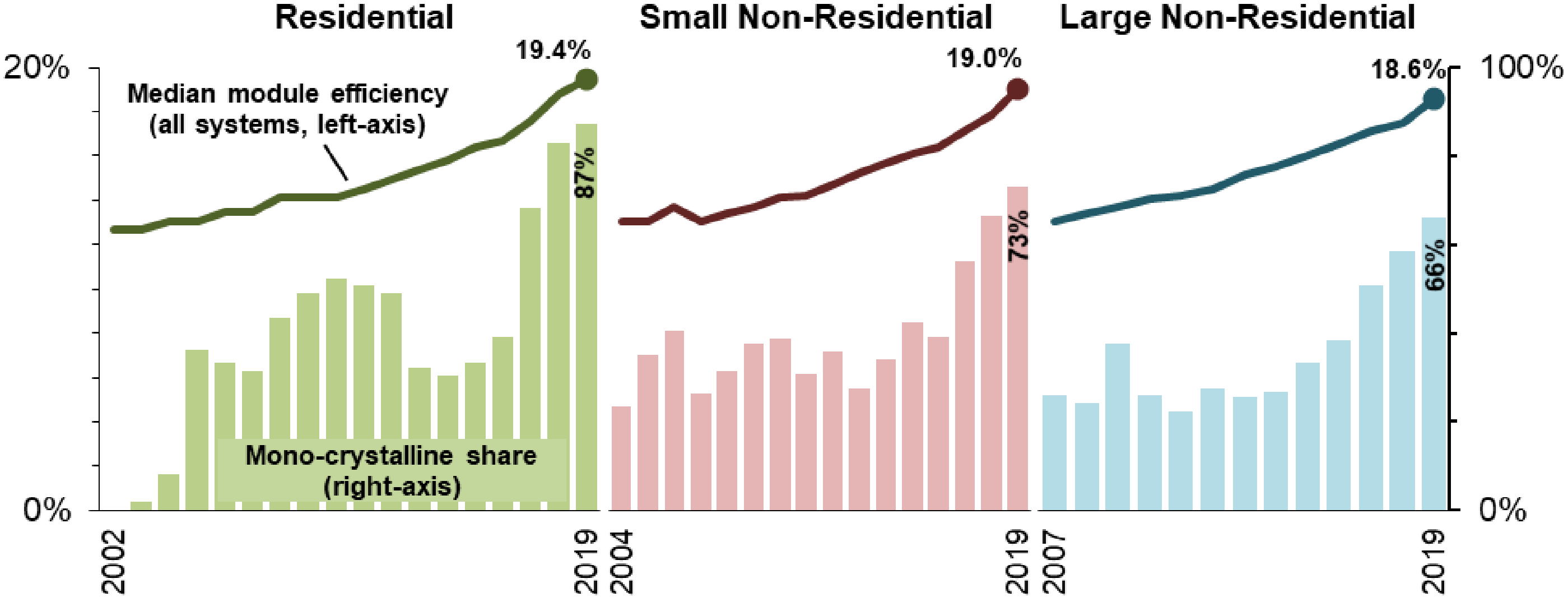
Residential



Non-Residential

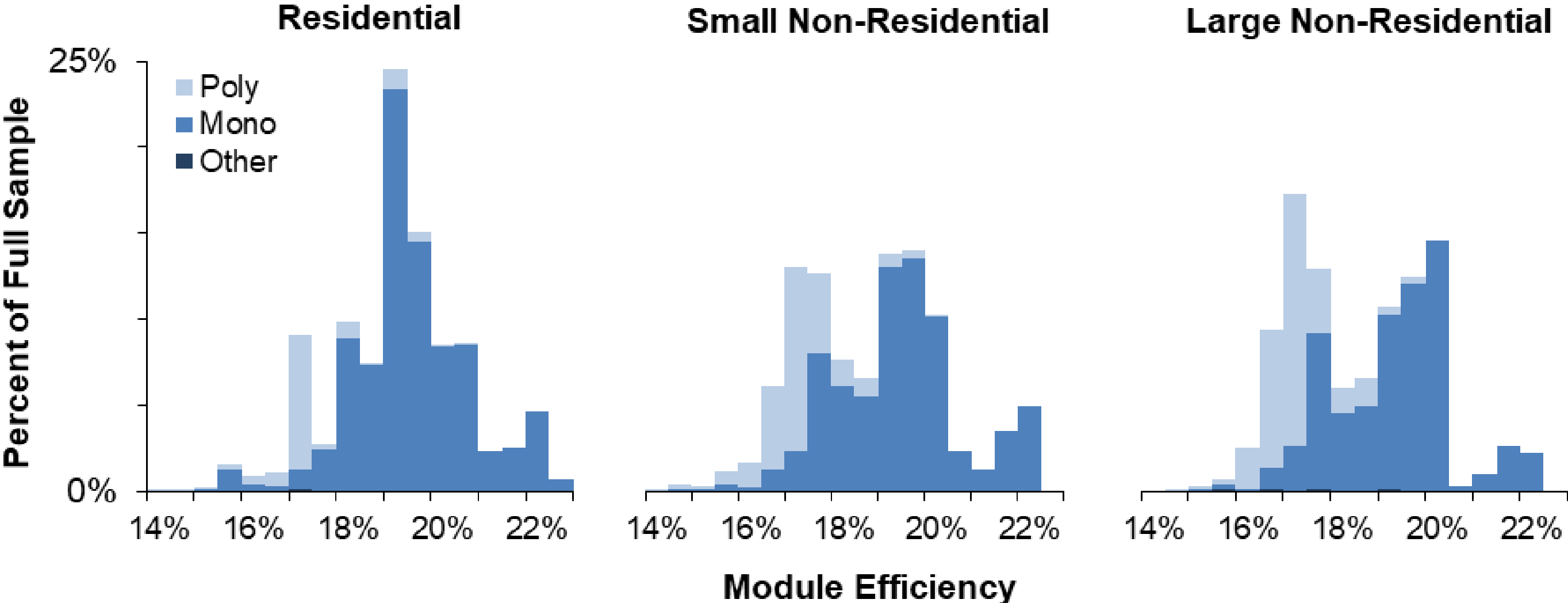


Median Module Efficiency and Mono-Crystalline Share

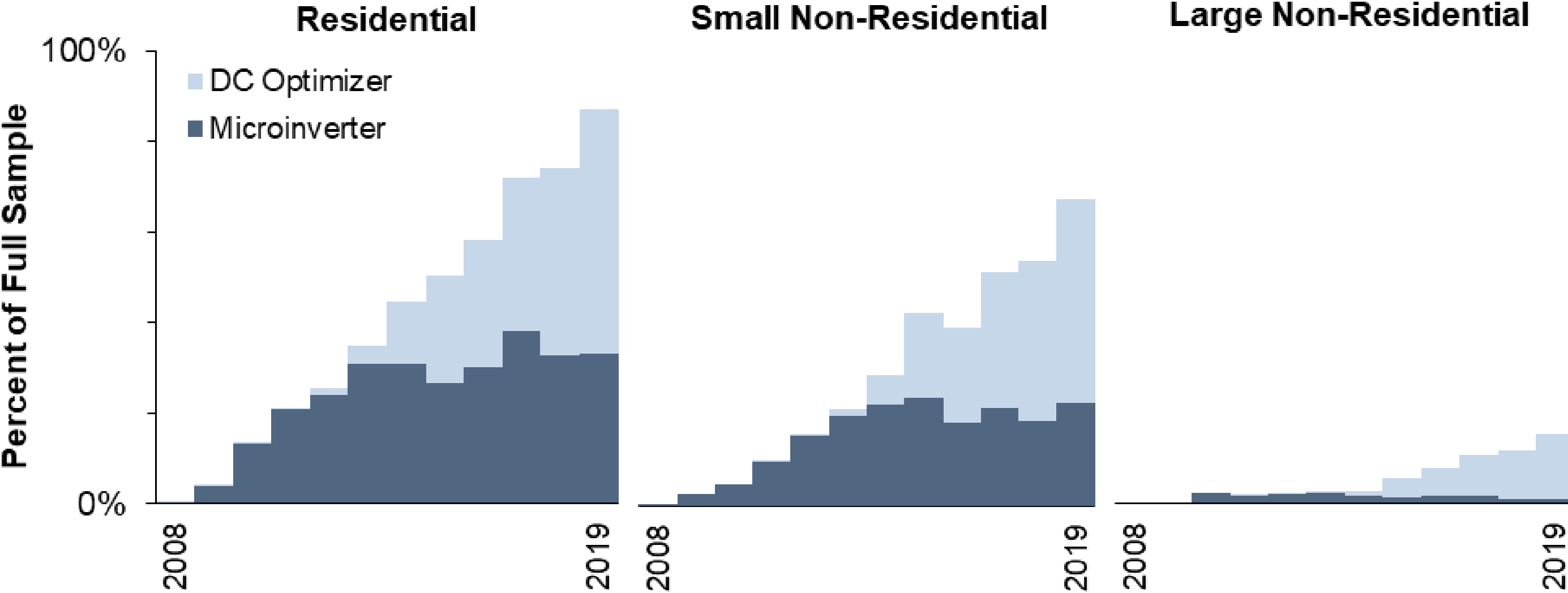


Notes: The range of years shown varies across customer segments depending on the data availability and sample size. In these charts and elsewhere, "small" vs. "large" non-residential are based on a 100 kW size threshold.

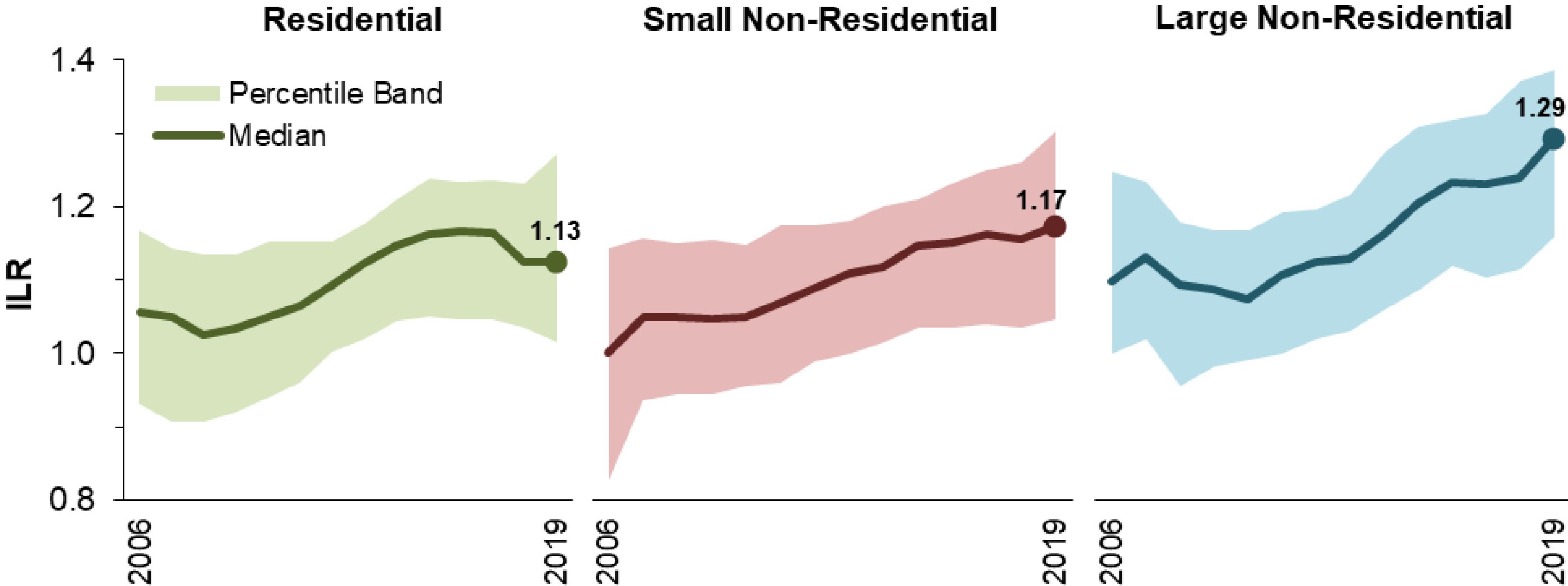
Module Efficiency Distribution for 2019 Systems



Module-Level Power Electronics Adoption Trends



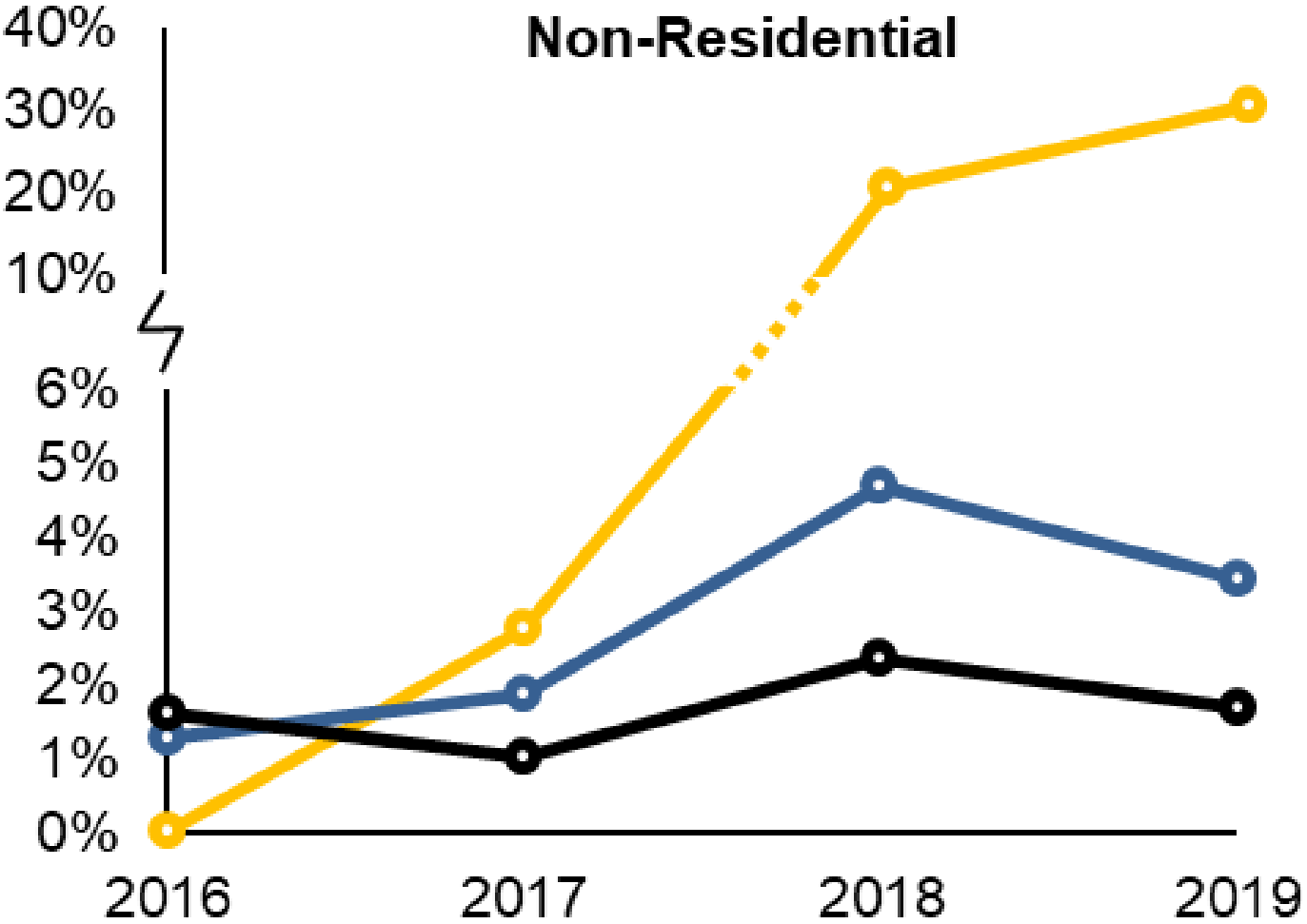
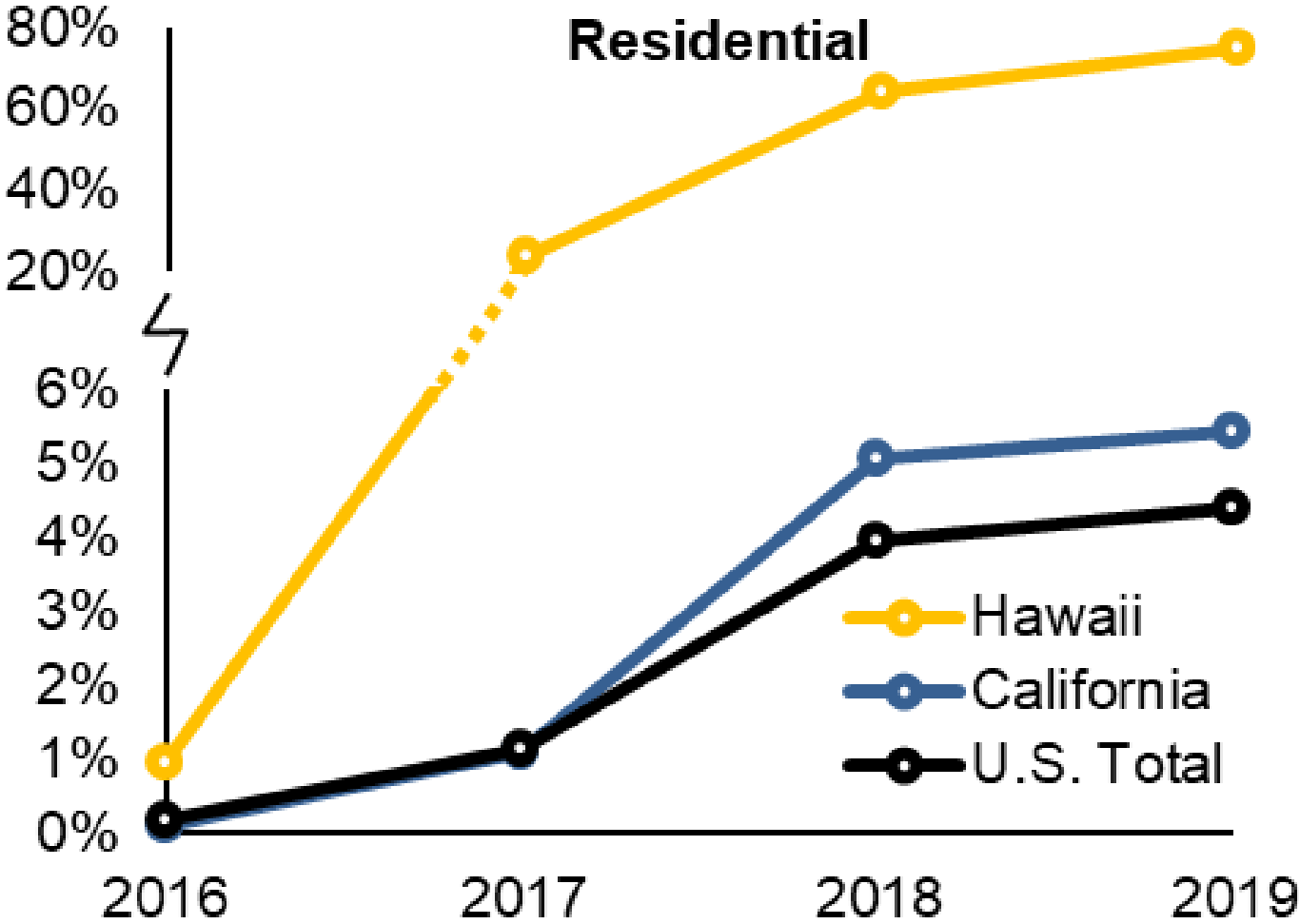
Inverter-Loading Ratio Trends



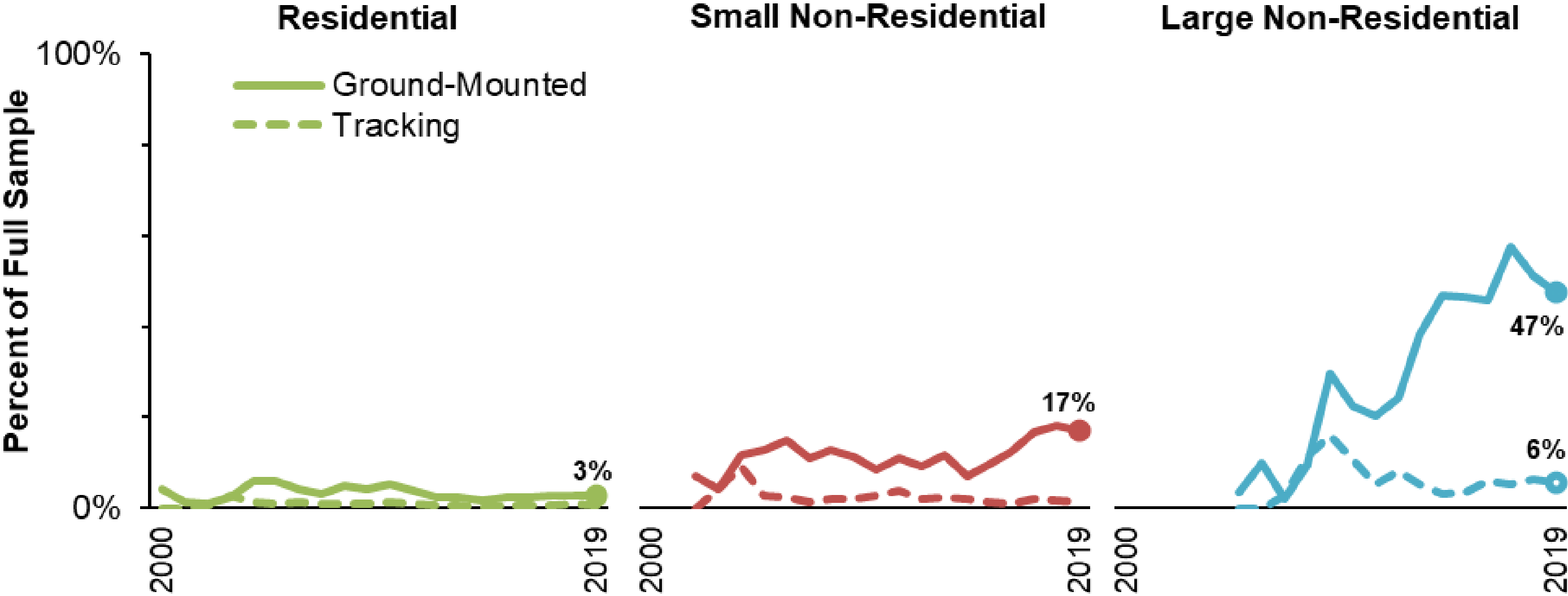
Notes: The Percentile Band refers to the range between the 20th and 80th percentiles.

Paired Solar+Storage Trends

Percent of PV Systems in Full Sample with Storage



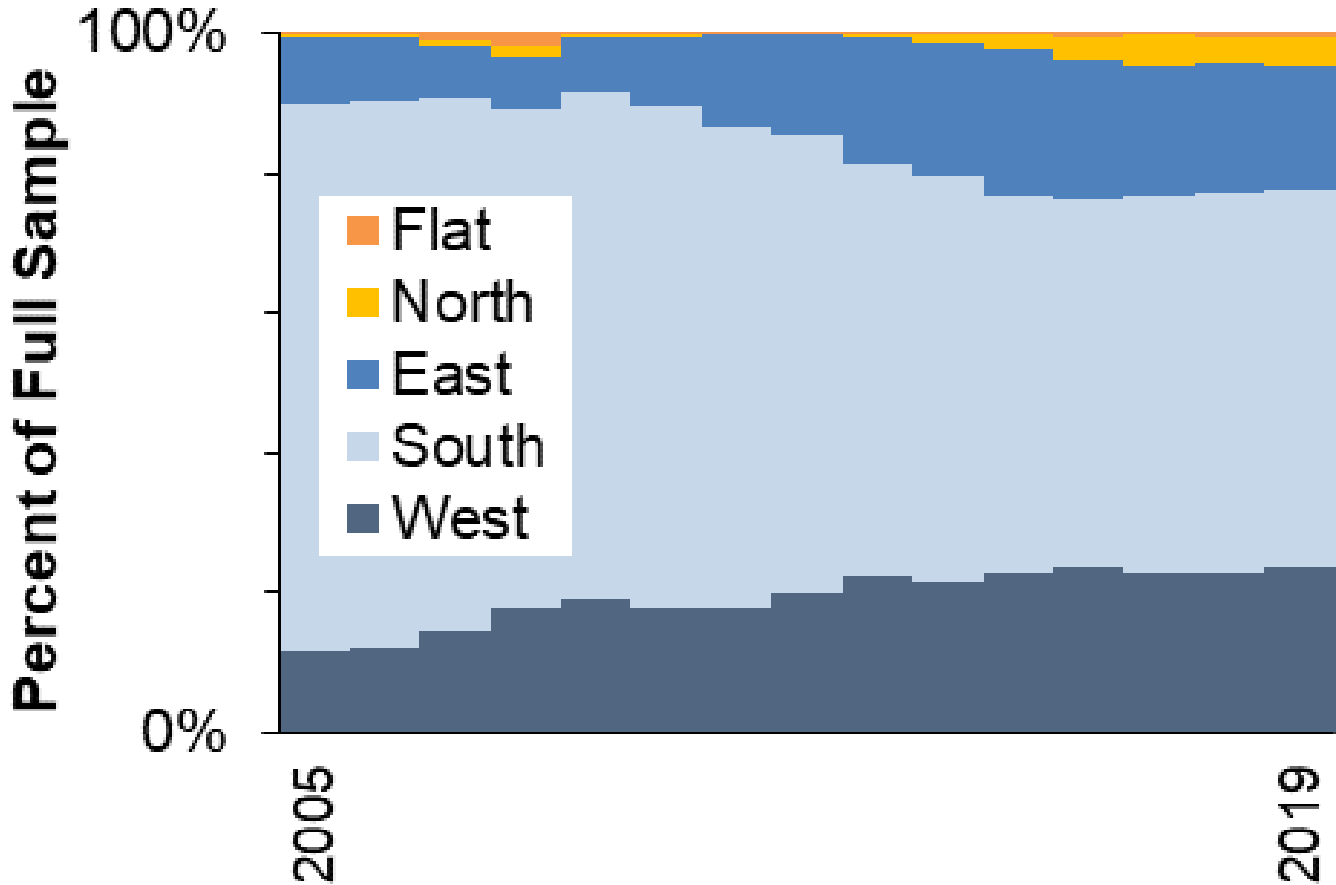
Panel Mounting Trends



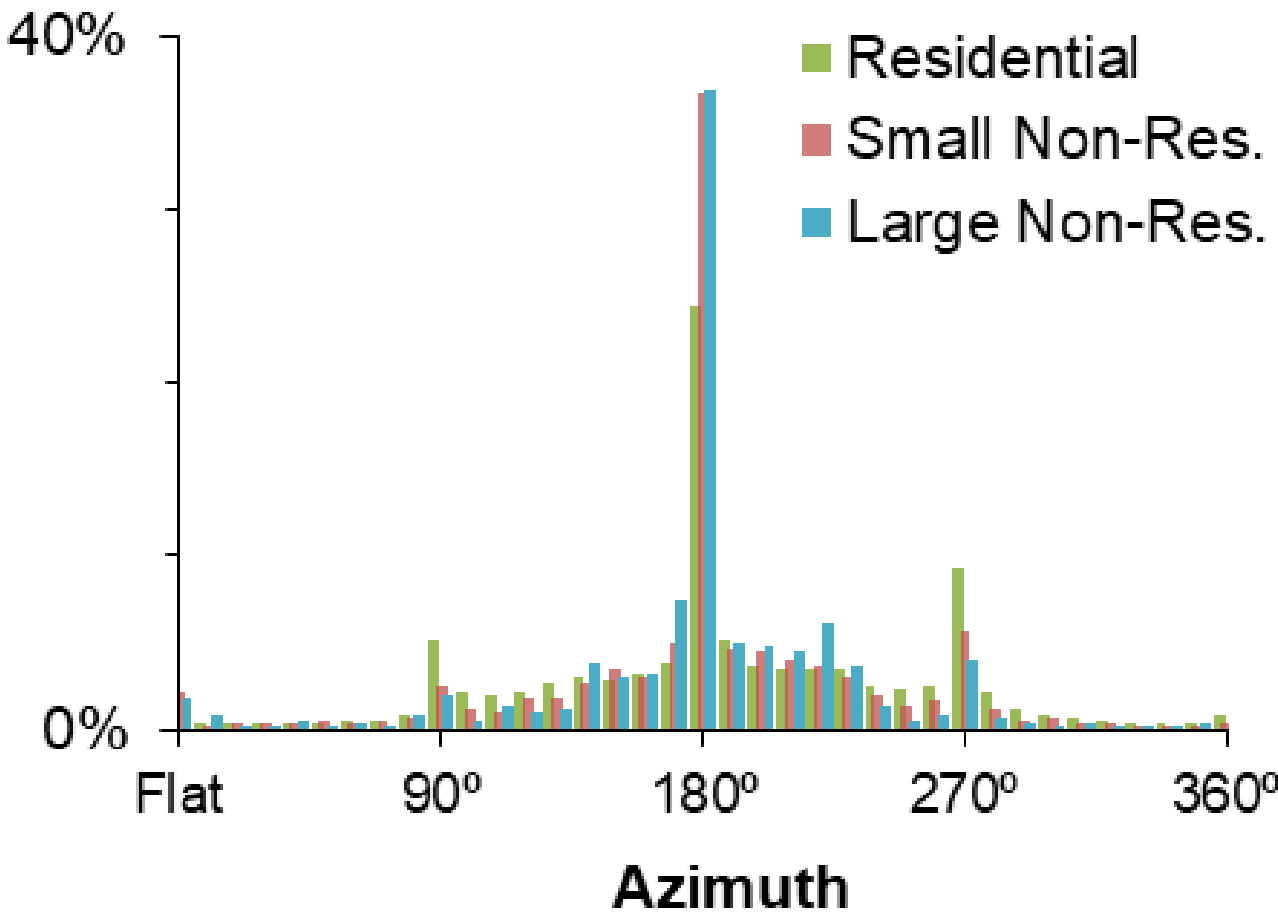
Notes: Summary statistics for any given year are shown only if at least 20 observations are available.

Panel Orientation Trends

All Customer Segments

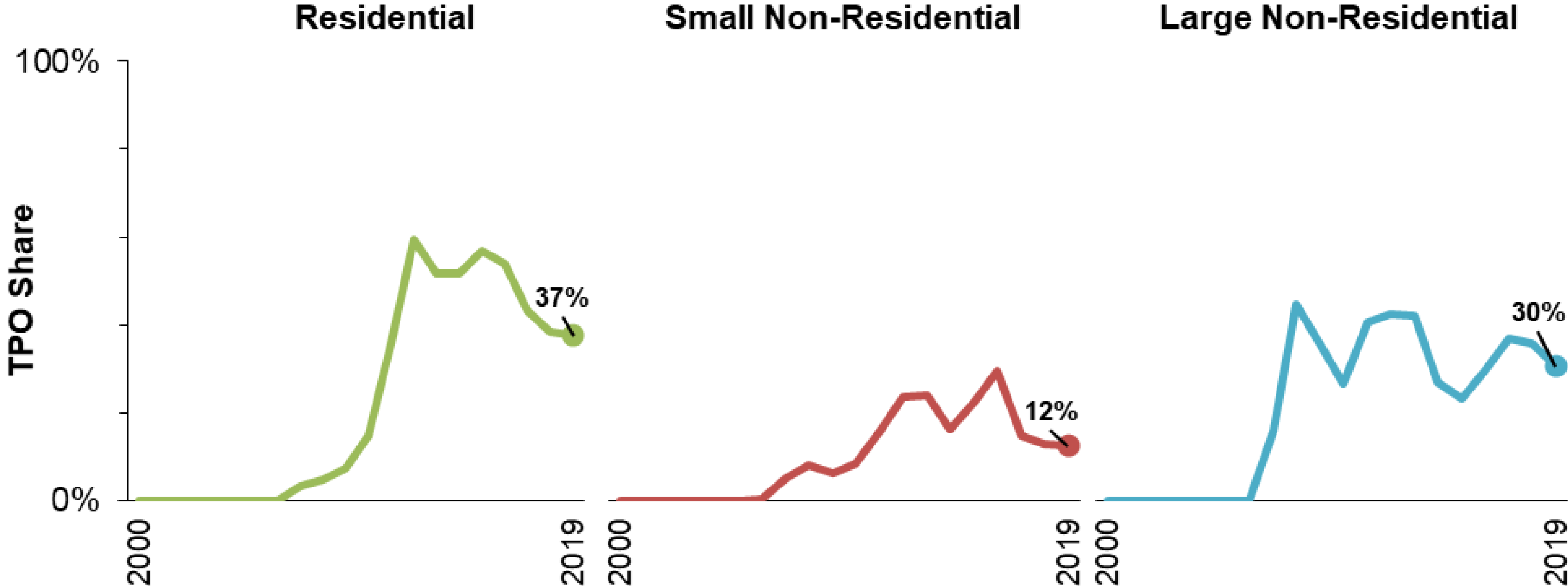


2019 Installations by Customer Segment

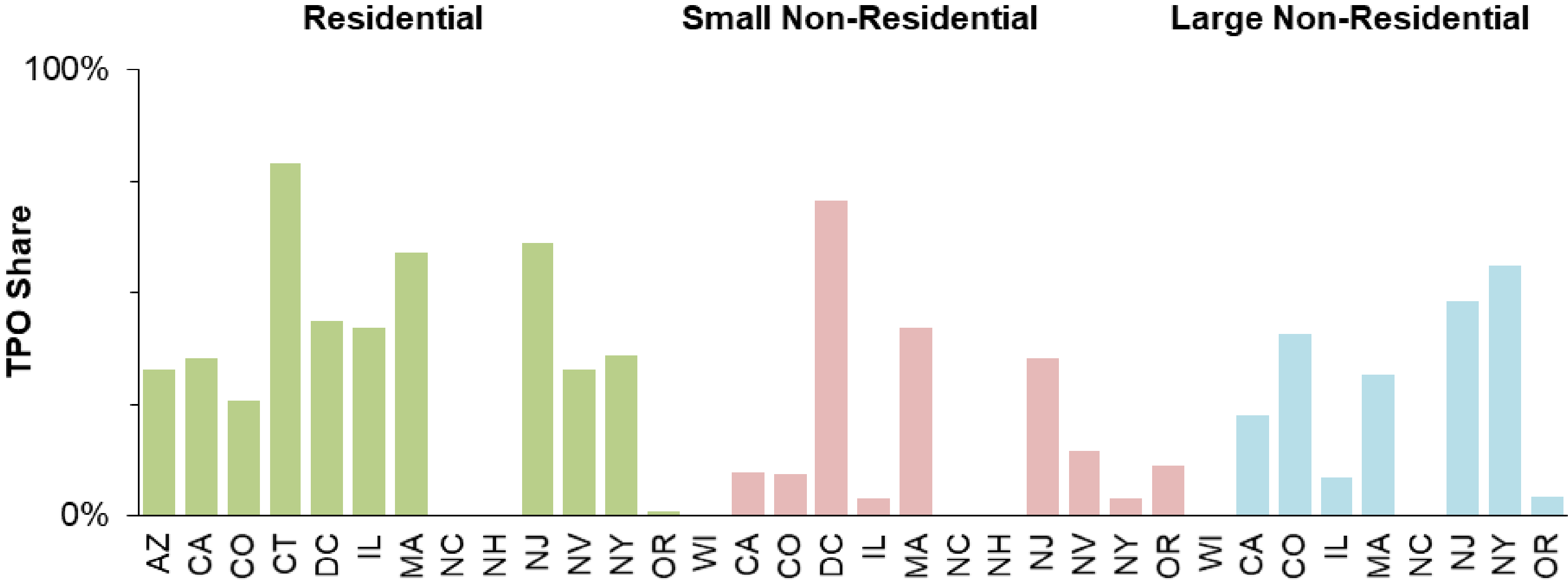


Notes: In the left-hand figure, azimuths are grouped according to cardinal compass directions $\pm 45^\circ$ (e.g., systems within $\pm 45^\circ$ of due-south are considered south-facing). Both figures exclude tracking systems.

Third-Party Ownership (TPO) Trends



TPO Shares by State in 2019

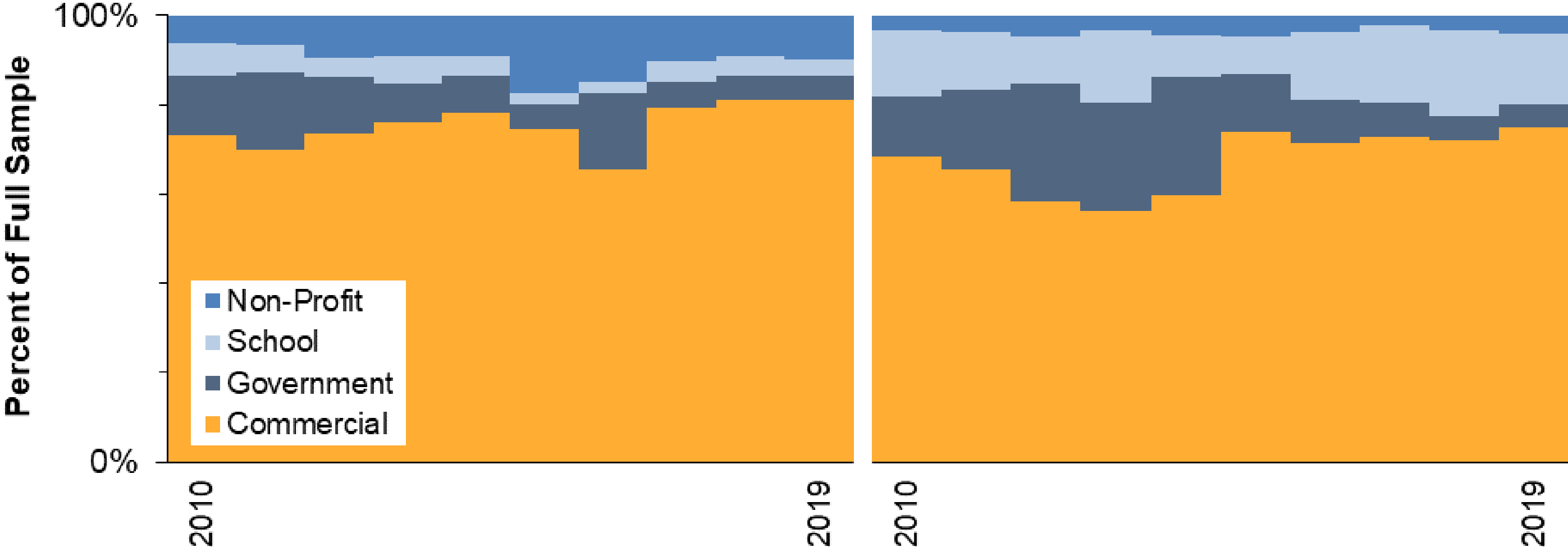


Notes: States included only if at least 20 observations available, if ownership is known for at least 50% of the observations, and only if the underlying data sources are deemed to be representative of the state as a whole.

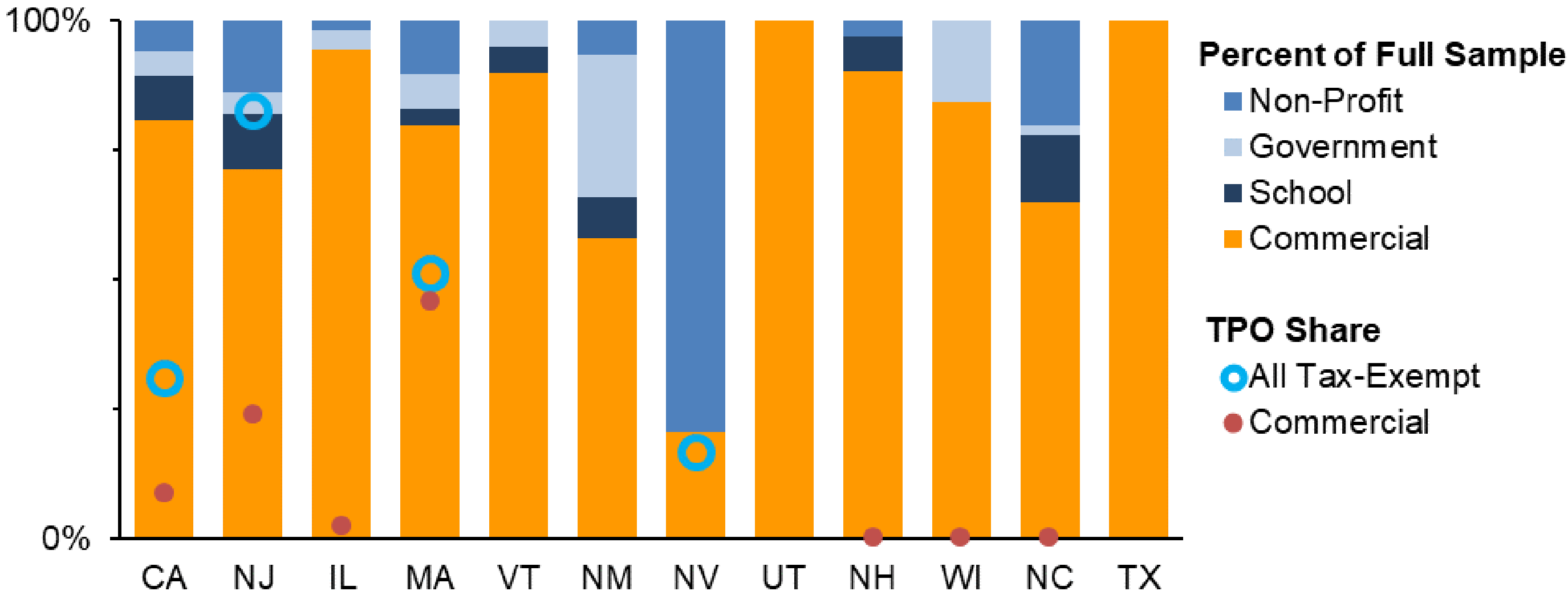
Non-Residential Customer Segmentation over Time

Small Non-Residential

Large Non-Residential



Non-Residential Customer Segmentation by State in 2019



Notes: Tax-exempt customers include non-profit, government, and schools. States included only if at least 20 observations available with known non-residential subsegment. TPO shares shown only if ownership status is known for at least 50% of the respective subsegment (commercial or tax-exempt).

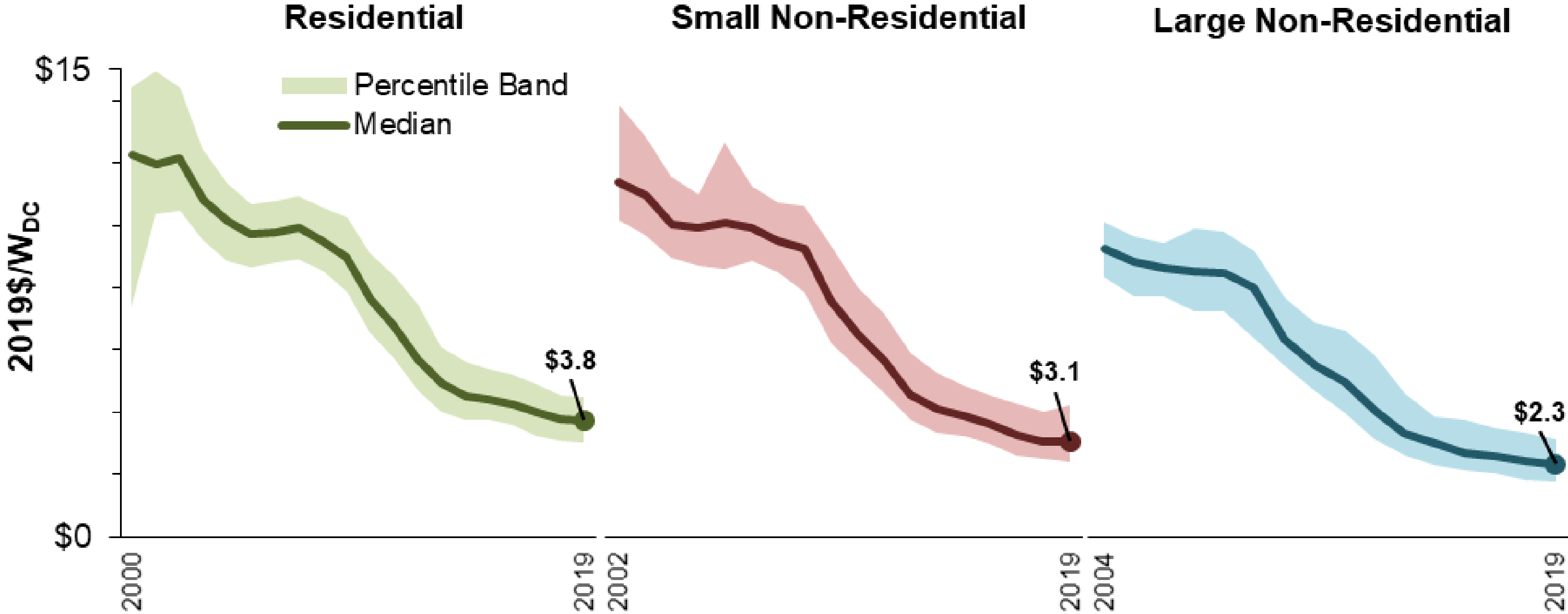
Temporal Trends in Installed Prices

Based on Installed-Price Sample

A Few Notes on Installed-Price Data

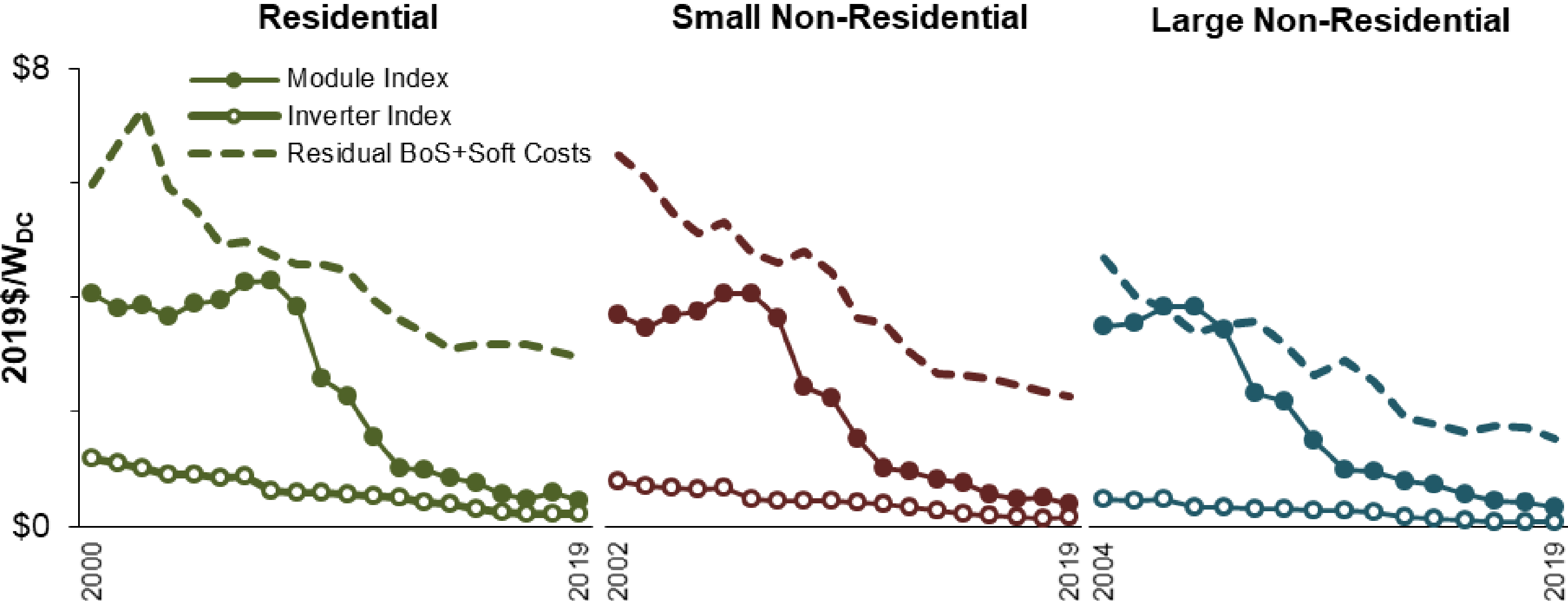
- Differs from the underlying cost borne by the developer or installer (price \neq cost)
- Unless otherwise noted, excludes TPO, battery storage, and self-installed systems
- Historical (i.e., systems installed through 2019) and therefore may not be representative of systems installed more recently or current quotes for prospective projects
- Self-reported by PV installers or customers; susceptible to inconsistent reporting practices

National Installed Price Trends



Notes: The range of years shown varies across customer segments depending on the data availability and sample size. The Percentile Band refers to the range between the 20th and 80th percentiles

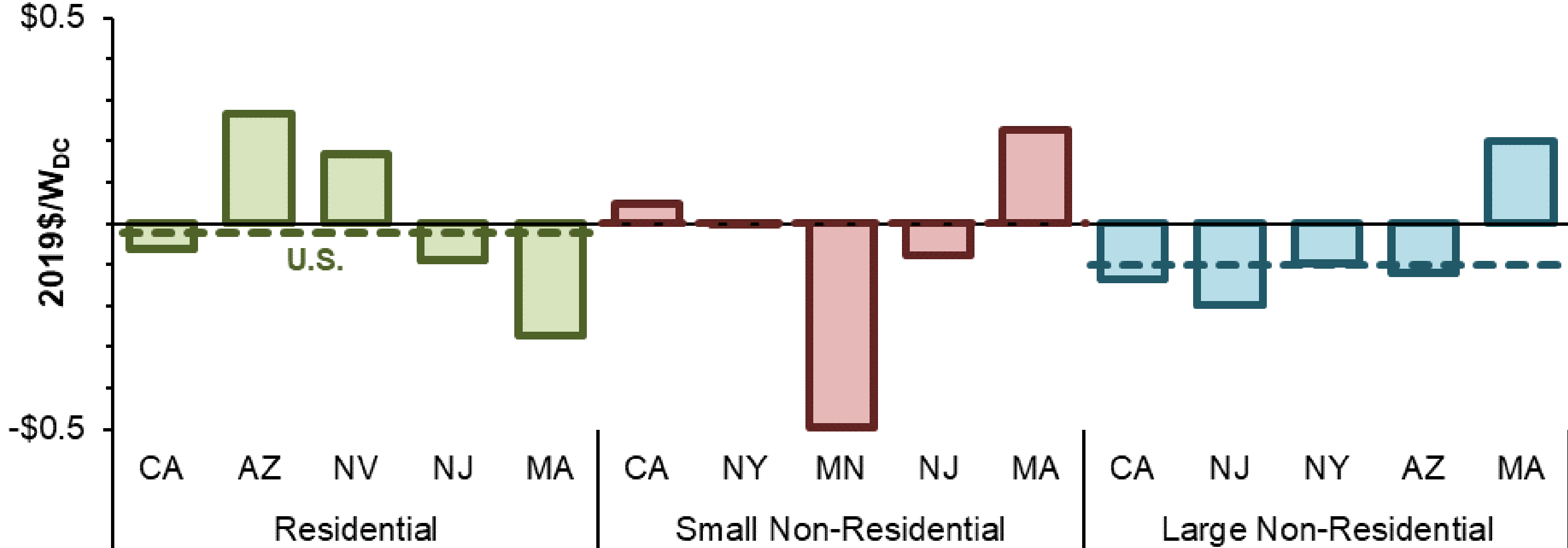
Underlying Trends in Component Costs



Notes: The Module and Inverter Price Indices are based on data from SPV Market Research and Wood Mackenzie, with adjustments by Berkeley Lab in order to extend those indices back in time and to differentiate among customer segments. The Residual term is calculated as the median installed price for each customer segment minus the corresponding Module and Inverter Price Indices with a one-year lag.

Year-over-Year Trends Nationally and for Select States

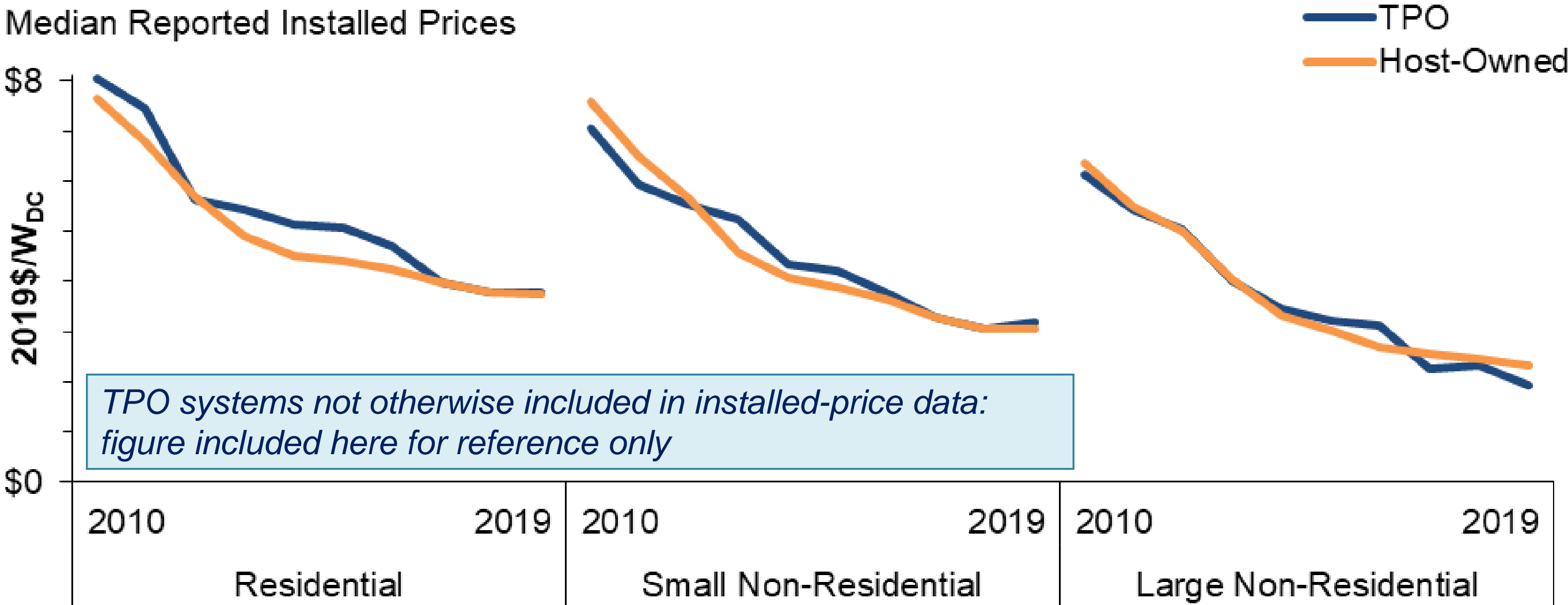
Year-over-Year Change in Median Installed Price (2018-2019)



Notes: The five largest state markets in the full data sample (based on 2019 systems) are shown for each customer segment. Dashed lines show the year-over-year change in national median installed prices.

Installed Prices Reported for TPO vs. Host-Owned Systems

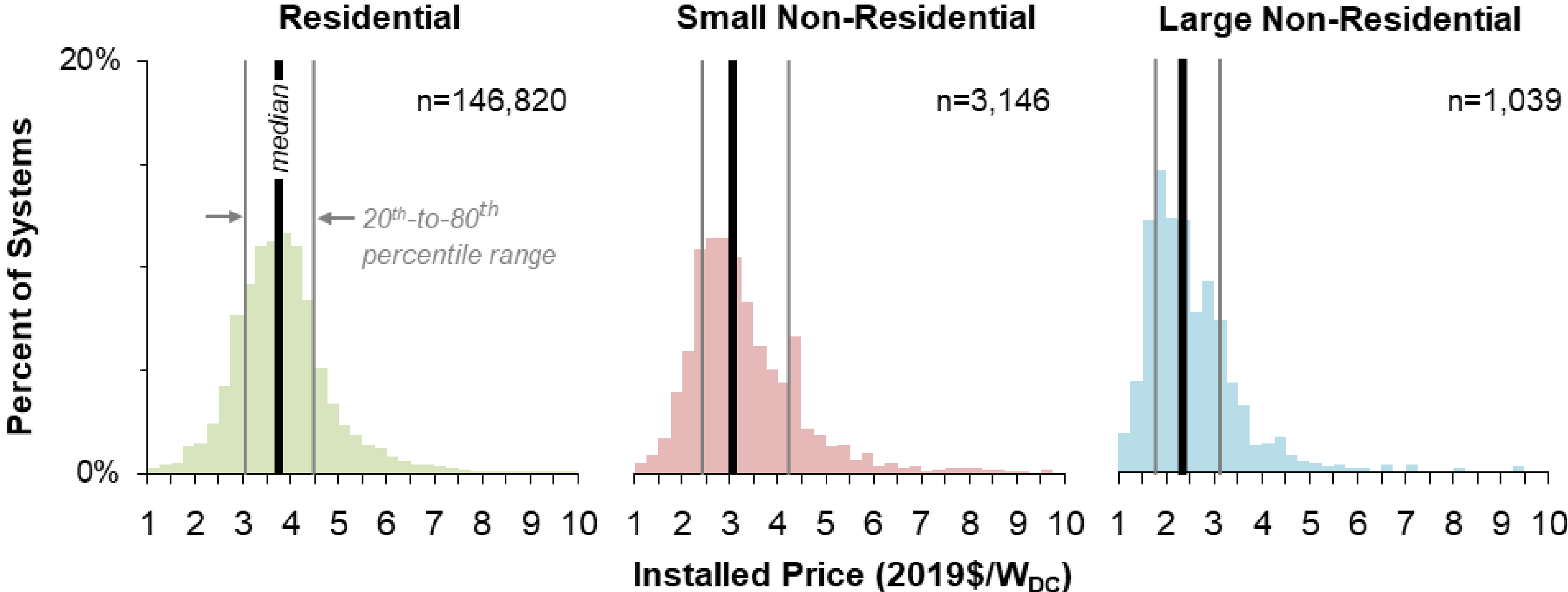
Median Reported Installed Prices



Variation in Installed Prices

Based on Installed-Price Sample

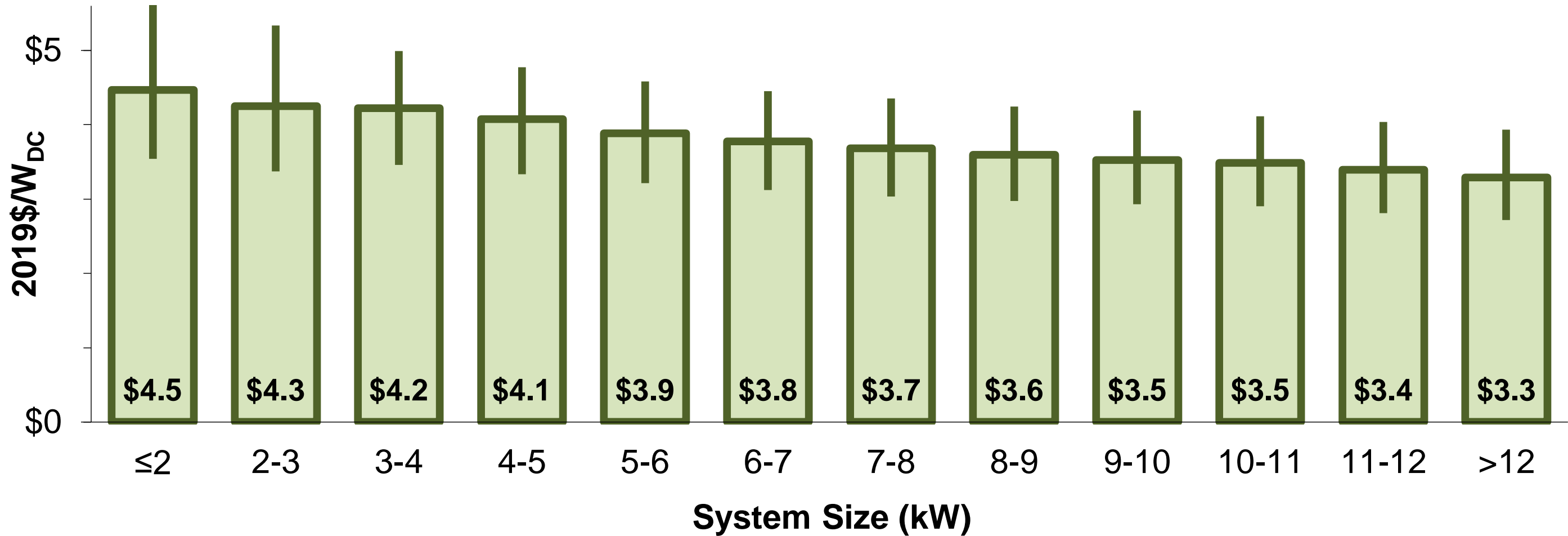
Installed Price Distributions for 2019 Systems



Installed Price Differences by System Size

2019 Residential Systems

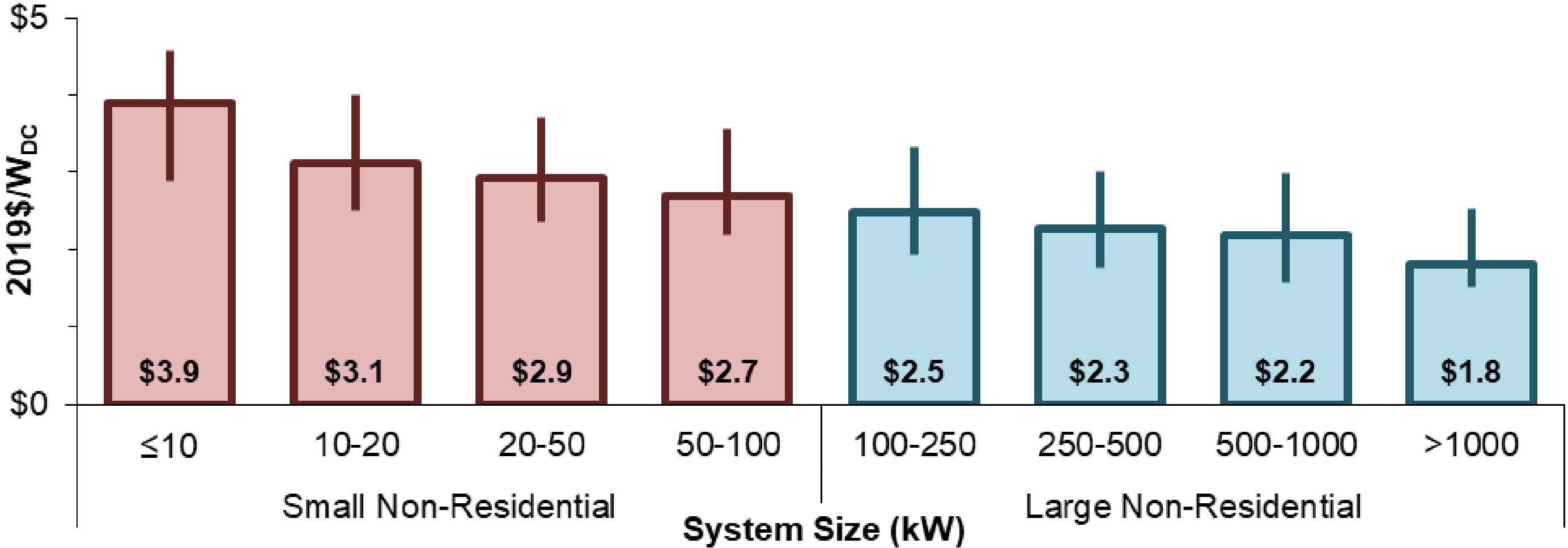
Median Installed Price and 20th/80th Percentiles



Installed Price Differences by System Size

2019 Non-Residential Systems

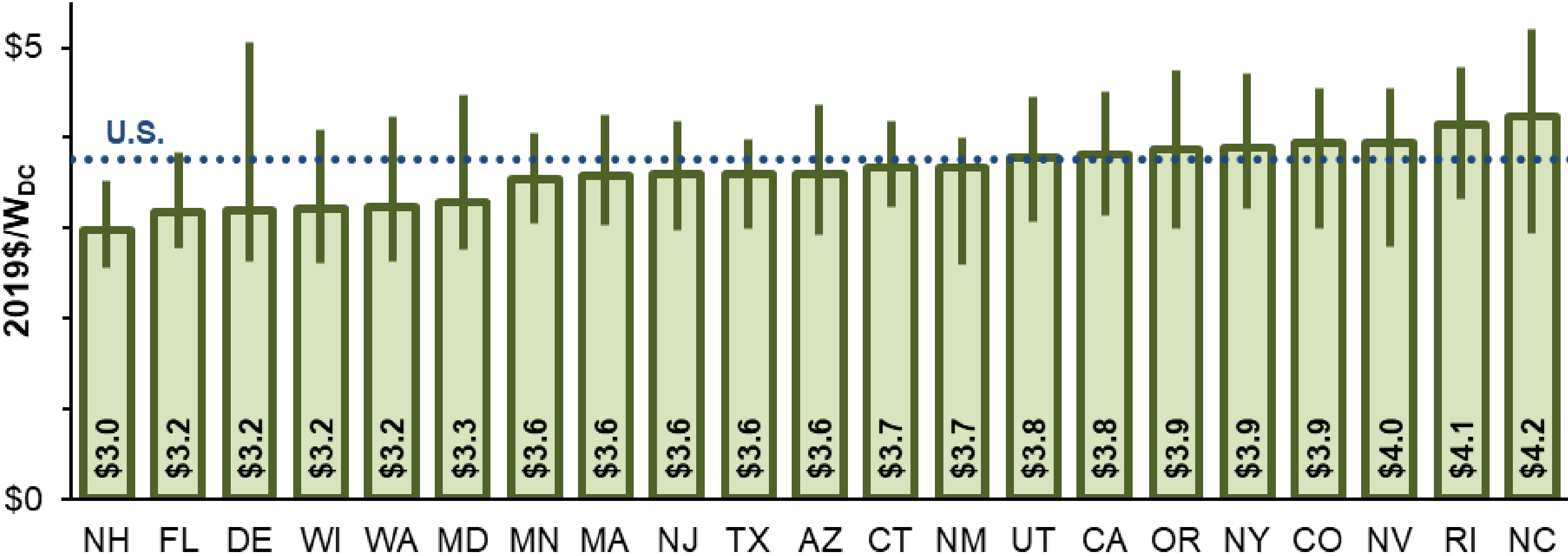
Median Installed Price and 20th/80th Percentiles



Installed Price Variation by State

2019 Residential Systems

Median Installed Price and 20th/80th Percentiles

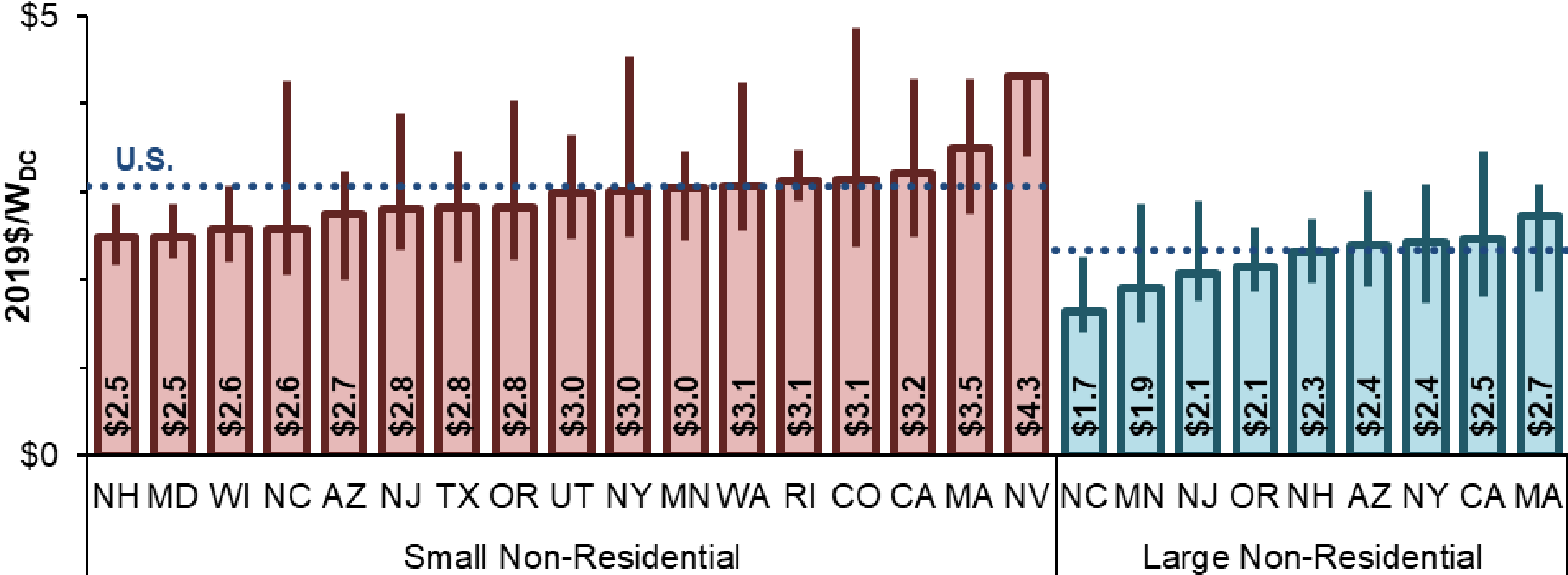


Notes: Data shown only if at least 20 observations are available for a given state.

Installed Price Variation by State

2019 Non-Residential Systems

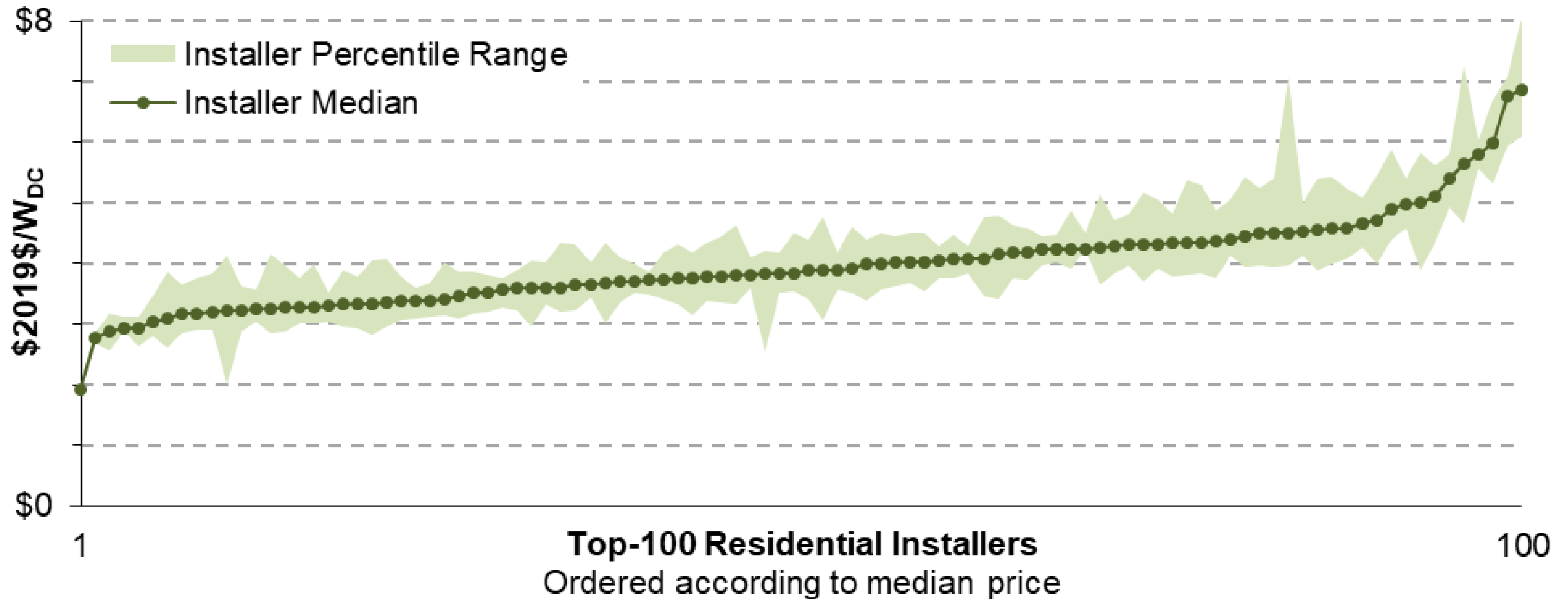
Median Installed Price and 20th/80th Percentiles



Notes: Data shown only if at least 20 observations are available for a given state.

Installed Price Variation across the Top-100 Installers

2019 Residential Systems

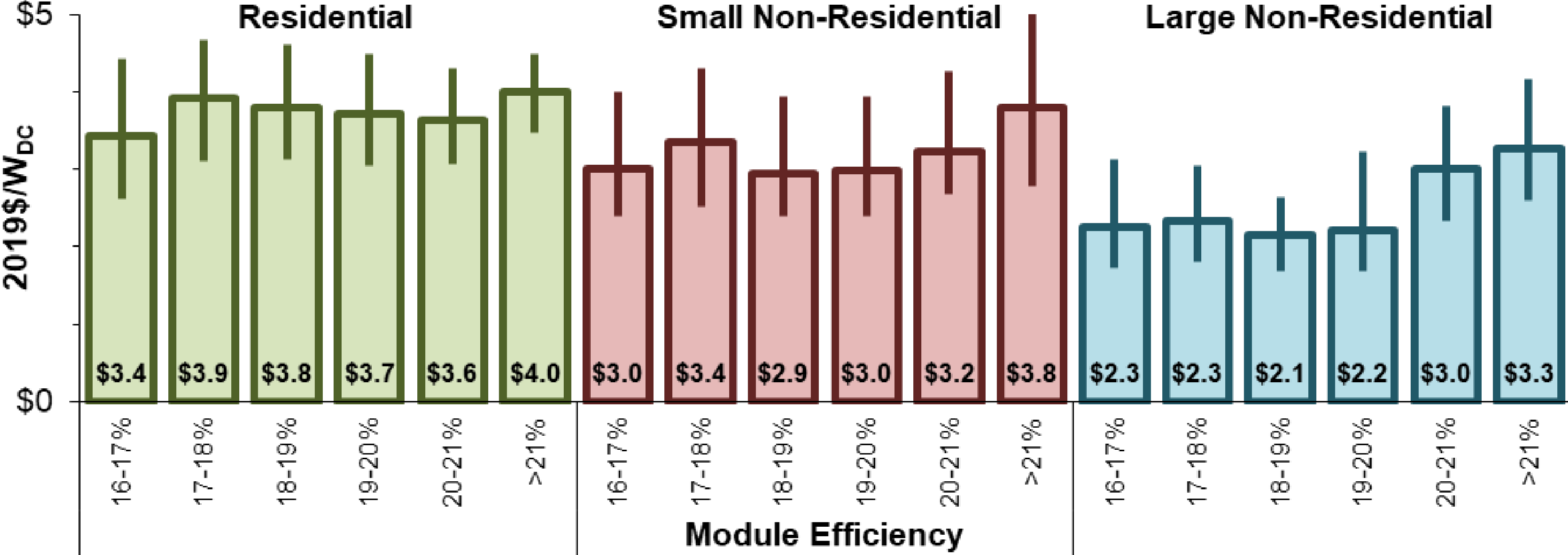


Notes: Each dot represents the median installed price of an individual installer, ranked from lowest to highest, while the shaded band shows the 20th to 80th percentile range for that installer.

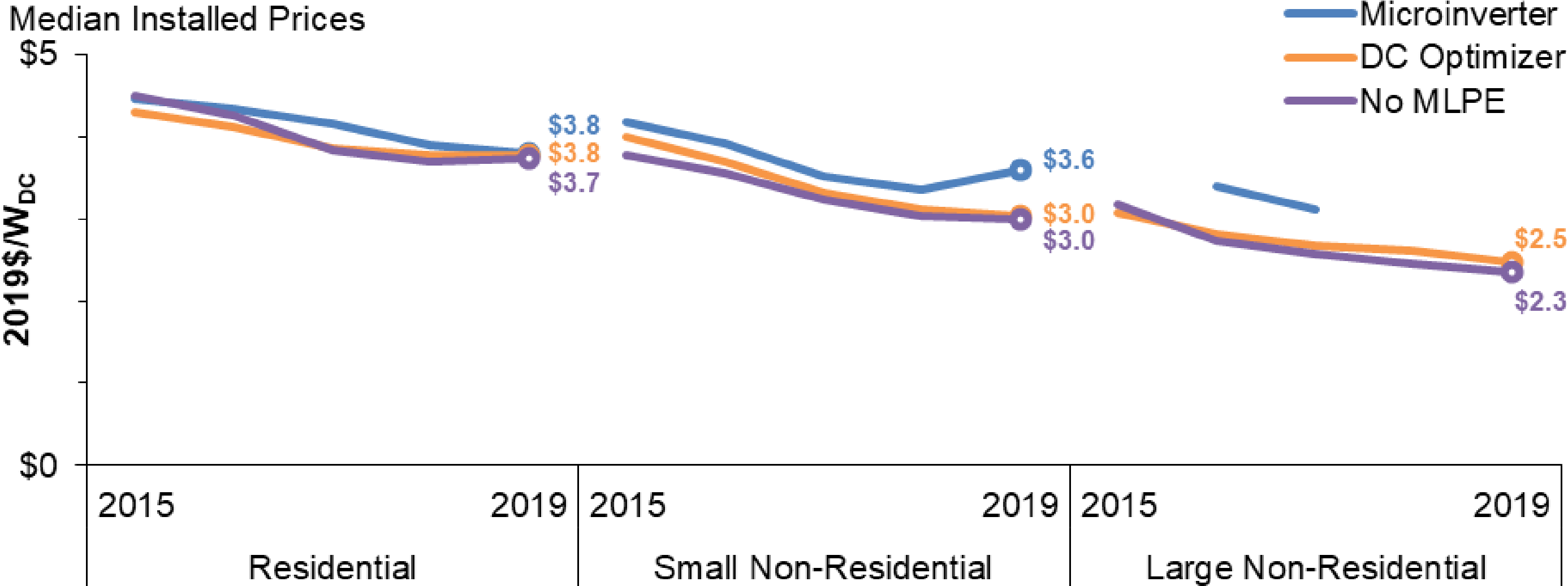
Installed Price Variation by Module Efficiency

2019 Systems

Median Installed Price and 20th/80th Percentiles



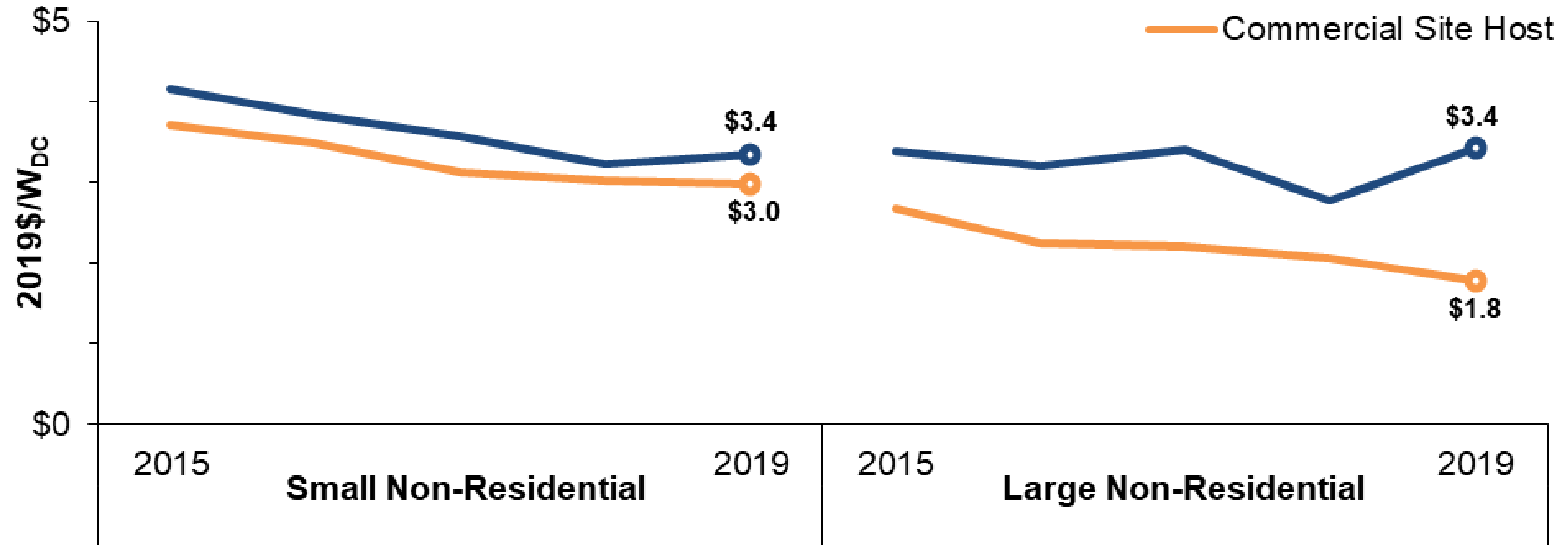
Installed Price Trends by Inverter Type



Notes: MLPE refers to Module Level Power Electronics (either a microinverter or DC optimizer). Data shown only if at least 20 observations available (impacting the trend line for large non-residential systems with microinverters).

Installed Price Differences for Commercial vs. Tax-Exempt Customers

Median Installed Prices



Notes: Tax-Exempt site hosts includes government, schools, and non-profits.

For more information

Download summary data tables and public data file:

<http://trackingthesun.lbl.gov>

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Appendix: Data Sources and Methods

Data Sources

Project-level data

- Provided by state agencies and utilities that administer PV incentive programs, renewable energy credit registration (REC) systems, or interconnection processes
- Some of these data already exist in the public domain (e.g., California's Currently Interconnected Dataset), though LBNL may receive supplementary fields, in some cases covered under non-disclosure agreements

66 entities spanning 31 states have contributed data

- See next slide for a list of these entities

Data sources have evolved over time, as incentive programs have phased out

- In many cases, utilities and PUCs have opted to continue data collection through other channels

List of Entities Contributing Data

AR State Energy Office	FL Gainesville Regional Utilities	OR Department of Energy
AZ Ajo Improvement Company	FL Orlando Utilities Commission	OR PacifiCorp
AZ Arizona Public Service	IL Department of Commerce & Economic Opportunity	PA Dept. of Community and Economic Development
AZ Duncan Valley Electric Cooperative	IL Power Agency	PA Department of Environmental Protection
AZ Mohave Electric Cooperative	KS Evergy	PA Sustainable Development Fund
AZ Morenci Water and Electric	KS Westar Energy, Inc.	RI National Grid
AZ Navopache Electric Cooperative	MA DOER	RI Commerce Corporation
AZ Salt River Project	MA Clean Energy Center	TX Austin Energy
AZ Sulfur Springs Valley Electric Cooperative	MD Energy Administration	TX CPS Energy
AZ Trico Electric Cooperative	ME Efficiency Maine	TX Frontier Associates
AZ Tucson Electric Power	MN Department of Commerce	UT Office of Energy Development
AZ UniSource Energy Services	MN Xcel Energy/Northern States Power	VA Department of Mines, Minerals and Energy
CA Public Utilities Commission	MO Ameren	VT Energy Action Network
CA Center for Sustainable Energy (Bear Valley Electric)	MO Evergy	VT Energy Investment Corporation
CA Center for Sustainable Energy (PacifiCorp)	NC Sustainable Energy Association	WA Puget Sound Energy
CA City of Palo Alto Utilities	NH Public Utilities Commission	WA Washington State University
CA Imperial Irrigation District	NJ Board of Public Utilities	WI Focus on Energy
CA Los Angeles Department of Water & Power	NM Energy, Minerals and Natural Resources Department	
CA Sacramento Municipal Utility District	NM Public Service Company of New Mexico	
CO Xcel Energy/Public Service Company of Colorado	NM Xcel Energy	
CT Green Bank	NV NV Energy	
CT Public Utilities Regulatory Authority	NY State Energy Research and Development Authority	
DC Public Service Commission	OH Public Utilities Commission	
DE Dept. of Natural Resources and Env. Control	OR Energy Trust of Oregon	
FL Energy & Climate Commission		

Key Definitions and Conventions

Customer Segments

- **Residential:** Single-family and, depending on the data provider, may also include multi-family
- **Small Non-Residential:** Non-residential systems $\leq 100 \text{ kW}_{\text{DC}}$
- **Large Non-Residential:** Non-residential systems $> 100 \text{ kW}_{\text{DC}}$ (and $\leq 5,000 \text{ kW}_{\text{AC}}$ if ground-mounted)
** Independent of whether connected to the customer- or utility-side of the meter*

Units

- Real 2019 dollars
- Direct current (DC) Watts (W), unless otherwise noted

Installed Price: Up-front \$/W price paid by the PV system owner, prior to incentives

Sample Frames and Data Cleaning

Full Sample

*Used to describe system characteristics
The basis for the public dataset*

Installed-Price Sample

Used in analysis of installed prices

1. Remove systems with missing size or install date
2. Standardize installer, module, inverter names
3. Integrate equipment spec sheet data
 - Module efficiency and technology type
 - Inverter power rating
 - Flag microinverters or DC optimizers
4. Convert dollar and kW values to appropriate units, and compute other derived fields
5. Remove systems if:
 - Missing installed price data
 - Third-party owned (TPO)
 - Battery storage included
 - System expansion
 - Self-installed