Issue:
Witness: Maurice Brubaker
Type of Exhibit: Surrebuttal Testimony
Sponsoring Parties: Missouri Industrial Energy Consumers
Case Nos.: EA-2023-0286
Date Testimony Prepared: November 3, 2023

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Union Electric Company d/b/a Ameren Missouri for Permission and Approval and Certificates of Public Convenience and Necessity Authorizing It to Construct Renewable Generation Facilities	)))))))	**Case No. EA-2023-0286**

Surrebuttal Testimony and Schedule of

Maurice Brubaker

On behalf of

Missouri Industrial Energy Consumers

December 15, 2023

BRUBAKER & ASSOCIATES, INC.

Project 11509

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OF THE STATE OF MISSOURI

In the Matter of the Application of Union Electric Company d/b/a Ameren Missouri for Permission and Approval and Certificates of Public Convenience and Necessity Authorizing It to Construct Renewable Generation Facilities	)	**Case No. EA-2023-0286**

STATE OF MISSOURI)
) **SS**
COUNTY OF ST. LOUIS)

Affidavit of Maurice Brubaker

Maurice Brubaker, being first duly sworn, on his oath states:

1. My name is Maurice Brubaker. I am a consultant with Brubaker & Associates, Inc., having its principal place of business at 16690 Swingley Ridge Road, Suite 140, Chesterfield, Missouri 63017. We have been retained by the Missouri Industrial Energy Consumers in this proceeding on their behalf.

2. Attached hereto and made a part hereof for all purposes is my surrebuttal testimony and schedule which were prepared in written form for introduction into evidence in the Missouri Public Service Commission, Case No. EA-2023-0286.

3. I hereby swear and affirm that the testimony and schedule are true and correct and they show the matters and things that they purport to show.

Maurice Brubaker

Subscribed and sworn to before me this 14th day of December, 2023.

ADRIENNE JEAN NAVARRO
Notary Public - Notary Seal
STATE OF MISSOURI
Jefferson County
My Commission Expires: Mar. 22, 2025
Commission # 21989987

Adrienne J Navarro
Notary Public

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Union Electric Company d/b/a Ameren Missouri for Permission and Approval and Certificates of Public Convenience and Necessity Authorizing It to Construct Renewable Generation Facilities	)	**Case No. EA-2023-0286**

Surrebuttal Testimony of Maurice Brubaker

Q PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A Maurice Brubaker. My business address is 16690 Swingley Ridge Road, Suite 140, Chesterfield, MO 63017.

Q WHAT IS YOUR OCCUPATION?

A I am a consultant in the field of public utility regulation and President of Brubaker & Associates, Inc., energy, economic and regulatory consultants.

Q PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND AND EXPERIENCE.

A I have a Bachelor's Degree in Electrical Engineering from Missouri University of Science and Technology (formerly Missouri School of Mines and Metallurgy and University of Missouri at Rolla), a Master of Science Degree in Engineering from Washington University in St. Louis, MO, and a Master's Degree of Business Administration from the Olin School of Business at Washington University in St. Louis, MO. I have been a consultant in the field of utility contracts, rates and regulation since 1970. I have testified on a number of subjects including planning, reliability, cost of service, revenue allocation and rate design.

I have testified in over 30 utility jurisdictions, including many times in Missouri. I have submitted testimony in over 600 cases, including in more than 180 cases during the last 20 years. Additional information is included in Appendix A to my testimony.

Q ON WHOSE BEHALF ARE YOU APPEARING IN THIS PROCEEDING?

A This testimony is presented on behalf of the Missouri Industrial Energy Consumers ("MIEC"), a non-profit company that represents the interests of industrial customers in Missouri utility matters.

Q HAVE YOU REVIEWED TESTIMONY FILED IN THIS CASE BY AMEREN MISSOURI ("AMO") AND BY THE STAFF?

A Yes. AMO has proposed four solar projects. Two (totaling 450 MW) were selected through competitive solicitations/negotiations and two (totaling 100 MW) are self-build projects with costs comparable to the other two.

Q PLEASE SUMMARIZE YOUR TESTIMONY AND RECOMMENDATIONS.

A The purpose of my testimony is to address certain aspects of the rebuttal testimony filed by representatives of the Staff of the Missouri Public Service Commission ("Staff").

Q PLEASE EXPLAIN.

A In rebuttal testimony, Staff has raised a number of issues and drawn a number of conclusions with respect to AMO's proposed new solar projects. My testimony addresses factors which I believe Staff has not adequately considered; namely, the need to replace retiring resources on a timely basis, the need to transition AMO's resource portfolio to one with a reduced component of resources that emit greenhouse

gases ("GHG") and to give full and appropriate consideration to the highly competitive nature of the demand for land on which to site renewable facilities as well as the market demand for the facilities. I urge the Commission to give full consideration to these and related factors in reaching its decision in this matter.

I also urge the Commission to adequately consider the risks to reliability and resource cost of placing too much reliance on an assumed ability to acquire needed resources in the market on a short notice or basis.

Q WHAT RESOURCE ADEQUACY CONCERNS DO YOU HAVE WITH STAFF'S TESTIMONY?

A The recommendation of Staff is not to pursue the four solar projects which AMO has presented. This course of action inherently implies an expectation of being able to purchase capacity and energy in the market instead. For example, Staff witness Busch says the following at page 2 of his rebuttal testimony:

> "Q. What is Staff's overall recommendation in this proceeding?
>
> A. Based on the evidence provided so far by Ameren Missouri through its direct filed testimony and the workpapers provided to Staff from Ameren Missouri, Staff recommends that the Commission reject the Company's request for authority to proceed with the four requested solar projects[1] at this time." [Footnote omitted.]

Q WHY IS RELIANCE ON PURCHASING IN THE MARKET IN ORDER TO MEET RESOURCE NEEDS OF CONCERN TO YOU?

A AMO has a need for both capacity and energy resources to serve its native load under circumstances where it will be retiring significant amounts of fossil (gas and coal)-fired generation capacity, and a need to transition the generation portfolio to one composed of a larger proportion of GHG-free resources, such as wind and solar.

Q WHAT IS YOUR CONCERN ABOUT RELYING UPON PURCHASED POWER?

A Purchased power has a role. It normally can be used to bridge short-term gaps in the resource portfolio. Sometimes, but not here, it can be a source of long-term purchased power contracts with third parties.

Q WHY IS RELIANCE ON PURCHASED POWER PROBLEMATIC AT THIS POINT IN TIME?

A First, the capacity market in the Midcontinent Independent System Operator ("MISO") territory is largely designed to rationalize temporary surpluses and shortages by facilitating the exchange of money for capacity. While this is a necessary and appropriate short-term market, it is not satisfactory in the long-term because most utilities in the MISO market are not in a position of having surplus power for the long-term, and certainly not surplus renewable power for the long-term.

Most utilities in MISO (and elsewhere in the United States as well) are facing near-term retirements of large amounts of coal and natural gas-fired capacity, and attempting to replace those resources with renewable resources, such as wind and solar. Those capacity resources must be provided by installing new generation facilities, since any surpluses in the market are short-term because all utilities are in the same situation of replacing retired capacity and trending their portfolio toward a larger renewable resource component.

Q PLEASE ELABORATE ON YOUR DISAGREEMENT WITH STAFF'S PERSPECTIVE.

A The point of view in Staff's recommendation seems to be based on the mistaken notion that it's easy to find renewable projects and to acquire and execute on the contracting

and construction in a short span of time. This is wrong. As AMO witness Arora noted at page 25 of his direct testimony, full cycle development of a renewable project often takes as many as eight years. It is not like ordering an automobile – it's not an off the shelf standard product that can be had whenever desired. Developing renewable projects is time consuming and very complex. Even if a project is optioned, it may be the case that failure to timely execute on the option allows other interested parties to acquire the site/solar panels and other equipment, and permits.

There is significant competition in the market place for sites and the equipment composing renewable facilities. This is only becoming a bigger problem as we go through time because of the increased demand on the part of many utilities and individual purchasers for these scarce resources. Failure to act when sites and equipment are available may result in a foregone opportunity that may not be replicated at a later time.

Q PLEASE OUTLINE YOUR EXPERIENCE WITH DEVELOPMENT OF RENEWABLE RESOURCES IN THE MISO TERRITORY?

A Over the last six years, I have represented customers in utility proceedings involving the development, certification, and related cost recovery for over 9,000 MW of renewable resources within the MISO footprint.

Q CAN YOU SHARE ANY INSTANCES OF PROJECTS BEING OPTIONED OR PARTIALLY DEVELOPED ONLY TO FACE SETBACKS, ADDITIONAL TIME DELAYS, AND PERHAPS LOSS OF PROJECT AVAILABILITY?

A Yes. One example is a current proceeding in Iowa involving MidAmerican Energy Company (Iowa Utilities Board, Docket No. RPU-2022-0001) and its request for

certification of 2,042 MW of wind resources and 50 MW of solar resources. MidAmerican Energy Company has reported that as time went by it lost the ability to contract for one of its best sites, a site for 300 MW of wind resources because a competing interest was able to provide the developer with a more timely and attractive contract.

Another example involves Interstate Power and Light Company ("IPL") in Iowa (Iowa Utilities Board, Docket No. RPU-2021-0003) and its effort to certify 400 MW of solar capacity. In that certification proceeding, IPL reported that it was able to secure sites and interconnection capability for 200 MW of solar power that was made available because of the retirement of IPL generation capacity. However, IPL had considerable difficulty in securing locations for an additional 200 MW of solar capacity, even though it has an ability to acquire the solar panels and supporting facilities. This demonstrates that there is a considerable risk of not being able to find adequate sites because of competition, unsatisfactory interconnection capability, local siting laws, and other factors. IPL filed its case with the Iowa Utilities Board in late 2021, and only recently was able to secure arrangements for this 200 MW of solar capacity.

Q DO YOU HAVE ANY OTHER EXAMPLES?

A Yes. Another recent example involves Entergy Louisiana, LLC ("ELL") in LPSC Docket No U-36190 in which ELL sought to certify 475 MW of solar capacity. ELL was successful in negotiating acquisition agreements with developers and (it thought) obtaining necessary local siting authority, and meeting other requirements. However, during the course of the 2022 certification proceeding before the Louisiana Public Service Commission, the local authority for the site involving 150 MW of solar

adopted some new rules which meant that ELL has to go back to the negotiating table to see if it can resurrect this project. The issue still is unresolved.

Q WHAT IS THE LESSON HERE?

A The lesson is that there is substantial competition for sites for renewable resources, which means that if they are not available now they'll be even less available or more difficult to acquire in the future. It is important to take steps to secure needed sites and capacity when they are available, rather than speculate on future availability and bear the risk of those sites becoming unavailable or more costly.

Q IN GENERAL, HOW WOULD YOU DESCRIBE THE CURRENT STATE OF THE SOLAR INDUSTRY?

A The solar industry has been temporarily disrupted by events such as the import tariff and other issues which have resulted in a general shortage of solar panels.

Q IS THIS A PERMANENT OR TEMPORARY SITUATION?

A In my opinion, and in the opinion of most knowledgeable industry participants, this is temporary and will be rectified. Import issues, and the recent passage of the Inflation Reduction Act ("IRA") that greatly liberalizes the availability of tax credits for solar resources, is expected to return the industry to a state of growth more comparable to what was experienced before these recent disruptions. It seems that the disruption is mainly a supply-side issue, and not a demand-side issue; in other words, the demand for solar resources remains high and is expected to increase over time.

Q DO YOU HAVE ANY AUTHORITATIVE REFERENCES TO SUPPORT THAT POINT OF VIEW?

A Yes. First, it is almost impossible these days to pick up any industry publications, or even such general market publications as *The Wall Street Journa*l, and not understand that there are considerable pressures on utilities and other energy consumers to migrate their portfolios away from fossil resources and toward renewable resources.

As an example, I have included as Schedule MEB-1 the Executive Summary of a December 2022 publication entitled "Solar Market Insight" by Wood Mackenzie and SEIA. Wood Mackenzie is a well-respected consulting agency with substantial presence in the renewable space and SEIA is, as the name implies, an organization composed of solar industry interests. The December 2022 "Quarterly Executive Summary" published by Wood Mackenzie and SEIA is a good source of trends in the industry,

To highlight just a couple of passages, the following appears on page 7 of the publication:

> "After 2022, we expect the solar industry to return to growth. In 2023, some projects that were delayed this year should obtain module supply and come online. And by 2024, the real impacts of the IRA will begin to come to fruition. From 2023-2027, Wood Mackenzie forecasts 21% average annual growth across all solar segments."

Also, as set forth on page 13, where Mackenzie and SEIA express the following:

> "Utility PV
>
> - 2,460 MW_{dc} installed in Q3 2022
> - 150 GW_{dc} of utility-scale solar will be added between 2022 and 2027
>
> Supply chain issues continued to constrain utility-scale deployments in Q3 2022. 2.5 GW_{dc} were installed during the third quarter, bringing the 2022 total to 7.4 GW_{dc} – barely two-thirds of the volume installed at this time last year. Another 4.5 GW_{dc} of newly contracted capacity was signed this quarter, the majority of which will come online between 2024-2025. This brings the total pipeline to 90 GW_{dc}, a slight increase

compared to last quarter. There are currently 30 GW_{dc} of projects under construction, though module shipment delays are stalling progress."

Q WOULD AN ALLEVIATION OF SUPPLY CHAIN SHORTAGES FOR SOLAR PANELS ALSO RESULT IN MORE SOLAR FARM SITES BECOMING AVAILABLE?

A No. Solar panels and physical sites for their placement are entirely different markets. Many factors will influence site availability and cost, but improved availability of solar panels could increase the number of developers looking for sites and therefore make site acquisition more difficult and costly. If anything, this underscores the importance of executing now on available site acquisition opportunities.

Q STAFF WITNESS SARAH L.K. LANGE, AT PAGE 8 OF HER REBUTTAL TESTIMONY, SEEMS DISMISSIVE OF AMO'S GOALS OF TRANSITIONING ITS PORTFOLIO TO ONE WITH A LARGER RENEWABLE COMPONENT. IN YOUR OPINION, IS IT APPROPRIATE TO DISMISS AMO'S GOALS IN THAT REGARD?

A No. Nationally, and globally, both utilities and governments are adopting goals of this nature for a number of reasons. In some cases, it is the result of complying with goals or policies adopted by governments, and in other cases it is driven by market demands to reduce the use of fossil resources in the operation and production of goods and services.

MIEC supports generation portfolio transitions like that outlined by AMO and urges the Commission to carefully consider the proposals.

Q IS THIS ALSO IMPORTANT FOR ECONOMIC DEVELOPMENT OF THE STATE?

A Yes. See, for example, this Commission's April 12, 2023 Report and Order in File No. EA-2022-0245 (Boomtown Solar) on page 31, referencing the testimony of AMO witness Robert Dixon, and noting that:

> "The Project has economic development benefits. Demand for clean, reliable, and affordable energy is an increasingly important factor in determining where businesses locate new jobs and investment. Missouri is competing with other states for new jobs and investment from businesses that have large energy demand and a need for renewable energy resources. Customer preferences for renewable energy and corporate sustainability goals by Missouri's large employers for their energy needs should not be dismissed.
>
> The Commission finds that the Project promotes the public interest."

Q TO BE CLEAR, ARE YOU SAYING THAT MIEC MEMBER COMPANIES ARE SUPPORTIVE OF A PORTFOLIO TRANSFORMATION BY AMO REGARDLESS OF COST?

A No, not at all. MIEC member companies support a rigorous technical review of this and other proposals; but want adequate consideration given to the need for portfolio transformation in the context of the realities of the high market place demand for quality renewable resources, and the importance to a utility and its customers of having control over its capacity resources rather than depending on the vagaries of the marketplace and hoping that the necessary resources will become available when needed.

Q DOES THIS CONCLUDE YOUR SURREBUTTAL TESTIMONY?

A Yes, it does.

Qualifications of Maurice Brubaker

Q PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A Maurice Brubaker. My business address is 16690 Swingley Ridge Road, Suite 140, Chesterfield, MO 63017.

Q PLEASE STATE YOUR OCCUPATION.

A I am a consultant in the field of public utility regulation and President of the firm of Brubaker & Associates, Inc. ("BAI"), energy, economic and regulatory consultants.

Q PLEASE SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND EXPERIENCE.

A I was graduated from the University of Missouri in 1965, with a Bachelor's Degree in Electrical Engineering. Subsequent to graduation I was employed by the Utilities Section of the Engineering and Technology Division of Esso Research and Engineering Corporation of Morristown, New Jersey, a subsidiary of Standard Oil of New Jersey.

In the Fall of 1965, I enrolled in the Graduate School of Business at Washington University in St. Louis, Missouri. I was graduated in June of 1967 with the Degree of Master of Business Administration. My major field was finance.

From March of 1966 until March of 1970, I was employed by Emerson Electric Company in St. Louis. During this time I pursued the Degree of Master of Science in Engineering at Washington University, which I received in June, 1970.

In March of 1970, I joined the firm of Drazen Associates, Inc., of St. Louis, Missouri. Since that time I have been engaged in the preparation of numerous studies relating to electric, gas, and water utilities. These studies have included analyses of the cost to serve various types of customers, the design of rates for utility services, cost forecasts, cogeneration rates and determinations of rate base and operating income. I

have also addressed utility resource planning principles and plans, reviewed capacity additions to determine whether or not they were used and useful, addressed demand-side management issues independently and as part of least cost planning, and have reviewed utility determinations of the need for capacity additions and/or purchased power to determine the consistency of such plans with least cost planning principles. I have also testified about the prudency of the actions undertaken by utilities to meet the needs of their customers in the wholesale power markets and have recommended disallowances of costs where such actions were deemed imprudent.

I have testified before the Federal Energy Regulatory Commission ("FERC"), various courts and legislatures, and the state regulatory commissions of Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Guam, Hawaii, Illinois, Indiana, Iowa, Kentucky, Louisiana, Michigan, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, Texas, Utah, Virginia, West Virginia, Wisconsin and Wyoming.

The firm of Drazen-Brubaker & Associates, Inc. was incorporated in 1972 and assumed the utility rate and economic consulting activities of Drazen Associates, Inc., founded in 1937. In April, 1995 the firm of Brubaker & Associates, Inc. was formed. It includes most of the former DBA principals and staff. Our staff includes consultants with backgrounds in accounting, engineering, economics, finance, mathematics, computer science and business.

Brubaker & Associates, Inc. and its predecessor firm have participated in over 700 major utility rate and other cases and statewide generic investigations before utility regulatory commissions in 40 states, involving electric, gas, water, and steam rates and

other issues. Cases in which the firm has been involved have included more than 80 of the 100 largest electric utilities and over 30 gas distribution companies and pipelines.

While the firm has always assisted its clients in negotiating contracts for utility services in the regulated environment, increasingly there are opportunities for certain customers to acquire power on a competitive basis from a supplier other than its traditional electric utility. The firm assists clients in identifying and evaluating purchased power options, conducts RFPs and negotiates with suppliers for the acquisition and delivery of supplies. We have prepared option studies and/or conducted RFPs for competitive acquisition of power supply for industrial and other end-use customers throughout the Unites States and in Canada, involving total needs in excess of 3,000 megawatts. The firm is also an associate member of the Electric Reliability Council of Texas.

In addition to our main office in St. Louis, the firm also has branch offices in Corpus Christi, Texas; Detroit, Michigan; Louisville, Kentucky and Phoenix, Arizona.

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Solar Energy Industries Association®

Wood Mackenzie
A Verisk Business

December 2022

US Solar Market Insight

Executive summary

Q4 2022

About the report

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US Solar Market Insight® is a quarterly publication of Wood Mackenzie and the SEIA®. Each quarter, we collect granular data on the US solar market from nearly 200 utilities, state agencies, installers, and manufacturers. This data provides the backbone of this US Solar Market Insight® report, in which we identify and analyze trends in US solar demand, manufacturing and pricing by state and market segment over the next five to ten years. All forecasts are from Wood Mackenzie, Limited; SEIA does not predict future pricing, bid terms, costs, deployment or supply. The report includes all 50 states, Washington, D.C., and Puerto Rico. Detailed data and forecasts are contained within the full version of the report.

References and Contact

- References, data, charts, and analysis from this executive summary should be attributed to "Wood Mackenzie/SEIA US Solar Market Insight®."
- Media inquiries should be directed to Wood Mackenzie's PR team (WoodmacPR@woodmac.com) and Morgan Lyons (mlyons@seia.org) at SEIA.
- All figures are sourced from Wood Mackenzie. For more detail on methodology and sources, access the full report at www.woodmac.com/research/products/power-and-renewables/us-solar-market-insight/.

Note on US Solar Market Insight report title: The report title is based on the quarter in which the report is released, not the most recent quarter of installation figures.

Contents

1. Key figures

- In Q3 2022, the US solar market installed 4.6 GW_{dc} of solar capacity, a 17% decrease from Q3 2021 and a 2% decrease from Q2 2022. The industry continues to be supply-constrained, most recently from import detentions.
- Solar accounted for 45% of all new electricity-generating capacity added to the US grid through the third quarter, more than any other electricity source.
- The residential segment had a historic quarter with 1.57 GW_{dc} installed, a 43% increase over Q3 2021 and a 16% increase over Q2 2022. California made up 36% of this total as installers continue to push to sell residential solar before changes to current net metering rates.
- There were 340 MW_{dc} of commercial solar installed, up 3% year-over-year and down 10% quarter-over-quarter. Community solar developers installed 212 MW_{dc}, down 17% both year-over-year and quarter-over-quarter.
- The industry deployed 2.5 GW_{dc} of utility-scale solar in Q3 2022, a 36% decrease from Q3 2021 and a 9% decrease from Q2 2022. The low installation figures are the result of previous project delays and continued supply chain constraints.
- Total 2022 installations are expected to land at 18.6 GW_{dc} – a slight increase from our previous outlook, but still a 23% decrease from 2021. Utility-scale solar installations are expected to decline 40% from 2021 with only 10.3 GW_{dc} installed.
- Wood Mackenzie expects the industry to remain supply-constrained through at least the second half of next year. Equipment importers are still contending with detainments as they seek to provide the documentation needed for compliance with the Uyghur Forced Labor Prevention Act (UFLPA).
- Once supply chain relief arrives, the true impacts of the Inflation Reduction Act will manifest in our outlooks. Beginning in 2024, annual installations of solar will consistently reach 30-40 GW_{dc}.
- On December 2nd, the Department of Commerce issued a preliminary affirmative ruling in the anticircumvention case initiated earlier this year. While the ruling was not issued in time to allow for incorporation into our forecasts, new tariffs present a downside risk to our outlook.

2. Introduction

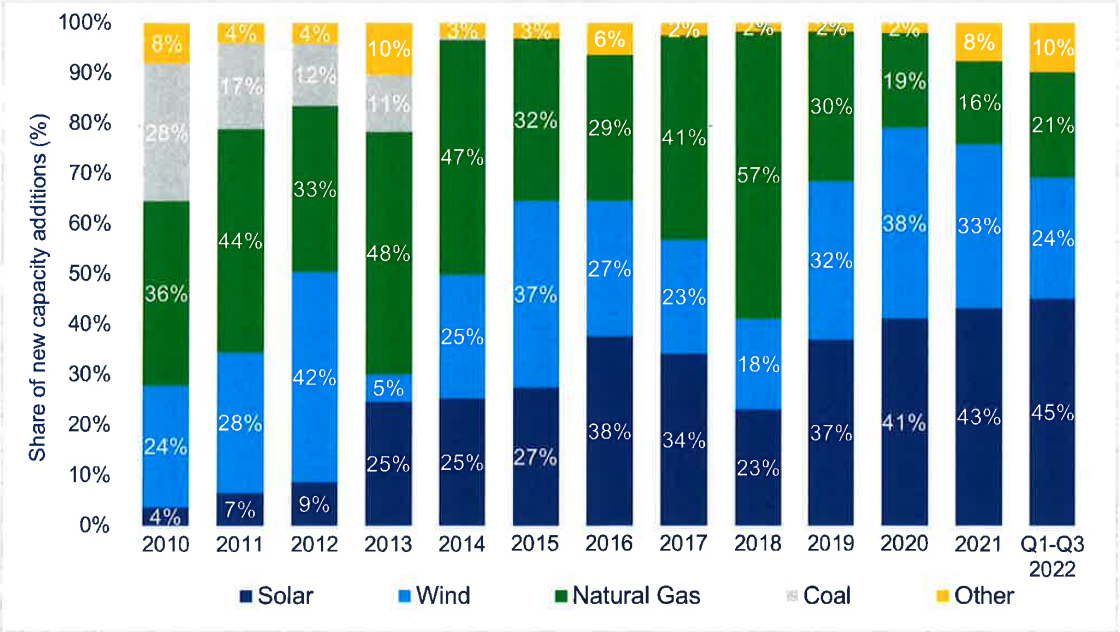
The US solar industry installed 4.6 gigawatts-direct current (GW_{dc}) of capacity in the third quarter of 2022, a 17% decrease from Q3 2021 and a 2% decrease from Q2 2022.

Commercial, community, and utility-scale solar were all down quarter-over-quarter – an unsurprising outcome given the nearly ubiquitous project delays from supply chain constraints. These segments installed 340 MW_{dc}, 212 MW_{dc}, and 2.5 GW_{dc}, respectively. If utility-scale solar reaches our 2022 forecast of 10.3 GW_{dc}, it will reflect a 40% drop from 2021 volumes.

The trend for residential solar looks quite different. Quarterly installs set another record at 1,568 MW_{dc}. The fundamentals for residential solar are strong – customers crave energy independence and savings from a solar system, particularly as retail power prices increase. Record volumes in California are also driving this growth, as the industry rushes to capture sales before the state shifts to a new net metering policy. More analysis of California market trends and their impact on the residential sector can be found in the full report.

Overall, solar PV accounted for 45% of all new electricity-generating capacity additions through the third quarter.

New US electricity-generating capacity additions, 2010 – Q1-Q3 2022



Source: Wood Mackenzie, US Energy Information Administration (for all other technologies)

An industry waits

After a year of starts and stops, the US solar industry once again finds itself waiting on the outcomes of several key policy issues. The first, and most pressing, is how US Customs and Border Protection (CBP) will manage the approval process under the UFLPA and the release of hundreds of solar equipment shipments still being detained.

The UFLPA took effect on June 21st, with detentions beginning shortly thereafter, but even after several months, CBP has not made major releases of equipment. As mentioned in last quarter's report, the requirements to demonstrate compliance with the UFLPA are more rigorous than those for the Withhold Release Order (WRO) issued last fall. Last quarter, importers were working with CBP on the required documentation and were expecting near-term releases as some manufacturers had started to file admissibility packages.

Unfortunately, little has changed since then. It is proving more difficult than expected to provide traceability for the sourcing of quartzite used in solar equipment. There are many questions around the required documentation that is needed to demonstrate compliance with the UFLPA. Furthermore, the CBP is still releasing detentions from last fall's WRO, a sign that UFLPA releases could take just as long. We still expect supply chain relief to arrive in the second half of 2023, but the exact timing is uncertain.

The solar industry is also waiting on guidance from the US Department of Treasury on how to qualify for the various tax credits and adders within the Inflation Reduction Act (IRA). These incentives will undoubtedly provide upside for solar project development, but without more specifics from the US government, it's difficult to assess which projects will qualify for various adders. The overwhelming sentiment from developers this quarter was that it's too soon to know how the bonus adders will impact their business.

Treasury collected public comments on various aspects of the IRA tax credits, which were due on November 4th. While there's no firm deadline for all Treasury guidance, most is expected sometime in the first quarter of 2023. Given this uncertainty, Wood Mackenzie has assumed most projects will earn the 30% ITC or $26/MWh PTC. In the medium-term, the availability of bonus adders will certainly provide upside to our outlooks after supply chain issues have been resolved.

California moves to net billing for distributed solar

Uncertainty around supply chain constraints and IRA qualifications aside, the distributed solar industry received some clarity for the segment's largest market. The California Public Utilities Commission (CPUC) issued the highly anticipated revision of its Proposed Decision (PD) for the next generation of net metering tariffs ("NEM 3.0"). November's PD makes several substantial changes to the first proposal from December 2021.

The November PD maintains several elements of the previous proposal (a shift to a "net billing" structure instead of "net metering" and compensating exports at the avoided cost

rate) but eliminates others (the Grid Participation Charge and Market Transition Credit). On balance, the new PD certainly elongates current payback periods for solar and solar-plus-storage, but not by as much as the previous proposal. Therefore, we still expect market contraction in both the residential and non-residential markets.

Importantly, if the November PD is finalized in its current form, the largest distributed solar market will no longer compensate solar exports at a customer's retail rate. More details on the PD and its impact can be found in the full report.

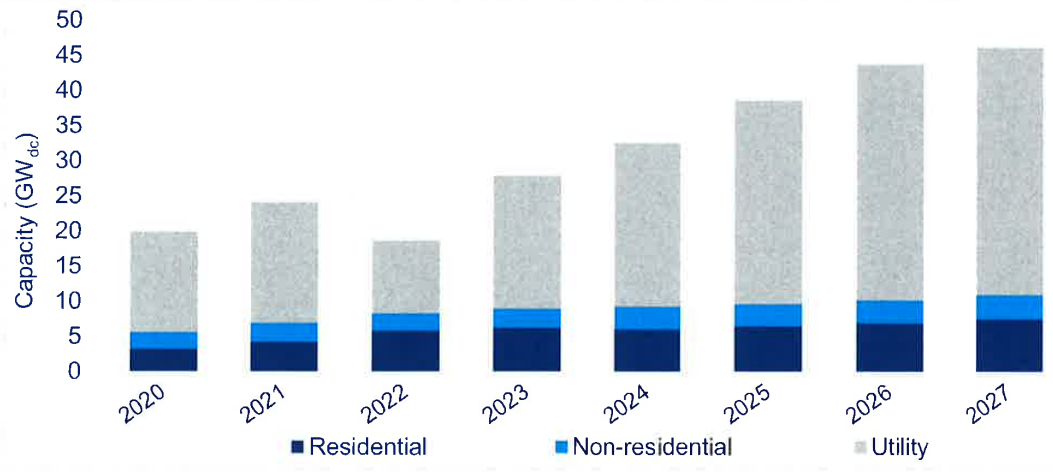
Average annual growth of 21% expected after 2022

After 2022, we expect the solar industry to return to growth. In 2023, some projects that were delayed this year should obtain module supply and come online. And by 2024, the real impacts of the IRA will begin to come to fruition. From 2023-2027, Wood Mackenzie forecasts 21% average annual growth across all solar segments.

It is worth noting that on December 2nd, the Department of Commerce (DOC) issued an affirmative preliminary determination on the anticircumvention case that was initiated earlier this year. This means that by early June 2024, new antidumping and countervailing duties (AD/CVD) could be applied to solar cells and module imports from certain companies with facilities in the four named Southeast Asian countries. The tariff rates will vary between producers.

In this report, our outlook does not include additional AD/CVD tariffs stemming from this case. New tariffs present downside risk to our forecasts, but it's too early to tell the extent of the impacts. We will be incorporating the impacts into future outlooks upon further investigation.

US solar PV installations and forecasts by segment, 2020-2027



Source: Wood Mackenzie

State solar PV installation rankings, Q1-Q3 2022

State	Rank			Installations (MW_{dc})		
	2020	2021	Q1-Q3 2022	2020	2021	Q1-Q3 2022
California	1	2	1	3,917	3,648	3,187
Texas	2	1	2	3,426	6,063	2,325
Florida	3	3	3	2,826	1,668	1,578
New York	8	9	4			
Nevada	15	10	5			
Illinois	13	7	6			
Arizona	9	13	7			
New Jersey	12	17	8			
Georgia	7	5	9			
Wisconsin	19	15	10			
North Carolina	5	8	11			
Tennessee	49	44	12			
Iowa	22	25	13			
New Mexico	16	31	14			
Michigan	27	14	15			
South Carolina	6	26	16			
Utah	11	16	17			
Maine	29	20	18			
Oregon	20	21	19			
Massachusetts	10	11	20			
Virginia	4	4	21			
Colorado	14	12	22			
Mississippi	31	50	23			
Pennsylvania	17	28	24			
Puerto Rico	34	29	25			
Maryland	26	27	26			
Hawaii	28	33	27			

Underlying data available in the full report

Source: Wood Mackenzie

State solar PV installation rankings, Q1-Q3 2022

State	Rank			Installations (MW_{dc})		
	2020	2021	Q1-Q3 2022	2020	2021	Q1-Q3 2022
Ohio	18	18	28			
Connecticut	24	22	29			
Missouri	33	32	30			
Washington	36	35	31			
Indiana	32	6	32			
Rhode Island	25	24	33			
Minnesota	21	30	34			
Arkansas	23	23	35			
Idaho	41	36	36			
New Hampshire	39	37	37			
Washington DC	35	34	38			
Vermont	42	39	39			
Oklahoma	40	42	40			
Louisiana	30	41	41			
Kansas	37	40	42			
Kentucky	46	43	43			
Delaware	44	38	44			
Montana	45	47	45			
Nebraska	43	45	46			
West Virginia	48	46	47			
Wyoming	38	48	48			
Alaska	47	49	49			
South Dakota	50	52	50			
North Dakota	52	51	51			
Alabama	51	19	52			

Underlying data available in the full report

Source: Wood Mackenzie

3. Market segment outlooks

3.1. Residential PV

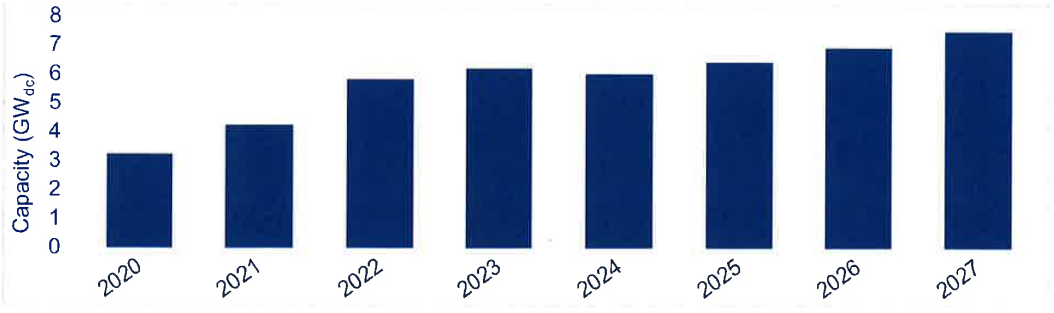
- 1,568 MW_{dc} installed in Q3 2022
- Up 43% from Q3 2021
- Up 16% from Q2 2022

More than 1,500 MW_{dc} were installed in the residential solar market in one quarter for the first time in Q3 2022. Nineteen states set quarterly records in Q3, with California (571 MW_{dc}), Florida (150 MW_{dc}), and Texas (130 MW_{dc}) again installing the most capacity. California alone surpassed 500 MW_{dc} for the first time. Although some installers continue to face challenges (supply constraints, interest rate increases, permitting and utility interconnection delays), recent retail rate inflation is a significant driver of growth.

Many installers indicate that module supply normalized in Q3 and they were able to secure modules for Q4 installations. However, as a result of supply chain issues from early 2022, coupled with strong demand, installers are still working through lingering customer backlogs. Permitting and utility interconnection delays in certain markets exacerbated these backlogs, with reports of some inspection times exceeding six months.

As a result of these trends, we have increased our residential outlook for 2022 to 37% year-over-year growth. We expect high retail rates and California demand pull-in to result in record installations as installers make progress on their backlogs. The release of the Revised PD in California fundamentally changes the shape of our long-term residential solar outlook. With implementation expected in April of next year, we expect high levels of installations through Q3 2023 as customers who submit an interconnection application before the deadline will qualify under NEM 2.0. 2024 will be the first full year of impacts from the new NEM 3.0 policy, contracting the California market by 39% and causing a 3% contraction in the national market. The residential solar industry also awaits guidance on implementation of the ITC adders, which may shake up the product landscape and provide a boost to third-party owned (TPO) projects.

Residential solar installations and forecast, 2020-2027



Source: Wood Mackenzie

3.2. Commercial PV

- 340 MW_{dc} installed in Q3 2022
- Up 3% from Q3 2021, down 10% from Q2 2022

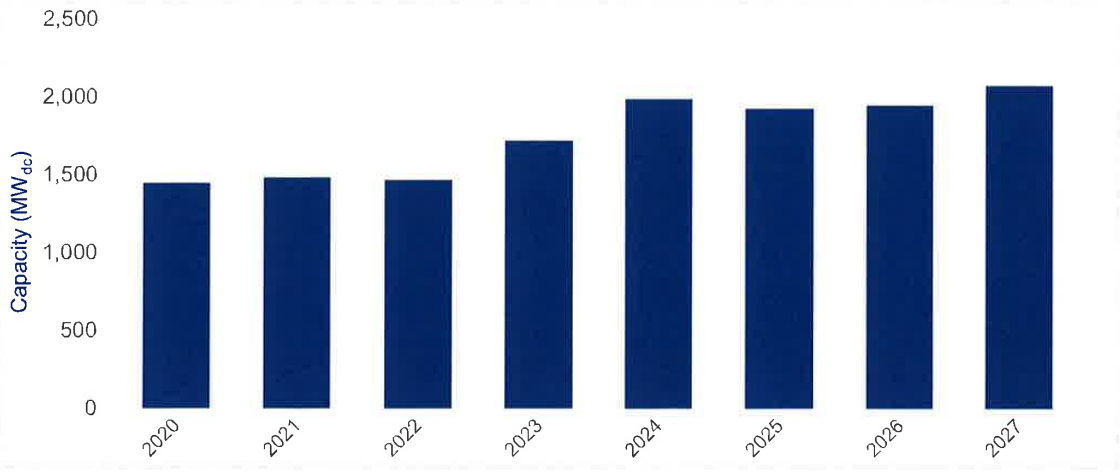
Note on market segmentation: Commercial solar encompasses distributed solar projects with commercial, industrial, agricultural, school, government or nonprofit offtakers, including remotely net-metered projects. This excludes community solar (covered in the following section).

Commercial solar volumes fell quarter-over-quarter as project delays from earlier in the year manifested. However, installation volumes did not contract as much as originally anticipated. Surprisingly, installations through the third quarter roughly match those of 2021. While there are some state-specific dynamics that partially explain this, it is still clear that 2022 volumes have been suppressed due to the supply chain constraints of the last year. Overall, we expect 2022 to be flat compared to 2021.

Next year will be a better year for the sector, with 17% growth expected. However, this represents a lower growth forecast than we were expecting last quarter, due to both the increase in projects expected to come online before the end of 2022, as well as reductions to a few states, including New Jersey and New York.

As mentioned in the Introduction, our forecasts do not incorporate any impacts from the ITC or PTC adders. Thus far, the low-income and energy communities adders are the most appealing to the commercial solar industry. The adders provide upside to our outlook, with commercial solar growing at an average annual rate of 7% through 2027. While there are still many challenges to commercial solar project execution, the IRA tailwinds should help sustain modest growth.

Commercial solar installations and forecast, 2020-2027



Source: Wood Mackenzie

3.3. Community solar PV

- 212 MW_{dc} installed in Q3 2022
- Down 17% from Q3 2021, down 17% from Q2 2022

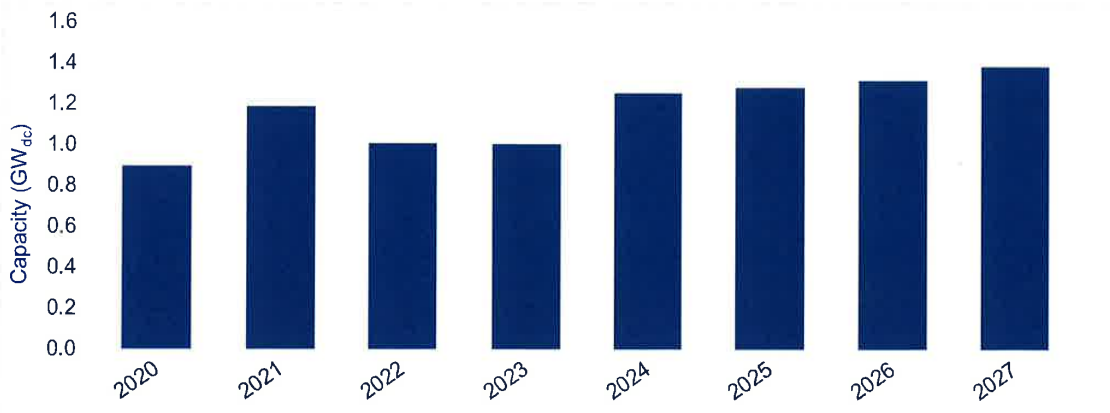
Note on market segmentation: Community solar projects are part of formal programs where multiple customers can subscribe to the power produced by a local solar project and receive credits on their utility bills.

Community solar installations declined in Q3 2022 for the second consecutive quarter. Low installation volumes in three key states—Maine, Massachusetts, and Maryland—contributed to most of the national decline. Interconnection backlogs and siting constraints continue to be the major obstacles hindering growth in these states. Additionally, the last several quarters of nation-wide supply chain constraints are extending project timelines into 2023 and beyond, limiting near-term installations.

Despite these challenges, our expectations for community solar in 2022 have increased by 8% compared to our previous outlook. This increase is driven primarily by significant growth in New York. The project pipeline in the state continues to come online at a very healthy pace, leading us to increase the forecast for 2022 by 21% compared to the previous outlook. Third quarter installation volumes in New York accounted for more than 60% of the national market.

Beginning this quarter, we have added a community solar forecast for California due to the passage of legislation requiring a state-wide community solar program. Although policy makers have not finalized many details of the program, we estimate it will result in an additional 570 MW_{dc} between 2024 and 2027. We attribute growth in our national five-year forecast to favorable conditions resulting from the IRA, as well as state policy initiatives in both mature and emerging community solar markets.

Community solar installations and forecast, 2020-2027



Source: Wood Mackenzie

3.4. Utility PV

- 2,460 MW_{dc} installed in Q3 2022
- 150 GW_{dc} of utility-scale solar will be added between 2022 and 2027

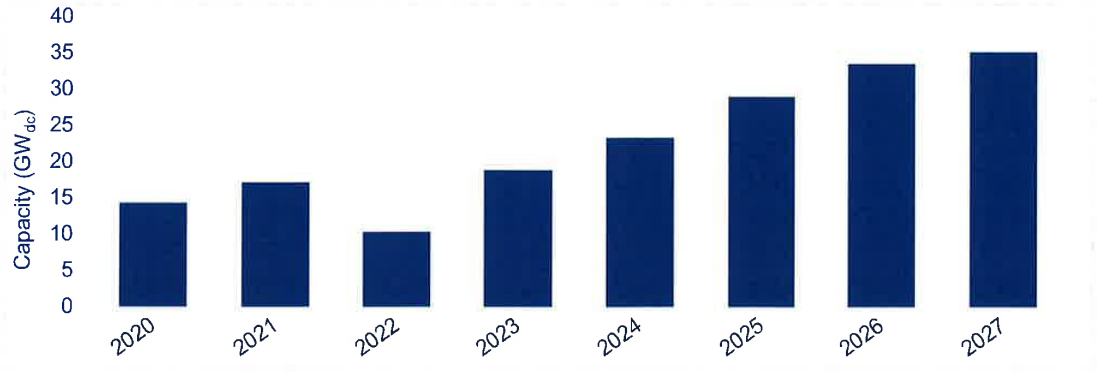
Supply chain issues continued to constrain utility-scale deployments in Q3 2022. 2.5 GW_{dc} were installed during the third quarter, bringing the 2022 total to 7.4 GW_{dc} – barely two-thirds of the volume installed at this time last year. Another 4.5 GW_{dc} of newly contracted capacity was signed this quarter, the majority of which will come online between 2024-2025. This brings the total pipeline to 90 GW_{dc}, a slight increase compared to last quarter. There are currently 30 GW_{dc} of projects under construction, though module shipment delays are stalling progress.

Industry players are cautiously optimistic as they begin to navigate newly available tax credit adders and financing options included in the IRA. Due to uncertainty around specific adder requirements, Wood Mackenzie assumes that utility-scale projects will earn the 30% ITC or the $26/MWh PTC, with most opting for the latter. The IRA's impacts are not expected to fully materialize until 2024-2025, while the near-term pipeline remains vulnerable to delays and cancellations.

As mentioned in the Introduction, UFLPA enforcement has caused widespread module detentions as the industry has scrambled to develop quartzite sourcing documentation. Because polysilicon sourced outside of China comprises a small share of the current market, the inability to demonstrate traceability of the quartzite will continue to threaten US module supply.

Wood Mackenzie anticipates another 2.8 GW_{dc} of utility-scale solar will come online this year, increasing the 2022 outlook to 10.3 GW_{dc}. After this year, IRA-driven demand and supply normalization will boost the utility-scale sector to 150 GW_{dc} of installations through the forecast period.

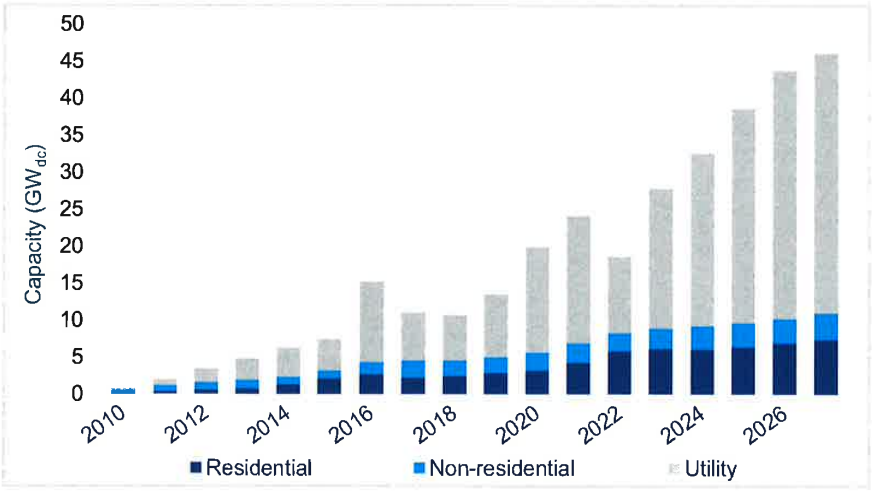
Utility solar installations and forecast, 2020-2027



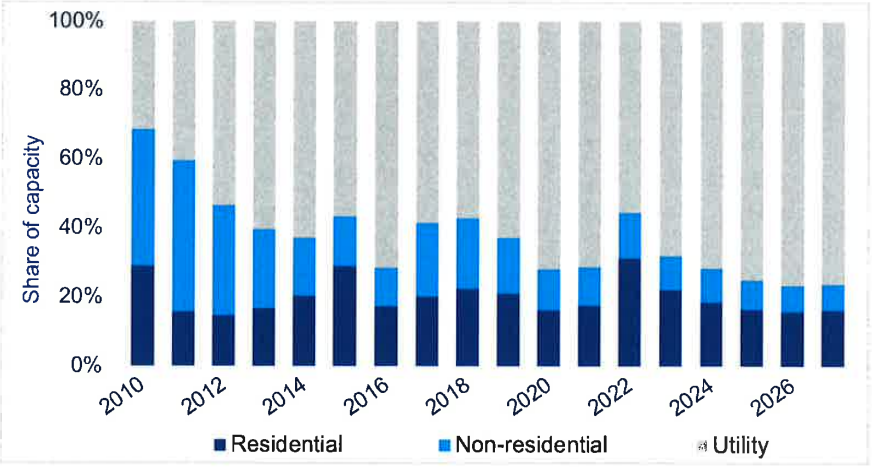
Source: Wood Mackenzie

4. US solar PV forecasts

US PV installation historical data and forecast, 2010-2027



US PV share of capacity (historical and forecast), 2010-2027



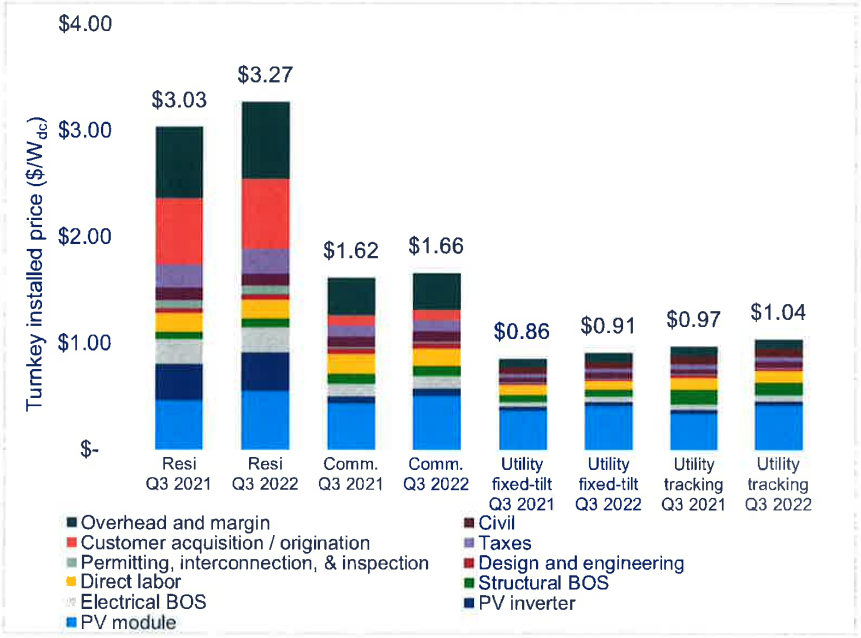
Source: Wood Mackenzie; Note that non-residential solar is broken out into commercial solar and community solar in the full data accompanying the US Solar Market Insight report.

5. National solar PV system pricing

Note: Wood Mackenzie has updated the reporting methodology for modeled prices to be consistent with US solar system pricing reports. Therefore, figures shown below may not match those published in earlier editions of the US Solar Market Insight report.

Wood Mackenzie employs a bottom-up modeling methodology to capture, track and report national average PV system pricing by segment for systems installed each quarter. The methodology is based on the tracked wholesale pricing of major solar components and data collected from industry interviews. Wood Mackenzie assumes all product is procured and delivered in the same year as the installation except modules for the utility segment, which are procured one year prior to commercial operation.

Modeled US national average system prices by market segment, Q3 2021 and Q3 2022



Source: Wood Mackenzie

System pricing increased by 8% for residential solar and by 3% for commercial solar compared to Q3 2021, as the impacts of the anticircumvention case and UFLPA continue to create a high pricing environment for modules. Pricing for utility-scale systems was also up by 6% for fixed-tilt and 7% for tracker systems compared to last year. Module pricing continues to climb on the heels of rising polysilicon prices. Equipment pricing and labor costs are also high, due to rising inflation, keeping system prices high across all segments.

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