



**CLEAN POWER ANNUAL MARKET REPORT 2023**



# Building The Clean Energy Economy

ACP sincerely thanks its member companies and other organizations for their contributions to the industry data provided in this report. ACP strives to provide the best information on the clean power industry—for the industry and by the industry—and therefore welcomes your comments.

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## We united the power of the the clean energy industry

The American Clean Power Association (ACP) is the leading voice of today's multi-tech clean energy industry, representing over 800 energy storage, wind, utility-scale solar, clean hydrogen, and transmission companies. ACP is committed to meeting America's national security, economic and climate goals with fast-growing, low-cost, and reliable domestic power.



# Clean Power Definitions

**Advanced development:** Projects not under construction, but with a PPA, firm equipment order, or moving forward with plans to be placed under utility ownership as of the end of the most recent quarter. For offshore wind, advanced development consists of projects that have secured offtake or have had successful bids in response to a state solicitation even if final offtake negotiations have not concluded.

**BESS:** Battery Energy Storage Systems

**Capacity:** Project nameplate capacity. Unless otherwise stated, ACP reports capacity in MW-ac.

**Clean power:** For the purposes of this report, clean power includes land-based wind, offshore wind, utility-scale solar, and battery storage technology.

**Decommissioned:** Project is offline and is no longer delivering power to the grid on a permanent basis. Physical removal of equipment is not a requirement.

**Duration:** The amount of time, in hours, a battery can discharge its power capacity before depleting its energy capacity. For example, a 2 MW battery that has 4 MWh of energy capacity has a duration of 2 hours.

**Full repowering:** Full decommissioning of a utility-scale project. The original equipment is physically removed from the project site and replaced with new utility-scale equipment.

**Inverter Loading Ratio (ILR):** The ratio of installed DC capacity to the inverter's AC power rating. Also known as the AC-to-DC ratio.

**Online:** Project has reached commercial operation and is delivering electricity to the ultimate point of delivery.

**Partial repowering, nacelle replacement:** Complete replacement of a utility-scale wind turbine's nacelle, rotor, and blades. The tower and foundation are retained.

**Partial repowering, major retrofit:** Complete replacement of a utility-scale wind turbine's rotor and blades, along with the replacement of at least one major component within the nacelle, typically the gearbox or the generator.

**Pipeline:** Projects either under construction or in advanced development.

**Repowered:** Full or partial equipment replacement. Currently only wind repowering activity is tracked, but ACP will expand repowering activity tracked as the market progresses.

**Under construction:** Construction team has begun work on the ground at the project site. For offshore wind, under construction is defined as in-ocean construction.



# Clean Power Acronyms

<b>AC</b>	Alternating Current	<b>NERC</b>	North American Electric Reliability Corporation
<b>BESS</b>	Battery Energy Storage Systems	<b>NO<sub>x</sub></b>	Nitrogen Oxides
<b>C&amp;I</b>	Commercial & Industrial	<b>NPCC</b>	Northeast Power Coordinating Council
<b>CAISO</b>	California ISO	<b>NYISO</b>	New York ISO
<b>CES</b>	Clean Energy Standard	<b>OEM</b>	Original Equipment Manufacturer
<b>CO<sub>2</sub></b>	Carbon Dioxide	<b>OREC</b>	Offshore Renewable Energy Credit
<b>DC</b>	Direct Current	<b>PM2.5</b>	Particulate Matter
<b>EPA</b>	Environmental Protection Agency	<b>PPA</b>	Power Purchase Agreement
<b>ERCOT</b>	Electric Reliability Council of Texas	<b>REC</b>	Renewable Energy Credit
<b>FERC</b>	Federal Energy Regulatory Commission	<b>RFC</b>	Reliability First Corporation
<b>FRCC</b>	Florida Reliability Coordinating Council	<b>RPS</b>	Renewable Portfolio Standard
<b>GHI</b>	Global Horizontal Irradiance	<b>RTO</b>	Regional Transmission Organization
<b>GW</b>	Gigawatts	<b>SREC</b>	Solar Renewable Energy Credit
<b>GWh</b>	Gigawatt hours	<b>SERC</b>	Southeast Reliability Corporation
<b>ILR</b>	Inverter Loading Ratio	<b>SO<sub>2</sub></b>	Sulfur Dioxide
<b>IOU</b>	Investor-Owned Utility	<b>SPP</b>	Southwestern Power Pool
<b>ISO</b>	Independent System Operator	<b>TRE</b>	Texas Reliability Entity
<b>ISO-NE</b>	ISO New England	<b>TW</b>	Terrawatts
<b>LCOE</b>	Levelized Cost of Energy	<b>TWh</b>	Terrawatt Hours
<b>MISO</b>	Midcontinent ISO	<b>WECC</b>	Western Electricity Coordinating Council
<b>MRO</b>	Midwest Reliability Organization	<b>WRO</b>	Withhold Release Order
<b>MW</b>	Megawatts		
<b>MWh</b>	Megawatt hours		

# INTRODUCTION



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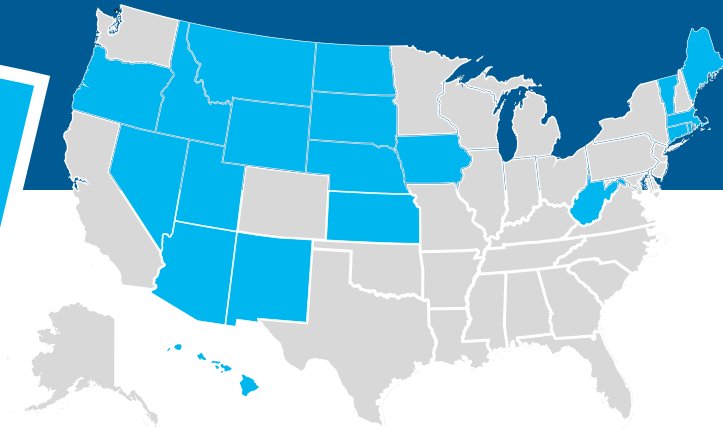


# The industry set a record year with **34 GW** coming online, bringing the clean power fleet to **262 GW**.

Since the passage of the IRA,

**\$421 billion** of capital investment announcements for clean energy projects, manufacturing facilities, and supply chain.

**117** new or expanded utility-scale clean energy manufacturing facilities have been announced, bringing an expected **42,000+** new American jobs.



**Wind, solar, and batteries** were the top choice of utility-scale power generation in 2023, representing **77%** of new power additions.



**Clean power is red, white, and blue** with projects or manufacturing facilities in **93% of Congressional districts**. Projects can be found in all 50 states.



Solar shines with nearly **20 GW of new addition** while **storage surges with operating capacity growing 86%** in 2023 as 8 GW are plugged in. Both technologies set annual addition records.



Across the United States, there are over **500 manufacturing facilities** dedicated to producing components and parts for wind, solar, and storage projects in the clean power industry.



The U.S. has enough installed utility-scale wind and solar capacity to power **69 million homes** and enough battery storage to power **5 million homes** during peak demand.



**34 GW** of clean power was installed in 2023, enough to power **540 billion LED lightbulbs**.



Wind, solar, and energy storage **employ 443,000 Americans with good paying jobs** across the country with more on the way.



**New York signed deals for over 4 GW of offshore wind** across three projects in 2023; first ever Gulf of Mexico offshore wind lease awarded.

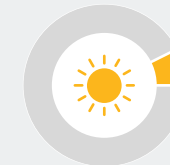


In 2023, wind and solar projects produced the **same amount of electricity** used in the following states combined: VT, RI, HI, ME, SD, WY, ND, ID, NM, CT, NE, UT, WV, NV, KS, MA, IA, OR, AZ

Wind was the **largest source of electricity** in four states in 2023:



**Wind energy** delivers more than **20%** of the electricity produced in 12 states: IA, SD, KS, OK, NM, ND, NE, CO, MN, TX, WY, ME



**Solar energy** delivers more than **10%** of electricity in nine states and DC: DC, CA, NV, MA, VT, HI, UT, RI, AZ, ME



# 2023 CLEAN POWER ACTIVITY



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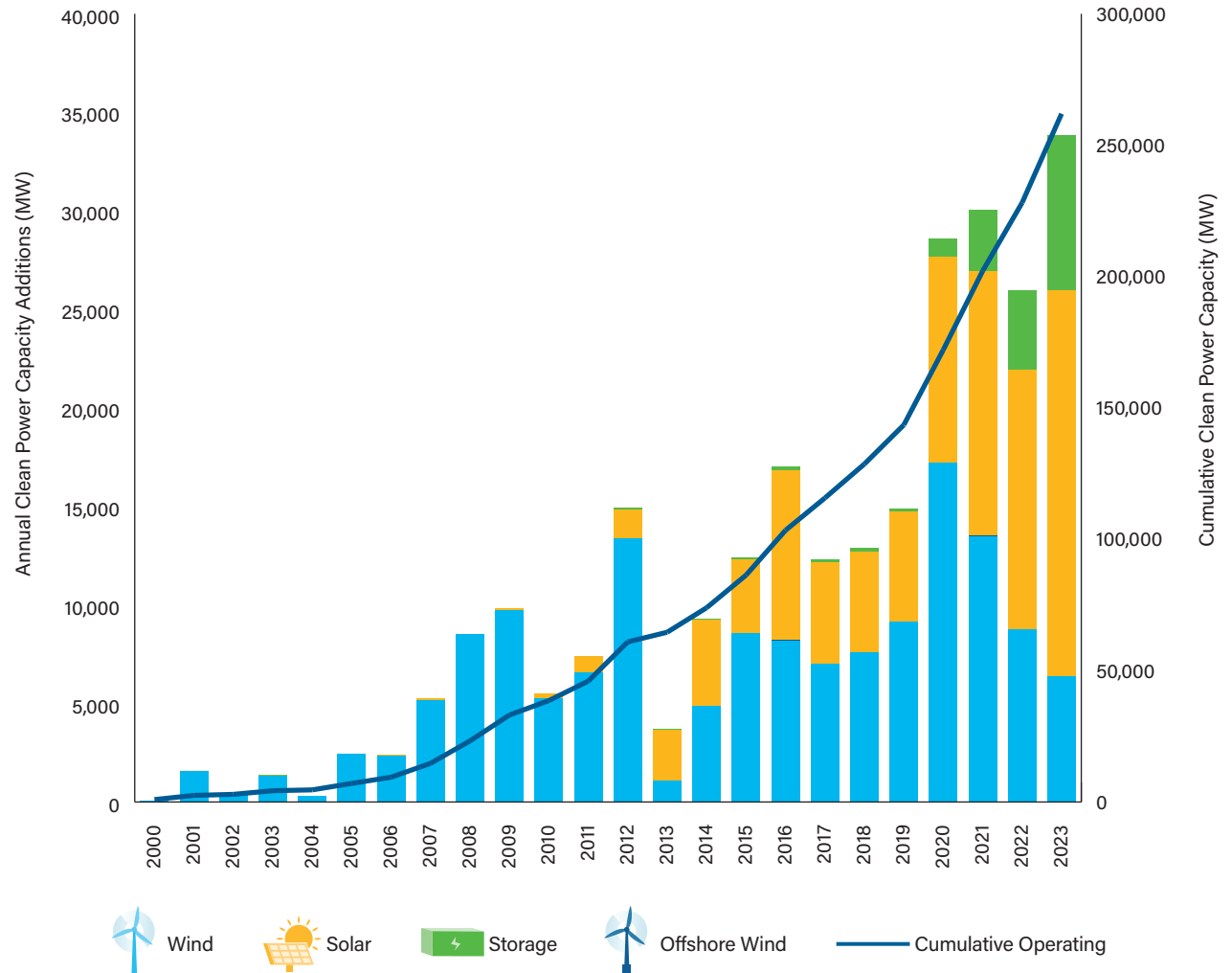
# 2023 Clean Power Activity

## Annual and Cumulative Clean Power Capacity

More than 33.8 GW of clean power installed in 2023, a record high

- In 2023, clean power developers in the U.S. commissioned 33,844 MW of new clean power capacity, setting a record for the most growth in operating clean power in a single year.
- The amount of clean power newly installed in 2023 surpassed 2022 by 7.9 GW, or 30%, and outpaced the previous annual record set in 2021 by 3.8 GW, or 13%.
- Storage and solar both saw a record year for installations, with solar accounting for 58% of all new capacity additions and storage 23%.
- Falling costs for modules and panels amid global oversupply conditions helped power the surge in solar capacity installations in 2023. Prices for battery storage units also sharply declined globally in 2023, with lower prices observed for key inputs lithium, nickel, and cobalt.
- The pace of new onshore wind capacity coming online slowed in 2023, down nearly 2.4 GW from its 2022 level, amid lengthy permitting processes, crowded interconnection queues, and a need for additional transmission out of wind-rich areas. Onshore wind made up just 19% of new clean power capacity in 2023.
- In total, 261,949 MW of clean power is in operation, which provide enough electricity to power 69 million American homes.

### U.S. Annual and Cumulative Utility-Scale Clean Power Capacity Growth

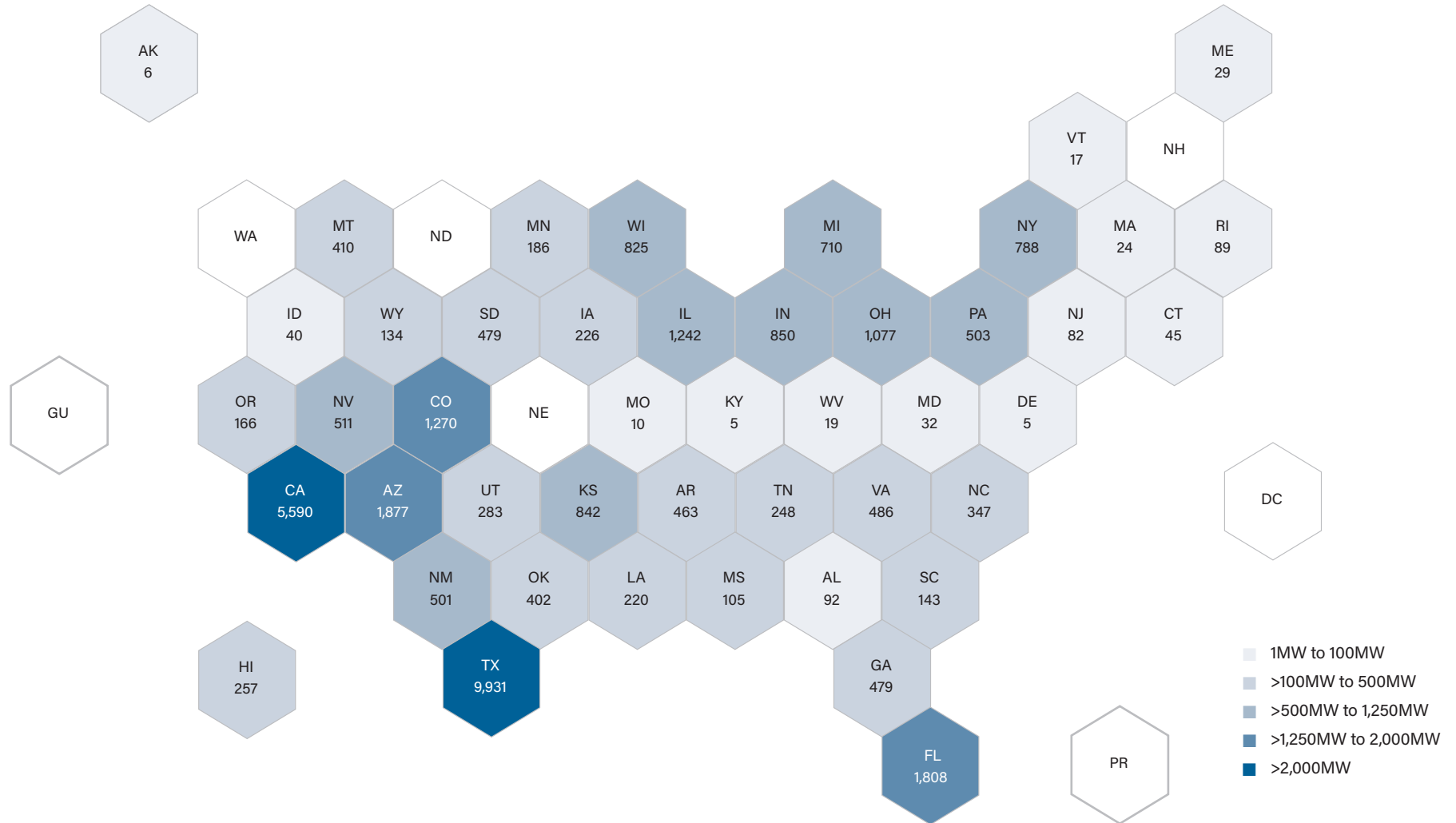


## 2023 Clean Power Activity

# Clean Power Capacity Installations in 2023 by State

Industry built 33.8 GW of new clean power projects across 46 states in 2023

## Clean Power Projects Installed in 2023



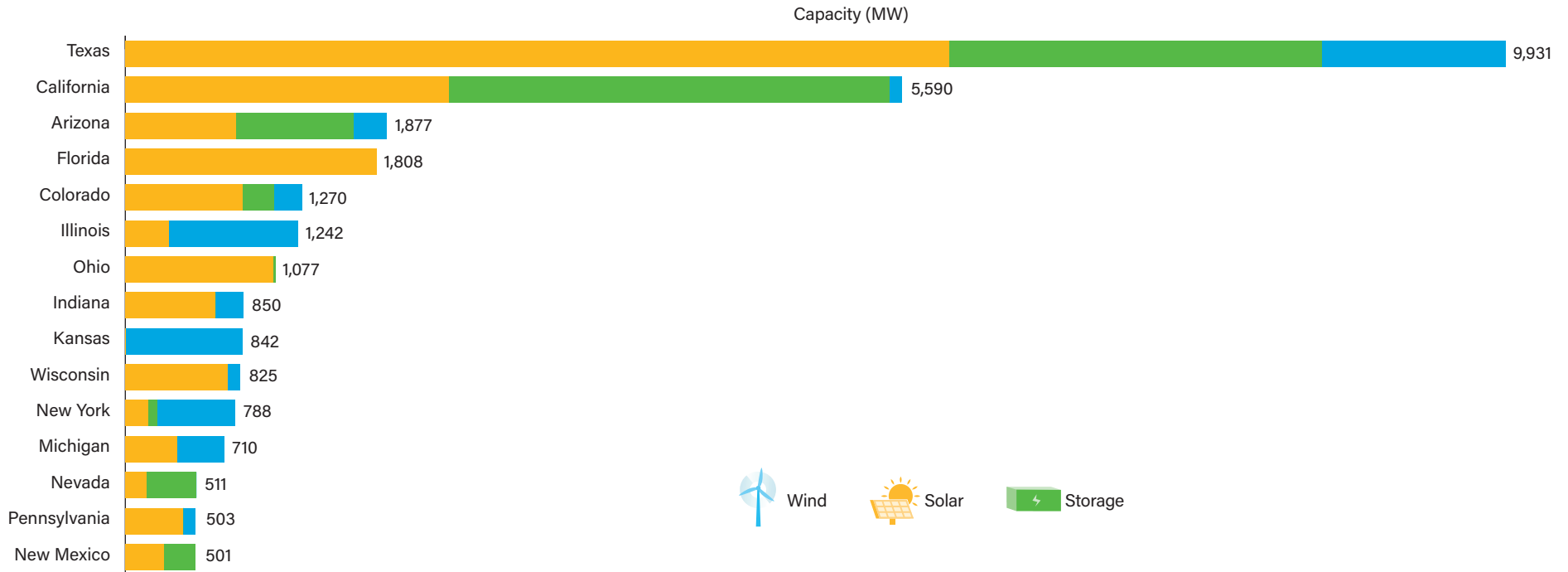


# 2023 Clean Power Activity

## Clean Power Additions, Top States

Texas maintains clean power leadership position

### Top States for Clean Power Additions in 2023



- Texas has led the nation in annual clean power installations since 2017. In 2023, Texas installed nearly twice as much capacity as any other state.
- 2023 marked a major shift towards solar and storage for Texas, after installing mostly wind in 2022.
- The top two states, Texas and California, brought online more new clean power in 2023 than the next 19 states combined.
- Some states focused on one technology, with Florida in the number four spot bringing on just solar projects, Kansas focused on wind, and Ohio's portfolio was dominated by solar.
- By technology, Texas led for solar and wind installations while California came in first for energy storage installations.

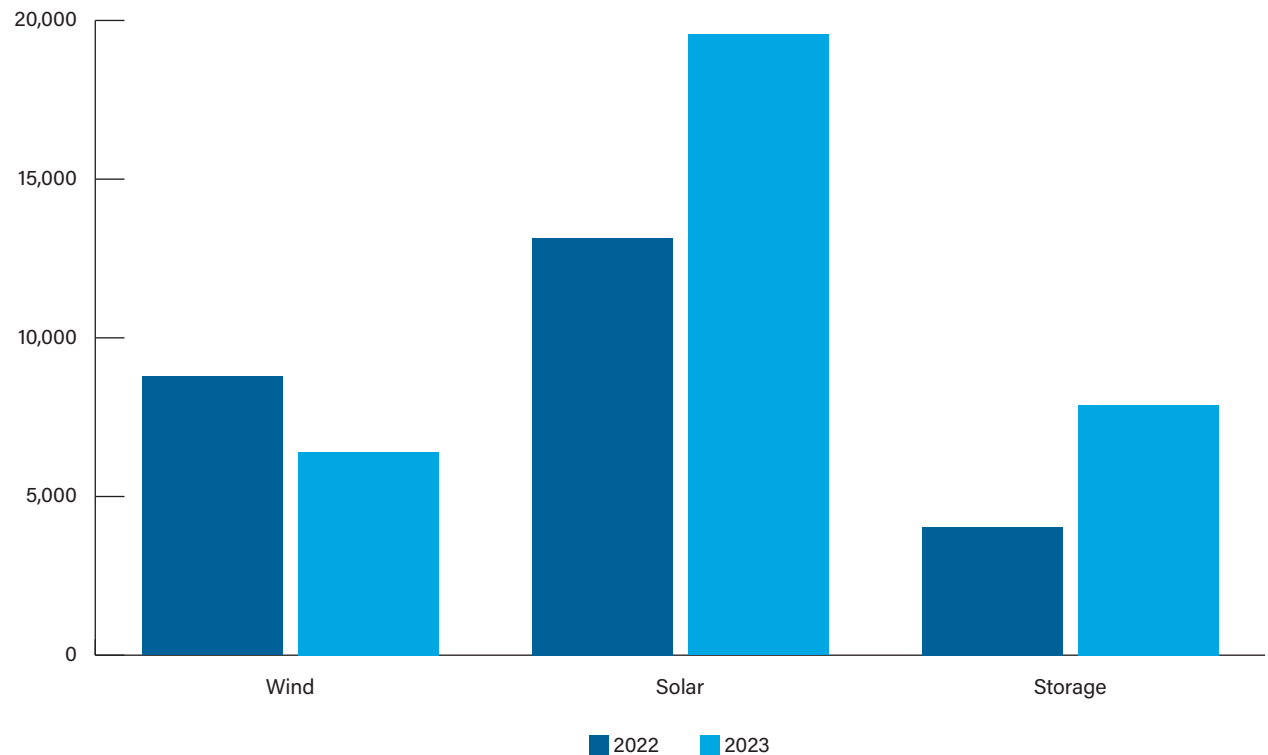
## 2023 Clean Power Activity

# Clean Power Capacity Installations by Technology, 2022 vs. 2023

### Nearly 50% more solar capacity came online in 2023 than in 2022

- The U.S. clean power industry brought 19,561 MW of new **solar** capacity online in 2023 – up 6.4 GW, or 49%, from 2022.
- Developers commissioned 7,881 MW of **energy storage** projects in 2023, nearly double the 4 GW brought online in 2022.
- The amount of **wind** generation brought online in 2023 came in 27% lower than in 2022, at 6,402 MW in the most recent year compared with 8,774 MW in 2022.
- Developers installed more new wind and solar capacity in the fourth quarter than the previous three quarters combined. Energy storage installations were more evenly distributed throughout the year; however, the fourth quarter did see the largest increase.
- Two new storage projects with a capacity of more than 300 MW came online in 2023, both in California: Moss Landing III and Desert Peak. The largest solar projects to come online in 2023 were both 500 MW and located in Texas: Ramsey Solar and Roseland Solar. NextEra Energy's 600 MW High Banks Wind Project in Kansas was the single biggest newbuild wind project to be commissioned.

### Capacity additions by technology, 2022 vs 2023



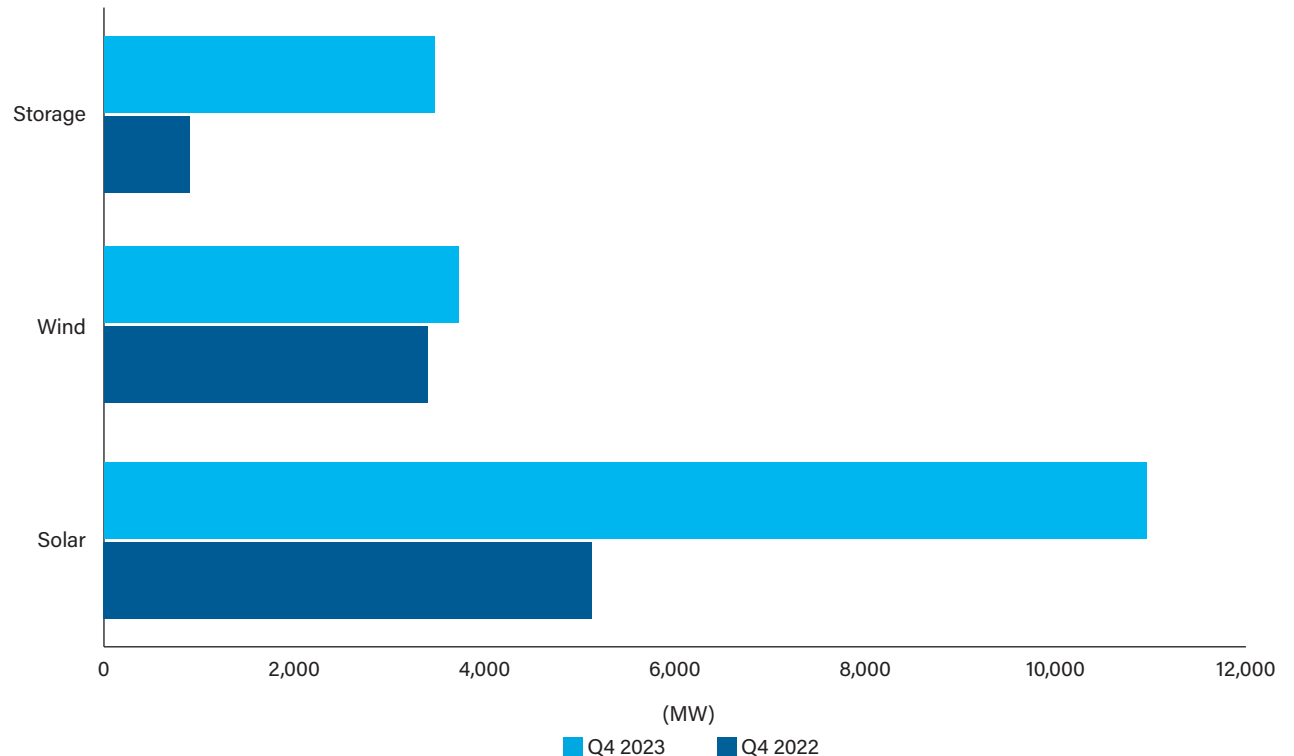
## 2023 Clean Power Activity

# Q4 2023 Clean Power Installations

### Q4 2023 was a record quarter for clean power capacity additions

- The U.S. clean power industry brought 18,155 MW of new capacity online in the fourth quarter of 2023 – the largest single quarter for new clean power on record.
- At 10,953 MW, solar provided more than 60% of the new clean power capacity that was commissioned in the fourth quarter.
- 5.9 GW, or 54%, of Q4's new solar came online in Texas. Most of those new projects were larger than 200 MW, with six projects coming in at 300 MW or more.
- Developers brought online 3,469 MW of new energy storage projects in Q4 2023, more than three times the amount that came online in Q4 2022.
- Five of the ten largest Q4 storage projects are located in Texas and three of the quarter's top ten are in California, furthering the two states' considerable lead over other parts of the country for the technology's deployment.
- With 3,733 MW of new onshore wind projects online in Q4 2023, slightly more capacity came online in that quarter than in the same quarter in 2022.
- Kansas was home to the quarter's largest new wind project for two quarters in a row: Q3's Sunflower Wind and Q4's High Banks Wind.

### Capacity additions by technology, Q4 2023 vs Q4 2022





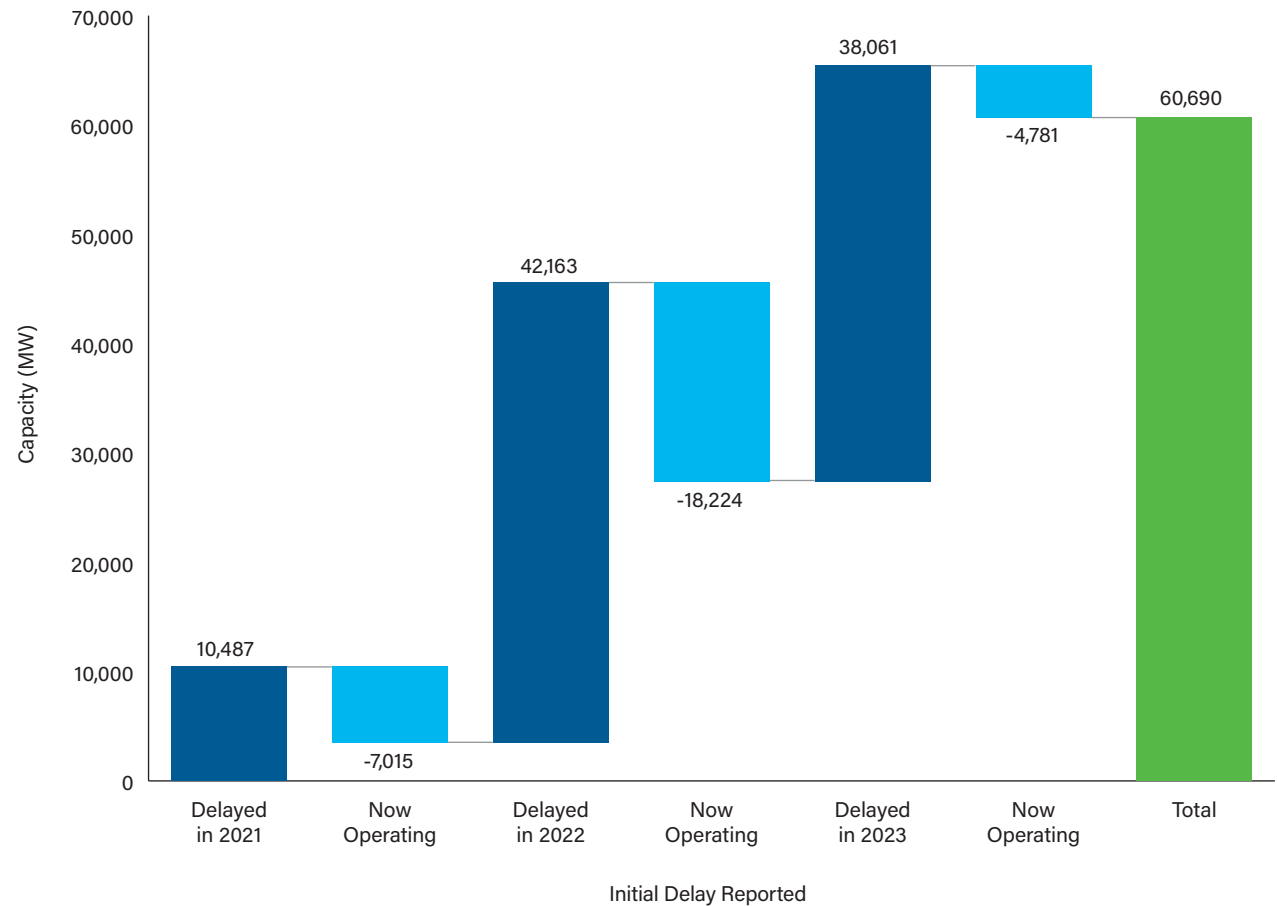
# 2023 Clean Power Activity

## Clean Power Delays

### More than 60 GW of clean power capacity experiencing delays

- Almost 11 GW of clean power capacity was delayed in 2021, with nearly two thirds of capacity having come online at the end of 2023. Developers reported a surge in delays in 2022, with more than 42 GW of projects experiencing delays. Of the delayed capacity, more than 18 GW have since begun commercial operations. 2023 was yet another year in which project delays posed a significant challenge for developers, with over 38 GW of projects unable to meet initial CODs. Throughout the year, around 4.8 GW of clean power capacity have become operational. Overall, there remains over 60 GW of clean power projects that have been delayed at the end of 2023.
- Utility-scale solar made up 70% of clean power capacity experiencing delays, owing to ongoing trade restrictions and supply chain issues.
- Onshore and offshore wind delays accounted for 18% of all delayed capacity. Permitting challenges, supply chain constraints, and grid interconnection delays have played a role.
- Battery storage projects continue to be the least affected, making up just 12% of delays. Most storage projects experiencing delays are co-located with solar projects.

### Clean Power Project Capacity Delayed

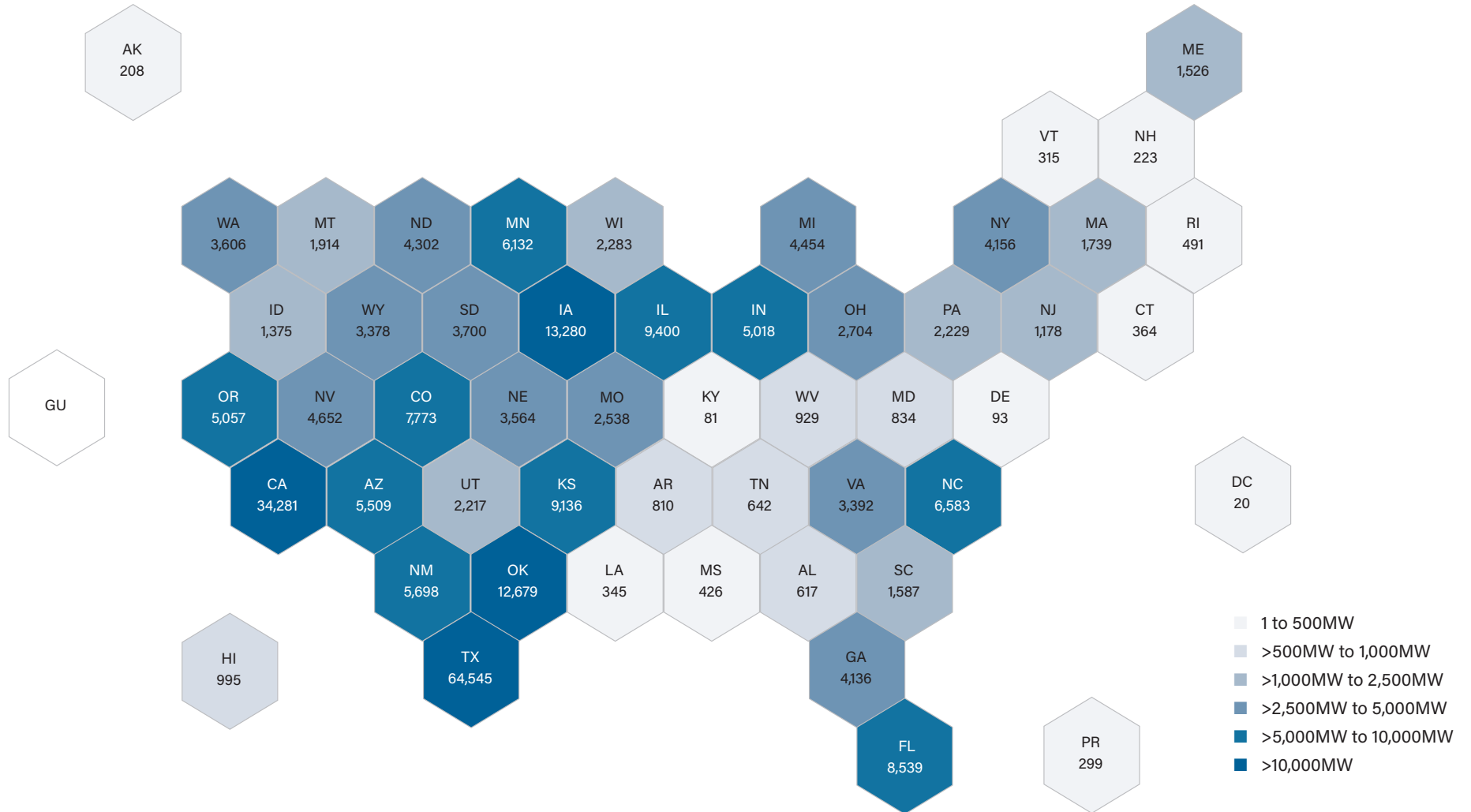


## 2023 Clean Power Activity

# Clean Power Capacity, by State

Clean power is present in all 50 states; 14 have 5 GW or more installed

## Operational Clean Power Capacity, by State



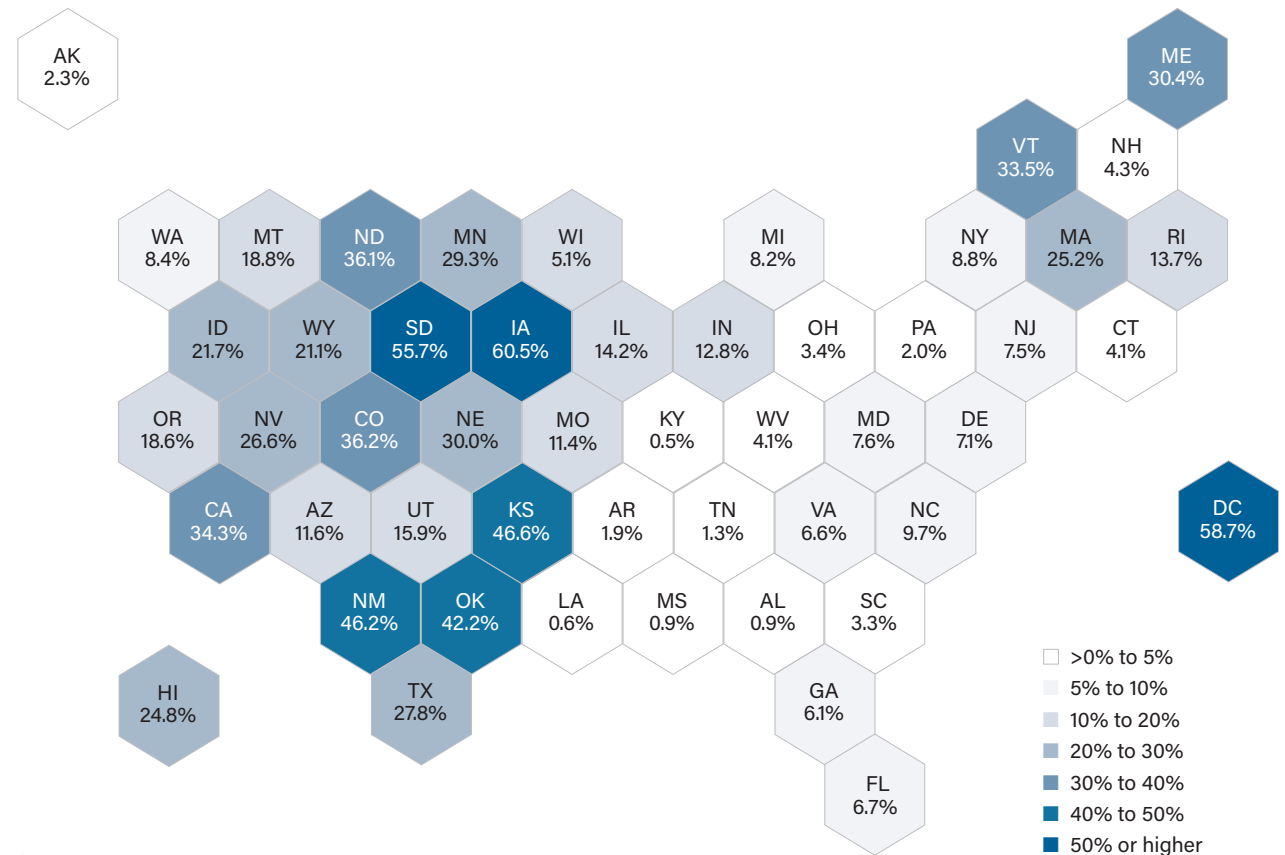
# 2023 Clean Power Activity

## Clean Power Share of Electricity Generation

### Wind and solar provided 16% of the nation's electricity in 2023

- Wind and solar are a major source of electricity for homes, businesses and industries across the country. In 2023, wind and solar generated 16% of the nation's electricity.
- Many states across the country generate an even larger share of their electricity from wind and solar. There are 22 states that generate 16% or more of their electricity from wind and solar and 27 states that generate at least 10% from these clean power resources.
- Iowa remains the leader in clean power share at 61%, South Dakota follows at 56% and Kansas claims third position with 47% of its power coming from clean energy. The District of Columbia, buoyed by large amounts of distributed solar and limited overall generation, generated 59% of electricity from clean power.
- New Mexico (46%) and Oklahoma (42%) join Iowa and Kansas as the only other states above 40%. In 2021, 36% of electricity generated in New Mexico was from wind and solar, marking a sizeable increase over the past two years.
- The pattern of top performers generally coincides with windy Midwestern states where there are significant amounts of wind capacity installed.
- Southeastern states dominate the bottom of the rankings. Wind and solar make up less than 1% of electricity generation in Mississippi, Alabama, Louisiana, and Kentucky.

### Wind + Solar Share of State Electricity Generation



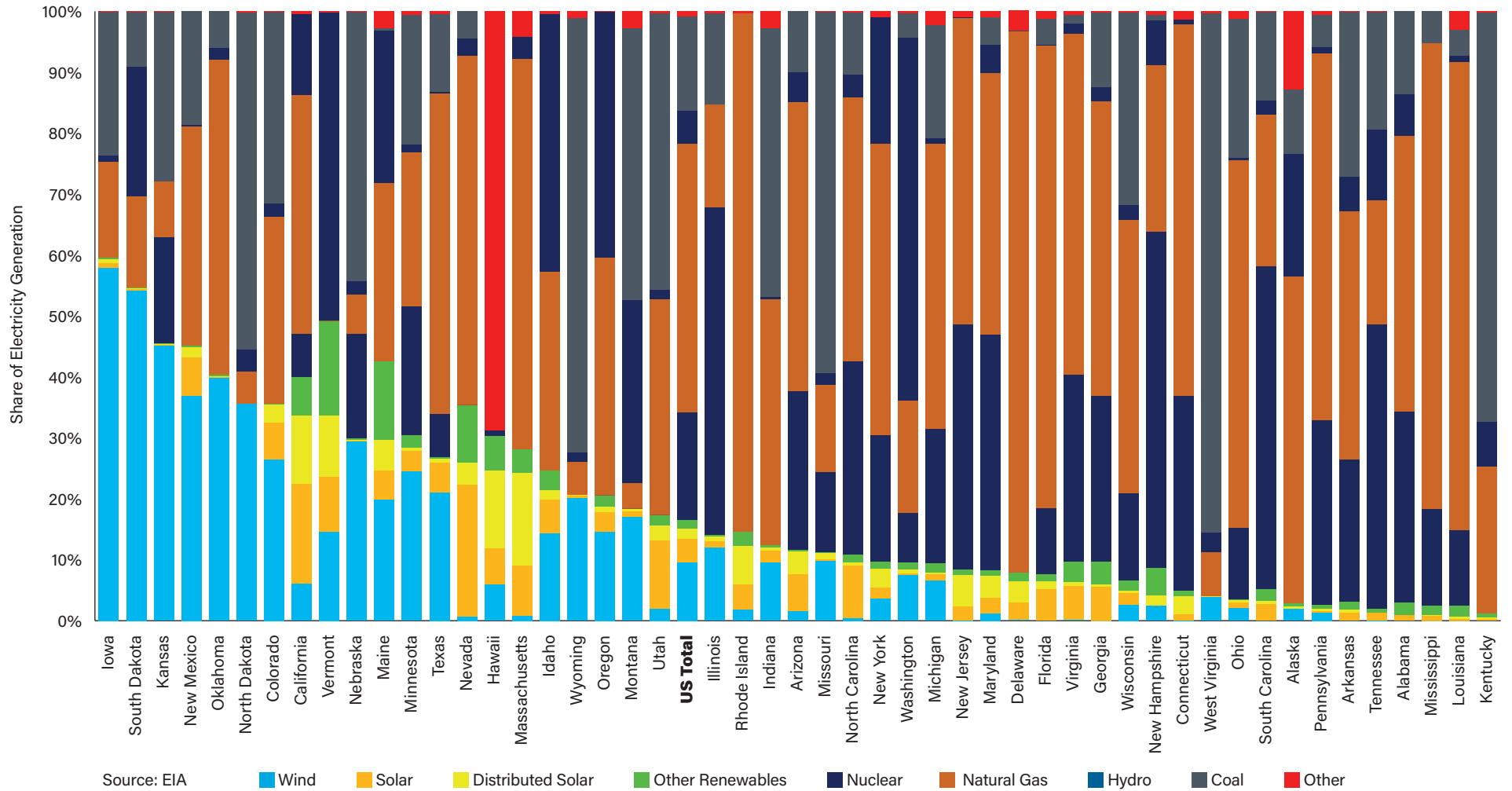
Source: EIA

# 2023 Clean Power Activity

## Electricity Generation Mix by State

Iowa leads all states by generating 61% of its electricity from wind and solar

### Electricity Generation Mix in 2023 by State



Source: EIA

Wind Solar Distributed Solar Other Renewables Nuclear Natural Gas Hydro Coal Other





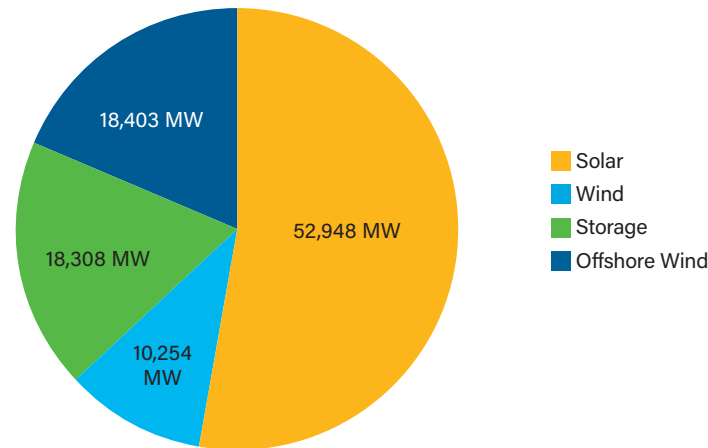
# 2023 Clean Power Activity

## Clean Power Pipeline

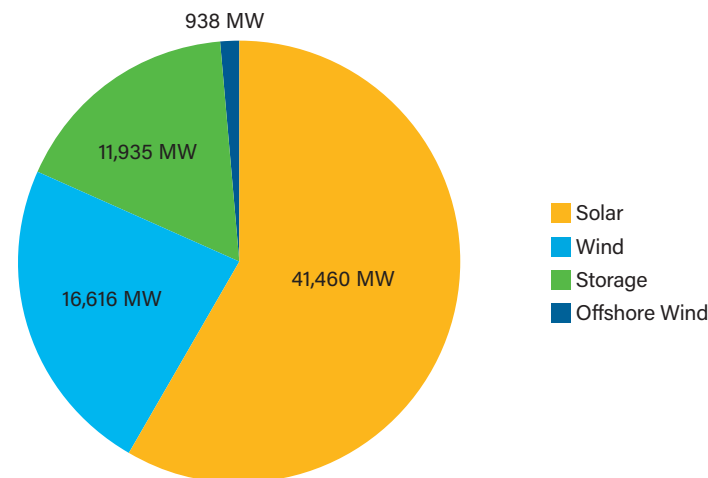
### Utility-scale Solar made up 55% of the clean power capacity in the development pipeline at the end of 2023

- At the end of 2023, the pipeline for utility-scale solar, land-based wind, battery storage, and offshore wind projects amounted to 170,862 MW.
- 70,950 MW of clean power projects were under construction while 99,913 MW of capacity was in advanced development.
- Utility-scale solar accounted for 55% of clean power capacity in the development pipeline, followed by battery storage at 18%, land-based wind at 16%, and offshore wind at 11%.
- The clean power pipeline experienced a 26% year-over-year growth from 135,221 MW at the end of 2022, when 92,958 MW of capacity was under construction and 42,263 MW of projects was in advanced development.
- Despite the overall expansion of the project pipeline, the different technologies did not grow at the same rate. Battery storage was a bright spot in 2023, as the pipeline capacity for battery storage projects grew by 13.5 GW, overtaking land-based wind as the technology with the second highest pipeline capacity.
- For comparison, utility-scale solar saw an increase of 14.2 GW, while the pipeline capacities for land-based wind and offshore wind grew by 6 GW and 1.8 GW respectively.

### Pipeline Capacity in Advanced Development



### Pipeline Capacity Under Construction



# U.S. ELECTRICITY SECTOR



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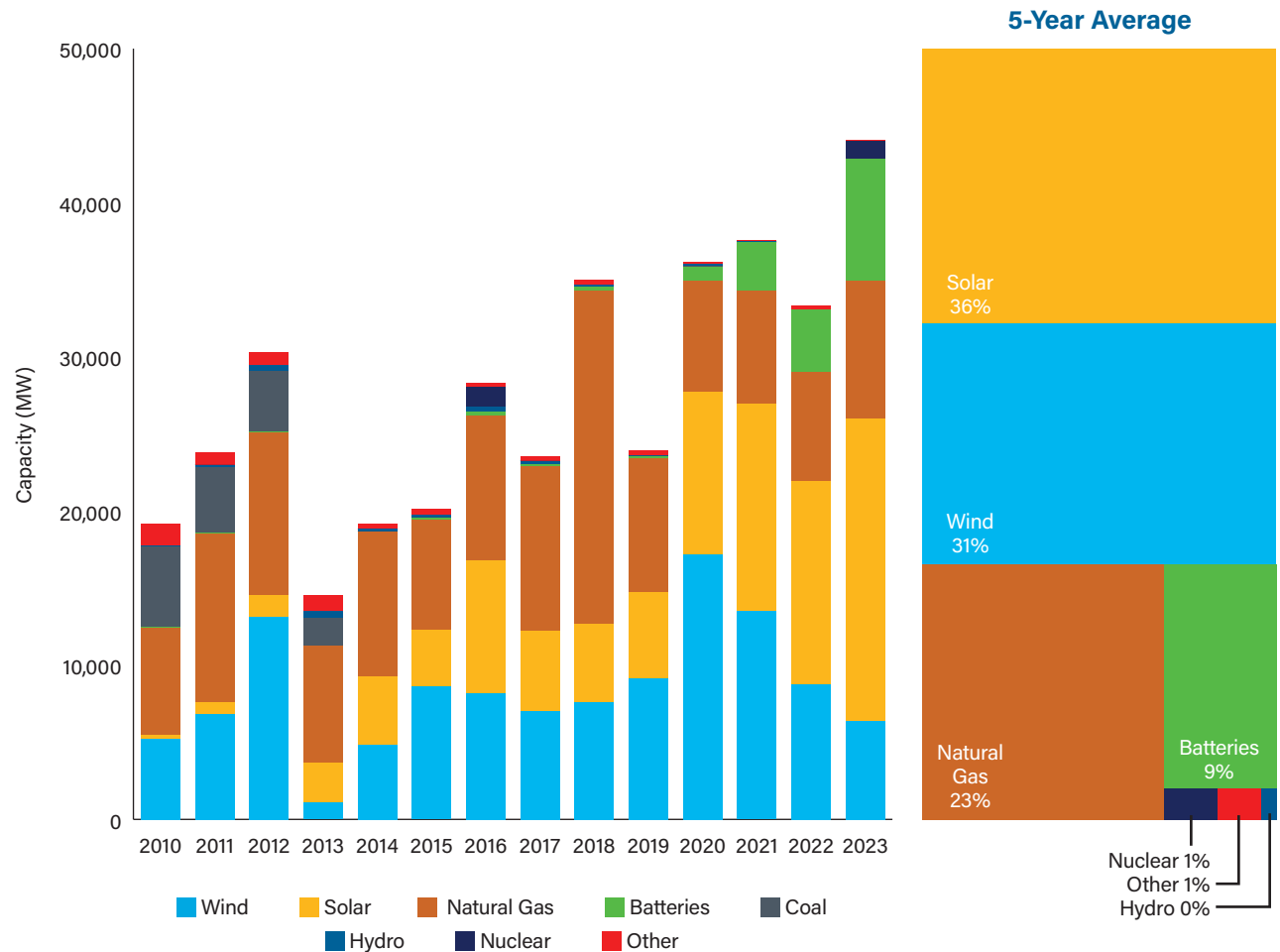


# U.S. Electricity Sector Annual Utility-Scale Power Capacity Additions

Grid adds most new capacity in 20 years; developers connect 44 GWs

- Project developers plugged in 44,087 MW of new power capacity to the electric grid in 2023. This is a 32% increase from the 33,289 MW added in 2022 and the most capacity installed in two decades. One must go all the way back to 2003 to find a year with more power capacity installed.
- Solar held a commanding lead over all technologies for the second year in a row. New utility-scale solar capacity totaled 19,561 MW, representing 44% of the market.
- Natural gas-fired capacity installations increased 27% compared to 2022, totalling 8,999 MW and representing 20% of utility-scaled deployments. Gas-fired capacity continues to be added to the grid in significant quantities, but natural gas additions haven't exceeded renewable additions since 2014.
- For the first time, battery energy storage system capacity installations exceeded land-based wind, finishing in third place for the year. Battery storage additions topped 7,881 MW or 18% of the market. Wind installations represent 15% of 2023 additions or 15% of the total.
- Overall, battery storage, solar, and wind represent 77% of 2023 utility-scale installations and 76% of the market over the past five years.

## Utility-Scale Power Capacity Additions



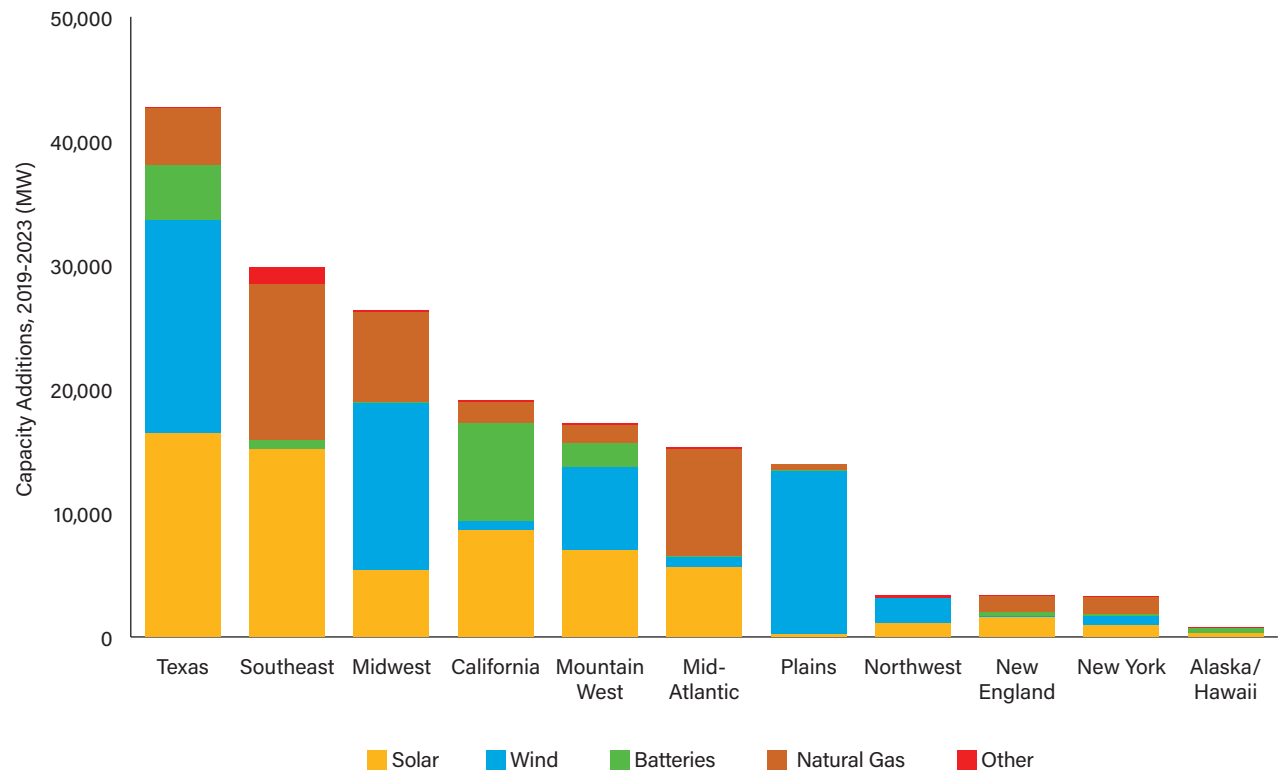
Source: ACP, EIA

# U.S. Electricity Sector Regional Capacity Additions, 2019-2023

All markets except the Mid-Atlantic added majority clean power capacity since 2019

- Utilities and power customers across the country increasingly prefer clean power resources over other generation technology. In every region except the Mid-Atlantic, clean power represents the majority of capacity installations over the past five years.
- The Plains have led all regions by share of wind, solar, and storage relative to their total capacity additions since 2019, coming in at over 96%. The Northwest follows at 94% and Alaska/Hawaii place third with 92%. California and the Mountain West both also saw clean power capture 90% of their regional market additions in this period.
- Solar and battery storage additions in the Southeast surpassed natural gas additions over the last five years, representing 53% of total additions.
- The Mid-Atlantic states saw the lowest share of clean power additions, though just short of a majority threshold at 43%. Natural gas was the overwhelming choice for new capacity in that region.
- At current trends, all markets will see the majority of new capacity additions coming from clean power technologies.

## Regional Capacity Additions, 2019-2023



Source: ACP, EIA

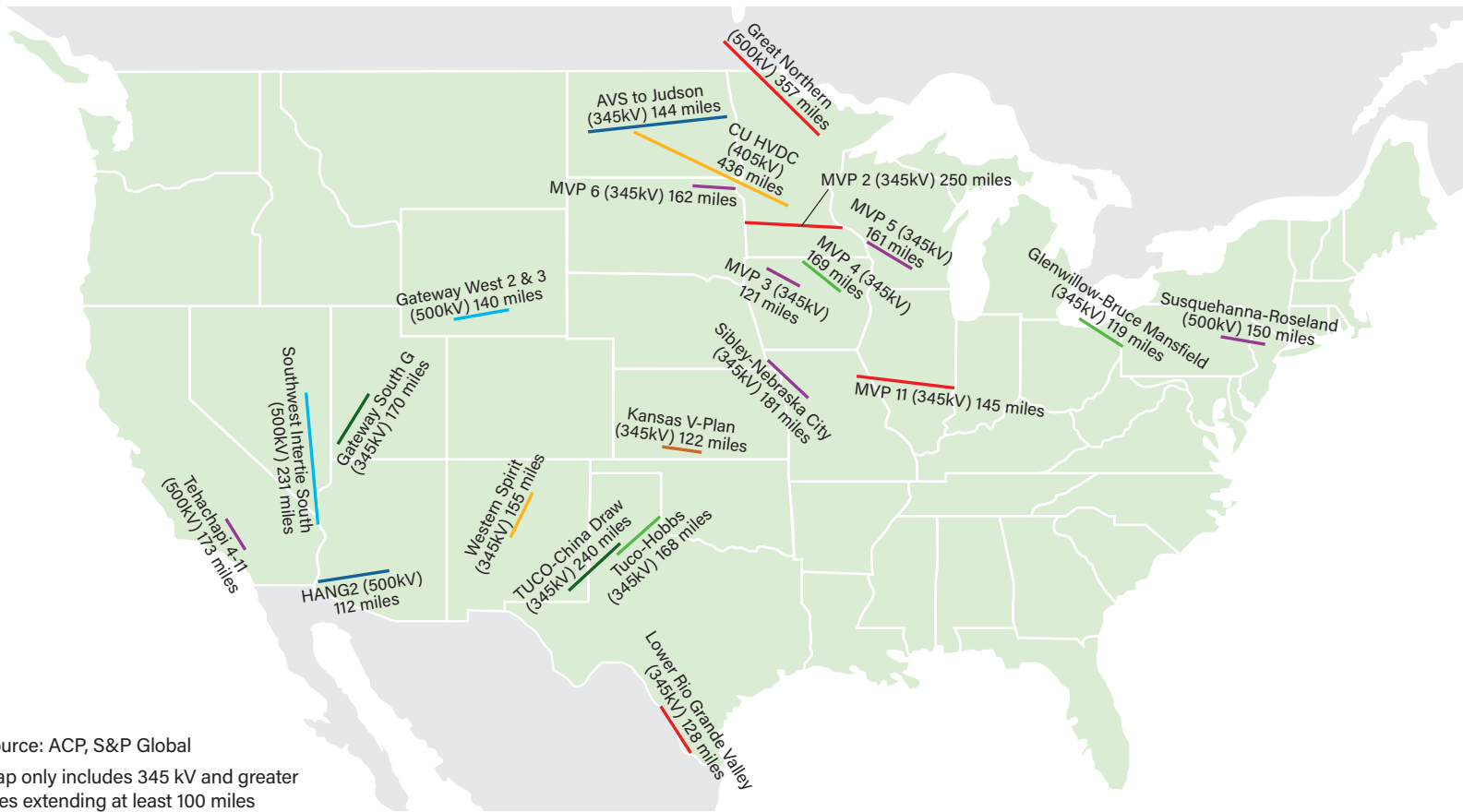


## Clean Power + Transmission

# High-Voltage Lines Built Since 2014

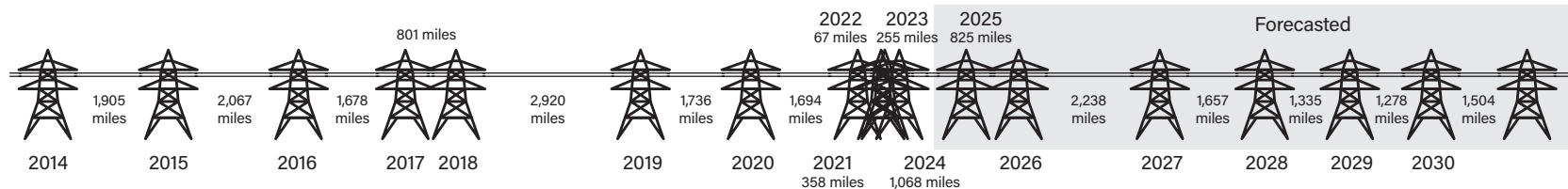
Only 255 miles delivered in 2023; developers pursuing 10,000 miles through 2030

## High-Voltage Transmission Lines Built 2014-2023



Source: ACP, S&P Global

Map only includes 345 kV and greater lines extending at least 100 miles

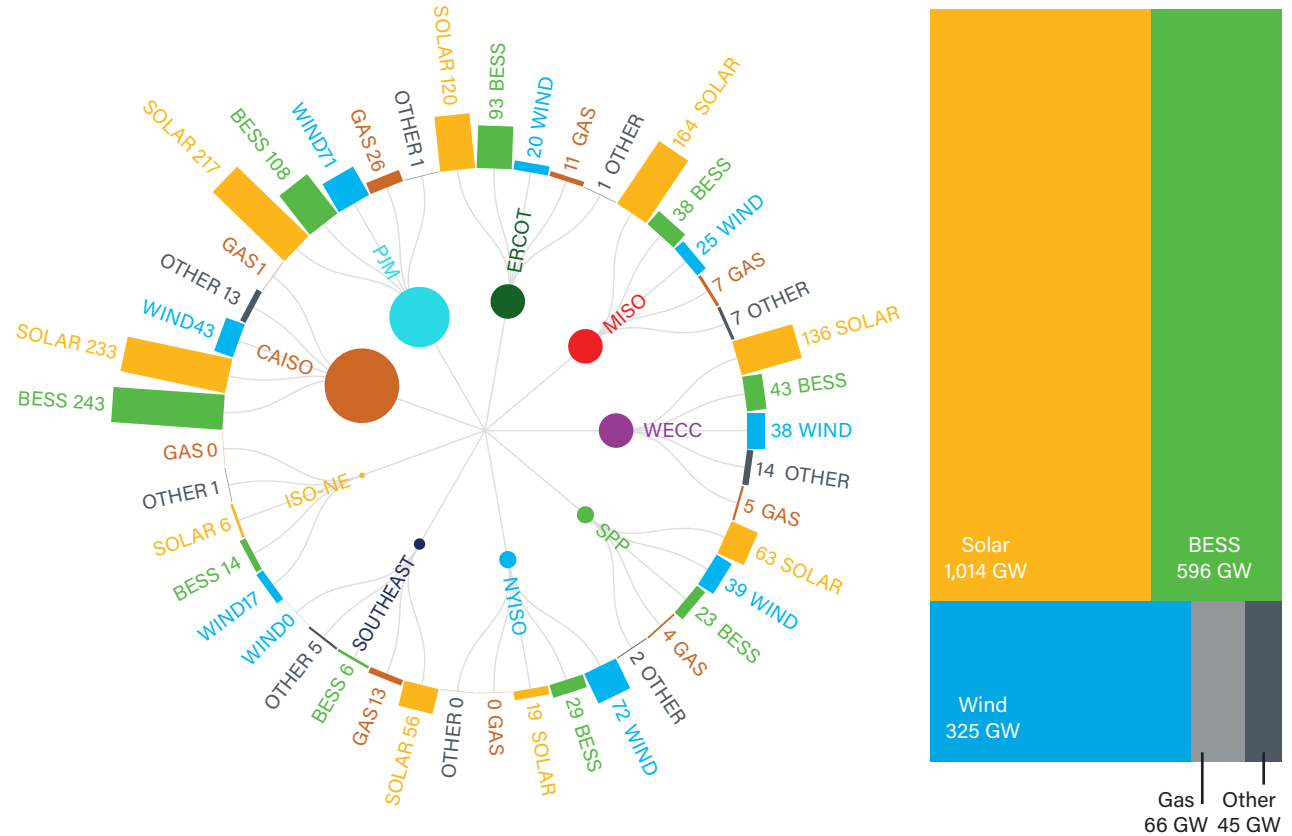


# U.S. Electricity Sector Interconnection Queues

## Solar, storage, and hybrid projects dominate queues totaling over 2,000 GW

- Interconnection queues are essentially a waiting list of proposed power projects seeking a grid connection in the coming months and years. While most projects that apply for interconnection are not subsequently built, data from these queues provides a good general indicator for mid-term trends in market, developer, and investor interest.
- As of June 2023, interconnection queues across the seven independent system operators and 14 major utilities in non-ISO regions include 2,050 GW of power capacity.
- Solar makes up 50% of queue volume, breaking away from the other technologies. CAISO, PJM, ERCOT, MISO, and utilities in the West all have at least 100 GW of solar in their queues.
- Queues for battery storage systems total 596 GW, or 30% of the total. In many cases, these storage systems are part of hybrid projects, most often paired with solar projects. In fact, there are nearly 700 GW of hybrid projects currently in queues. CAISO and PJM both have over 100 GW of BESS capacity in their queues, while ERCOT is just shy of that figure at 93 GW.
- There are 325 GW of wind capacity actively in interconnection queues, making up 16% of the total. NYISO has the most wind in the queue of any market, primarily due to active offshore wind project applications. PJM is just behind at 71 GW.
- Gas makes up just 66 GW of queue activity, concentrated in PJM, the Southeast, and ERCOT.

### Interconnection Queues



Source: ACP, S&P Global.  
All values in GWac  
Data as of 6/28/2023





# CLEAN POWER PROCUREMENT



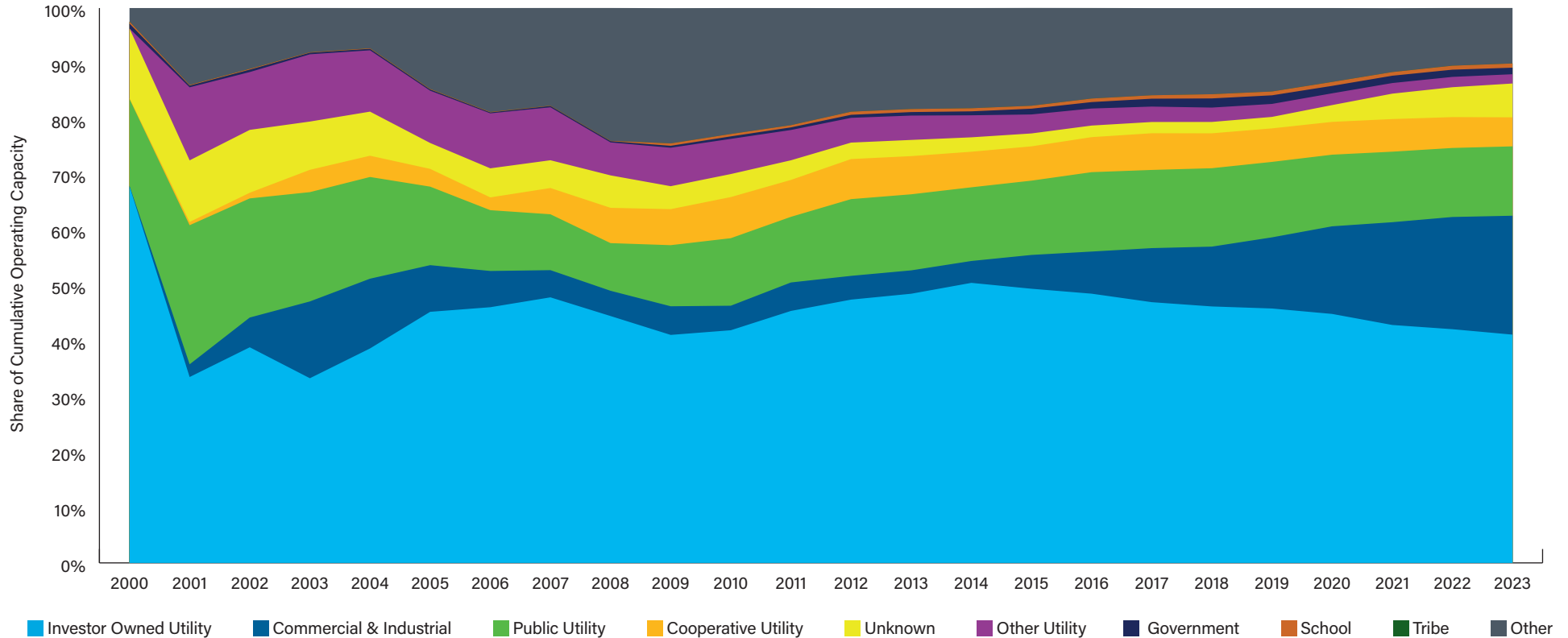


## Clean Power Procurement

# Operating Clean Power Offtake by Purchaser Type

Corporate buyer share reaches 21% of operating capacity

## Share of Cumulative Operating Clean Power by Purchaser Type



- Since 2000, utilities have made up most of the offtake for operating capacity in the U.S. Utilities' share of operating offtake capacity has hovered between 60% and 75% during this period.

- Among utilities, investor-owned utilities (IOU) have been responsible for much of clean power procurement. IOUs alone accounted for offtaking 41% of operating capacity in 2023.

- Commercial & industrial purchasers are swiftly becoming the second largest group, going from

procuring 0% of operating capacity in 2000 to 21% in 2023.

- Public utilities and cooperative utilities are the third and fourth largest groups, procuring 12% and 5% of operating clean power capacity respectively.





A woman wearing a white hard hat, blue safety glasses, and a high-visibility yellow and orange safety vest is working on a solar panel array. She is looking up and to the right, focused on her task. The background shows a clear blue sky with some clouds and a line of trees. The solar panels are mounted on a structure, and the woman is wearing black gloves and several colorful bracelets on her left wrist. A blue vertical bar is on the left side of the image, and a yellow diagonal line runs across the middle.

# CLEAN POWER MANUFACTURING AND TRADE



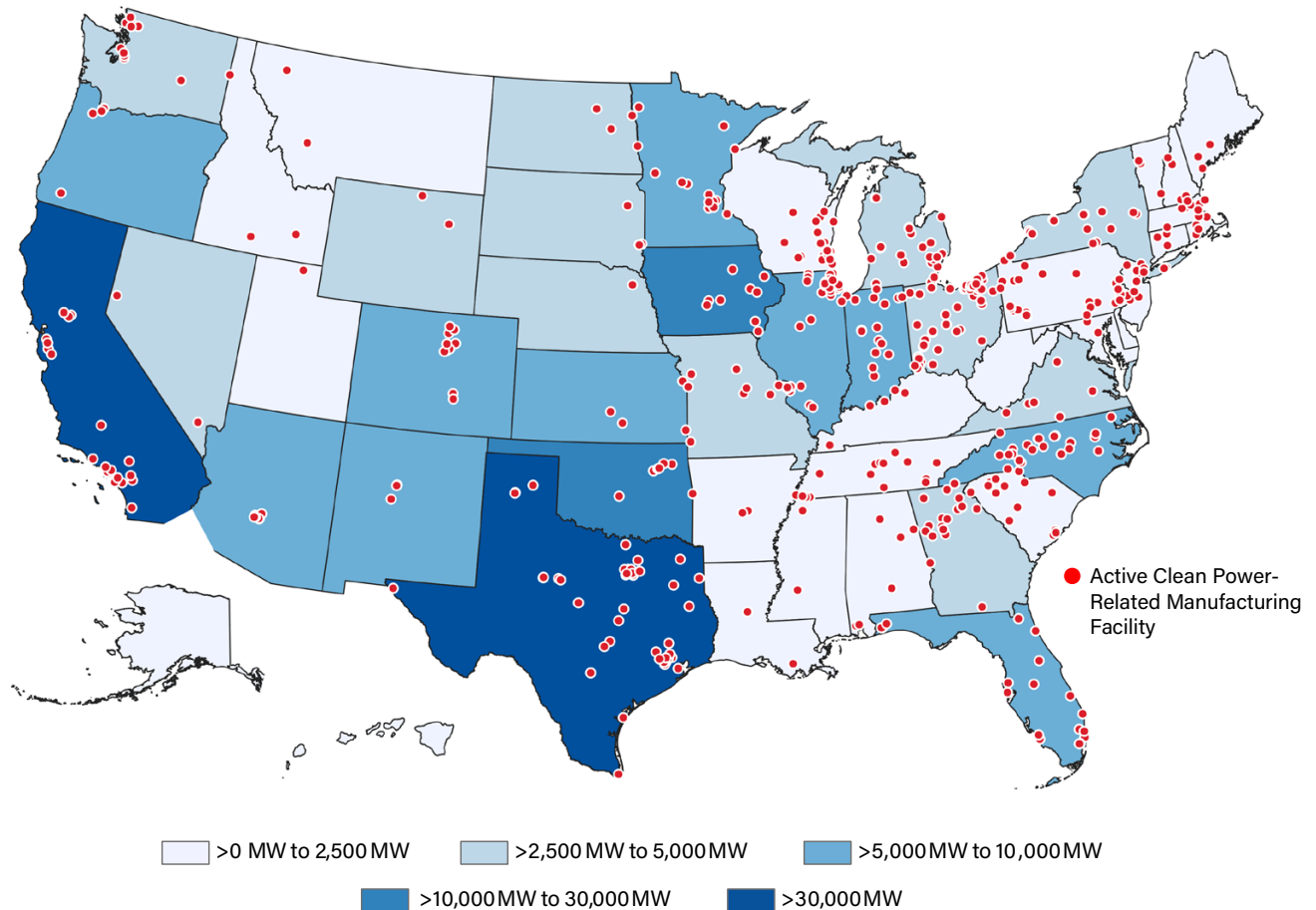
# Clean Power Manufacturing

## Clean Power Manufacturing and Capacity

There are over 500 active clean power-related manufacturing facilities across the U.S.

- There are nearly 450 wind-related manufacturing facilities. Aside from providing major components such as blades, towers, and nacelles, there are hundreds of smaller manufacturers providing other components such as coatings, lubricants, power transmission components, and other raw materials to the wind sector.
- There are over 60 utility-scale solar-related manufacturing facilities active in the U.S., supporting module making, polysilicon production, tracking technology, and bill of materials or balance of plant manufacturing.
- While battery manufacturing is still a nascent industry in the U.S. with only two manufacturers supplying modules or packs for the stationary storage market, 20 new facilities are expected to come online by 2030. Most of the announced facilities will support module and cell manufacturing.
- The Inflation Reduction Act (IRA) has stimulated new investment in domestic clean power manufacturing. As of February 9, 2024, companies have announced 123 new, expanded, or reopened manufacturing plants serving wind, solar, energy storage, and transmission technologies.

### Clean Power Manufacturing and Capacity by State



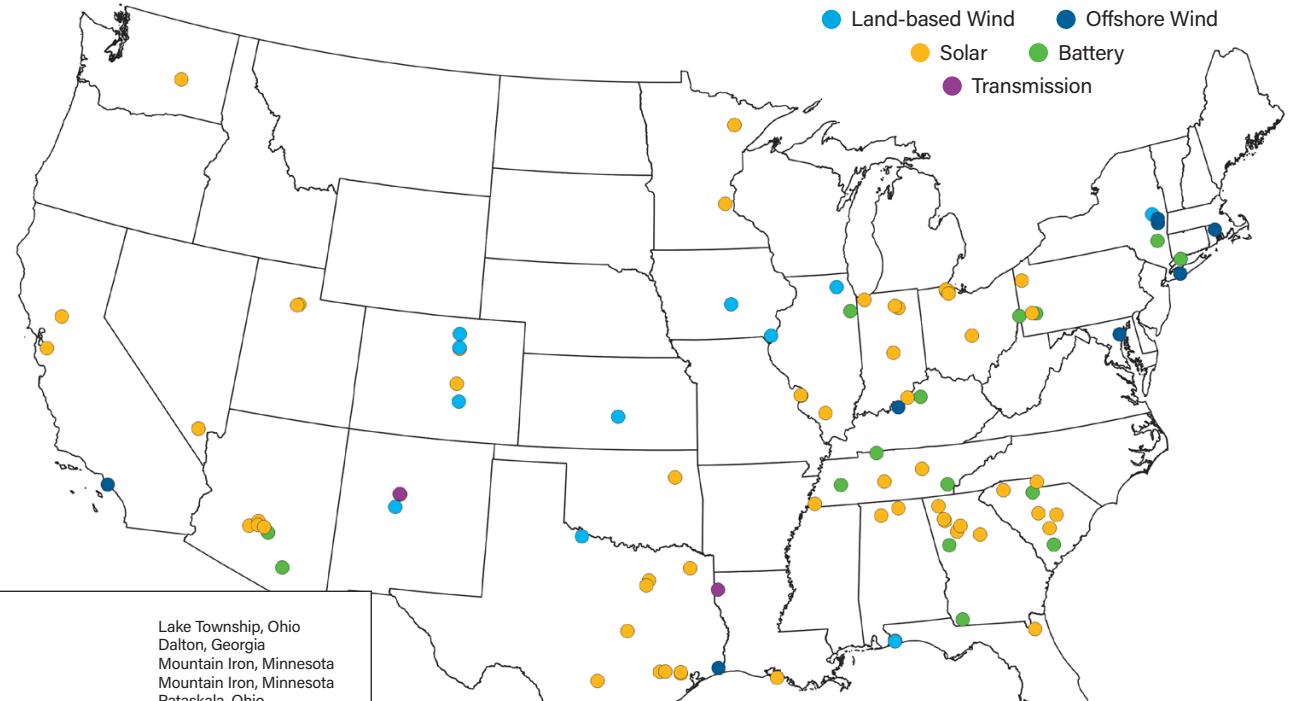
# Clean Power Manufacturing

## Clean Power Manufacturing Announcements

123 new, expanded, or reopened manufacturing facilities with active announcements

- Since the passage of the IRA, clean energy manufacturers have been rapidly announcing new manufacturing facilities to support the clean energy supply chain across wind, solar, battery storage, and transmission.
- To date, 123 new manufacturing facilities or facility expansions have been announced. This includes 78 solar manufacturing facility additions, 20 new grid-scale battery storage manufacturing facilities or facility expansions, 4 grid connection facilities, 12 land-based wind power manufacturing facilities, and 9 offshore wind power manufacturing facilities.
- Of the 123 facility announcements, 44 facilities have either completed construction or are currently under construction.
- In all, facilities announced represent over \$35 billion in capital investment and will support nearly 42,000 new manufacturing jobs.

### Utility-Scale Clean Power Manufacturing Announcements, August 16th, 2022 through February 9th, 2024



COMPLETED		Solar continued	
<b>Offshore Wind</b> Nucor Steel	Brandenburg, Kentucky	First Solar III	Lake Township, Ohio
<b>Onshore Wind</b> GE Vernova (GE) Siemens Gamesa	Schenectady, New York Fort Madison, Iowa	Hanwha Qcells	Dalton, Georgia
<b>Solar</b> Array Technologies & Lock Joint Tube Canadian Solar Enphase	Temple, Texas Mesquite, Texas West Columbia, South Carolina	Heliene	Mountain Iron, Minnesota
Enphase First Solar I First Solar II	Arlington, Texas Perrysburg, Ohio Lake Township, Ohio	Illuminate USA	Mountain Iron, Minnesota
		Mersen	Pataskala, Ohio
		Nevados	Columbia, Tennessee
		Nextracker Inc. / Asteelflash/USI	Mount Pleasant, Texas
		Nextracker Inc. / MSS Steel	Fremont, California
		Nextracker Inc. / Unimacts	Memphis, Tennessee
		OMCO Solar	Las Vegas, Nevada
		Polar Racking	Pierceton, Indiana
		Prysmian Group	Unknown, Michigan
		REC Silicon & Mississippi Silicon	Du Quoin, Illinois
		Terabase Energy	Moses Lake, Washington
		TerrePower	Woodland, California
			Sparta, Tennessee

UNDER CONSTRUCTION		Solar	
<b>Battery</b> American Battery Factory	Tucson, Arizona	Energate	West Valley, Utah
EOS Energy Enterprises, Inc.	Turtle Creek, Pennsylvania	First Solar IV	Trinity, Alabama
Form Energy	Weirton, West Virginia	First Solar V	Iberia Parish, Louisiana
ICL	St. Louis, Missouri	Hanwha Qcells	Cartersville, Georgia
Pomega Energy Storage Technologies	Walterboro, South Carolina	Meyer Burger	Goodyear, Arizona
<b>Offshore Wind</b> Ørsted	Sparrows Point, Maryland	OMCO Solar	Unknown, Alabama
<b>Onshore Wind</b> Arcosa CS Wind	Belen, New Mexico Pueblo, Colorado	Polar Racking	Unknown, Florida
		Runergy	Huntsville, Alabama
		Seraphim Energy Group (SEG)	Houston, Texas
		SolarLink	Las Vegas, Nevada
		Suniva	Norcross, Georgia



A photograph of an offshore wind farm with several white wind turbines in a blue sea under a clear sky. A purple diagonal banner is on the left side of the image.

# PRICING AND COSTS



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## Clean Power Costs

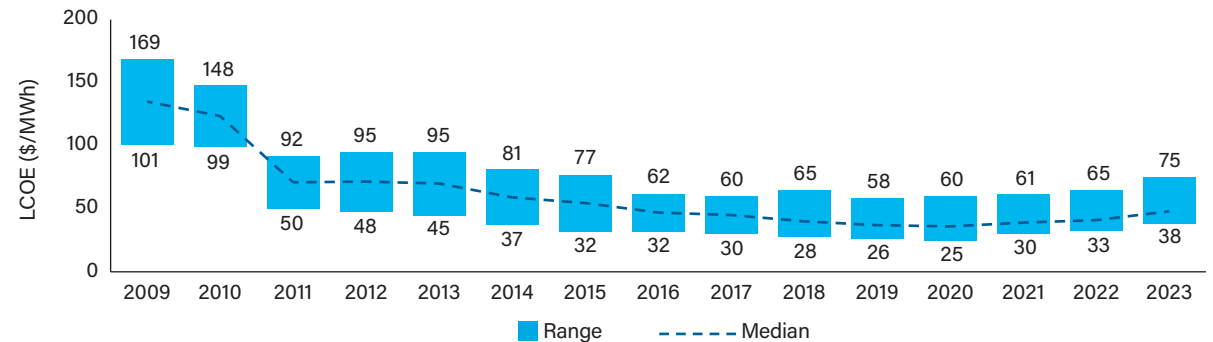
# Levelized Cost of Clean Energy

## Despite recent cost increases, wind and solar remain competitive

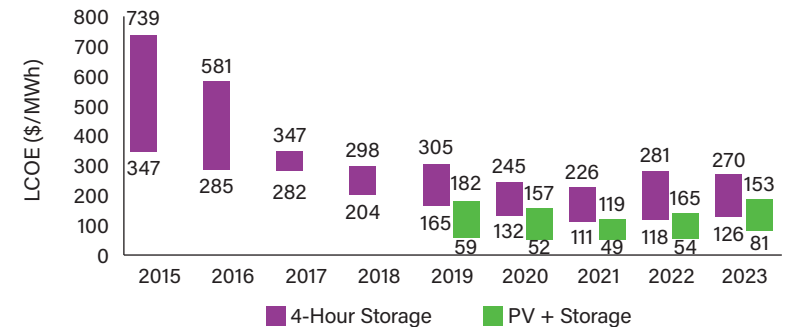
- Levelized cost of energy is the lifetime price level that developers/owners of renewable energy projects need to secure to cover project and operational costs and receive a reasonable profit margin for their work bringing the project to market. As generation technologies that do not rely on fuel to produce electricity, technological advances that lead to falling equipment costs and improved efficiencies translate quickly to reductions in LCOE.
- Following years of cost declines, the LCOE of wind and solar increased over the last three years. Supply chain challenges, logistics cost increases, higher commodity prices, trade barriers, regulatory uncertainties, and macroeconomic inflationary pressure impacted the industry. Despite the increase, wind and solar remain competitive.
- The unsubsidized (not considering tax credits) LCOE of wind power plants is 31% lower than a decade ago. The average cost of wind energy is approximately \$48/MWh. Larger turbines and more efficient capture of blowing winds have contributed to an increase in the overall output of wind projects, bringing down the incremental cost of energy production.
- The cost of producing electricity from solar has declined 46% in the last 10 years thanks to advances in module efficiency, increasing project size and scale, advances in operations and maintenance strategies, and better output performance.
- The levelized cost of a four-hour duration energy storage facility serving energy markets in the U.S. ranged from \$126-177/MWh, down significantly from a range of \$347-\$739/MWh in 2015.
- The levelized cost of hybrid facilities pairing solar generation with battery storage have also declined over the past four years. In 2023, the average levelized cost of a solar plus storage facility ranged from \$81-153/MWh. The exact configuration of these hybrid plants plays a big role in the cost profile.

### Levelized Cost of Energy

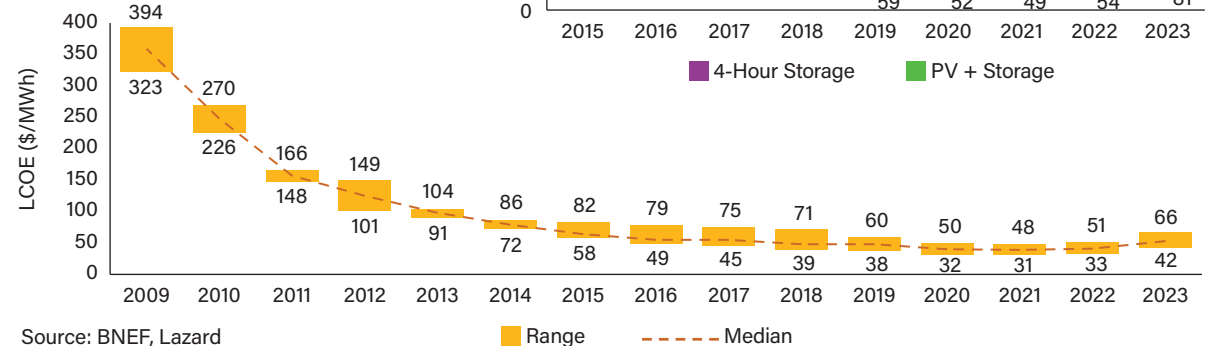
#### Wind



#### Storage



#### Solar



Source: BNEF, Lazard  
Does not include tax benefits.



# LAND-BASED WIND POWER

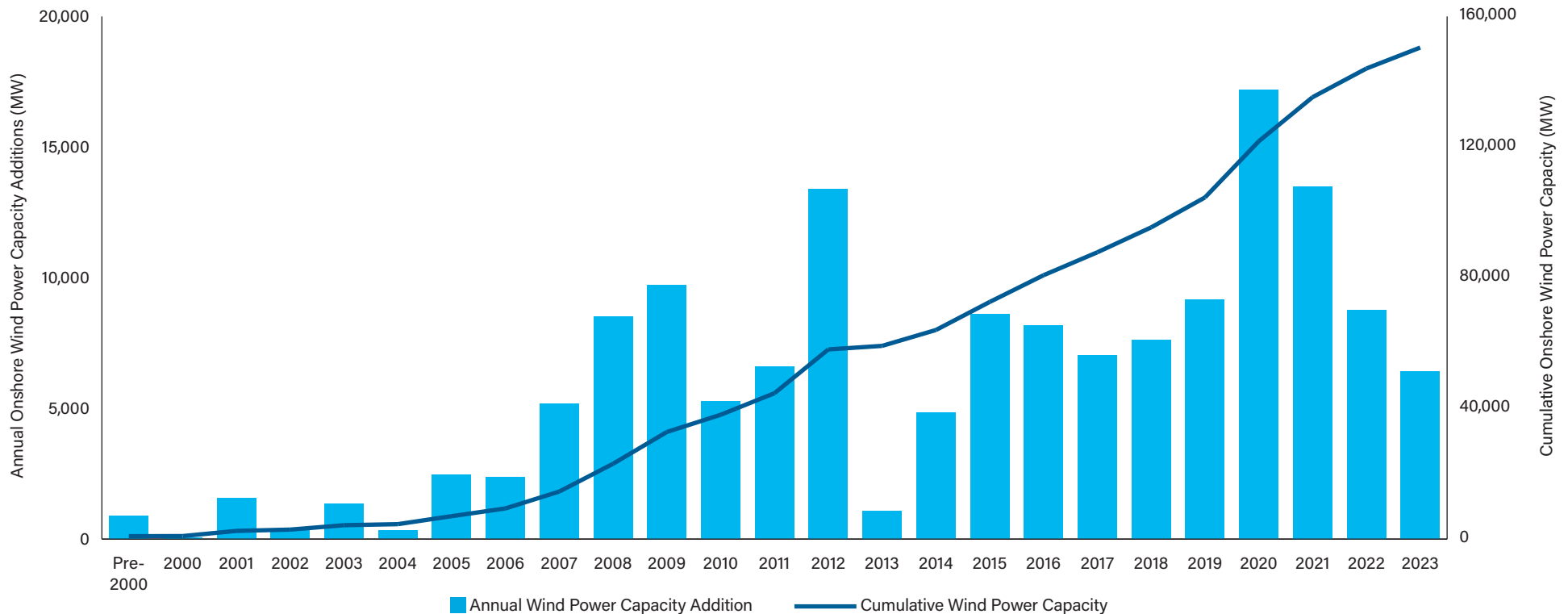


## Land-Based Wind Power

# Annual and Cumulative Wind Power Capacity

6.4 GW installed in 2023 brings the cumulative year-end capacity to over 150 GW

## U.S. Annual and Cumulative Wind Power Capacity Growth



- 2023 continued to see a decrease in wind capacity installed, marking the lowest year since 2014. The U.S. wind market installed 1,910 wind turbines with a total capacity of 6,402 MW, down from 8,876 MW last year and 13,667 MW installed in 2021.
- The cumulative operating wind power capacity rose to 150,455 MW at the end of 2023.
- More than half of the wind came online during the last quarter of 2023. Similar to 2022, there was little growth in Q2 and Q3 of 2023, with less than a GW added in each.
- Wind installations continue to be down due to market saturation in certain areas but also permitting and development delays in others. Factors such as changes in incentives, fluctuations in costs, and delays in permitting and regulatory approvals may have influenced the reduced number of commissioned wind projects.

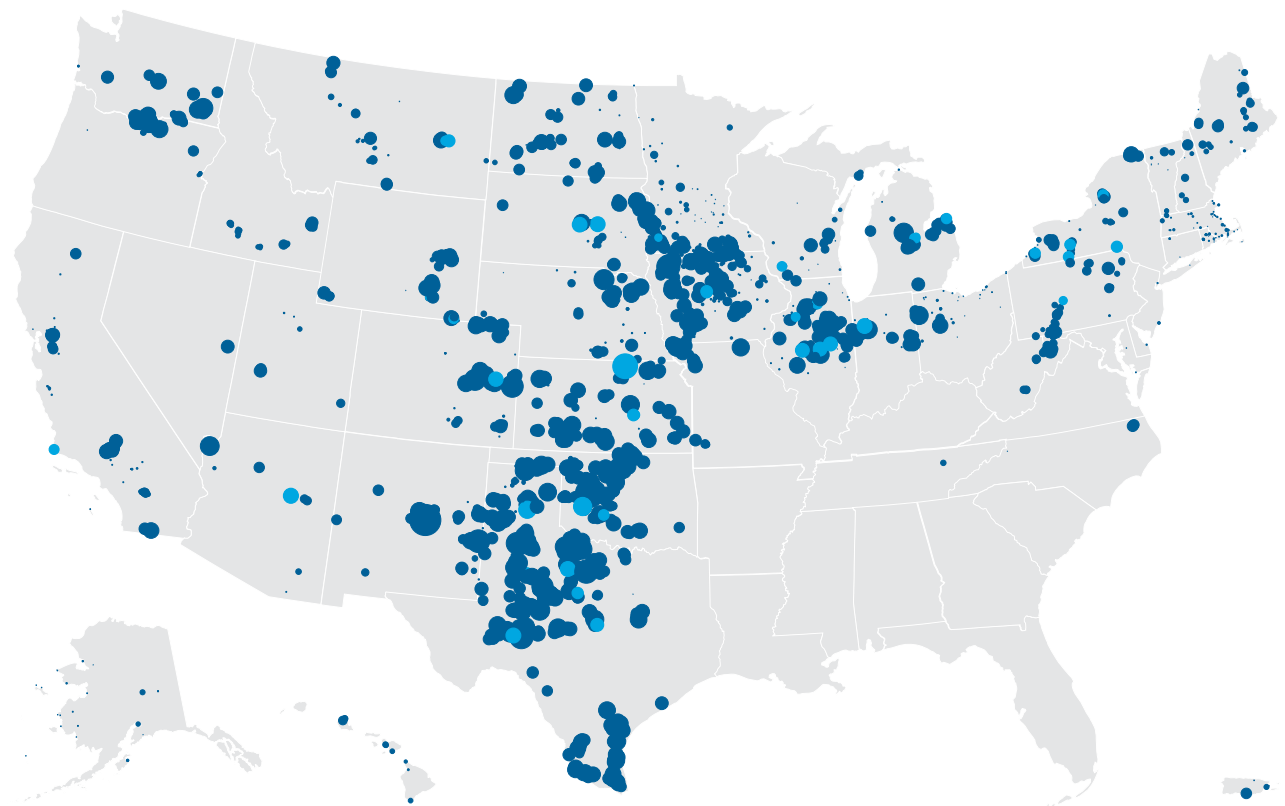
# Land-Based Wind Power

## Land-Based Wind Projects

Over 6.4 GW of land-based wind power projects added to the grid in 2023

- Wind developers brought 81 project phases online in 2023. These projects were spread across 17 states, including four states that added 500 MW or more.
- Texas continued to see the most additions in a single year at 1,323 MW. Illinois and Kansas were close to one another at 919 MW and 838 MW respectively. New York rounded out the top four at 557 MW.
- The High Banks Wind project in Kansas took the top spot for the largest wind project phase built in 2023 at 557 MW. This was followed by the 300 MW Seven Cowboy wind project in Oklahoma and the 266 MW Goodnight wind project in Texas.
- Developers commissioned nearly 2.3 GW less wind power in 2023 compared to 2022, a continued downward trend since 2020.
- That being said, U.S. wind power capacity has almost tripled in the last 10 years and is 36 times larger than what it was 20 years ago.

### Land-Based Wind Power Projects



- Wind Projects Online in 2023
- Wind Projects Online Before 2023



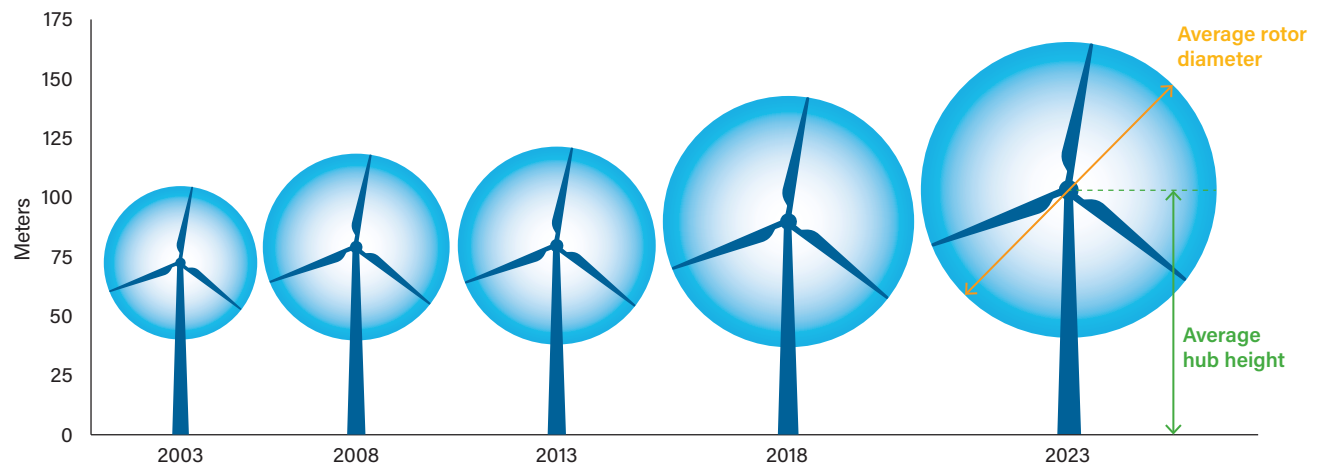
# Land-Based Wind Power

## Average Wind Turbine

In 2023, the average wind turbine had a 100m hub height, 133m rotor diameter, and 3.5 MW capacity

- Over 1,900 turbines were brought online in 2023, bringing the total operating turbine fleet to over 71,000 turbines.
- Over the past decade, the average hub height of land-based wind turbines has increased by 30%, reaching 100m in 2023.
- The average rotor diameter has experienced an even more significant increase, outpacing hub height growth. In 2023, turbines installed had an average rotor diameter of 133m, a 50% increase from 10 years ago.
- The average nameplate capacity of each turbine reached a high of 3.5 MW in 2023. This is more than double what it was in 2013. As a result, more than 1,050 homes in the U.S. could be powered by the average turbine installed in 2023. This is based off the latest generation weighted average capacity factor published by DOE's onshore wind market report.

### Evolution of the "Average" Utility-Scale Turbine



YEAR	2003	2008	2013	2018	2023
Average Hub Height (m)	70	77	77	87	100
Average Rotor Diameter (m)	69	84	89	113	133
Average Capacity (MW)	1.4	1.7	1.7	2.4	3.5
Homes Powered	263	427	529	856	1,058

An aerial photograph of a large solar farm. The solar panels are arranged in neat, parallel rows that stretch across a field. The sun is low on the horizon, creating a warm, golden glow and casting long, soft shadows across the panels. The background shows a line of trees and a clear sky. A blue diagonal line cuts across the image, separating the title area from the rest of the page.

# UTILITY-SCALE SOLAR



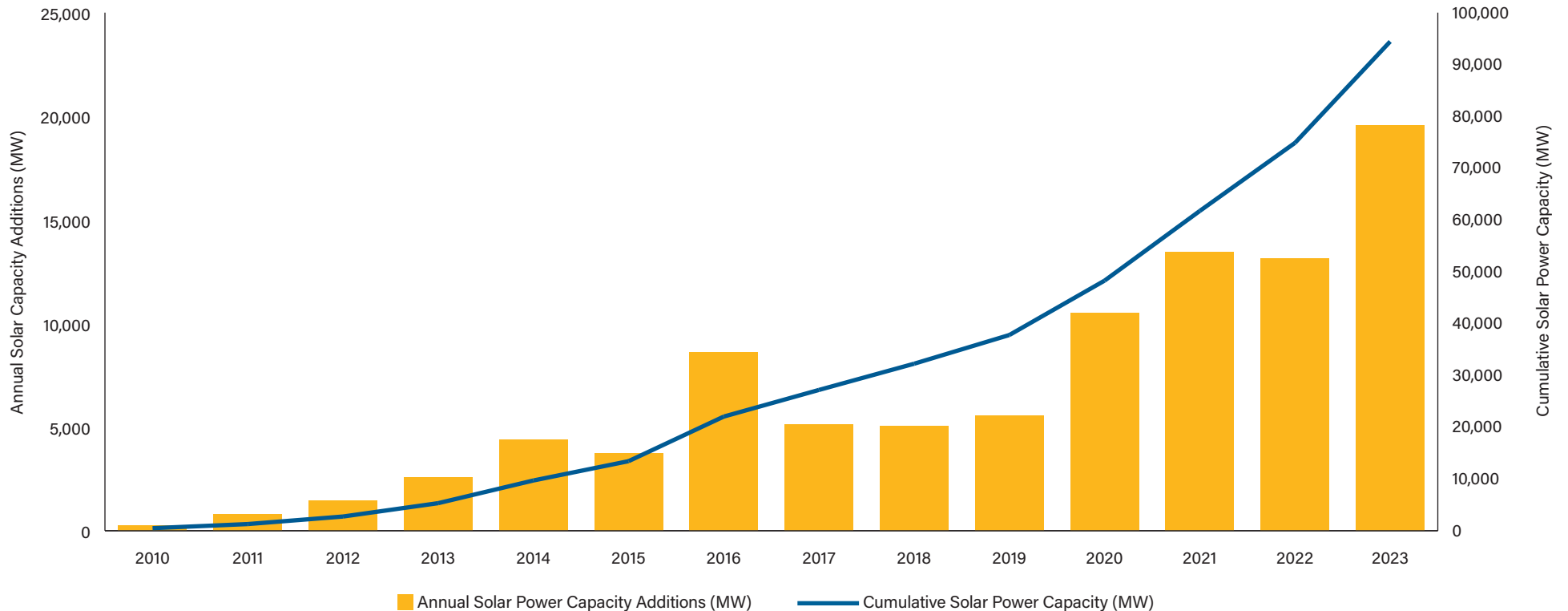
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# Utility-Scale Solar Annual and Cumulative Solar Power Capacity

## Over 19.5 GW of utility-scale solar added to the grid in record-breaking year

### U.S. Annual and Cumulative Solar Power Capacity Growth



- In 2023, the U.S. solar industry broke records to add 19,561 MW of utility-scale solar capacity to the grid, bringing the cumulative operating capacity to 94,425 MW.

- The record-breaking year saw a 49% increase in installations compared to 2022 as the annual capacity additions grew by 6,421 MW.
- Following a slow year in 2022, the U.S. solar industry experienced a rebound, continuing a growth trajectory

that began in 2019. The solar industry's banner year was likely a reflection of easing supply chains and the falling costs for modules and panels due to global oversupply conditions.

# BATTERY ENERGY STORAGE SYSTEMS

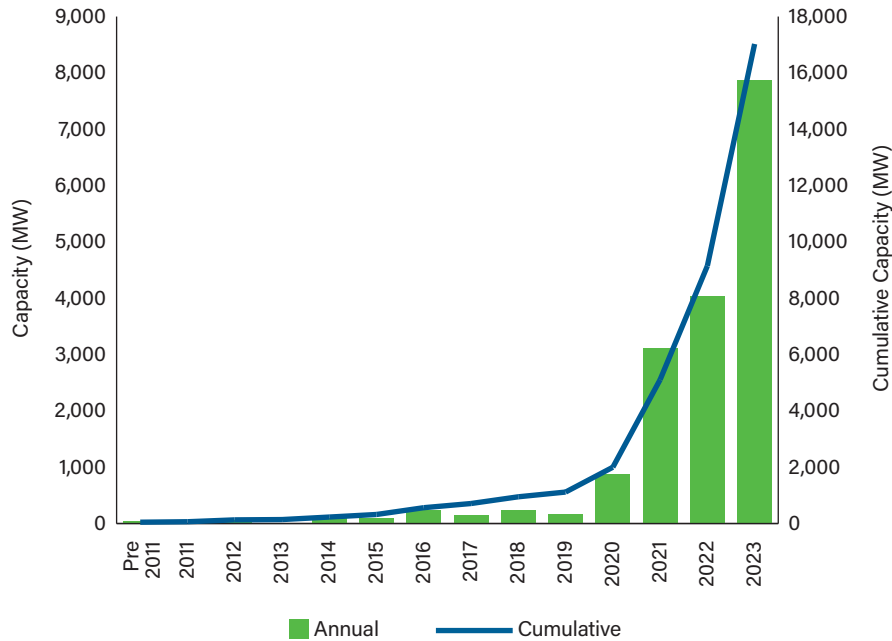


## Battery Energy Storage Systems

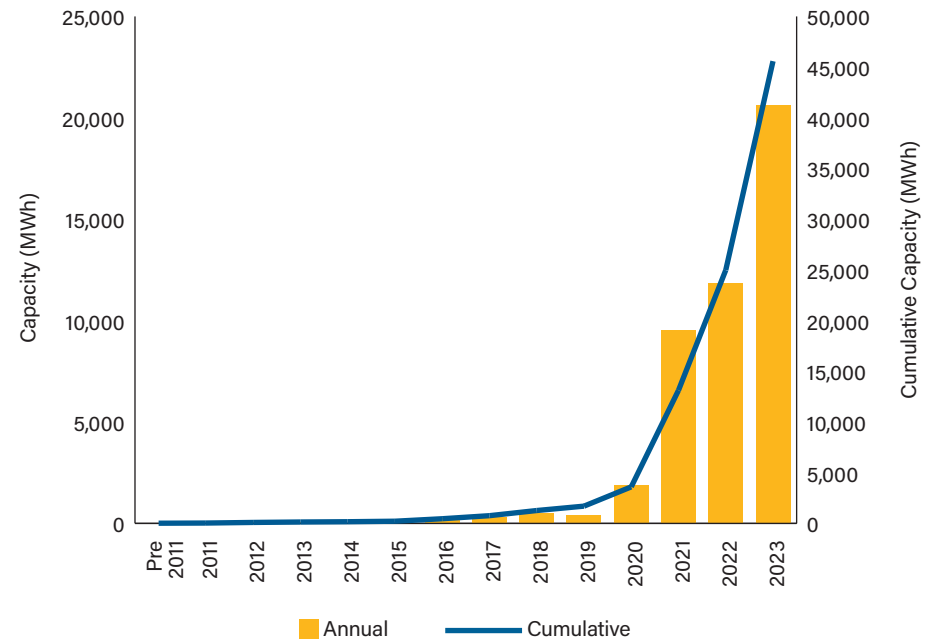
# Annual and Cumulative Energy Storage Power Capacity

## Another record year for battery storage installations

U.S. Annual and Cumulative Battery Storage Capacity Growth (MW)



U.S. Annual and Cumulative Battery Storage Capacity Growth (MWh)



- ACP tracks the U.S. utility-scale battery storage market in terms of power capacity (MW), which is the total possible instantaneous discharge capability, and energy capacity (MWh), which is the maximum amount of stored energy.
- Battery storage has been on a rapid upward trajectory over the past few years. 2023 represents a record year for battery storage, with 7,881 MW/20,609 MWh commissioned. Cumulative operating capacity, in MW, increased by 86% in 2023 and cumulative energy storage capacity, in MWh, increased by 83% in 2023.

- Battery storage installations in 2023 outpaced 2022, the previous record year, by 95%, a near doubling of capacity installed in MW terms.
- In total, there is 17,027 MW/45,588 MWh of battery storage operating across the country.

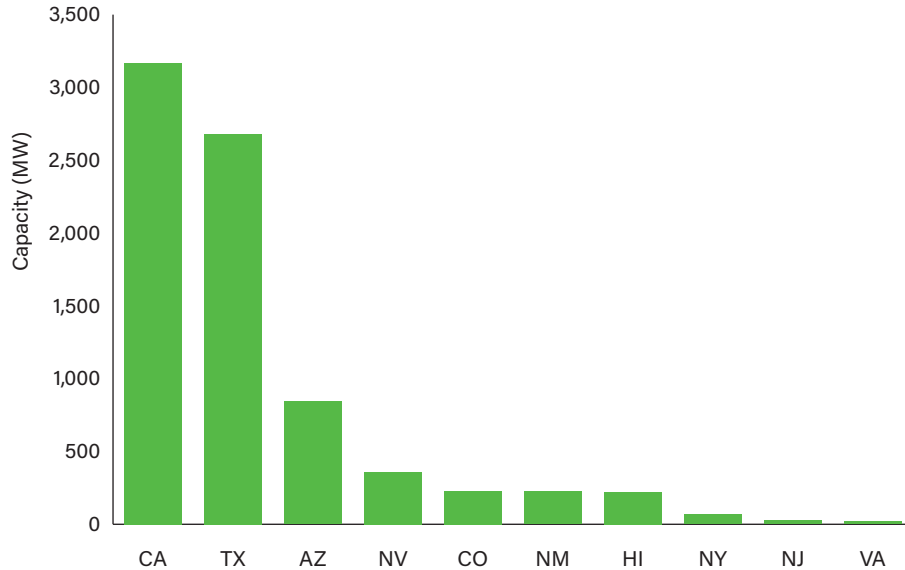


## Battery Energy Storage Systems

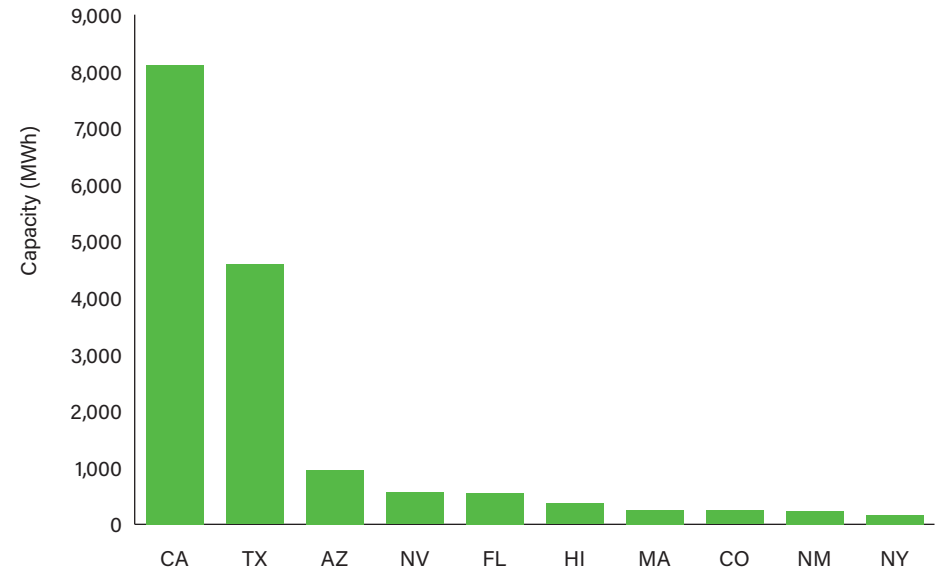
# Top States for Storage, 2023 and Cumulative

## California and Texas lead all states in 2023 battery storage additions, cumulative storage capacity

2023 Battery Storage Capacity Additions (MW)



Cumulative Battery Storage Capacity (MWh)



- California led all states in 2023, adding 3,166 MW of battery storage capacity. Texas followed with 2,680 MW. Arizona (842 MW), Nevada (360 MW), and Colorado (230 MW) round out the top five.
- In terms of cumulative battery storage deployment, California is by far the leader with 8,107 MW of capacity deployed. Again, Texas follows with 4,587 MW. Arizona (964 MW), Nevada (561 MW), and Florida (555 MW) follow Texas in cumulative battery storage capacity.

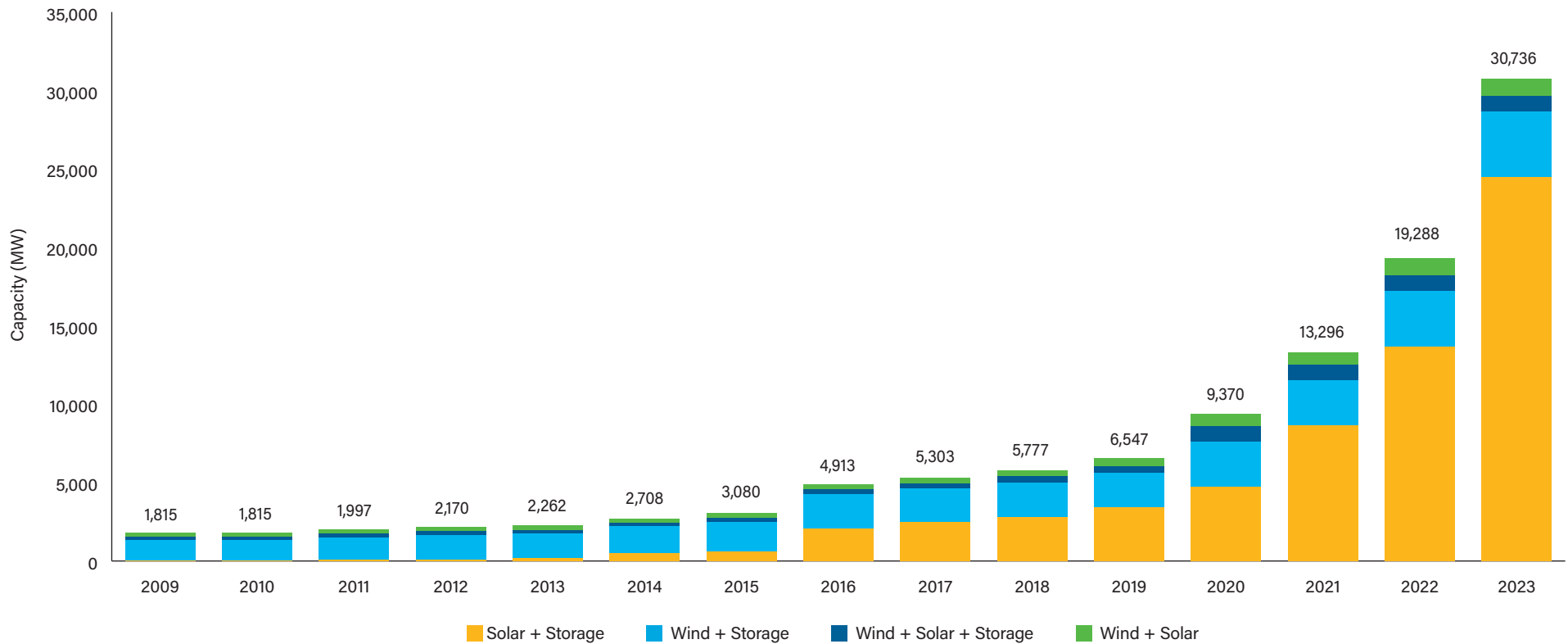
- California also leads all states in MWh terms, deploying 10,045 MWh in 2023 bringing the state's cumulative total to 27,712 MWh.
- Texas follows California with 3,694 MWh deployed in 2023, bringing the state's cumulative total to 6,064. The ratio between MW and MWh suggests a shorter average duration in Texas.



# Battery Energy Storage Systems Operational Hybrid Project Capacity

Over 11.4 GW of hybrid projects installed in 2023

## Cumulative Operational Hybrid Capacity by Year



- Pairing battery storage with wind and solar power can enhance the integration, reliability, and flexibility of renewable energy, improve grid stability, and provide additional value-added services to the electricity grid.
- In 2023, over 11 GW of new hybrid project capacity came online, 95% of which is comprised of solar + storage projects. 2023 hybrid installations were 90% higher than 2022, setting a new record in the hybrid space.
- In total, over 30.7 GW of hybrid project capacity is operational in the U.S. Solar + storage projects have become dominant over the past five years and now account for 80% of operating capacity. Wind + storage makes up 13% of operating hybrid capacity, wind + solar + storage 3%, and wind + solar the remaining 3%.



# OFFSHORE WIND



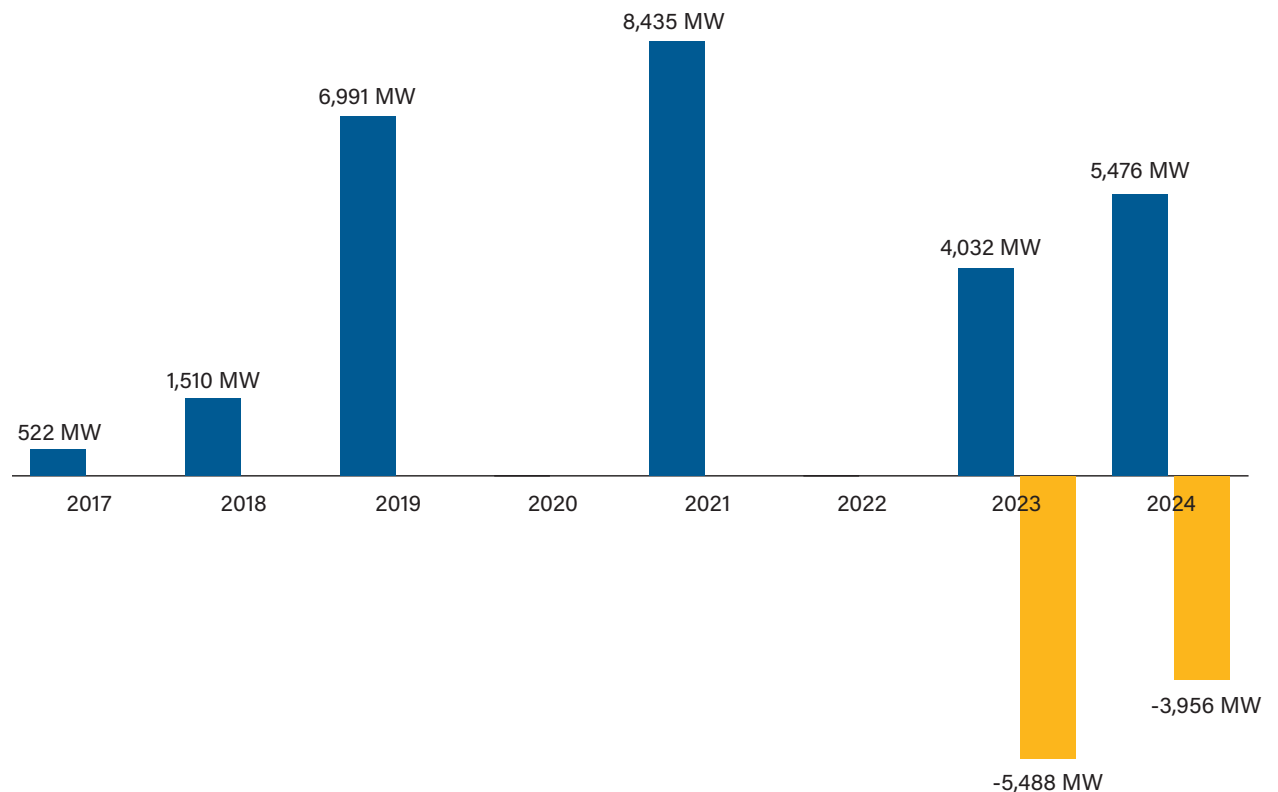
## Offshore Wind

# Offshore Wind Procurement

Over 4 GW of offshore wind procured in 2023, but net total capacity procured was down for the year due to project cancellations

- New York State procured over 4 GW of offshore wind in 2023 across three projects – Attentive Energy One (1,404 MW), Community Offshore Wind (1,314 MW) and Excelsior Wind (1,314 MW).
- There were, however, several PPA terminations and project cancellations in 2023. Ocean Wind 1 (1,100 MW), Ocean Wind 2 (1,148 MW), Commonwealth Wind (1,232 MW), Park City Wind (804 MW), and SouthCoast Wind (1,204 MW) all announced they would be terminating their offtake agreements in 2023.
- In 2024 to date, New Jersey has procured over 3.7 GW of new offshore wind capacity via Leading Light Wind (2,400 MW) and Attentive Energy Two (1,342 MW).
- Similarly, 2024 has seen Skipjack Wind (966 MW), Empire Wind 2 (1,260 MW) and Beacon Wind (1,230 MW) announce that they would be ceasing development due to project economics.
- In late February 2024, Empire Wind 1 (810 MW) and Sunrise Wind (924 MW) were awarded new PPAs as part of a re-bid process in which their old PPAs were terminated.

### Offshore Wind Procurement by Year



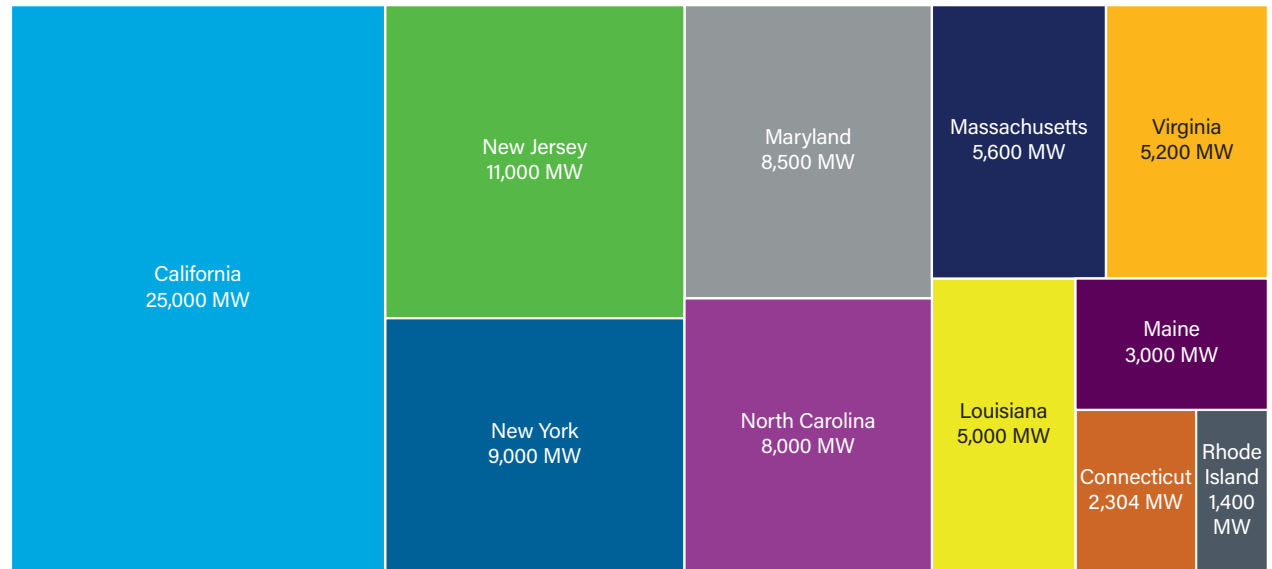


# Offshore Wind State Updates

## Eleven states have set offshore wind procurement targets totaling over 84,000 MW

- In April 2023, Maryland lawmakers passed a bill setting the state's offshore wind target to 8.5 GW by 2031.
- On July 27, Maine Governor Janet Mills signed legislation setting an up to 3,000 MW target for floating offshore wind in federal waters by 2040. The legislation authorizes the Governor's Energy Office to establish an offshore wind energy procurement and schedule.
- In September, the California Senate passed AB 1373, a clean energy bill that paves the way for the state's first-ever offshore wind market. The bill authorizes the state to act as a central buyer for long-lead time resources such as offshore wind. Governor Newsom signed the bill into law in October.
- To date, eleven states have combined to set offshore wind procurement targets totaling 84,000 MW.

### Offshore Wind Targets by State



American Clean Power is the voice of companies from across the clean power sector that are powering America's future, providing cost-effective solutions to the climate crisis while creating jobs, spurring massive investment in the U.S. economy and driving high-tech innovation across the nation. We are uniting the power of America's renewable energy industry to advance our shared goals and to transform the U.S. power grid to a low-cost, reliable, and renewable power system. Learn more about the benefits clean power brings to America at [www.cleanpower.org](http://www.cleanpower.org).



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