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The Energy Transition: The Growth of Renewables and Financing Risks

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Michael Plante
Senior Research Economist and Advisor
Federal Reserve Bank of Dallas

Kunal Patel
Senior Business Economist
Federal Reserve Bank of Dallas

SungJe Byun
Senior Economist
Federal Reserve Bank of Dallas

Joseph Kneip
Supervision and Risk Coordinator
Federal Reserve Bank of Dallas

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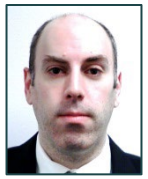
Our Host and Presenters Today

SungJe Byun
Federal Reserve Bank
of Dallas



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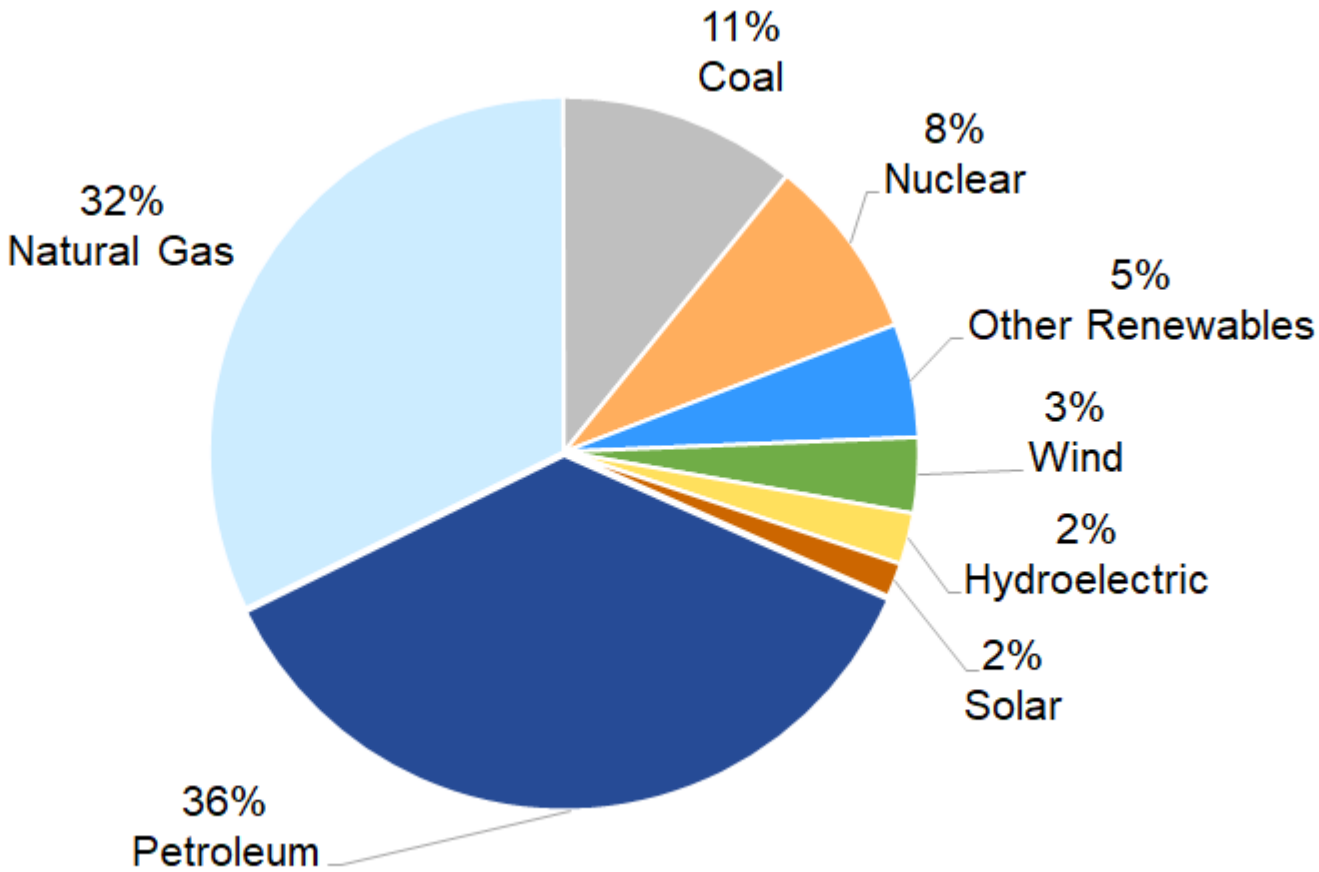
Goals of Today's Session

- Discuss the current role of wind and solar power in the United States energy mix and the economy
- Highlight trends in onshore and offshore wind in the United States
- Highlight trends in utility-scale and residential solar in the United States
- Summarize current trends in bank lending for renewable energy
- Highlight some key risks associated with financing solar and wind projects
- Take questions

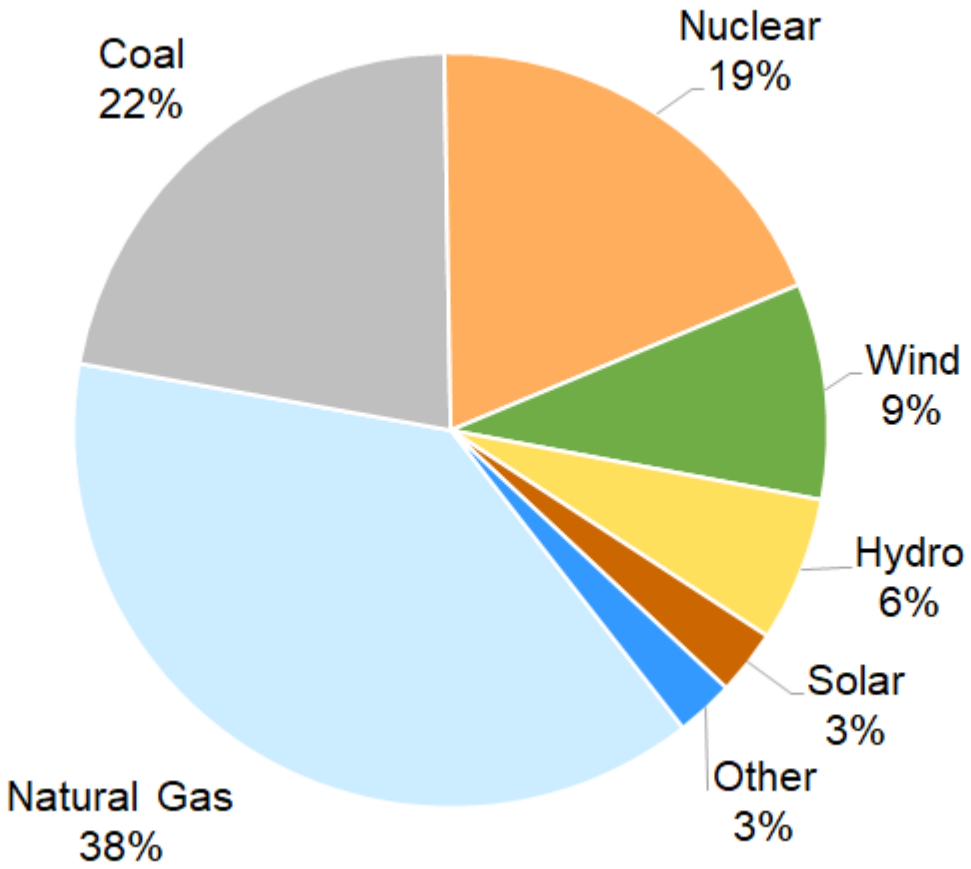
Overview and Outlook

Renewables Were 12 Percent of U.S. Energy Consumption in 2021



Note: Pie chart shows the share of total U.S. energy consumption due to each category.
Source: U.S. Energy Information Administration

Wind and Solar Provided 12 Percent of U.S. Electricity Generation in 2021



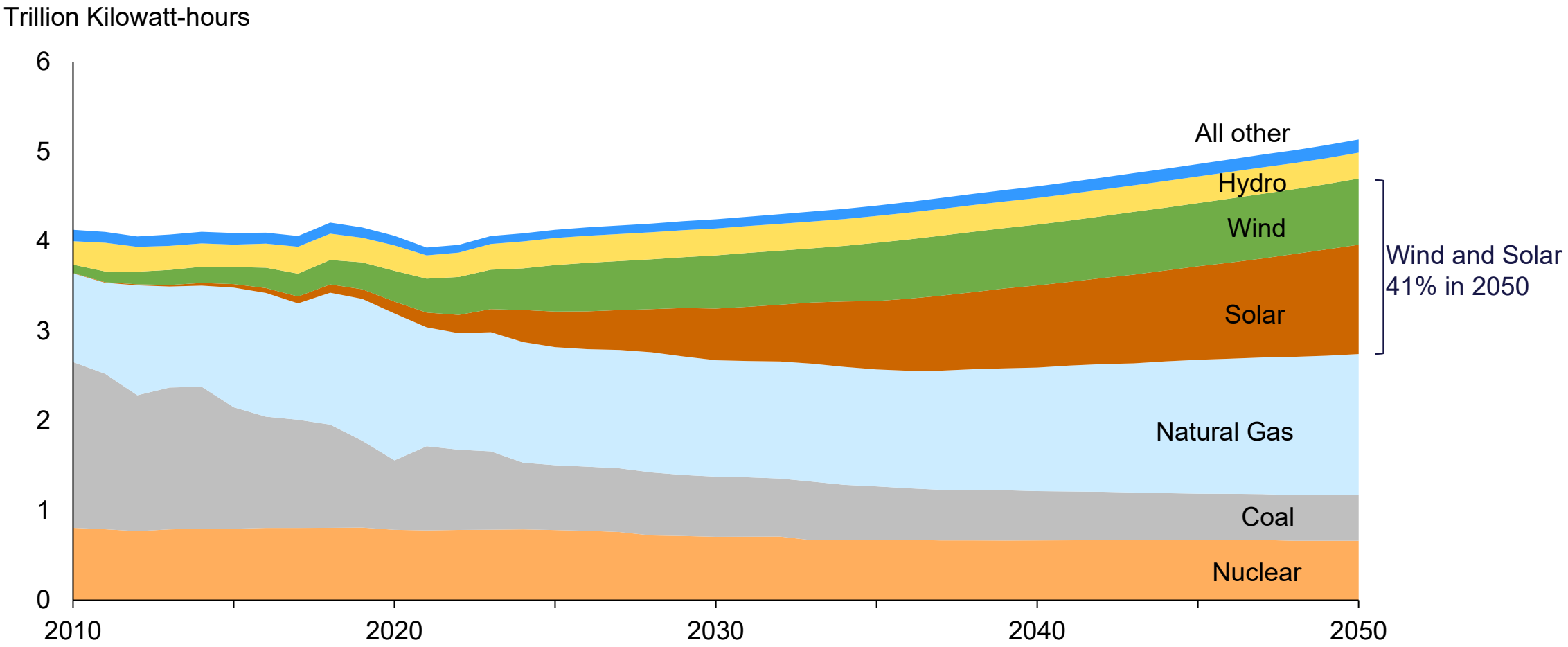
Note: Chart shows share of total electricity generation due to each energy source.
Source: U.S. Energy Information Administration

Employment in Solar and Wind Growing

- Data limitations often prevent accurate measurement of contributions of wind and solar to the economy.
- The U.S. Energy and Employment Report, produced by the U.S. Department of Energy, measures broad employment trends across all energy industries.

	Employment	
	2020	2021
Solar	316,675	333,887
Wind	116,817	120,164
Private non-farm payrolls	120,806,000	127,099,000

Significant Expansion Expected through 2050



Note: Projections through 2050 are from the Annual Energy Outlook 2022 report.
Source: U.S. Energy Information Administration

Inflation Reduction Act Will Boost U.S. Renewable Spending

Key takeaways:

- Incentives to boost adoption of various renewable and clean energy technologies: wind, solar, electric vehicles, carbon sequestration, and more

- Incentives for expanding domestic supply chain of those technologies:
  - Production tax credit for domestically produced solar, wind turbine, and offshore wind components

Wind and Solar Will Benefit from Extended Tax Credits

- Production and investment tax credits (PTC, ITC) extended to end of 2024

- New “Clean Energy” tax credits for projects starting in 2025:
  - Base PTC credit of 0.3 cents per kWh, base ITC credit of 6 percent of cost
  - Max PTC credit of 1.5 cents, ITC of 30 percent of cost
  - Additional credits for meeting domestic content and location requirements
  - Applies to “zero-greenhouse emission” technologies

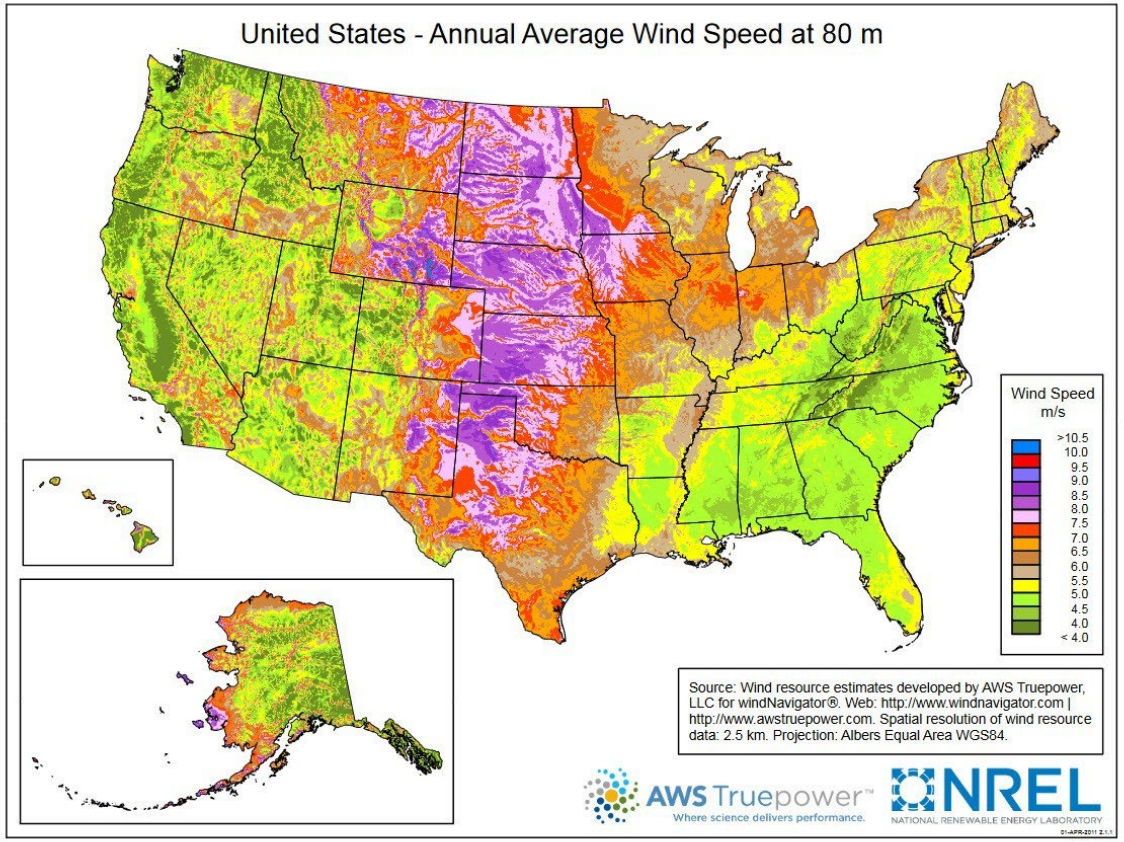
Poll Question

Has the Inflation Reduction Act changed your institution's attitude toward renewable energy (i.e., view on opportunities for renewables)?

A. Increases our interest significantly
B. Increases our interest a small amount
C. No change
D. Reduces our interest a small amount
E. Reduces our interest significantly
F. Don't know/not sure

Onshore and Offshore Wind in the United States

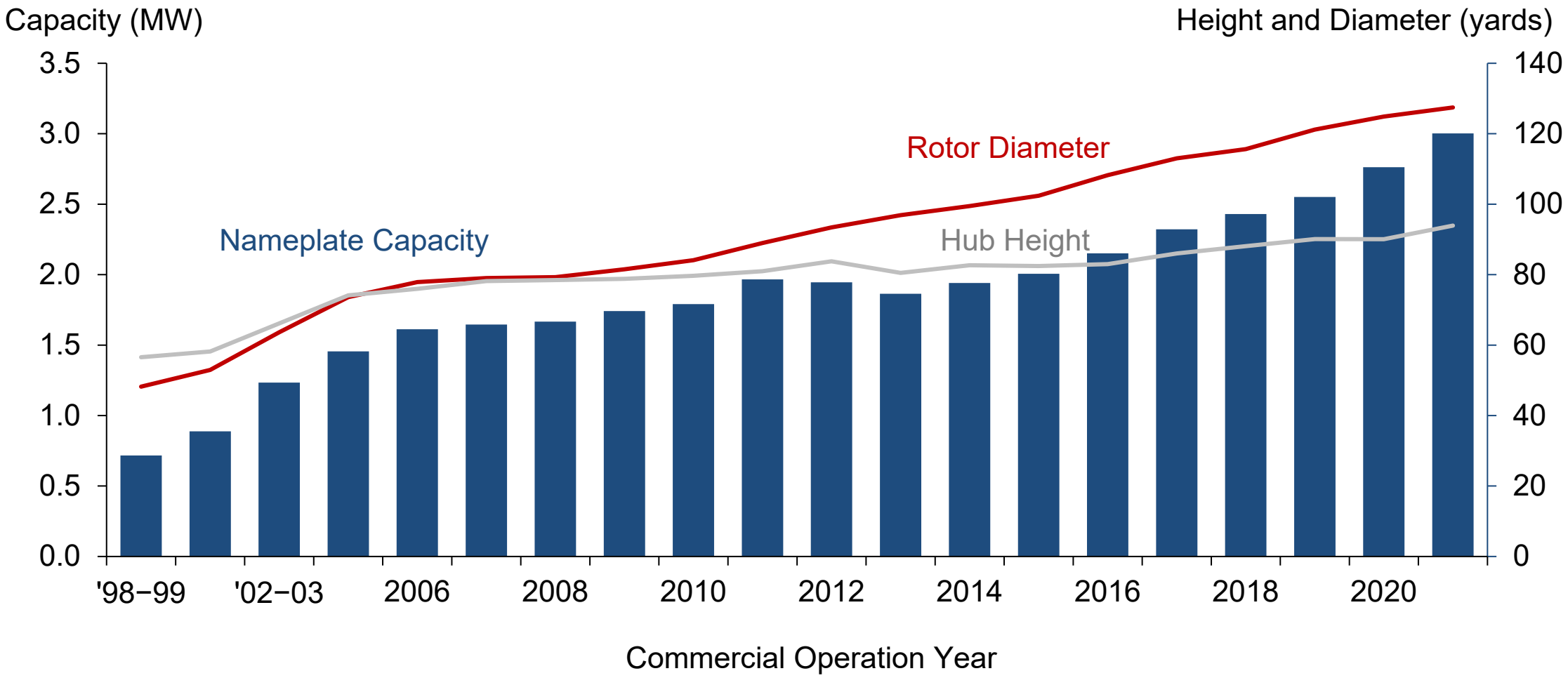
“Wind Belt” Dominates Resources and Capacity



Top 10 States	Capacity (MW) 2022 Q2	Capacity (MW) 2020 Q4
TX	36,808	33,133
IA	12,428	11,660
OK	11,992	9,048
KS	8,245	7,016
IL	7,037	6,409
CA	6,112	5,922
CO	5,198	4,692
MN	4,578	4,299
ND	4,302	2,723
NM	4,235	3,989
Top 10 total	**100,935**	**88,891**
Top 11–20 states	**29,841**	**25,788**
Remaining 30 states	**8,240**	**7,661**

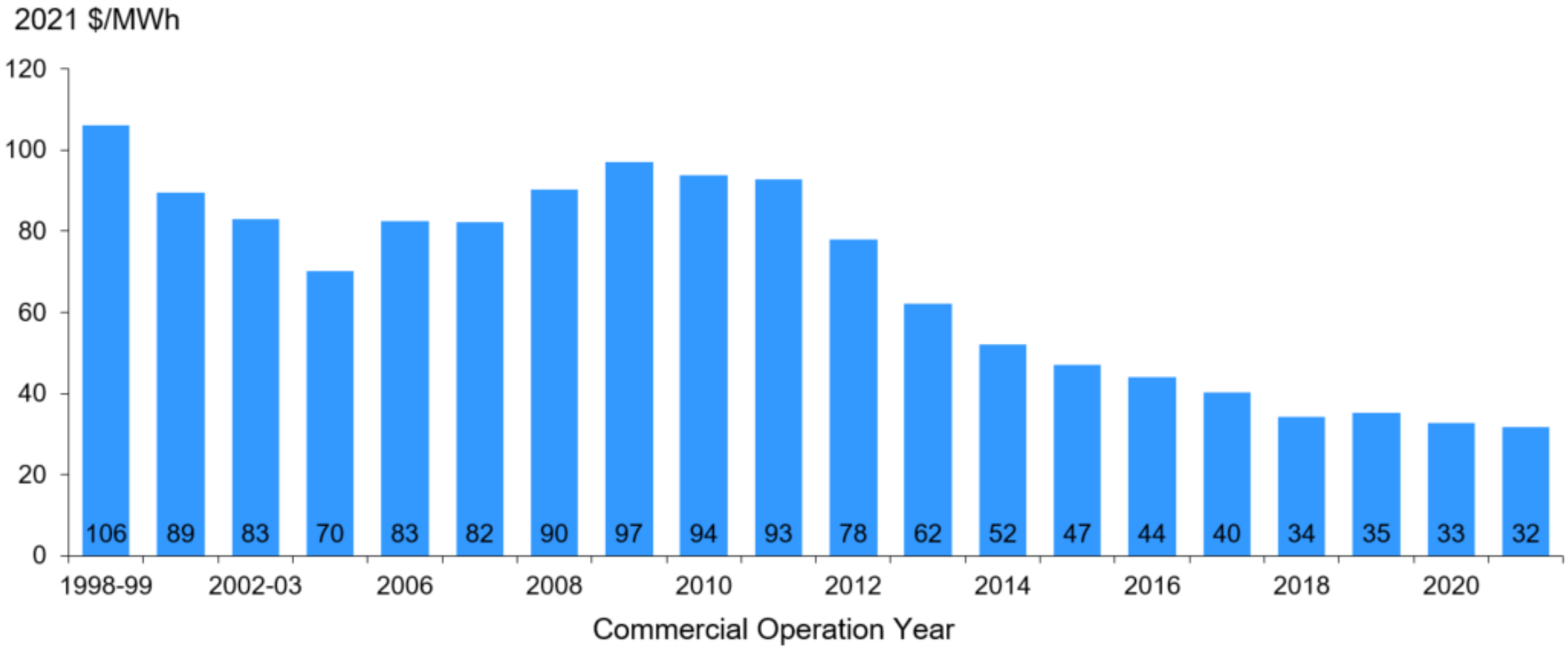
Note: m stands for meters and m/s stands for meters per second. In the table, MW is megawatts.
Source: AWS TruePower; National Renewable Energy Laboratory; Office of Energy Efficiency & Renewable Energy; American Clean Power Association

Turbines Becoming Bigger and More Efficient



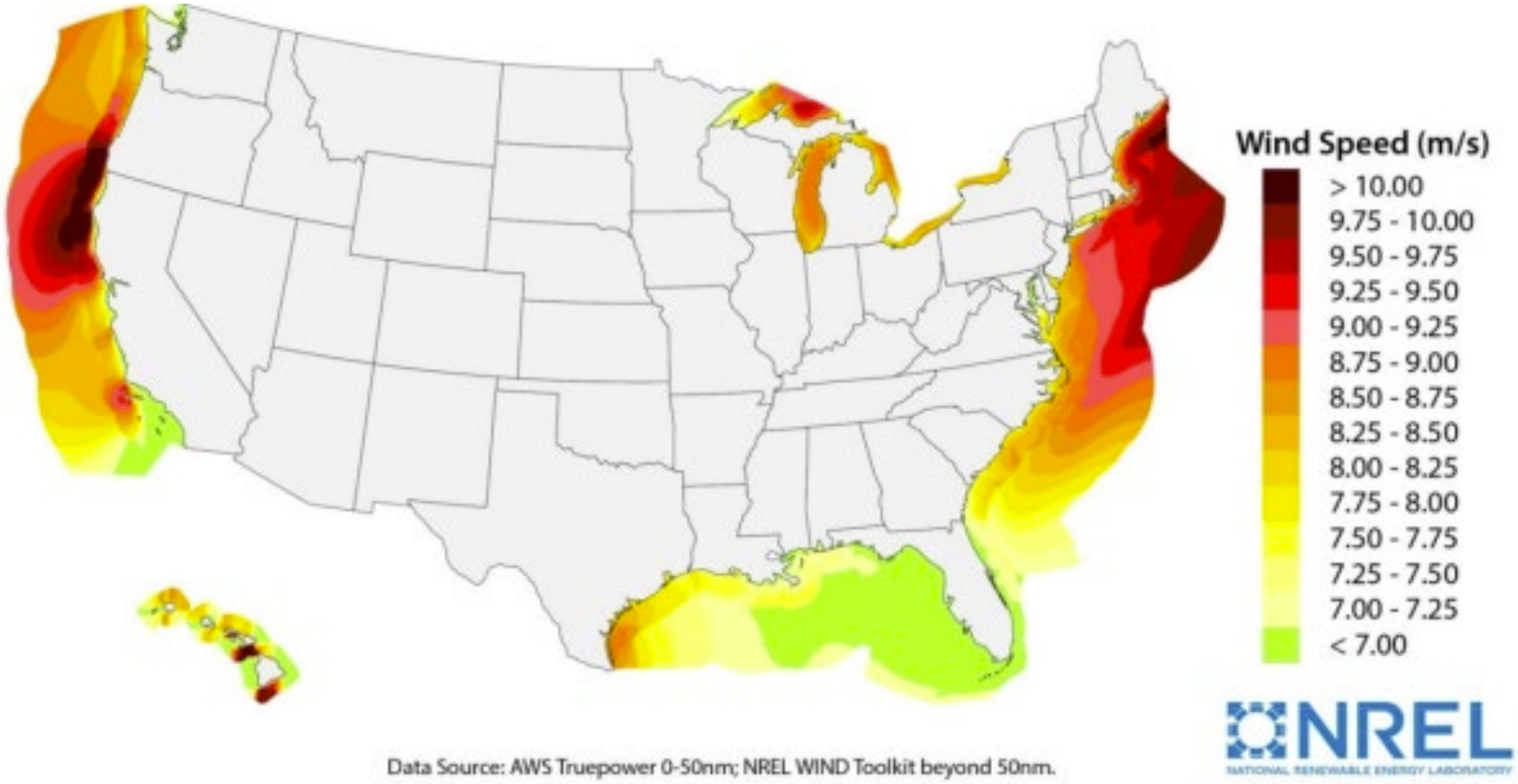
Note: MW is megawatts.
Source: ACP; Lawrence National Berkeley Laboratory

Newer Wind Projects Have Lower Levelized Cost of Energy (LCOE)



Note: LCOE is generation-weighted average and unsubsidized (does not include impact of the Production Tax Credit on costs). MWh is megawatt-hour.
Source: Lawrence National Berkeley Laboratory

Offshore Wind Resources on the Coasts

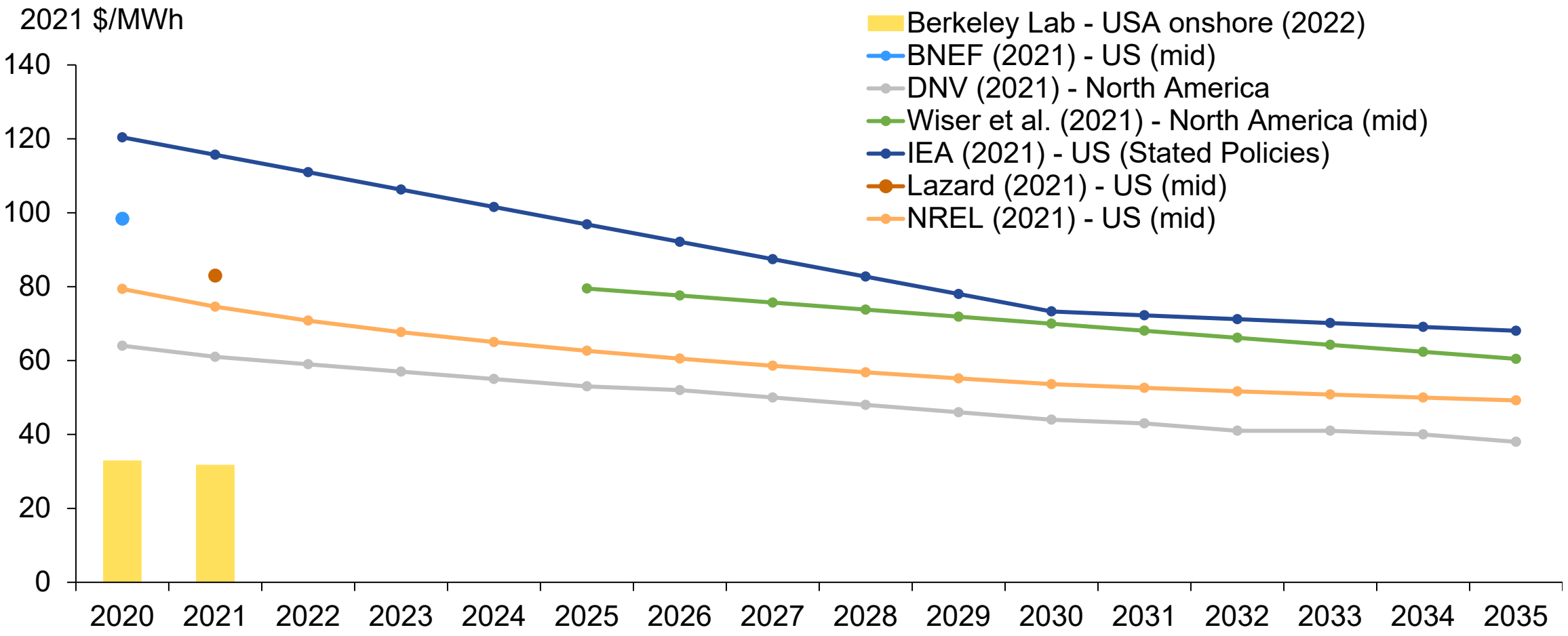


Note: m/s is meters per second and nm is nautical miles.
Source: AWS Truepower; National Renewable Energy Lab

Little Installed Capacity but Growing Pipeline

- Offshore wind is a nascent industry in the United States.
- Operating capacity is 42 megawatts (MW).
- Current onshore wind capacity is close to 139,000 MW.
- Another 932 MW of offshore wind is approved to begin construction.
- Over 39,000 MW is at various stages of the planning/permitting process.

Cost of Electricity from Offshore Wind Remains High



Note: MWh is megawatt-hour; BNEF is Bloomberg New Energy Finance; IEA is International Energy Agency; NREL is National Renewable Energy Laboratory.
Source: U.S. Department of Energy Offshore Wind Market Report: 2022 Edition

Poll Question

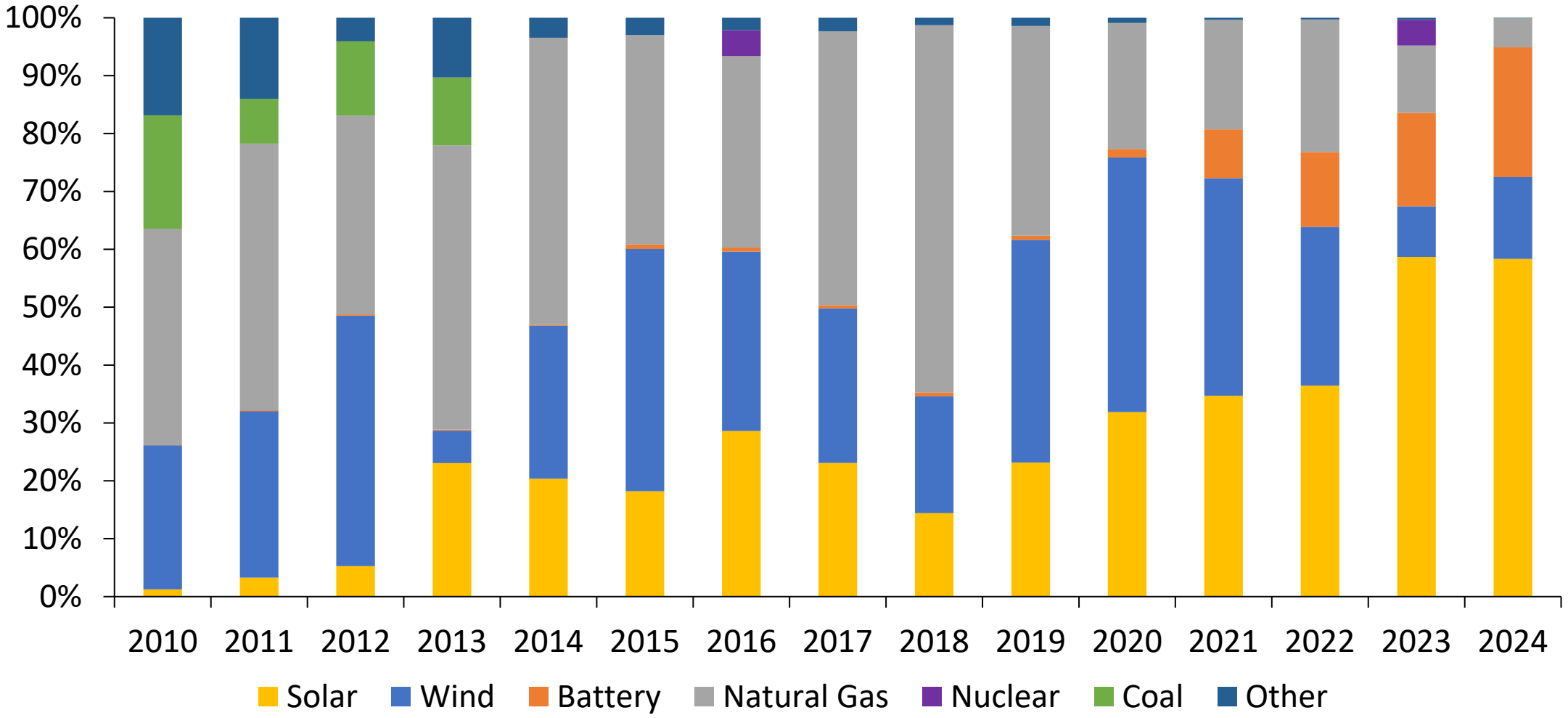
Which renewable energy has the largest generating capacity in the United States?

A. Utility-scale solar
B. Residential solar
C. Onshore wind
D. Offshore wind
E. Other

Solar Power in the United States

Solar is the Leading Source of New Generation Capacity

New capacity additions as a percentage share

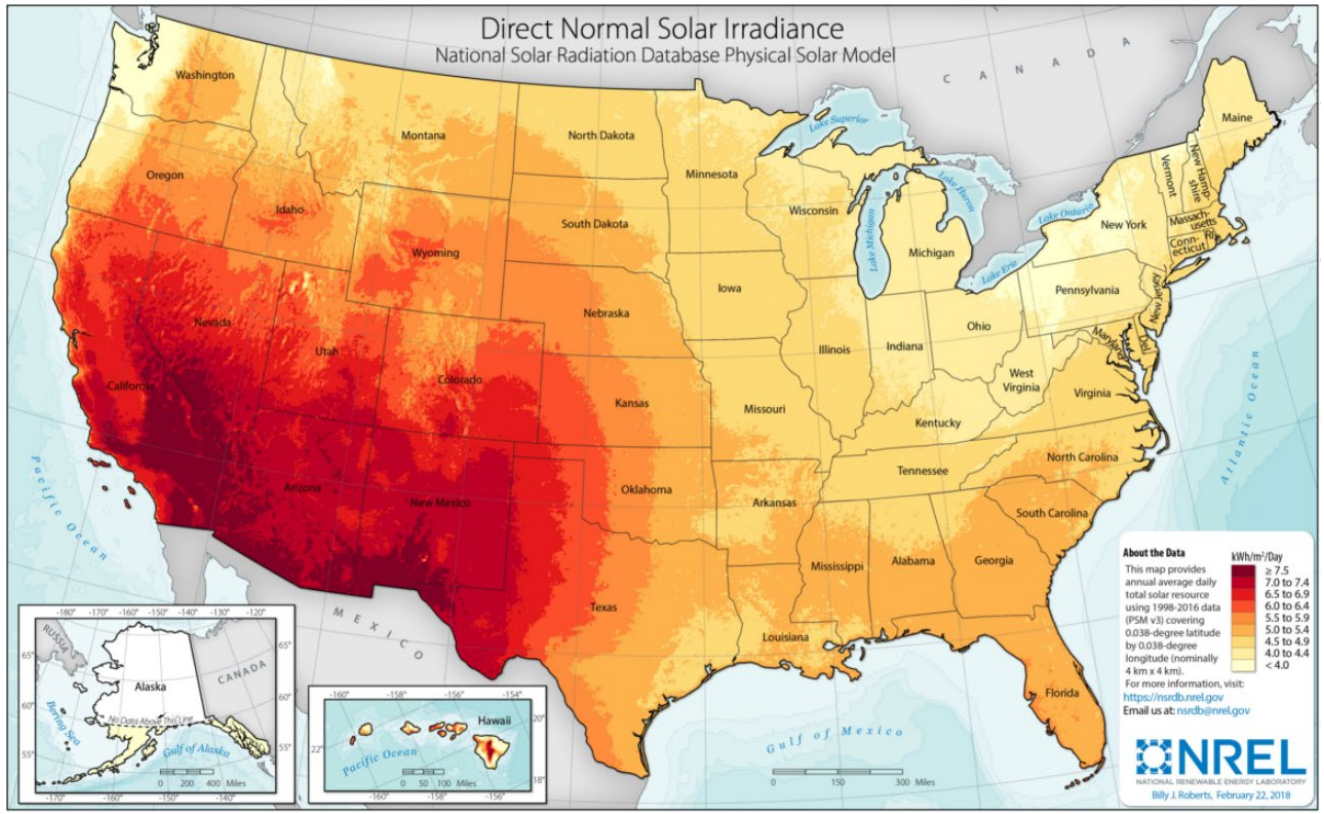


Source: U.S. Energy Information Administration, Preliminary Monthly Electric Generator Inventory, August 2022

Solar Has More Geographical Distribution than Wind

Utility Scale Solar:

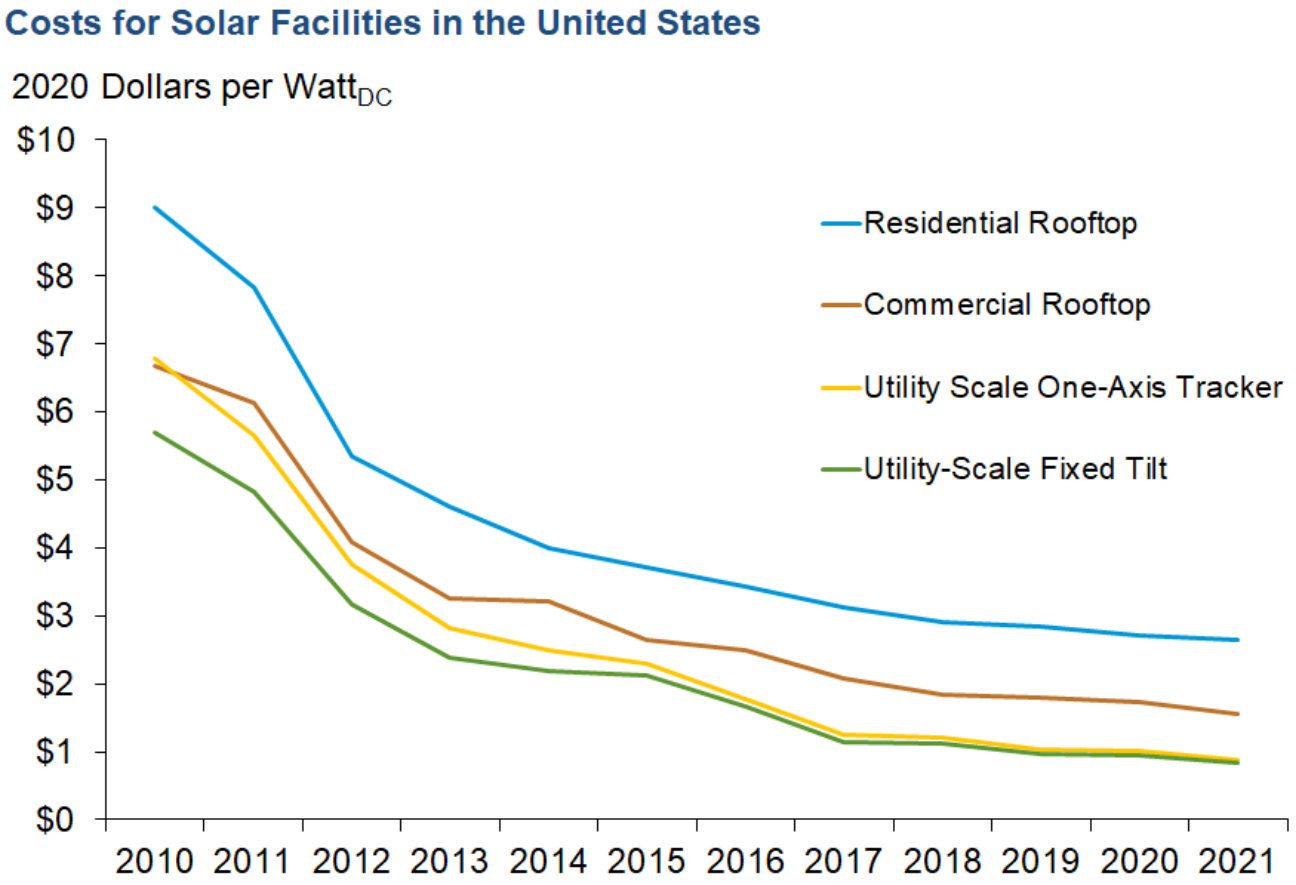
Top 10 States	Capacity (MW) Dec. 2021	Capacity (MW) Dec. 2020
CA	**15,582**	**14,236**
TX	**8,838**	**4,880**
NC	**5,749**	**5,191**
FL	**4,879**	**3,775**
NV	**3,151**	**2,517**
GA	**3,080**	**2,210**
AZ	**2,811**	**2,431**
VA	**2,203**	**1,315**
UT	**1,457**	**1,196**
MA	**1,195**	**1,026**
Top 10 total	**48,944**	**38,775**
Top 11–20 states	**8,470**	**6,447**
Remaining 30 states	**4,403**	**3,201**



Note: Data is only for utility-scale solar, and the top 10 states ranking is for December 2021.
Source: U.S. Energy Information Administration, Preliminary Monthly Electric Generator Inventory, August 2022

Declining Costs and Tax Credits Drive Solar Installation

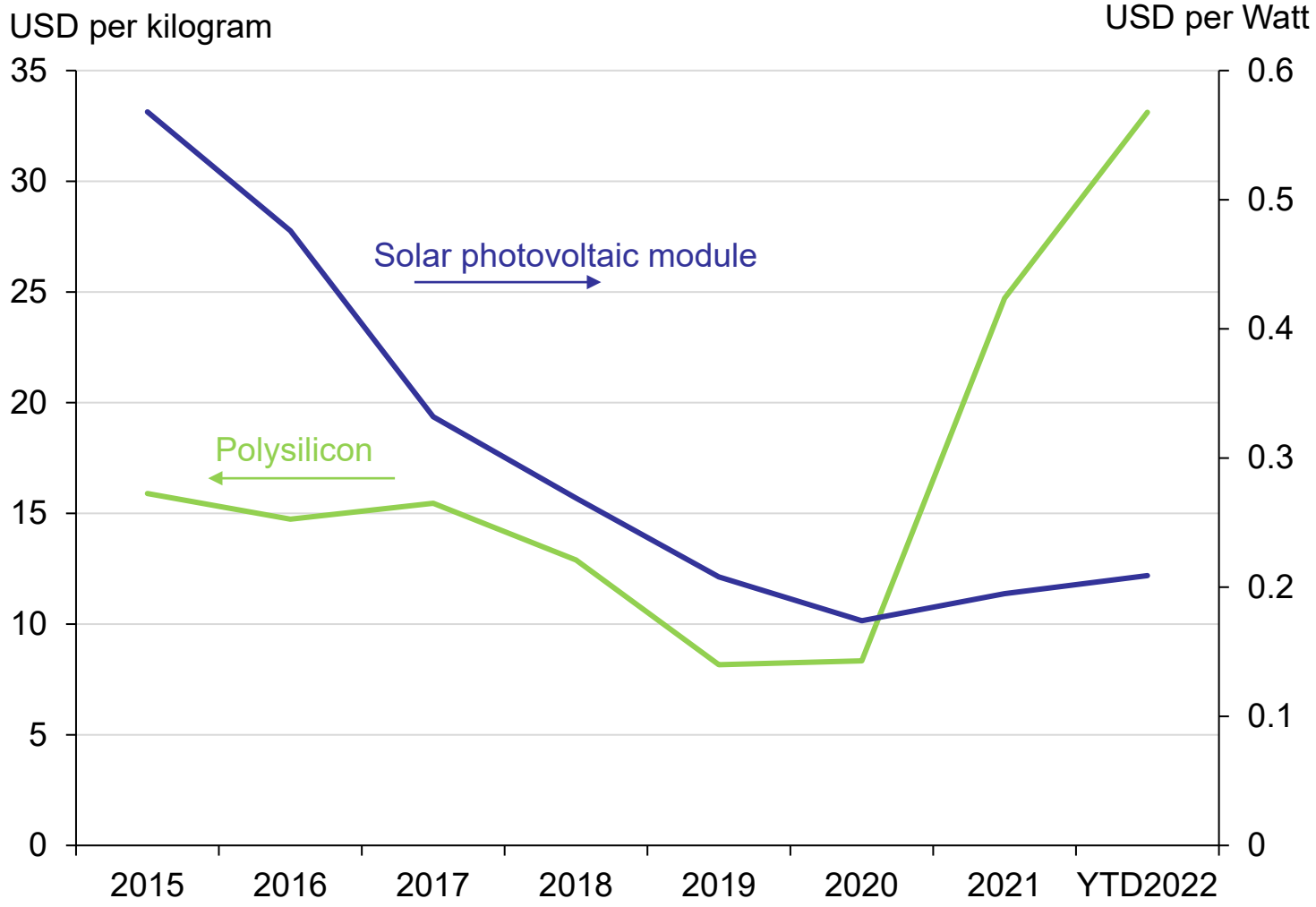
- Solar modules have become more efficient over the past decade, driving better economics.
- The Inflation Reduction Act provides additional incentives.



Note: Estimates above do not include federal and/or state incentives.
Source: National Renewable Energy Laboratory

Input Costs Rose over Past 24 Months, Although Increase in Panel Prices Smaller

- Supply chain disruptions and polysilicon price increases raised the cost of solar modules in 2021 and 2022.
- The majority of polysilicon processing and solar module manufacturing takes place in China.
- While there has been a significant jump in the price of polysilicon, the increase in module prices has been smaller as it only makes up a small portion of the overall cost.

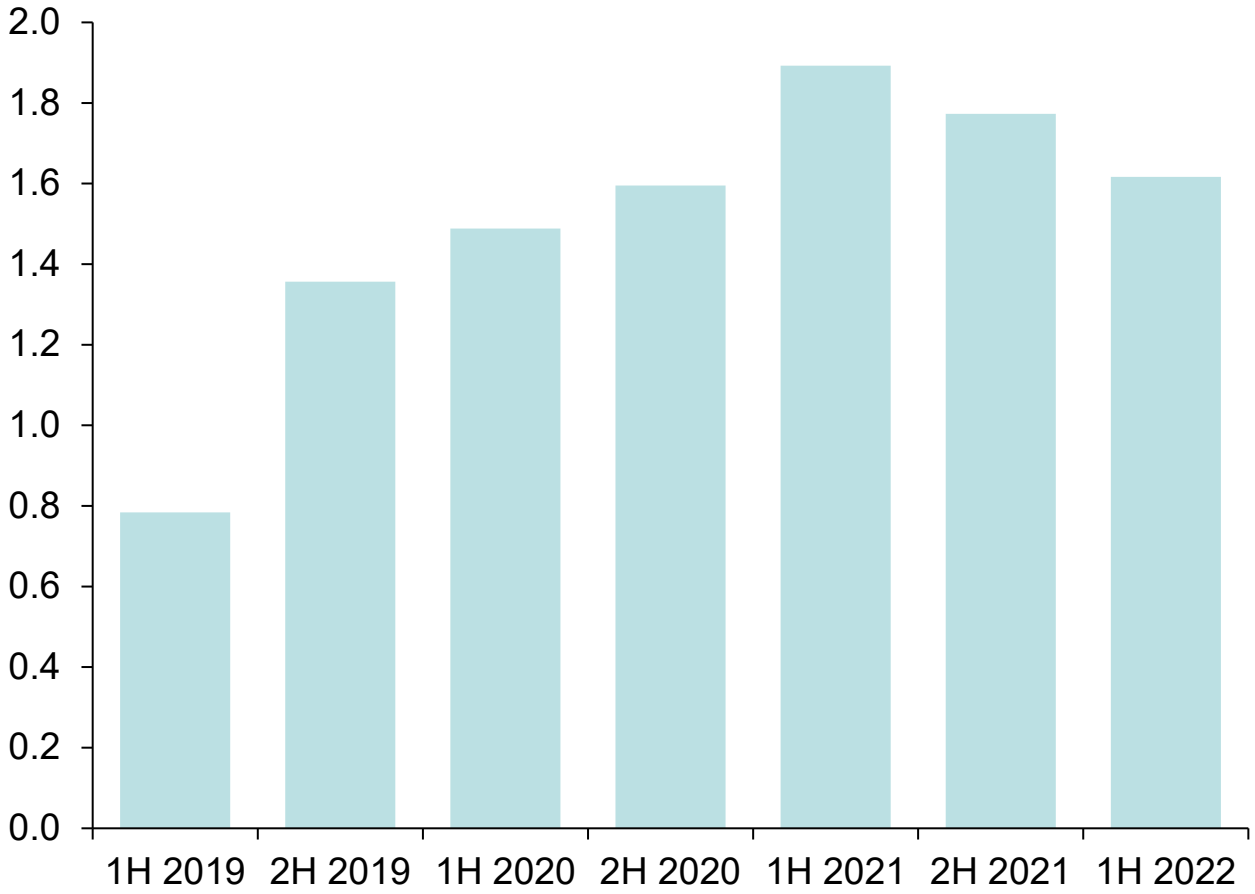


Note: Solar photovoltaic module price is for polycrystalline. 2022 data is through July.
Source: Bloomberg

Supply-chain Delays Have Caused Solar Panel Module Imports to Modestly Decline, Causing Project Delays

- There is currently strong demand from developers for solar projects.
- However, a variety of reasons have caused imports to decline in 2nd half 2021 vs. 1st half 2021, and further into 1st half 2022:
  - Supply chain delays
  - Ban on importing panels which may have polysilicon from the Xinjiang region in China
  - Uncertainty regarding tariffs

Monthly average U.S. imports of photovoltaic modules in millions

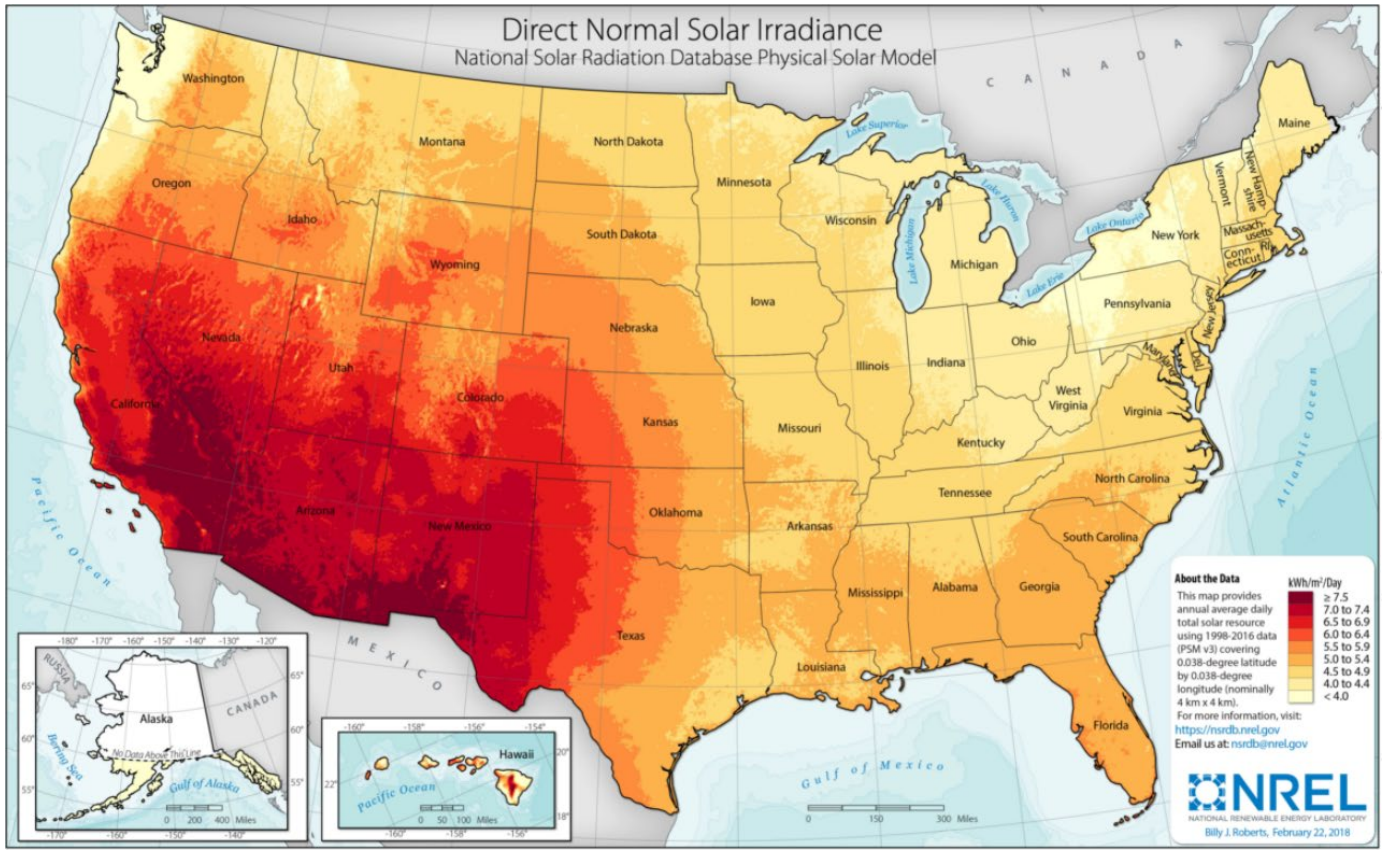


Source: U.S. Energy Information Administration

Largest Market for Residential Solar is California

Residential Solar:

Top 10 States	Capacity (MW) Dec. 2021	Capacity (MW) Dec. 2020
CA	8,000	6774
AZ	1,466	1200
TX	1,256	909
NY	1,046	921
NJ	1,042	934
FL	1,001	665
MA	820	731
MD	685	629
NV	552	438
CO	527	320
Top 10 total	**16,394**	**13,522**
Top 11–20 states	**2,885**	**2,334**
Remaining 30 states	**1,701**	**1,284**



Note: Data is only for residential solar, and the top 10 states ranking is for December 2021.
Source: U.S. Energy Information Administration

Residential Solar Has Sizeable Costs Related to Sales and Marketing, Overhead, and Profit on a Per Watt Basis

- Residential solar is considerably more expensive than utility-scale solar.
- This is primarily because residential solar has a sizeable sales and marketing, overhead, and profit-related cost.
- This is also because of economies of scale.

	Residential (2020 USD/$Watt_{DC}$)	Utility-scale (2020 USD/$Watt_{DC}$)
Module	0.33	0.33
Inverter	0.27	0.04
Balance of system	0.32	0.19
Sales Tax	0.06	0.04
Install Labor	0.18	0.11
Sales and Marketing	0.48	0.00
Overhead (General and Administrative)	0.28	0.07
Profit	0.28	0.04
Other	0.45	0.07
Total	2.65	0.89

Note: Residential solar is for a 7.15-kW system, and utility-scale-solar is for a 100 MW one-axis tracker. “Install Labor and Equipment” category used to provide “Install Labor” for utility-scale estimate. “Engineering, Procurement, and Construction/Developer Profit” used to provide “Profit” for utility-scale estimate. “Developer Overhead” and “Engineering, Procurement, and Construction Overhead” categories used to provide “Overhead (General and Administrative)” for utility-scale estimate. There was no Sales and Marketing estimate for utility-scale solar.
Source: NREL U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021.

Poll Question

Indicate your financial institution's involvement in financing solar and/or wind energy projects.

A. Currently and/or have previously financed
B. Have not financed but have considered
C. Have not financed and have not considered
D. Unsure/Not Applicable

Shared National Credit (SNC) Trends in the Renewable Energy Sector

Key Takeaways from SNC

- SNC renewable lending is estimated at $81 billion (1.5 percent).
- Relatively large loan commitments are provided by foreign banking organizations' (FBOs) U.S. operations.
- Criticized SNC renewable credits are trending down since 2015 and are also less cyclical than oil and gas credits and other SNC credits.

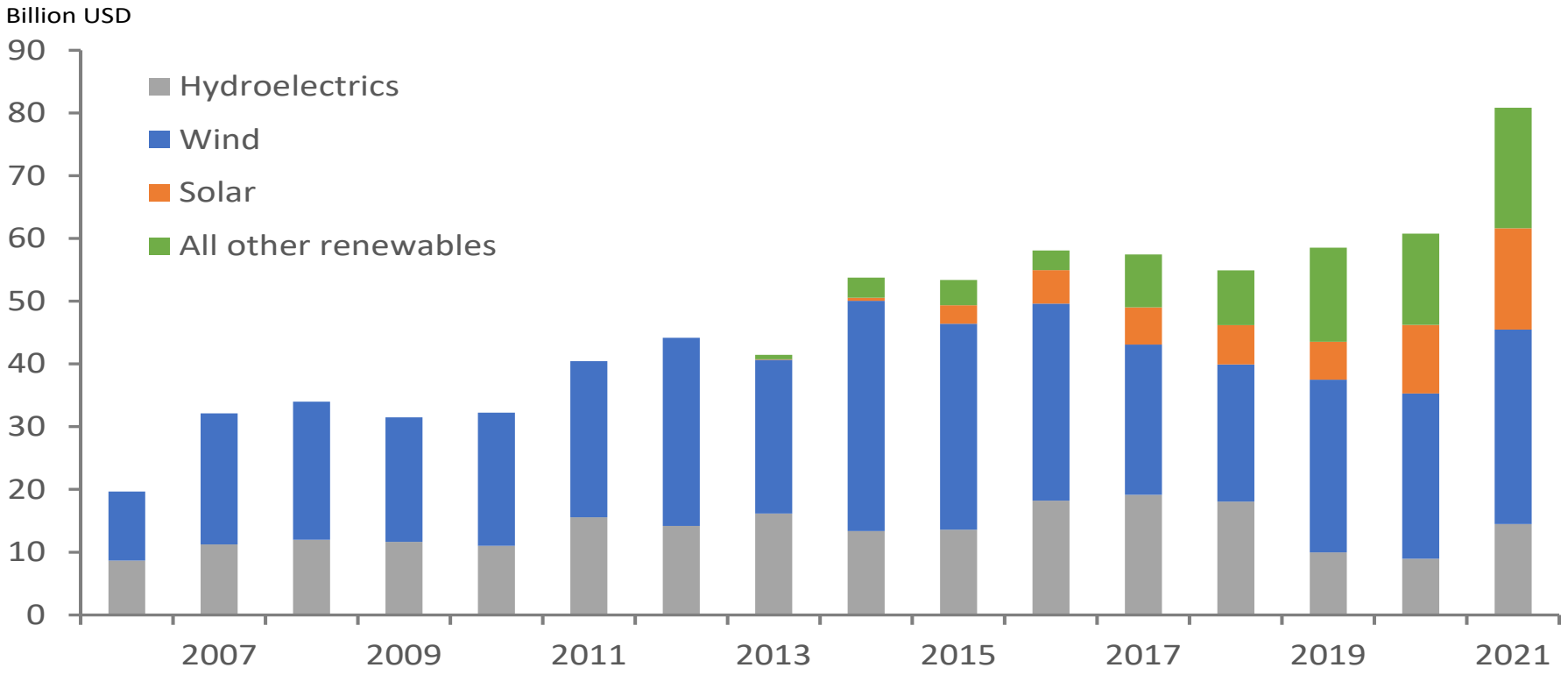
SNCs May Not Capture All Renewable Credits

- SNC registry requires:
  - The syndicated loan to be held by at least three federally supervised banks
  - Aggregate exposures greater than $100 million

- Industry classification may not be detailed enough to capture evolving trends in financing to solar and wind projects.
  - No NAICS designation for developers, platform companies, or financial investors of solar and wind projects
  - Unable to separate balance-sheet financing of companies' renewable projects from those associated with other businesses (e.g., nonrenewable portfolios for utility)

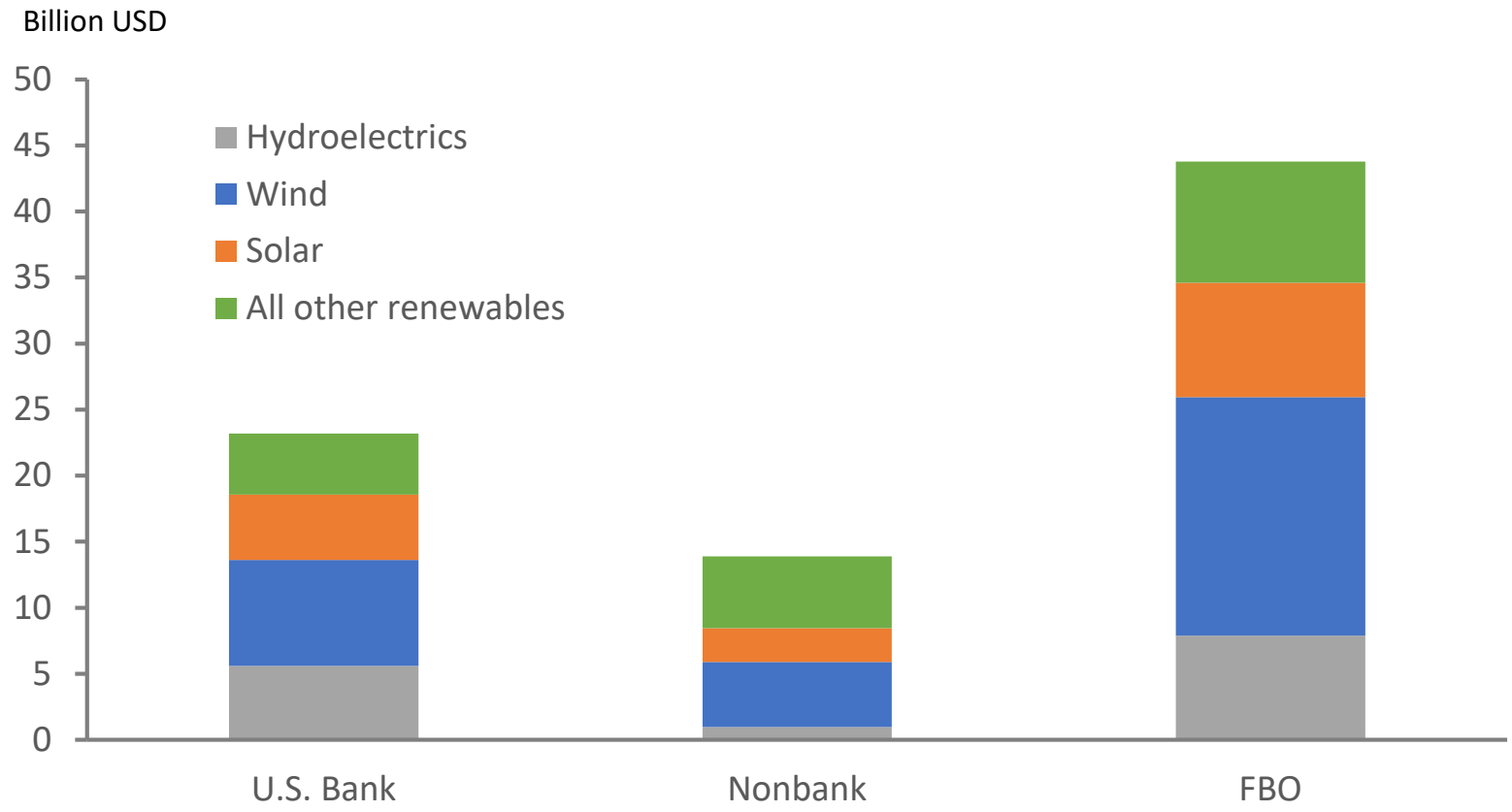
SNC Renewable Commitments Are Increasing

- Committed exposures total $81 billion and have more than doubled since 2010.
- Many renewable projects are too small for syndication and/or cannot be captured fully based on NAICS.



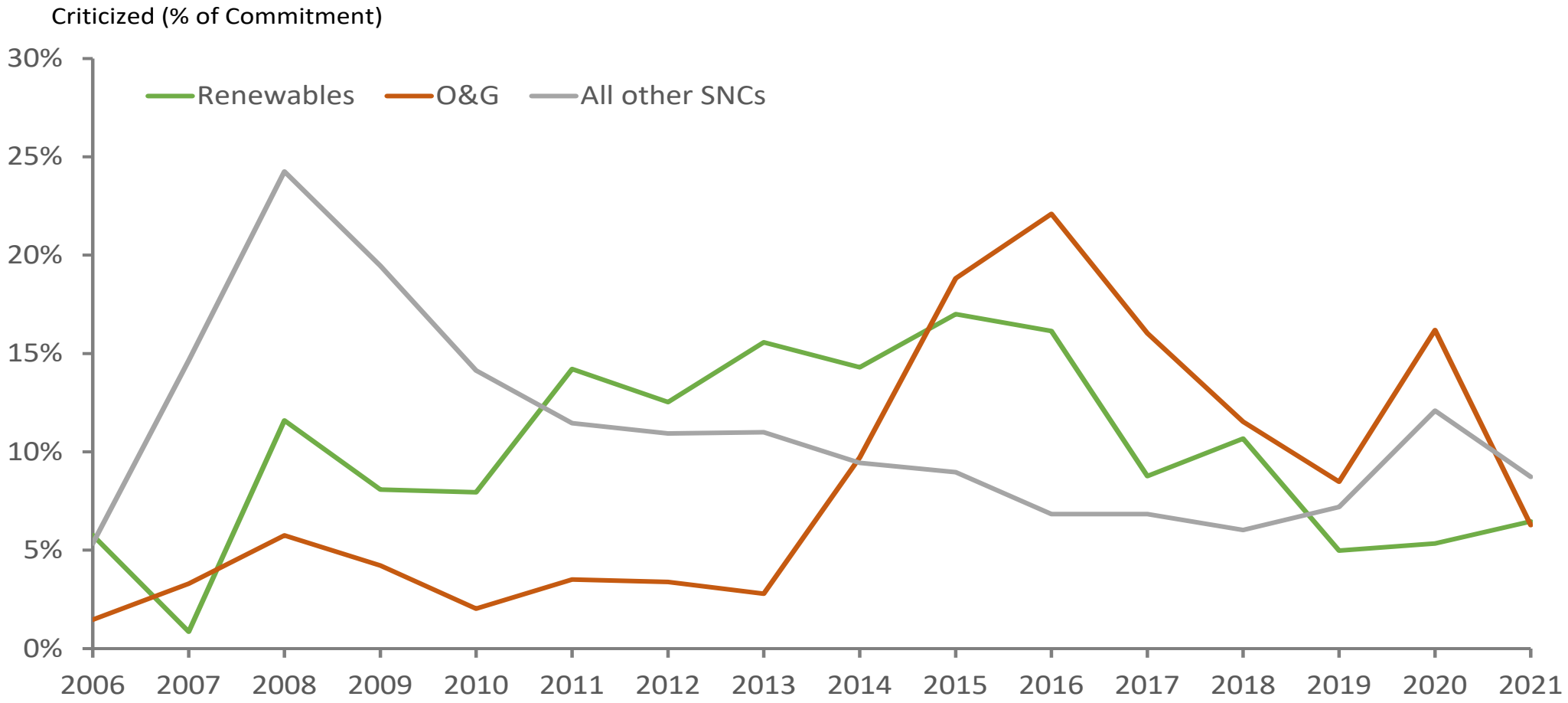
Note: All other renewables include geothermal, biomass, and all other electric power including independent power producers (IPPs).
Source: SNC

FBOs' U.S. Operations Active in Renewable Lending



Note: Committed exposures as of December 31, 2021. All other renewables include geothermal, biomass, and all other electric power, including IPPs.
Source: SNC

SNC Energy Credit Quality Trends



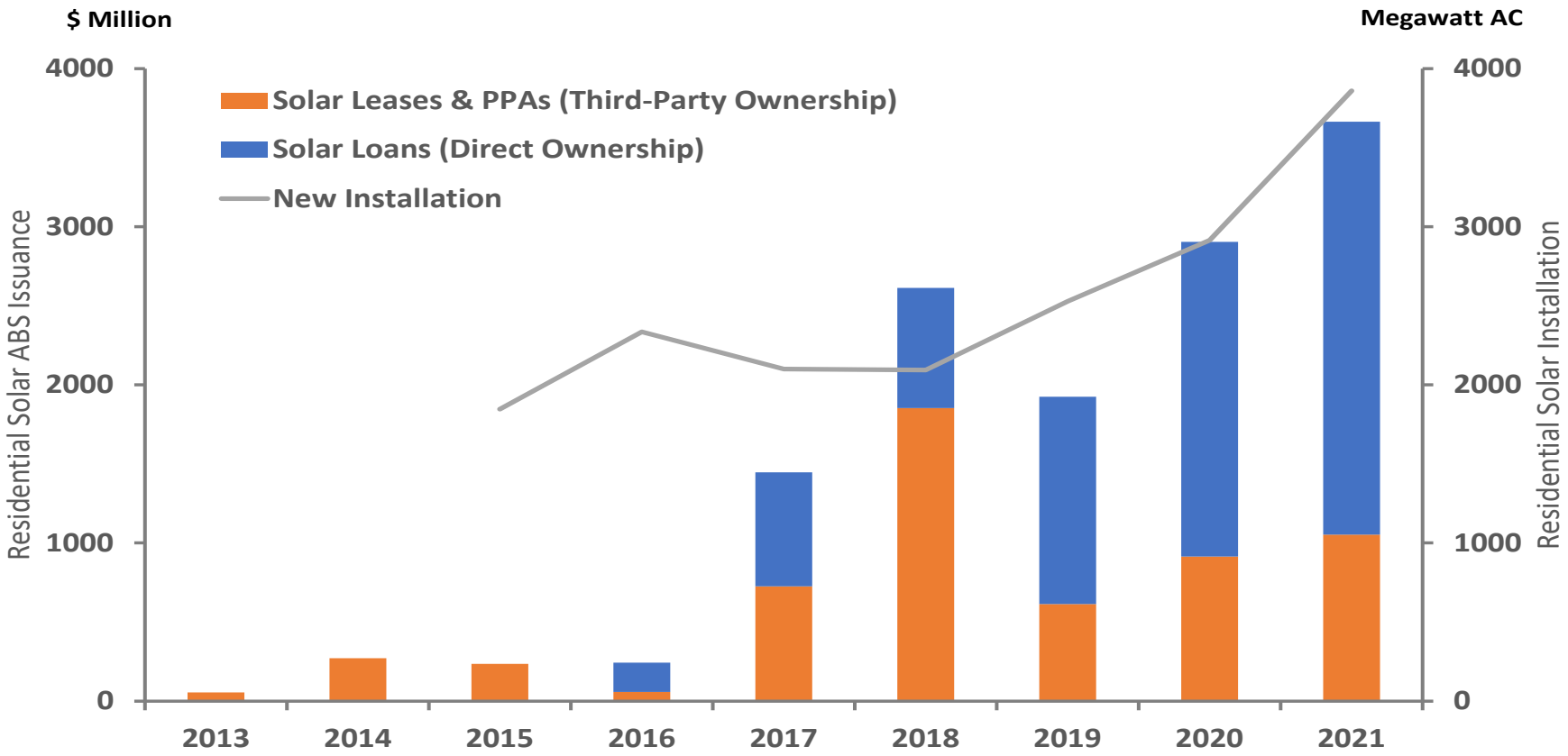
Note: Criticized commitments are commitments rated Special Mention, Substandard, Doubtful, or Loss. These commitments reflect deterioration of the repayment prospects and deserve management's close attention.
Source: SNC

Residential Solar Financing Risks

Key Takeaways for Residential Solar

- Residential Solar is transitioning from third-party ownership model to direct ownership model.
- Under direct ownership model, solar loan borrowers are subject to technology, operation and maintenance (O&M), and legal/regulation risks.
- Solar loan amounts are increasing and maturities are lengthening.

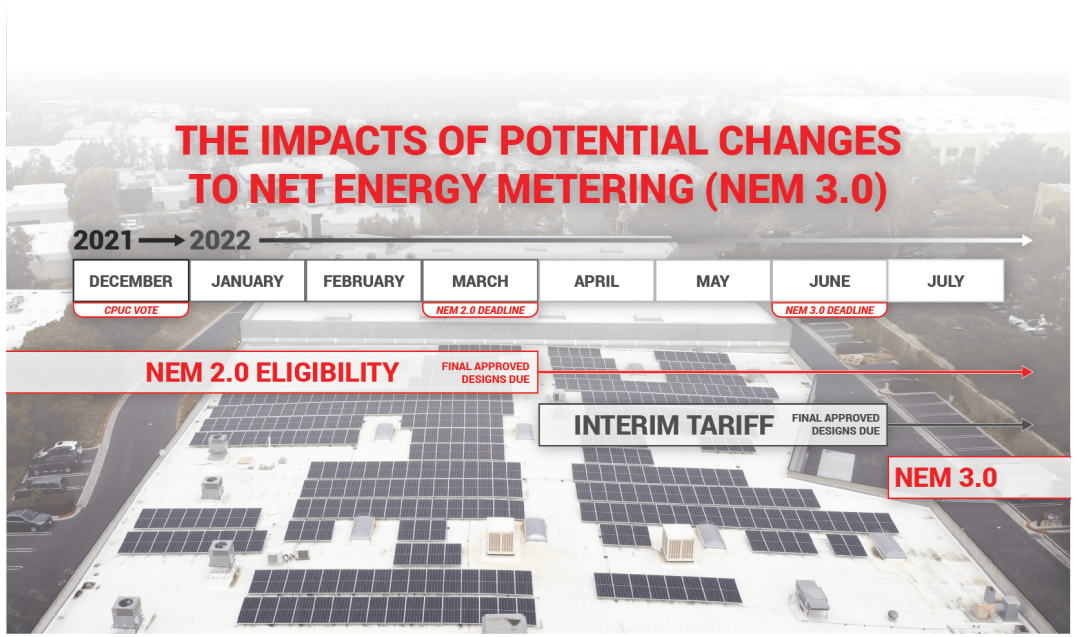
Direct Ownership Accounts for a Growing Percentage of Residential Solar



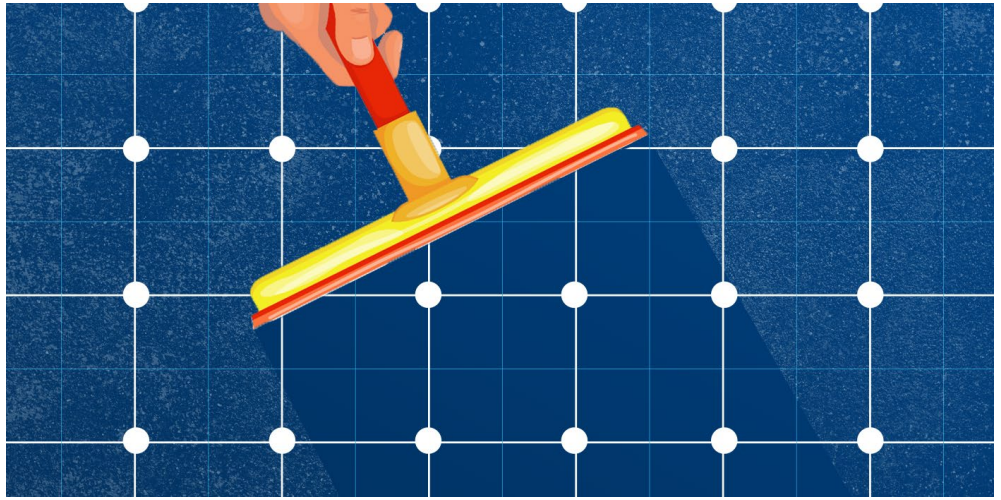
Note: Solar asset-backed security (ABS) issuance amounts as of December 31, 2021. PPAs is short for power purchasing agreements. “Solar leases & PPAs” includes three ABS securities backed by solar renewable energy credits.
Source: Bloomberg

Homeowners Face Operation Risks When Owning a Solar Energy System

- Change in federal tax incentives and/or state regulations could affect solar loan performance.
- Homeowners are responsible for O&M and face the risk of damage or destruction as well.

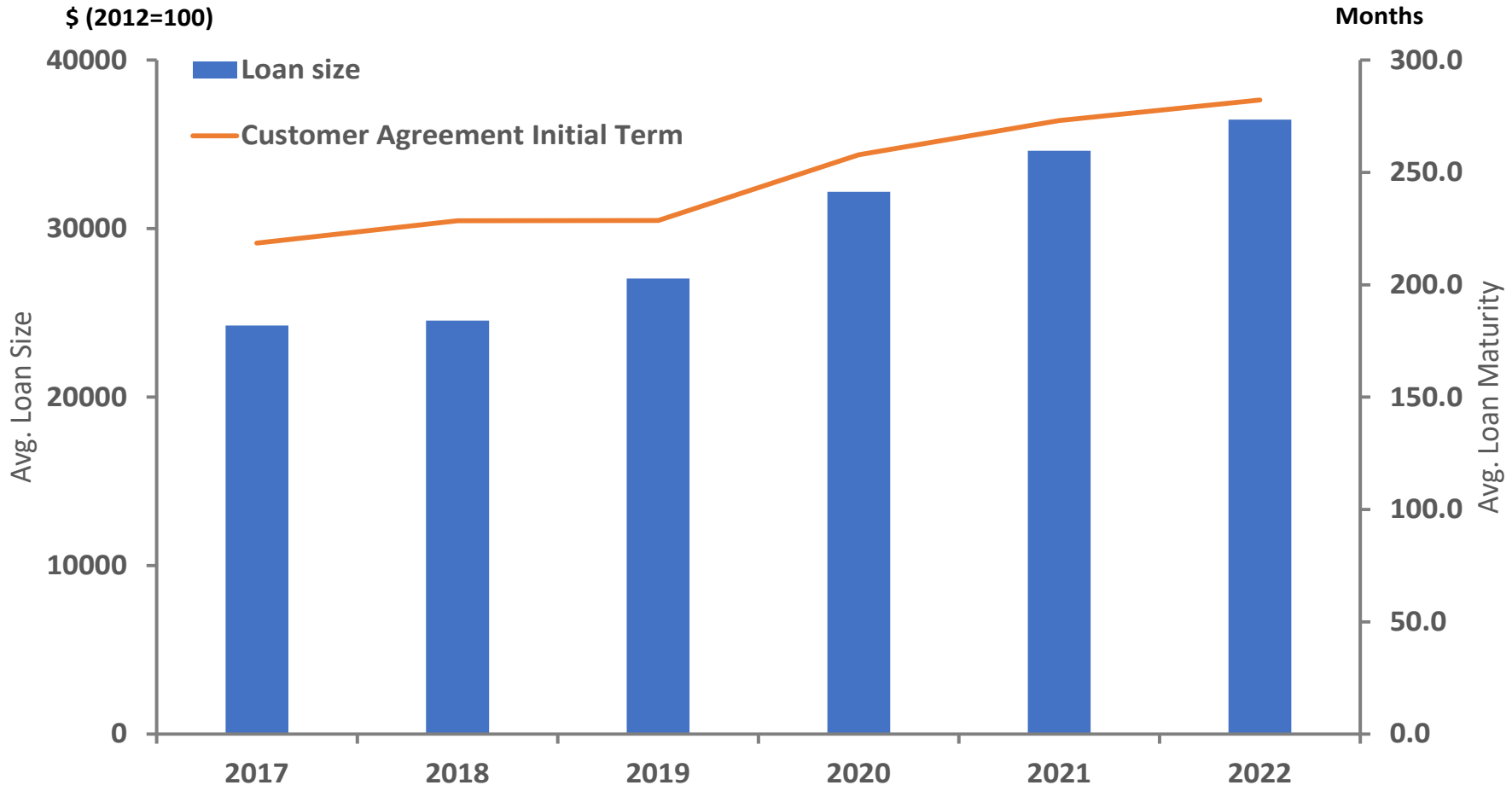


Source: Ravel Energy



Source: SolarReviews

Solar Loans Are Getting Larger and Longer



Note: Loan size and customer agreement initial term are weighted average across solar loan ABS securities.
Source: Kroll Bond Rating Agency, LLC

Poll Question

In your opinion, do you believe the risks associated with financing solar and/or wind energy projects are:

A. Increasing
B. Decreasing
C. Unchanged

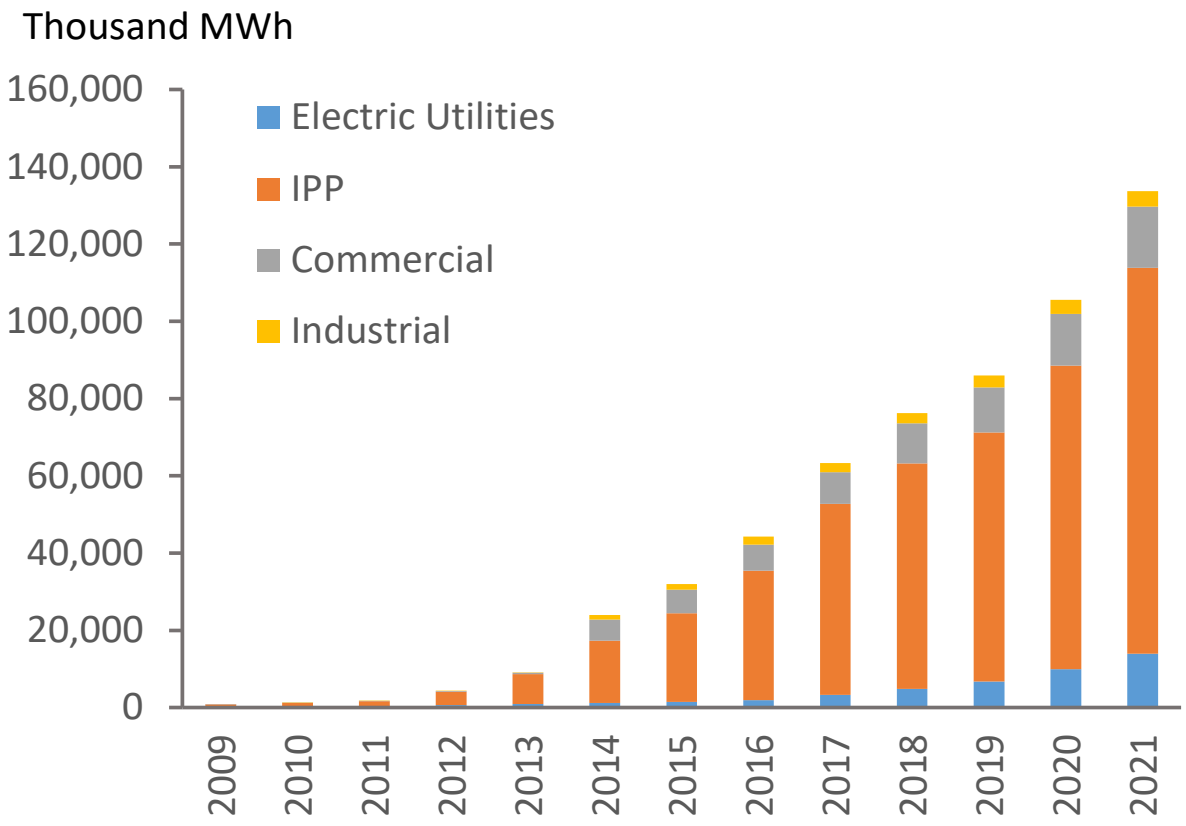
Utility-Scale Financing Risks

Key Takeaways for Utility-Scale Financing Risks

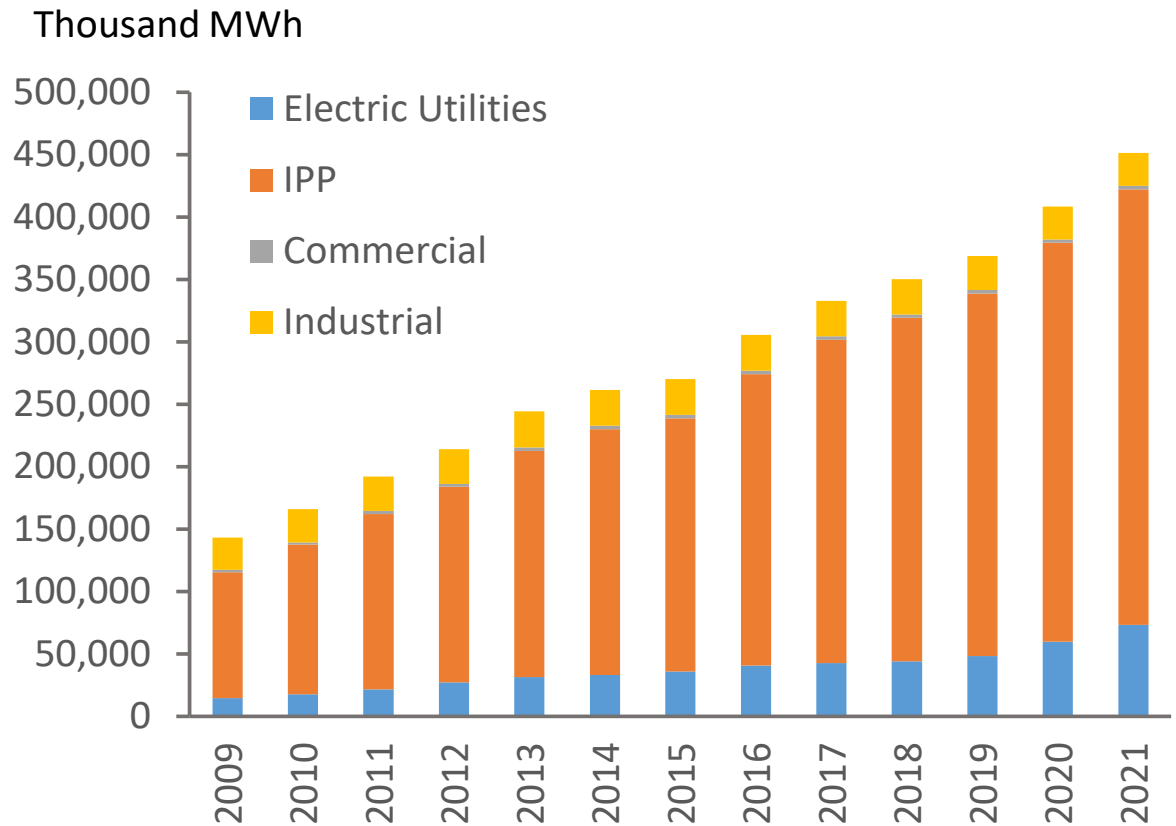
- Independent power producers (IPPs) are the major players in U.S. solar and wind projects in the United States, and they face distinct risks throughout the electricity value chain.
- Industry analysis suggests solar generation may be overestimated, which can impair project cash flow.
- Curtailment levels are non-negligible, result in lower utilization of installed capacity, and can reduce project cash flow.
- Congestion may lead to basis risk resulting in lower project cash flow.
- There is growing interest from corporations to purchase solar and wind energy, and shortened corporate contracts are creating greater merchant tail risk for generators and lenders.

IPPs Continue to Be the Major Players in U.S. Solar and Wind Projects

Electricity generation from solar, by sector

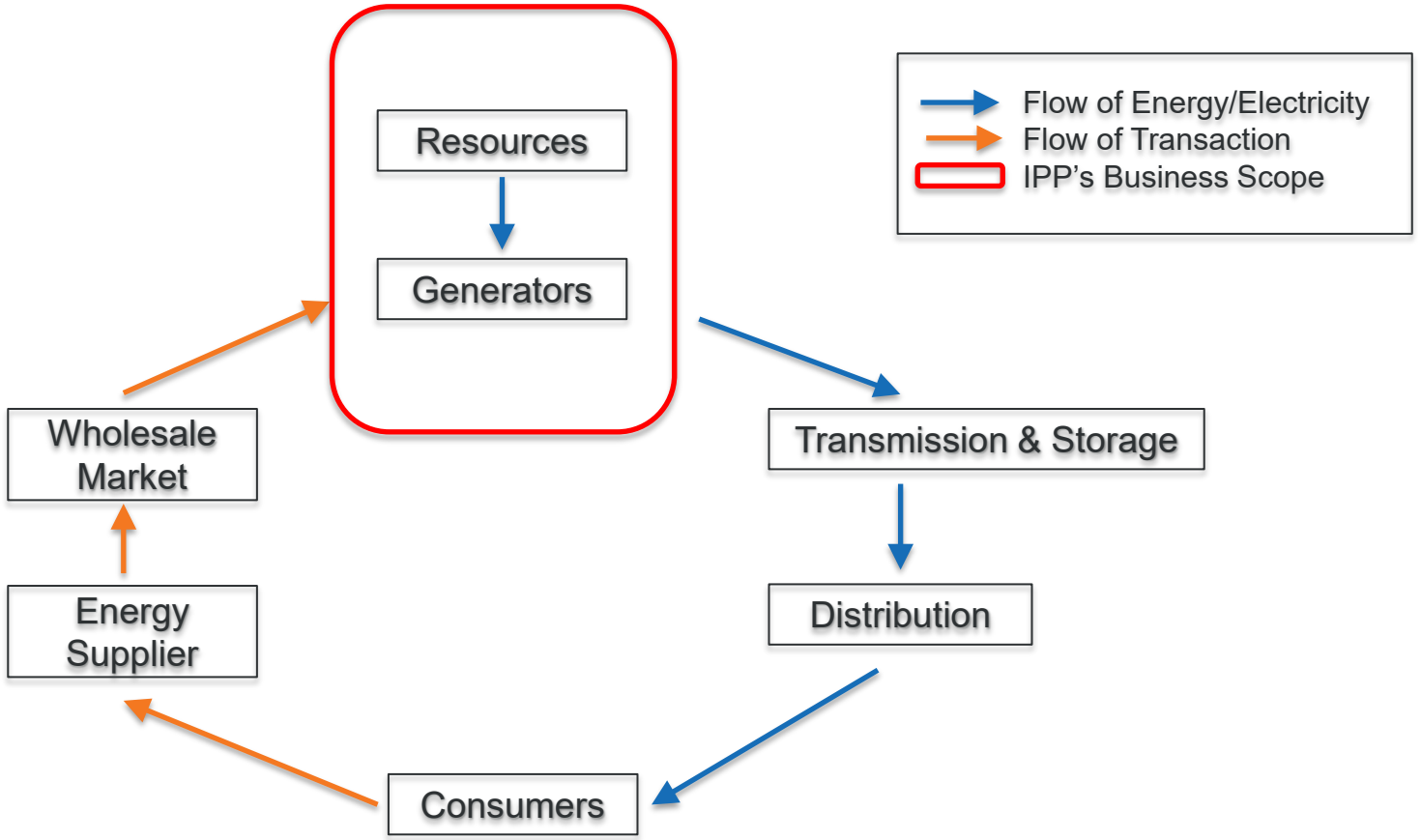


Electricity generation from wind, by sector



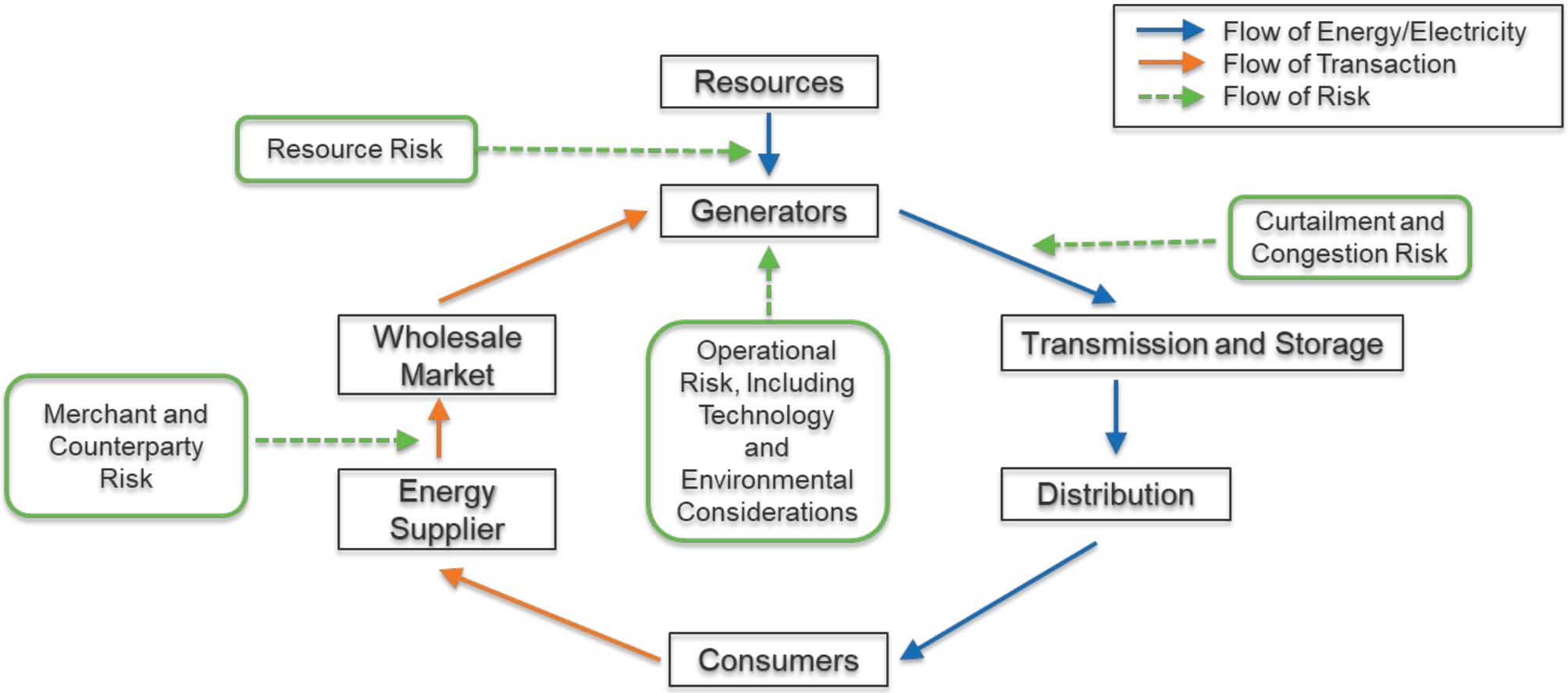
Source: U.S. Energy Information Administration

IPPs Involved in Resource Generation; Not Vertically Integrated in Transmission and Distribution



Source: Federal Reserve Bank (FRB) Dallas

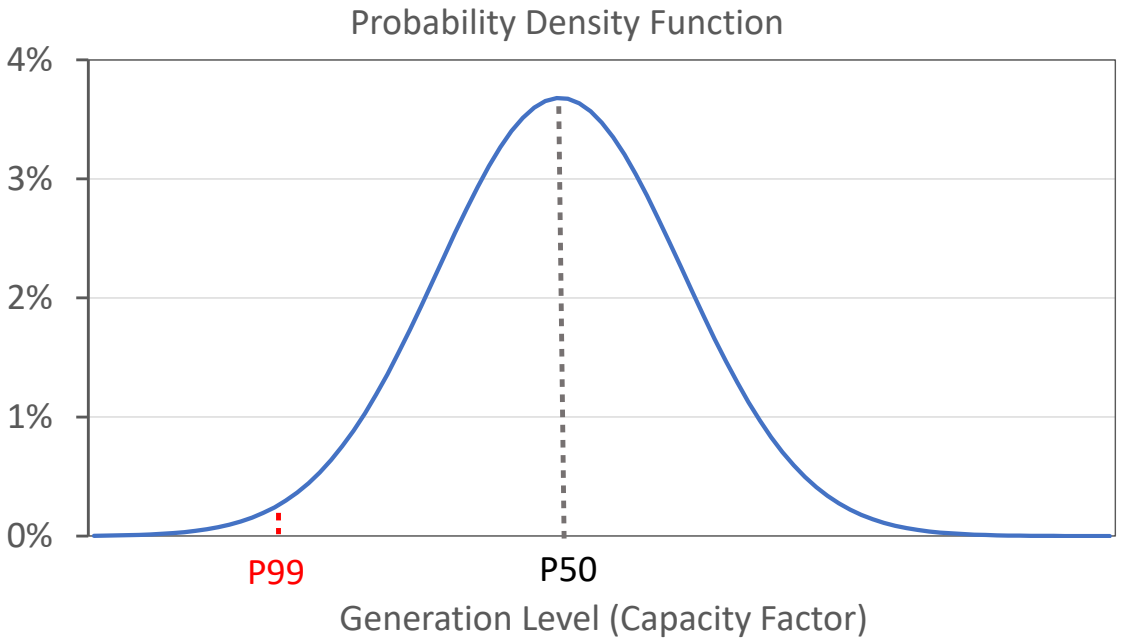
Various Risks Exist throughout the Value Chain of Electricity Generation



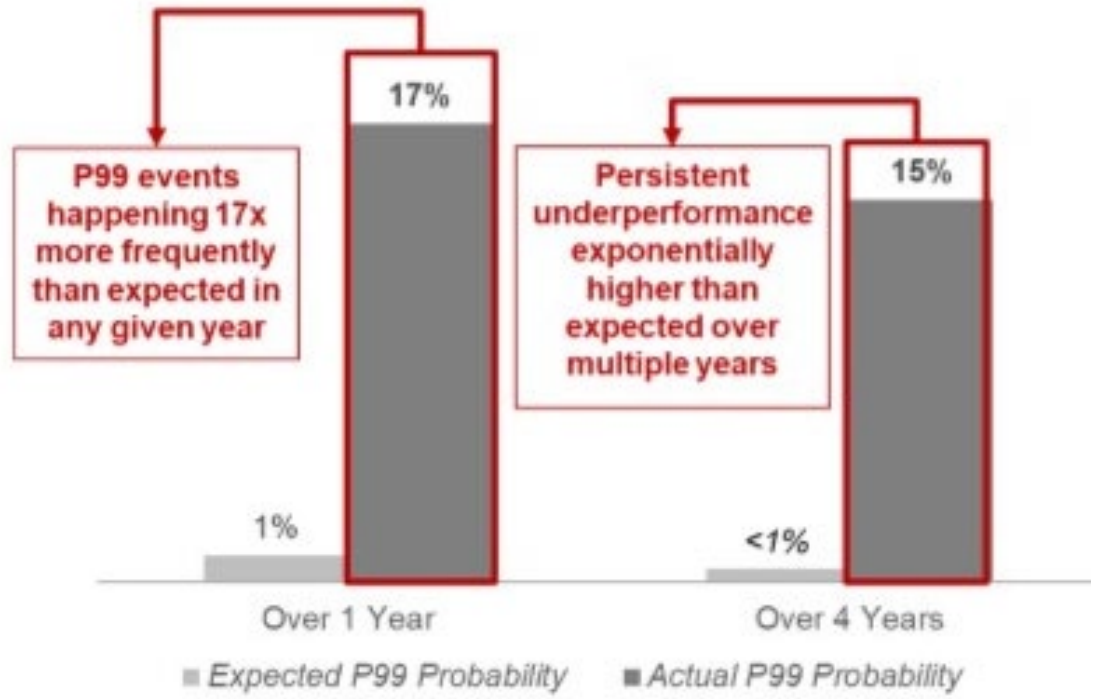
Source: FRB Dallas

Resource Risk; Industry Analysis Suggests Renewable Generation May Be Persistently Overestimated; Can Impair Project Cash Flow

P99 in a renewable resource generation assessment indicates that 99 percent of the time, actual generation is forecast to be above the P99 level.



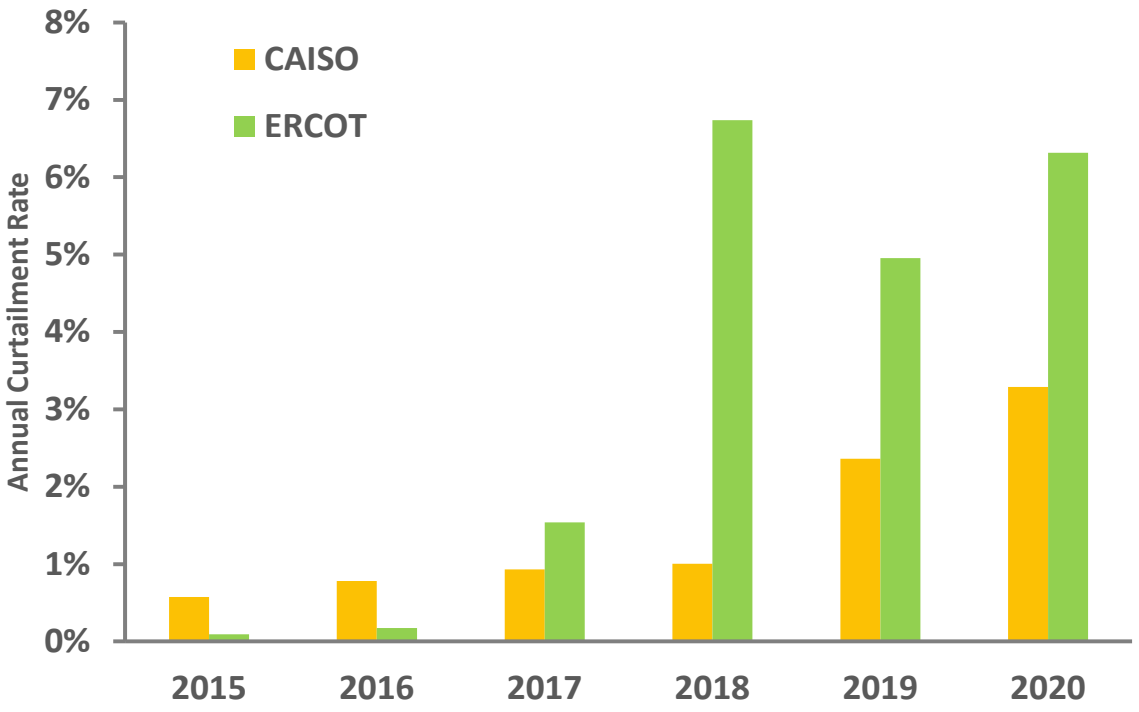
Source: FRB Dallas



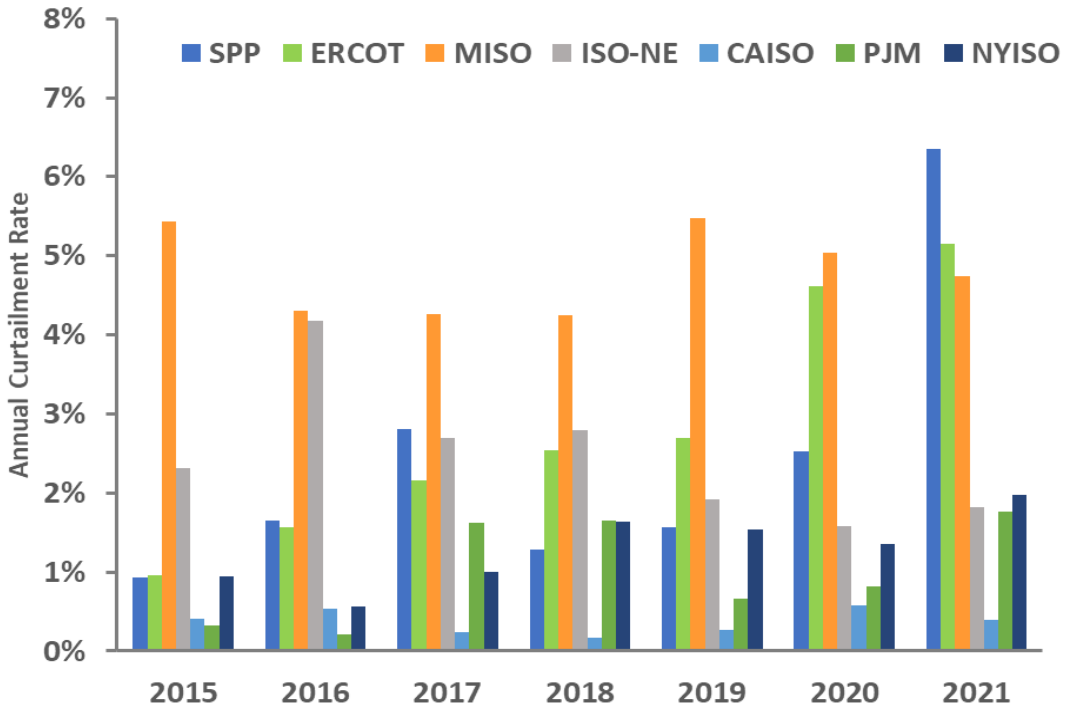
Source: kWh Analytics

Curtailment Risk; Curtailment Results in Lower Utilization of Installed Capacity; Can Reduce Project Cash Flow

Solar Curtailment



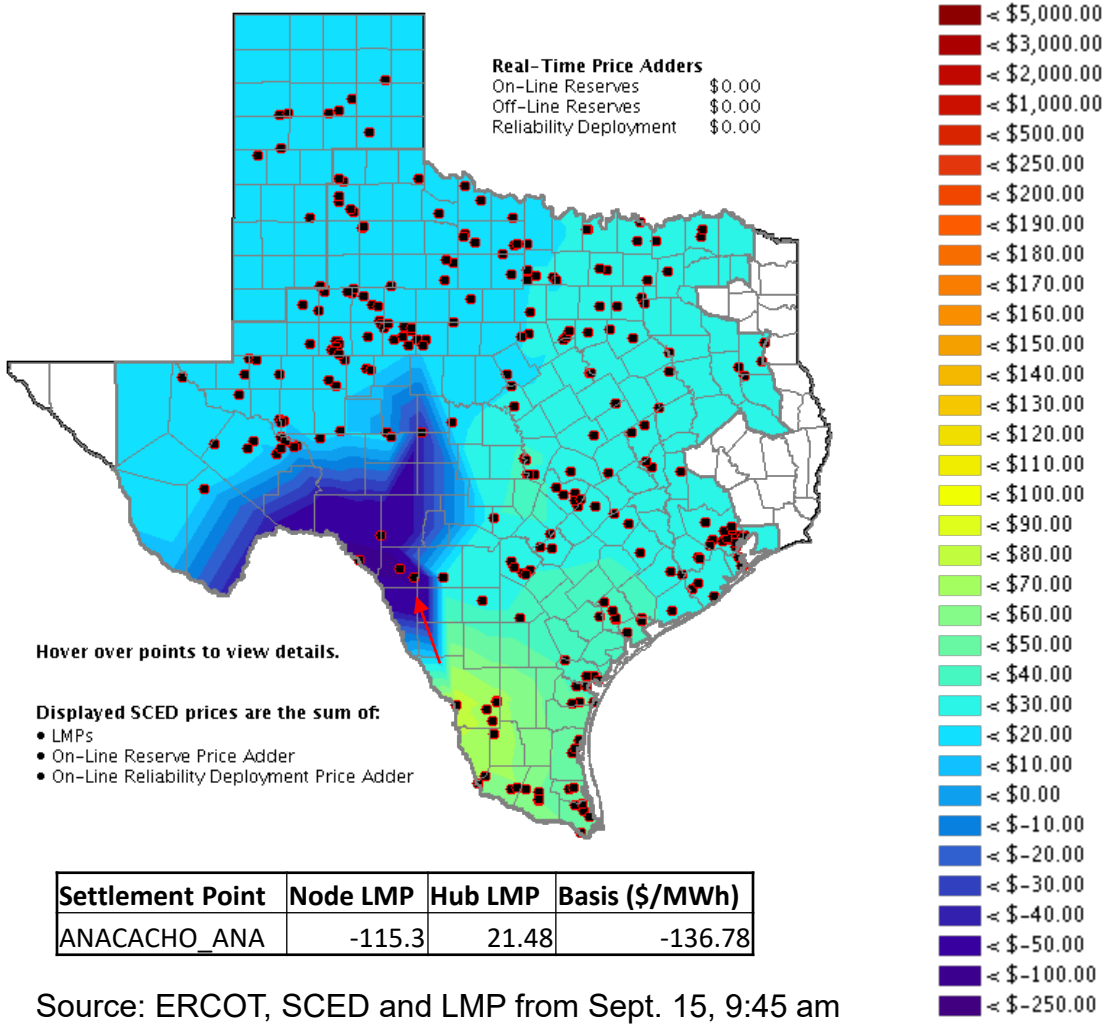
Wind Curtailment



Note: Curtailment at select independent system operators/regional transmission organizations (ISOs/RTOs)
Source: Berkeley Lab, California Independent System Operator (CAISO), Electric Reliability Council of Texas (ERCOT), Southwest Power Pool (SPP), Midcontinent Independent System Operator (MISO), ISO New England (ISO-NE), (PJM Interconnection (PJM), New York ISO (NYISO)

Congestion; Results in Lower Marginal Prices; Risk Often Assumed by Project, Not Off-taker

When congestion occurs, the nodal price declines (actual project revenue) below the hub price (assumed revenues for settling the PPA contract) giving rise to basis risk.



Settlement Point	Node LMP	Hub LMP	Basis ($/MWh)
ANACACHO_ANA	-115.3	21.48	-136.78

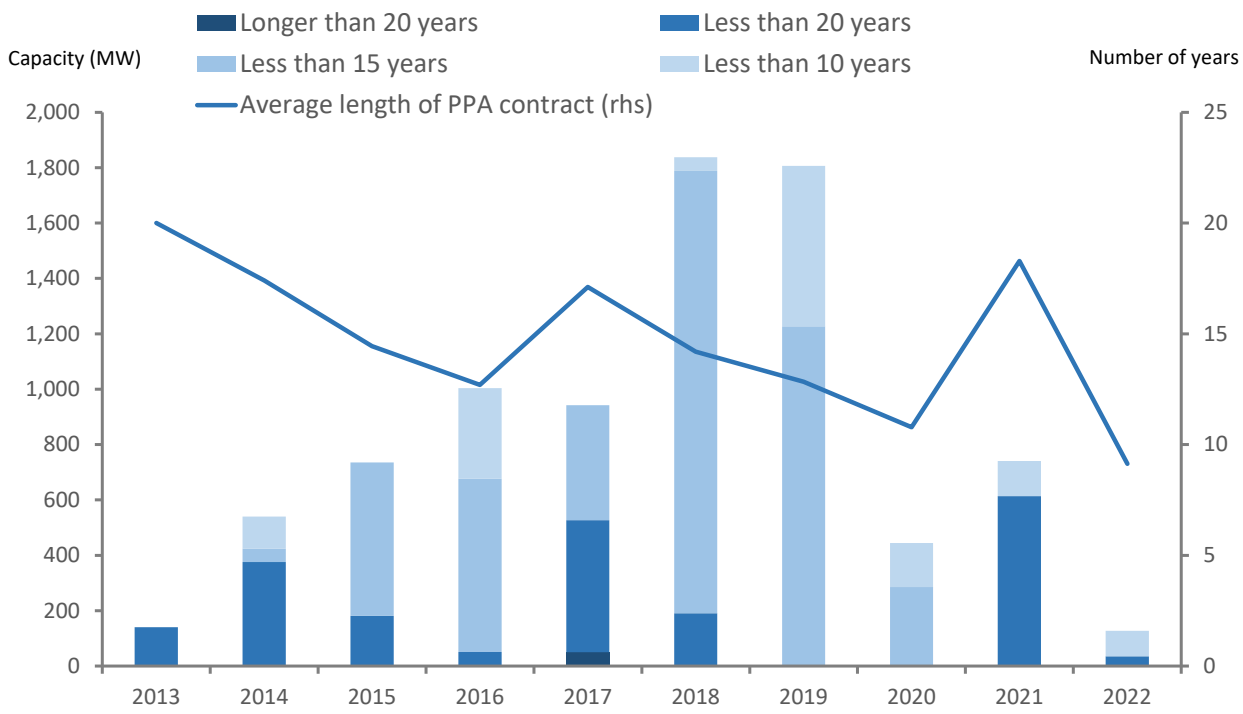
Source: ERCOT, SCED and LMP from Sept. 15, 9:45 am

Power Purchase Agreements (PPAs) Hedge Merchant Risk

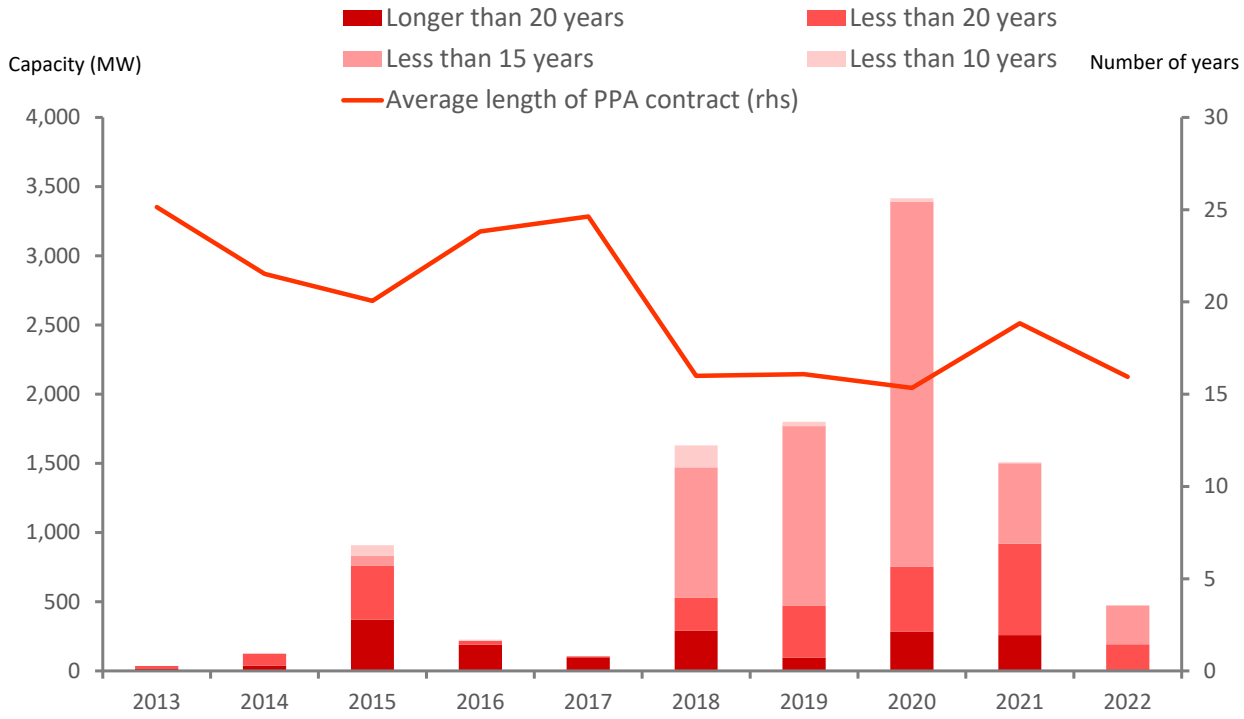
- A PPA is a long-term contract between the producer of the electricity and a purchaser.
- PPAs are used by both wind and solar power producers.
- The contract can require physical delivery or be financially settled (i.e., synthetic).
- Although PPAs mitigate merchant risk, they give rise to counterparty credit risk.

Shorter Corporate PPAs Leading to Greater Merchant Tail Risk

Wind



Solar



Note: Capacity-weighted average length of corporate PPA contract
Source: BloombergNEF

Scenario Analysis is Fundamental to Assessing Borrower's Cash Flow

- Scenario analysis, including related assumptions, is a critical component of sizing the debt.
  - A resource assessment provides the foundation for repayment analysis.
  - Numerous additional assumptions may reduce borrower's cash flow, including, but not limited to, merchant prices, basis, technology degradation, resource availability, and curtailment.

To Ask a Question

- **Use the chat feature in the webinar.**
  (*Ask Question* button on bottom of screen)

- **Email your question to: questions@askthefed.org.**

- **Use the "Ask a Question" feature on the Ask the Fed® website: www.askthefed.org**

Thanks for joining us.

www.askthefed.org

Acronyms/Abbreviations

- ABS: asset-backed security
- ERCOT: Electric Reliability Council of Texas21
- FBO: foreign banking organization
- GDP: gross domestic product
- IPP: independent power producer
- ITC: investment tax credit
- LCOE: levelized cost of energy
- MW: megawatt
- NAICS: North American Industrial Classification System
- PPA: power purchase agreement
- RPS: renewable portfolio standards
- SNC: shared national credit