Wind Investment Analysis

By Dan, Rahul, Nelson,
and Paul

Market Value by Region ISO

Independent System Operators

Whole sale market value of wind energy in 2022 ($/MWh)

ISO-Northeast: **$78.6**

CAISO-California: $66.5

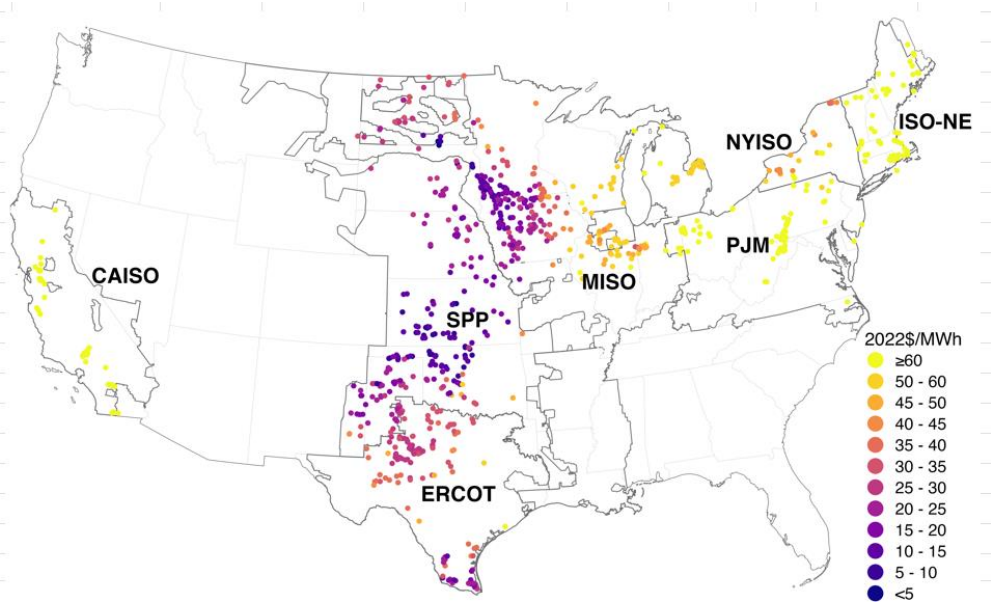
PJM-Interconnection: $55.5

SPP-Southwestern Power Pool: **$15.5**

NYISO – New York: $43.2

ERCOT – Electric Reliability Council of Texas: $29.3

MISO – Midcontinent: $27.3



Berkeley Lab, Hitachi, ISOs, 2023

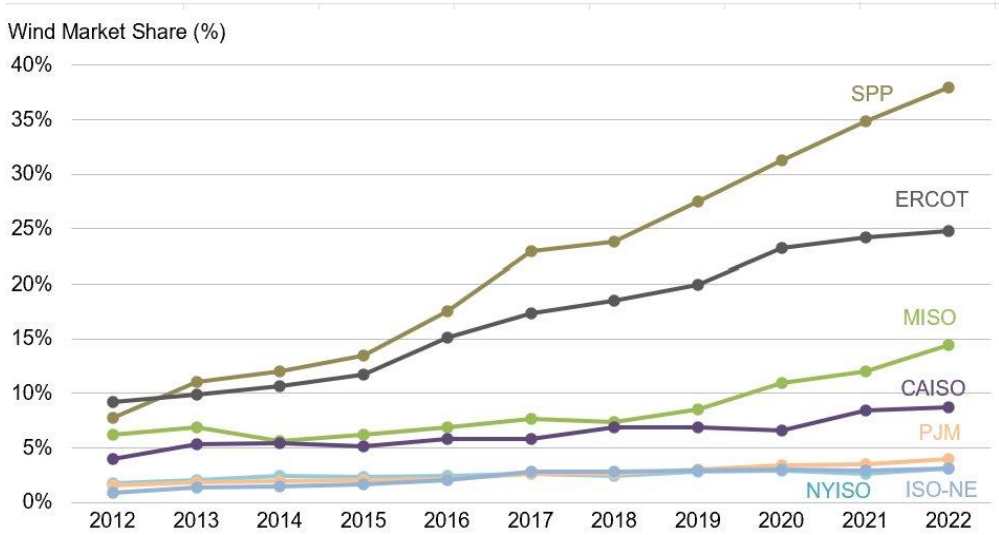
Market Share by Region ISO

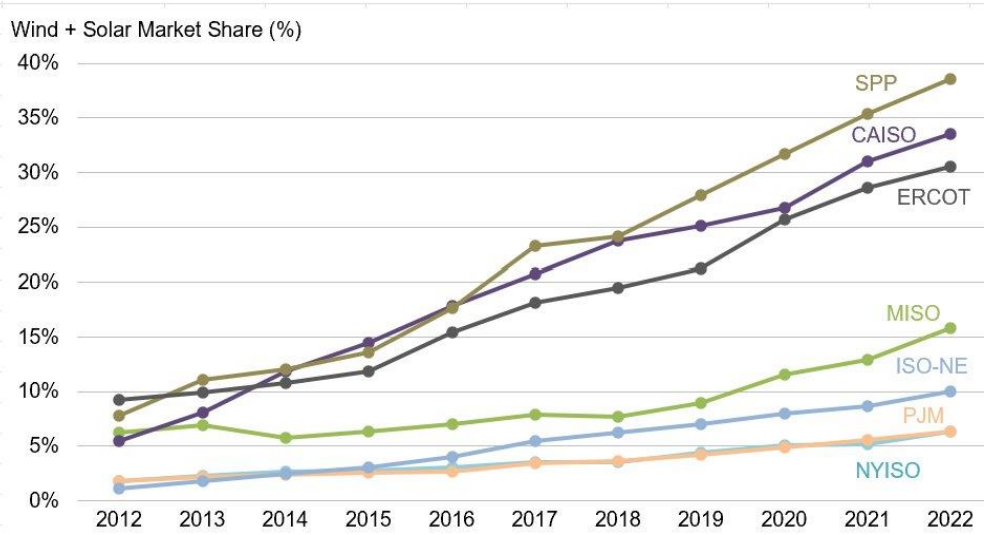
Wind Shares

ISO-Northeast: 3.2%
CAISO-California: 8.7%
PJM-Interconnection: 4%
SPP-Southwestern Power Pool: **37.9%**
NYISO – New York: 3.1%
ERCOT – Electric Reliability Council of Texas: 24.8%
MISO – Midcontinent: 14.5%

Wind+Solar Shares

ISO-Northeast: 10%
CAISO-California: 33.5%
PJM-Interconnection: 6.4%
SPP-Southwestern Power Pool: **38.5%**
NYISO – New York: 6.3%
ERCOT – Electric Reliability Council of Texas: 30.6%
MISO – Midcontinent: 15.8%





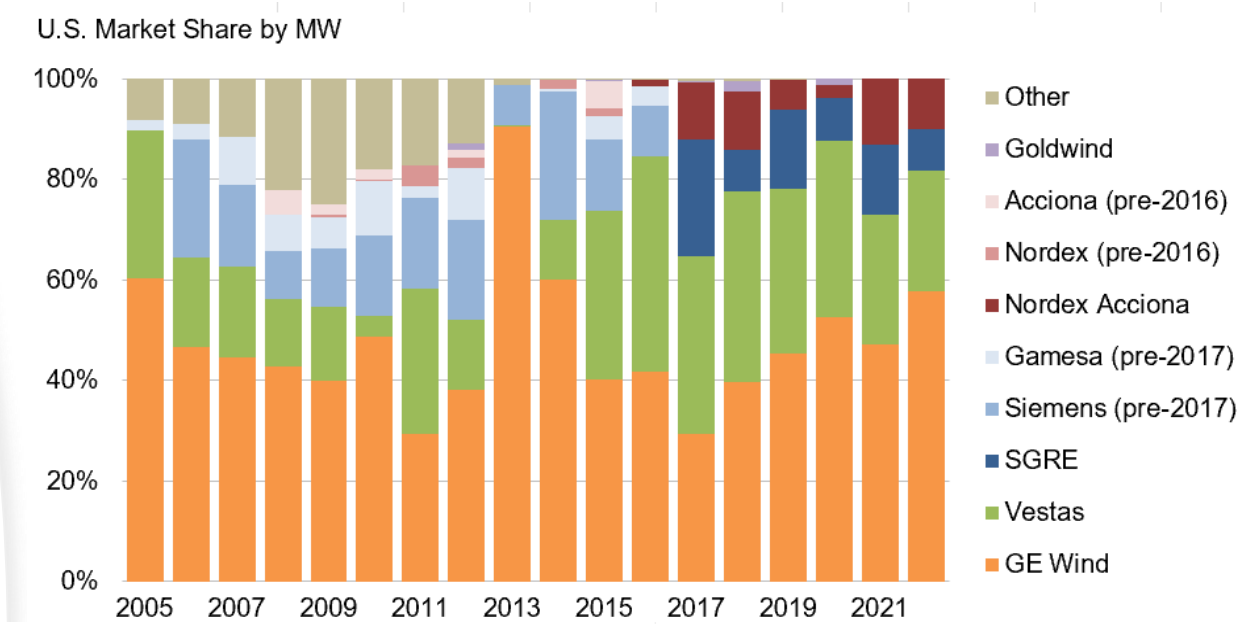
MISO, CAISO, SPP, NYISO, PJM, ISO-NE, ERCOT, 2023

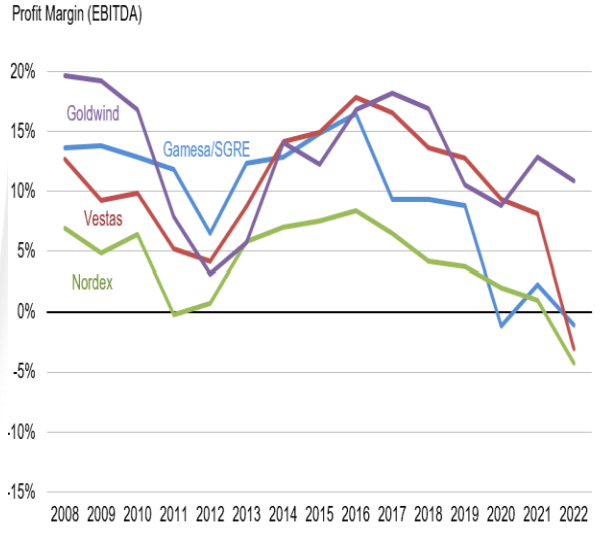
Market Share and Profitability by Manufacturer

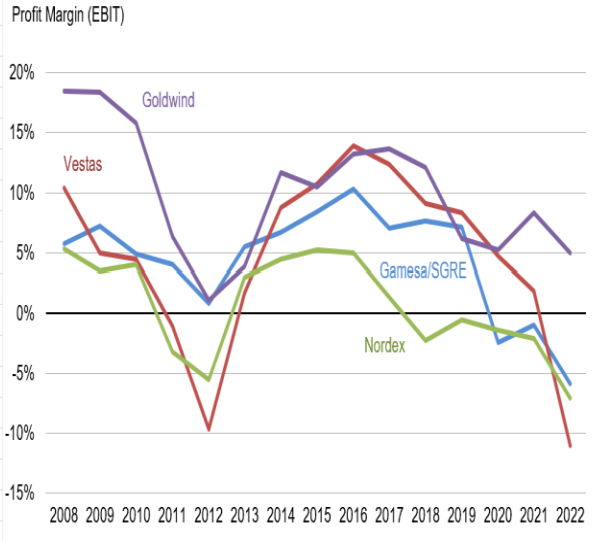
2022 Shares

- GE Wind: 4,918
- Vestas: 2048
- SGRE: 691
- Nordex Acciona: 854

Goldwin has the highest profit margin of 11%(EBITDA) and 5% (EBIT)

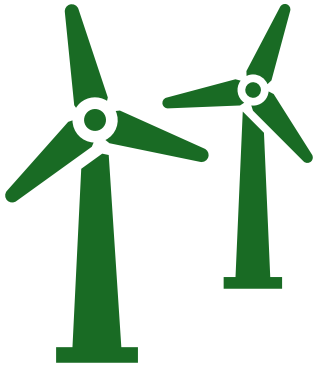




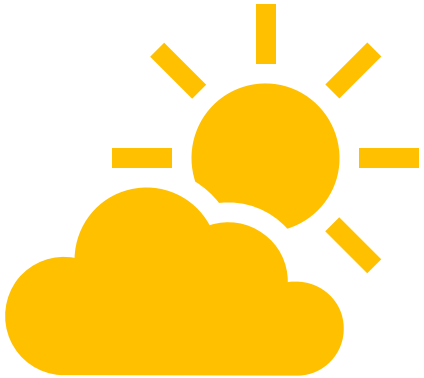


ACP, OEM 2023

Forecasting Wind Capacity



The U.S. added 8.5 GW of wind power capacity in 2022, totaling $12 Billion of investment.



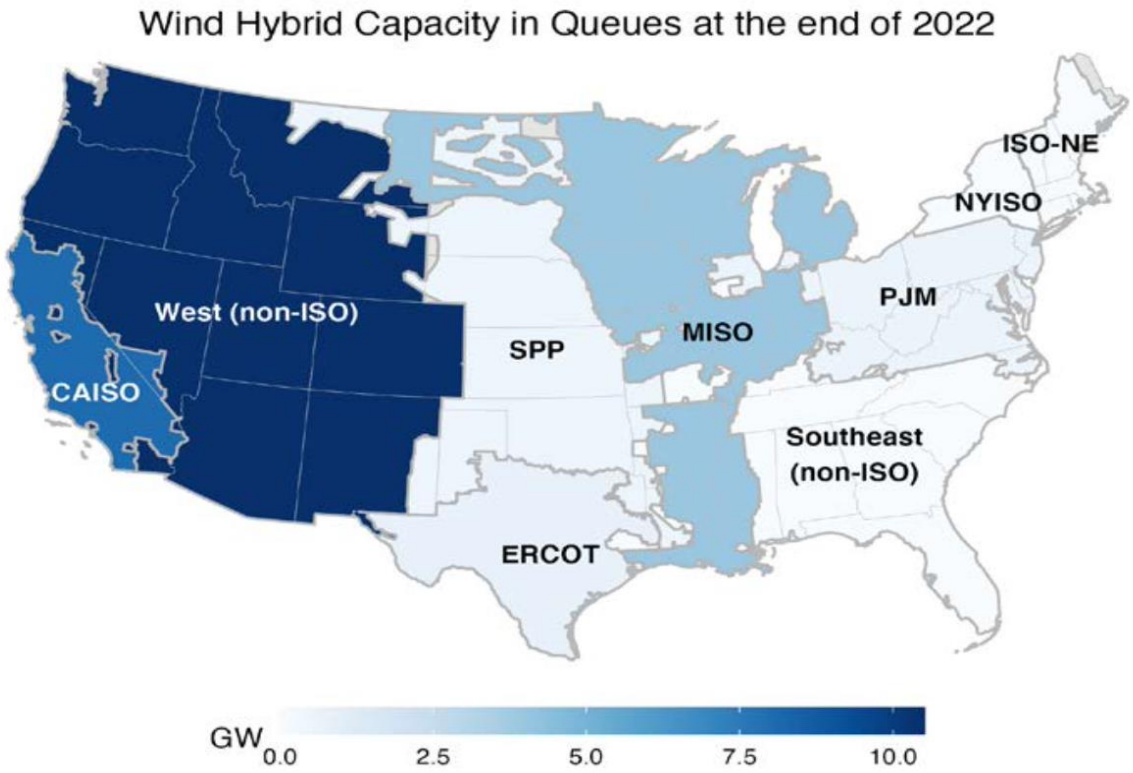
Wind power represented the second largest source of U.S. electric-power capacity additions in 2022, at 22%, behind Solar's 49%.

A record-high 300 GW of wind power capacity now exists in transmission interconnection queues.

U.S. DOE Office of Energy Efficiency & Renewable Energy Land-Based Wind Market Report: 2023

Forecasting Wind Capacity

- Of the 300 GW in the pipeline, **113 GW** of are **offshore**.
- The three regional operators with the **most wind** in their queues at the end of 2021**:**
  - **NYISO -**New York Independent System Operator
  - **Non-ISO West**
  - **PJM** - Pennsylvania, New Jersey, Maryland

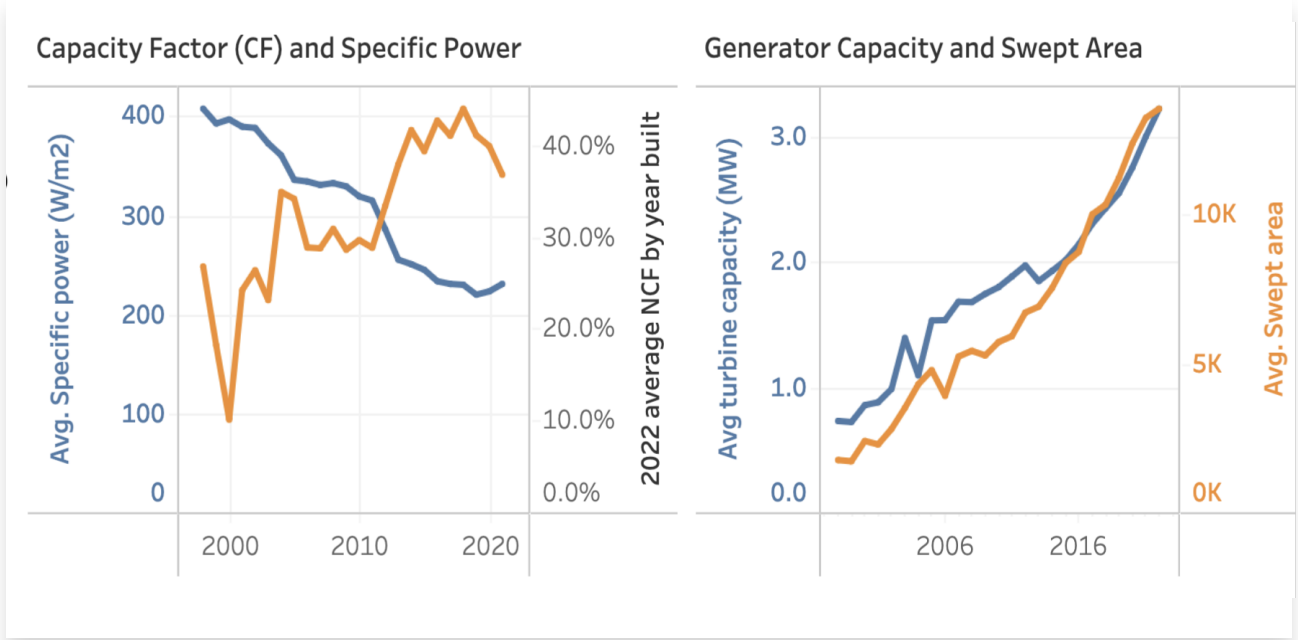


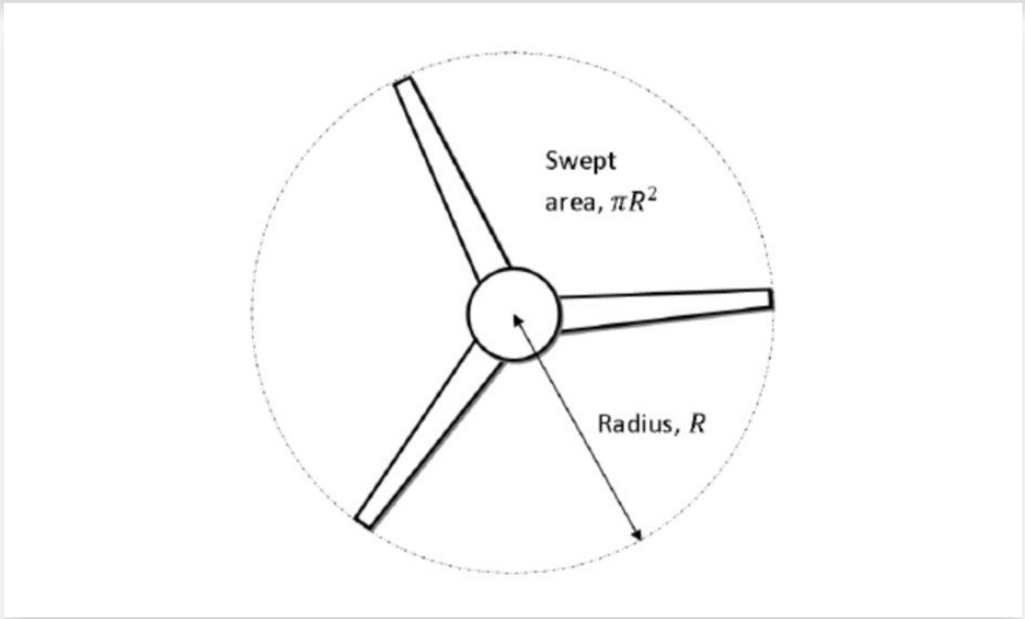
Source: Berkeley Lab review of interconnection queues

U.S. DOE Office of Energy Efficiency & Renewable Energy Land-Based Wind Market Report: 2023

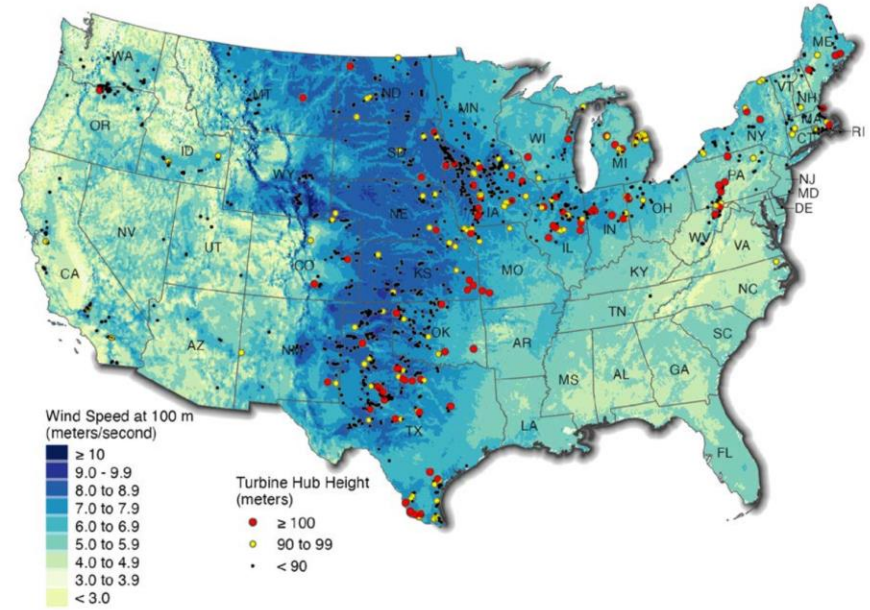
Key Terms

- **Capacity Factor** – A measure of a turbines actual output compared to its maximum output
- **Specific Power** – The ratio of a turbine's maximum capacity (watts) compared to its rotor swept area (m2)

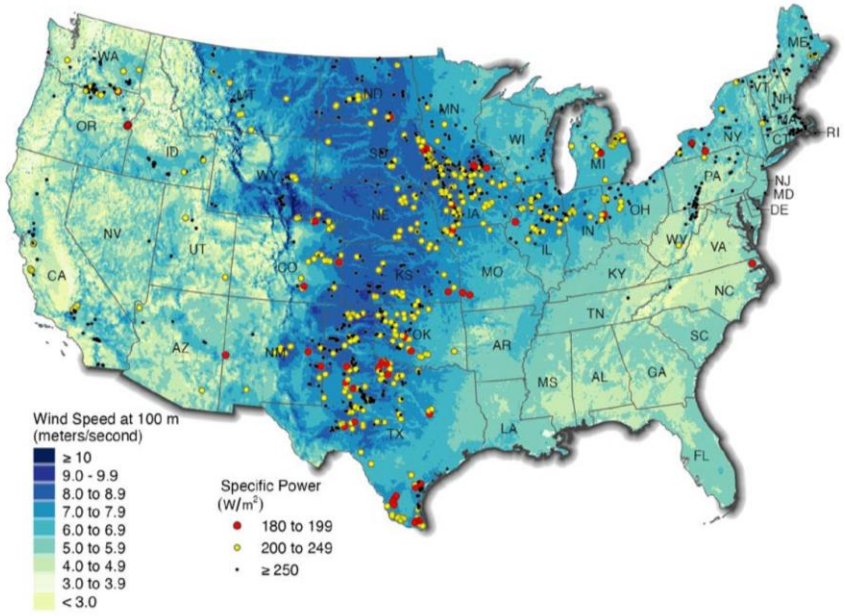




Berkeley Lab Energy Technologies Area Land-Based Wind Market Report, 2023



Sources: ACP, U.S. Wind Turbine Database, AWS Truepower, Berkeley Lab



Sources: ACP, U.S. Wind Turbine Database, AWS Truepower, Berkeley Lab

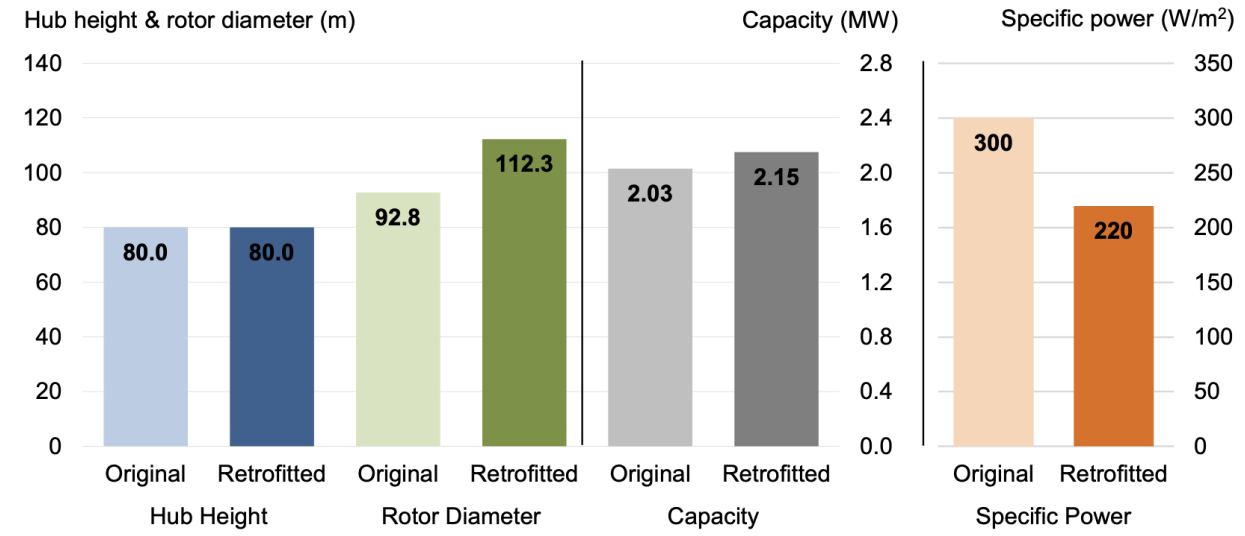
Maximizing Efficiency

- Very tall (>100m) and lower specific power turbines tend to be concentrated in the **upper Midwest** and **Northeast** regions
- **Taller towers** produce **more power** due to higher wind speeds
- **Lower specific power** turbines were designed for low speed wind areas, but are being used more and more in high speed areas as well.
- These are potentially attractive because they are **less costly** and **less sensitive** to fluctuations in the wind speed, making them a better fit for lower wind speed areas

U.S. DOE Office of Energy Efficiency & Renewable Energy Land-Based Wind Market Report: 2023

Retrofitting Older Turbines

- The most common retrofit in 2022 was the replacement of shorter with **longer blades**, with a modest increase in capacity.
- These retrofits drove a significant **decrease** in **average specific power**, from 300 to 220 W/m2.
- These trends have resulted in an **increase** in **Capacity Factor** over the last 2 decades.



Sources: ACP, Berkeley Lab, turbine manufacturers

U.S. DOE Office of Energy Efficiency & Renewable Energy Land-Based Wind Market Report: 2023

Environmental Impact

1. The U.S. wind capacity avoids an estimated 340 million metric tons (Mt) of CO2 emissions annually

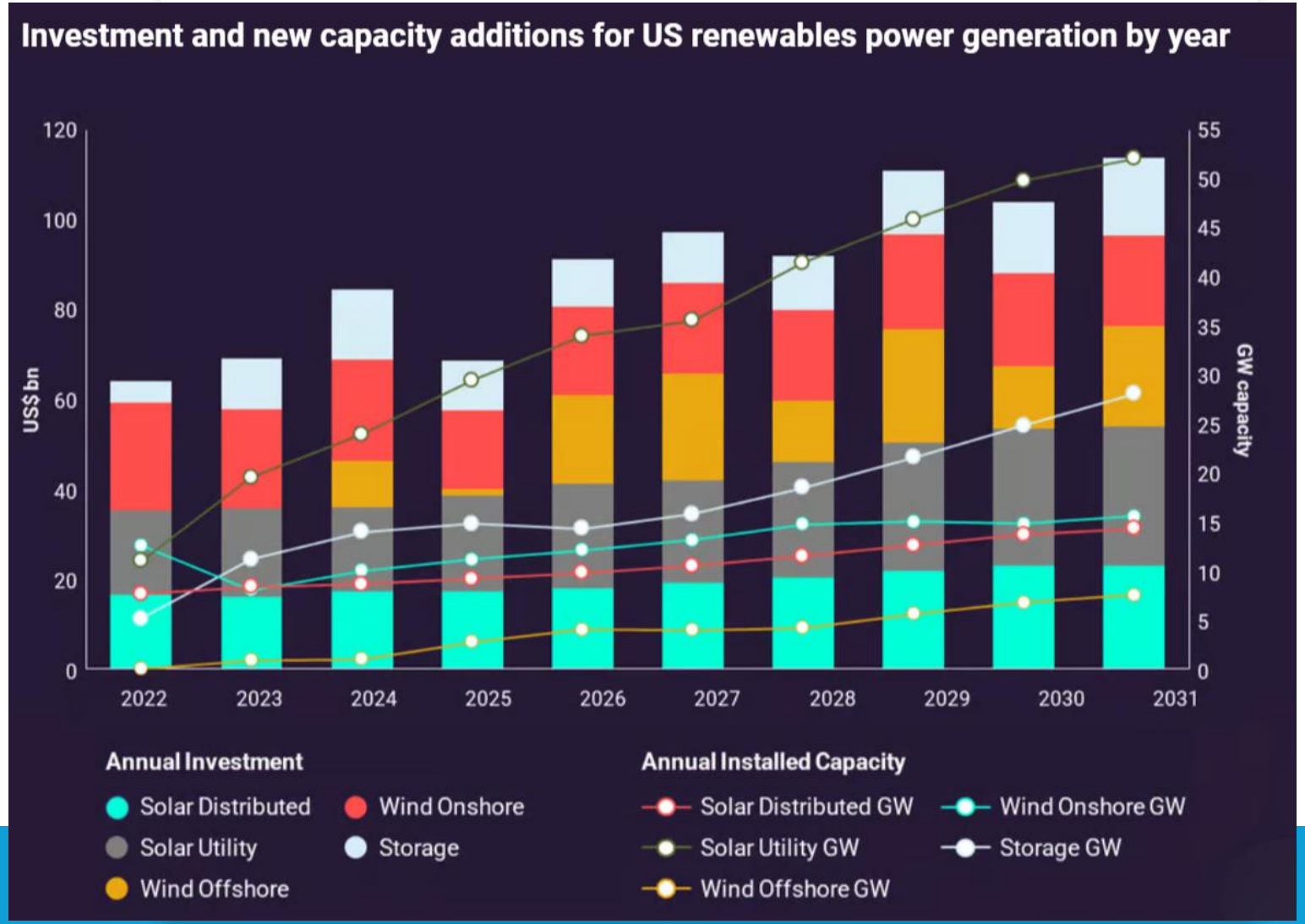
2. The U.S. Department of Energy found wind could provide 20% of U.S. electricity by 2030 and 35% by 2050

3. if 35% of U.S. electricity was wind-generated by 2050, electric sector GHG emissions would be reduced by 23%

1. *ACP (2023) "Wind Power Facts."*
2. *U.S. Energy Information Administration (EIA) (2023) Monthly Energy Review April 2023.*
3. *U.S. DOE (2015) Wind Vision Report*

Company and Investor Impacts

- Inflation Reduction Act (IRA) remain in place until 2032
- China produces nearly 70% of all powertrains and 65% of castings, while the US produced none of either in 2021
- The ACP expects annual wind, solar and energy storage capacity installations to grow to over 90 GW by the end of the decade, more than tripling the 28 GW installed in 2021



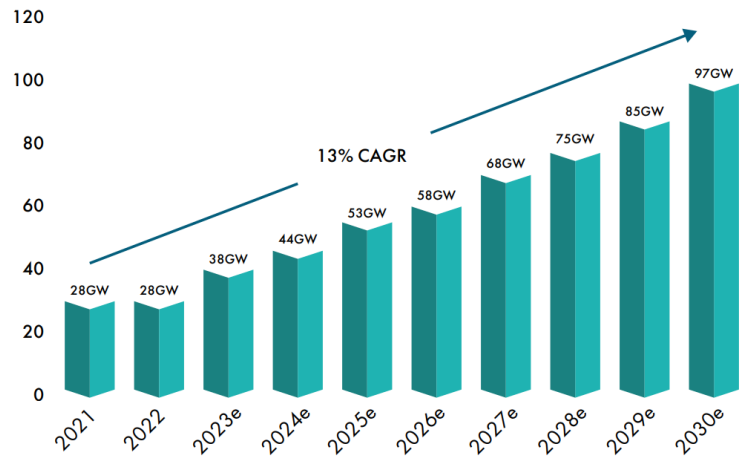
1. *ACP (2024) "US Clean Energy Industry Reports Milestones"*
2. *GWEC (2023) "Global Wind Report"*

Domestic Investment Incentives

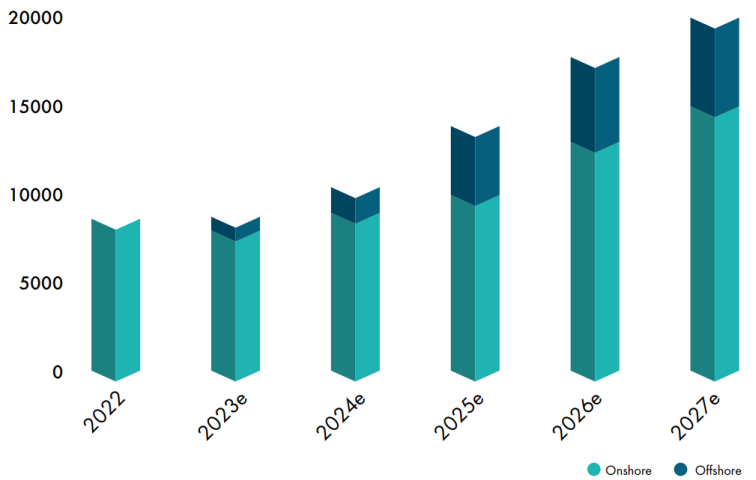
1. The Act provides a **tax credit**: advanced manufacturing production credits (AMPC), for **US-made** renewable equipment

2. Incentivizes developers of US renewable projects to purchase **domestically produced** equipment by providing an additional tax credit if they meet **domestic content requirement** (DCR) thresholds

Projected annual clean power capacity installations under the IRA

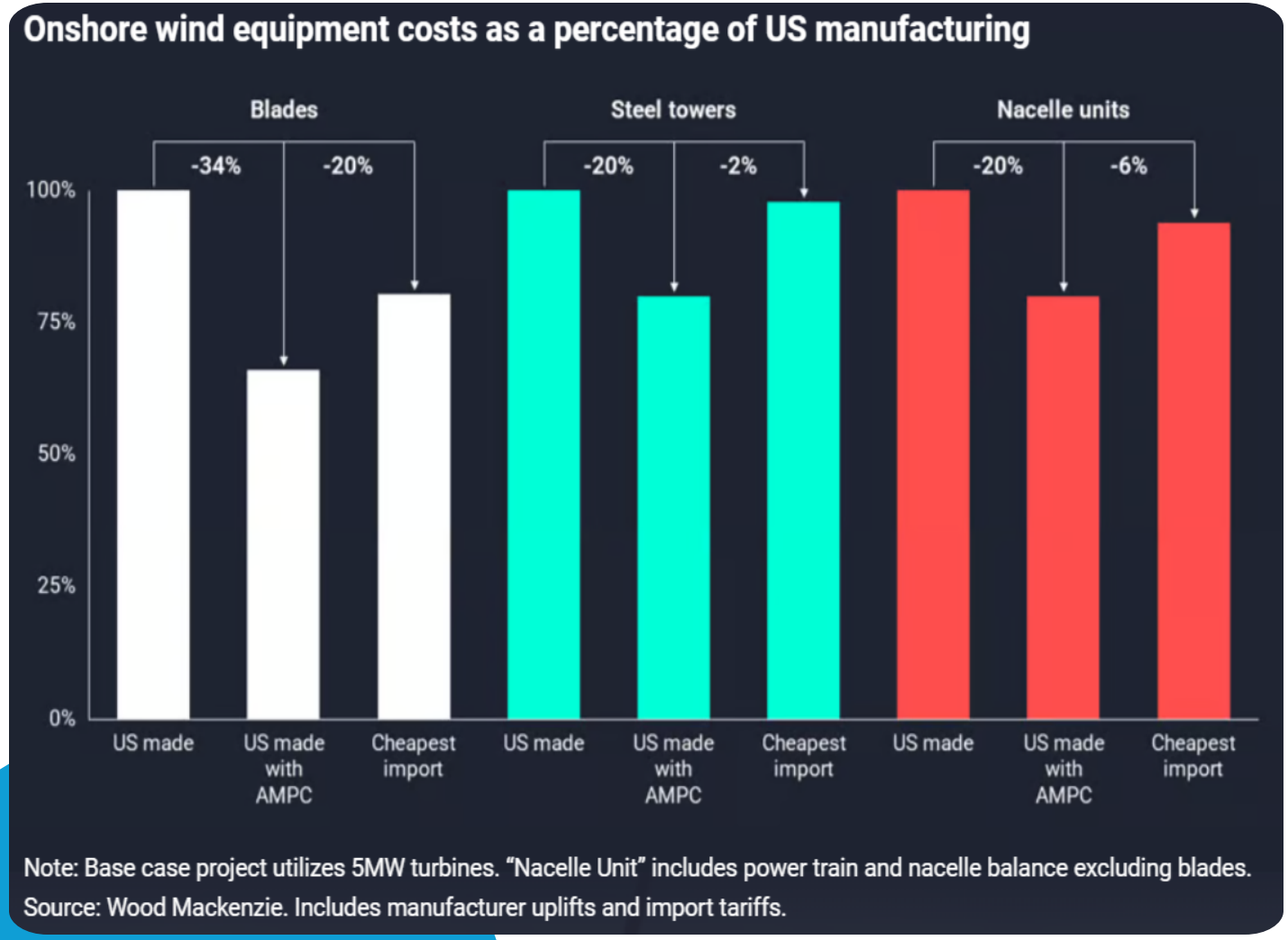


US new wind power installations forecast (MW)



1. *Energy.gov (2024) "Inflation Reduction Act Spurs Breakthrough in Domestic Wind Production"*

Onshore Wind Energy

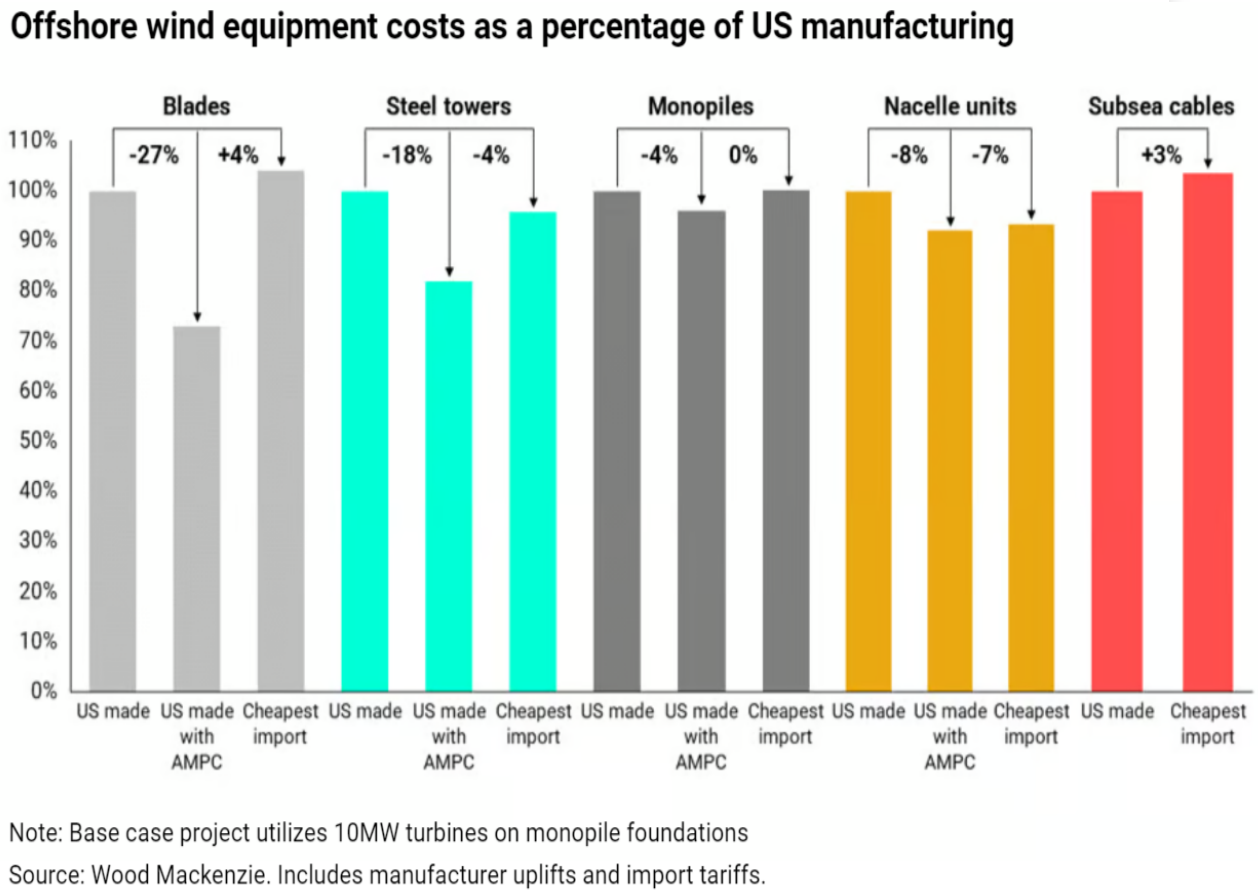


- The **credits** will help manufacturers (OEMs) be more competitive by **reducing** production **costs** and **improving margins** in the short term and will **incentivize** manufacturing **capital expenditure**
- The industry faces a near-term **shortage** of US **equipment.** This creates **leverage** in **pricing** for manufacturers, as developers will struggle to be able to meet **DCR thresholds**

1. *Wood Mackenzie (2024) "What the Inflation Reduction Act means for US renewables manufacturers"*

Offshore Wind Energy

- Ambitious targets, **lack of** existing **supply** chain, focus on local manufacturers
- Orders for monopile foundations, steel towers, cables and blades are increasing rapidly
- Meeting DCR thresholds can increase developer equipment costs by up to 3%. Bonus adders return up to 7% for a **net gain of 4%**
- **6 year backlog** for current forecasted project capacity



1. *Wood Mackenzie (2024) "What the Inflation Reduction Act means for US renewables manufacturers"*

Main Takeaways for Investors

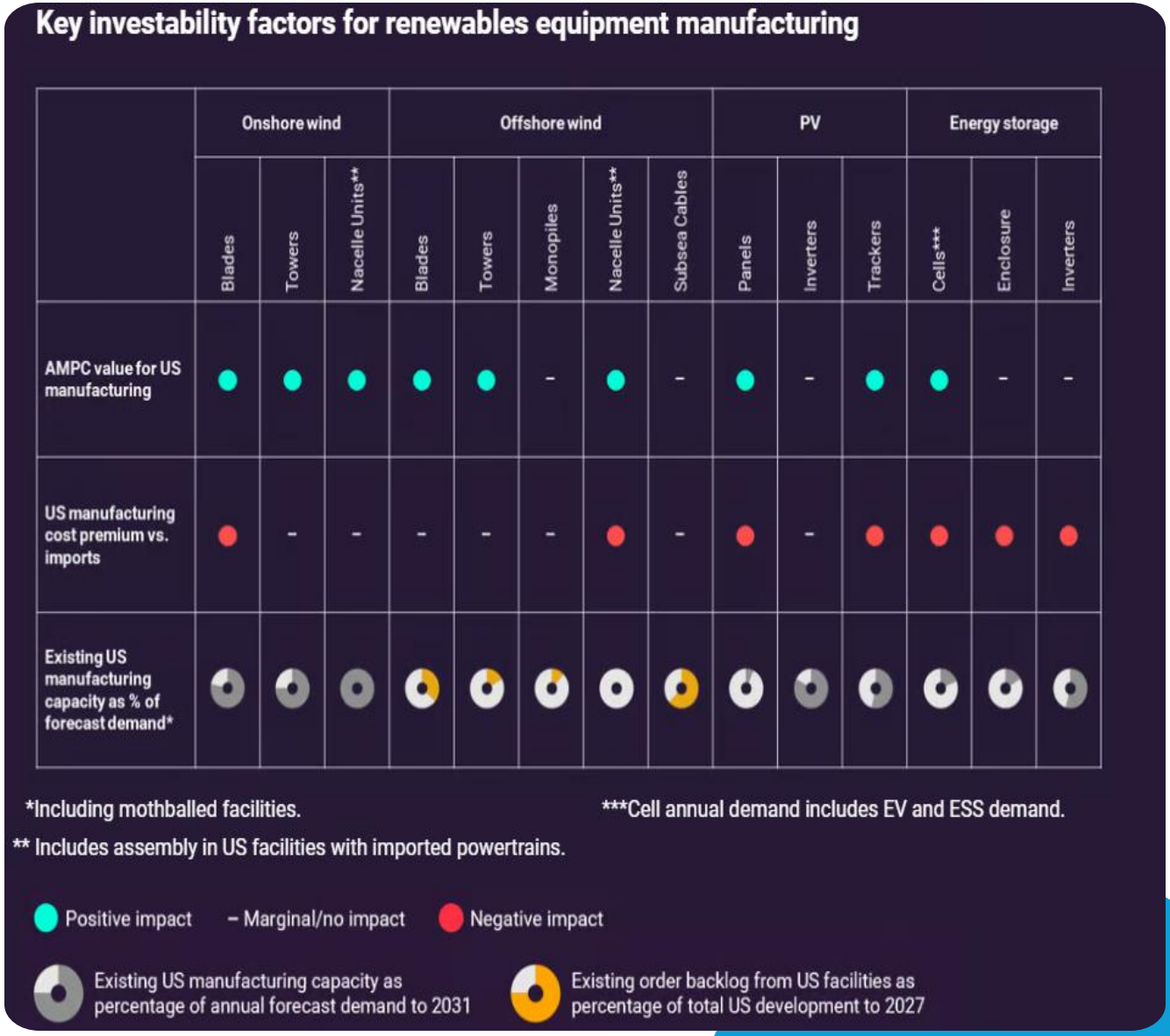
- AMPC and DCR will **help spur investment in US renewables** manufacturing
- PV panel manufacturers (Solar) **face considerable challenges** when it comes to developing a self-sufficient domestic manufacturing capability
- **US** manufacturing **costs** are **16-33% higher** than imported equipment

Program Uncertainties

1. How will the **IRA assess** how much of the **manufacturing process** must be conducted in the US?

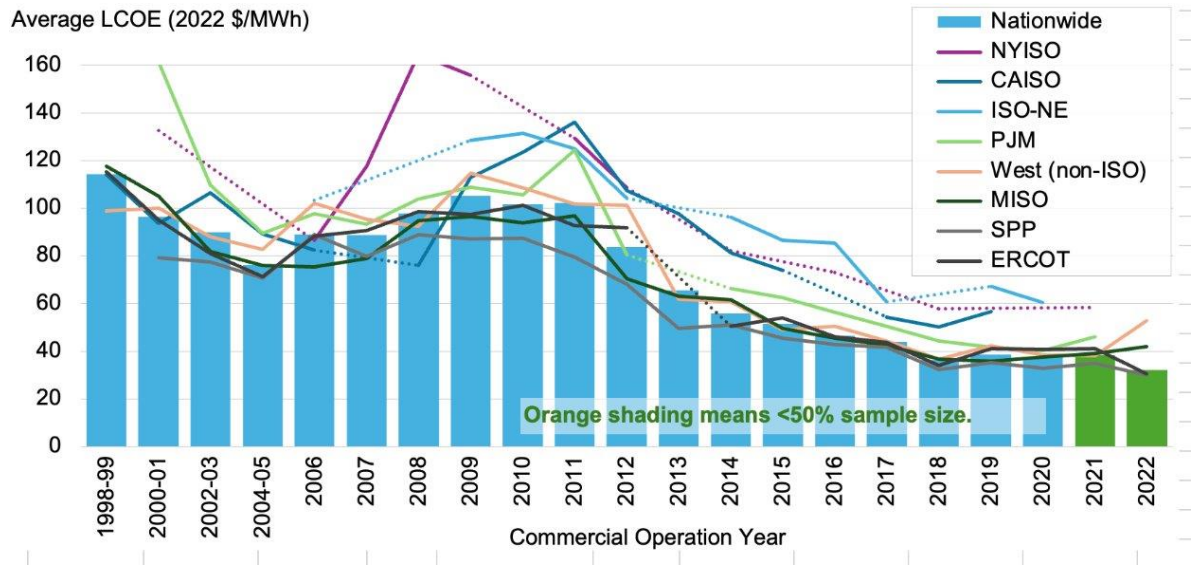
2. How will **imported** subcomponents used in **domestically assembled** equipment be counted as?

3. Steel and iron need to be **100%** from the **US**



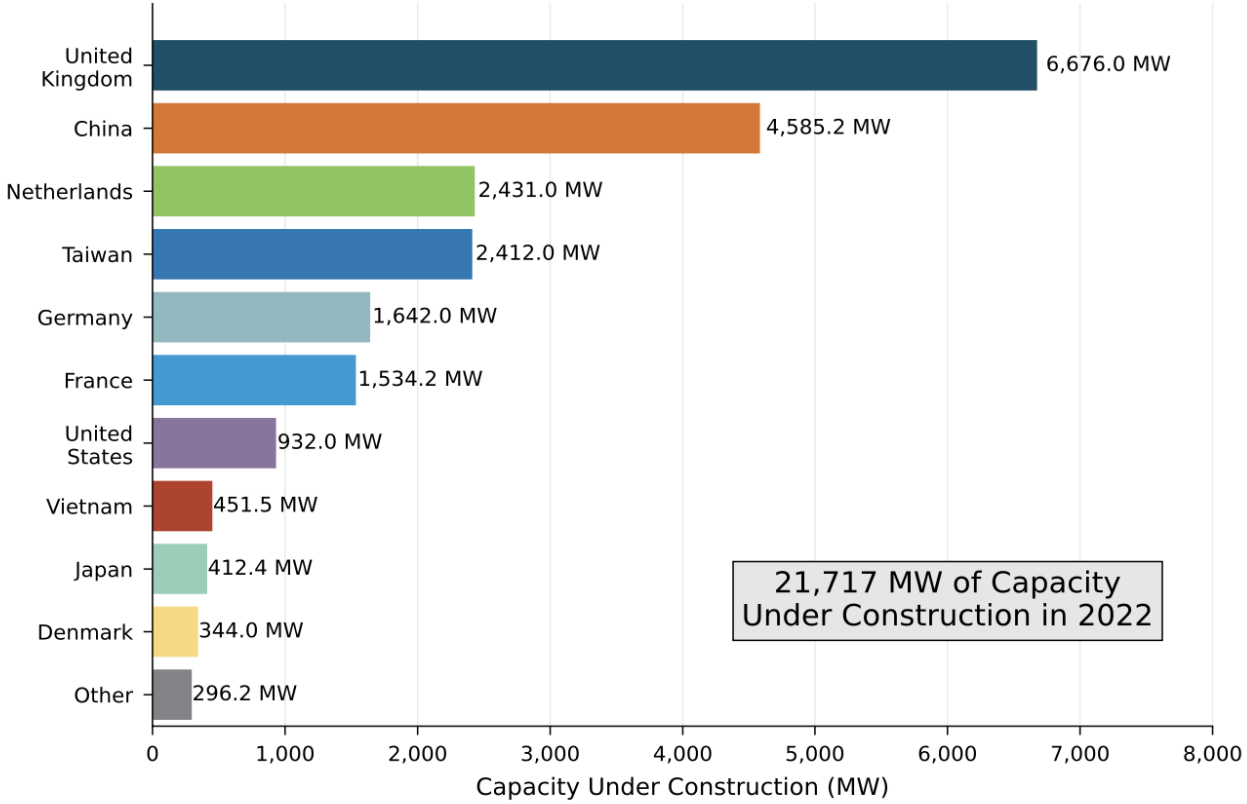
Levelized Cost Trends

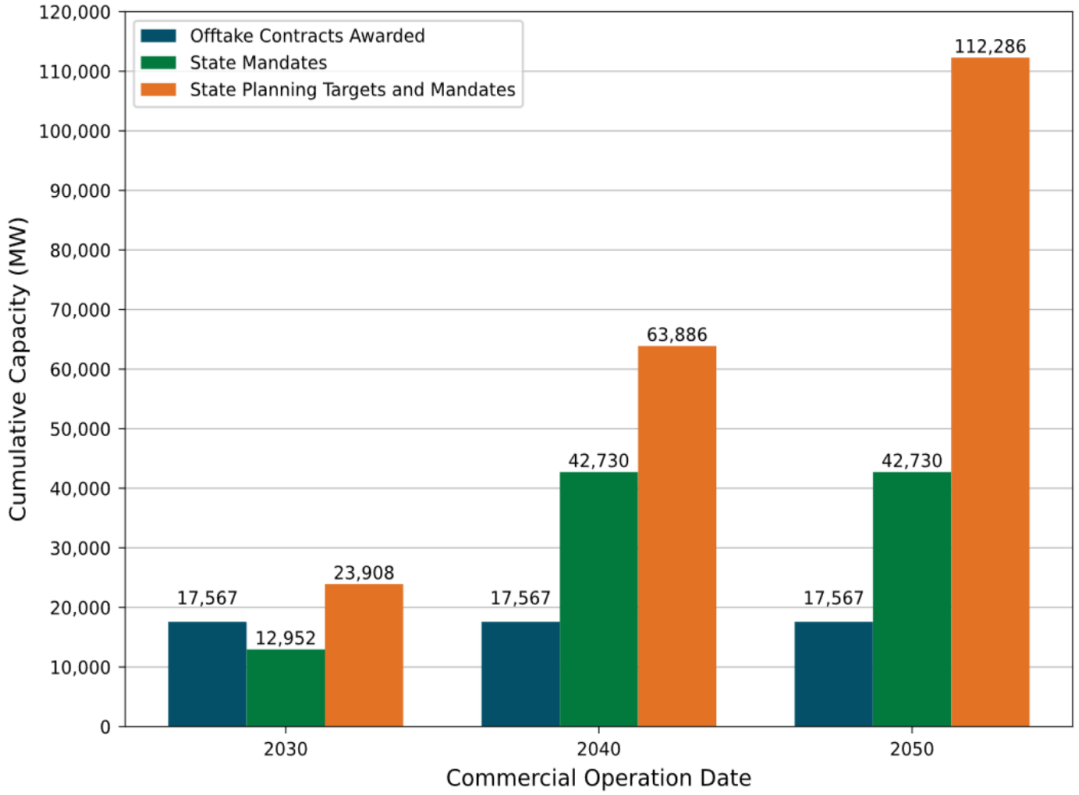
- LCOE: Levelized Cost of Energy
- The average levelized cost of wind energy for projects built in 2022 was around $32/MWh, with the lowest costs in SPP and ERCOT.



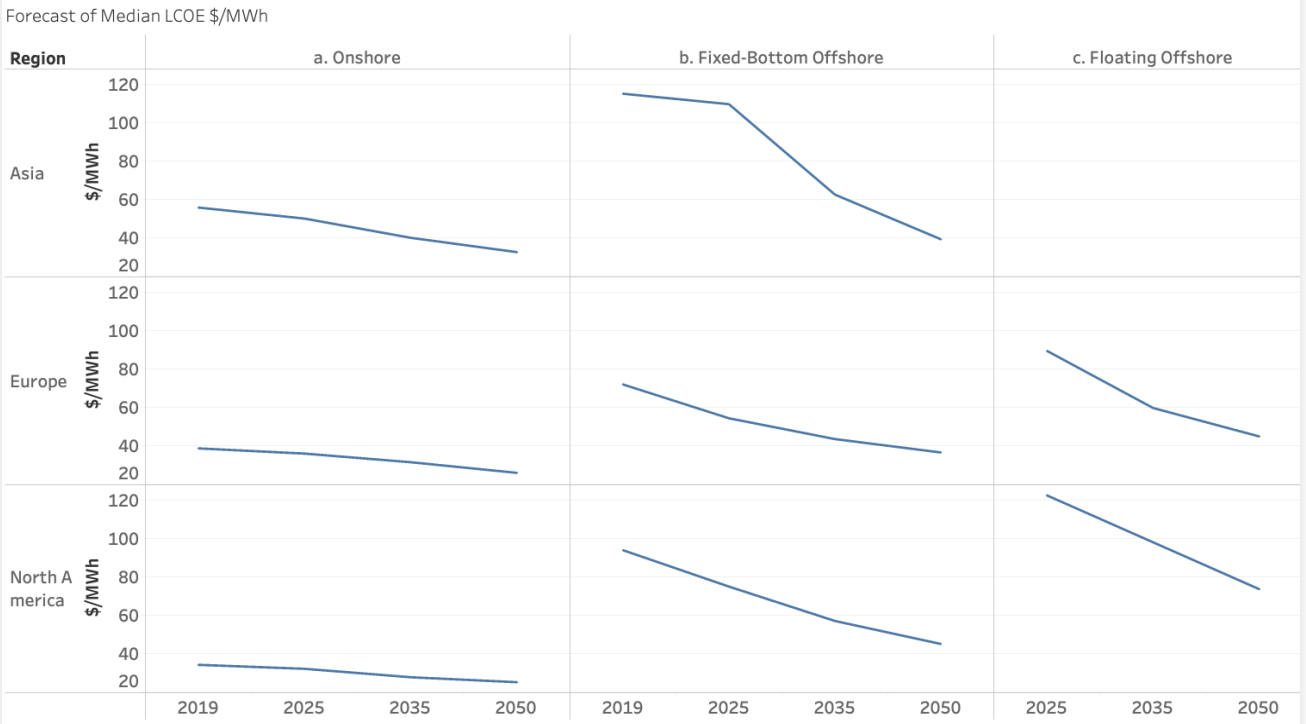
Offshore Turbine Growth

- Rapid Expansion: Although starting from a smaller base, offshore wind is experiencing rapid growth, with significant capacity planned for the next decade. The U.S. aims to achieve 30 GW of offshore wind by 2030 and exceed 112 GW by 2050.





Onshore vs. Offshore LCOE Forecast



- Higher Costs but Larger Scale: Offshore wind projects are more expensive than onshore but offer larger capacity per turbine, which can generate significant power even in low wind conditions.

Onshore Vs. Offshore Economics

Costs	Onshore	Offshore
Operation & Maintenance Costs	$45,000	$1,800,000
Capital Costs	$4,200, 000	$30,000,000
Revenue		
Net Annual Revenue	$270,360	$985,680
Payback Period	**15.5 years**	**30.4 years**

***These are simplified calculations for installation of 1 turbine based on average values from data sources to provide estimates on the timeframe for returns on investment**

*Onshore cost values were aggregated as averages of $/kW from US DOE Land Based Wind Energy Report 2023 and WINDExchange Land Based Wind Energy Economics Guide

*Onshore revenue values were aggregated using national average PPA price of $30/MWh and an assumed capacity factor of 40% from the US DOE Land Based Wind Energy Report 2023 and WINDExchange Land Based Wind Energy Economics Guide

*Offshore cost values were aggregated as averages of $/kW from UC Berkeley Energy 2035 and Beyond Report

*Offshore cost revenues were aggregated using projected PPA price of $53/MWh and assumed capacity factor of 50% from UC Berkeley Energy 2035 and Beyond Report

Sources: UC Berkeley Energy 2035 and Beyond Report, Wood Mackenzie Onshore Wind Energy Report, US DOE Land Based Market Wind Report 2023, DOE Offshore Wind Market Report 2023

Recommendation

Short-Term

- Invest in new onshore wind farms in Northeast, Midwest, and non-ISO West
- Existing wind farms in ERCOT (Texas) and SPP (Southwest)

Long-Term

- Invest in offshore Northeast and West coast

* UC Berkeley 2035 and Beyond The Report on Offshore Wind