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Renewable Power Generation Costs in 2024

Presenters:
Saied Dardour, Deborah Ayres & Lourdes Zamora, Renewable Energy Costs and Outlook team

TUESDAY, 02 SEPTEMBER 2025 • 14:00 – 14:30 CEST

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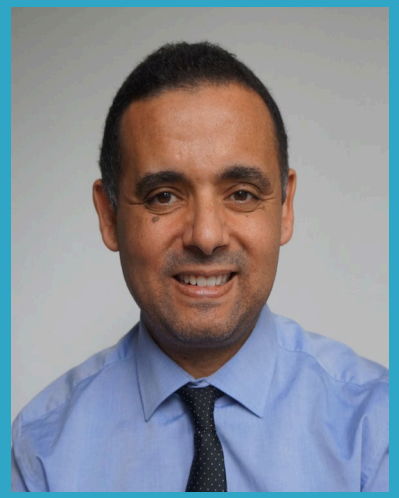
SPEAKERS



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Another Record Year for Renewables

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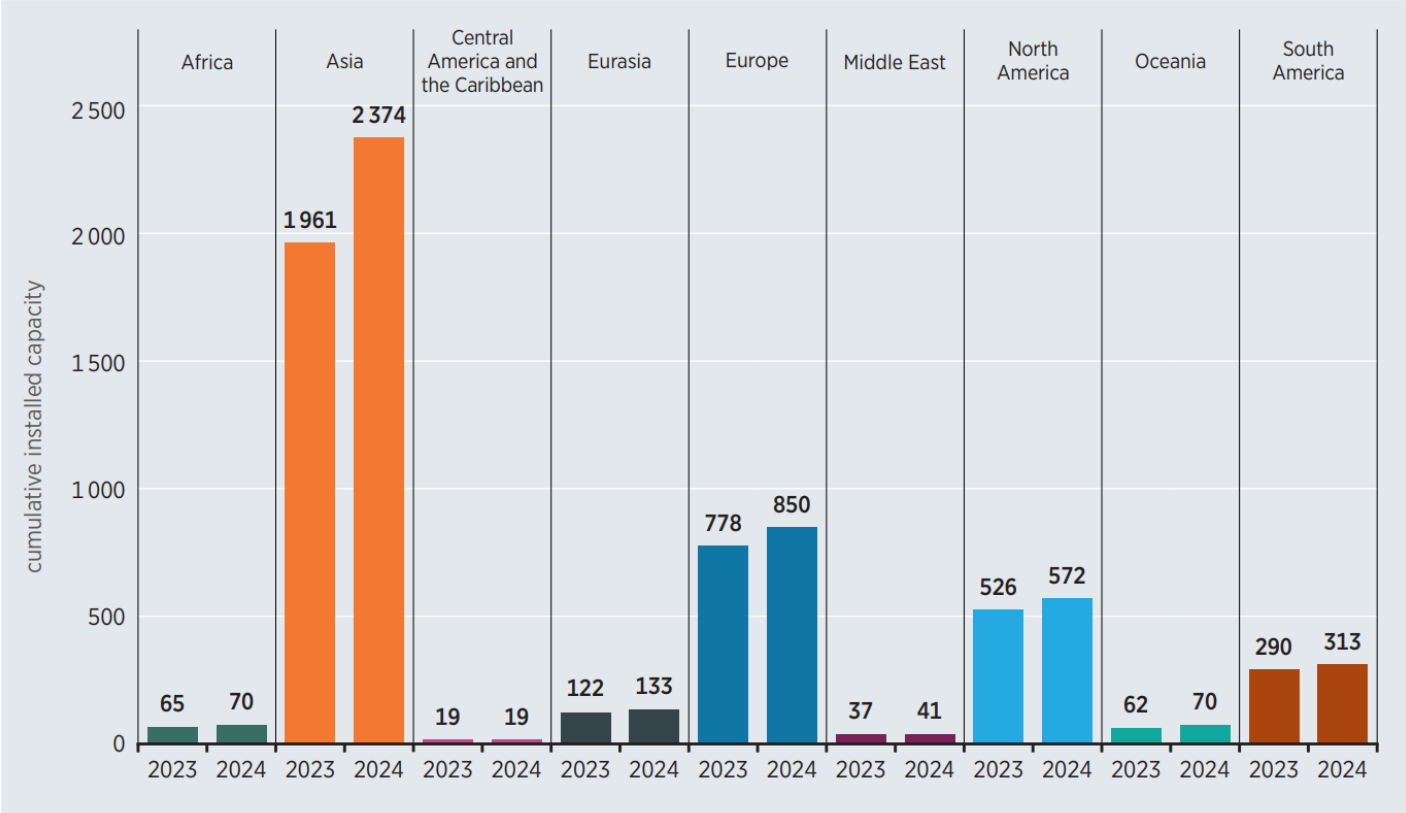
- 585 GW of renewable capacity was added in 2024, representing a 24% increase from 2023.
- Solar PV led in capacity addition: +452 GW, accounting for over three-quarters of new capacity.
- This momentum reflects falling technology costs, supportive policies, and a rapid global shift away from fossil fuels.
- All other regions also recorded year-on-year growth, albeit with significant variation in scale.
- China added the largest share, while the United States, India, Brazil and Germany also made important contributions.



Note: GW = gigawatt.

Renewable power capacity by region, 2023 and 2024

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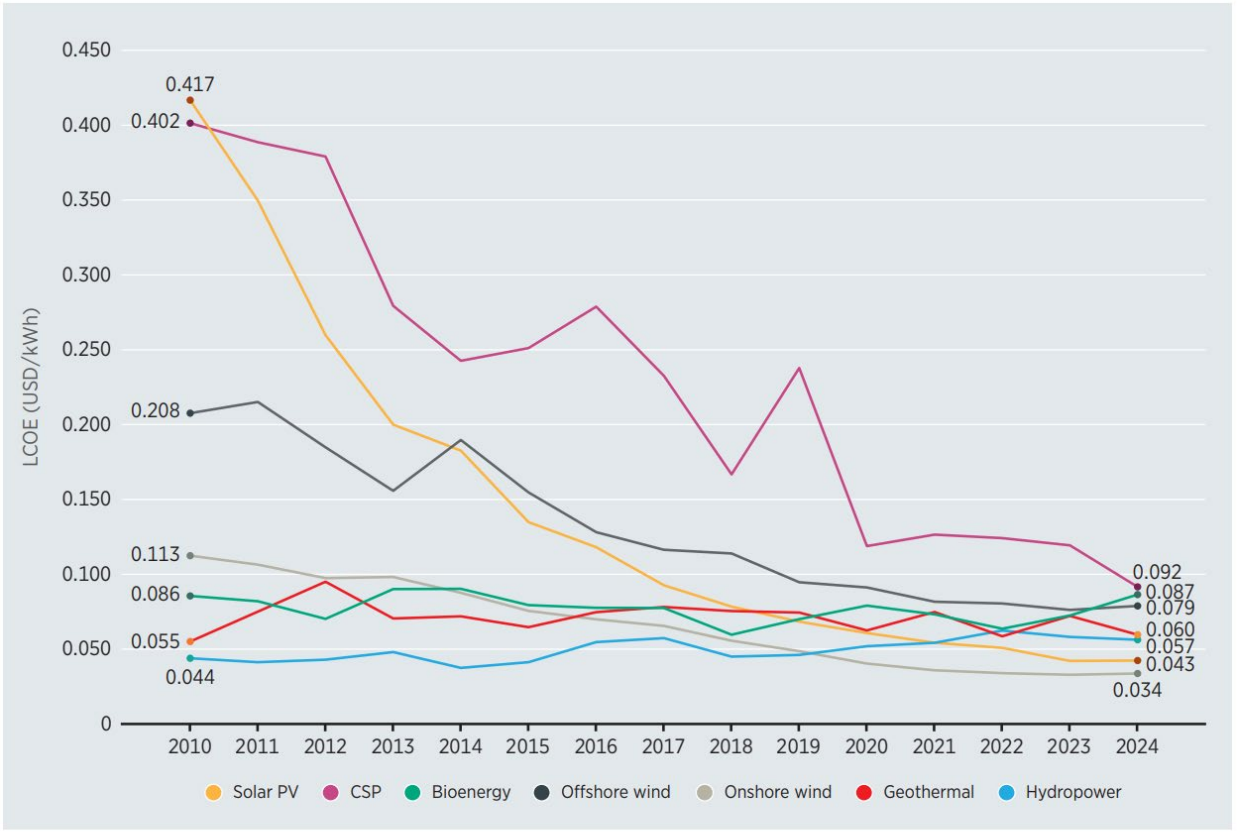
Costs Continue to Fall

- In 2024, onshore wind was the lowest-cost technology globally, averaging USD 0.034/kWh, followed by solar PV at USD 0.043/kWh.
- This marks a dramatic decline since 2010 - onshore wind down 70%, solar PV down 90%.
- 91% of new utility-scale renewable projects commissioned in 2024 delivered power cheaper than fossil fuel alternatives.
- Long-term cost reductions are expected from continued technological learning and supply chain maturity.
- Emerging geopolitical risks - including tariffs on renewable components and materials - could raise costs in the short term.



Notes: CSP = concentrated solar power; kWh = kilowatt hour; LCOE = levelised cost of electricity; PV = photovoltaic; USD = United States dollar.

Renewable energy cost decline (2010-2024)

The Hidden Costs of Financing

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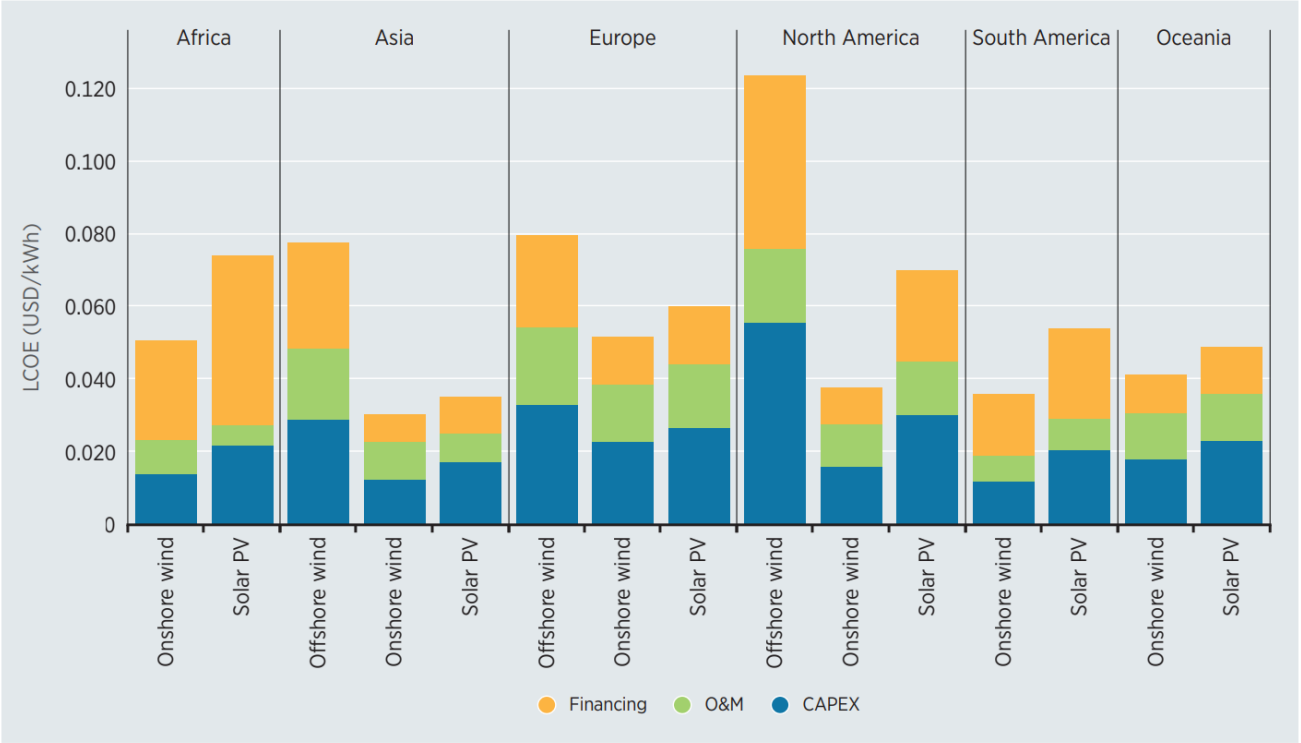
- In many emerging and developing markets, financing costs - not technology - are the biggest barrier to cheaper renewables.
- High perceived risk inflates WACC, sometimes doubling LCOEs.
- For example:
  - Onshore wind LCOE in 2024 was nearly identical in Africa (USD 0.051/kWh) and Europe (USD 0.052/kWh).
  - But in Africa, financing costs dominated, while in Europe, CAPEX was the main driver.
- To unlock investment, countries need:
  - Risk mitigation tools,
  - Institutional strengthening,
  - and blended finance to attract private capital.



Notes: CAPEX = capital expenditure; kWh = kilowatt hour; LCOE = levelised cost of electricity; O&M = operation and maintenance; PV = photovoltaic; USD = United States dollar.

Perceived “high risk” countries face higher capital costs, inflating the share of financing costs in LCOE.

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Lower Costs (and Reduced Human Health Impacts)

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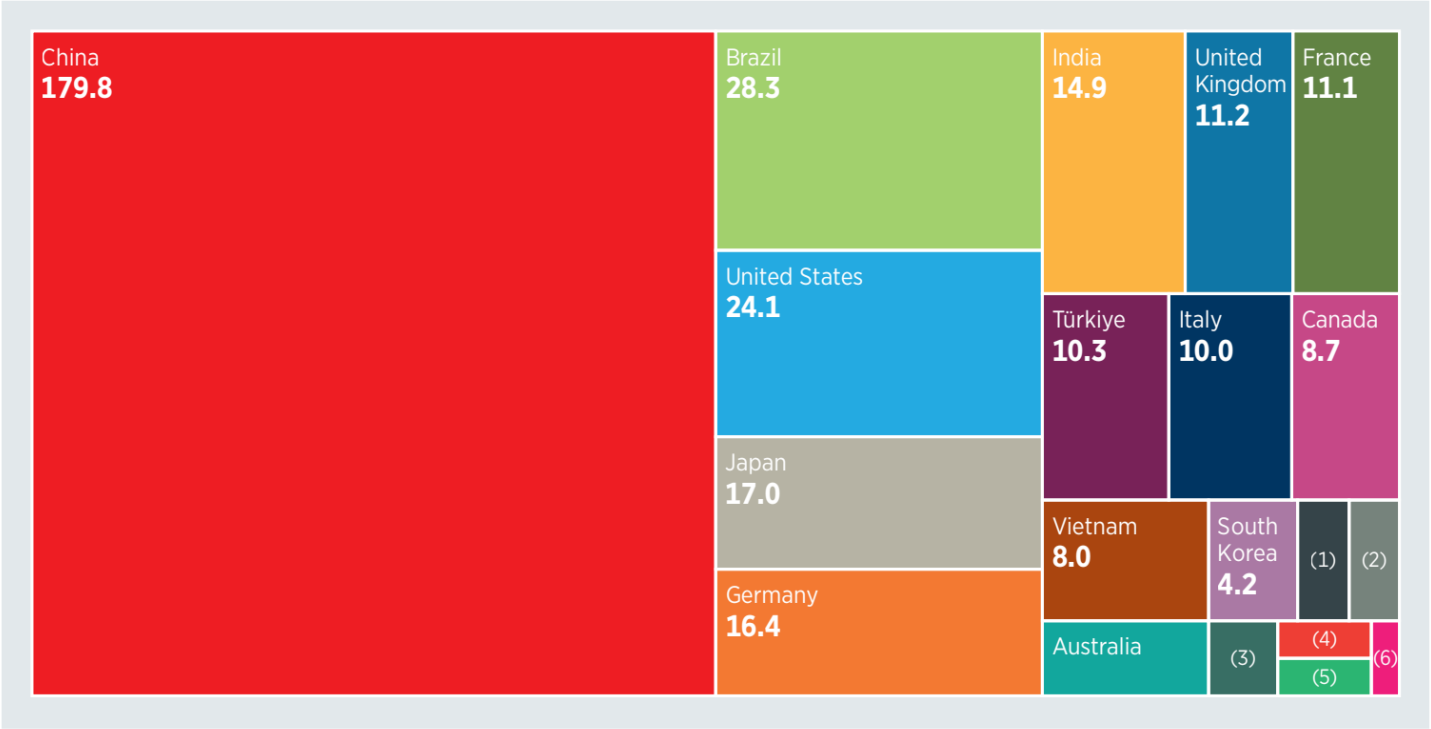
- In 2024, we estimate that renewable electricity helped avoid USD 467 billion in fossil fuel costs globally.
- These savings come from reduced fuel imports and avoided generation costs - especially in fossil-importing regions like the EU, South Asia, and Africa.
- Renewables also helped avoid significant CO_2 emissions and health impacts from air pollution exposure.
- The co-benefits of renewables - cost savings, cleaner air, and energy independence - are now central to energy planning in both advanced and emerging economies.



Notes: (1) Indonesia 2.5; (2) Mexico 2.4; (3) Malaysia 2.0; (4) Argentina 1.4; (5) Philippines 1.4; (6) South Africa 0.9.

Avoided fossil fuel costs (467 USD billion)
from renewable electricity generation in 2024

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Renewable Power Generation Costs Database /Datafile

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Renewable Power Generation Costs in 2024 Datafile

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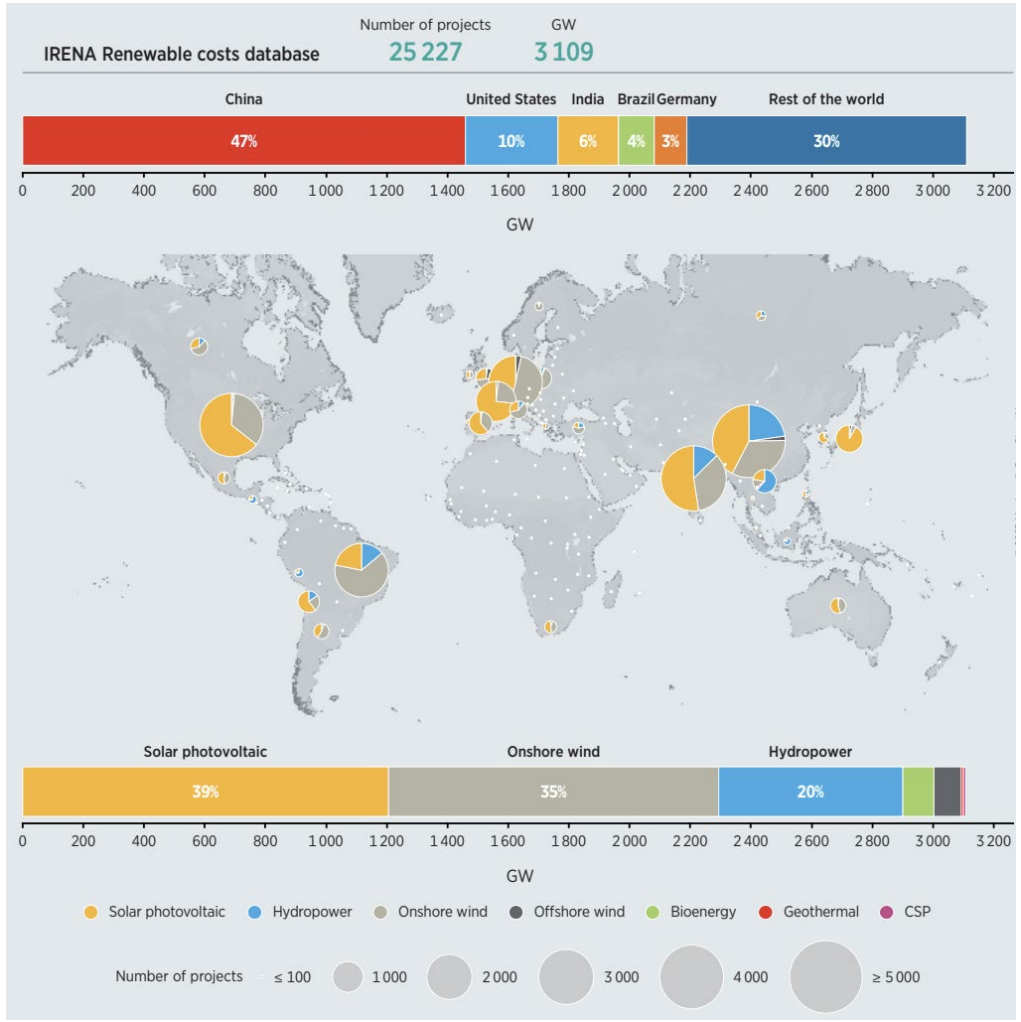

https://www.irena.org/Publications/2025/Jun/Renewable-Power-Generation-Costs-in-2024

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Solar Photovoltaic

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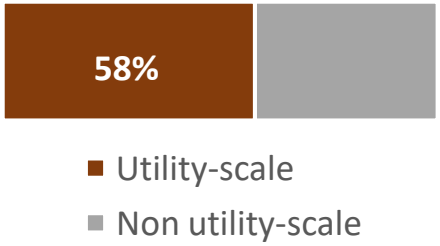
Cost trends : Utility scale solar PV 2010-2024

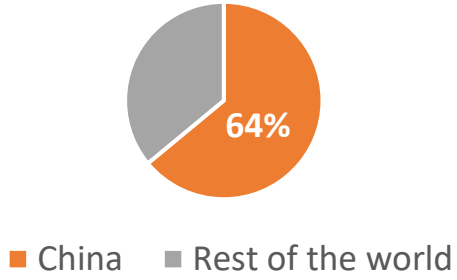
In 2024, 452 GW were commissioned.

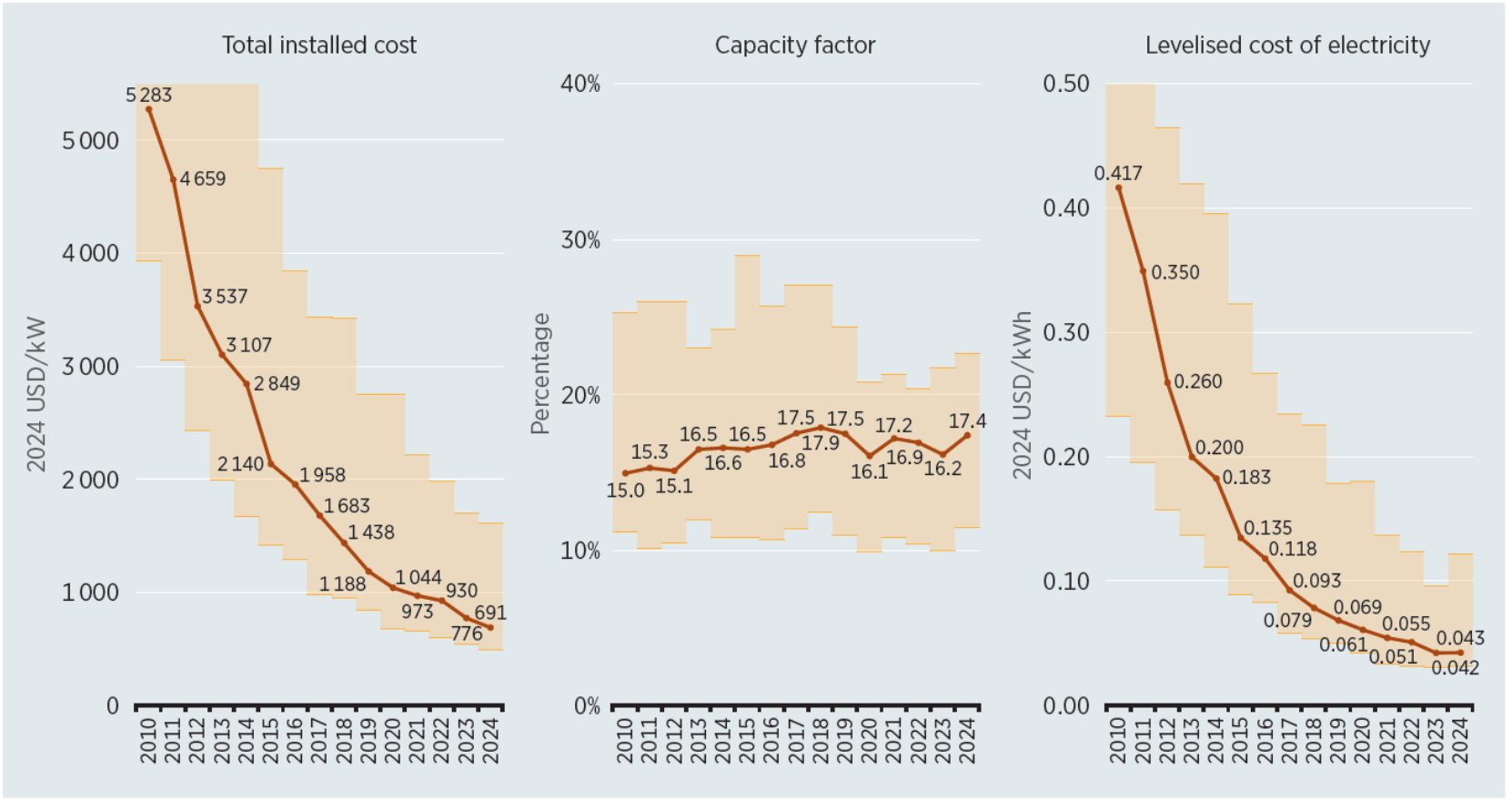
58% of the total deployment was in the form of utility-scale projects.

Utility-scale solar PV additions 2024



Capacity additions 2024

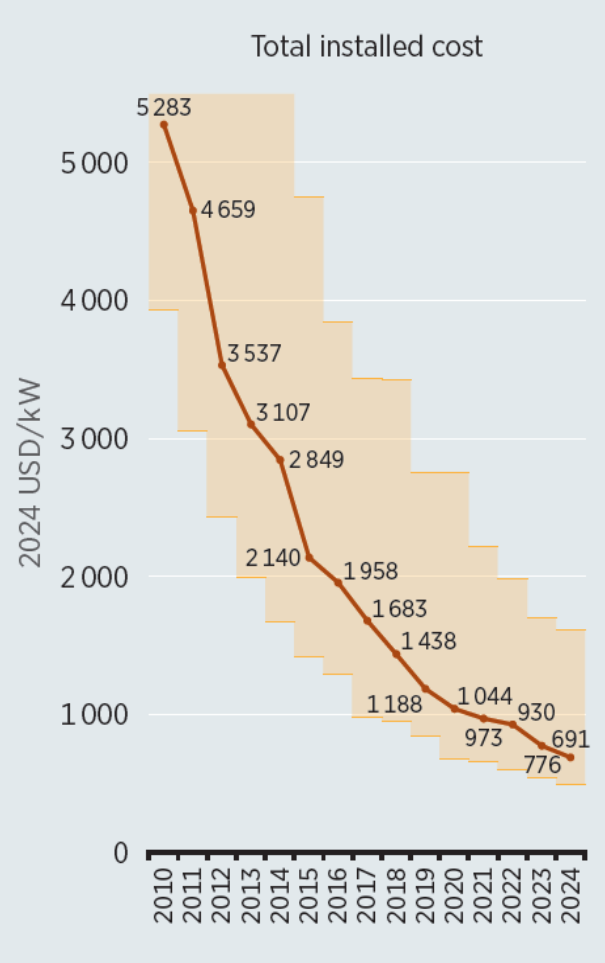




Between 2010-2024, the global weighted average:

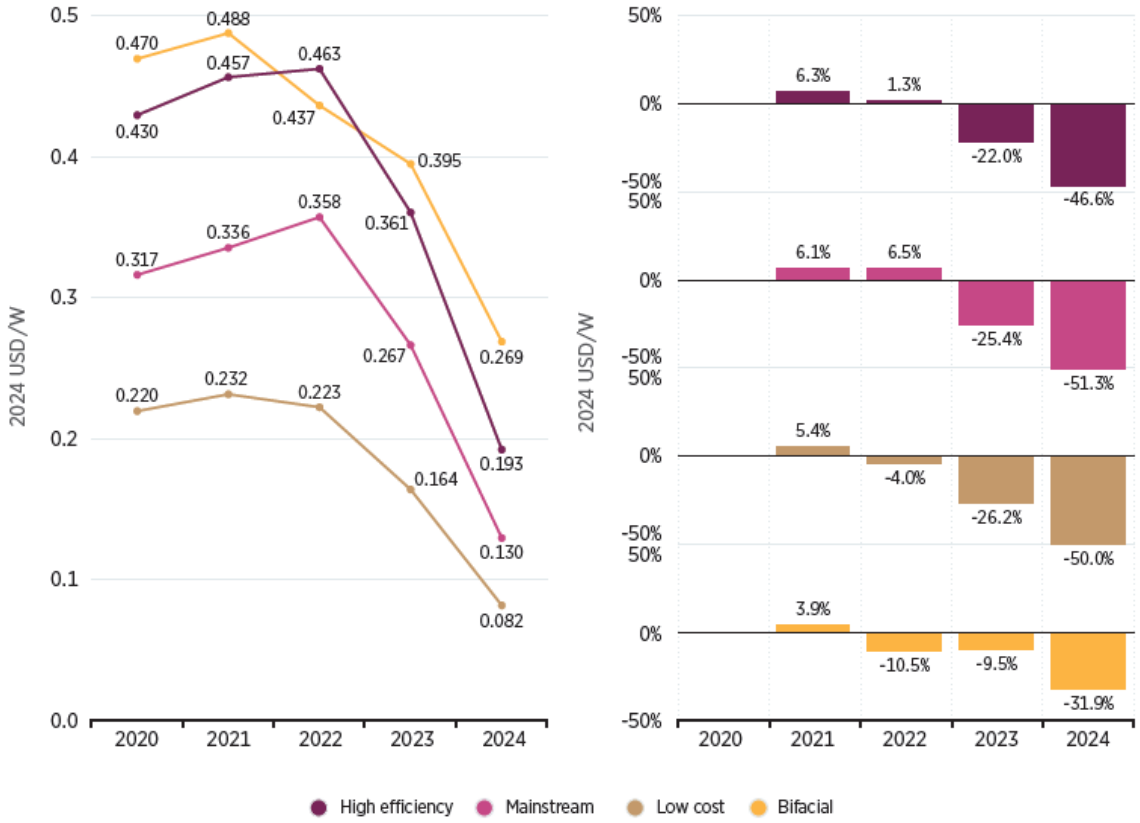
- **LCOE** decreased by 90%
- **Total installed cost** fell by 87%

Total Installed Cost



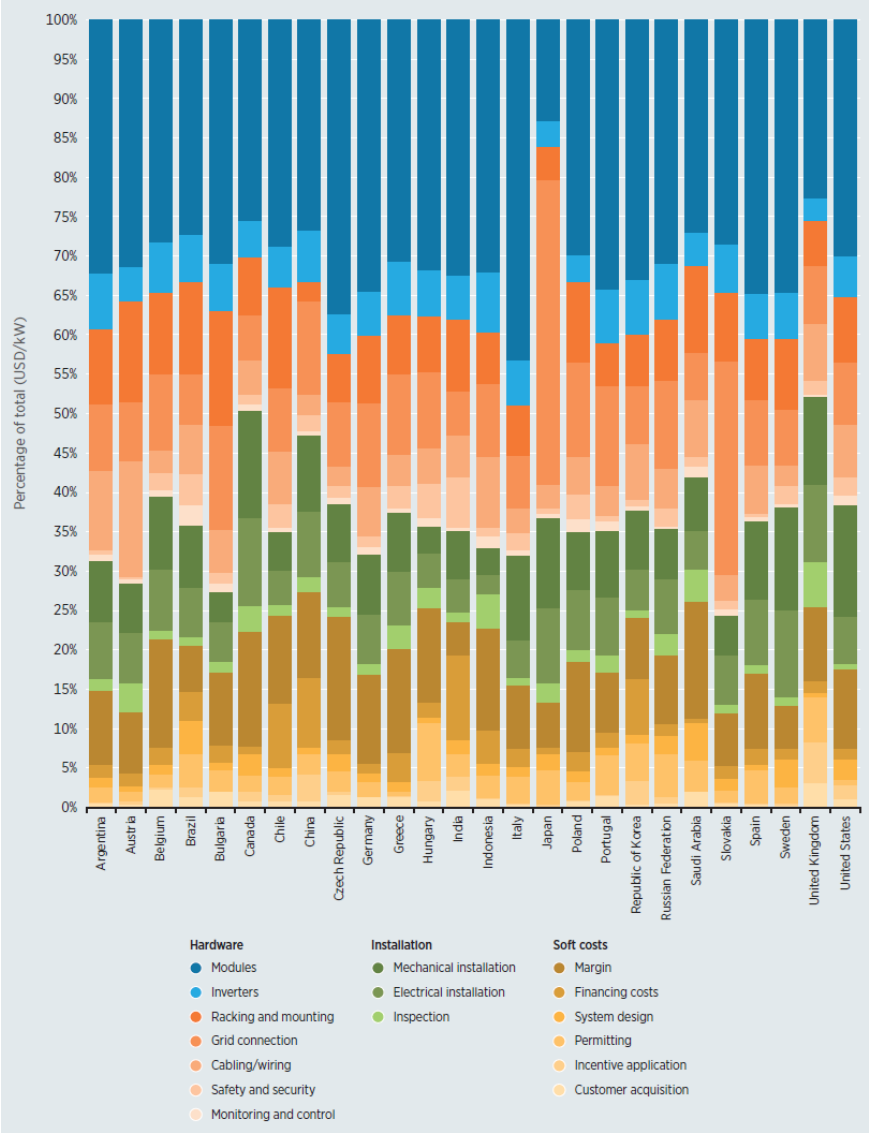
- Total Installed Costs had a 11% year-on-year decrease.
- India: **525 USD/kW**

All the module technologies sold in Europe were at their lowest levels yet by the end of 2024.



Solar PV technology is already mature but it is still underdoing improvements to increase efficiency.

PV total installed cost breakdown

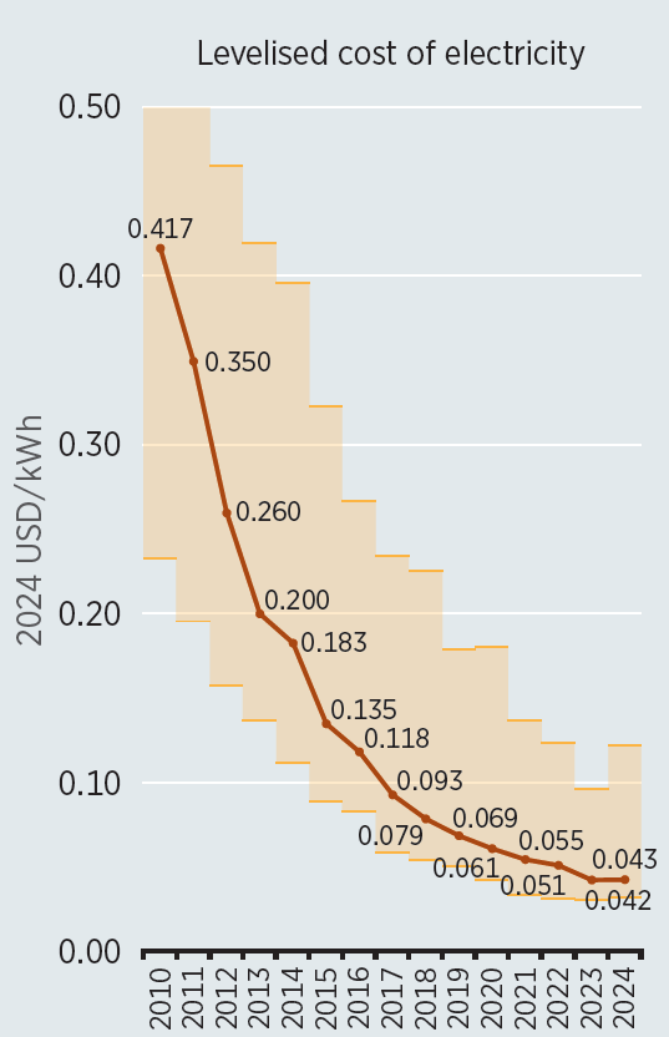


Prices are not only related to modules and regional cost variations persist…

BoS cost made up about 65% of total installed costs of utility-scale PV plants.

Soft cost categories made up on average 30% of total BoS costs.

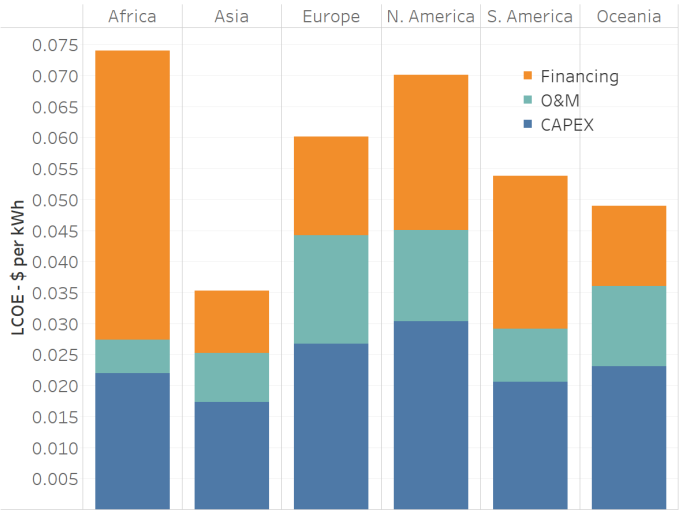
Levelized Cost of Electricity



- Between 2023 and 2024, most countries exhibited increasing LCOE trends, due to higher financing cost.

	2015			2024		
	5th percentile	Weighted average	95th percentile	5th percentile	Weighted average	95th percentile
	(2024 USD/kWh)					
Africa	0.100	**0.225**	0.356	0.049	**0.074**	0.186
Central America and the Caribbean	0.117	**0.154**	0.258	0.070	**0.091**	0.152
Eurasia	0.247	**0.338**	0.439	0.068	**0.087**	0.256
Europe	0.081	**0.150**	0.182	0.041	**0.060**	0.103
Oceania	0.106	**0.119**	0.122	0.033	**0.049**	0.065
Other Asia	0.101	**0.181**	0.378	0.035	**0.070**	0.146
Other North America	0.091	**0.163**	0.425	0.062	**0.094**	0.147
Other South America	0.091	**0.122**	0.192	0.040	**0.063**	0.126
Brazil	0.144	**0.180**	0.193	0.036	**0.048**	0.077
China	0.104	**0.097**	0.186	0.028	**0.033**	0.052
India	0.073	**0.091**	0.178	0.032	**0.038**	0.059
United States	0.093	**0.160**	0.302	0.049	**0.070**	0.141

- Financing share on the LCOE varies between regions.



Low cost-finance is therefore crucial to an affordable energy transition

- Levelized cost of Electricity remained flat, with a slight increase of 0.6%.
- China: **0.033 USD/kWh**

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Onshore wind

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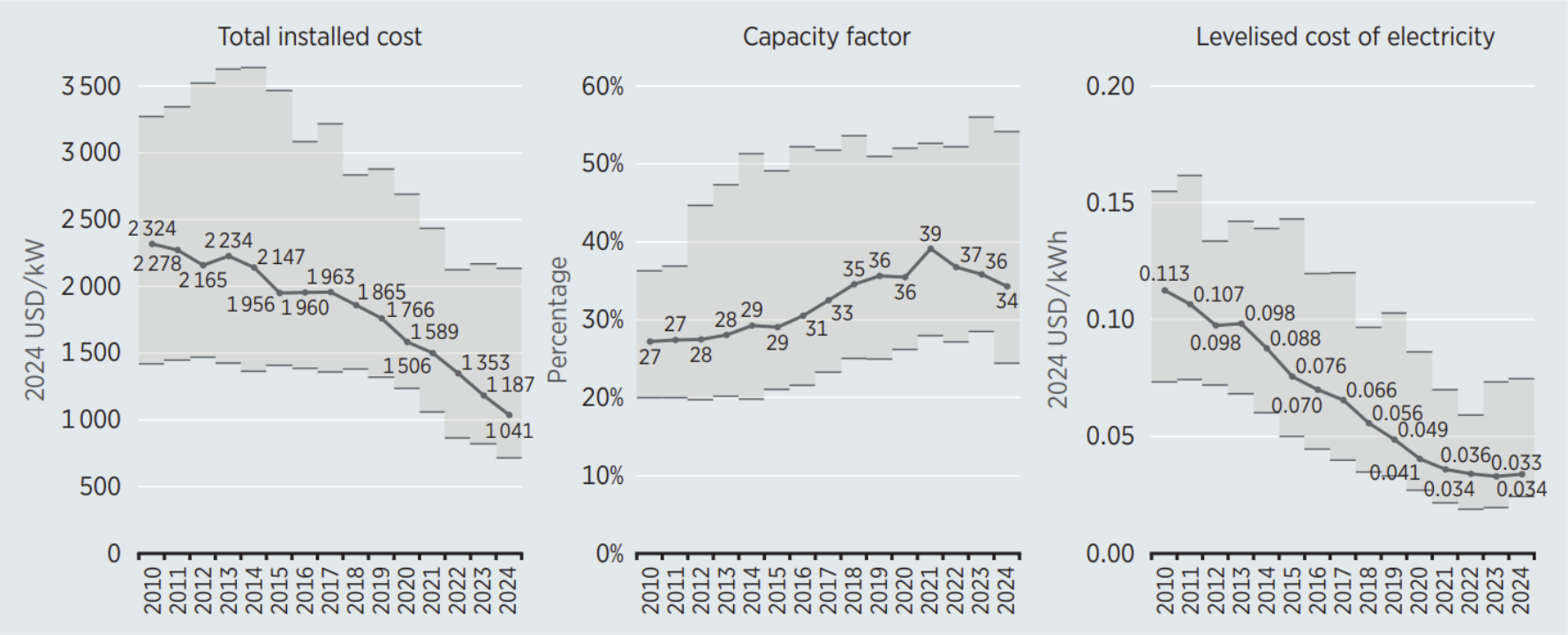
Cost trends: Onshore Wind 2010-2024



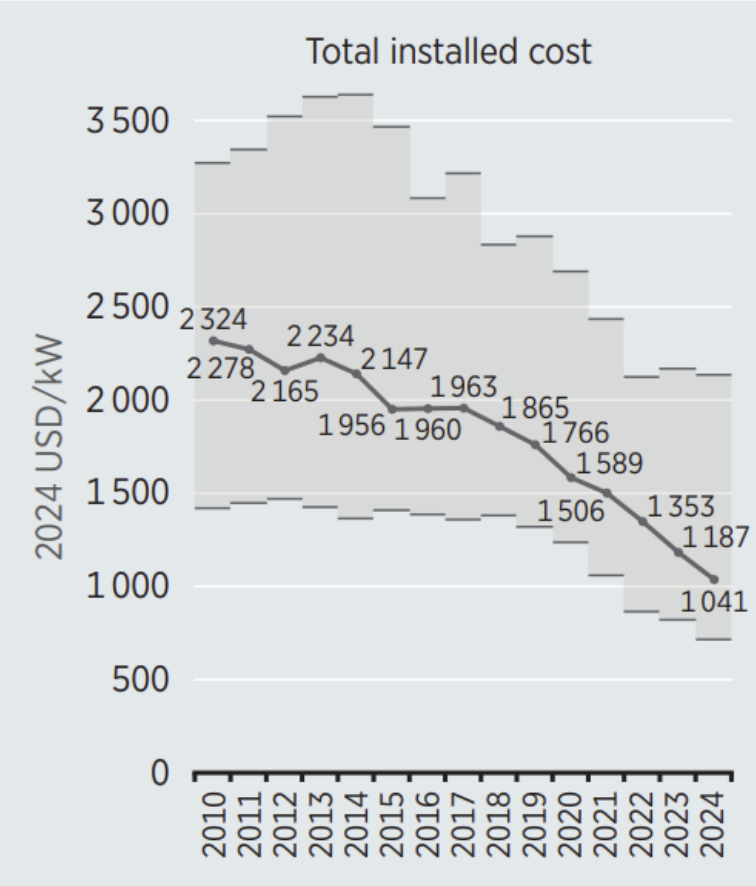
2010-2024

The global weighted average:

- **Total installed cost** fell by 55%
- **Capacity factor** increased from 27% to 34%
- **LCOE** decreased by 70%

In 2024, new utility-scale onshore wind projects remained the cheapest source of renewable electricity.

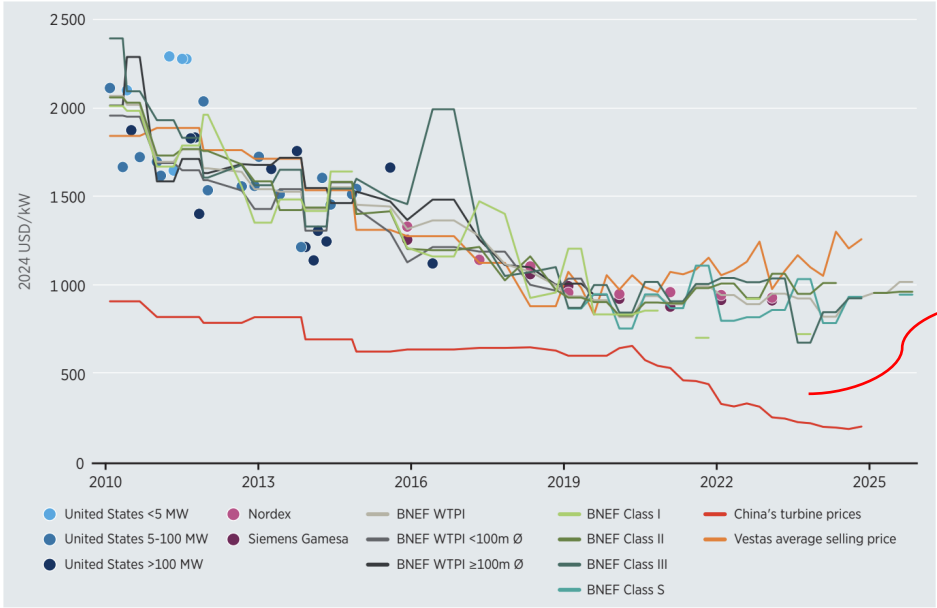
Total Installed Cost



- Total Installed Costs had a 12% year-on-year decrease.
- China: **856 USD/kW**

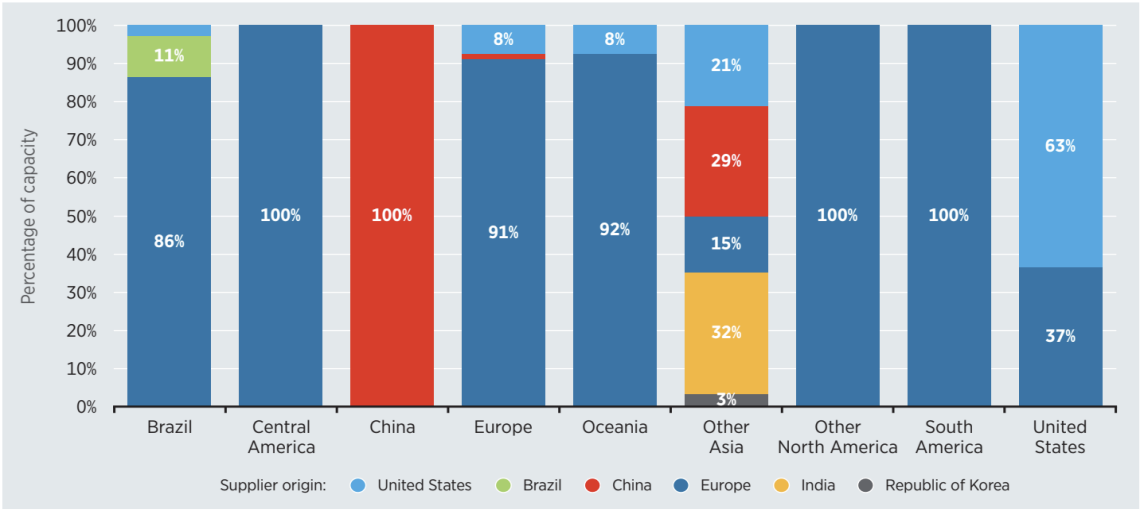
- Globally, wind turbine prices remained relatively stable throughout 2024.

Wind turbine prices



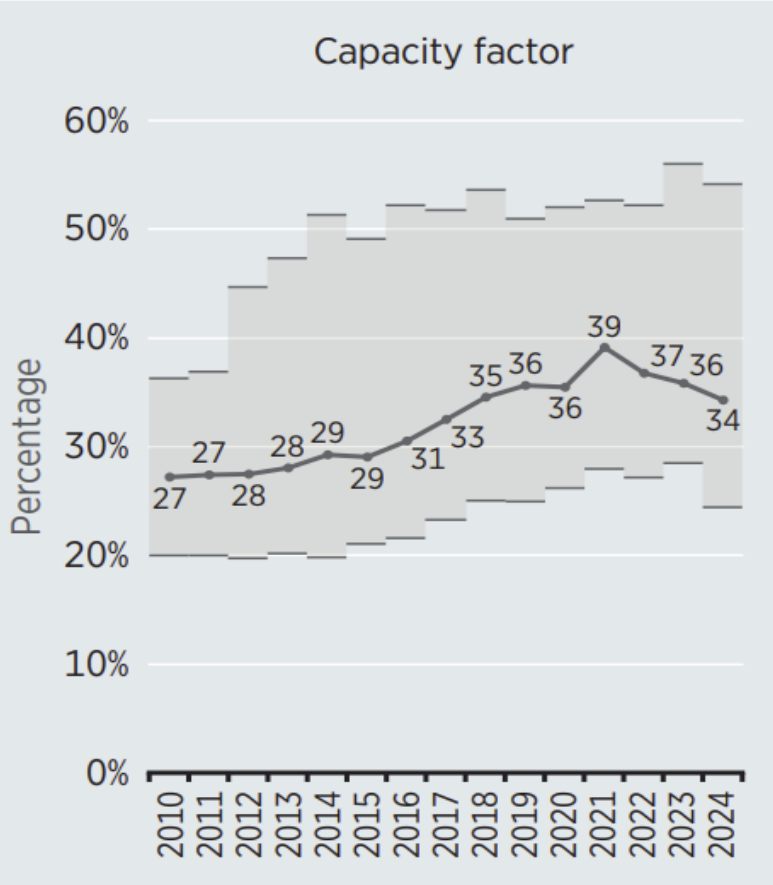
China 80% ↓ than elsewhere

Wind turbine origin

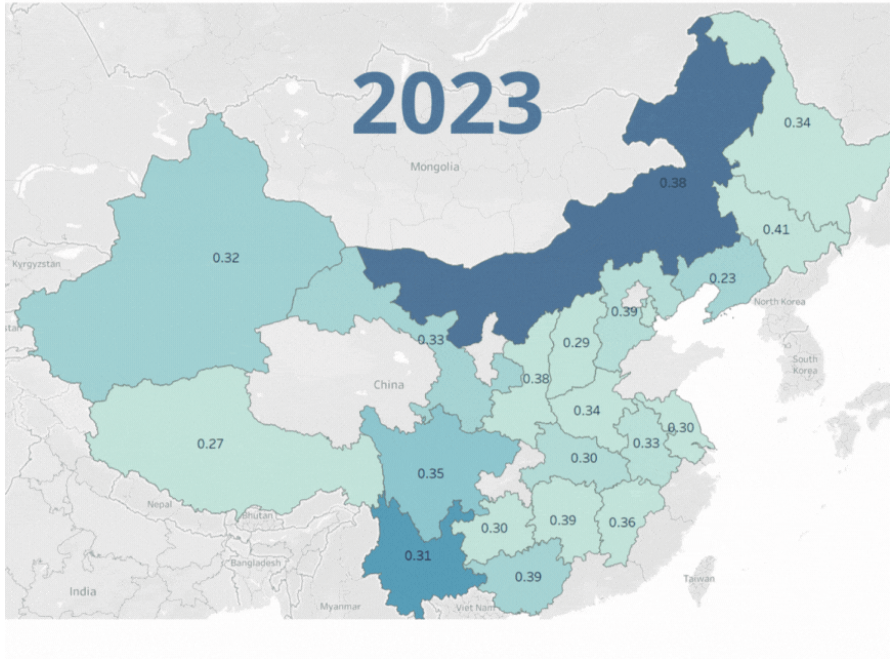


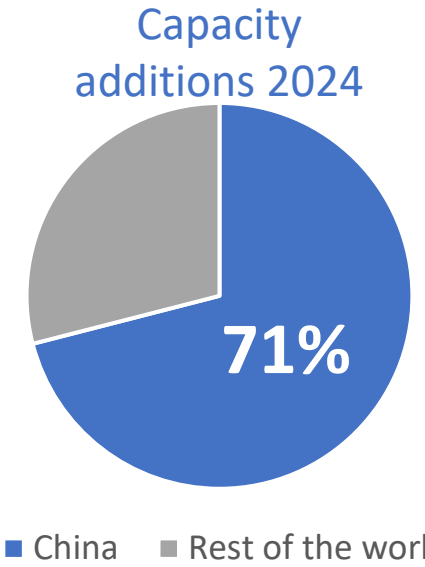
- Wind turbine supply is dominated by OEMs from Europe and China.
- Distribution may shift in coming years as market dynamics evolve.

Capacity Factor



- In 2024, China's share represented 71% of the new onshore wind capacity additions.

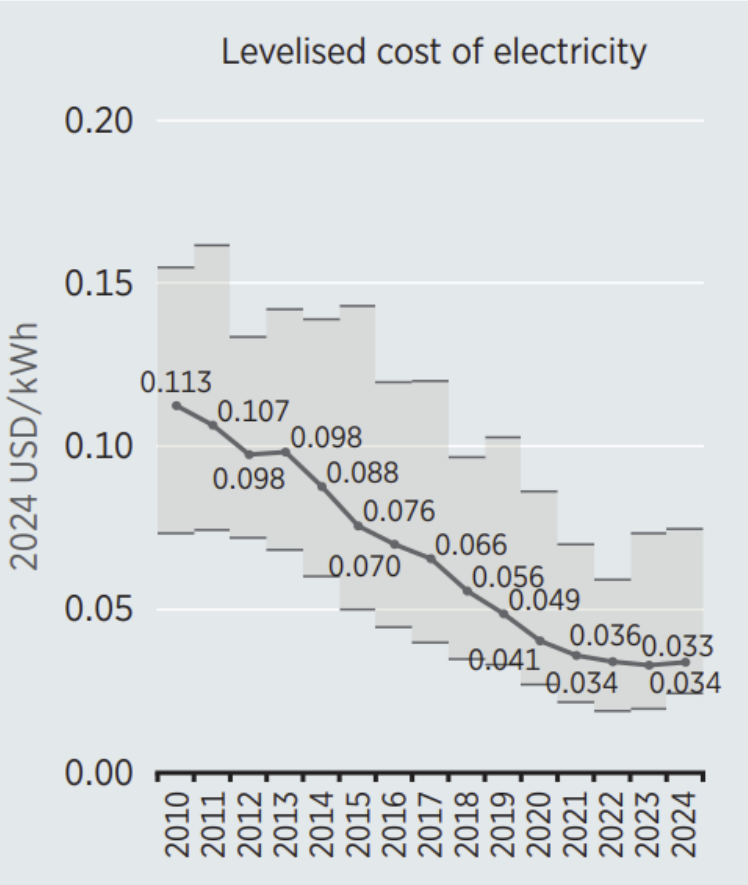




- In China, capacity factors fell from 35% to 33%, as a broader geographical distribution occurred.

- Capacity factor decreased 6% year-on-year.
- Project delays from transmission bottlenecks point to a need for more investment in transmission infrastructure.

Levelized Cost of Electricity



	2010			2024		
	5th percentile	Weighted average	95th percentile	5th percentile	Weighted average	95th percentile
	(2024 USD/kWh)					
Africa	0.077	**0.077**	0.077	0.043	**0.051**	0.058
Central America and the Caribbean	0.101	**0.101**	0.101	0.081	**0.081**	0.081
Eurasia	0.142	**0.142**	0.142	0.050	**0.070**	0.101
Europe	0.094	**0.144**	0.216	0.034	**0.051**	0.075
Oceania	0.127	**0.144**	0.156	0.037	**0.041**	0.044
Other Asia	0.118	**0.162**	0.177	0.037	**0.072**	0.159
Other North America	0.088	**0.120**	0.145	0.032	**0.035**	0.037
Other South America*	0.071	**0.107**	0.344	0.038	**0.064**	0.100
Brazil	0.122	**0.122**	0.122	0.024	**0.030**	0.037
China	0.074	**0.092**	0.115	0.023	**0.029**	0.048
India	0.061	**0.100**	0.125	0.043	**0.048**	0.053
United States	0.071	**0.114**	0.157	0.026	**0.039**	0.052

Notes: * Regions where data was only available for projects commissioned in 2012, not 2010; see Annex III for regional country groupings.

- LCOE rose by 3% year-on-year.
- Between 2023 and 2024, most countries exhibited either stagnant or slightly increasing LCOE trends.

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Offshore wind

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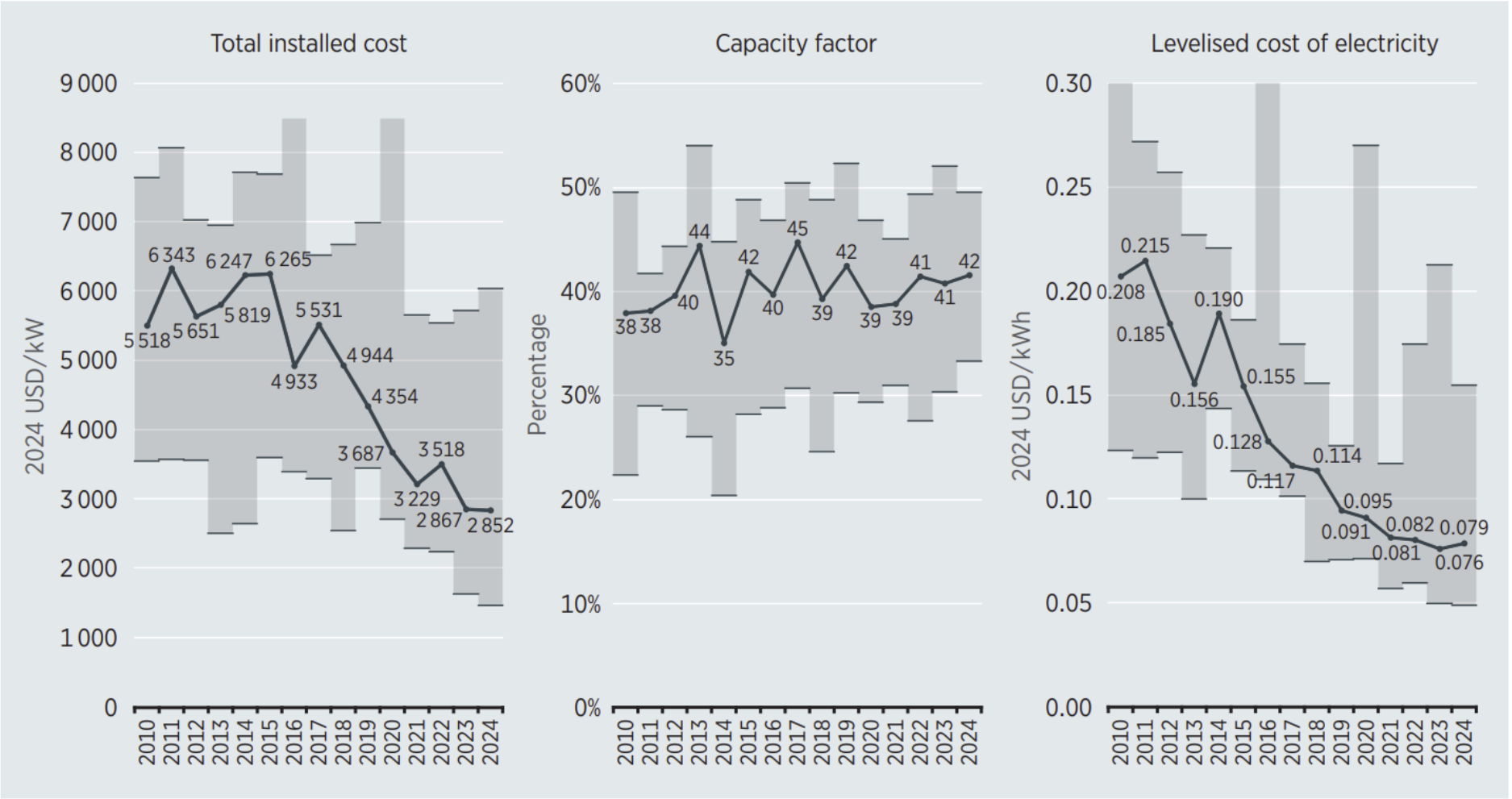
Cost trends: Offshore Wind 2010-2024



2010-2024

The global weighted average:

- **Total installed cost** reduced by 48%
- **Capacity factor** increased from 38% to 42%
- **LCOE** decreased by 62%

Cost trends: Offshore Wind 2023-2024

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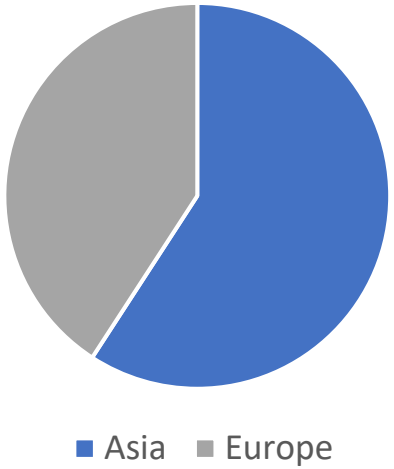
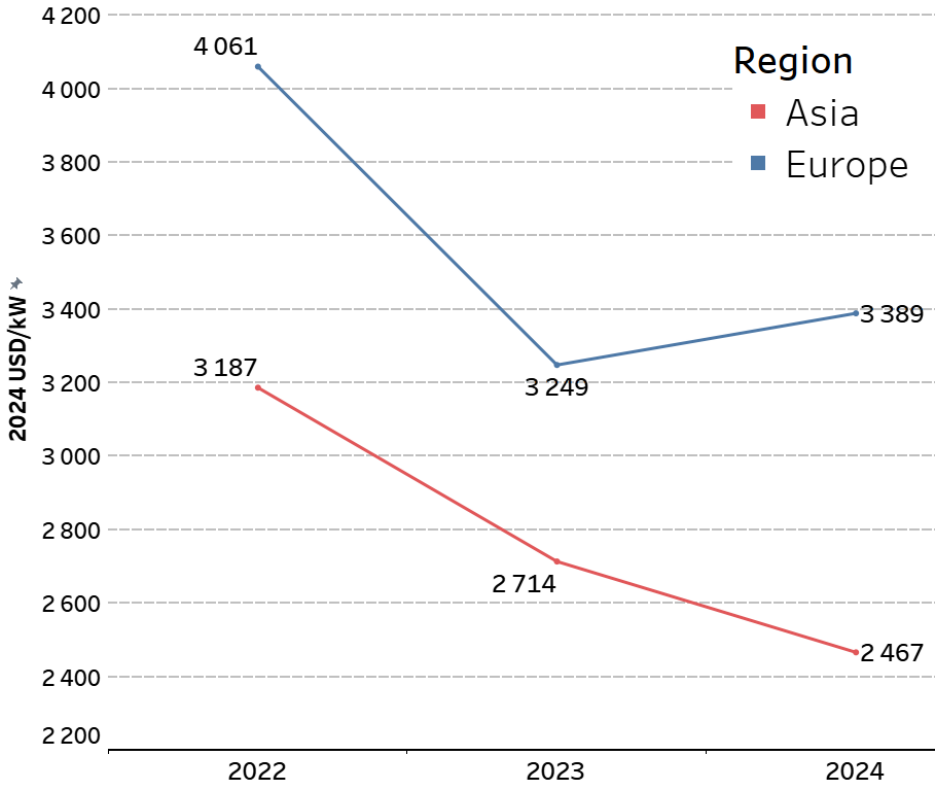
Capacity additions 2024



- In 2024, Asia accounted for >50% of new offshore wind capacity.

- **Asia:** slight decrease in TIC & LCOE due to China cost reductions, partially offset by higher-cost markets.
- **Europe:** increase in TIC & LCOE.



	2010			2024		
	5th percentile	Weighted average	95th percentile	5th percentile	Weighted average	95th percentile
	(2024 USD/kWh)					
Asia	0.135	**0.201**	0.222	0.047	**0.078**	0.164
China	0.133	**0.200**	0.220	0.046	**0.056**	0.063
Japan	0.212	**0.212**	0.212	0.181	**0.181**	0.181
Europe	0.142	**0.208**	0.246	0.056	**0.080**	0.125
Denmark	0.119	**0.119**	0.119	0.053	**0.053**	0.053
France	n.a.	**n.a.**	n.a.	0.123	**0.123**	0.126
Germany	0.195	**0.198**	0.205	0.070	**0.069**	0.094
The Netherlands*	0.115	**0.115**	0.115	0.066	**0.066**	0.066
United Kingdom**	0.218	**0.228**	0.237	0.057	**0.059**	0.063

Notes: * Countries where data were only available for projects commissioned in 2015, not 2010; ** countries where data were only available for projects commissioned in 2023, not 2024; see Annex III for regional country groupings; n.a. = not available.

- Emerging markets may raise costs, but global averages are moderated by experienced markets.

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Global Expansion & Innovation in Offshore Wind

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In 2024,

56.3 GW

of capacity awarded worldwide.

- Technology drives new opportunities for offshore wind, supported by well-designed auction frameworks and effective risk sharing mechanisms.

- New markets: Asia (beyond China), Oceania, emerging Europe, Africa, South America

Technological innovation:

- **Larger turbines:** scaling capacities and rotor diameters.

- **Next-gen vessels:** faster, more efficient installation.

- **Enhanced operations:** improved construction and maintenance practices.

Icons: Freep!k

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Battery storage

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Global battery storage deployment

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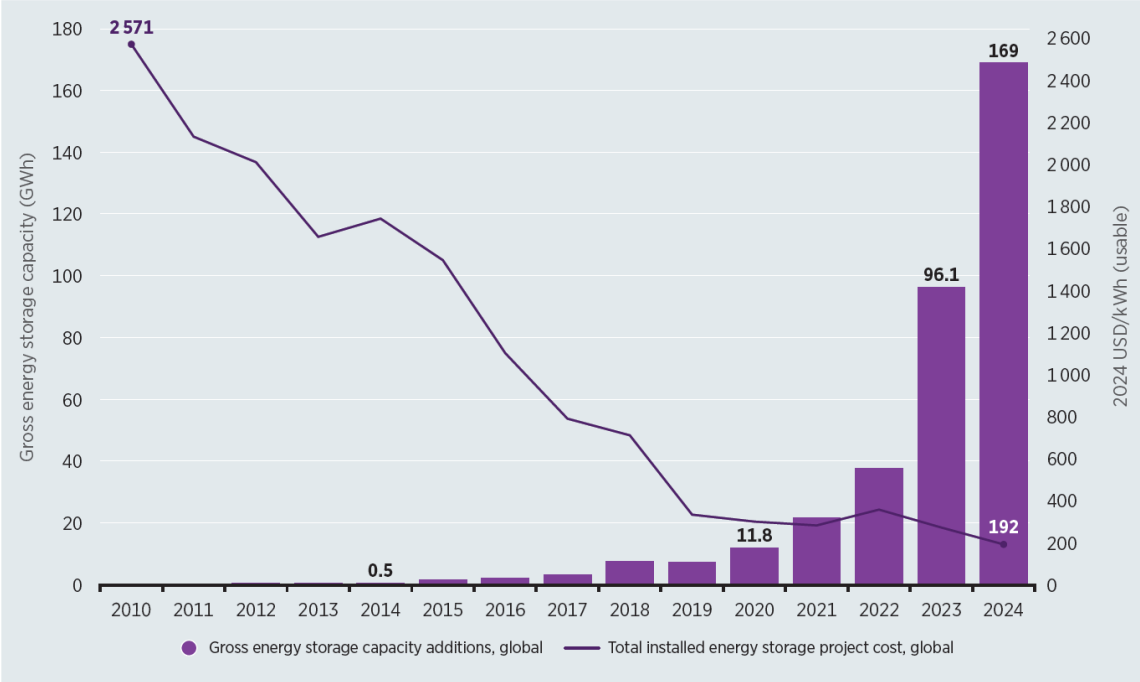
The global energy storage market keeps growing

Capacity additions

reached 169 GWh in 2024
76% increase compared to 2023

Chemistry

Lithium-ion batteries lead utility-scale deployments



Market leaders

China and United States

Costs of installed energy storage

fell by -93% between 2010-2024
decrease by 30% year-on-year

Most Competitive LDES

Pumped storage USD 156/kWh

Icons: Freep!k, Flaticon, Icons8

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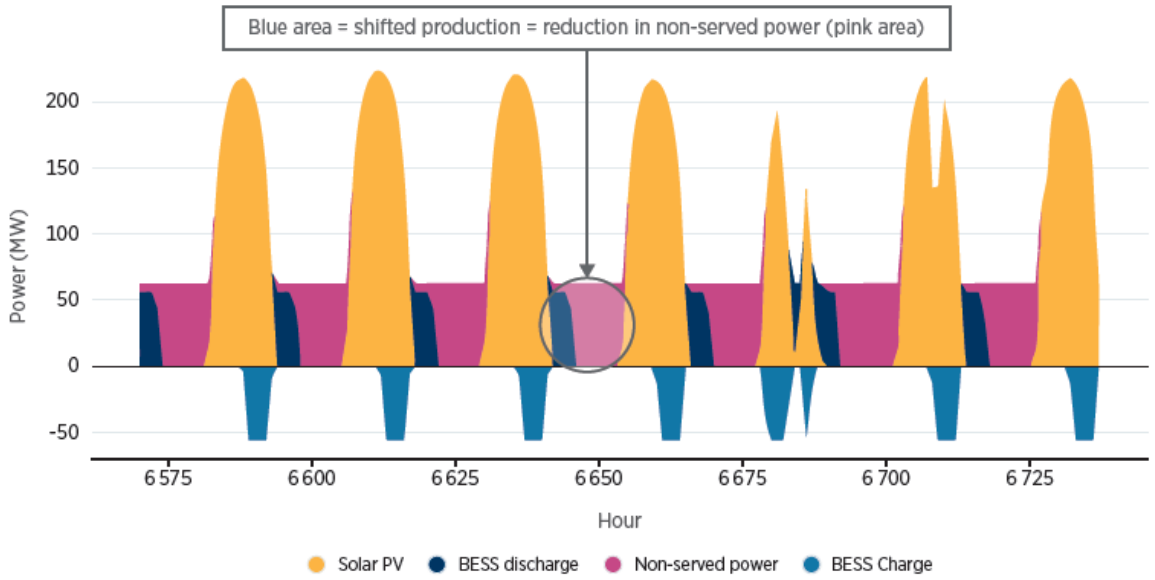
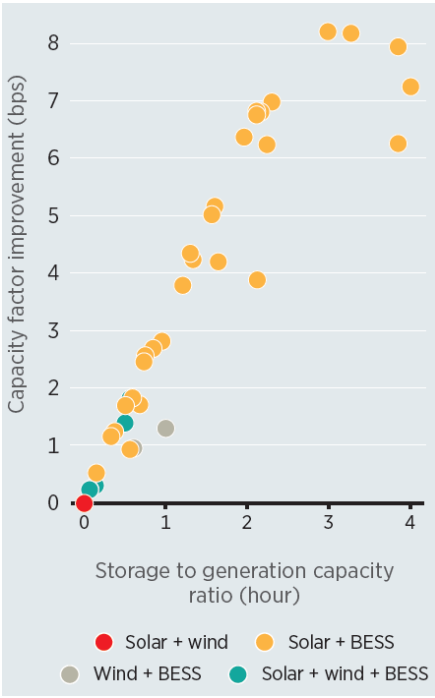
Hybrid system deployment is increasing

- Renewables coupled with battery storage are rapidly matching fossil fuel-based generation costs in key markets.
- **United States**: a weighted average LCOE of USD 0.079/kWh

Capacity factor estimated by a linear optimization



Relationship between storage capacity and capacity factor improvement



Larger batteries deliver greater performance gains, but require higher BESS investments

Key take aways

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1 **Total installed costs** declined across most renewable technologies, except for bioenergy, in 2024.

2 **LCOE** for solar and wind is stabilizing, while greater cost-reduction potential remains for emerging technologies such as batteries.

3 **Financing costs** remain a key determinant of renewable project viability, financing share being significant in Africa.

4 A growing number of **hybrid projects** combining solar, wind and storage are being deployed enhancing economic performance and grid flexibility.

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Q & A
5 min

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