Tracking the Sun

Pricing and Design Trends for Distributed Photovoltaic Systems in the United States

2019 Edition

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trackingthesun.lbl.gov

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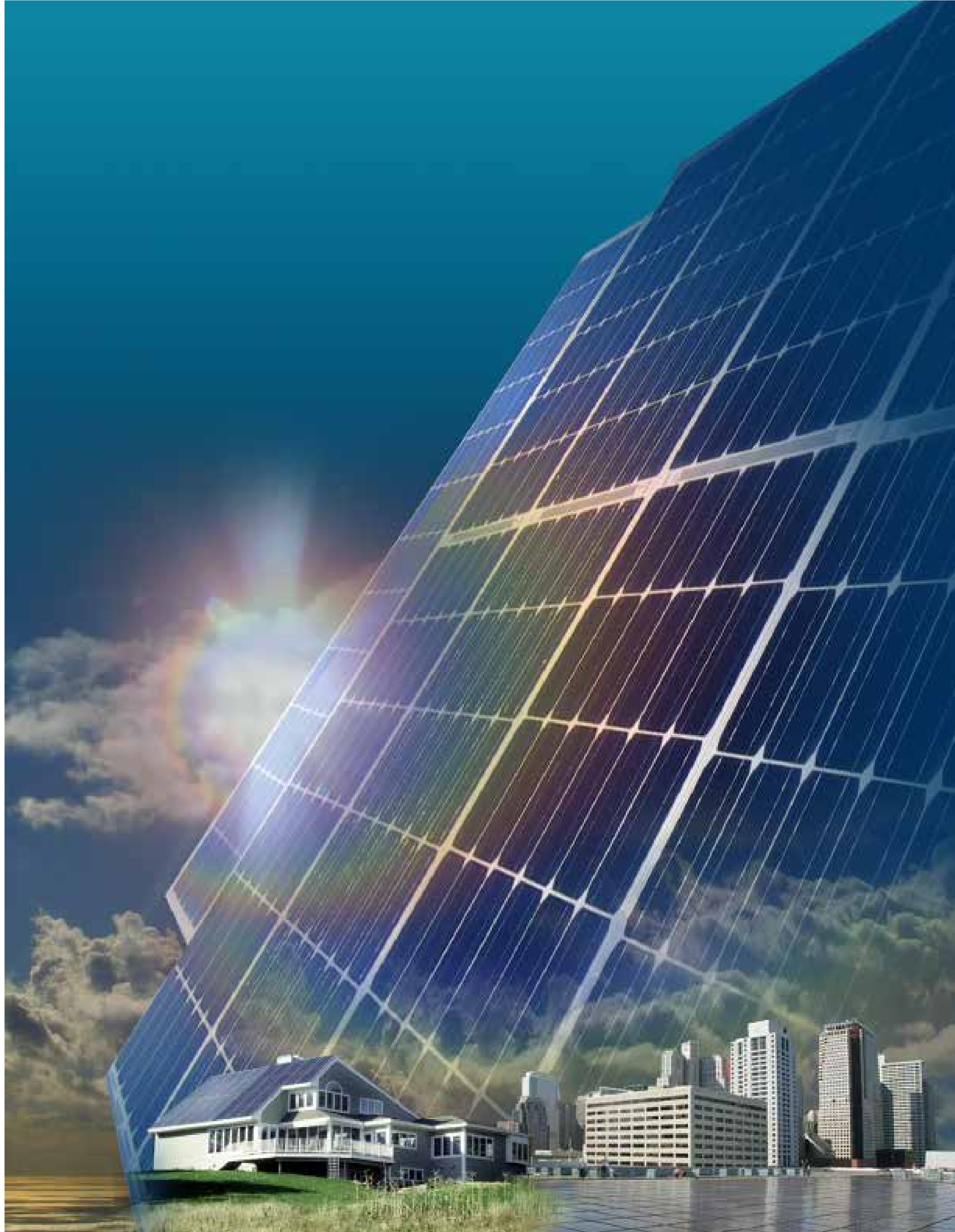

Report Overview

Summarizes installed prices and other characteristics of grid-connected, distributed solar photovoltaic (PV) systems in the United States

- **Focuses on projects installed through 2018 with preliminary data for the first half of 2019**
- **Describes and analyzes trends related to:**
  - **Project characteristics**, including system size and design, ownership, customer segmentation, and other attributes
  - **National median installed prices**, both long-term and recent trends, focusing on host-owned systems
  - **Variability in pricing across projects** according to system size, state, installer, module efficiency, inverter technology, residential new construction vs. retrofit, tax-exempt vs. commercial site hosts, and mounting configuration

"Distributed PV"

For the purpose of this report, includes residential and non-residential systems that are roof-mounted (of any size) or ground-mounted up to 5 MW_{AC}

Tracking the Sun public data file

The full dataset (excluding any confidential data) is available for download via trackingthesun.lbl.gov

New Features and Related Research

New Features in This Year's *Tracking the Sun*

- ***Expanded Discussion of Project Characteristics.*** Additional trends related to distributed PV orientation, inverter loading ratios, and solar-plus-storage
- ***Focus on Host-Owned Systems for Installed Pricing Analysis.*** Excludes third-party owned (TPO) systems from the analysis of installed pricing trends, though those systems are retained when describing other project characteristics
- ***Multi-Variate Regression Analysis.*** Now includes an econometric model of installed pricing variation across residential systems installed in 2018, supplementing the descriptive analysis

Related, Ongoing National Lab Research

- ***Utility-Scale Solar.*** LBNL annual report on utility-scale solar (PV and CSP) describing trends related to project characteristics, installed prices, operating costs, capacity factors, and PPA pricing
- ***PV System Cost Benchmarks*** developed by NREL researchers, based on bottom-up engineering models of the overnight capital cost of residential, commercial, and utility-scale systems
- ***Other Derivative Works*** that rely on the Tracking the Sun dataset include in-depth statistical analyses of PV pricing dynamics, solar-adopter demographics, impacts of solar on property value, and other topics

Data Sources, Methods, and Market Coverage

Data Sources

Tracking the Sun relies on 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

67 entities spanning 30 states contributed data to this year's report

- See Table A-1 in the Appendix of the report 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

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 ≤100 kW_{DC}
- **Large Non-Residential:** Non-residential systems >100 kW_{DC} (and ≤5,000 kW_{AC} if ground-mounted)

  ** Independent of whether connected to the customer- or utility-side of the meter*

Units

- Real 2018 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

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

Installed-Price Sample

Used in analysis of installed prices

5. Remove systems if:
   - Missing installed price data
   - Third-party owned (TPO)
   - Battery storage included
   - Self-installed

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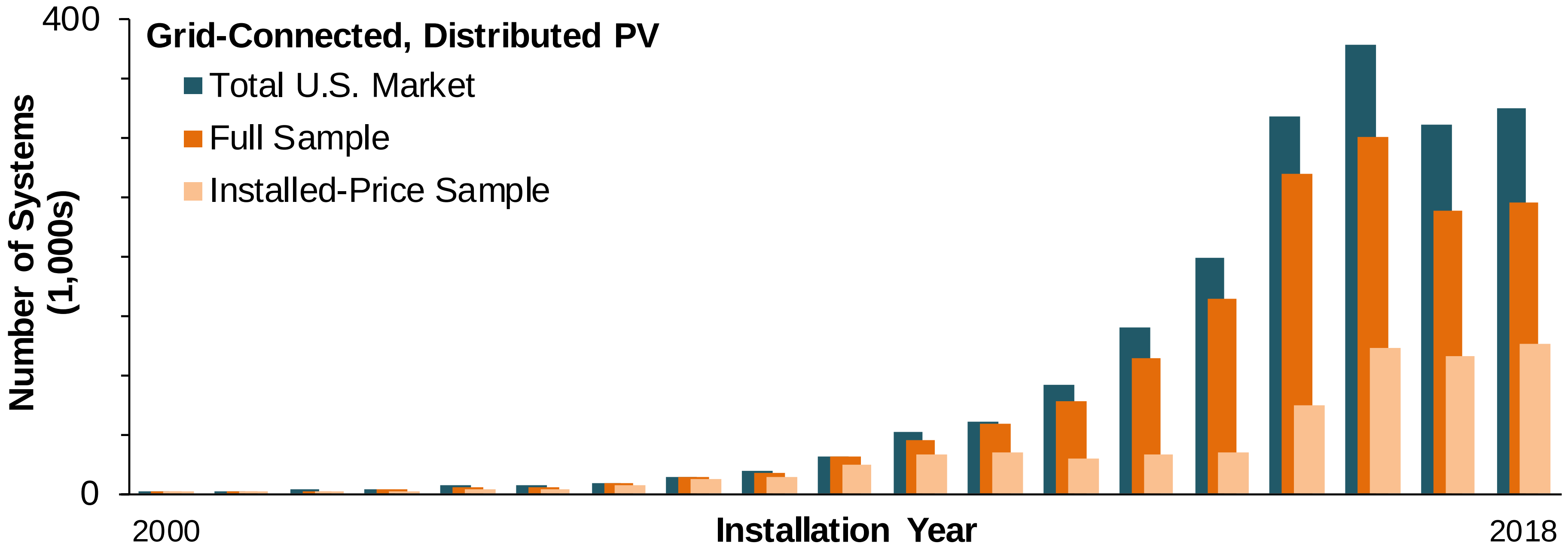
Sample Size Relative to Total U.S. Market

Full Sample

- **1.6 million** systems through 2018 (81% of U.S. market)
- 250,000 systems installed in 2018 (76% of U.S. market)

Installed-Price Sample

- **680,000** systems through 2018
- 120,000 systems installed in 2018



Notes: Total U.S. distributed PV installations are based on data from IREC (Sherwood 2016) for all years through 2010 and from Wood Mackenzie and SEIA (2019) for each year thereafter.

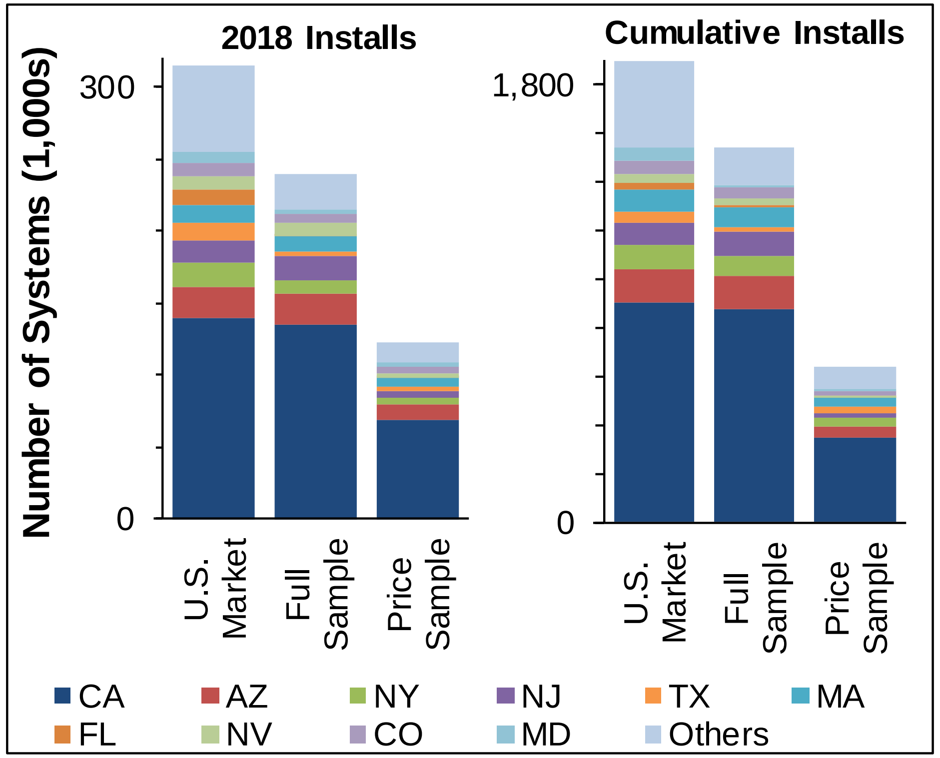
Gap between Full Sample and Total U.S. Market: Associated mostly with smaller and mid-sized state markets either missing or under-represented in the sample; see next slide

Gap between Installed-Price Sample and Full Sample: Primarily TPO systems and systems missing installed price data; larger gaps in 2013-2015 due to transitional data collection issues in CA and high TPO market shares

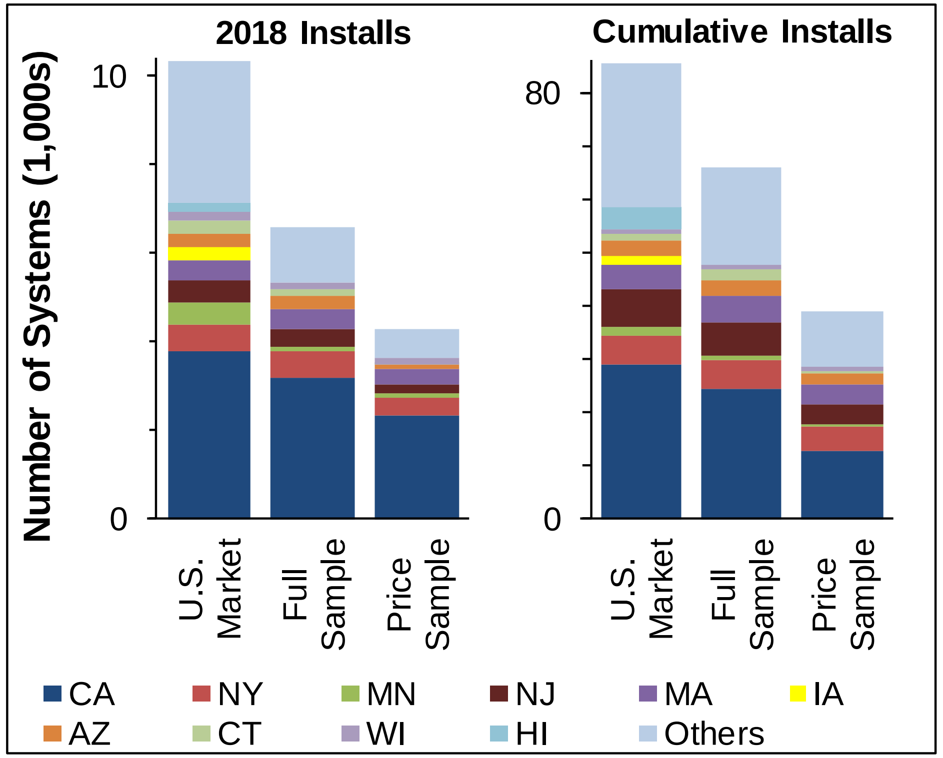
State-Level Sample Distribution and Market Coverage

- CA dominates the sample, as in the larger U.S. market
- Coverage in larger markets is generally strong, though with a few exceptions: res (TX, FL, MD); non-res (MN, IA, HI)
- Smaller state markets somewhat under-represented in the sample (aggregated here as “Others”)
- Slightly better coverage for the residential market than for non-residential

Residential



Non-Residential



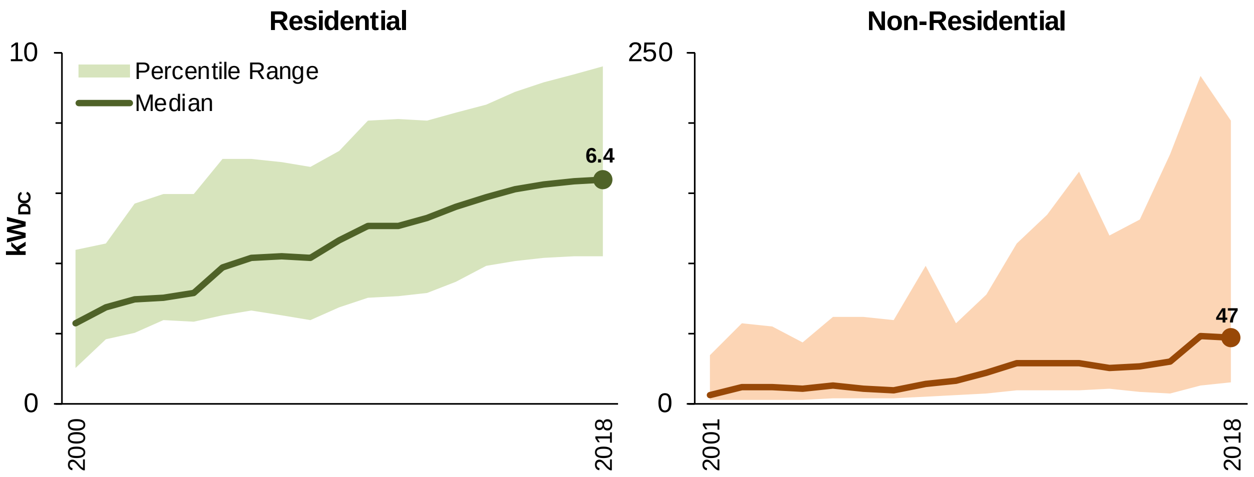
Notes: Data for the total U.S. market are from Wood Mackenzie and SEIA (2019). The figure identifies the top-10 states in each customer segment, based on total U.S. market installations in 2018. The figure consolidates non-residential systems rather than distinguishing between the two size classes used elsewhere in the report, as U.S. market data are available only for non-residential systems as a whole.

Distributed PV System Characteristics

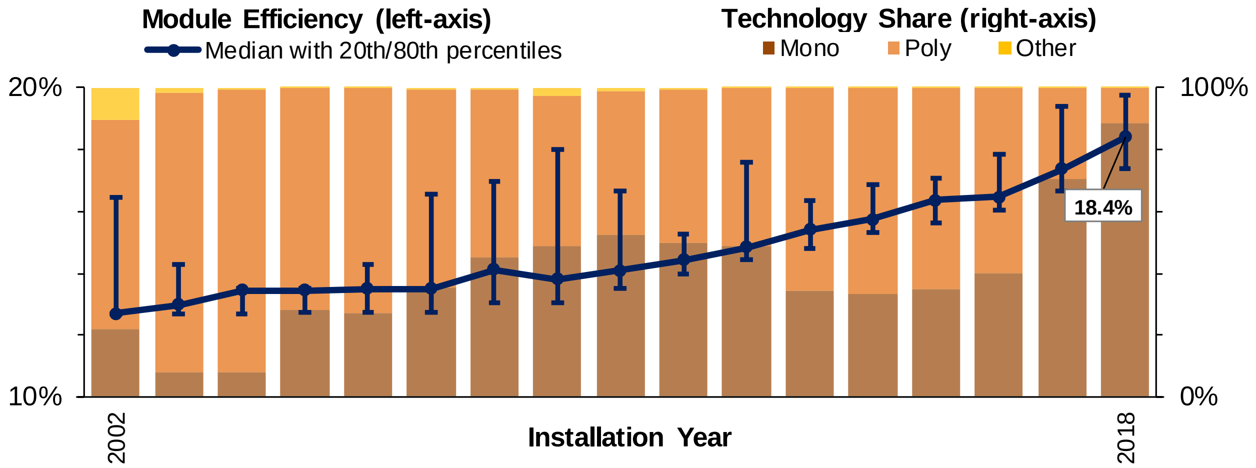
Based on Full Sample

System Size and Module Efficiency

System Size Trends



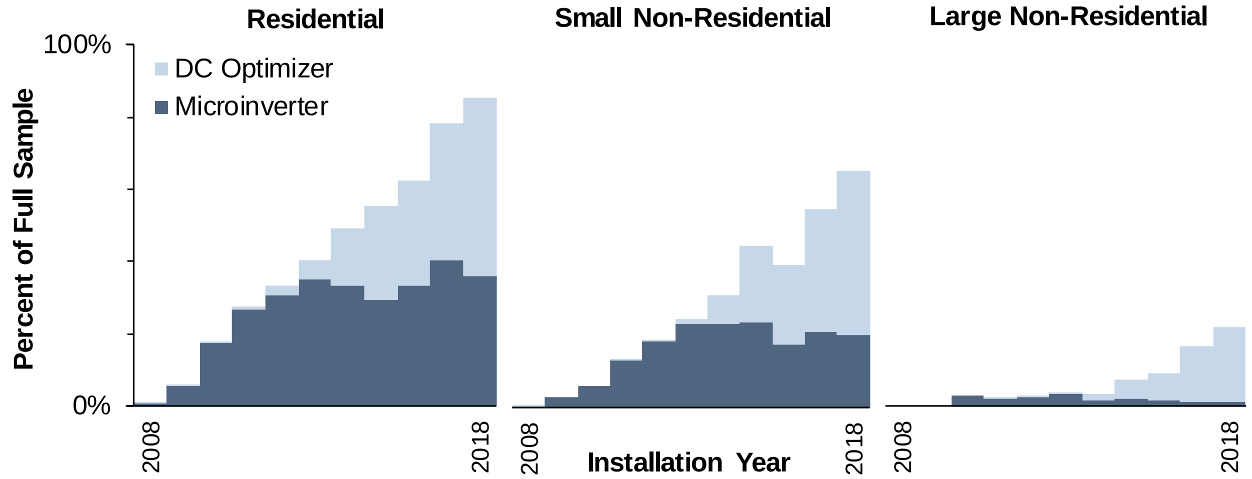
Module Efficiency and Technology Trends



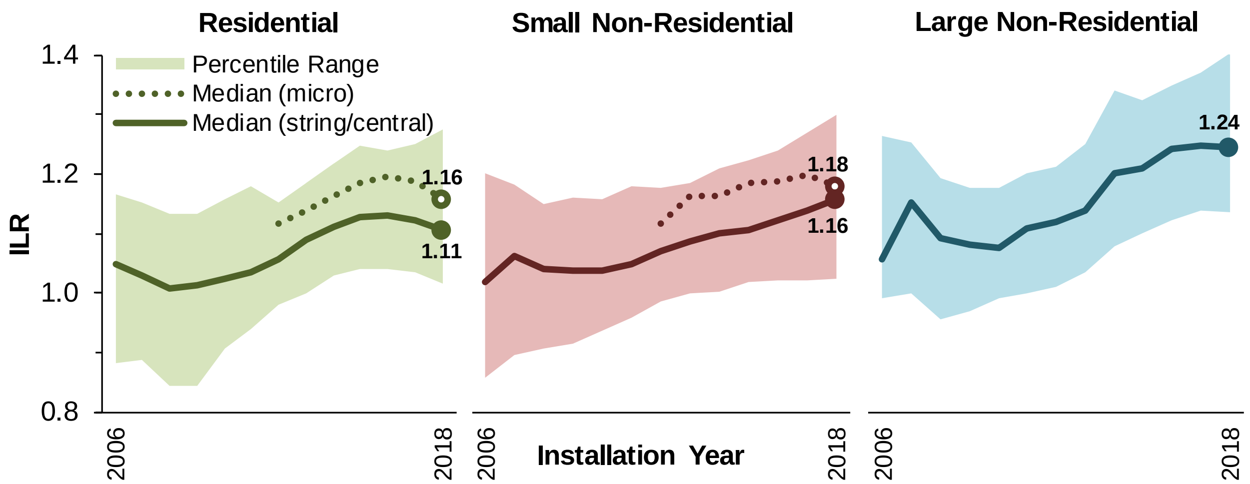
- Increasing system sizes and module efficiencies are key pathways to reducing PV system costs per watt
- Median sizes rising across all customer segments
  - For residential, from 2.4 kW to 6.4 kW over 2000-2018
  - Reflects both declining costs and rising module efficiencies (especially for space-constrained projects)
  - For non-residential, pronounced increases at upper end of size range
- Median module efficiencies rose from 12.7% in 2002 to 18.4% in 2018
  - Rapid rise over the last several years reflects growing market share of mono-crystalline modules and increasing use passivated emitter rear-cell (PERC) technology
  - Poly-crystalline module efficiencies also rising over time

Inverter-Related Trends

Module-Level Power Electronics



Inverter Loading Ratios



- Module-level power electronics (MLPEs), which include both microinverters and DC optimizers, have continued to gain share across the sample
  - 85% of residential, 65% of small non-residential, and 22% of large non-residential systems installed in 2018
  - DC optimizers dominate growth since 2013
- Inverter-loading ratios (ILRs, the ratio of module-to-inverter nameplate ratings) vary widely across projects
  - Have generally grown over time, are higher for systems with micro-inverters, and are higher for large non-residential systems
  - Rising ILRs partly reflect increasing system sizes and efficiencies, as well as falling module costs (making higher ILRs more economically attractive)

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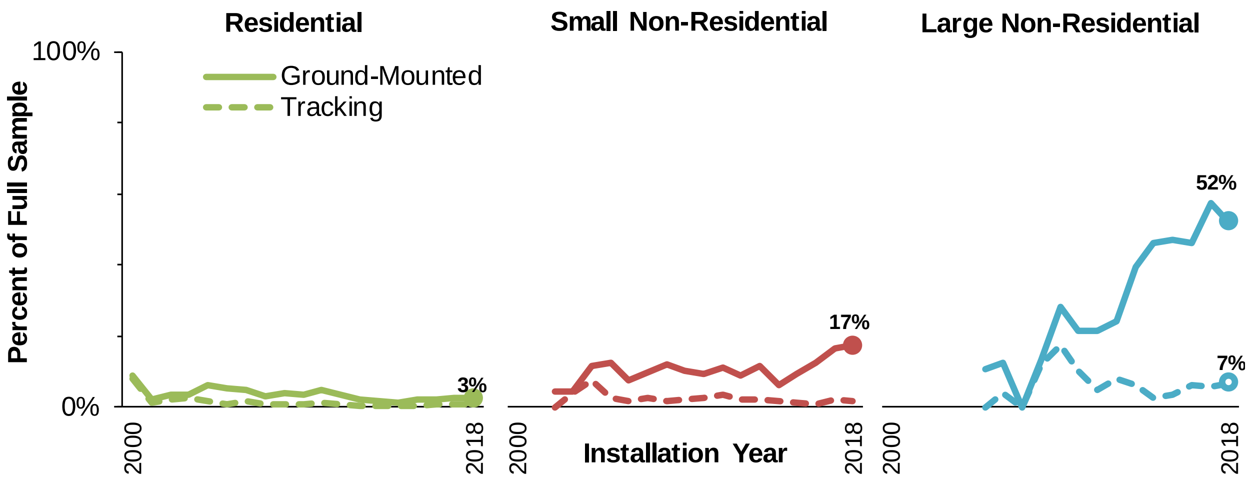
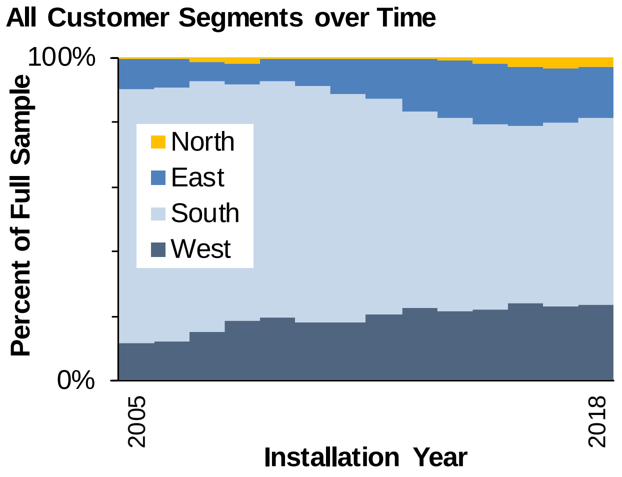
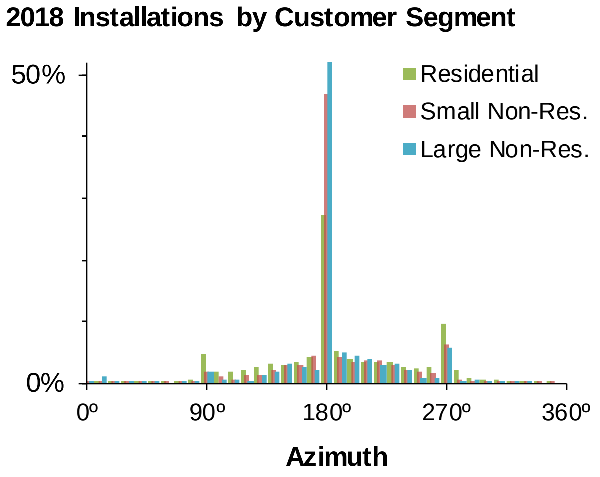
System Mounting and Orientation

Ground-Mounting and Tracking Equipment



System Orientation





- Ground-mounting most prevalent among large non-residential systems, while use of tracking is limited
  - Roughly half of all large non-residential systems in the 2018 sample are ground-mounted, while 7% have tracking
  - Ground-mounting much less common among residential and small non-residential systems, and negligible shares have tracking
- Panel orientations becoming more diverse over time, partly due to falling project costs
  - 57% of systems installed in 2018 face south, 23% to the west, and most of the remainder to the east
  - Greater share of non-residential systems face exactly due-south, likely due to greater prevalence of ground-mounting and flat rooftops than in residential sector

Solar-plus-Storage Adoption

Share of Annual PV Installations with Battery Storage

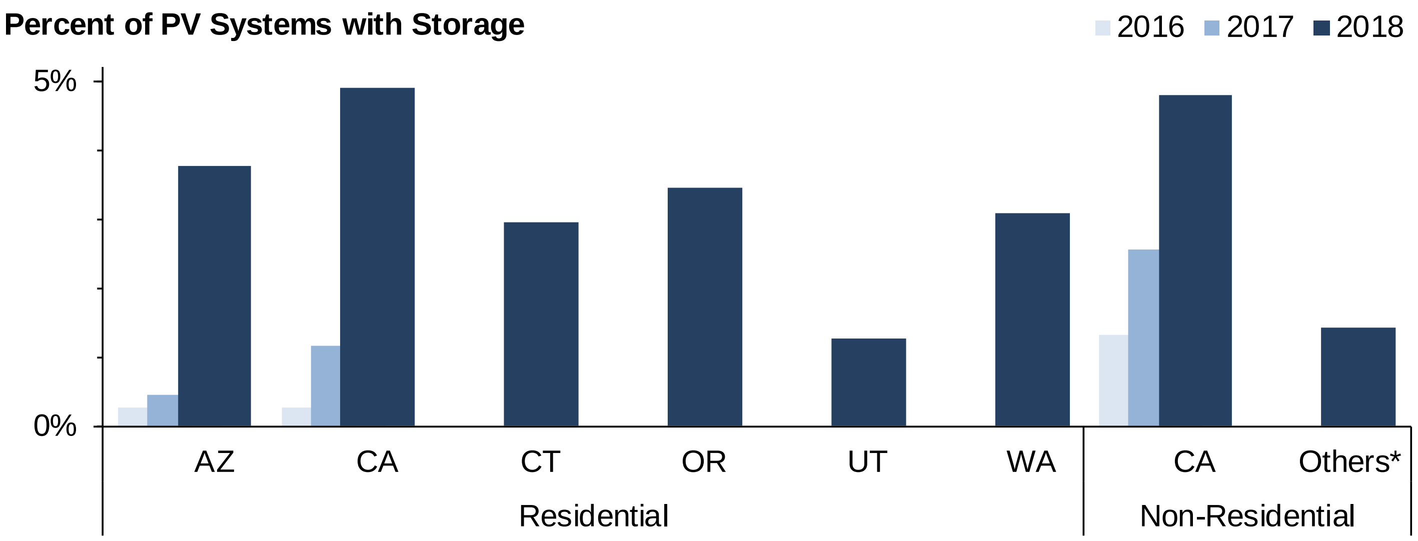
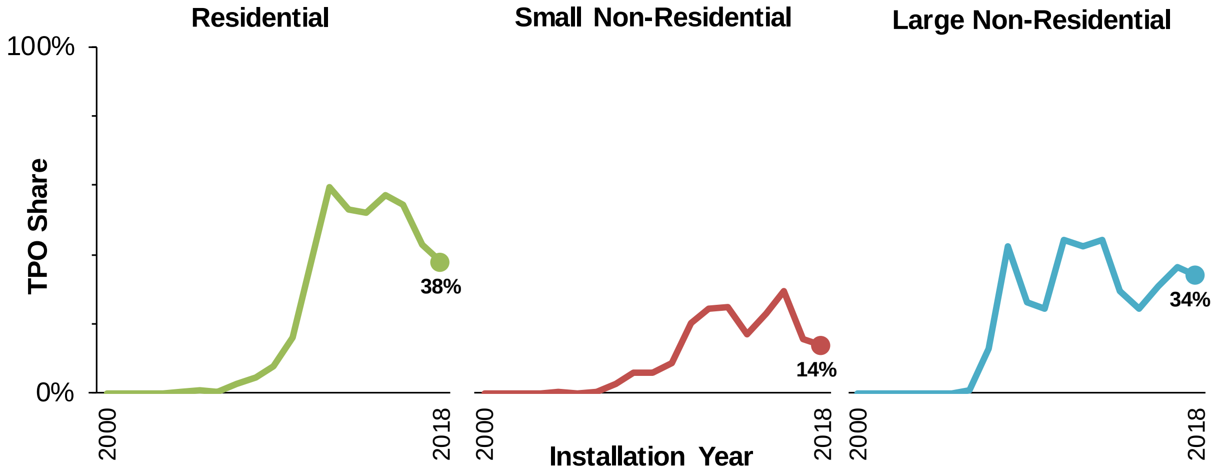


Figure includes only those states and years with sufficient sample size and coverage. For non-residential systems, all states other than California with sufficient data are grouped together.

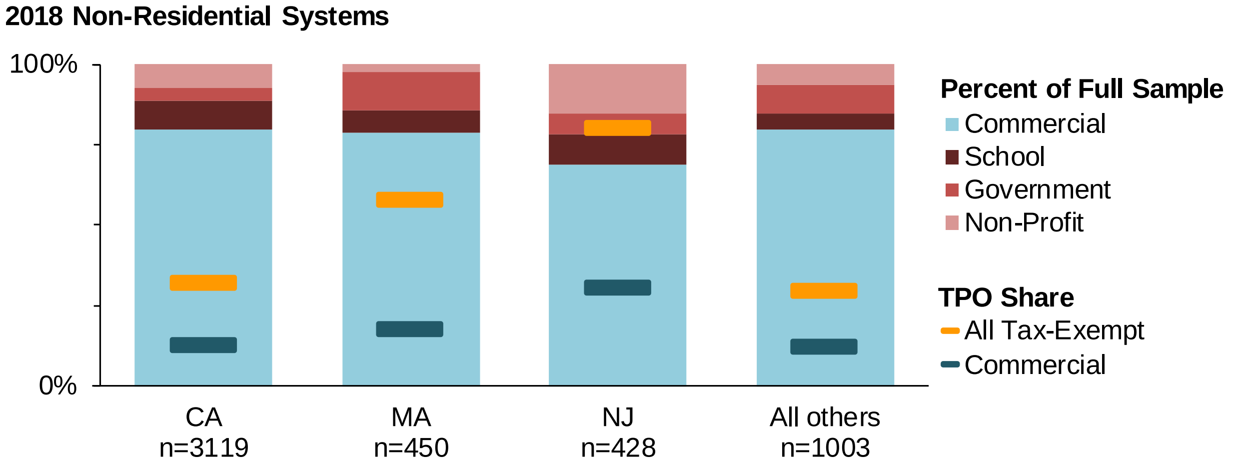
- Small but increasing share of distributed PV projects are paired with battery storage
  - Typically ranges from 1-5% in 2018 across a limited set of states in our dataset with available data
  - Higher percentages in some utility jurisdictions (e.g., 20% for Salt River Project in AZ)
  - Also, higher percentages in Hawaii, not included in our data (60% of PV permits issued on Oahu in 2018 had storage, per the HI DBEDT)
- Trends reflect:
  - Falling storage costs
  - Customer reliability needs
  - New rate designs and incentives that encourage storage with PV (e.g., net billing rates, demand charges, TOU)

Third-Party Ownership and Customer Segmentation

Third-Party Ownership



Non-Residential Customer Segmentation



- Data show the growth, and more recent decline, of third-party ownership (TPO) in residential and small-non-residential segments
  - Reflects emergence of residential loan products as well as retrenchment of SolarCity/Tesla
  - For large non-residential customers, TPO shares have remained fairly steady
- Disproportionate share (20% in 2018) of non-residential systems were installed at tax-exempt customer sites (schools, government, non-profits)
- TPO in non-residential sector more prevalent among tax-exempt site hosts (40% in 2018 vs. 14% at for-profit commercial sites)
  - TPO allows tax-exempt customers to monetize tax benefits

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Temporal Trends in Median Installed Prices

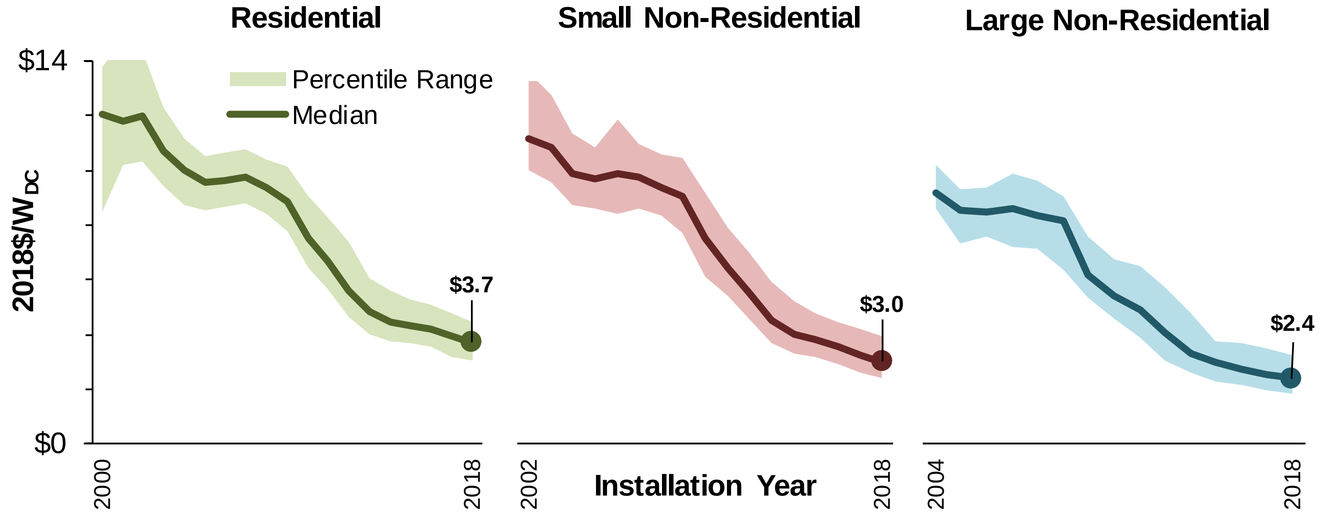
Based on Installed-Price Sample

A Few Notes on Installed-Price Data

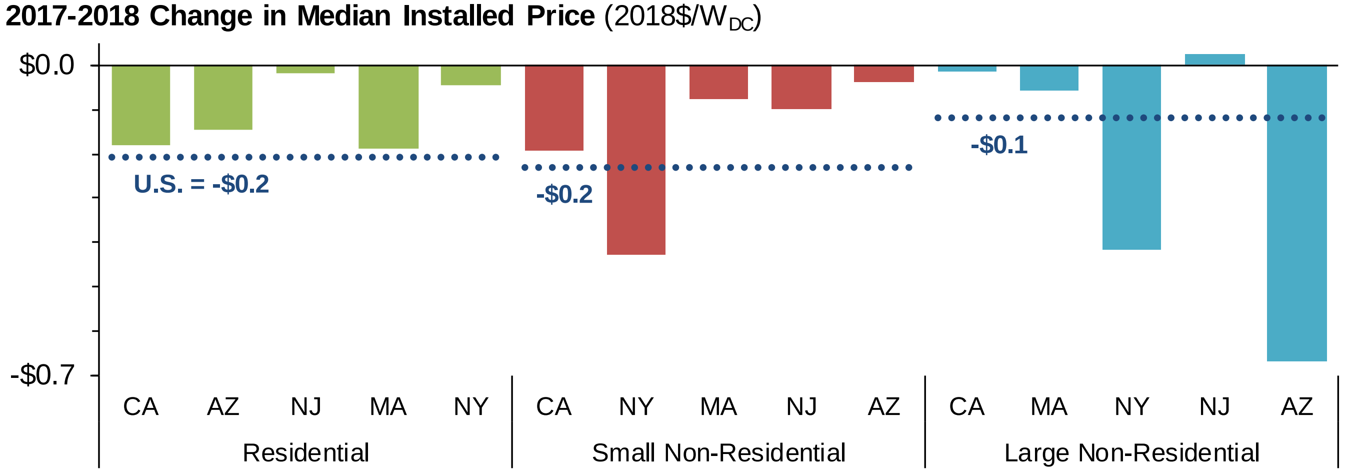
- Differs from the underlying cost borne by the developer or installer (price ≠ cost)
- Unless otherwise noted, excludes TPO, battery storage, and self-installed systems
- Historical (i.e., systems installed through 2018) and therefore may not be representative of systems installed more recently or current quotes for prospective projects
- Self-reported by PV installers or customers; susceptible to inconsistent reporting practices

Installed-Price Declines in 2018 Maintained Their Recent Trajectory

National Median Installed Prices: 2000-2018



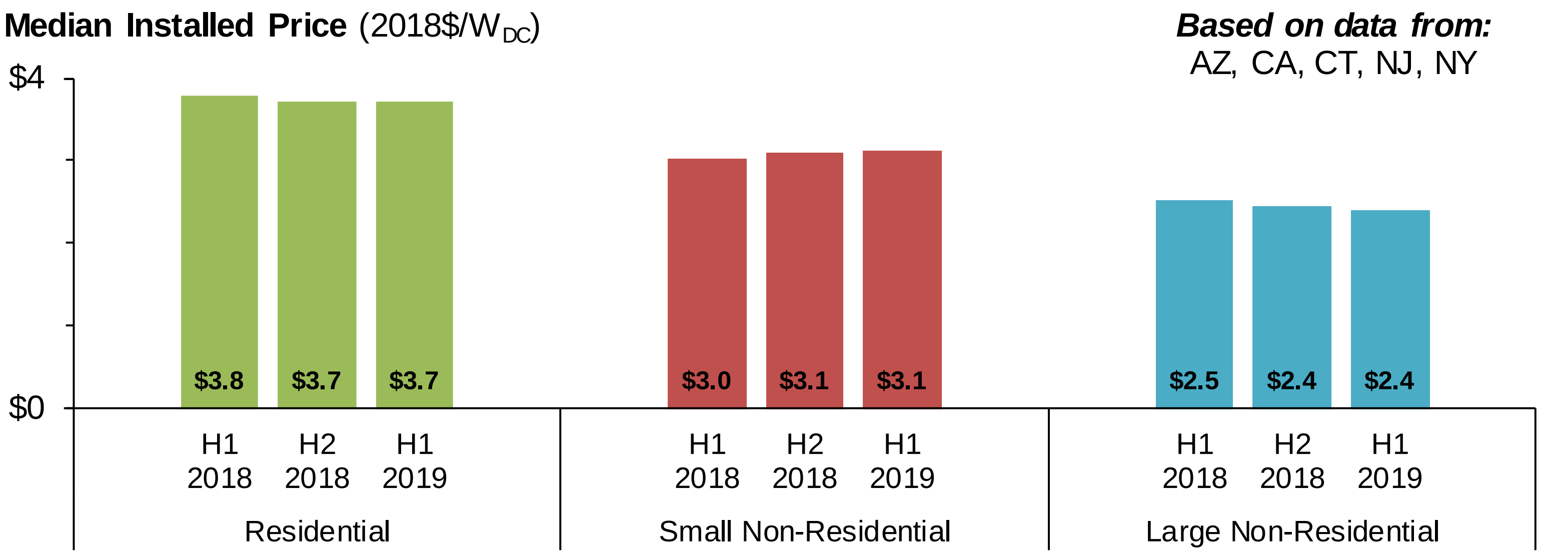
Year-over-Year Price Declines in Large State Markets



- Long-term annual price declines over the full analysis timeframe have averaged roughly $0.5/W per year
- Over the last year of the analysis period (2017-2018), median prices fell by $0.2/W (5%) for residential, $0.2/W (7%) for small non-residential, and $0.1/W (5%) for large non-residential systems
  - Consistent with the pace of price declines since 2014
  - A tapering off from earlier years, due to underlying module-cost trajectory, as well customer acquisition costs, maturing markets, loan fees, and other factors
- Recent rates of decline in large state markets vary
  - In the residential sector, all exhibit slower declines than the national median, suggestive of diminishing cost reduction opportunities
  - Non-residential markets vary more dramatically, indicative of smaller samples and more varied projects

Preliminary Data for H1 2019 Show Modest Price Declines

Preliminary and Partial Data for H1 2019

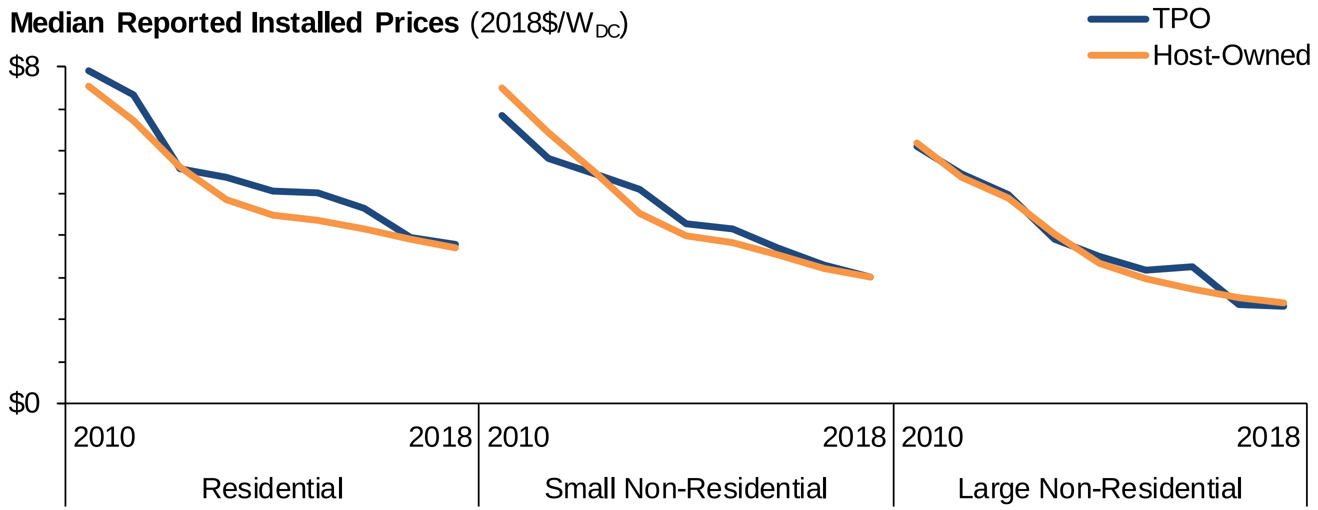


- Data are based on a subset of the larger state markets
- Suggest a continuing but modest decline in national median prices, at least in the residential and large non-residential segments
  - Relative to the first half (H1) of 2018, median installed prices for H1 2019 fell by $0.1/W for both the residential and small non-residential segments
  - Median prices for small non-residential systems instead rose slightly
- As noted, recent price declines in these state have been lower than in other states, and may thus understate the drop in national median prices over H1 2019

Side Bar: *Installed Prices Reported for TPO Systems*

- Depending on the particular project or firm, installed prices reported for TPO systems may represent:
  - An appraised value or fair-market value construct (as often used as the basis for federal tax credits)
  - An actual transaction price between the third-party financier and an independent installer
- In the latter case, the price may or may not cover all project development costs (e.g., customer acquisition may be performed/procured separately by the financier)
- Median prices reported for TPO systems in recent years correspond quite closely to host-owned systems, but diverged in earlier years, especially for residential
  - Convergence over time partly reflects changes in reporting conventions by some large TPO providers

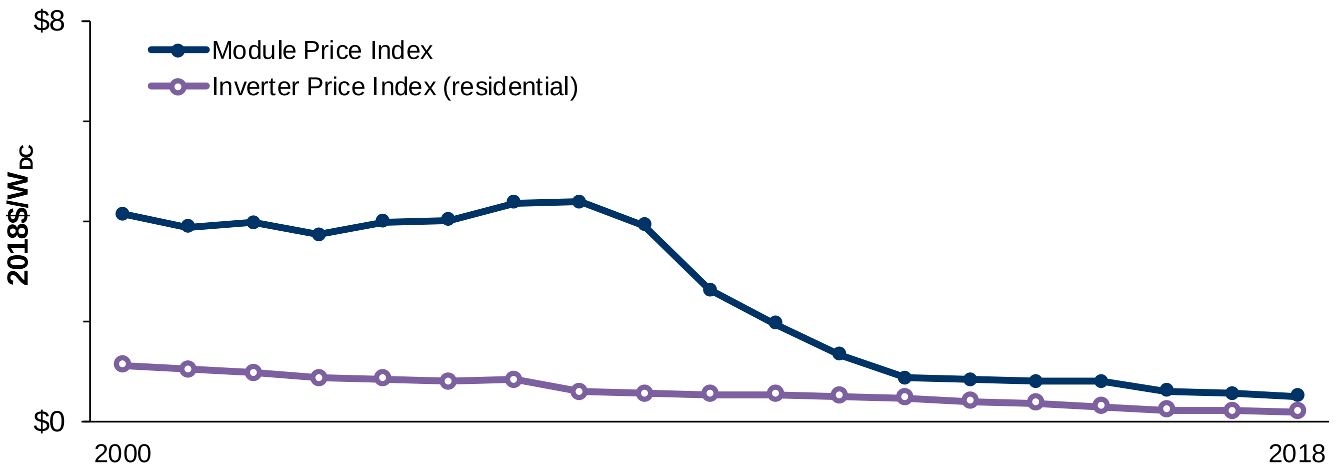
Installed Prices for TPO vs. Host-Owned Systems



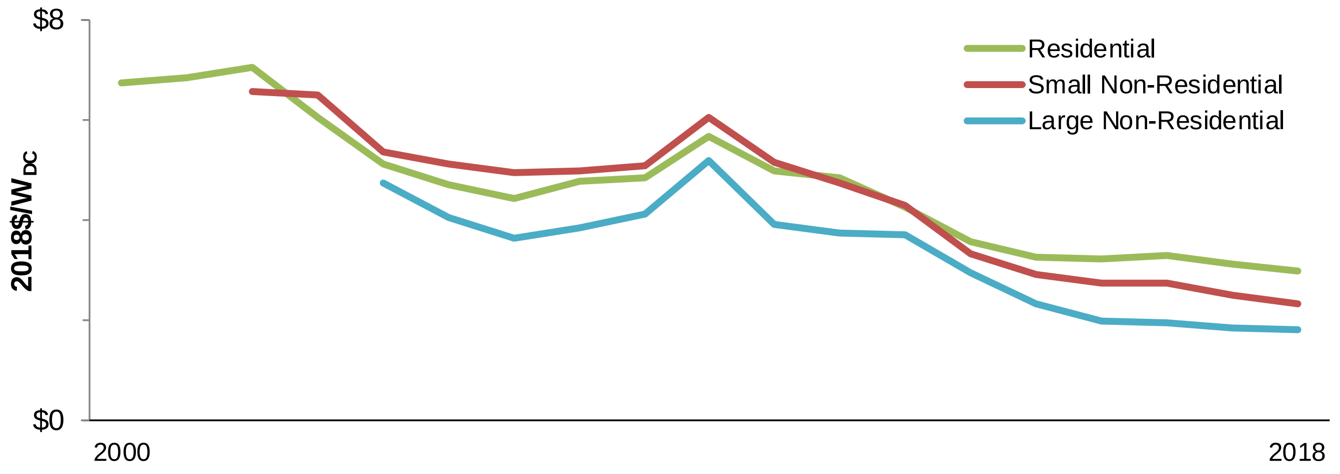
TPO systems not otherwise included in installed-price analysis à figure above for reference only

Installed Price Declines Reflect Reductions in Both Hardware and Soft Costs

Module and Inverter Price Indices*



Residual Balance-of-Systems and Soft Costs*



Over the long-term:

- 44% of total drop in residential installed prices associated with falling module prices, 11% with falling inverter prices, and the remaining 45% with the collective assortment of balance of systems (BoS) and soft costs—i.e., the residual term in the figure
- Soft costs: customer acquisition, installation labor, loan fees, installer margins, and other business process costs

Since 2014 (when module price declines tapered off)…

- 36% of total drop in residential prices associated with modules, 28% with inverters, and 36% with BoS+soft costs
- For non-residential systems, slightly higher percentage (55%) of recent price drop due to BoS+soft costs

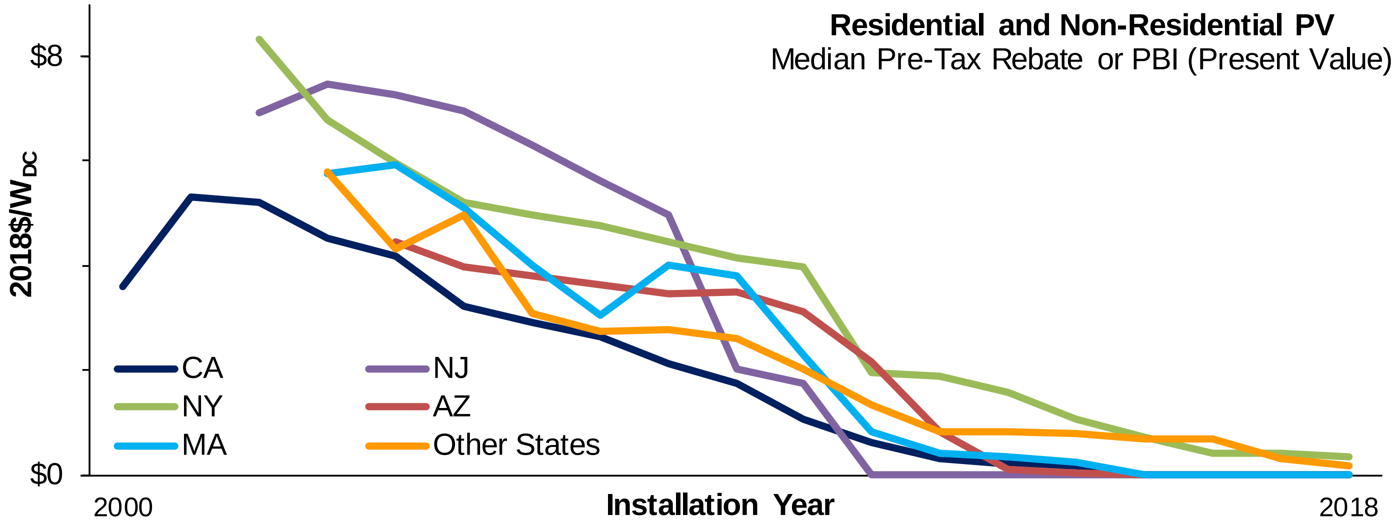
** The Module Price Index is the U.S. module price index published by SPV Market Research (2019). The Inverter Price Index is a weighted average of string inverter and microinverter prices published by Wood Mackenzie and SEIA (2019), based on the mix for each segment, extended backwards in time using inverter costs reported for systems in the LBNL data sample. The Residual term for each customer segment is calculated as the median installed price for that segment minus the Module Price Index and the corresponding Inverter Price Index for that customer segment.*

Installed Price Declines Have Been Partially Offset by Falling Incentives

- Various forms of incentives have been offered to distributed PV, depending on the state and time
  - Tax credits, RECs, net metering, rebates, performance-based incentives (PBIs), etc.
- Focusing here just on direct cash incentives provided in the form of rebates and PBIs…
  - At their peak, many programs were offering incentives of $4-8/W
  - Have been largely phased-out over time, or have diminished to below $0.5/W
  - Partly a response to installed-price declines, emergence of other incentives, and increasing penetration
  - Incentive declines have also likely helped to motivate further price declines

Long-term drop in rebates and PBIs equates to 66% to 100% of the installed price decline among larger state markets

State and Utility Rebates and Performance-Based Incentives



Notes: The figure depicts the pre-tax value of rebates and performance-based incentives (calculated on a present-value basis) provided through state and utility PV incentive programs.

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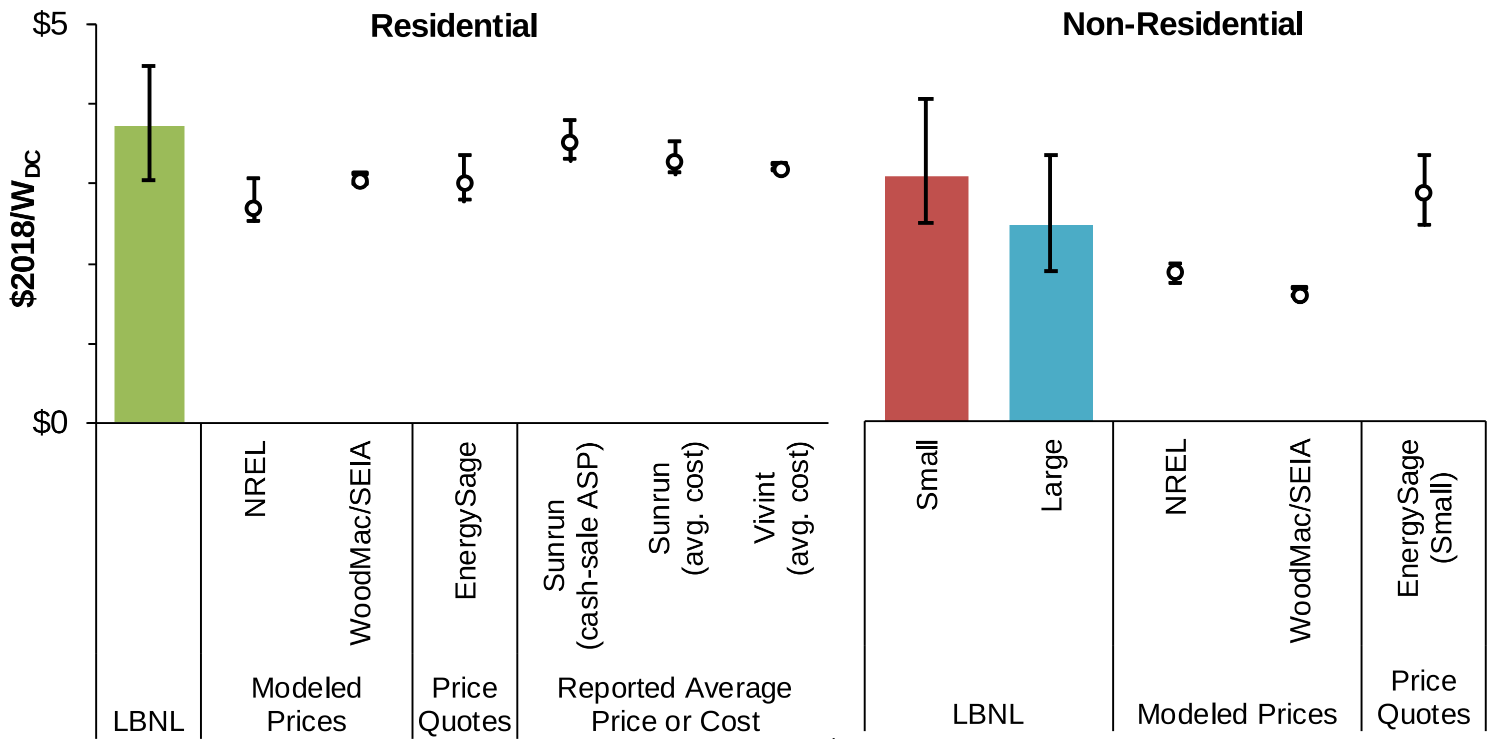
National Median Installed Prices Are Relatively High Compared to Other Recent Benchmarks



*Notes: **LBNL** data are the median and 20th and 80th percentile values among projects installed in 2018. **NREL** data represent modeled turnkey costs in Q1 2018 for a 6.2 kW residential system (range across system configuration and installer type, with weighted average) and a 200 kW commercial system (range across states and national average) (Fu et al. 2018). **WoodMac/SEIA** data are modeled turnkey prices for 2018 (the average, min, and max of quarterly estimates); their residential price is for a 5-10 kW system with standard crystalline modules, while the commercial price is for a 300 kW flat-roof system (Wood MacKenzie and SEIA 2019). **EnergySage** data are the median and 20th and 80th percentile range among price quotes issued in 2018, calculated by Berkeley Lab from data provided by EnergySage; quote data for non-residential systems are predominantly from small (<100 kW) projects. **Sunrun** and **Vivint** data are the companies' reported average selling prices or ASP (Sunrun only) or costs in 2018 (the average, min, and max of quarterly values).*

- Other benchmarks include bottom-up modeled prices, price quotes, and average costs or prices reported by several large installers
- Other benchmarks align more closely with the 20th percentile values in the LBNL dataset and may be representative of "best in class" or "turnkey" systems and/or relatively low cost markets
- Divergence from national medians may reflect factors such as: timing/vintage, location, price vs. cost, value-based pricing, system size and design, scope of costs included, installer characteristics

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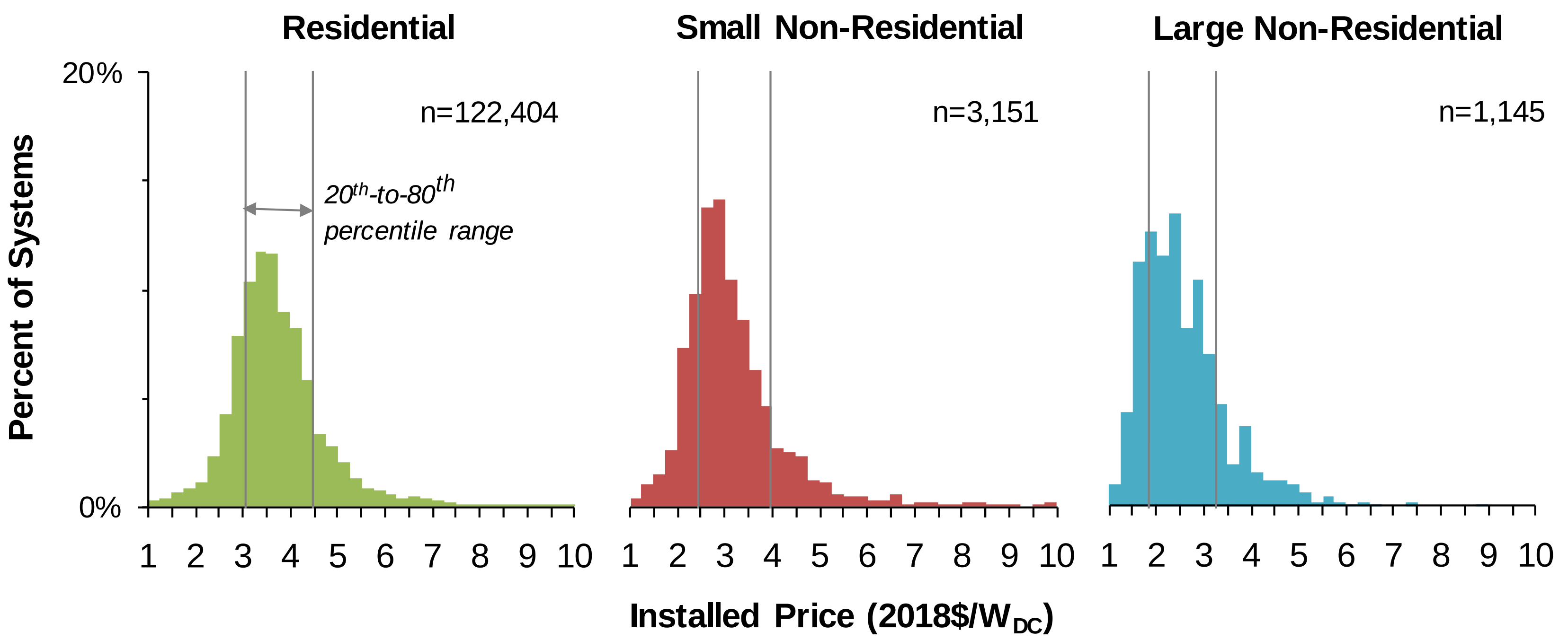
Variation in Installed Prices

Installed Prices Vary Widely Across Individual Projects

Installed Price Distribution for Systems Installed in 2018



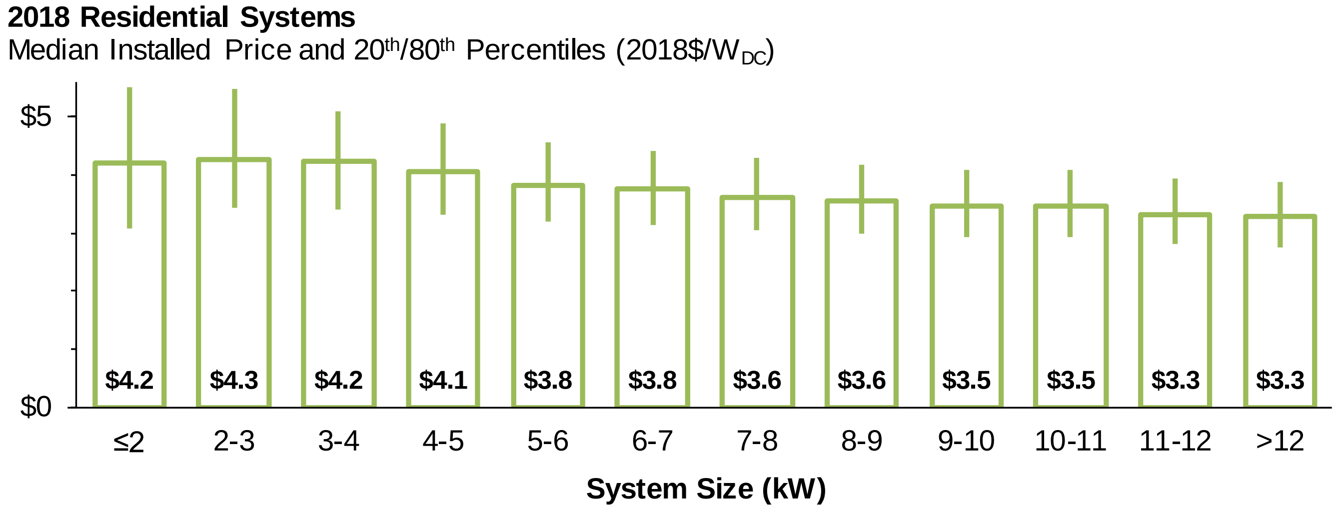
20th-to-80th Percentile Bands for Systems Installed in 2018

- $3.1/W - $4.5/W (residential)
- $2.4/W - $4.0/W (small non-residential)
- $1.8/W - $3.3/W (large non-residential)

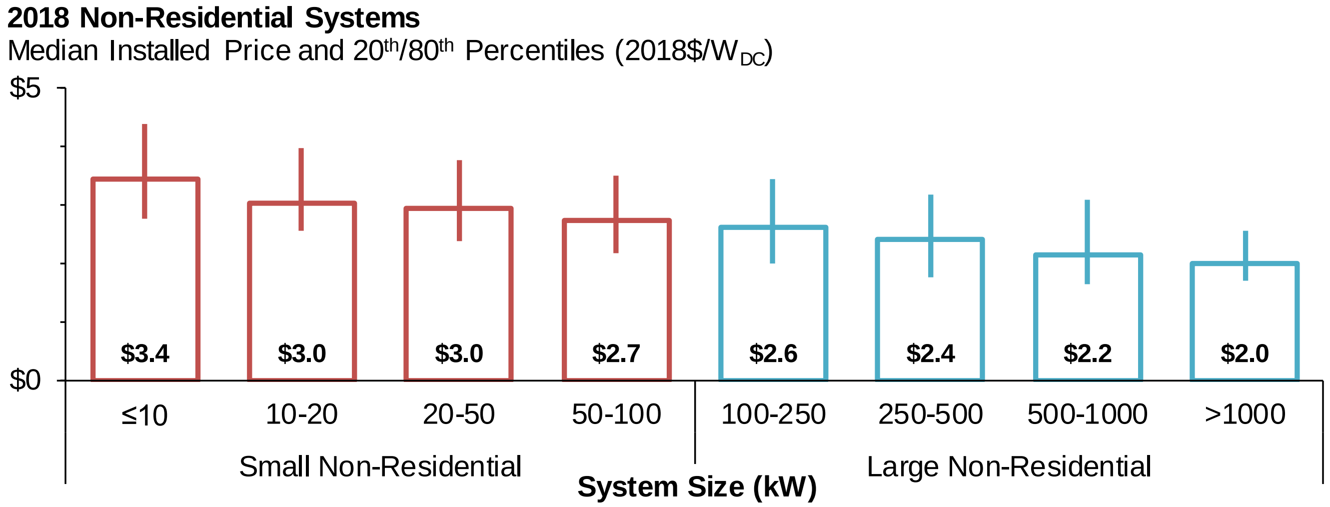
- Wide pricing variability has persisted over time, despite continuing maturation of the U.S. PV market
- Reflects underlying differences in:
  - Project characteristics
  - Installer attributes and pricing strategy
  - Features of the local market, policy, and regulatory environment
- Potential pricing drivers explored through the remainder of this report, and through other analyses, many of which rely on Berkeley Lab's dataset
  - Burkardt et al. (2014), Dong and Wiser 2013, Dong et al. (2014), Gillingham et al. (2014), Nemet et al. (2016a, 2016b, 2017), O'Shaughnessy (2018), and O'Shaughnessy et al. (2018)

Strong Economies of Scale Exist Among Both Residential and Non-Residential Systems

Residential Systems



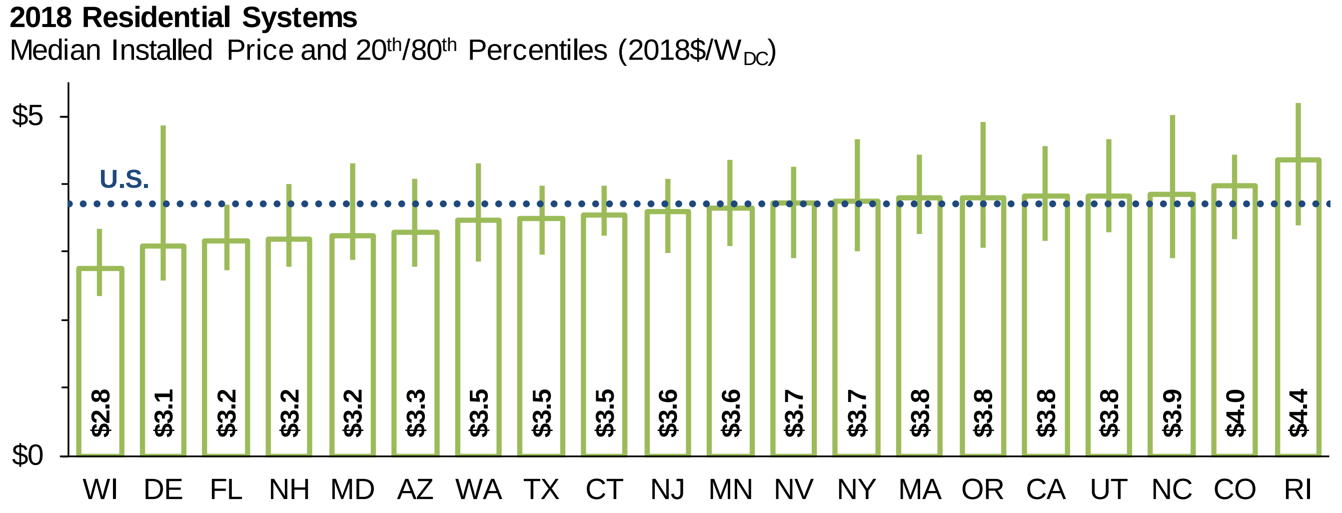
Non-Residential Systems



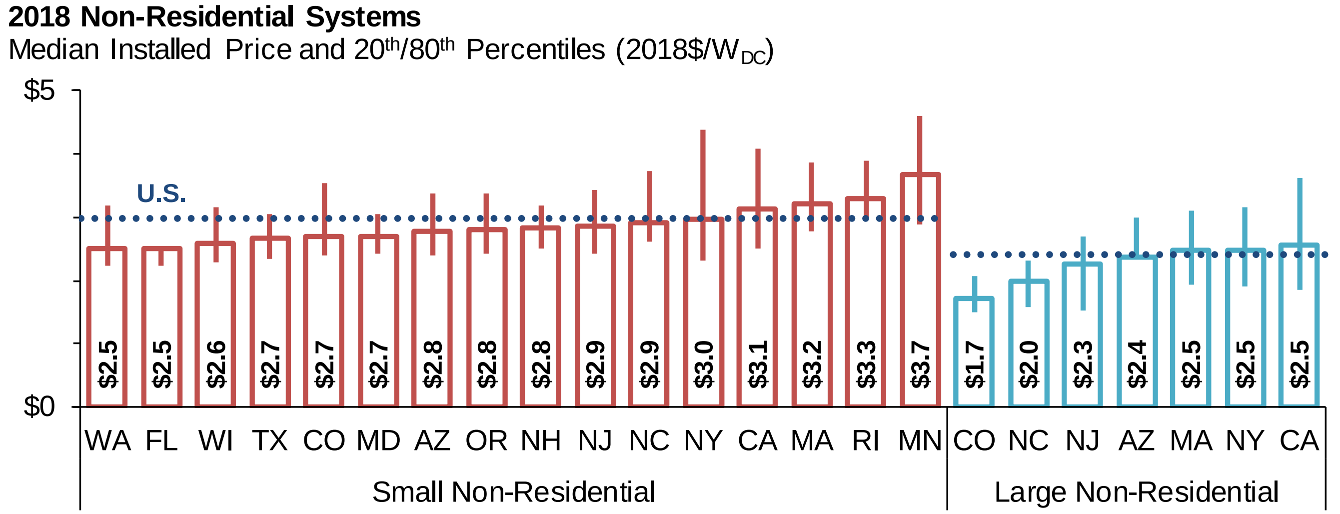
- Among residential systems installed in 2018, median prices were roughly $1/W lower for the largest (>12 kW) systems compared to the smallest (≤2 kW) systems
- Among non-residential systems, which span an even wider size range, median prices were $1.4/W lower for systems >1,000 kW, compared to the smallest non-residential systems ≤10 kW (keeping in mind that ground-mounted systems in this report are capped at 5 MW_{AC})
- Diminishing returns to scale are also evident

Installed Prices Vary Widely Among States

Residential Systems



Non-Residential Systems

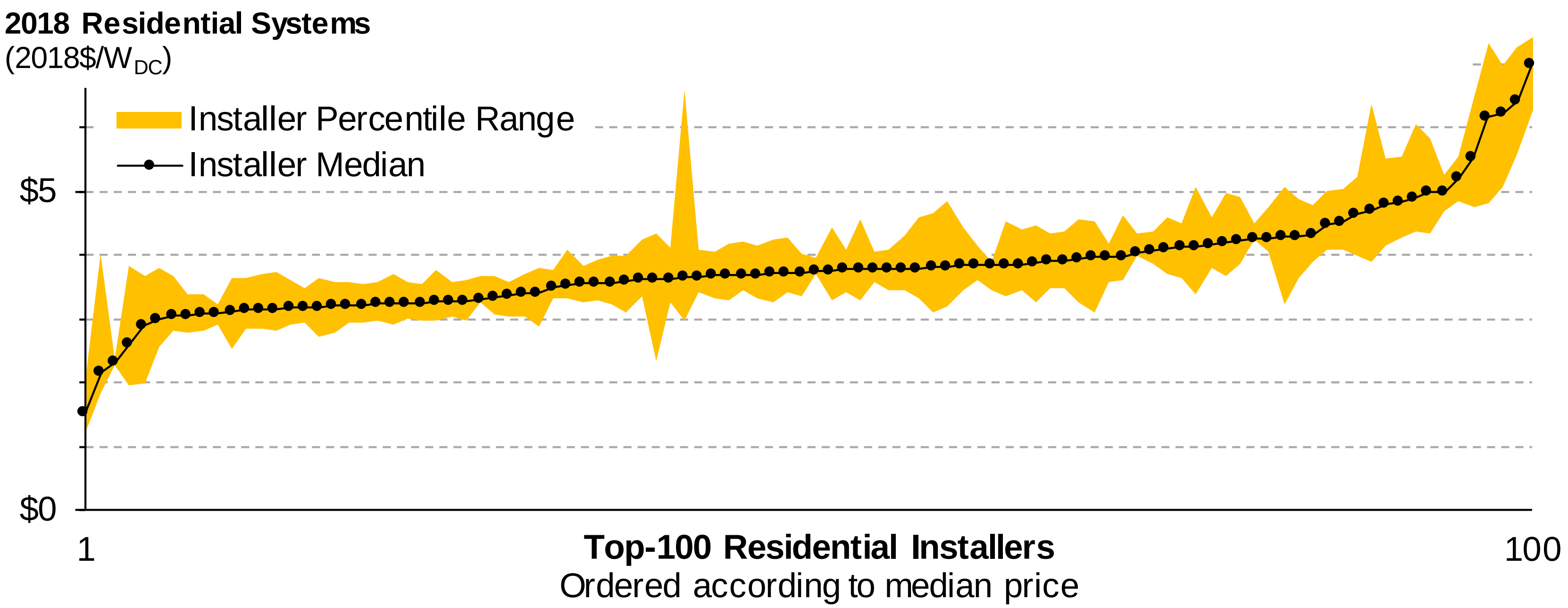


Notes: Data shown only if at least 20 observations are available for a given state.

- Cross-state pricing differences reflect both idiosyncratic features of particular states (a single large installer with anomalous prices) as well as more-fundamental differences in market and policy conditions
  - Market size, competition, incentive levels, permitting and interconnection processes, labor costs, etc.
- Some of the largest markets (CA, MA, NY) are relatively high-priced, pulling overall U.S. median prices upward, but most states' median prices are below the national median
  - Later regression analysis shows that larger markets, in fact, do tend to have lower prices, but other factors seemingly counteract that effect in the figures above

Wide Pricing Variability Exists Across Major Residential Installers

Top-100 Host-Owned Residential Installers in 2018

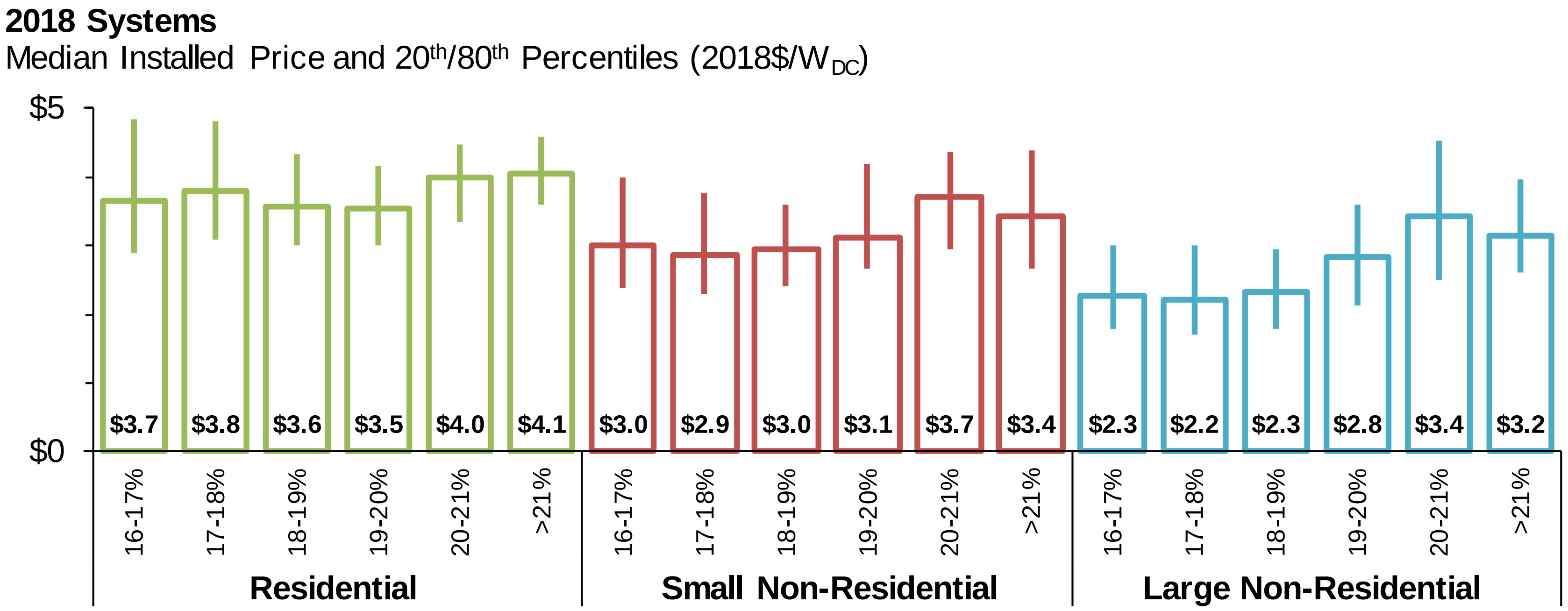


Notes: Each dot represents the median installed price of an individual installer, ranked from lowest to highest, while the shaded band shows the 20th to 80th percentile range for that installer.

- Ignoring the tails, median prices across the top-100 residential installers in 2018 generally ranged from \$3.0/W to \$5.0/W, with most below \$4.0/W
- Differences reflect installer-level attributes, such as:
  - Pricing strategy and business model
  - Firm size and experience
  - Level of training
  - Specialization and component preferences
- …as well as simply features of the markets in which each installer operates (especially for local/regional firms)

Installed Prices Are Substantially Higher for Systems with "Premium Efficiency" Modules

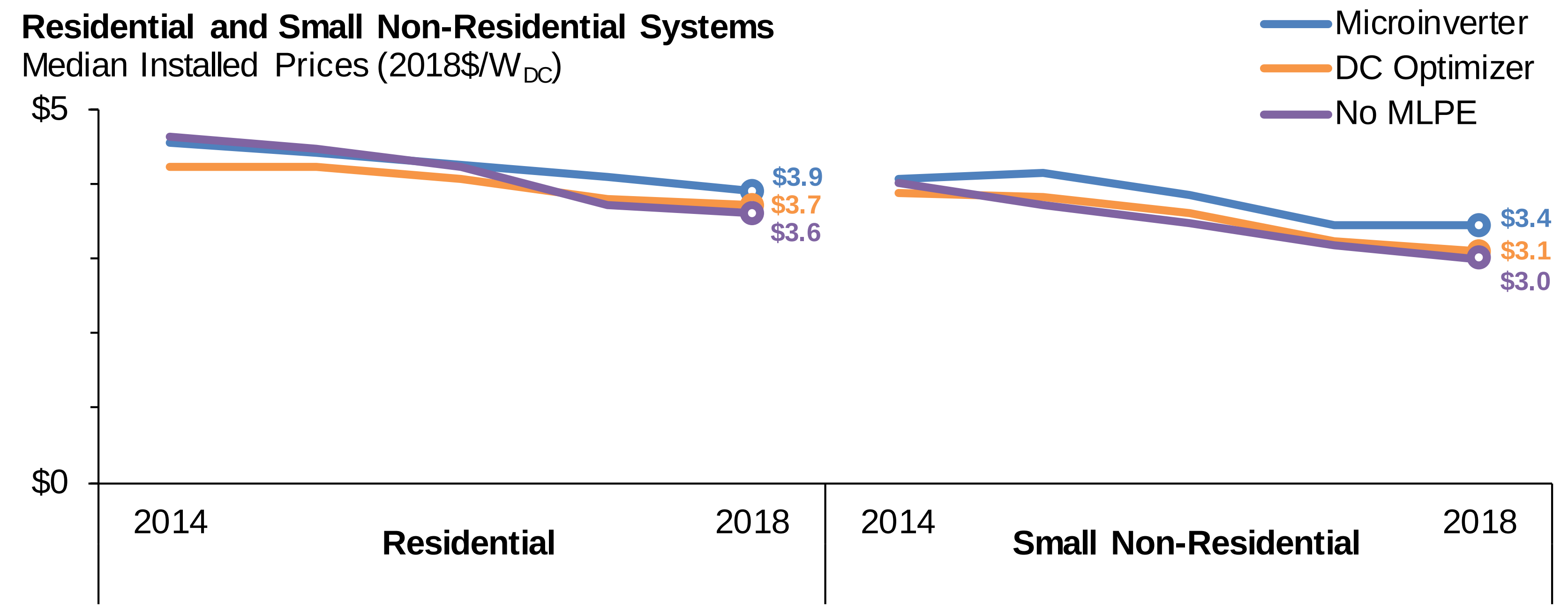
Installed Price Variation with Module Efficiency



- Installed prices are markedly higher for systems with module efficiencies >20% than for those with lower efficiencies
- Median prices differ by $0.4-$0.9/W between systems with efficiencies above or below 20%, depending on customer segment
- Almost all modules in the dataset with >20% efficiency are n-type mono-crystalline modules by SunPower or LG, which often sell at a substantial premium over lower efficiency mono modules
- Variation in module pricing can reflect differences in not just efficiency, but other performance attributes, warranty terms, and aesthetics as well

Installed Prices are Higher for Systems with MLPEs, with the Greatest Premium for Systems with Microinverters

Installed Price Variation with Inverter Type

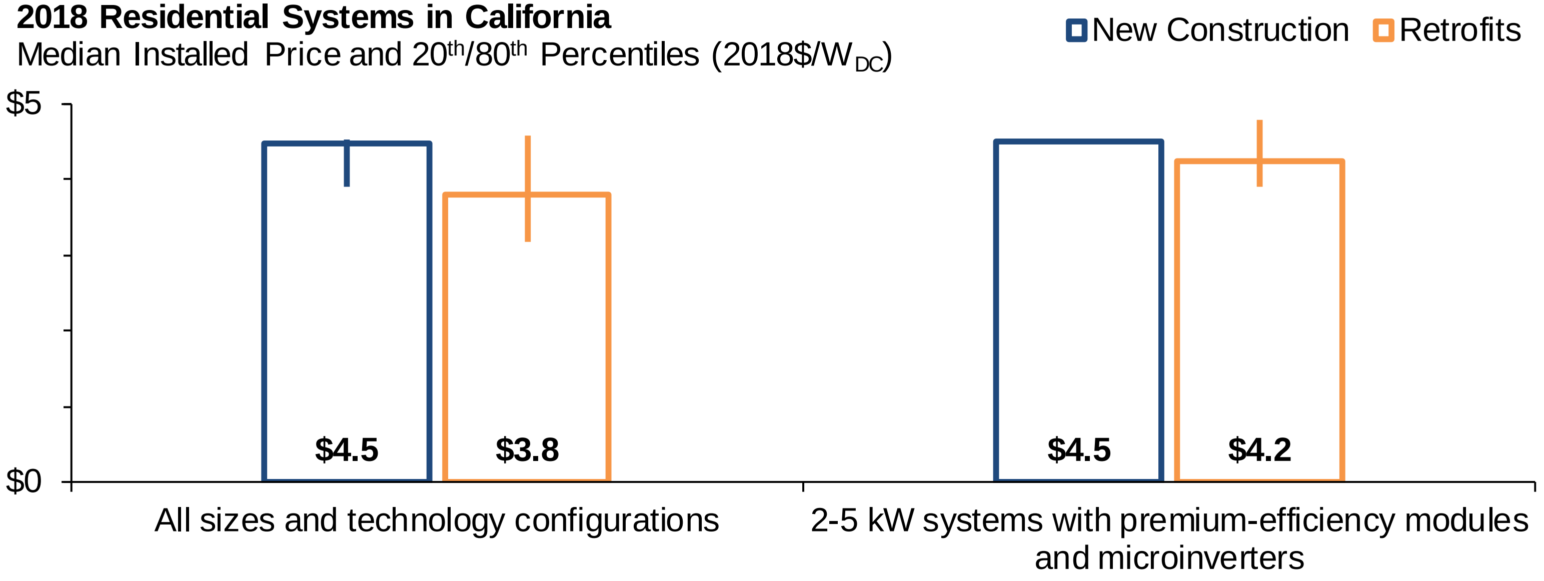


- Installed-price differences between systems with and without MLPEs are relatively small and have not been altogether consistent over time
- Installed-price difference in 2018 more-or-less coincide with cost premiums for each type of MLPE
- E.g., for residential systems, median prices for systems with microinverters were roughly $0.3/W higher, while those with DC optimizers were roughly $0.1/W higher, compared to systems with no MLPEs
- Non-residential systems exhibit similar installed-price differences across inverter technologies

Potential Cost Advantages for Residential New Construction Are Offset by Other Factors

- Installing systems in new construction can potentially offer cost advantages through economies of scale (in large housing developments), economies of scope, and lower customer acquisition costs
- At the same time, new construction systems tend to be smaller (2-5 kW) and typically include premium efficiency modules and MLPEs
- Data for California shows that residential new construction systems are, in fact, higher priced than retrofits—even after controlling for system size, module efficiency and MLPEs
- Those results driven primarily by a single installer, and later regression analysis finds that average prices are, in fact, lower in new construction

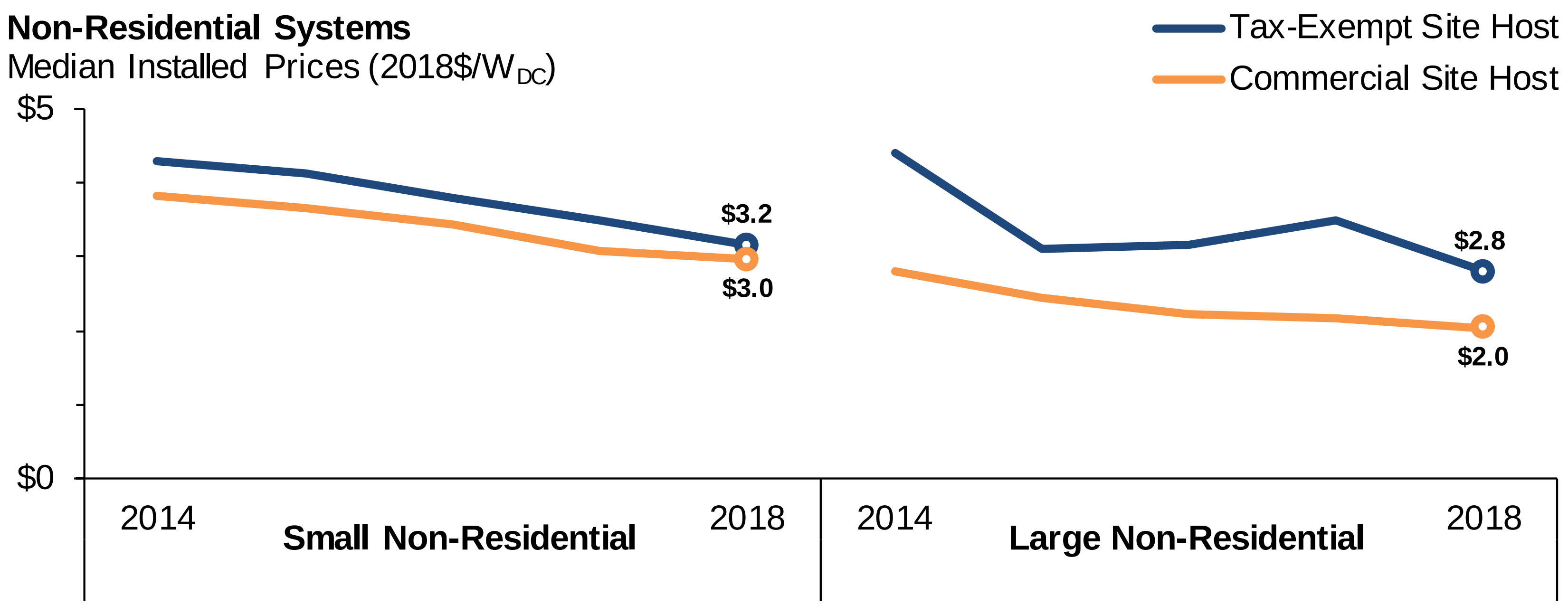
Residential New Construction vs. Retrofits in California



Notes: We focus here on California as relatively few other states provide data indicating which PV systems were installed on new construction. Several issues with the installed price data for new construction systems are worth noting. First, we commonly observe that identical prices are reported for all systems within a given development, presumably because the developer purchases the set of systems as a bulk order. This is a smaller scale issue than what we observe in the 2018 dataset, where one individual installer, representing more than 80% of the new construction systems, report most systems at the same price ($4.5/W). Second, to the extent that certain costs are shared between the PV installation and other aspects of home construction (e.g., roofing and electrical work), the entities reporting installed-price data may have some discretion in terms of how those shared costs are allocated to the PV system, which can create difficulties in making a true apples-to-apples comparison with retrofit systems.

Installed Prices Are Consistently Higher for Systems at Tax-Exempt Customer Sites than for Systems at Commercial Sites

Commercial vs. Tax-Exempt Site Hosts over Time

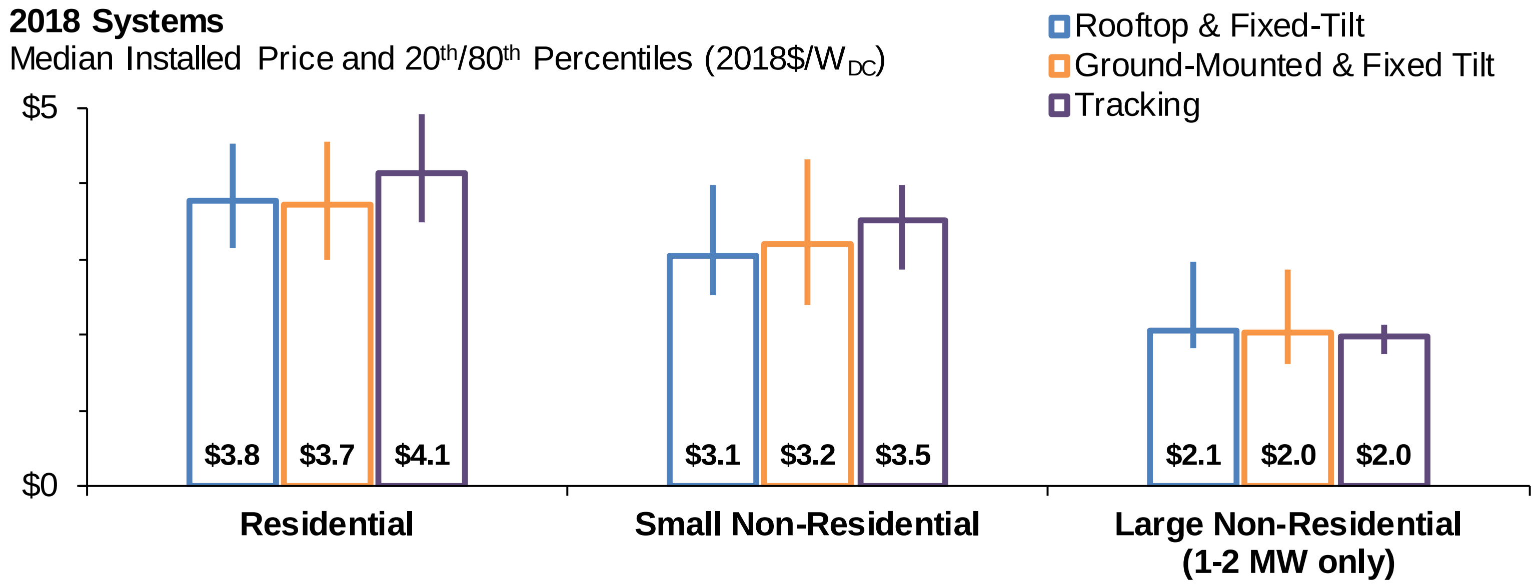


- Differences are fairly consistent over time and are most pronounced among large non-residential systems
- Higher prices for systems at tax-exempt customer sites potentially reflect:
  - Prevailing wage/union labor requirements
  - Domestically manufactured components
  - Shade or parking structures
  - Lower borrowing costs (enabling higher-priced systems to pencil-out)
  - Smaller sizes within the large non-residential segment

Installed Prices Higher for Systems with Tracking

- Variation in mounting configurations can lead to differences in installed prices (e.g., due to cost of tracking equipment, trenching and foundation-work for ground-mounting, etc.)
- Results show a distinct premium for systems with tracking equipment, at least within the residential and small non-residential segments, as one would anticipate (lack of apparent effect for large non-residential systems is likely just an artifact of small underlying sample sizes).
- No clear or consistent difference between fixed-tilt ground-mounted and roof-mounted systems (though regression analysis does find a fairly strong and statistically significant effect)

Installed Prices by Mounting Configuration



Notes: The comparison among large non-residential systems focuses specifically on systems in the 1-2 MW size range, in order to maintain comparability across mounting configurations in this customer segment.

Multi-Variate Regression Analysis

2018 Host-Owned Residential Systems

Multi-Variate Regression Analysis Isolates the Effects of Individual Pricing Drivers by Controlling for Correlations Among Them

This statistical model is based largely on previous econometric analysis of the *Tracking the Sun* dataset (Gillingham et al. 2014; Nemet et al. 2017; O’Shaughnessy 2019)

The model can be summarized by the following equation:

$$p = \alpha + system\beta_1 + market\beta_2 + installer\beta_3 + S + Q + \varepsilon_i$$

where:

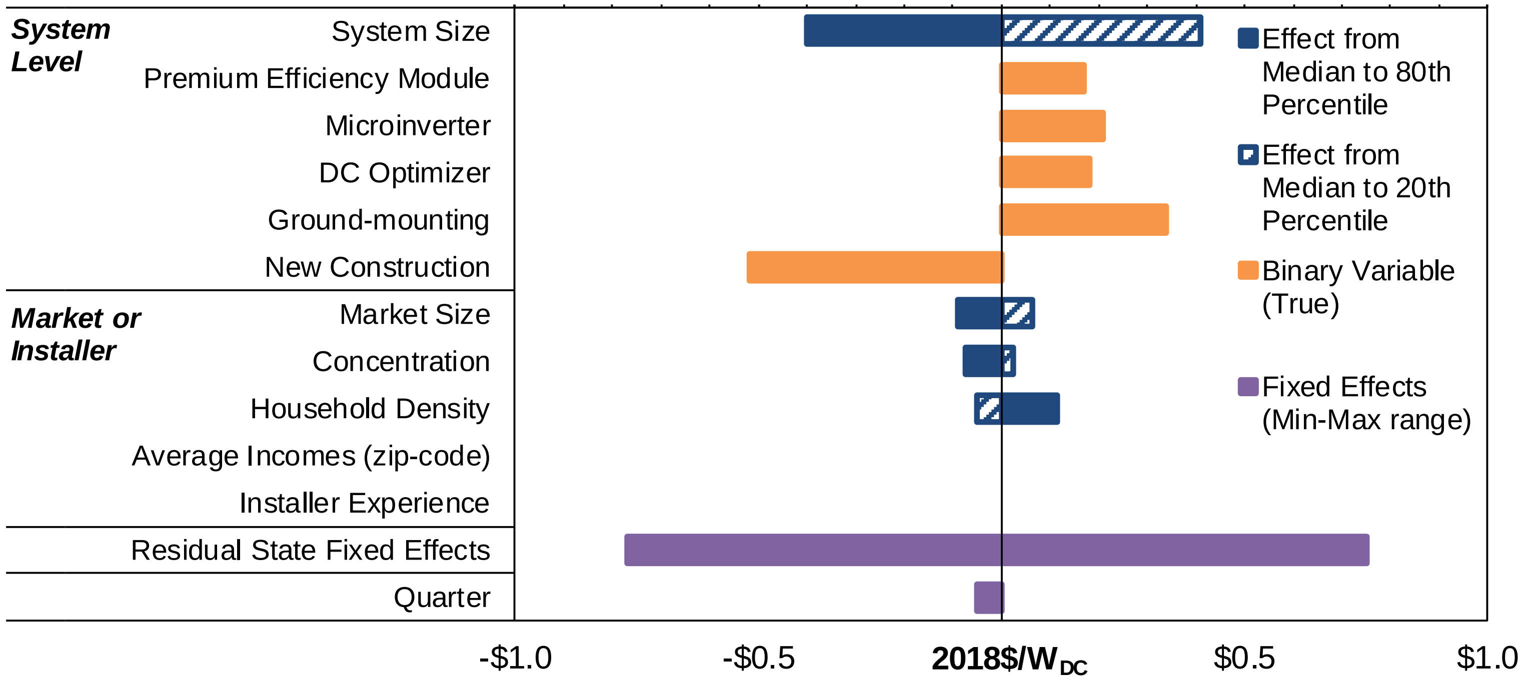
- p is the system price
- The terms *system, market*, and *installer* represent vectors of system-, market, and installer-level variables, respectively; the terms β represent the numeric effects of those variables on prices
- S is a state fixed effect; it measures the average price difference by state after controlling for all the other factors in the model
- Q is a quarterly fixed effect; it measures the average price difference by quarter after controlling for all other factors

We estimate the model based on 2018 residential systems from the installed-price dataset, though the full dataset is used to generate some of the variables

Regression Analysis Shows Larger Effects for the System-Level Pricing Drivers than for the Market- and Installer-Level Drivers

- Of the system-level pricing drivers, largest effect associated with system size:
  - System size (**$0.8/W** range between 20th and 80th percentile system sizes)
  - Module efficiency (**+$0.2/W** for systems with premium efficiency modules), inverter type (**+$0.2/W** for systems with either microinverter or DC-optimizers), ground-mounting (**+$0.3/W**), and new construction (**-$0.5/W**)
- Comparatively smaller effects for the modeled market- and installer-related drivers:
  - Market size (a **$0.2/W** range between the 20th to 80th percentile values for market size), market concentration (a **$0.1/W** range), household density (a **$0.2/W** range), average household income (**no effect**), and installer experience (**no effect**)

Impact of Modeled Variables on Installed Prices



Notes: For continuous variables, the figure shows the effect on system prices associated with moving from the median to the 20th and 80th percentile values of those variables. For binary variables, the figure shows the effect if that binary variable is true, and for fixed effects variables, the figure shows the range between the minimum and maximum effect of the variables in each set. See Appendix C for further definition of each regression variable, and for the full set of regression results presented in terms of individual variable coefficients and standard errors.

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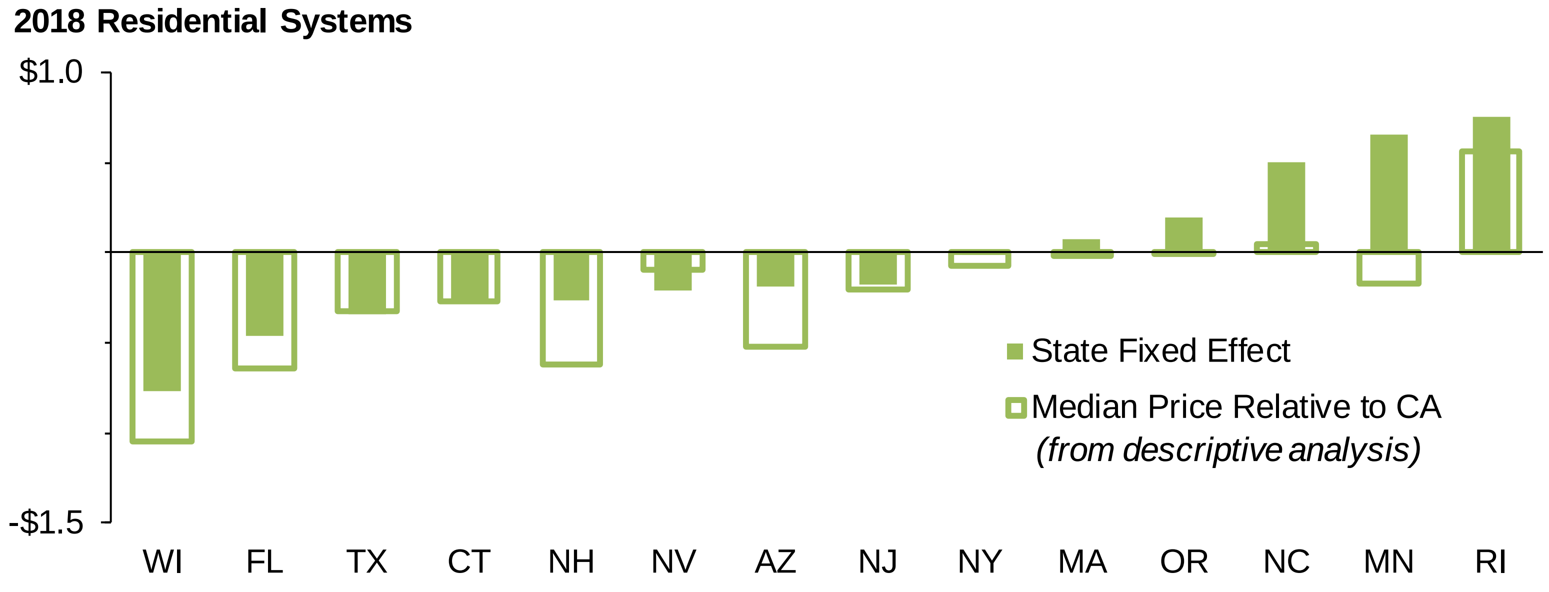
Substantial Residual Pricing Differences Remain across States, Even After Controlling for Other Pricing Drivers

State Fixed Effects Compared to Difference in Medians



State fixed effects represent difference in average price relative to California, after controlling for other variables

Median price relative to CA based on earlier results comparing simple median prices across states

- State fixed effects span a range of $1.5/W
- Indicates that other, unobserved factors, beyond the modeled price drivers, significantly impact installed prices at the state- or local-levels
- Fixed effects for individual states coincide closely with earlier descriptive results in some cases, diverge significantly in others
- But overall range in state-level pricing is similar

Conclusions

- Installed prices for distributed PV have fallen dramatically over time, though the rate of decline has slowed in recent years
- Historical installed price reductions attributable to declines in both hardware and soft costs, with slightly greater impacts on the hardware side
- Going forward, however, soft cost reductions will be most critical to sustaining PV system price declines, given the limits to further hardware cost savings
- Lower installed prices in other major national PV markets (e.g., see Seel et al. 2014) and in some U.S. states, as well as the high degree of variability in U.S. system pricing, suggest that deeper reductions in soft costs are possible
- Achieving dramatic reductions in soft cost may accompany market scale, but also likely requires research and innovation targeting specific soft costs as well as efforts aimed at supporting efficient and competitive PV markets

For more information

Download the report, briefing, summary data tables, and public data file: http://trackingthesun.lbl.gov

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