U.S. Distributed Solar and Storage

2025 Data Update

October 2025

Accompanying dataset and data visualization available at:
trackingthesun.lbl.gov

Disclaimer: This document summarizes data and trends, but neither comments on nor recommends any specific policies.

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This work was funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy under Contract No. DE-AC02-05CH11231.

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Acknowledgements

This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under Contract No. DE-AC02-05CH11231 (Award Number 38444).

Overview

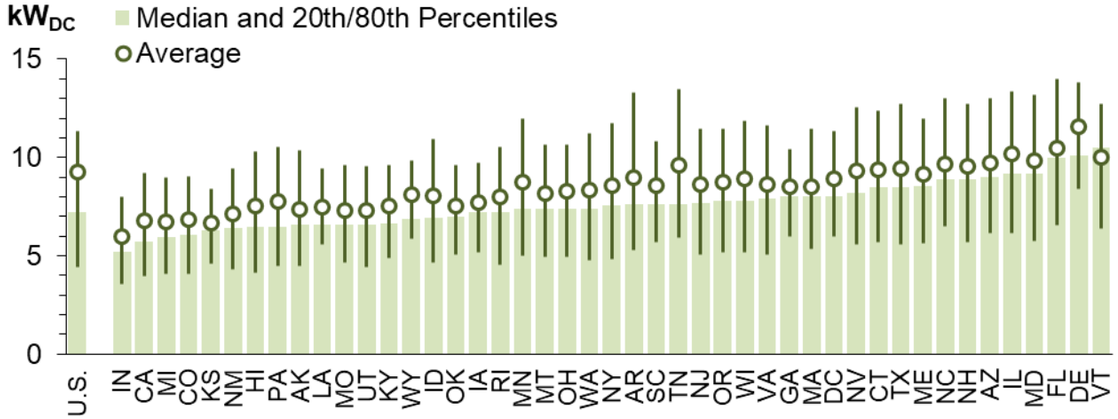
Berkeley Lab collects project-level data on distributed* solar photovoltaic (PV) and distributed PV+storage systems in the United States

- Latest data update includes project-level data for roughly 4.9 million systems, including 515,000 systems installed in 2024 covering 95% of the total U.S. market (see Appendix for details on data sources)
- Data are accessible through a public data file and data visualization tool at *trackingthesun.lbl.gov*
- Slide deck provides summary statistics for systems installed in 2024 and recent YoY trends relating to:
  - **Project characteristics**, including system size, component type, storage pairing, and other technical details
  - **Installed pricing** across projects and differences based on project size, financing, and other factors
  - **Customer characteristics**, including customer segmentation, financing, and estimated household income
- Appendix provides methodological details and additional summary statistics, including time-series data

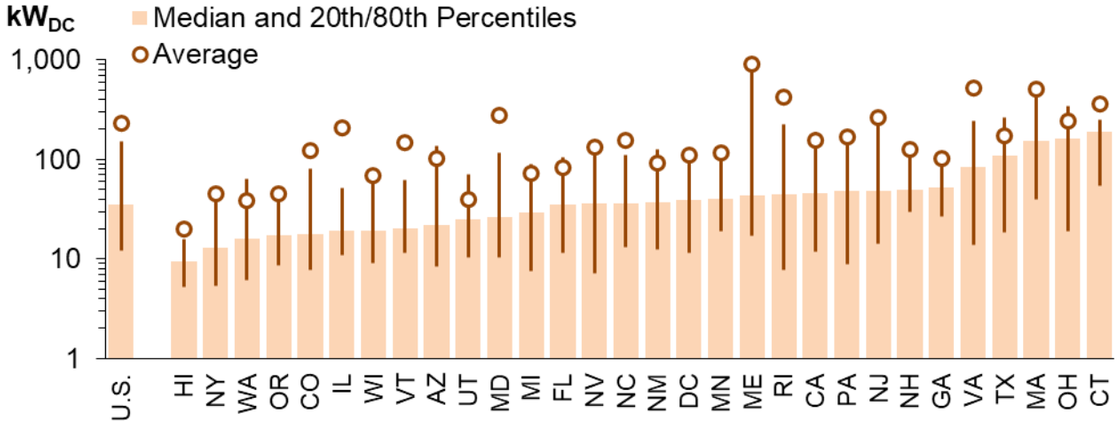
** For the purpose of this data summary, "distributed" PV systems consist of all residential systems, roof-mounted non-residential systems, and ground-mounted non-residential systems up to 7 MW_{DC}, regardless of project ownership or off-take agreements, including community solar. Ground-mounted non-residential systems larger than 7 MW_{DC} (or 5 MW_{AC}) are covered in Berkeley Lab's Utility-Scale Solar dataset and associated data summary.*

PV System Sizing Distributions (2024 Installs)

Residential System Sizes



Non-Residential* System Sizes



- The median U.S. residential system size was 7.2 kW in 2024, with most systems ranging from roughly 4-11 kW (the 20th to 80th percentile band), averaging 9.3 kW
- CA, which comprises a large portion of the residential sample, had a relatively small median size of 5.7 kW, while most other states had median sizes >7 kW
- Non-residential systems (as defined here*) had a median size of 35 kW in 2024, but a long upper tail and an average size of 232 kW (note logarithmic y-axis)

  *Note: Later figures distinguish between **Small (≤100 kW)** vs. **Large (>100 kW) Non-Residential** systems, if possible*

- The composition of the non-residential PV market can vary considerably from state to state, contributing to the wide variation in system sizing observed in 2024

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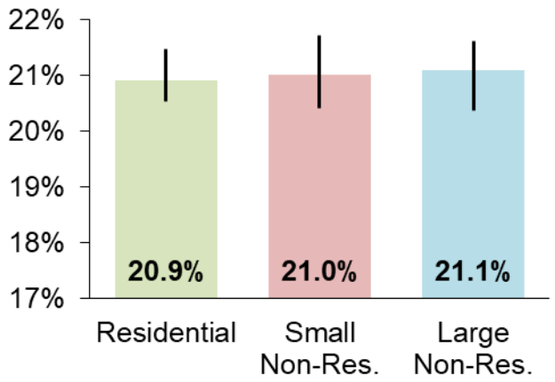
** Notes: Summary statistics are shown for any given state only if at least 20 observations are available, and states are ordered according to increasing median system size. Non-residential systems are defined here to include roof-mounted systems of any size and ground-mounted systems up to 7,000 kW. See appendix for time trend data of system sizes.*

PV System Technical Features (2024 Installs)

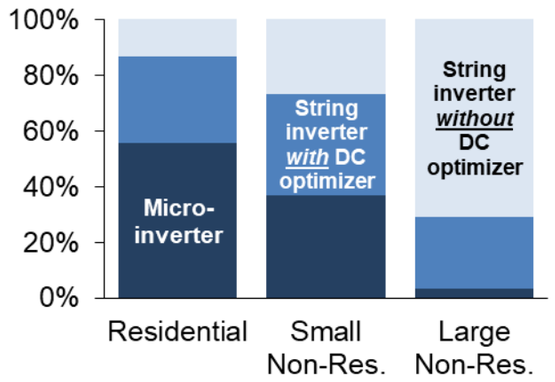
Module Efficiency

Median and 20th/80th Percentiles



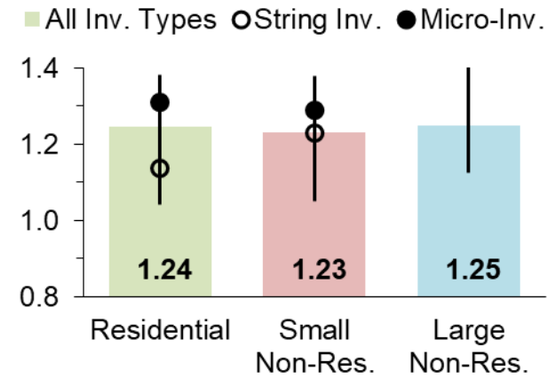
Inverter Technology

Sample Shares



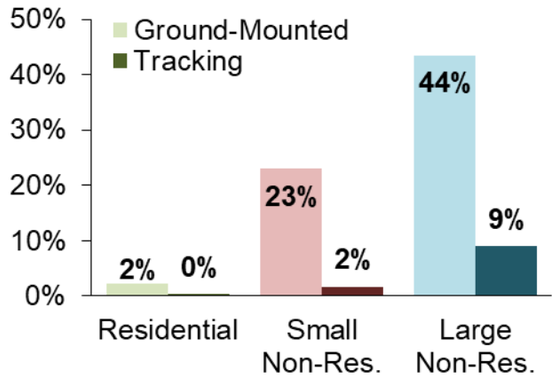
Inverter Loading Ratio

Median and 20th/80th Percentiles



Array Type

Sample Shares



- Module efficiencies were similar across customer segments, with a median of roughly 21% and a percentile range of 20.5-21.5% (for residential)
- Module-level power electronics, which include both microinverters and DC optimizers, were used in 87% of residential and 73% of small non-residential systems in 2024, but in only 29% of large non-residential systems, consisting almost entirely of DC optimizers
- Median inverter loading ratios (the ratio of module DC capacity to inverter AC capacity) were similar across customer segments, but microinverter systems had higher ILRs than those with string inverters
- Ground-mounting was used by almost half of large non-res. systems and one-quarter of small non-res. systems, but most were fixed-tilt (i.e., not tracking)

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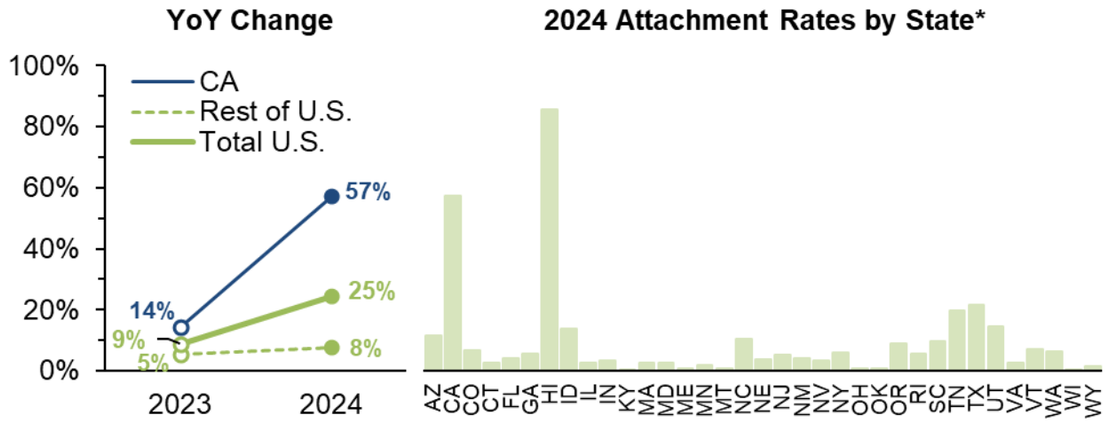
Notes: We calculate module efficiencies for each system based on the nameplate rating and surface area of the module model; both values are taken from module spec sheet data, using either the California Energy Commission's current solar equipment lists or SolarHub. DC Optimizer share is based only on systems with SolarEdge inverters, as those are the only records in the dataset for which the presence of DC optimizers can be determined; thus the DC optimizer share shown here may understate the actual share of power optimizers in the data sample. See appendix for time trend data and other technical features.

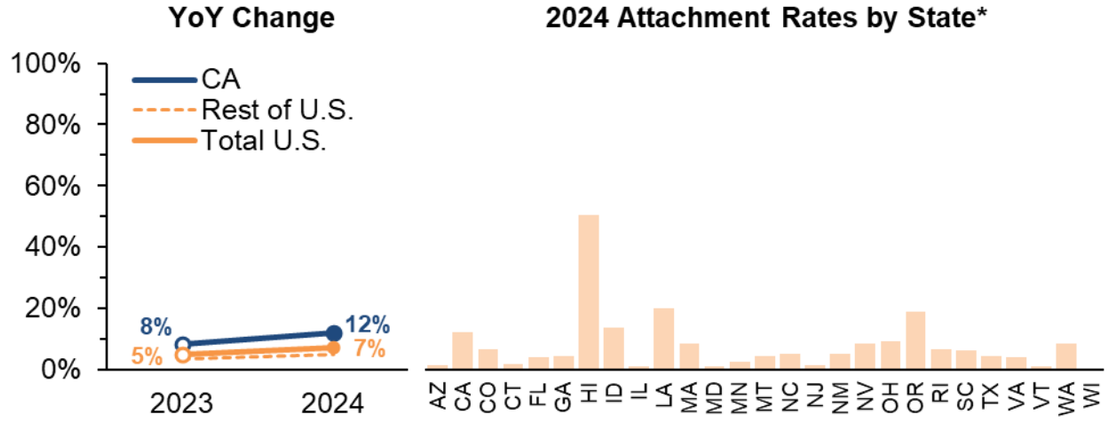
Storage Attachment Rates

Percent of new PV installs paired with storage

Residential Storage Attachment Rates



Non-Residential (all*) Storage Attachment Rates

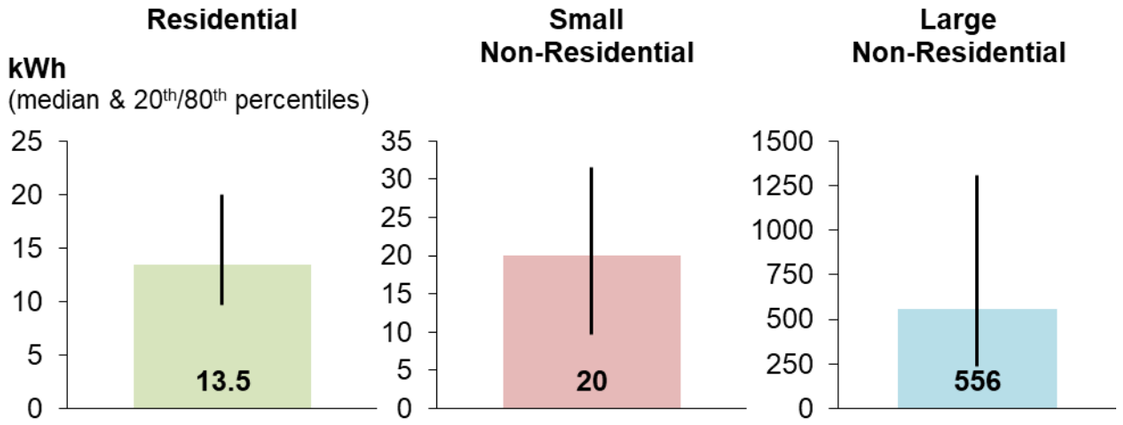


- Residential attachment rates in CA rose sharply from 14% in 2023 to 57% in 2024, but attachment rates generally rose more slowly elsewhere, from 5% to 8% of systems across all other states combined
- HI had, by far, the highest residential attachment rates of any state in 2024 (85%), followed by CA and several other states in the 10-20% range, but most states had residential attachment rates <5% in 2024
- Non-res. attachment rates in CA rose much more modestly than residential rates, from 8-12%, while total U.S. non-residential attachment rates grew from 5-7%
- HI had the highest non-residential attachment rate of any state in 2024 (50%), but, like CA, it was much lower than the residential attachment rate in the state
- Non-res. attach. rates in most other states were <5%

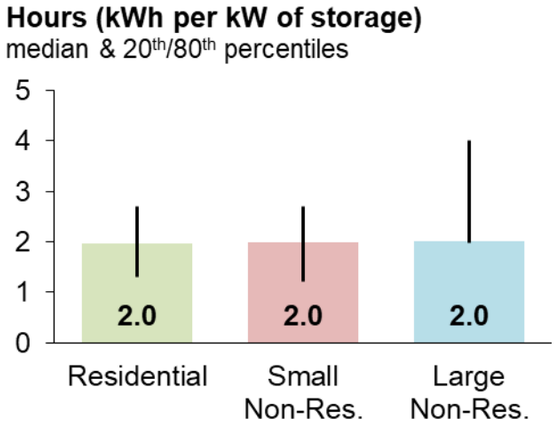
Notes: State-level attachment rates are shown only if available data cover at least 50% of the state market volume. Non-residential attachment rates are based on all non-residential systems, both small and large, as attachment rate data are available for a number of states without the corresponding PV system size. Note that attachment rates do not cover the entire distributed storage market, as they do not capture storage additions to existing PV systems or stand-alone storage installations. See appendix for longer-term time-trend data of attachment rates.

Storage System Sizing (2024 Installs)

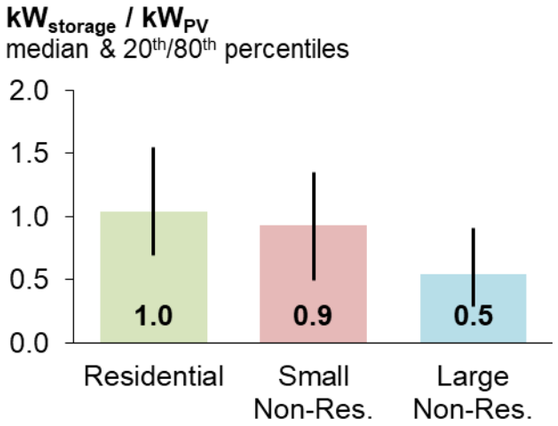
Battery Storage Capacity (kWh)



Storage Duration (hours)



Ratio of Storage-to-PV kW

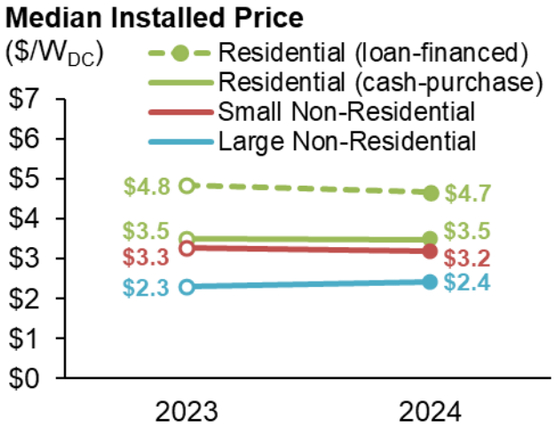


- Residential battery storage systems had a median size of 13.5 kWh in 2024 (the size of single PowerWall), with most systems ranging from 10-20 kWh
- Batteries installed with small non-res. PV systems were slightly larger (20 kWh), while those installed with large non-res. PV systems had a median size of ~550 kWh
- Across all three customer segments, median storage duration was 2 hours (i.e., 2 kWh per kW of storage), but large non-residential systems had a larger contingent of longer duration batteries, with at least 20% of paired systems having 4+ hours of storage
- For residential and small non-res. systems, storage kW capacity was roughly equal to the paired PV capacity, but large non-res. systems had smaller batteries relative to their PV capacity (a median kW ratio of 0.5)

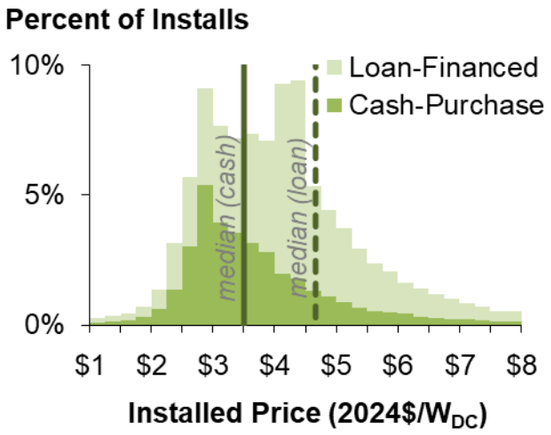
Notes: California represents a disproportionate share (~90%) of the storage sizing data; the results shown here are thus heavily driven by storage sizing trends in CA. See appendix for time trend data on storage system sizing.

Installed Prices for *Stand-Alone PV Systems*

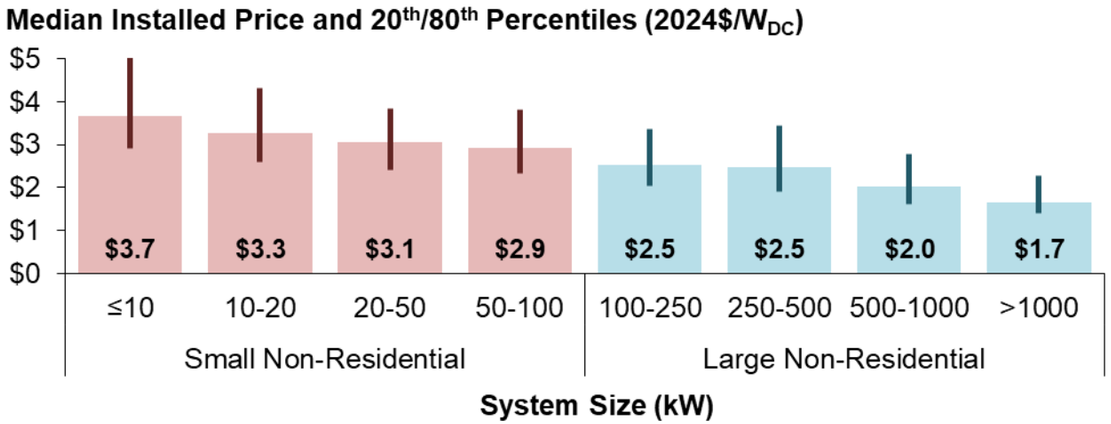
Median Price Change YoY



Residential Prices (2024)



Non-Residential Prices by System Size (2024)

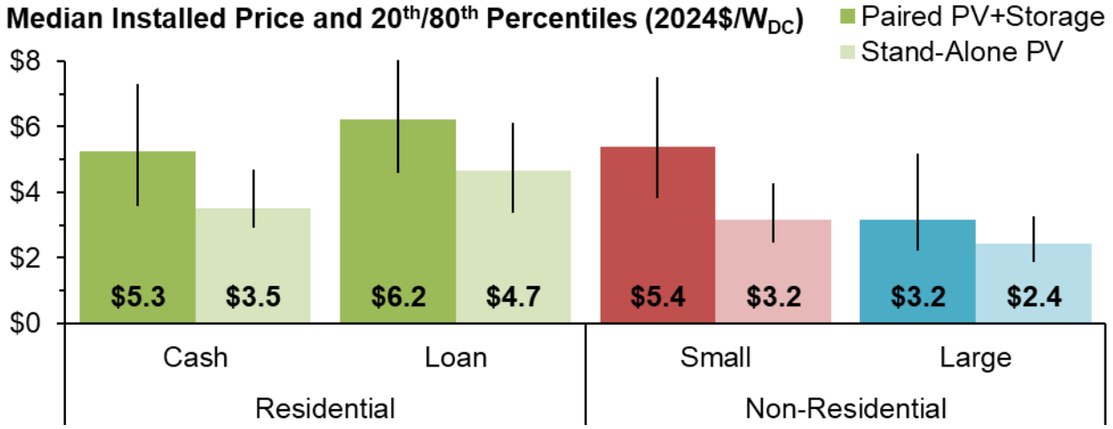


- In inflation-adjusted terms, installed prices remained largely flat from 2023 to 2024, with small increases or decreases (±$0.1/W) depending on the segment
- For residential PV, loan-financed systems were considerably higher priced than cash-purchase systems in 2024 (median prices of $4.7/W vs. $3.5/W), due partly to the loan fees rolled into the up-front price
- Beyond differences in cash vs. loan, the residential pricing distribution in 2024 had a wide upper tail; the mode (i.e., the most common pricing level) was well below the median (mode <$3/W for cash-purchase)
- Pricing for non-residential systems exhibit clear economies of scale, with a $2/W difference in median prices across the system size range shown, but also wide pricing variability within any given size range

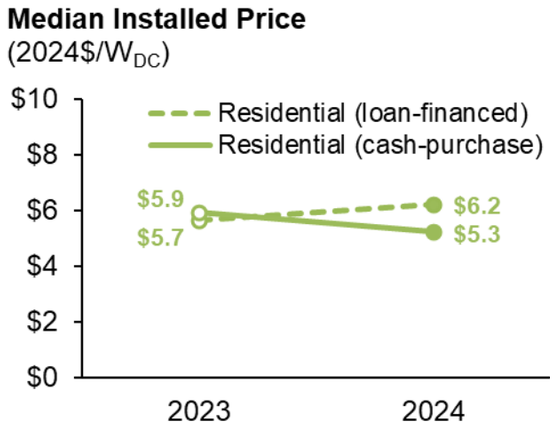
Notes: Installed pricing data are self-reported by the installer or customer and represent the gross price paid by the system owner, before any incentives or tax credits. The figures show data only for host-owned (i.e., excluding third-party owned) systems. Host-owned residential systems are segmented in cash-purchase or loan-purchase based on data from UCC-1 filings compiled by FirstAmerican. See appendix for longer term time trend data and additional statistics, including state- and installer-level pricing data.

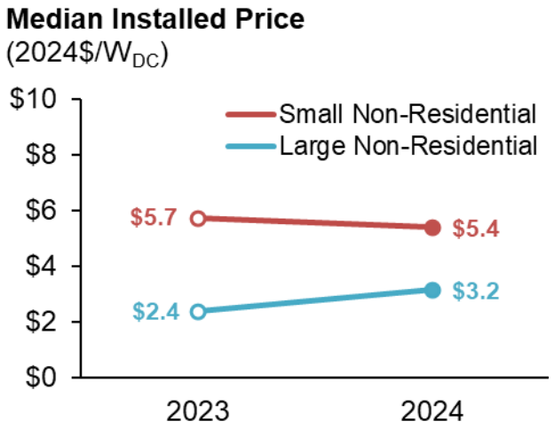
Installed Prices for *Paired PV+Storage Systems*

Paired PV+Storage vs. Stand-Alone PV (2024 Installs)



YoY Change in Median Installed Price



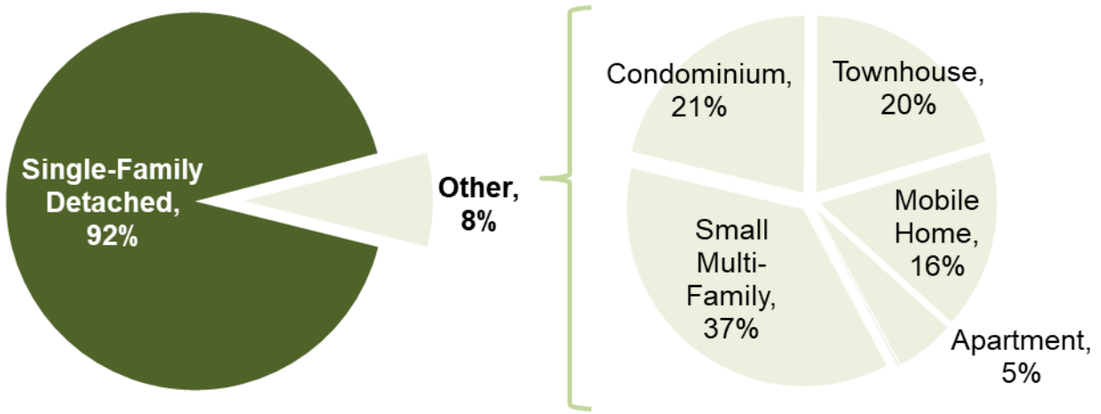


- Installed prices of paired PV+storage systems are denoted here in terms of dollars per kW *of PV capacity*, to allow comparison to stand-alone PV
- The median cash price of paired residential systems in 2024 was $1.7/W higher than for stand-alone systems, while the corresponding differentials were $2.2/W for small non-res. systems and $0.8/W for large non-res.
- Median cash-purchase price for paired residential systems fell by $0.6/W from 2023 to 2024, in inflation adjusted terms, but rose by $0.5/W for loan-financed systems
- Median prices fell for paired small non-res. systems and rose for large non-res. Systems (but sample sizes for large paired systems are small and susceptible to idiosyncratic YoY changes)

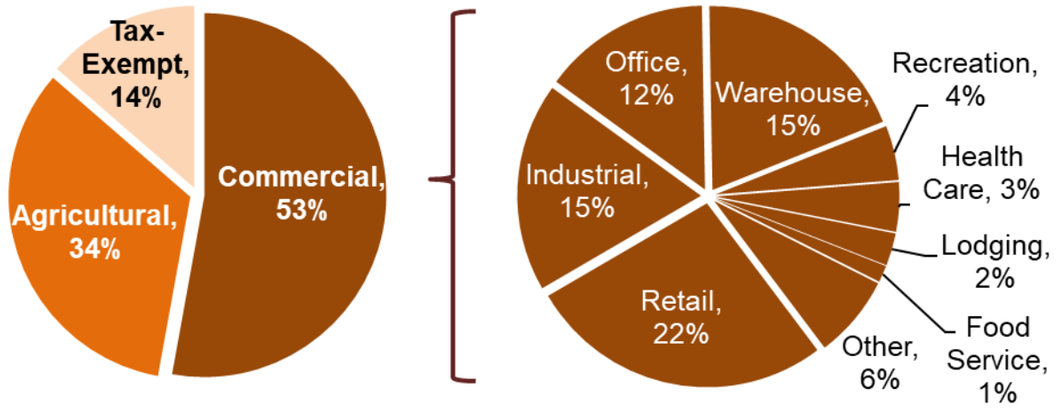
Notes: Installed pricing data are self-reported by the installer or customer and represent the gross price paid by the system owner, before any incentives or tax credits. The figures show data only for host-owned (i.e., excluding third-party owned) systems. Host-owned residential systems are segmented in cash-purchase or loan-purchase based on data from UCC-1 filings compiled by FirstAmerican. Note also that the installed pricing data for paired PV+storage systems consists disproportionately of data from California (~90% of the pricing data for paired residential systems).

Customer Segmentation by Building or Business Type

2024 Residential Installs



2024 Non-Residential Installs

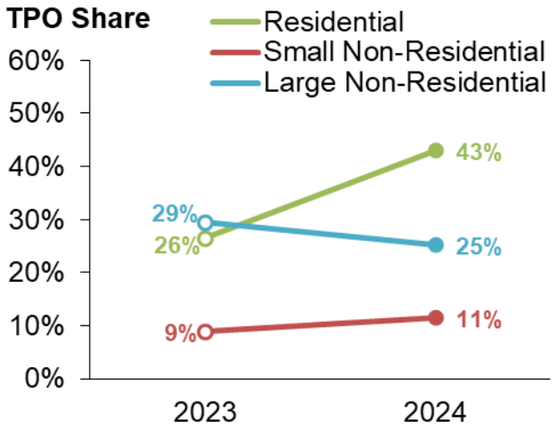


- Residential systems in 2024 were overwhelmingly installed (92%) on single-family detached homes
- Other types of residential installations are mostly on small multi-family buildings (e.g., duplexes), condos, townhomes, and mobile homes; a small percentage are on apartments or other large multi-family buildings
- Among non-residential systems installed in 2024, roughly half (53%) were on commercial buildings, 34% were on agricultural land, and the remainder were at tax-exempt customer sites (schools, government, houses of worship, etc.)
- Commercial systems spanned a diverse range of business types, the largest in 2024 being retail, warehouse, industrial, and office buildings

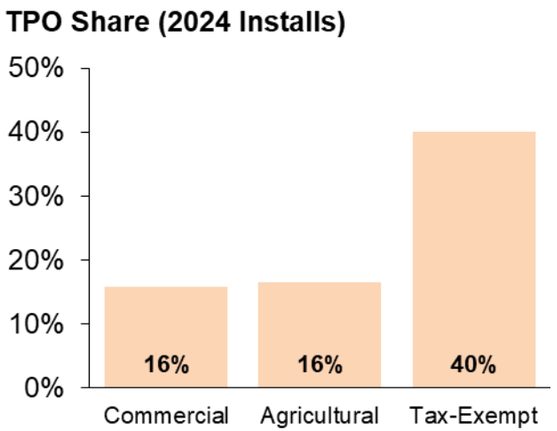
Notes: Customer segmentation is based on detailed land-use codes from CoreLogic, which are derived from county records and can vary from county to county in terms of how particular building types are defined. Berkeley Lab aggregates those land use codes into the particular categories presented here. See Appendix for data on system sizing across non-residential business types.

Third-Party Ownership (TPO) Rates

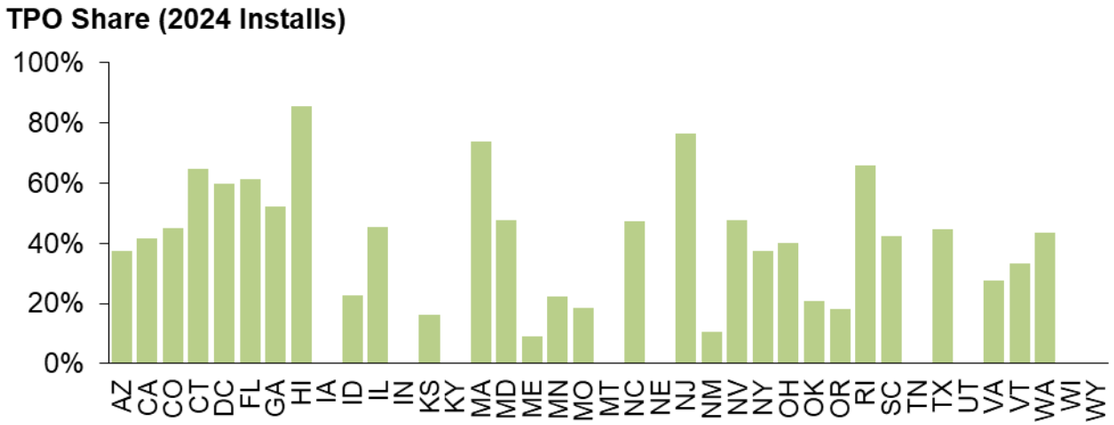
TPO Rates: 2024 vs. 2023



Non-Res. TPO by Sector



Residential TPO by State

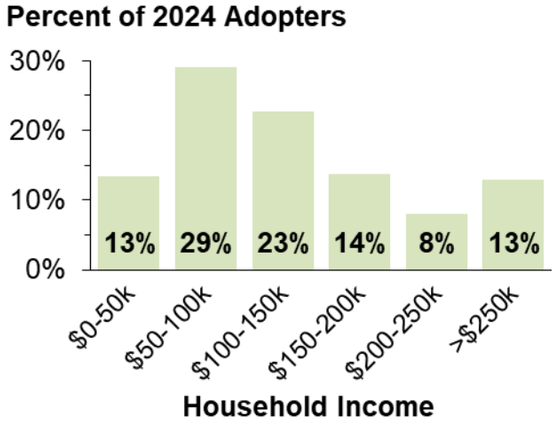


- Residential TPO rates rose sharply, from 26% in 2023 in 2024 to 43%, reaching levels not seen in nearly a decade (see longer time series data in Appendix)
- TPO rates for small and large non-residential systems moved in opposing directions, but in both cases the YoY changes were within the range of annual fluctuations observed in recent years
- Non-residential TPO rates in 2024 were considerably higher for systems installed by tax-exempt site hosts (40%) compared to those for commercial (16%) and agricultural customers (16%)
- Residential TPO shares varied substantially across states, from <10% in some to >60% in others; see Appendix for non-residential TPO rates by state and also by business type

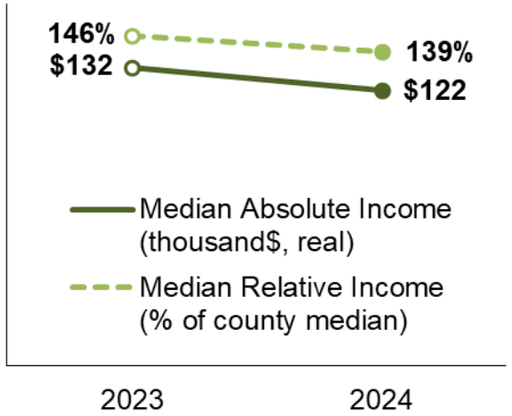
Notes: In the bottom figure, TPO rates are shown for any individual state only if data are available for at least 50% of all residential systems installed in that state in 2024.

Solar-Adopter Household Incomes

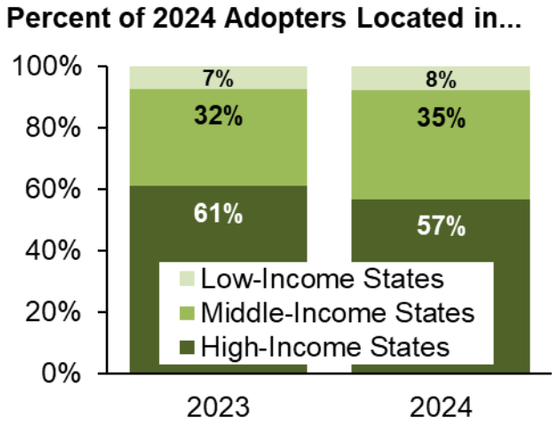
Income Distribution (2024)



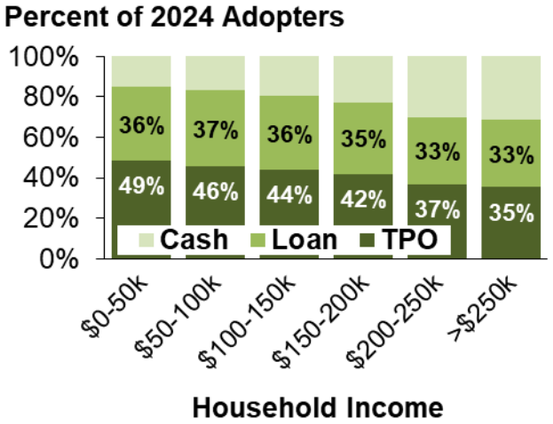
YoY Change 2023-2024



Distrib. by State Income



Financing Type



- Households installing solar in 2024 span all income levels, with the largest contingent in the $50-100k range, followed by those in the $100-150k range
- 2024 solar adopters had lower incomes than 2023 adopters ($122k vs. $132), but were still wealthier than the general population, with median incomes 39% higher than their county median income
- 2024 saw a slight shift in the residential PV market toward middle- and low-income states*, but high-income states still represent a disproportionate share (57%) of the market
- Lower income solar adopters were more likely than higher-income adopters to use some form of financing (either TPO or loans, though TPO shares differed the most across income levels)

Notes: For the figure on the upper right, relative income is calculated by dividing each solar adopter's household income by the median income of all households in the same county; the values plotted in the figure are the medians of those percentage values across all solar adopters. For the figure on the lower left, states are categorized based on their median household income, with roughly an equal number of households in each of the three groups of states. See Appendix for additional methodological details as well as longer-term time series data and additional statistics.

Appendix

Appendix Contents

Data Sources, Methods, and Market Coverage

Key Definitions and Conventions

Customer Segments*

- **Residential:** Single-family and, depending on the data provider, may also include multi-family
- **Non-Residential:** Non-residential rooftop systems of any size and ground-mounted systems ≤5,000 kW_{AC}
  - Some figures further subdivide Non-Residential into **Small** vs. **Large Non-Residential**, based on a cutoff of **100 kW_{DC}**

* Unrelated to system ownership or whether it is connected to the customer- or utility-side of the meter

Units

- Real 2024 dollars (unless otherwise noted)
- Direct-current Watts (W_{DC}), unless otherwise noted

Installed Price: Up-front price (2024$/$W_{DC}$) paid by the PV system owner

- Prior to incentives (i.e., the gross price)
- Inclusive of any up-front loan-financing fees passed through the installer

Datasets and Sources

Annual data update involves cleaning, standardizing, and merging data from varied sources, ultimately culminating in the creation of <u>two distinct, but overlapping, datasets</u>

PV-Attribute Dataset

- Data resolved at the individual project level
- Includes PV system attributes such as system size, reported price, component make/model, installer name, location, customer segment, and an indicator for third-party financing, among other items
- Data provided by state agencies, utilities, and other organizations, typically collected through incentive programs and/or interconnection processes
- In total, 72 entities spanning 31 states contributed data to this year's data update, though not all contributed new data this year (see next slide)

Address-Level Dataset

- Data resolved at the street address level
- Compiled by merging addresses from PV-Attribute dataset with additional PV system addresses from building permit datasets purchased from BuildZoom[1] and Ohm Analytics[2]
- Other data are then appended onto those addresses, including: building property attributes (from Cotality[3]), estimated household income (from Experian[4]), and PV financing data (from FirstAmerican[5])
- Also includes permitting dates and a limited set of PV system attributes from building permit descriptions

[1]https://www.buildzoom.com/data, [2]https://www.ohmanalytics.com, [3]https://www.cotality.com, [4] https://www.experian.com/business/products/income-insight, [5]https://dna.firstam.com/solutions/property-data/datatree-property-research

List of Utilities and Agencies Contributing Data

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

**denotes active data providers*

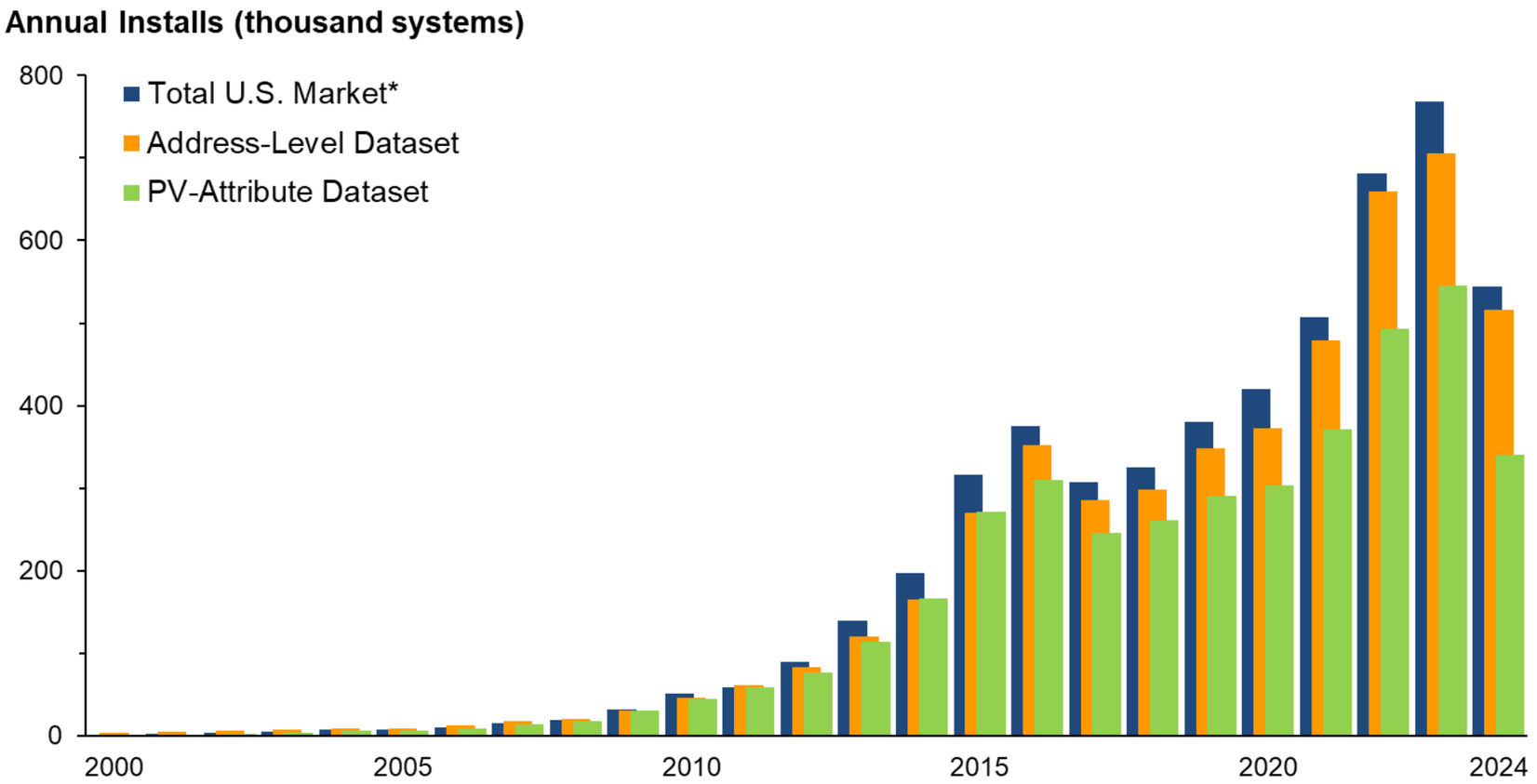
Sample Sizes Relative to Total U.S. Market

Address-Level Dataset

- **4.9 million** systems through 2024 (93% of the U.S. market)
- 515,000 systems installed in 2024 (95% of the U.S. market)

PV-Attribute Dataset

- **4.0 million** systems through 2024 (76% of U.S. market)
- 340,000 systems installed in 2024 (62% of U.S. market)
- A subset of the PV-attribute dataset is used for installed price analysis, as described later



**Total U.S. Market size is based on data from Interstate Renewable Energy Council for all years through 2010 and from Wood Mackenzie and SEIA's annual "Solar Market Insight" report for each year thereafter. Those data represent estimates of total U.S. annual installations each year.*

State-Level Sample Distribution and Market Coverage

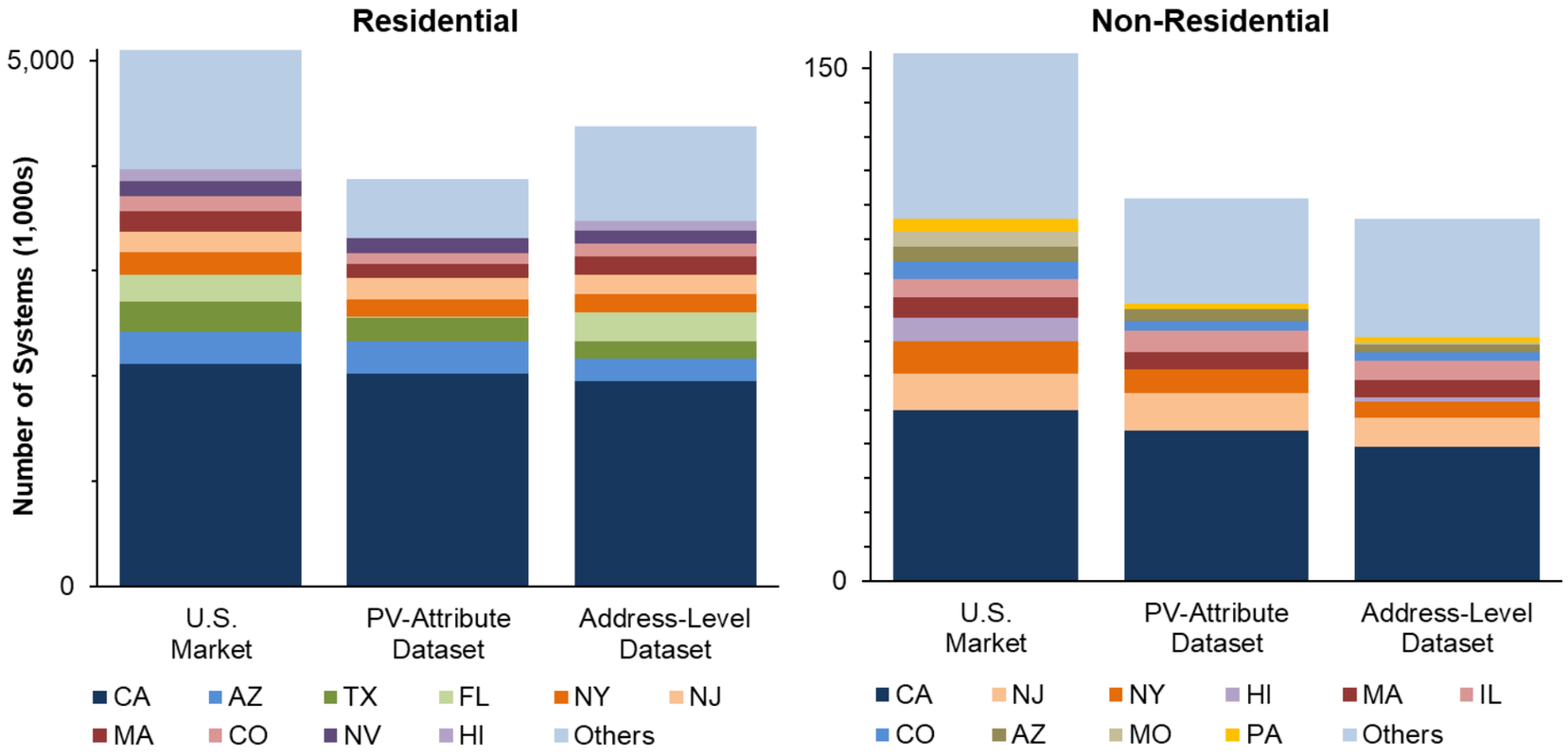
Sample Distribution: CA dominates the sample, as it is the largest in the overall U.S. market

Market Coverage:

- Similar overall level of market coverage for both residential and non-residential
- Larger state markets are generally well represented within both datasets
- The most significant gaps are for the collection of smaller state markets (aggregated in the figures as “Others”)

Cumulative PV Installs through 2024 (thousands)

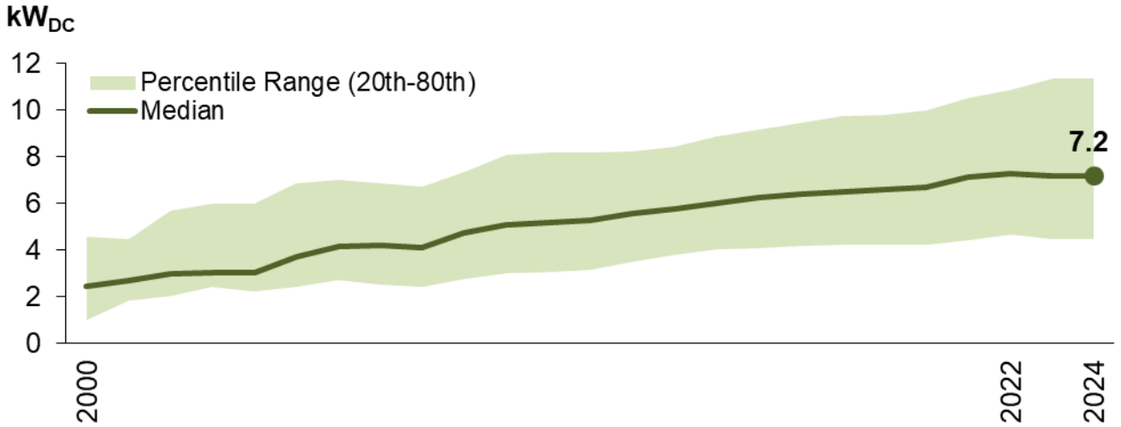
The figures show the top-10 states in each customer segment, based on cumulative installs through 2024, and all other states are combined in the “Other” category. Total U.S. Market based on WoodMac/SEIA (2025).



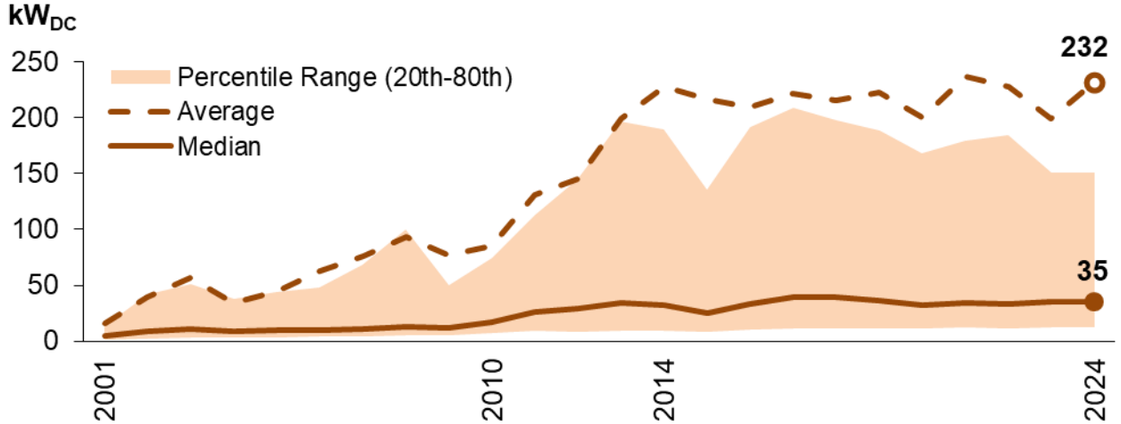
PV System Characteristics

System Size Trends

Residential System Size Time Trends



Non-Residential System Size Trends

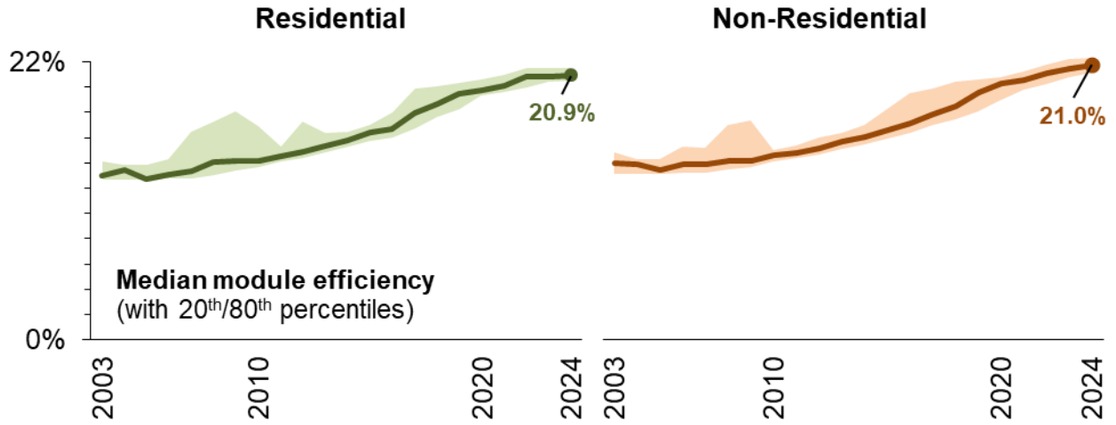


- Median residential system sizes rose steadily over the last two decades by ~5% per year, but the trend has been flat from 2022-2024; corresponds to trends on the next slide in module efficiencies
- Non-residential system sizes vary widely (e.g., from roughly 10-150 kW between the 20th and 80th percentiles in 2024), but the sizing distribution has remained fairly stable since 2014 (e.g., with average sizes fluctuating between 200-235 kW in each year)
- This contrasts with the years immediately prior to 2014, which saw a rapid increase in the prevalence of relatively large non-residential systems, as indicated by the sharp rise in average sizes (rising from 85 kW to 230 kW between 2010-2014)

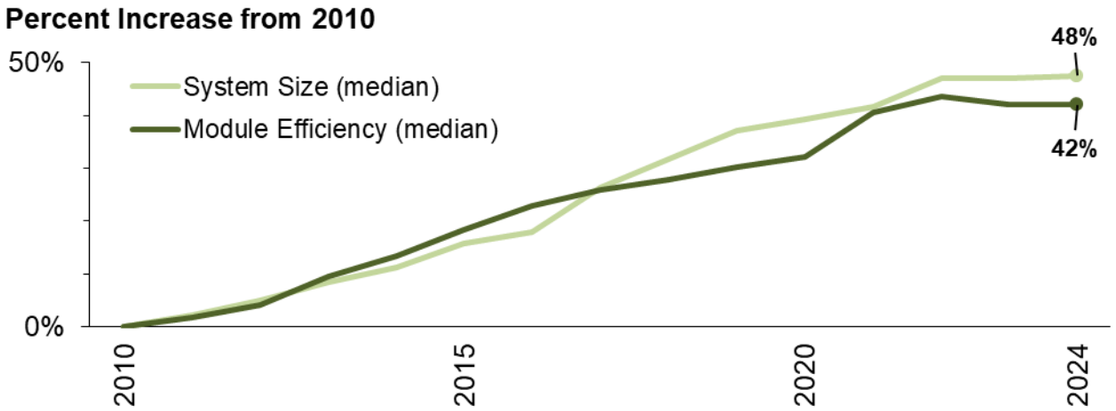
Notes: Summary statistics for any given year are shown only if at least 20 observations are available.

Module Efficiency Trends

Module Efficiency Trends over Time



Residential Module Efficiency vs. System Sizing

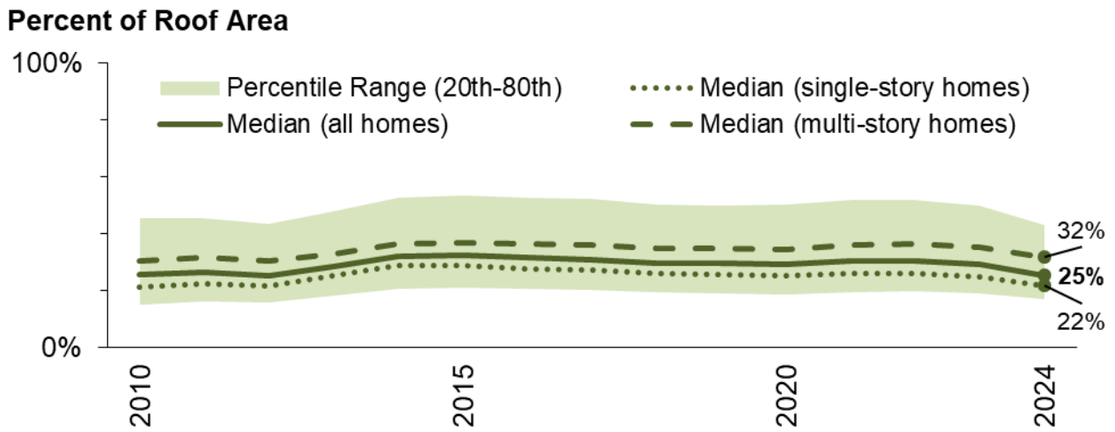


- Median module efficiencies have risen over time (e.g., by 0.4% per year, on average, for residential systems, from 13.0% in 2003 to 20.9% in 2024), though residential efficiencies were flat from 2022-2024
- Higher module efficiencies allow denser installations, enabling reductions in soft costs and BoS costs that scale with square footage
- Changes in residential system sizing closely track module efficiency since 2010 (bottom figure)
- Suggests that module efficiency gains have been the driving force behind rising residential system sizing, where roof and shading constraints are often binding

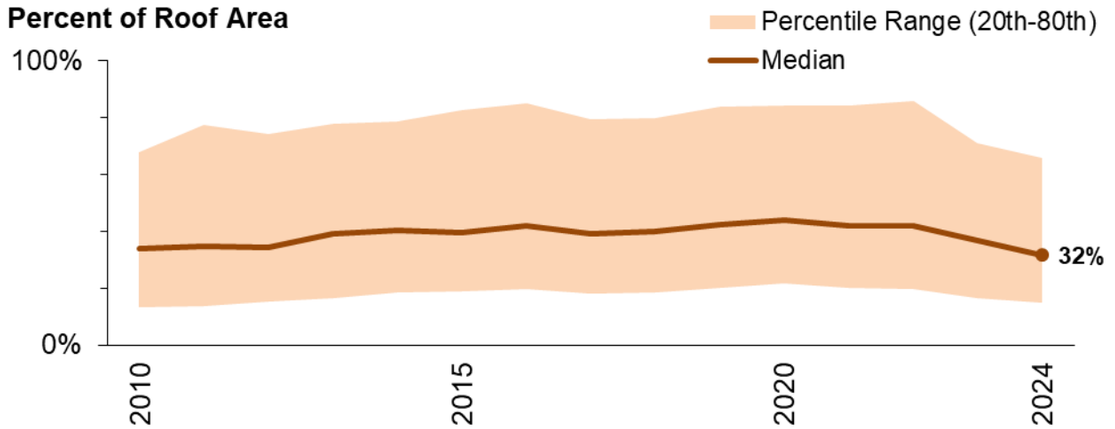
Notes: We calculate module efficiencies for each system based on the nameplate rating and surface area of the particular module model used. Both values are taken from module spec sheet data, using either the California Energy Commission's current solar equipment lists or SolarHub (a free public repository of module and inverter spec sheet data).

PV Roof-Coverage Trends

Residential Roof-Coverage Ratio



Non-Residential Roof-Coverage Ratio

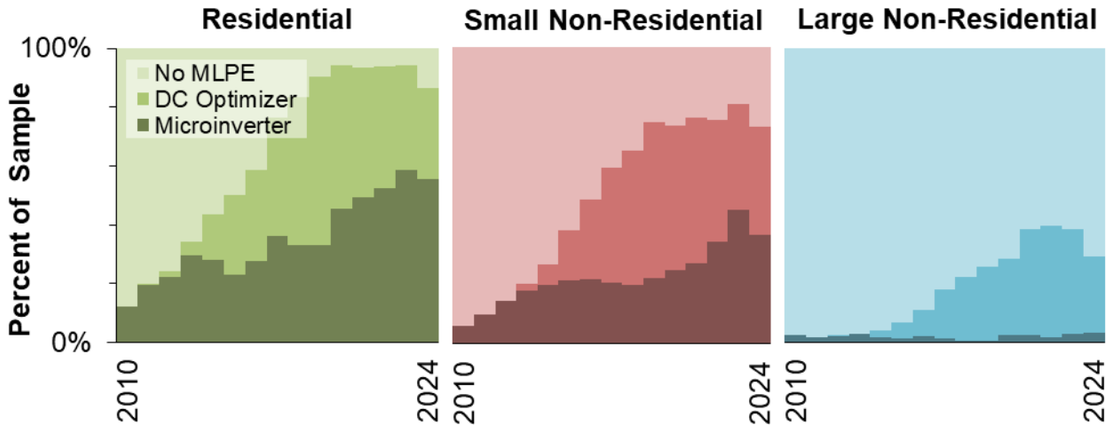


- Roof-coverage ratio is the percentage of total roof-space covered with PV, calculated based on project-specific data for module and roof area (see Notes)
- Residential roof-coverage ratios typically ranged from 16-41% of total roof area in 2024 (across the percentile band shown), and were larger for multi-story homes (a median of 32%) compared to single-story (22%)
- Roof-coverage ratios for non-residential systems varied more widely, from 15-66%, reflecting the broader range of building types and configurations
- Median roof coverage ratios fell in 2024 relative to 2023 (from 29% to 25% for residential, and from 37% to 32% for non-residential), both at or near historical lows over the timeframe shown

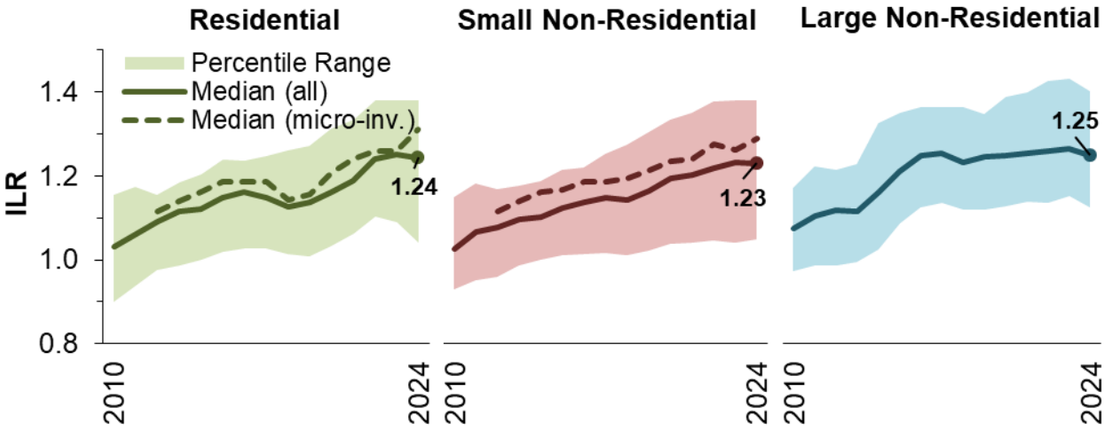
Notes: Module square footage is based on the specific module models used in each installation, with panel surface area based on spec-sheet data for those particular models (see previous slide on data sources). We approximate roof area using data from CoreLogic on the ground-floor square footage of each building, adjusted based on actual or assumed roof tilt (20 degrees for residential and flat roof for non-residential). In some cases, ground floor square footage is estimated based on total square footage and number of stories.

Inverter Technology Trends

Microinverter and DC Optimizer Trends



Inverter Loading Ratios (DC-to-AC Ratio)

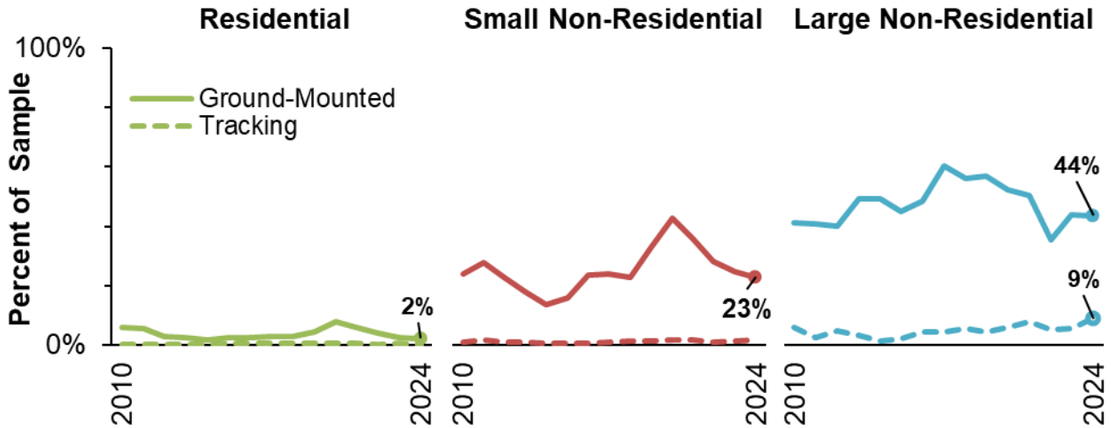


- MLPE shares grew steadily in all customer segments until 2019/2020 and have remained largely flat since then (albeit with a slight drop from 2023-2024)
- Even while total MLPE shares remained flat, micro-inverter shares continued to grow in the residential and small non-res markets (e.g., from 33% to 56% of residential systems between 2019 and 2024), displacing market share from DC optimizers
- Inverter-loading ratios (or ILRs, the ratio of module-to-inverter nameplate ratings) have grown over time with declining module costs and microinverter share
- Median ILRs were historically higher for large non-residential systems, but are now roughly equivalent across sectors (ranging from 1.23-1.25)

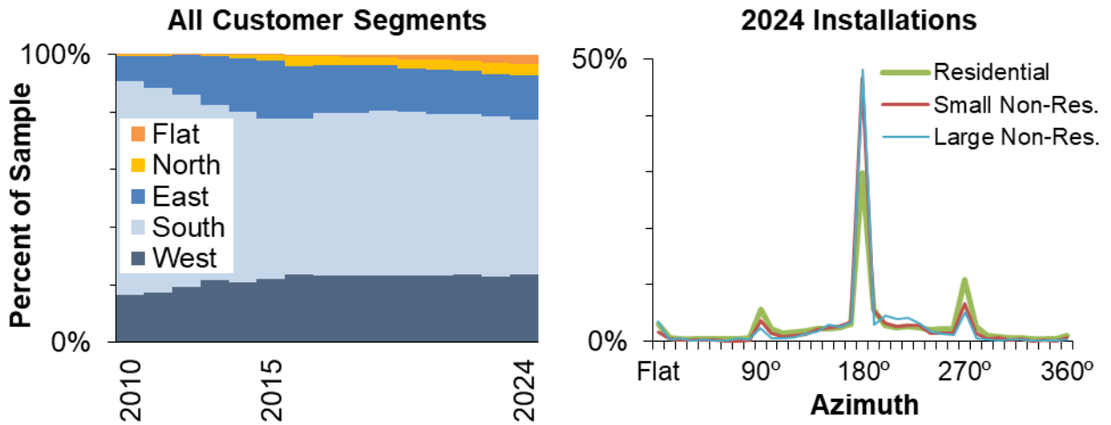
Notes: DC Optimizer share is based only on systems with SolarEdge inverters, as those are the only records in the dataset for which the presence of DC optimizers can be determined. As a result, the DC optimizer share shown in the figures likely understates the actual share of power optimizers in the data sample.

Mounting Configuration and Panel Orientation Trends

Ground-Mounting and Tracking Equipment



Panel Orientation



- Ground-mounting has been most prevalent among large non-residential systems (35-60% of systems each year from 2010-2024) and has also been common among small non-res. systems (13-43% of systems per year), but is rarely used for residential
- Tracking was used in a small share of large non-res. systems (1-9% each year) and almost never by small non-residential or residential systems
- The distribution in panel orientations hasn't changed much since 2015, with about half (54%) of all panels facing toward the south in 2024, 23% to the west, and most of the remainder to the east
- A greater share of non-res. systems faces *exactly* due-south compared to residential, likely due to greater prevalence of ground-mounting and flat rooftops

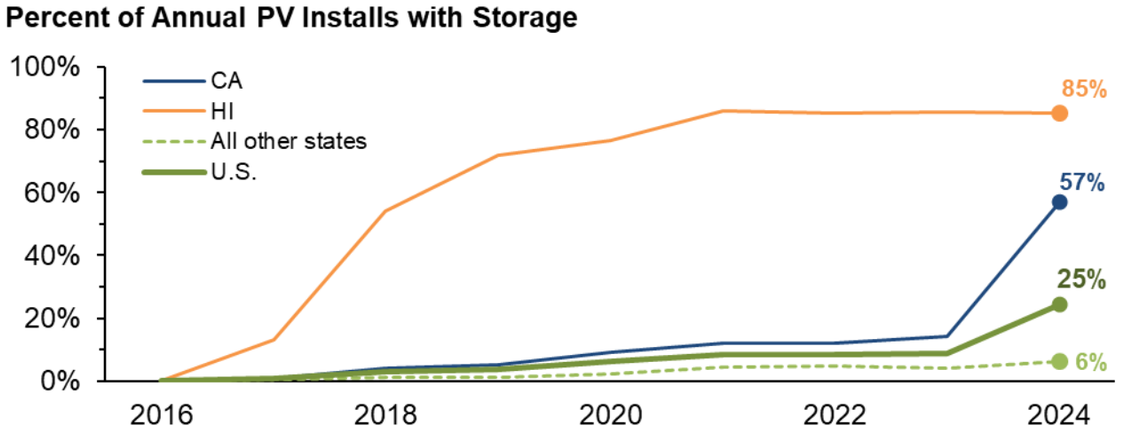
Notes: Summary statistics for any given year are shown only if at least 20 observations are available. Figures in the top panel include only those where mounting type is known. Figures in the bottom panel exclude tracking systems, and in both figures, the orientation is based on the primary array (for systems with multiple arrays facing different directions). For the figure on the lower left, azimuths are grouped according to cardinal compass directions ±45° (e.g., systems within ±45° of due-south are considered south-facing). For the figure on the lower right, panel orientations are grouped in 10-degree bins.

Storage Attachment Rates and Paired PV+Storage System Characteristics

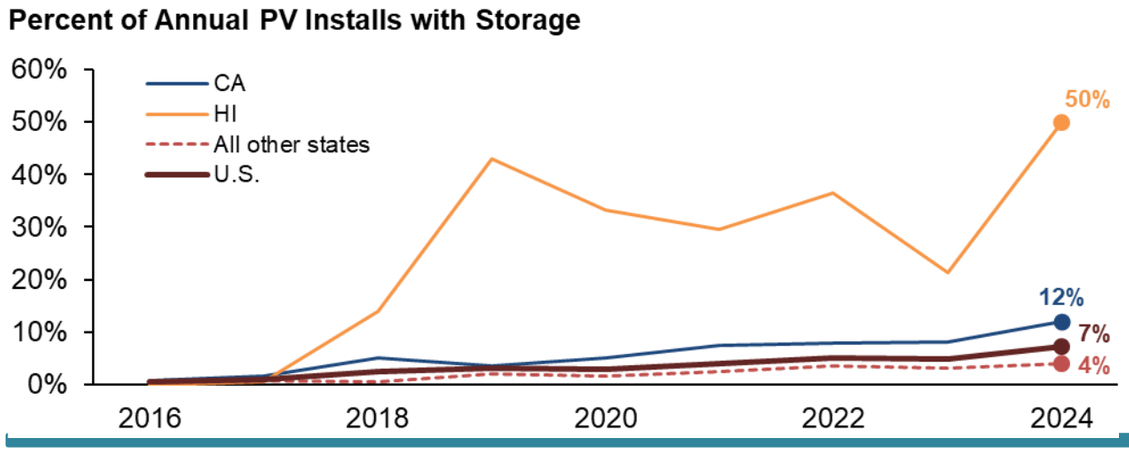
Storage Attachment Rates

Percent of PV systems installed each year with storage

Residential Storage Attachment Rates over Time



Non-Residential Storage Attachment Rates over Time

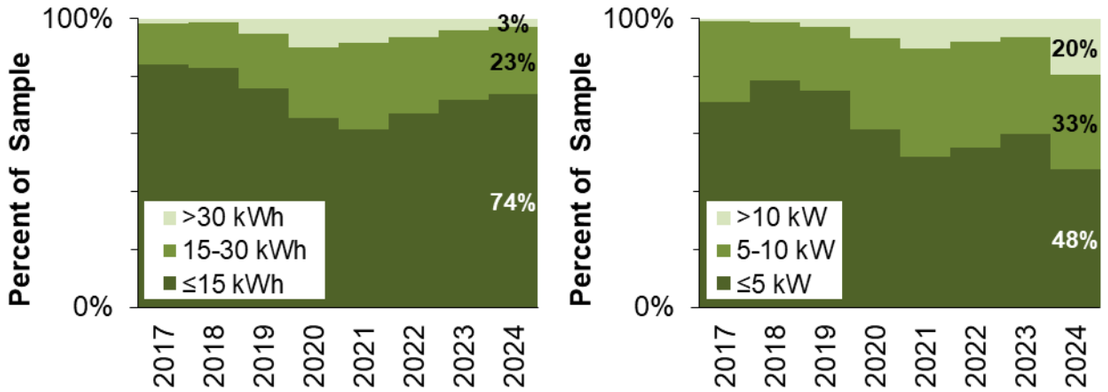


- Residential attachment rates in HI rose rapidly from 2017-2021 after changes in the state's net metering rules, and have remained at ~85% since 2021
- As noted in the main body, residential attachment rates in CA rose dramatically in 2024, also following changes in its net metering rules
- Average residential attachment rates outside of HI and CA have risen gradually, reaching 6% of all new PV installs in 2024
- Non-residential attachment rates are generally lower than residential attachment rates, including in both HI and CA

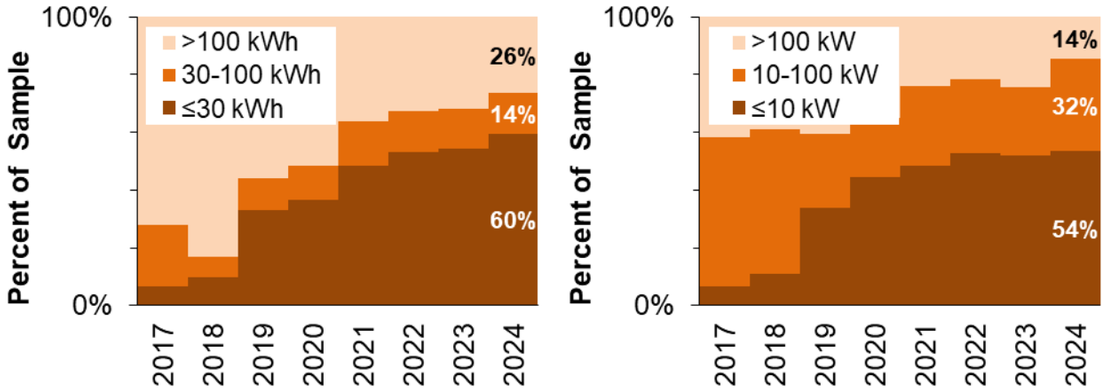
Notes: State-level attachment rates are shown only if available data cover at least 50% of the state market volume. Non-residential attachment rates are based on all non-residential systems, both small and large, as attachment rate data are available for a number of states without the corresponding PV system size. Note that attachment rates do not cover the entire distributed storage market, as they do not capture storage additions to existing PV systems or stand-alone storage installations.

Paired PV+Storage System Sizing Trends

Residential Storage Sizing Trends (kWh and kW)



Non-Residential Storage Sizing Trends (kWh and kW)

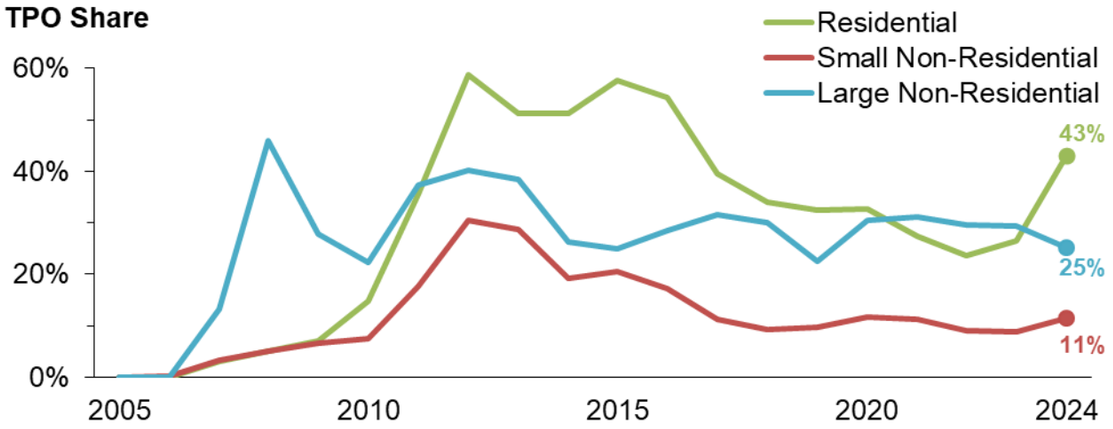


- The residential market had been trending toward systems with larger amounts of energy (kWh) capacity until 2021, but reversed course since then
- However, the residential market has continued its trend toward increasing battery power (kW) capacity
- Paired PV+storage systems in the non-residential market have been steadily progressing toward smaller system sizes, as seen in both the storage energy (kWh) and power (kW) capacity trends
- Sizing trends can reflect changes in battery product designs (power to energy ratios) and in customer use-cases (e.g., solar self consumption vs. battery backup power vs. demand charge management)

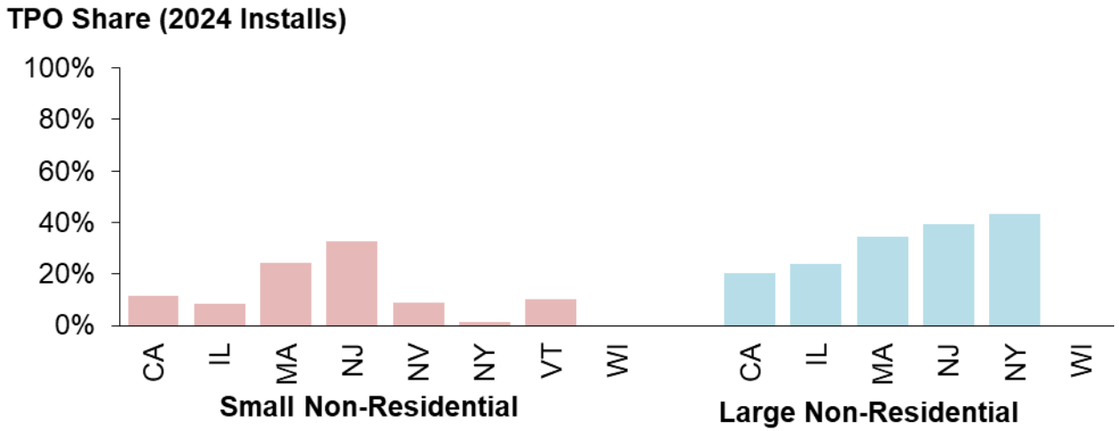
Third-Party Ownership and Customer Segmentation

Third-Party Ownership Trends

TPO Trends over Time



Non-Res TPO by State



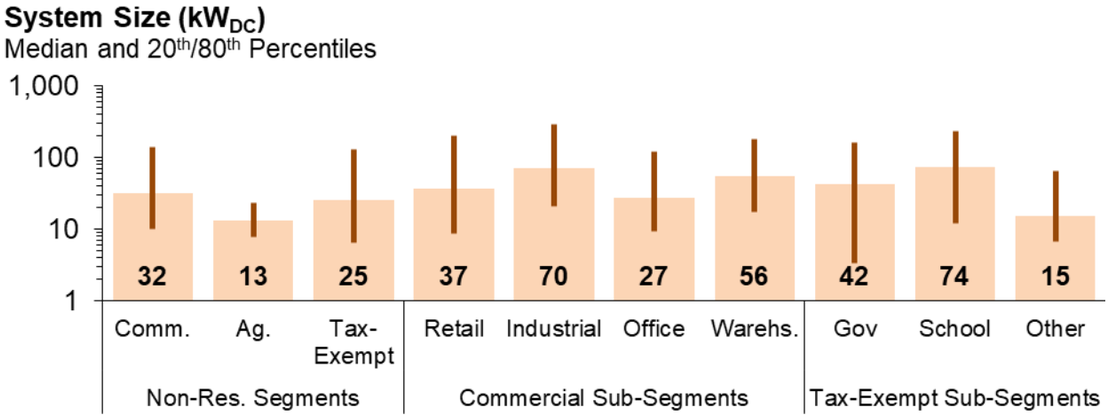
- Since its historical highs in the early/mid-2010's, TPO shares for residential systems had been steadily falling, before reversing course in 2023 and then sharply increasing in 2024
- Non-residential TPO shares also peaked in the early 2010's and have tended to fluctuate YoY since that time, with TPO rates for small non-residential systems consistently well below the other customer segments
- Non-residential TPO shares vary across states, from 0-33% for small non-residential systems and from 0-43% for large residential systems (among those states with sufficient data available)
  - Note that cross-state differences can be idiosyncratic, given small underlying sample sizes for some states

Notes: In the bottom figure, TPO rates are shown for any individual state only if data are available for at least 20 systems and at least 50% of all non-residential systems installed in that state in 2024.

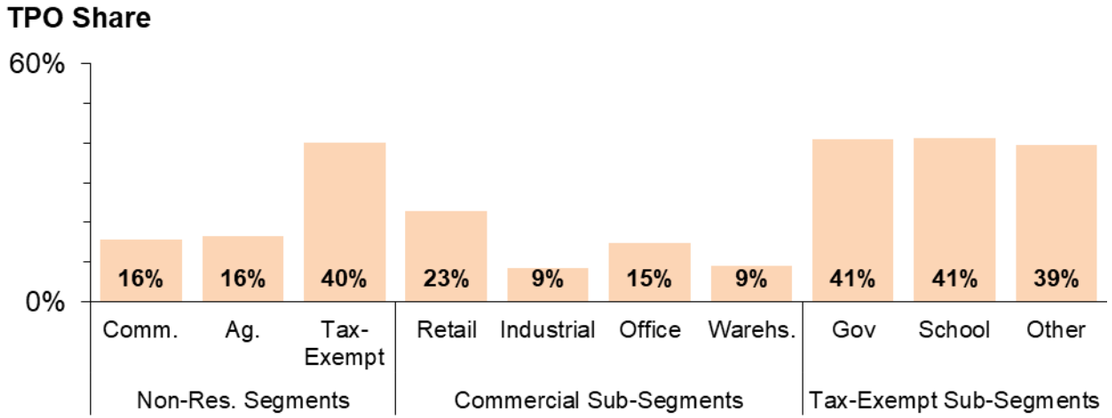
Non-Residential Sub-Segment Details

System sizing and TPO rates

System Sizing (2024 Non-Residential Systems)



Third-Party Ownership (2024 Non-Residential Systems)



- The largest system sizes in 2024 were at schools and industrial properties, though median sizes in all segments were <100 kW
- Systems installed on agricultural properties were generally quite small (mostly in the 10-20 kW range); many of these are likely on small family farms, partly serving residential loads
- TPO rates among commercial customer business types varied in 2024, with the highest TPO rates observed for retail establishments (23%), but considerably lower TPO rates for industrial and warehouse facilities (9%)
- Among tax-exempt site hosts, TPO rates were similar across the organization types shown

Notes: See previous slide for data sources used to define customer segments. The figures include only the most common commercial and tax-exempt sub-segments; other and unknown sub-segments are omitted for brevity.

Installed Price Trends

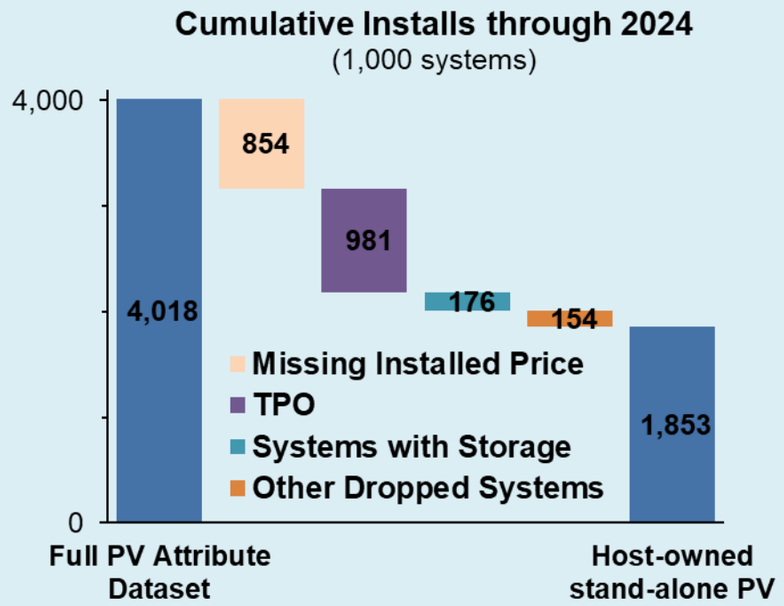
Installed-Price Analysis: Additional Methodological Details

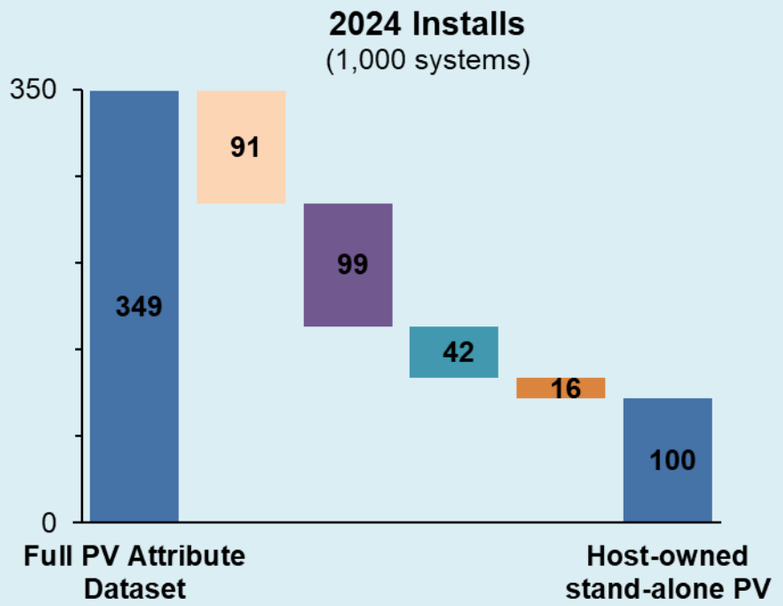
Installed-price data are…

- Self-reported by the installer or customer
- The gross price paid by the system owner, before any incentives or tax credits
- Inclusive of any dealer fees for loan-financed systems and may include other ancillary items related to the PV installation (e.g., for electrical or roofing work)
- Adjusted for inflation, unless otherwise noted

Analysis is based on a subset of the PV-Attribute Dataset:*

- Unless otherwise noted, focuses on host-owned, stand-alone PV (i.e., excludes TPO and paired PV+storage systems)**



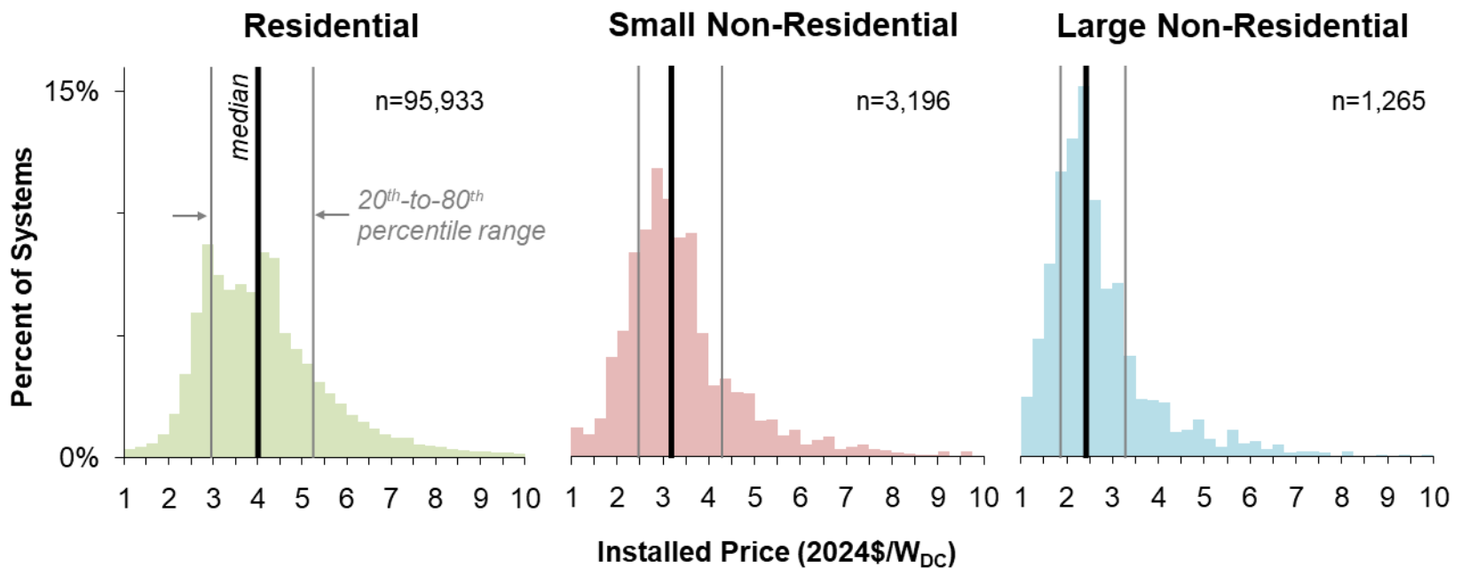


*Some data sources do not provide installed-price data. In addition, reported installed prices outside the range of $1-20/W (nominal) are assumed to be data entry errors and are excluded from the analysis.
**Self-installed systems are also excluded from the installed-price analysis.

Installed-Price Distributions for Systems Installed in 2024

Host-owned, stand-alone PV systems

Price Distribution for 2024 Installs



2024$/$W_{DC}$	Residential	Small Non-Resid.	Large Non Resid.
20th Percentile	$3.0	$2.5	$1.9
Median	***$4.0***	***$3.2***	***$2.4***
80th Percentile	$5.2	$4.3	$3.3

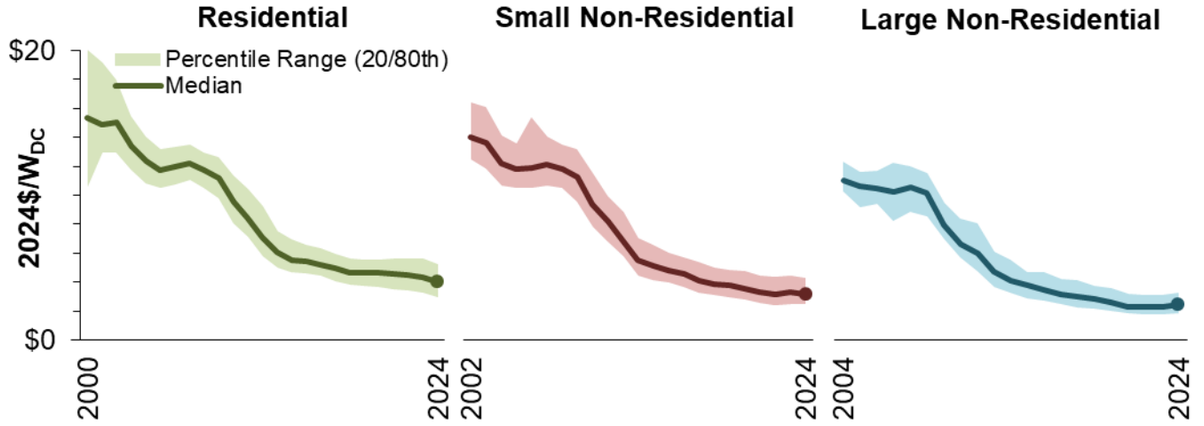
- Wide pricing variability exists within each customer segment, especially for residential systems
- Reflects underlying differences in:
  - Dealer fees for loan-financed systems
  - Project technical characteristics
  - Installer attributes
  - Local market, policy, and regulatory environment
- Later slides explore a subset of pricing drivers through *descriptive analysis*
  - Other studies have employed more sophisticated statistical methods to estimate the effects of pricing drivers

**The figures here include both cash- and loan-financed systems but exclude third-party owned systems.*

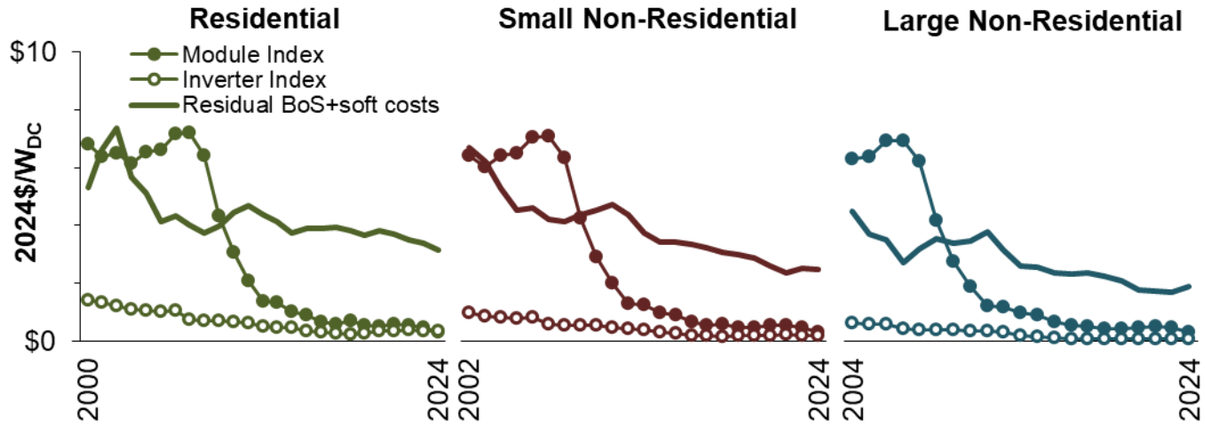
Long-Term Trends in Installed Prices and Component Costs

Host-owned, stand-alone PV systems

National Installed Prices over Time (Inflation-Adjusted)



Underlying Trends in Component Costs



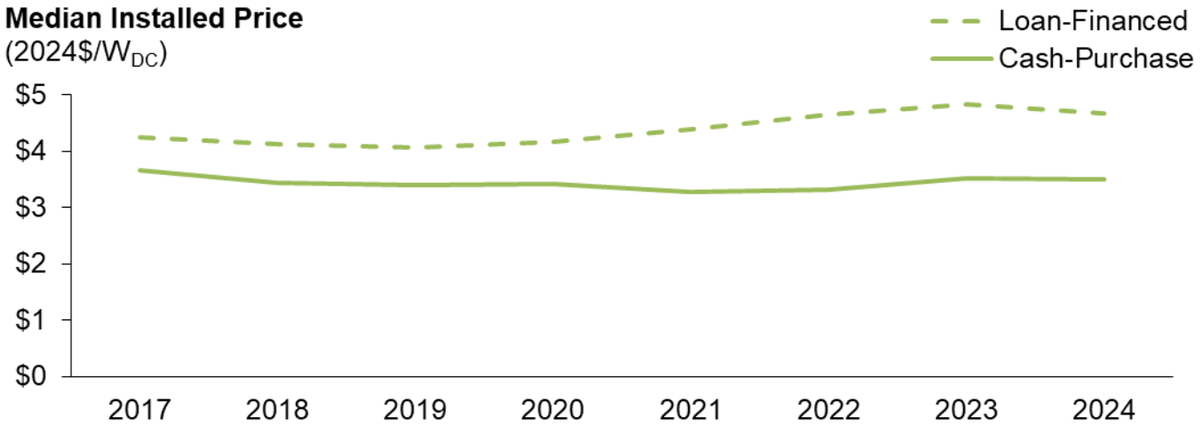
- Over the past two decades, installed prices have fallen by $9-11/W across each customer segment, equivalent to a 70-80% reduction in real (inflation-adjusted) terms
- Price declines were most pronounced through 2014, driven primarily by falling module costs
- Price declines since then have occurred at a more modest pace of $0.1-0.2/W per year, on average, driven primarily by changes in soft costs and other balance of system (BoS) costs
  - Soft costs include customer acquisition, installation labor, permitting and interconnection, financing fees (for certain loan-financed systems), taxes, and profit
- Soft costs and other BoS costs collectively represent roughly 80% of the total installed price of residential systems, and slightly less for non-residential, based on median installed prices in 2024

Notes: Summary statistics for any given year are shown only if at least 20 observations are available. 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, and represent the price paid by the installer. The Residual term is calculated as the median installed price for each customer segment minus the corresponding Module and Inverter Price Indices in the preceding year (to reflect some supply-chain lag).

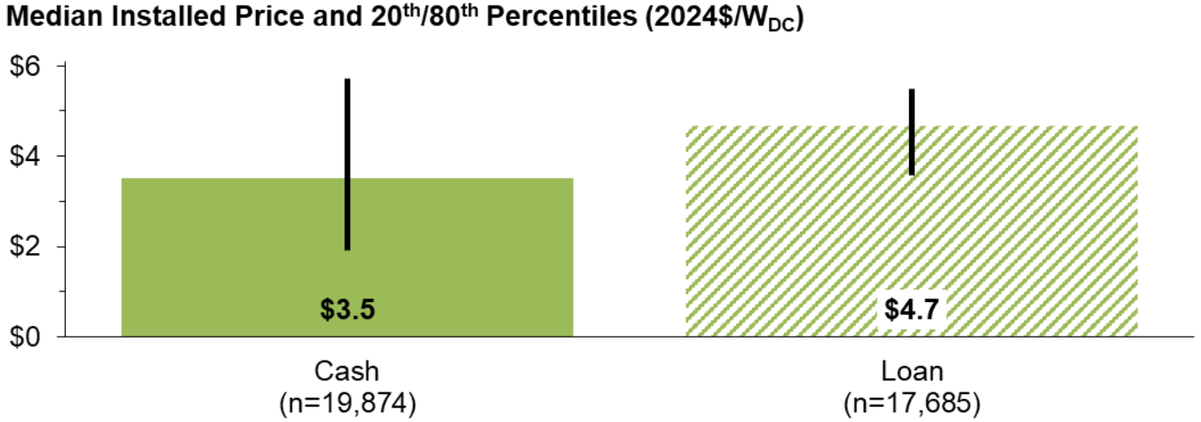
Installed Price Comparison: Cash vs. Loan-Financed

Host-owned, stand-alone residential PV

Trend over Time



2024 Installs



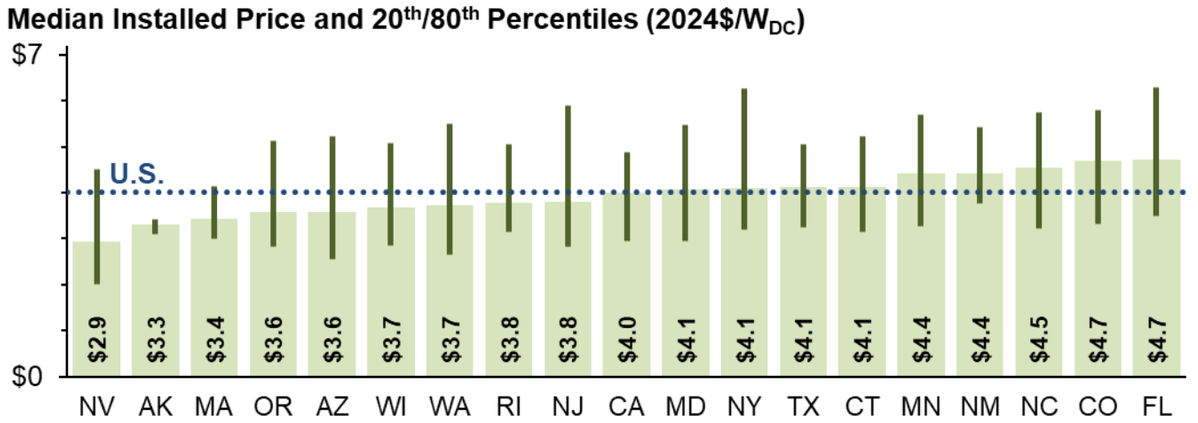
- The preceding pricing data for host-owned residential systems include both cash-purchase and loan-financed systems
- Loan-financed systems often include dealer fees rolled into the up-front price paid by the customer
- Data to distinguish loan vs. cash-purchase are available for ~45% of the installed-price sample
- As shown in the top figure, median prices for loan financed systems have been consistently higher than for cash purchased systems, with the gap growing from $0.6/W in 2017 to $1.2/W in 2024
- Not all of that differential is directly the result of dealer fees, as other factors may also contribute to pricing differences between loan-financed and cash-purchase systems

Notes: Host-owned systems are segmented in cash-purchase or loan-purchase based on data from UCC-1 filings compiled by FirstAmerican. Only those systems that can be confidently identified as either cash or loan are included in the figures here.

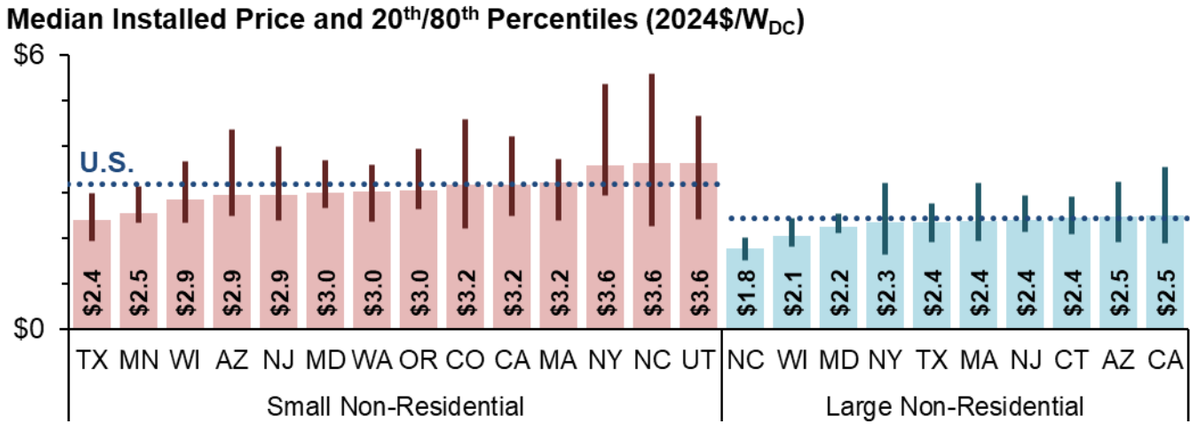
State-Level Differences in Installed Prices

Host-owned, stand-alone residential PV

Residential Systems Installed in 2024



Non-Residential Systems Installed in 2024



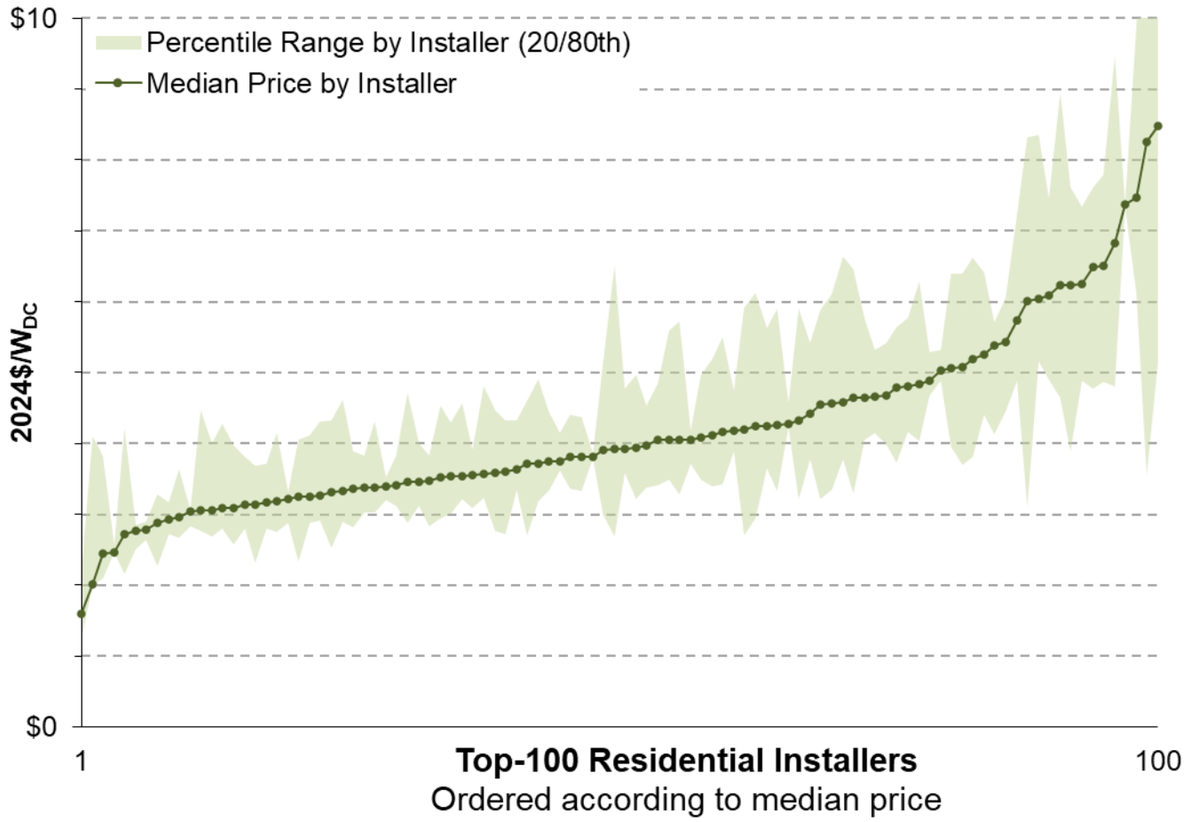
- Median prices vary across states within each customer segment, particularly for residential and small non-residential
- Residential pricing in CA, which dominates the sample, is near the middle of the pack for residential
- Cross-state pricing differences can reflect differences in market and policy conditions (e.g., financing choices, market size, population density, permitting processes, etc.) as well as, in some cases, idiosyncratic features of particular states (e.g., a single large installer with anomalous prices)

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

Installer-Level Pricing Differences

Host-owned, stand-alone residential PV

Top-100 Installers of Host-Owned Residential Systems



- Median prices across the top-100 residential installers in 2024 ranged from $2.7 to $6.5/W (ignoring apparent outliers at either end outside of that range)
- Roughly one-half had median prices below $4/W, but only a handful had median prices less than $3/W, and almost 20% had median prices greater than $5/W
- Differences in installer-level pricing can reflect firm-level characteristics (e.g., vendor relationships, business models), features of the local markets in which each installer operates, as well as differences in how each installers report prices
- Project level pricing also varied considerably for individual installers (shaded area), with percentile bands typically spanning a range of $1-2/W, reflecting unique features of individual projects and customers

Notes: To generate this figure, the number of host-owned residential installations in 2024 is first tabulated for each installer, based on systems in the dataset. The top-100 installers are then selected and ordered according to the median installed price of their host-owned residential systems in 2024. Each dot in the figure then represents the median installed price for an individual installer, and the shaded band shows the 20th to 80th percentile range across all systems for that installer.

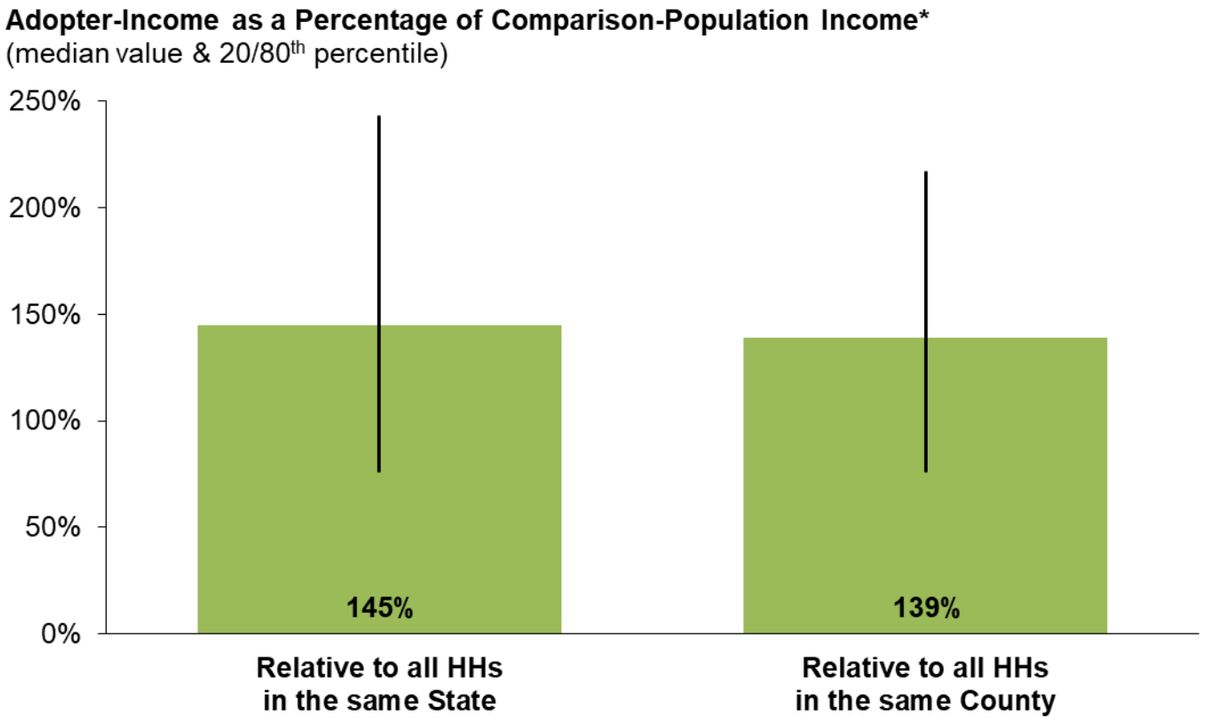
Residential Solar-Adopter Income Trends

Income Trends Analysis: Additional Methodological Details

- Relies on estimated household (HH) incomes purchased from Experian, developed with their *Income Insight™* model
- Incomes estimates are current as of Q2 2025 → therefore trends over time reflect current incomes of residential adopters differentiated by year of adoption, not their income at the time of adoption
- Because income estimates are current incomes (i.e., are already in real dollars), no inflation adjustments are required or applied
- Incomes are expressed in both absolute terms (dollars) and relative terms (as a percentage of each adopter's county or state median income)
- We focus here on national trends, with an emphasis on PV systems installed from 2010-2024; additional data, including state-level trends and data for earlier years, are available through Berkeley Lab's online data visualization tool

Distribution of 2024 Solar-Adopter *Relative* Incomes

Solar-Adopter Relative Incomes



** Notes: Relative income for each solar adopter is calculated as the ratio of its estimated household income to the median income of all households in the same state or county. The figure then shows the distribution in those relative income values across 2024 solar adopters. To ensure internal consistency, we rely on relative incomes estimates provided directly by Experian, based on Experian's estimated household incomes for all households in each state and county.*

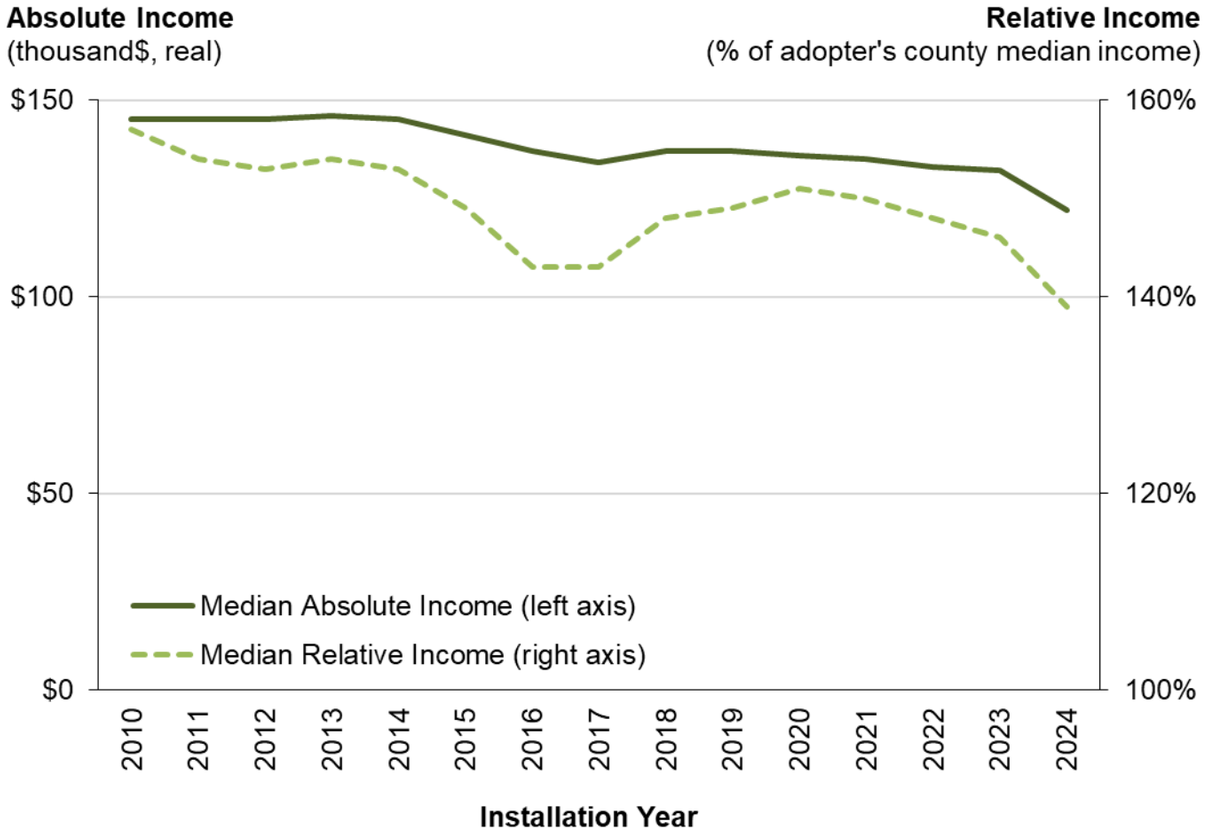
Definition: *Relative Income* = solar-adopter income as a percentage of the median income of all HHs in the comparison population

- Here we compare to median incomes of all HHs in the same state or county (see figure note)
- But comparison population can be defined at other geographical scales and for either all HHs or only owner-occupied HHs within a given region

- As shown, solar-adopter incomes generally skew high compared to other HHs in the same state or county (i.e., median values >100%)
- Prior work has shown that the skew diminishes considerably if comparing at the Census tract or block group, and essentially vanishes if comparing to only owner-occupied households within those areas

Long-Term Trends in U.S. Median Solar-Adopter Incomes

Median Solar-Adopter Incomes over Time

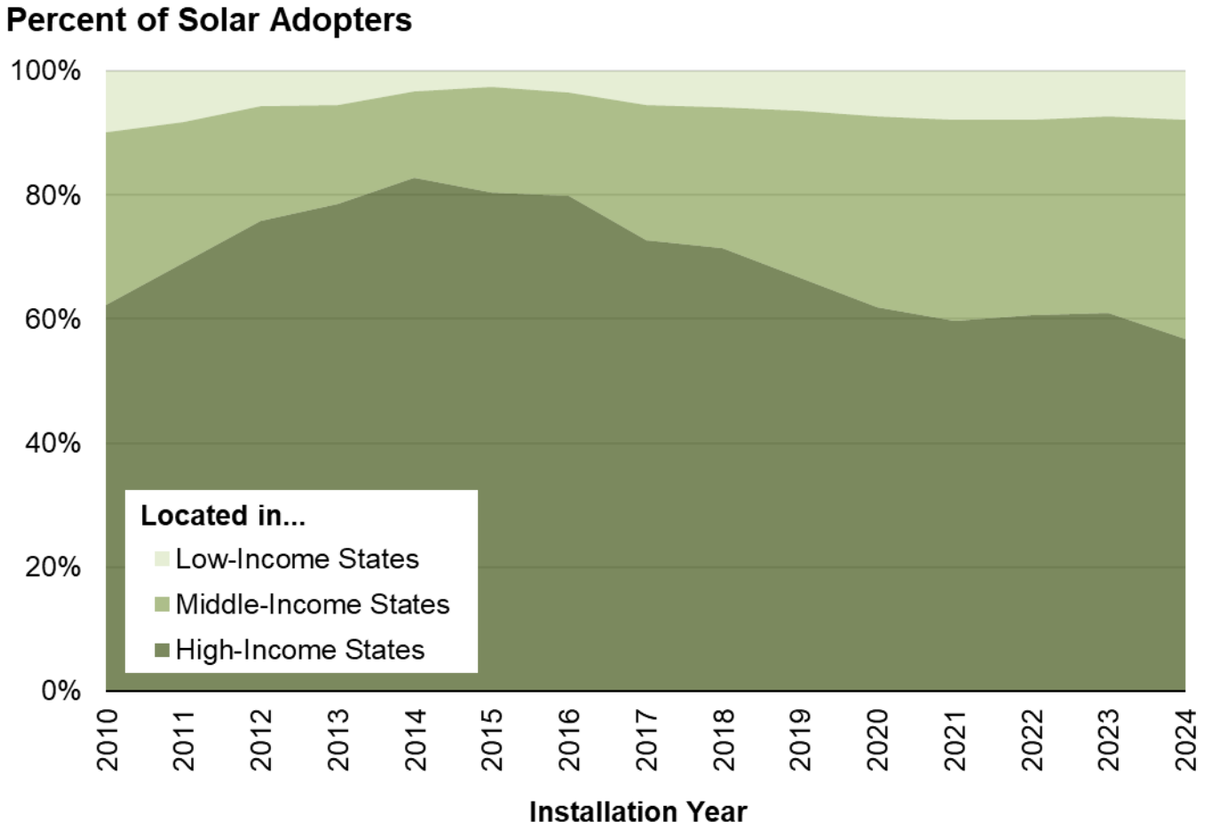


Notes: Incomes estimates are current as of Q2 2025. Therefore, trends over time show the trend in current incomes of residential adopters based on the year in which they installed PV, not their income at the time of adoption.

- Solar adoption has gradually shifted over time toward progressively less affluent HHs, with median incomes falling from $145k for HHs that installed PV in 2010 to $122k for HHs installing PV in 2024 [recall: these represent current incomes]
- These trends can be decomposed into a "broadening" and “deepening” of solar markets
- Deepening refers to a shift in adoption toward less affluent households *within* a given region, captured here by the long-term decline in *relative* income (compared to the median income of all HHs in the same county)
- Broadening, as shown on the next slide, refers instead to a shift in adoption toward less affluent regions of the country

Long-Term Trends in State-Level Solar Market Distribution

Adopter-Distribution Based on State Median Income



Notes: States are categorized based on their median household income (i.e., "High Income" states are those with the highest state median household income), with roughly an equal number of households in each group.

- Solar adoption has been broadening primarily into "middle-income states" (as defined in figure notes), reaching 35% of 2024 installs in the study sample; less so into "low-income states", which continue to comprise a disproportionately small fraction of the sample (8% in 2024)
- High-income states still make up a disproportionate share (57%), compared to their share of all U.S. households (32%), though their share has shrunk considerably over time, from a high of 83% in 2014
- Trends over time are driven heavily by shifts in market share between CA (a high-income state) and several populous middle-income states (FL, IL, TX, and AZ)

For more information

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This work was funded by the U.S. Department of Energy Solar Energy Technologies Office, under Contract No. DE-AC02-05CH11231.