

CLIMATE ENERGY FINANCE

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ANU Solar Oration: Solar Step Change

4 November 2024

Solar Step Change

Agenda

Solar has become the dominate source of net new electricity capacity installed globally

Global solar install estimates regularly upgraded: hard to forecast disruption

China is leading a global step change in cleantech manufacturing capacity

Solar continues to be deflationary

Solar + Batteries + EV => accelerating the technology disruption

China cleantech is going global: ODFI + exports + offshoring manufacturing

China leads the world: 22 GW of RE + 3 GW BESS per month (18 GW solar)

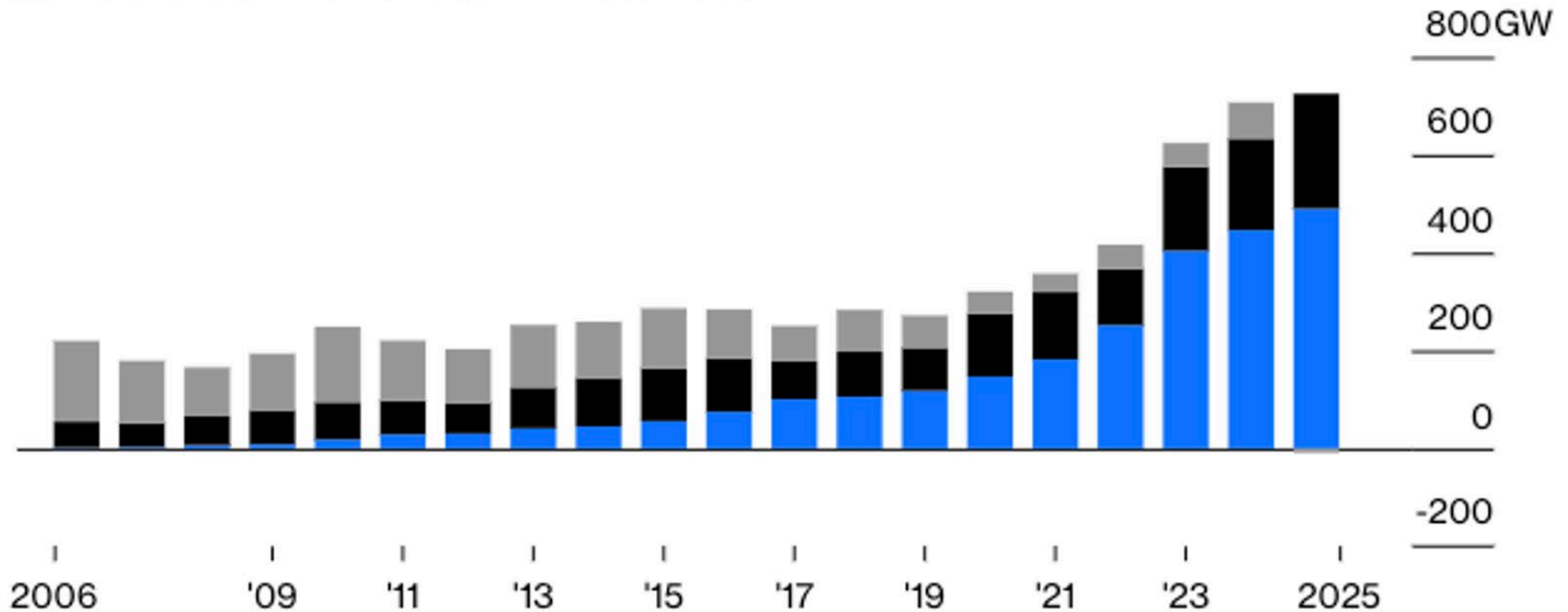
Time for Australia to act: Safeguard Mechanism, Carbon Leakage Review, NZEA, CIS, FMIA, NRF and Green Metal Exports 

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Two-Thirds of New Electricity Generating Capacity Is Solar Power

New installations minus retirements

■ Photovoltaic ■ Other clean ■ Fossil fuels

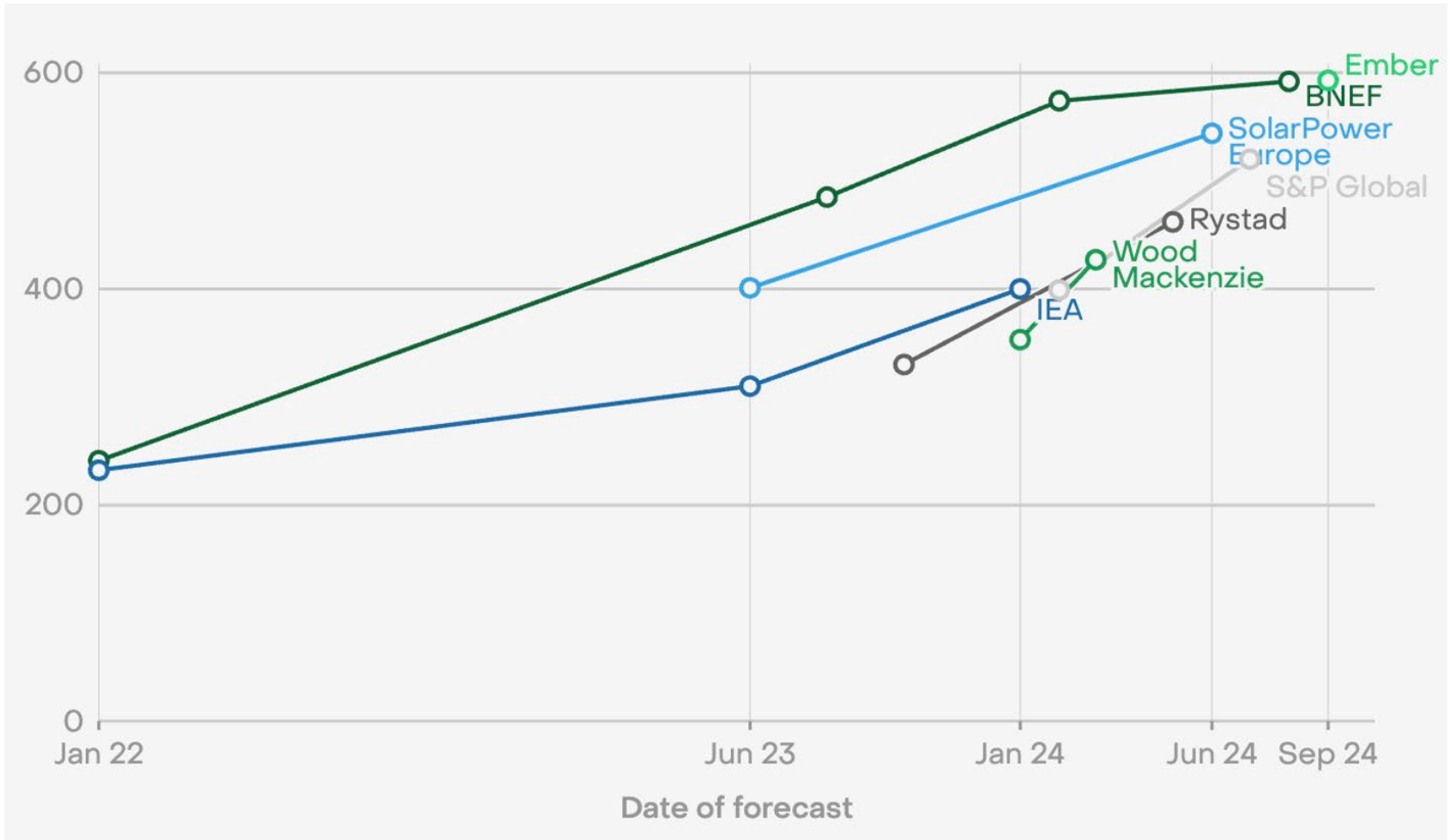


Source: BloombergNEF

Note: Data for 2023 to 2025 are forecasts.

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Constant upgrades to global solar install forecasts



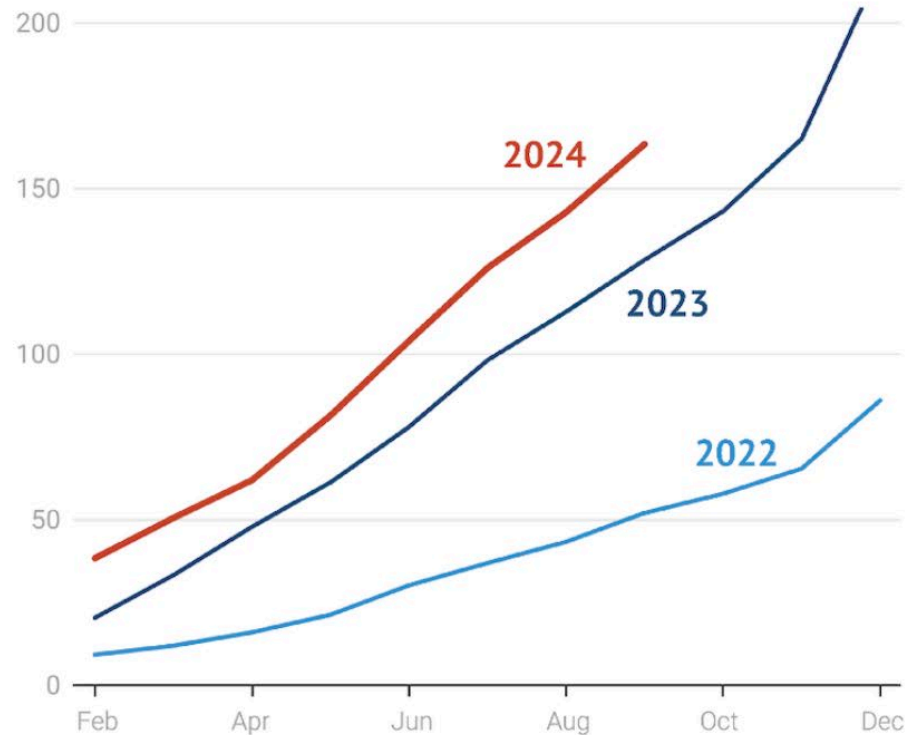
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China's Wind and Solar Growth Continues in 2024

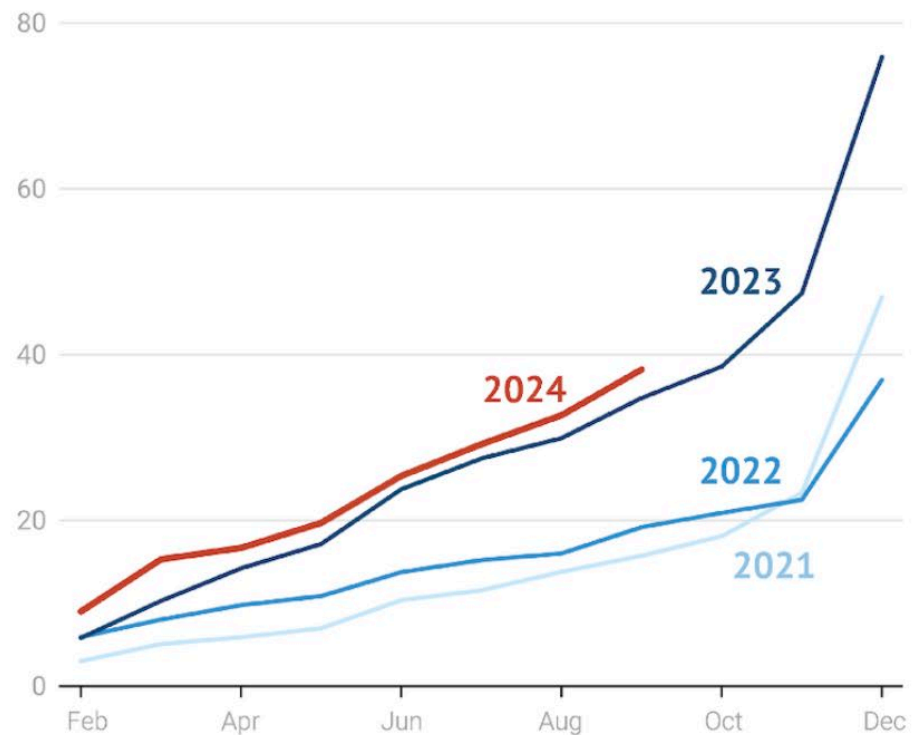
China solar installs: 2021 54GW, 2022 86GW, 2023 217GW, 2024 >250GW

Cumulative new capacity per year, GW

Solar



Wind



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Pakistan is set to install 10-15GW of Solar in 2024

Opinion

David Fickling,
Columnist

An Electricity Protection Racket Makes Pakistan Opt Out

Clean power can provide the solution if the government would only accept it.

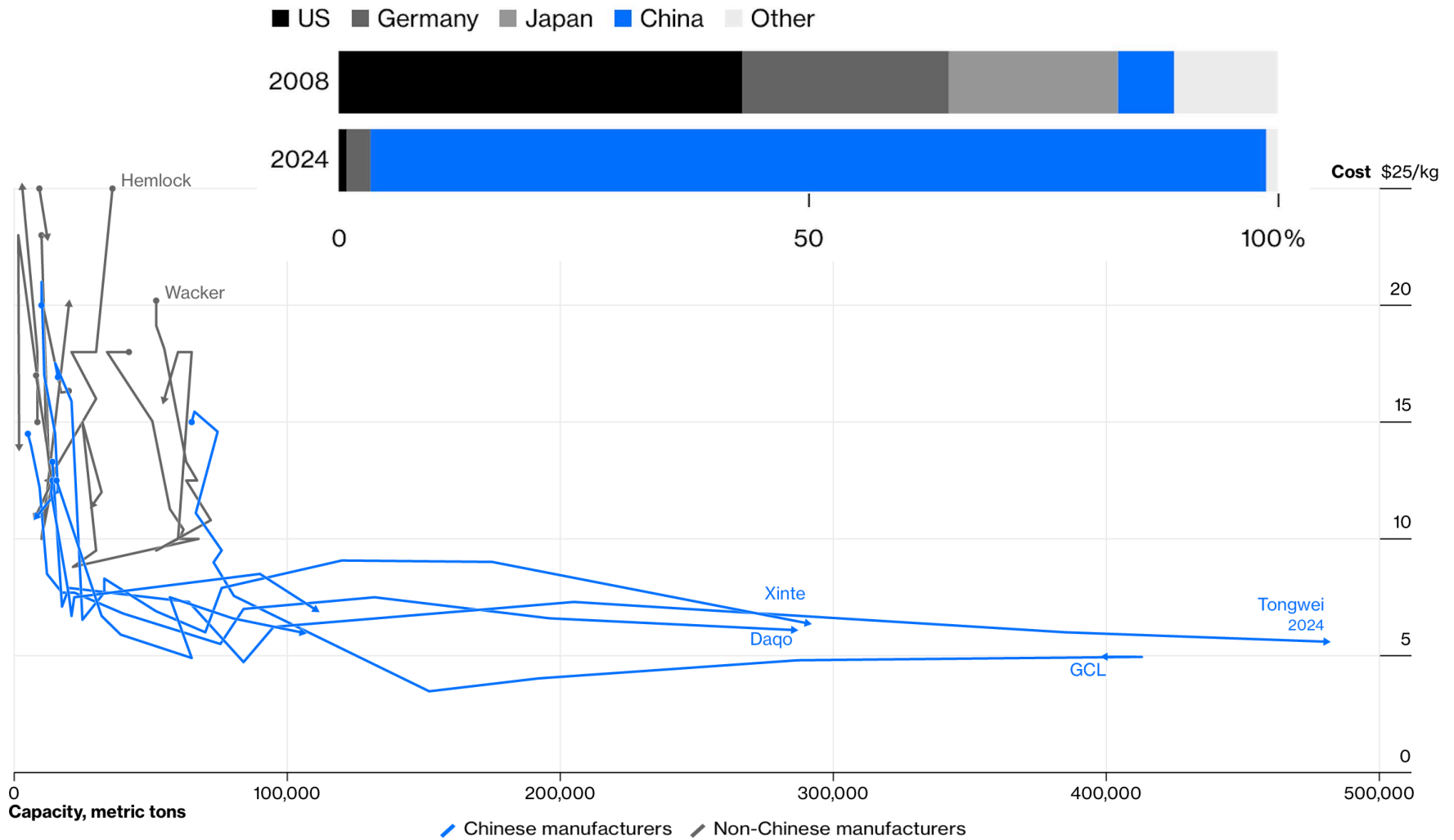
22 August 2024 A recent study by BloombergNEF analyst Jenny Chase illustrates the extraordinary scale of this off-the-books boom. Last year, \$1.45 billion in solar panels were exported from China to Pakistan. That's enough to buy about 6 gigawatts of modules, sufficient to provide about 7% of Pakistan's electricity. Roughly the same amount was imported in the first six months of this year alone. With the drop in cell prices over the past year, that now represents something closer to 13 GW.



Separate evidence from machine-learning processing of satellite imagery suggests huge amounts of panels are going undetected. The area of arrays visible from space is equivalent to a minimum of between 1.4 GW and 2.8 GW, BloombergNEF found. Much appears to be built on the rooftops of factories, for industries to consume themselves. Chase estimates that a total 12.7 GW was installed by the end of last year and a further 10 GW to 15 GW will be added in 2024, making Pakistan the world's sixth-largest solar market.

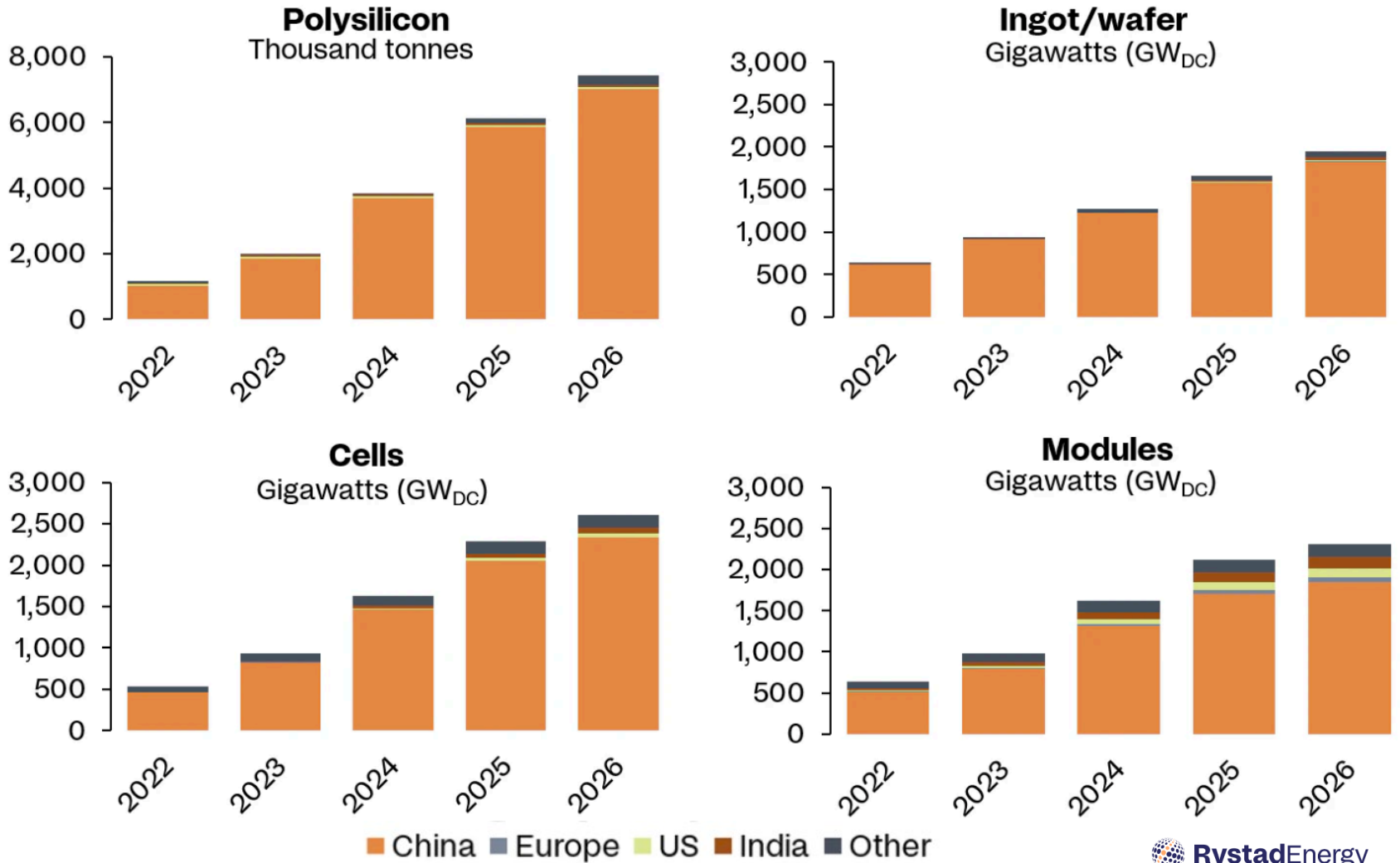
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How China Came to Control 90% of the Global Solar Market



Solar Step Change - Manufacturing

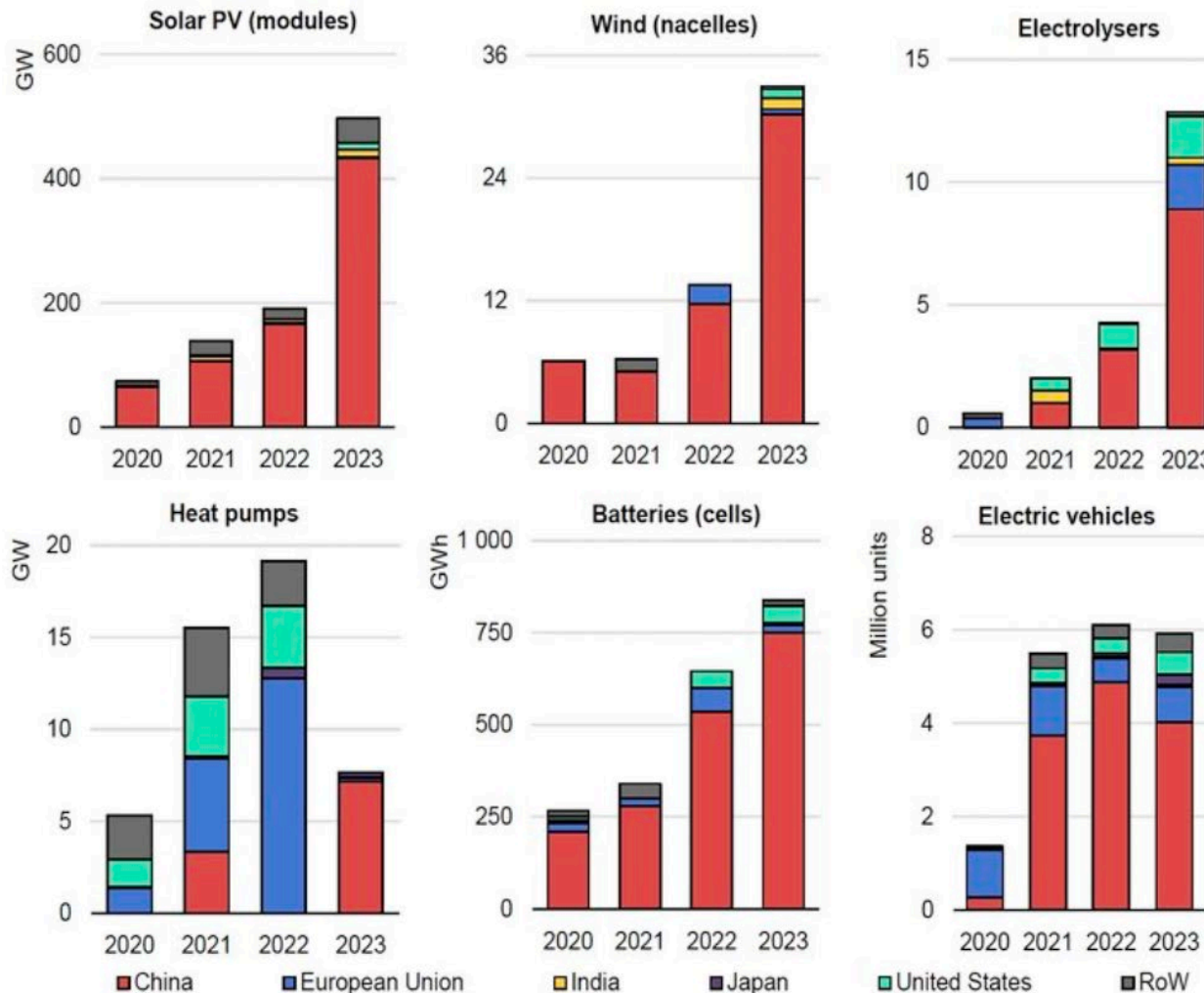
Global Manufacturing Capacity for Solar Components



Solar Step Change - Manufacturing

Global Cleantech Manufacturing Capacity Expansions by Year

Figure 1.6 Net manufacturing capacity additions for selected clean energy technologies by country/region, 2020-2023



Solar Step Change

How China Came to Control 90% of the Global Solar Market

Chinese PV Industry Brief: JinkoSolar breaks ground on 56 GW solar factory

JinkoSolar has broken ground on a 56 GW PV panel factory in China's Shanxi province. It says the new facility will be vertically integrated and will be constructed in four 14 GW phases.

MARCH 29, 2024 **VINCENT SHAW AND VALERIE THOMPSON**



JinkoSolar has started building a 56 GW vertically integrated module factory in Shanxi province. The project, situated in the Shanxi Comprehensive Reform Demonstration Zone, involves a total planned investment of CNY 56 billion (\$7.8 billion), divided into four phases. Each phase will include 14 GW for the integration of ingots, wafers, solar cells, and modules. All phases are projected to be completed within a two-year construction period. The first-phase and second-stage projects are on track to start production in the first quarter and second quarter of 2024, while the third phase and fourth phase are scheduled for completion and production in 2025.

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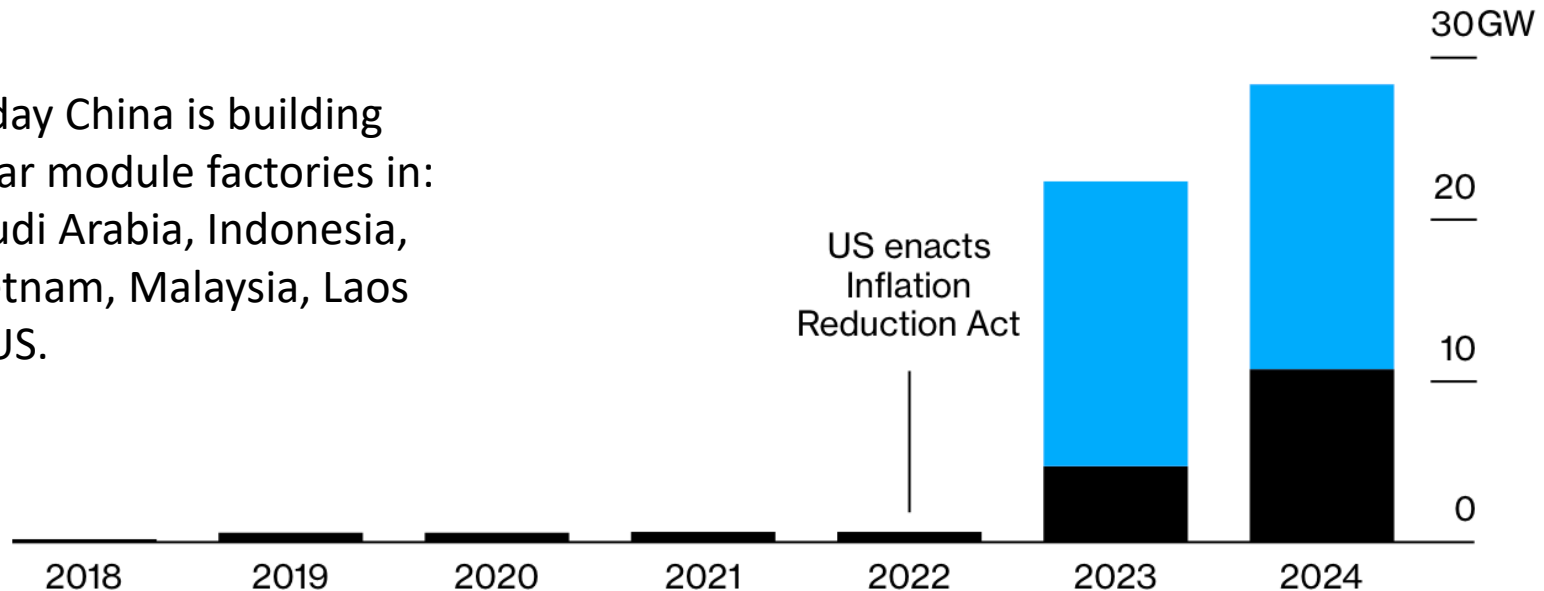
How China Came to Control 90% of the Global Solar Market

Chinese Solar Manufacturers Have Big American Ambitions

Production capacity of China-backed solar panel factories in the US

■ Operating ■ Announced

Today China is building solar module factories in: Saudi Arabia, Indonesia, Vietnam, Malaysia, Laos & US.



Source: BloombergNEF

Note: Data as of Aug. 2024

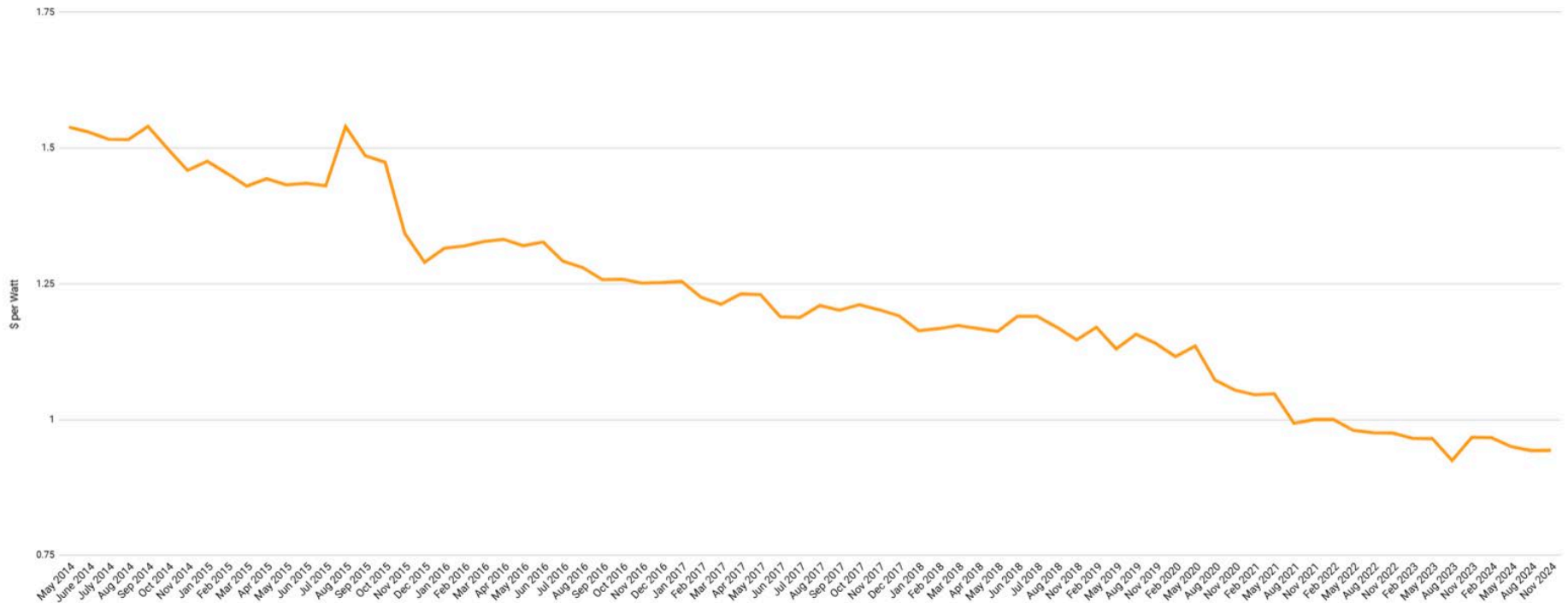
Source: Bloomberg, <https://www.bloomberg.com/news/features/2024-10-29/ira-investment-created-us-jobs-and-tax-breaks-for-chinese-solar-firms>

CEF: https://climateenergyfinance.org/wp-content/uploads/2024/10/final-_-CEF-Report-China-Outbound-FDI-2-October-2024-2.pdf

Solar Step Change - Deflation

Solar remains deflationary, and this will continue for the next decade

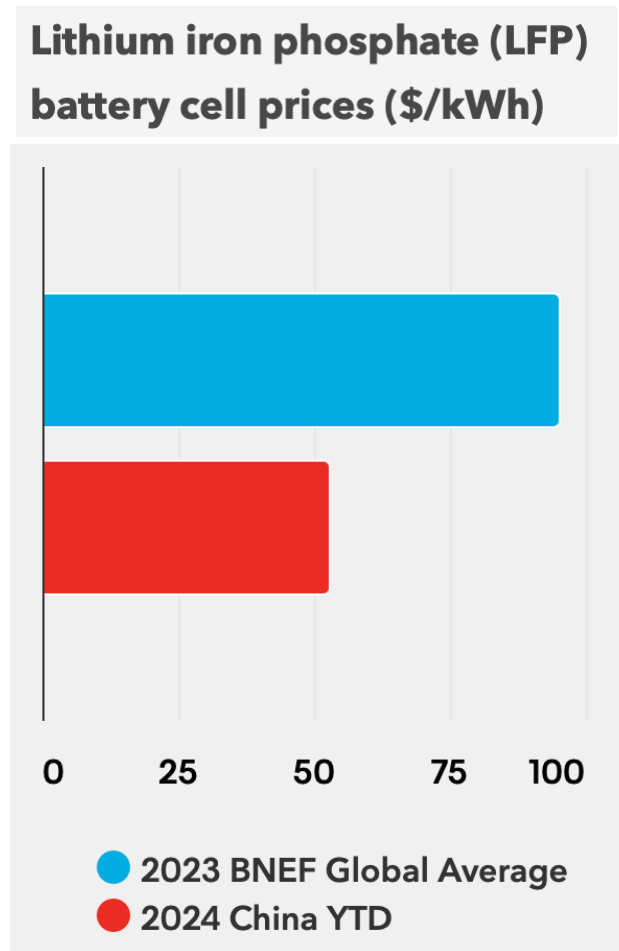
Historic average Australian installed commercial solar panel cost (A\$/watt)



Source: Solar Choice, <https://www.solarchoice.net.au/solar-panels/solar-power-system-prices/>

Solar Step Change: A Battery Turbo-charge

China's Low-Cost Battery Push



BESS + Solar => Disruption!

Sungrow secures 7.8 GWh battery storage deal with Saudi Arabia's Aljihaz Holding

China's Sungrow has signed three landmark energy storage contracts with Saudi Arabia's Aljihaz Holding, amounting to the world's largest grid-side storage order. Each project will have a capacity of 2.6 GWh, totaling 7.8 GWh.



By Vincent Shaw | Jul 16, 2024



3 Chinese clean-energy firms to set up solar, wind manufacturing in Saudi Arabia

- Jinko Solar, TCL Zhonghuan and Envision Energy will set up joint ventures with Saudi Arabia's Public Investment Fund and a private firm

[Yujie Xue](#) | 17th July 2024 | SCMP

Three major Chinese clean-energy manufacturers will build production plants in Saudi Arabia to expand their global footprints amid US and European trade barriers and fierce competition at home.

[Saudi Arabia's](#) Public Investment Fund (PIF) announced on Tuesday that it will form joint ventures in the [Middle Eastern](#) country with Jinko Solar and TCL Zhonghuan, two of the world's largest producers of [solar modules and solar silicon wafers](#), as well as [wind turbine](#) maker Envision Energy.

Australia must look to strategic partnerships with our key trade partners, as part of the FMIA

BESS + Solar => Disruption!

2GW of Solar + 11GWh of BESS in Chile

CATL to supply Greenergy 1.25GWh BESS for 'world's largest energy storage project' in Chile

By [Jonathan Tourino](#) October 30, 2024 Energy Storage News



CATL supply will cover phase four of the Oasis de Atacama project in Chile which is expected to be operational by 2026. Image: Greenergy

Spanish independent power producer (IPP) **Greenergy** has secured a 1.25GWh energy storage supply agreement with **CATL** for its Oasis de Atacama project in Chile.

The capacity will be for the **Oasis de Atacama solar-plus-storage project in Chile**, which is the 'world's largest energy storage' project with a total 11GWh of battery capacity and 2GW of solar PV.

China's >US\$100bn Cleantech ODFI since 2023

China's response to the growing US and EU anti-China trade barriers

Investment						Date of	Expected	
US\$m	Technology	Company	Investment Partner	Location	news	Product	start of production	Confirmed / FID
8,100	Battery	CATL	n.a.	Debrecen, Hungary	May'2024	Battery Mfg, 100GWh	2025	Yes
5,600	NEV	Human Horizons	Ministry of Investment	Saudi Arabia	Jun'2023	NEV Mfg - MoU	n.a.	No
4,200	Hydro	Power China	n.a.	Tanzania	Feb'2024	Hydro-electricity - 2,115MW	2024	Yes
3,300	Grid T&D	China State Grid	n.a.	Brazil	Apr'2024	2*1,500km grid transmission lines	n.a.	Yes
2,600	Solar Farms	CEEC	ACWA & Aramco	Saudi Arabia	Feb'2024	2,600MW of solar farm	2024	Yes
2,450	Wind Farm & BESS	Goldwind	Omni Energy	NSW, Australia	Aug'2024	1.4GW wind, 200MW-2hr BESS	2028	No
2,360	Battery	Gotion	n.a.	Michigan, US	Aug'2024	Battery Mfg	n.a.	No
2,200	Battery	CALB	n.a.	Portugal	Jan'2024	Battery Mfg, 15GWh	2026	No
2,100	Solar Mfg	TCL Zhonghuan	RELC & Vision	Saudi Arabia	Jul'2024	20GW solar wafers pa	n.a.	No
2,000	Wind Farms	CEEC	ACWA Power	Uzbekistan	Aug'2024	to construct a 1GW wind farm	2026	Yes
2,000	Solar Farms	CGN	n.a.	Laos	Aug'2024	2,000MW of solar across 3 farms	2026	Yes
2,000	Hydro	CEEC	China Energy	Pakistan	Aug'2024	Hydro-electricity - 884MW	2025	Yes
2,000	BESS	Sungrow	Algihaz	Saudi Arabia	Jul'2024	BESS - 7,800MWh	2025	No
1,575	Battery	EVE Energy	n.a.	Coventry, UK	Mar'2024	Battery Mfg	n.a.	No
1,550	Battery Materials	Huayou Cobalt	n.a.	Acs, Hungary	Jul'2024	Cathodes, 100,000tpa	2026	Yes
1,500	Solar Farms	Jinko Solar	EDF & TAQA	Dhafrah UAE	Aug'2024	1,500MW solar farm	2024	Yes
1,500	Grid T&D	Southern Power Grid	Chilean partners	Chile	Apr'2024	1,342km grid transmission line	n.a.	No
1,500	Battery Materials	Shanghai Putailai	n.a.	Sundsvall, Sweden	May'2023	Graphite anodes, 100,000tpa	n.a.	No
1,500	BESS	BYD	Grenergy	Atacama, Chile	Sept'2024	BESS - 3,000MWh	2025	Yes
1,450	Battery	Envision AESC	n.a.	Kentucky, US	Sep'2023	Battery Mfg, 30GWh	2024	Yes
1,450	Battery	Envision AESC	n.a.	Douai, France	Nov'2023	Battery Mfg, 9GWh	n.a.	Yes
1,400	Battery	EVE Energy	n.a.	Debrecen, Hungary	Nov'2023	Battery Mfg, 28GWh	2025	Yes
1,400	Battery Materials	CATL	YLB Mining	Bolivia	Jan'2024	Lithium hydroxide, 50,000tpa	n.a.	Yes
1,350	Battery Materials	Shanghai Shanshan	n.a.	Finland	Oct'2023	Graphite anodes, 100,000tpa	n.a.	No
1,332	NEV	Geely's Volvo	n.a.	Košice, Slovakia	Jul'2022	NEV Mfg - 250,000 units pa	2026	No

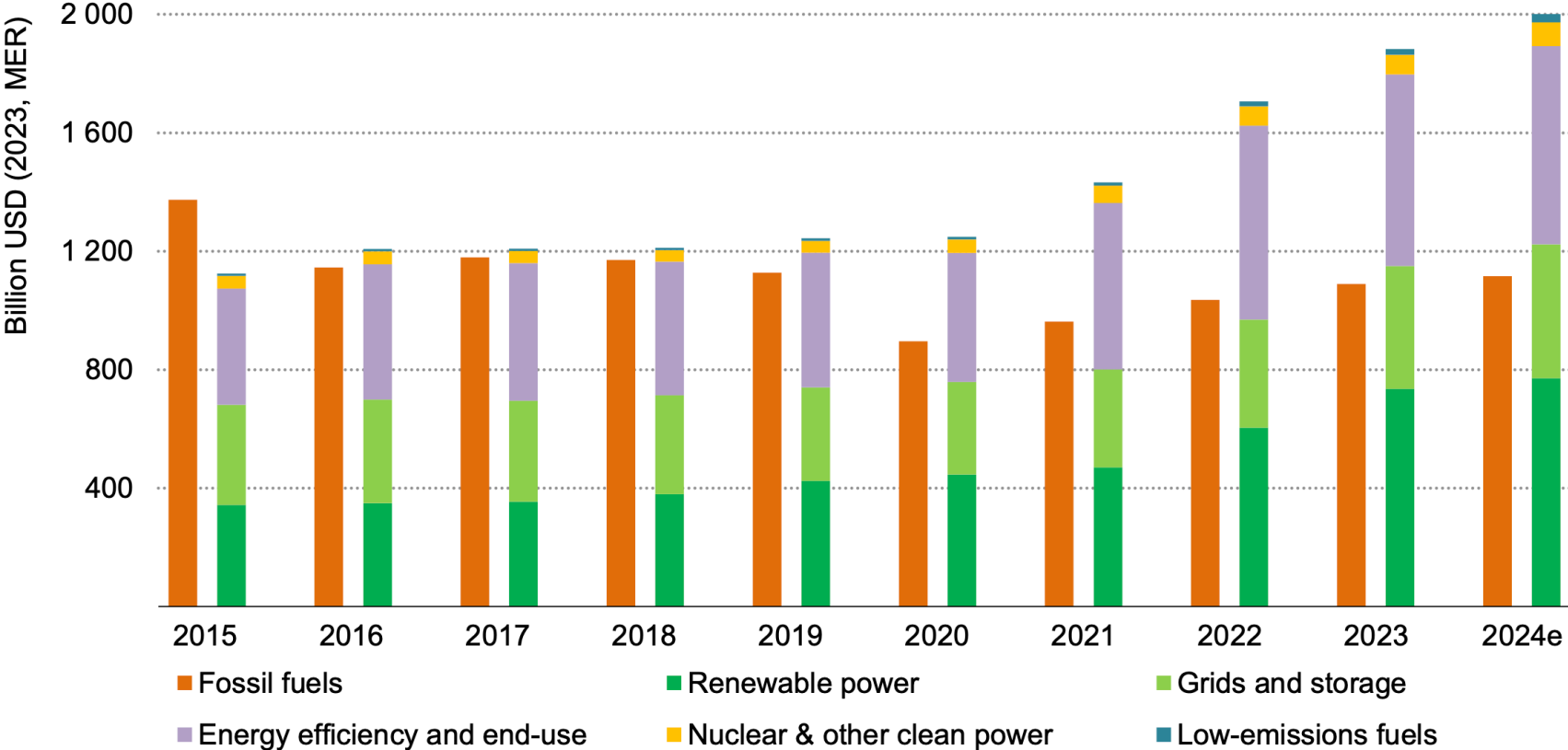
Source: CEF Report: [Green capital tsunami](#)

<https://climateenergyfinance.org/wp-content/uploads/2024/10/final--CEF-Report-China-Outbound-FDI-2-October-2024-2.pdf>

The Global Energy Transition

The world now invests almost twice as much in clean energy as it does in fossil fuels...

Global investment in clean energy and fossil fuels, 2015-2024e



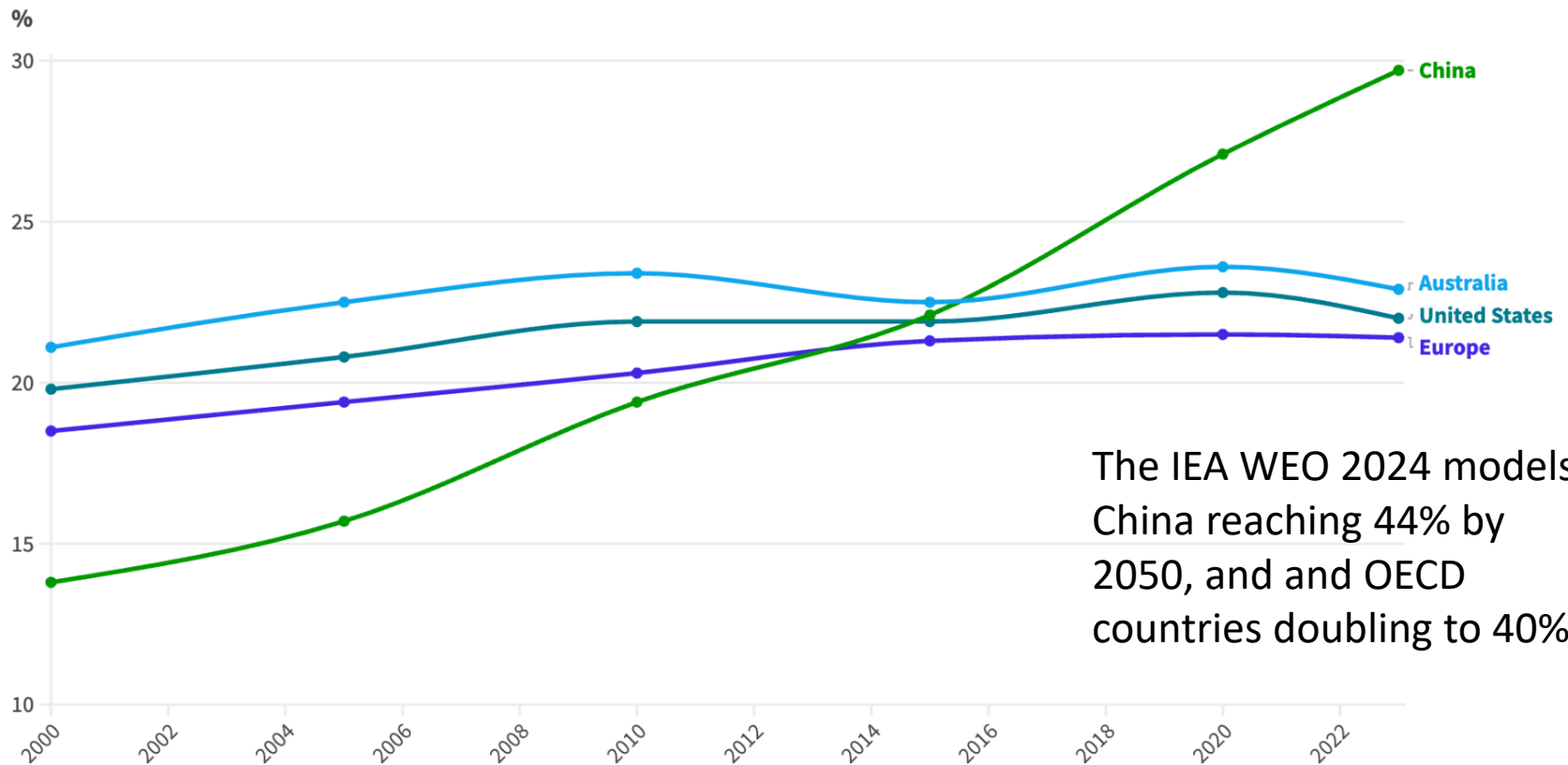
Source: IEA World Energy Investments 2024

China's Electrification of Everything

China Leads the world on Progressive Electrification of Everything

Share of final energy from electricity

China has leapfrogged United States, Europe and Australia in electrification



The IEA WEO 2024 models China reaching 44% by 2050, and and OECD countries doubling to 40%.

China is installing 22GW per month of RE

Zero emissions energy is 36% of total generation in 9MCY2024

China's Electricity Generation Mix in Jan-Sept 2024 (Adjusted for DER)

		9MCY2024	Share of Generation Jan-Sept	Change (y-o-y %)	9MCY2024 Adjusted	Share of Generation Jan-Sept Adjusted	Sep-24	Change (y-o-y %)
Thermal Power	TWh	4,744	67.2%	1.9%	4,744	63.7%	545	8.9%
Hydropower	TWh	1,004	14.2%	16.0%	1,004	13.5%	120	-14.6%
Nuclear Power	TWh	328	4.6%	1.5%	328	4.4%	36	2.8%
Wind Power	TWh	673	9.5%	10.8%	693	9.3%	75	31.6%
Solar Power	TWh	307	4.4%	27.0%	676	9.1%	73	38.0%
Total Power Generation	TWh	7,056	100.0%	5.4%	7,445	100.0%	849	8.7%
Variable Renewable Generation	TWh	981	13.9%	15.4%	1,370	18.2%	148	37.5%
Zero Emissions Power Generation	TWh	2,312	32.8%	13.5%	2,701	36.3%	304	7.4%

Source: NBS, Ember, CEF Estimates

China is installing 22GW per month of RE

RE Momentum in 8MCY2024 has Slowed, it is 'only' +21% yoy

The month of September 2024 was 27GW of RE

New Capacity Installed in China in Jan-Aug 2024

		Jan-Aug 2024	Share of new adds (%)	Change (yoy %)	Aug-24	Share of new adds (%)
Thermal Power	GW	28.6	14%	-17%	4.2	17%
Hydropower	GW	6.6	3%	-9%	0.7	3%
Nuclear Power	GW	1.2	1%	0%	0.0	0%
Wind Power	GW	33.6	16%	16%	3.7	15%
Solar Power	GW	140.0	67%	24%	16.5	66%
Total capacity added	GW	210.0	100%	14%	25.1	100%
Renewable Energy adds	GW	180.2	86%	21%	20.9	83%
Zero Emissions Capacity Adds	GW	181.4	86%	21%	20.9	83%
Investment in Completed Power Grid Project	1 billion yuan	333.0		19%	79.0	

Source: NBS, CEF Estimates

Xi Jinping's Great Economic Rewiring Is Cushioning China's Slowdown

Advances in EV, solar and semiconductors are helping the nation navigate its property slump

By Bloomberg News 16 July 2024

Solar Step Change

How China Came to Control 90% of the Global Solar Market



Australian Government
Australian Trade and Investment Commission

21 October 2024

SunDrive Solar and Trinasolar to manufacture solar panels in Australia

The joint venture will combine SunDrive's innovative technology with Trinasolar's manufacturing expertise.

China's Trinasolar is teaming up with Australia's SunDrive Solar to manufacture solar panels in Australia.

The 2 companies have signed a memorandum of understanding to form a joint venture (JV). The majority Australian-owned JV will aim to establish solar manufacturing capabilities in Australia.

SunDrive will lead an application for funding under the Australian Government's Solar Sunshot program to help advance the JV's solar module production. The funding will also support feasibility studies for further extending the solar manufacturing value chain at the AGL Hunter Energy Hub site.

The proposed manufacturing facility is expected to create 400 highly skilled jobs.

Bringing world-class solar manufacturing to the region

SunDrive Solar is an Australian solar technology company. Its copper metallisation technology has the potential to revolutionise solar manufacturing by replacing silver with copper, a more abundant and cost-effective material.

Trinasolar is a global provider of photovoltaic (PV) module and smart energy solutions. To date, the company has delivered more than 225 GW of solar modules worldwide. It has been serving the Australian market since 2009.