

ICES BIENNIAL WORKSHOP VIII • GENEVA • 29 SEPTEMBER 2026

The Global Green Industrial Revolution, 2010–2026

China from the 12th Five-Year Plan (2010) to global green-technology leadership (2026)

Session: 09:40 — GREEN STRATEGIES: comparative visions of Europe, China, USA

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Structured on the common metrics proposed for this workshop, for direct comparison with the EU and USA presentations.

AGENDA

Scope, Metrics & Method

WHAT THIS COVERS

China, 2010–2026, on the eight common metrics proposed for this session — so that the three presentations (EU / China / USA) can be read side by side.

Where a metric cannot yet be supported by official Chinese data, this is stated rather than estimated.

DATA BASIS

Installed capacity and generation: CEC (China Electricity Council) annual statistical bulletins and compilations, full-national caliber, year-end.

Demand: national statistics and CEC; population on the annual-average resident basis, consistent with official per-capita GDP.

Policy: the 12th–15th Five-Year Plans, the 2020 Dual Carbon pledge and the 2025 NDC.

THE EIGHT COMMON METRICS — AND WHERE THEY ARE ANSWERED

1	Energy supply per capita, by technology	Slide 07
2	Energy demand per capita	Slide 08
3	Carbon emissions from power per capita	Slide 10
4	EV manufacture and use per capita	Slide 12
5	Grid energy storage per capita	Slide 13
6	Solar and wind generation rollout	Slide 09
7	Regional disparity within the country	Slide 14
8	Role of policies and incentives	Slides 03–06

Cross-country reference values in this deck are drawn from Eurostat, the EEA, SolarPower Europe and the US EIA, and are labelled as such. The EU and USA presentations remain the authoritative source for their own figures.

All Chinese physical data are stated on a full-national caliber unless a footnote says otherwise.

Policy Timeline: 2010–2026

Four consecutive Five-Year Plans — one continuous industrial strategy, with a consistent set of instruments.

2010**12th FYP preparation**

New energy designated a strategic emerging industry; wind feed-in tariffs introduced; EV “纯电驱动” technology route adopted.

2012–2015**12th FYP implementation**

Binding energy-intensity target –16% (achieved –18.4%); solar capacity rises 60× in five years; world’s largest wind market by 2015.

2016–2020**13th FYP & Dual Carbon pledge**

Power-sector reform and emissions-trading pilots; Made in China 2025 prioritises EVs; September 2020: peak before 2030, neutrality before 2060.

2021–2025**14th FYP: scale & global dominance**

Carbon-peak action plan; new-type power system; annual wind + solar additions accelerate from 120 GW (2022) to 434 GW (2025).

2026–2030**15th FYP: the “Energy Power” strategy**

New NDC: 3,600 GW wind + solar by 2035; 300 GW of new-type storage by 2030; storage and grid flexibility as system priorities.

Sources: 12th–15th Five-Year Plan outlines; NDRC Five-Year Plan completion assessments; 2025 NDC submission.

12th Five-Year Plan (2011–2015): Strategic Foundations

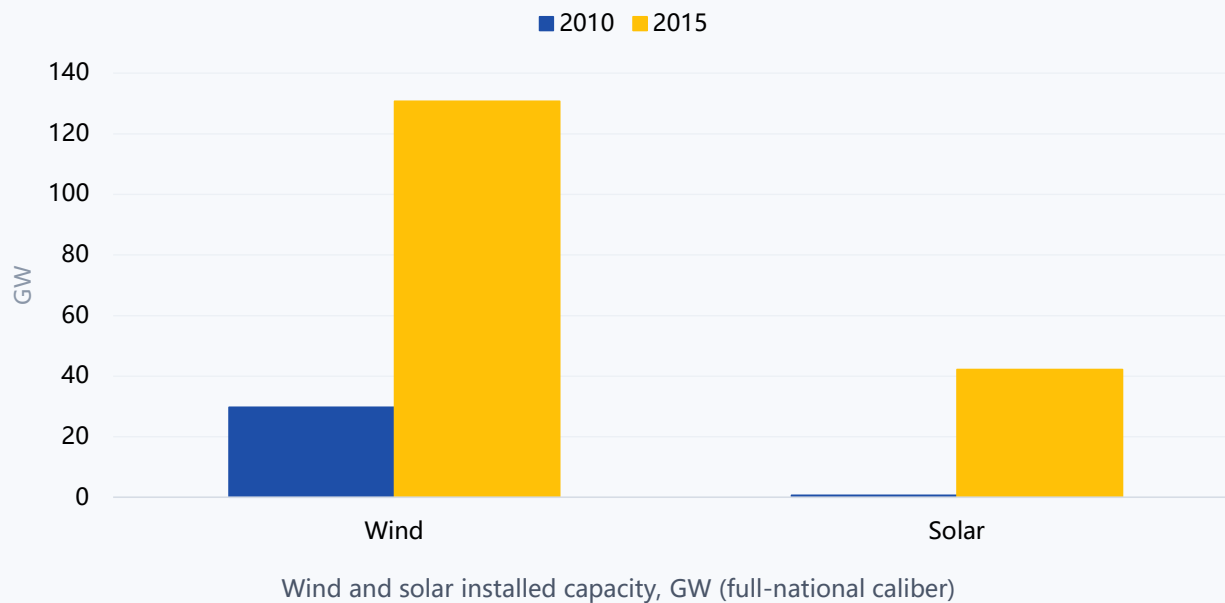
Laying the industrial groundwork

The 12th FYP explicitly designated new energy a “strategic emerging industry”. It introduced wind feed-in tariffs, launched the EV “纯电驱动” technology route, and set the first binding energy-intensity target of –16% against 2010.

By 2015 China had built the world’s largest wind market, and solar capacity had grown more than 60-fold in five years — the base from which global leadership was later built.

Key policy instruments

Feed-in tariffs; technology roadmaps; state-backed R&D; demonstration zones; early EV deployment subsidies.



60×

Solar capacity growth, 2010–2015

331k

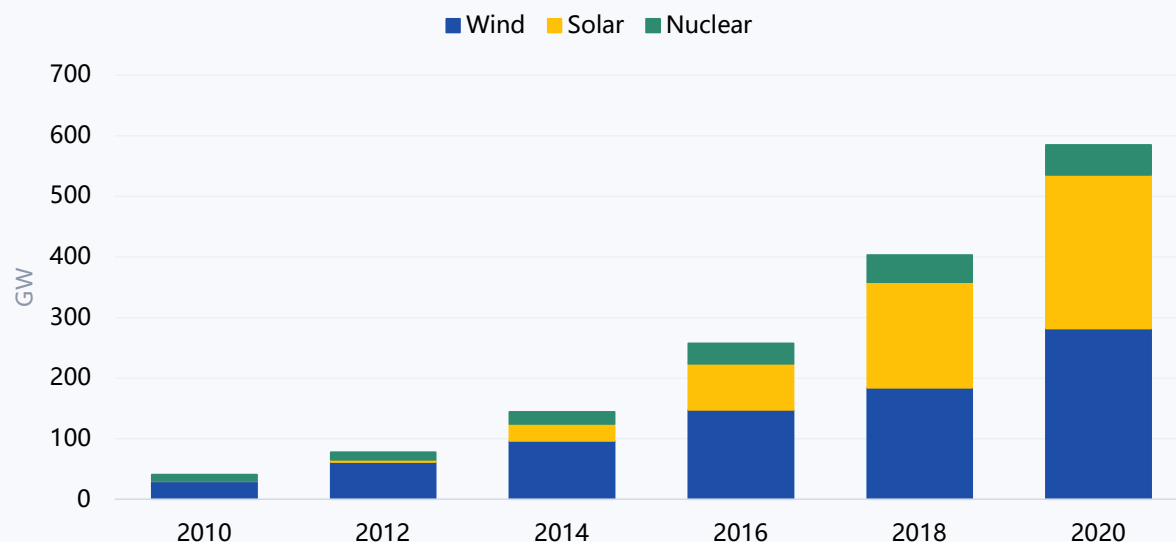
EV sales in 2015

–18.4%

Energy intensity, met vs –16% target

Sources: CEC installed-capacity series (30号/29号 dataset); CAAM for EV sales; NDRC 12th FYP completion assessment. Note: Solar 2010 = 0.7 GW is taken on a full-national caliber (consistent with 2015); the 6000 kW and above caliber gives 0.26 GW, which would imply ~160x. The 60x figure uses the full national caliber for both years.

13th Five-Year Plan (2016–2020): Acceleration & Dual Carbon



Wind, solar and nuclear capacity, GW — consistent full-national caliber throughout

5.7%

Avg annual GDP growth, 2016–2020

3.0%

Avg annual energy-consumption growth

56.8%

Coal share of primary energy, 2020

Energy intensity fell 13.2% over the 13th FYP against a –15% target — the one missed binding target of the period.

Sources: CEC capacity series; National Bureau of Statistics energy-consumption data; NDRC 13th FYP assessment.

Decoupling began, and ambition surged

The economy grew twice as fast as total energy demand over the 13th FYP, and according to the IEA, China was one of the largest contributors to global energy savings in the period.

(IEA, Energy Efficiency in Emerging Economies — China profile)

In September 2020, President Xi announced the “Dual Carbon” targets: peak CO₂ before 2030 and carbon neutrality before 2060.

Power-sector reform, emissions-trading pilots and Made in China 2025 accelerated EV and battery industrialisation.

Landmark 2020

Carbon peak by 2030, neutrality by 2060 — a domestic pledge converted into an industrial strategy.

14th–15th Five-Year Plan (2021–2030): Scale & Dominance

China moved from rapid deployment to global supply-chain dominance, and set new 2030 and 2035 benchmarks.

1,842

GW

Combined wind + solar capacity by end-2025 — 47.3% of total installed power capacity, but 22.1% of generation.

3,891

GW

Total installed power generation capacity by end-2025 — up from 966 GW in 2010, a 4.0-fold increase.

300

GW

New-type energy-storage target for 2030 under the 15th FYP “Energy Power” strategy.

14th FYP (2021–2025)

Carbon-peak action plan; new-type power system; annual wind + solar additions raised from 120 GW (2022) to 434 GW (2025).

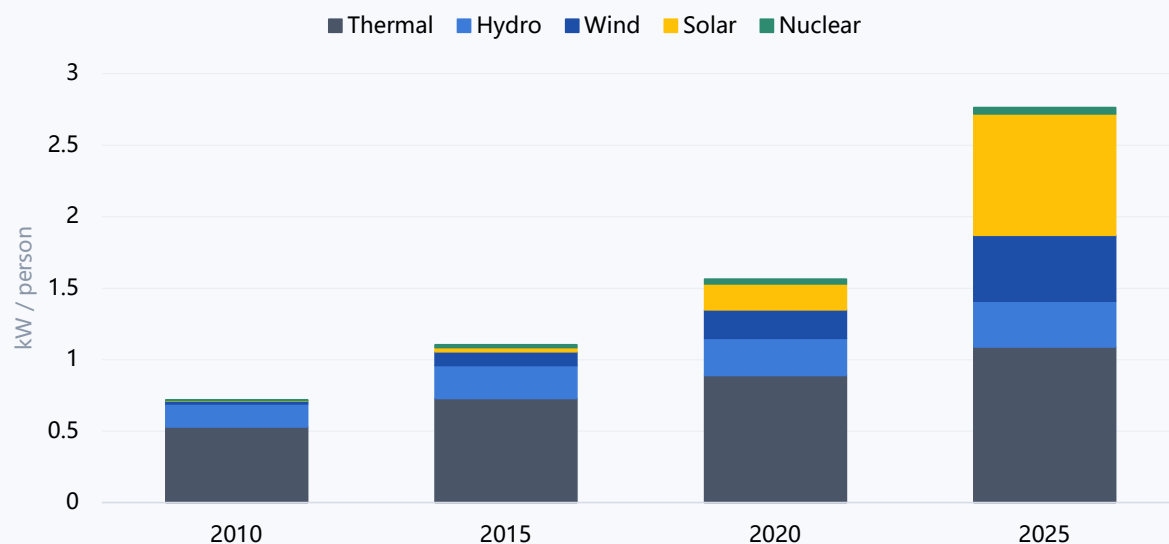
15th FYP (2026–2030)

New NDC: 3,600 GW of wind + solar by 2035; a “new energy system” built around storage and grid flexibility.

The gap that defines the next phase: wind and solar now supply 47.3% of installed capacity but only 22.1% of electricity generated. Closing that gap — storage, grid flexibility, market design — is the central task of the 15th FYP.

COMMON METRICS

Metric 1 — Power Installed Capacity per Capita, by Technology



Panel A: Installed power capacity per person, kW — stacked by technology

Installed capacity per person nearly quadrupled, led by solar and wind

From 0.72 kW/person (2010) to 2.76 kW/person (2025) — a 3.8× rise, led by solar and wind.

Solar overtook hydro and now approaches thermal; non-fossil capacity reached 61.7% of the total by 2025.

The utilisation gap

Full-load hours (average utilization hours of 6,000 kW-and-above plants; CEC 2025 statistical bulletin) fell from ~4,660 (2010) to ~3,119 (2025) — down 33%. Variable renewables added capacity far faster than the load they serve.

Composition shift

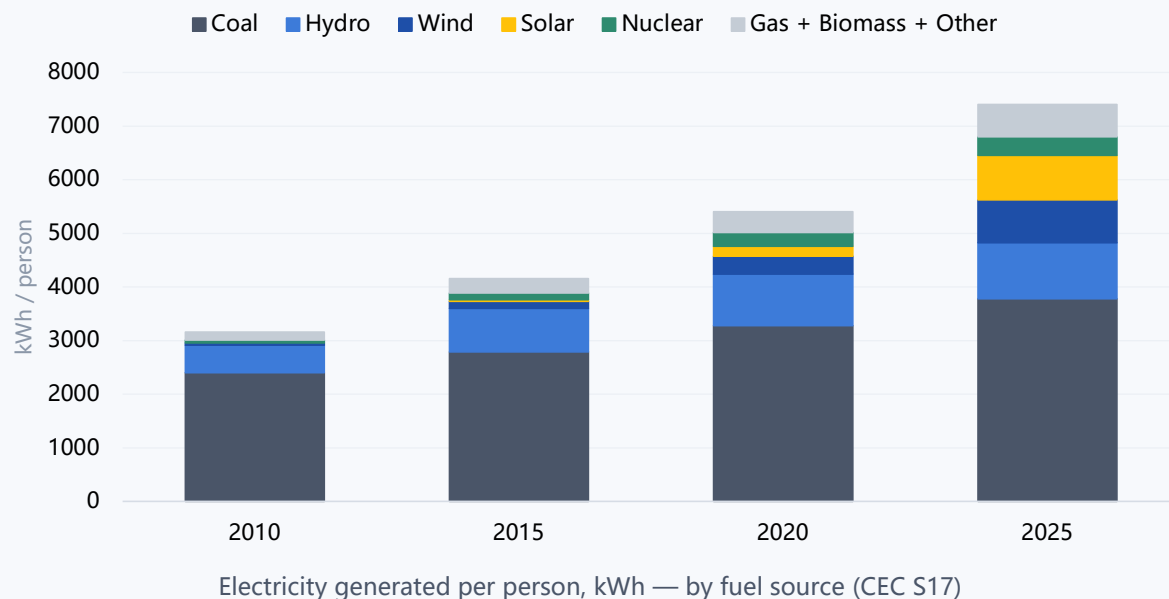
Non-fossil capacity: 26.6% (2010) → 61.7% (2025).
Non-fossil generation: 19.6% (2010) → 42.9% (2025). The gap is the storage/flexibility agenda.

Sources: CEC S1 (installed capacity) and S14 (annual-average population). Per-capita capacity = total capacity / population. See Metric 1a for per-capita generation by fuel.

Note: capacity is a stock measure; generation is a flow. The ratio (utilisation) fell because variable renewables have lower capacity factors than thermal baseload.

COMMON METRICS

Metric 1a — Electricity Generated per Capita, by Fuel



Generation per person rose 2.3×; coal still dominates but its share halved

From 3,160 kWh/person (2010) to 7,406 kWh/person (2025) — a 2.3× rise, driven by broad-based electrification.

Coal still supplies 3,783 kWh/person but its share fell from ~76% to ~51%; non-fossil generation reached ~43% (including biomass).

Fuel mix transition

Coal -25 pp / Hydro roughly flat / Wind +9 pp / Solar +11 pp / Nuclear +3 pp (2010–2025). The fall in coal's share, not its absolute level, is the decarbonisation signal.

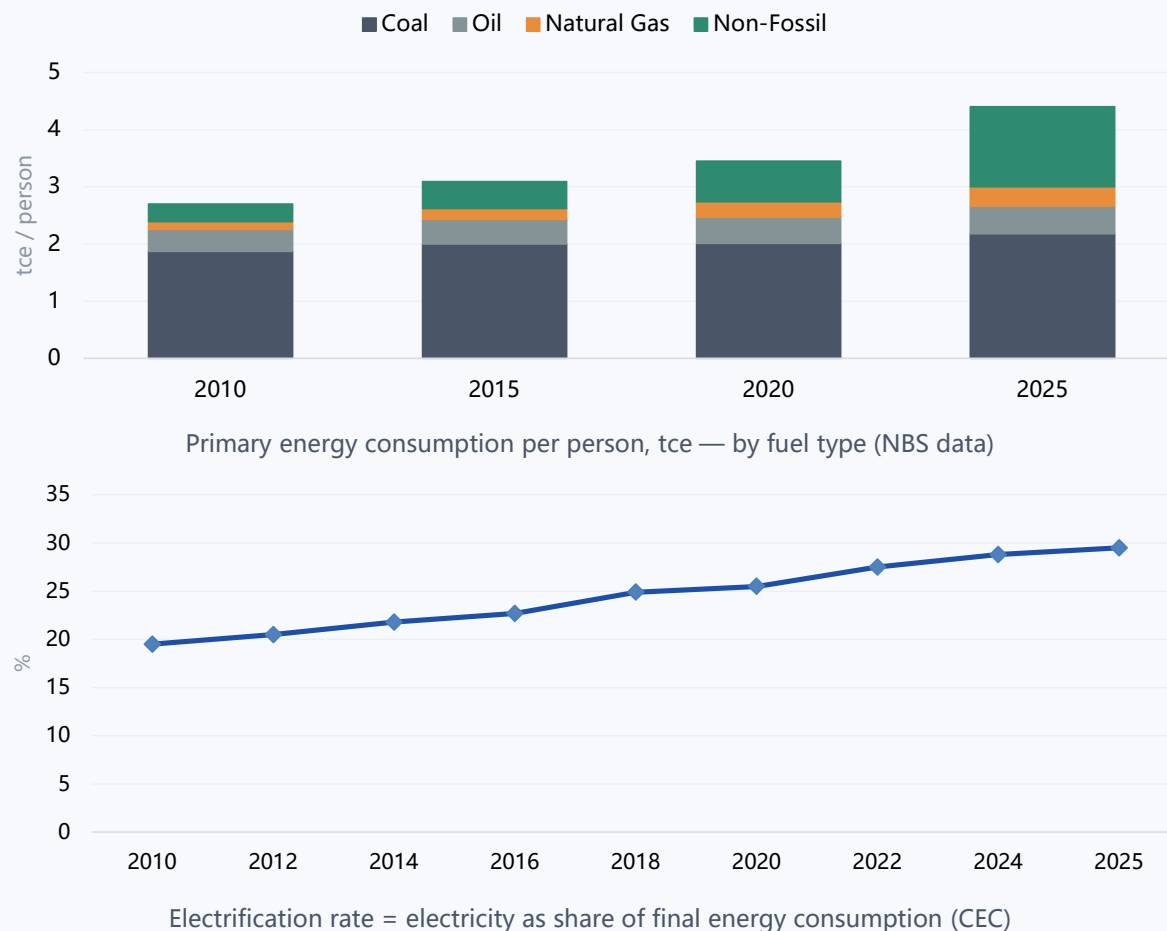
Why it matters

Per-capita generation exceeds per-capita final electricity use (grid losses and non-final uses). Both are rising, which is why absolute generation, not only capacity, keeps climbing.

Sources: CEC S17 generation by fuel (TWh) / annual-average resident population (S14). "Gas+Biomass+Other" groups minor fuels for readability; see S17 for full detail.

COMMON METRICS

Metric 2 — Primary Energy Consumption per Capita



Total energy demand per capita up ~63%; coal share fell from 69% to 51%

Primary energy consumption rose from ~2.7 tce/person (2010) to ~4.4 tce/person (2025). Coal still dominates but fell from 69% to 51% of the total; non-fossil energy more than tripled. Electrification rose from ~20% to 29.5% — each percentage point represents ~350 TWh of additional electricity demand, roughly the annual electricity consumption of a mid-sized industrial province such as Anhui.

Fuel mix transition

Coal -17 pp / Oil roughly flat / Gas +4 pp / Non-fossil +12 pp (9.4%→ 21.7%) (2010-2025). Non-fossil now exceeds oil on a per-capita basis.

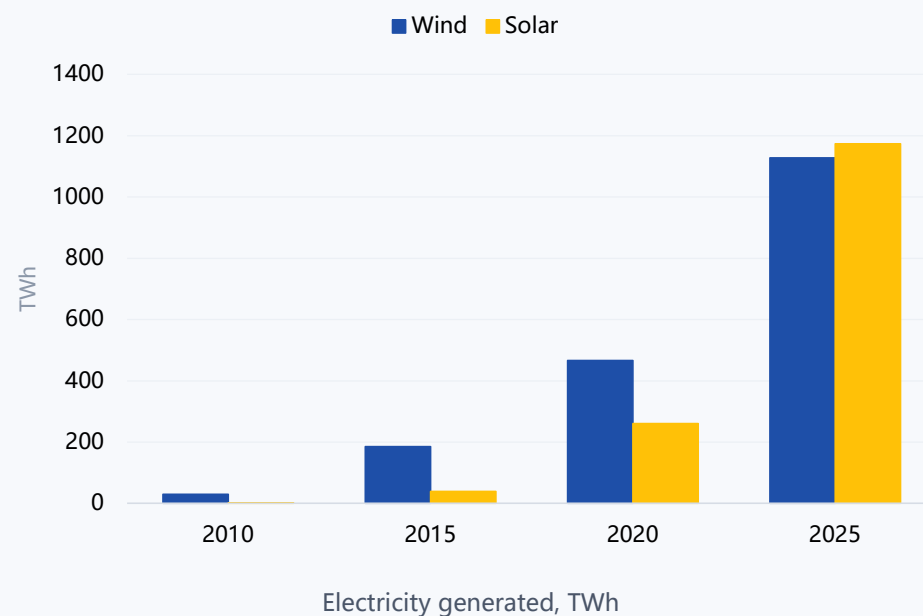
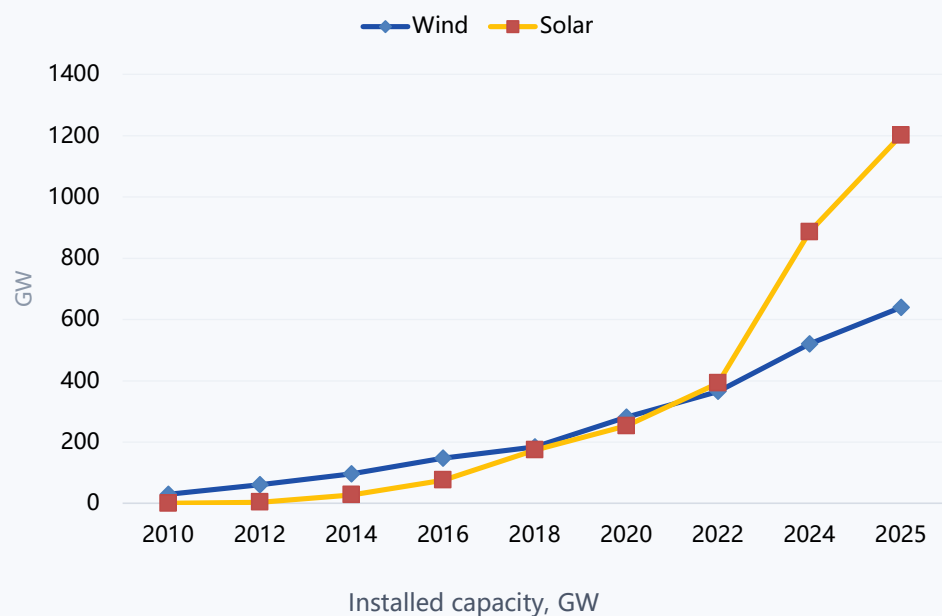
CROSS-COUNTRY REFERENCE (indicative)

China ~4.4 / 3.9 (NBS/EI) / EU ~3.9 / USA ~9.1 tce per person (2025; EU/USA on Energy Institute caliber, 1 tce = 29.31 GJ).

Sources: NBS Statistical Yearbook / Statistical Communiques for total primary energy and fuel shares; population on annual-average resident basis (S14); CEC China Electrification Development Report 2026. EU/USA figures are indicative; see partner presentations for authoritative data.

COMMON METRICS

Metric 6 — Solar and Wind: Capacity and Generation



1,842 GW

Wind + solar capacity, 2025 — 47.3% of all installed capacity

2,300 TWh

Wind + solar generation, 2025 — 22.1% of all electricity

434 GW

Wind + solar added in 2025 alone — a world record

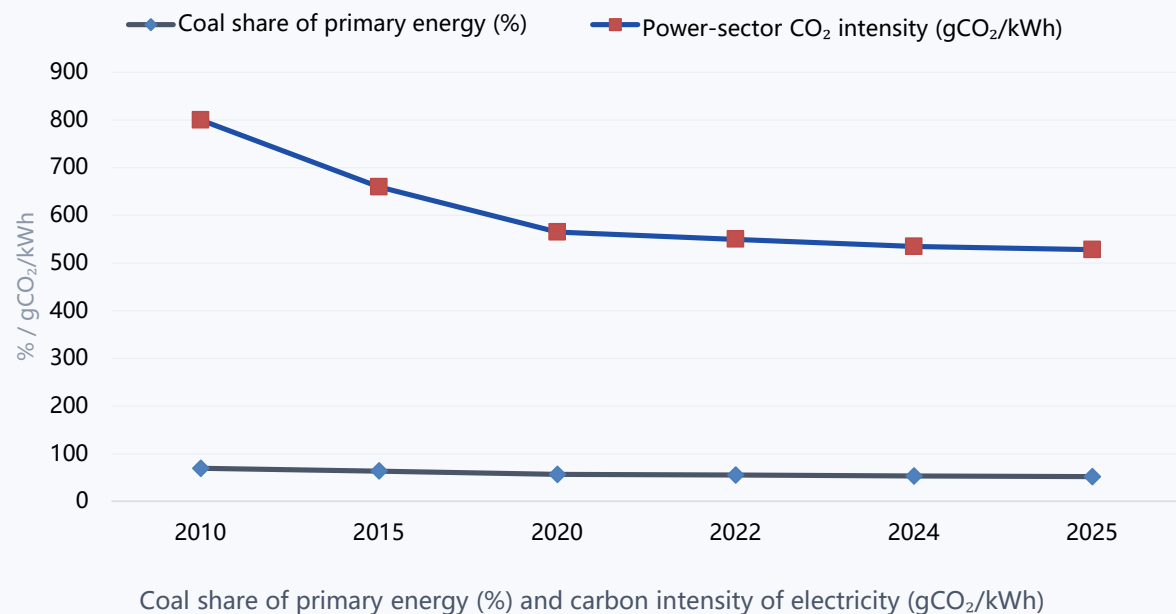
×1,350

Solar capacity growth, 2010–2025 (0.7 → 1,201.7 GW)

Wind + solar capacity exceeded thermal capacity for the first time in 2025, by 303 GW. Generation share is 22.1% — the difference is the storage and grid-flexibility agenda. Sources: CEC annual series.

COMMON METRICS

Metric 3 — Carbon Emissions from Power: Totals, Intensity and per Capita



Emissions still rising, but the power mix is decarbonising

Total and per-capita CO₂ are still rising because electricity demand itself keeps growing. But the carbon intensity of electricity fell by roughly one-third between 2010 and 2025, from about 800 to about 528 gCO₂/kWh.

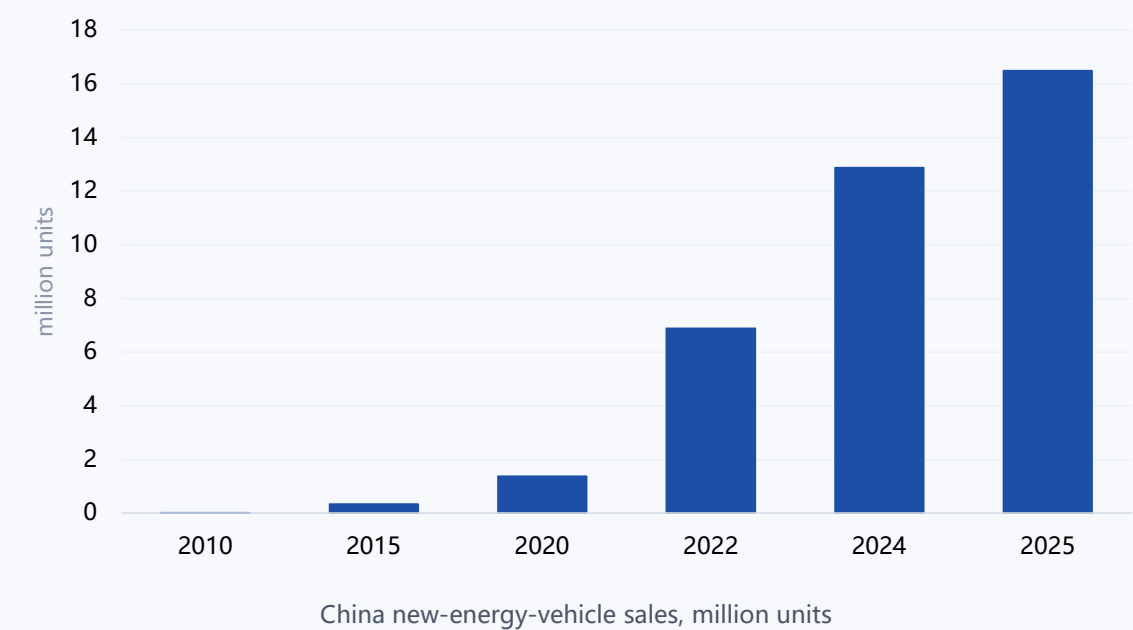
Key insight

The trajectory now hinges on the pace of coal displacement, which is a variable depending on the scale of renewable build-out.

Power-sector CO₂ intensity from CEC's own reporting (565 gCO₂/kWh in 2020); 2010 and 2015 values are indicative. Coal share from the NBS 2025 Statistical Communiqué. Per-capita CO₂ from the Global Carbon Budget.

COMMON METRICS

Metric 4 — Electric Vehicles: Manufacture and Use per Capita



From follower to global leader in fifteen years

NEV sales rose from 5,000 units in 2010 to 16.49 million in 2025 — 47.9% of all new cars sold in China, and 50.8% of domestic sales. China has led global EV sales for eleven consecutive years.

31.3

NEVs per 1,000 people — national fleet, end-2025

11.7

NEVs sold per 1,000 people in 2025

12.0%

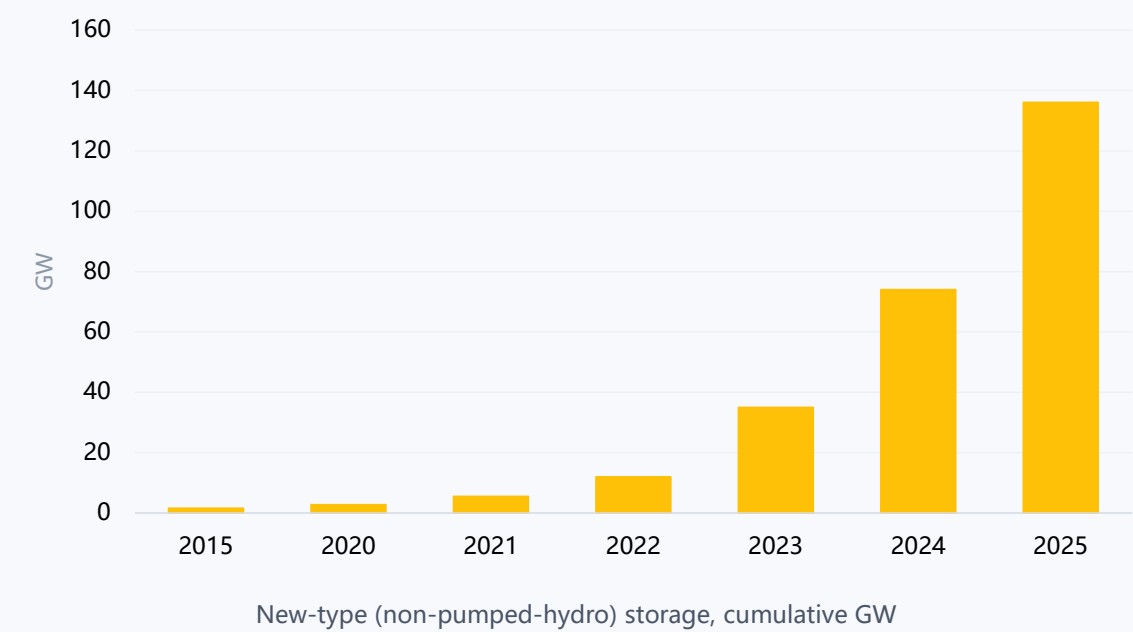
NEV share of the entire national car fleet

Fleet reached 43.97 million vehicles at end-2025; 2025 exports of NEVs doubled to 2.615 million.

Fleet data from the Ministry of Public Security, January 2026. Per-capita figures use the 2025 annual-average resident population of 1,406.6 million.

COMMON METRICS

Metric 5 — Grid Energy Storage and per-Capita Capacity



The fastest-growing system resource in the power sector

New-type storage reached 136 GW / 351 GWh by end-2025, up 84% in a single year and more than 40-fold on the end of the 13th FYP. Total storage, including 66 GW of pumped hydro, is about 202 GW.

144 W

Grid storage per person in China (202 GW / 1,406.6 m)

102.7 GW

Total storage in Europe, end-2025 — 53.3 GW of it pumped hydro

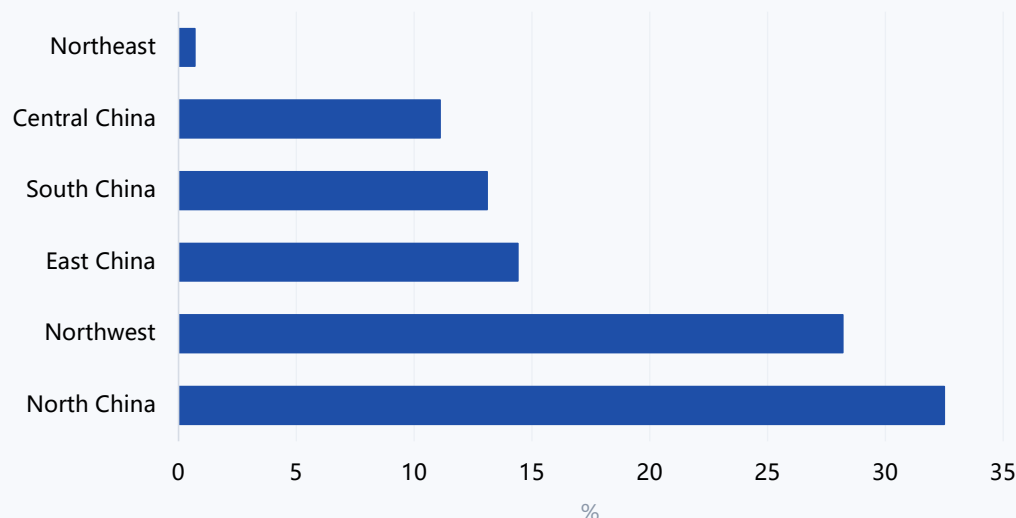
300 GW

New-type storage target for 2030

China leads on absolute scale; Europe is still ahead per person — ≈195 W against 144 W.

Sources: National Energy Administration press conference, January 2026, and China New-Type Storage Development Report (2026). European total from EMMES 10 (Energy Storage Europe / LCP Delta, 2026), covering the EU-27 plus the UK, Switzerland and Norway.

Metric 7 — Regional Disparity: The West–East Divide



Where the storage was built: regional shares, 2025

Resources, demand and storage are all mismatched

The richest wind resources lie in the Three Norths — Inner Mongolia, Xinjiang and Gansu — and the best solar irradiance is on the Qinghai–Tibet Plateau. Demand is concentrated on the eastern coast. Storage is following the generation, not the load: North and Northwest China together hold 60.7% of national new-type storage.

Leaders and laggards

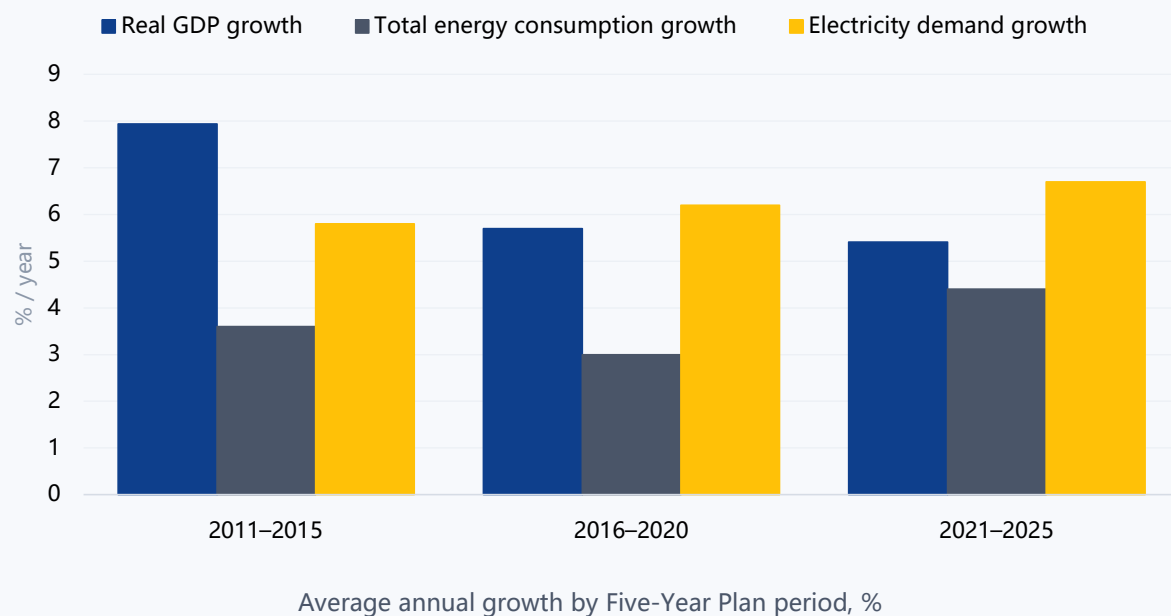
Inner Mongolia 20.3 GW, Xinjiang 18.8 GW and Shandong 11.2 GW lead on storage; eight further provinces exceed 5 GW. Electrification diverges just as widely — 41.7% in the Greater Bay Area and 34.1% in the Yangtze Delta against 21.4% in Beijing–Tianjin–Hebei.

Two strategies bridge the divide

Ultra-high-voltage transmission corridors and the “沙戈荒” desert renewable bases; meanwhile distributed rooftop solar is booming in the eastern provinces.

ENHANCEMENT: the earlier draft carried a map image with no supporting data. The regional shares and provincial totals above are from the National Energy Administration’s China New-Type Storage Development Report (2026); the electrification rates are from CEC’s China Electrification Development Report 2025, which finds 14 provincial-level regions above the national average.

GDP–Energy Decoupling and Electrification — and Its Limits


0.48 → 0.81

Energy demand elasticity to GDP

0.73 → 1.23

Electricity demand elasticity to GDP

28.8%

 China's electrification rate, 2024
— from 25.5% in 2020

Total energy decoupled — electricity did not

Total energy consumption has grown more slowly than GDP in every plan period since 2011, so its elasticity has stayed below 1. But the margin is narrowing — 0.48, then 0.49, now 0.81 — while electricity has crossed from 0.73 to 1.23. Electricity demand grew 5.8%, 6.2% and 6.7% a year across the three periods, overtaking real GDP growth in the 13th FYP and widening the gap since.

NOT A REVERSAL — SIX YEARS RISING

On a 2020-price basis, electricity intensity bottomed at 713.6 kWh per ¥10,000 in 2019 and has risen every year since, reaching 770.0 in 2025 — up 7.9%. The "2022 trough" was an artefact of using current-price GDP.

Demand outlook

AI data centres and EV charging are now adding load faster than efficiency is removing it.

Where China Stands in 2026 — and the New Demand Question

January–July 2026, CEC monthly bulletin — the most recent data available at the time of this workshop.

4,078 GW

Total installed capacity, end-July 2026
(+11.0% y/y)

1,975 GW

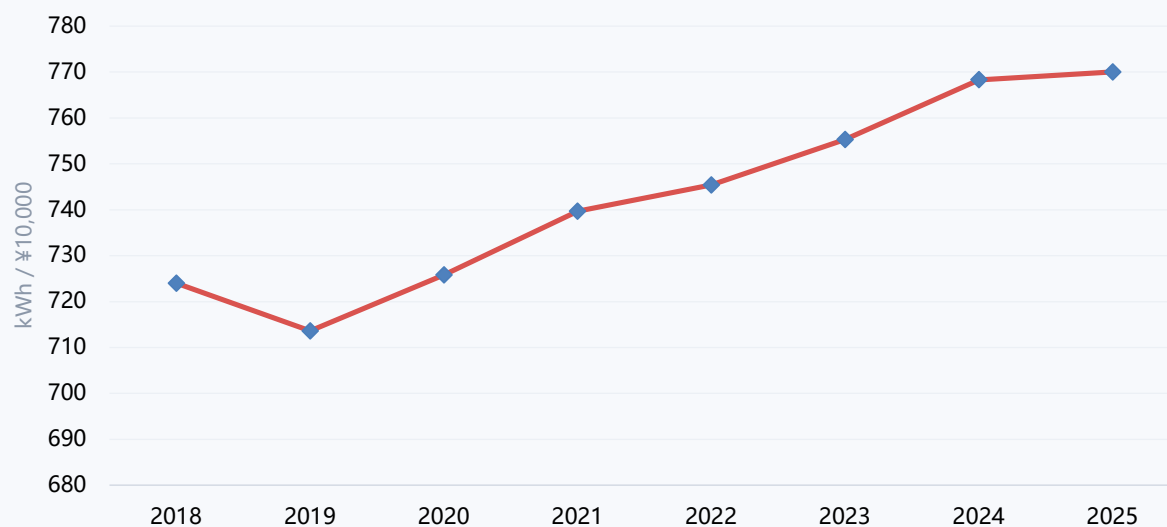
Wind + solar capacity, end-July 2026 —
48.4% of the total

6,140 TWh

Electricity consumed, Jan–Jul 2026 (+4.7%
y/y)

194 GW

New capacity added Jan–Jul 2026 — down
138 GW from 332 GW a year earlier



Electricity intensity of GDP, 2020-price basis — a sustained rise from the 2019 low

The new demand question

The downward trend in electricity intensity ended in 2019, not 2022.

DATA CENTRES TO 2030

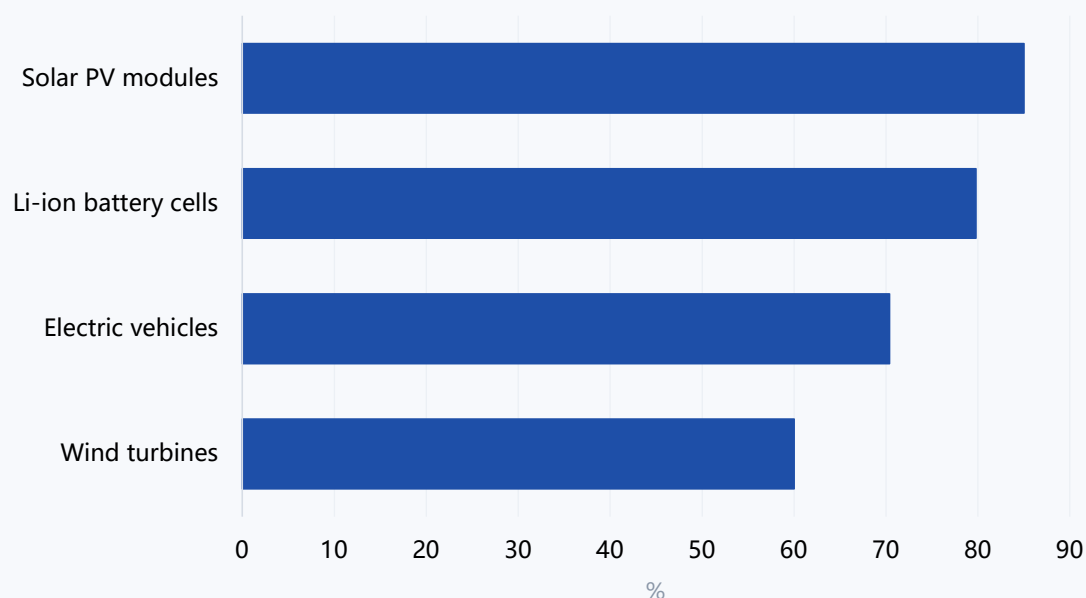
CAICT projects data-centre electricity demand at 300–700 TWh by 2030 (from ~166 TWh in 2024). New centres concentrate in the same coastal load centres that already import power from the west; the national target requires new hub data centres to source >80% of their power from green energy.

Sources: CAICT; IEA, Energy and AI 2025.

TIMELINESS: this page did not exist in the earlier draft. It adds the CEC monthly bulletin for January–July 2026 (capacity 407,820 MW, wind + solar 197,524 MW, demand 613.99 TWh, new additions 193.97 GW against 332.48 GW a year earlier). Wind and solar were 133 GW of the 194 GW added. Cumulative months are shown separately and are not spliced into the annual series.

Global Green-Technology Manufacturing: “The New Trios”

Solar panels, lithium-ion batteries and electric vehicles have replaced clothing, furniture and appliances as China’s signature export trio.



China’s share of global MANUFACTURING OUTPUT, not of exports

85%

Solar PV module output

79.8%

Li-ion battery cells

From domestic deployment to global supply chains

In 2023, exports of these three product groups passed ¥1 trillion for the first time. Clean-energy industries were estimated to account for about 10% of China’s economy and roughly 26% of GDP growth in 2024.

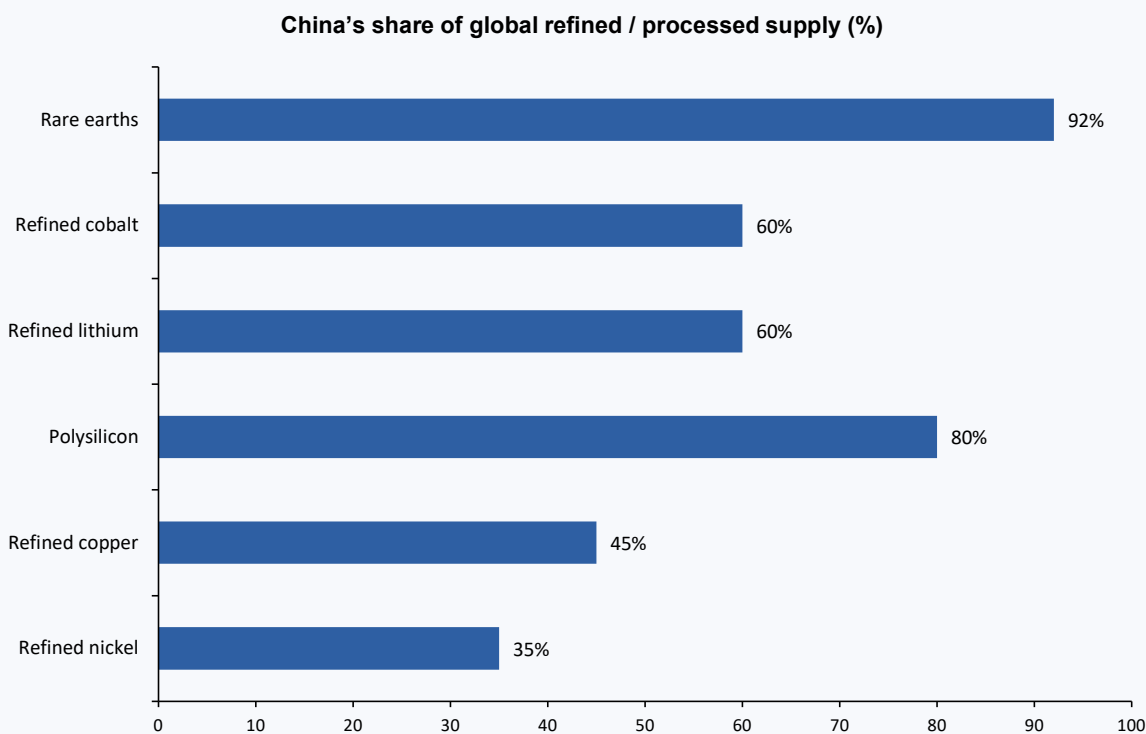
WHERE THE PRESSURE IS BUILDING

EU anti-subsidy investigations, US Section 301 tariffs and local-content requirements are raising the cost of market access. At home, overcapacity in PV and batteries has pushed prices below cost for parts of the supply chain — the industrial-policy bill for global leadership.

BACKUP

Materials & Upstream Supply Chains — the other half of the manufacturing story

Goal 1b of the proposal asks about the material supply base. China's advantage lies less in the mine than in the refinery.



Sources: IEA, Global Critical Minerals Outlook 2025; USGS, Mineral Commodity Summaries 2026. Shares are refining/processing capacity unless noted.

See Slide 18 (manufacturing output) and Backup 2 (known gaps).

Refining dominance

China refines ~19 of the 20 critical minerals tracked by the IEA; its average global refining share is ~70% (IEA, Global Critical Minerals Outlook 2025). The shift is recent — most of this mid-stream capacity was added after 2010, lifting China from a minority refining position to ~70% average global share of the IEA-tracked critical minerals by 2025 (IEA GCMO 2025).

Material base of green-tech manufacturing

China accounts for ~50% of world crude steel, ~55% of primary aluminium and ~50% of refined copper; clean-energy is now the fastest-growing demand driver (IEA).

Processing hub, not just miner

With <5% of global reserves of some minerals (e.g. cobalt, nickel), China nonetheless holds the midstream: ~60% of cobalt and ~35% of nickel refining (USGS 2026; IEA).

Reading the Three Presentations Side by Side

The workshop metrics applied to China; EU and USA cells carry a figure only where one is published.

Metric (2025 unless stated)	China	EU	USA
Population (million)	1,406.6	≈449	≈342
Total installed capacity (GW)	3,891	see EU presentation	1,374
Wind + solar capacity (GW)	1,842	see EU presentation	see USA presentation
Wind + solar share of installed capacity	47.3%	≈71%	≈22%
Electricity demand per capita (kWh)	7,371	≈5,450	≈12,000
Coal share of electricity generation	50.3%	≈10%	see USA presentation
Power-sector CO ₂ intensity (gCO ₂ /kWh)	≈528	213 (2024)	see USA presentation
Grid-scale storage (GW, all technologies)	≈202	102.7 (Europe)	43
Electric vehicle sales (million)	16.49	2.89	see USA presentation

Caliber notes: China's power-sector CO₂ intensity ≈528 gCO₂/kWh is a direct-emissions basis; the US presentation's ≈525 gCO₂e/kWh is a life-cycle basis — not directly comparable. The EU wind+solar share ≈71% is an installed-capacity (AC) basis; China's 47.3% is likewise capacity-based (its generation share is far lower).

Two structural differences stand out. First, scale: China's installed capacity is roughly 2.8× the USA, and its wind-and-solar fleet is larger in absolute terms than either partner's — but the EU is still ahead on share of capacity (≈71% against 47.3%). Second, mix: Europe has pushed coal to about a tenth of generation, whereas coal still supplies half of China's electricity.

EU and USA reference values are drawn from Eurostat, the European Commission's quarterly electricity market reports, EMMES 10 (Energy Storage Europe / LCP Delta), SolarPower Europe and the EIA, and are labelled "≈". Cells marked "see ... presentation" are deliberately left to the partner delegation.

Challenges & Future Outlook

Outlook to 2030

Peak before 2030 • Neutral before 2060

The 15th FYP (2026–2030) answers the gaps above with binding national targets for energy and power:

- **Power system rebuilt: non-fossil gen → 50%**
Total capacity → 5,400 GW; electricity's share of final energy → 35%.
- **Renewables at scale: 3,500 GW capacity**
Wind + solar > 2,800 GW (>50% of total); generation 6,000 TWh.
- **Flexibility built in: storage → 300 GW**
New-type storage 300 GW (from 136); pumped hydro 160 GW; peak-shaving > 100 GW; VPPs > 50 GW.
- **Firm low-carbon baseload**
Nuclear → 110 GW; hydro → 410 GW; coal repurposed as flexible backup.
- **Carbon locked in**
Non-fossil energy use → 25%; CO₂ intensity –17% vs 2025; peak before 2030 secured.

1 Grid integration and curtailment

Renewable curtailment fell from 17% in 2016 to under 4% in 2024, but rapid build-out in the Three Norths keeps long-distance transmission corridors under stress.

2 Coal dependence

Coal is 32% of installed capacity but still 50% of generation. Peak coal consumption is targeted before 2030, yet new coal plants continue to be approved for peak shaving and grid stability.

3 AI data-centre demand

Data-centre consumption is projected to exceed 400 TWh by 2030 — about 4% of national demand — creating new load centres that complicate the decarbonisation trajectory.

4 Electricity intensity is rising again

On a constant-price basis the electricity intensity of GDP bottomed in 2019 and has risen for six straight years, reaching 770.0 in 2025.

5 Trade barriers and supply-chain pressure

EU anti-subsidy investigations, US tariffs and local-content rules threaten export growth, while domestic overcapacity in PV and batteries compresses margins.

Caliber: “coal” here means coal-fired plant only — 32.4% of installed capacity and 50.3% of generation in 2025.

What the Transition Looks Like on the Ground

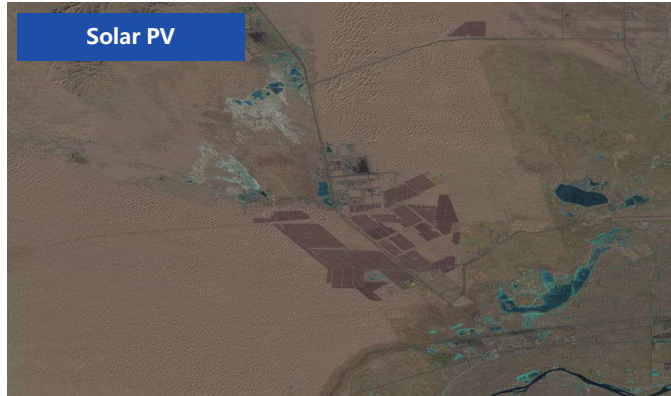
Clean-energy supply, electric-vehicle charging and electrified rail in China

Wind power



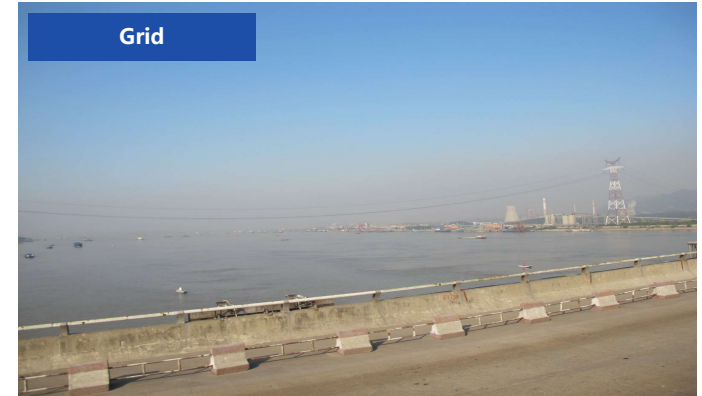
Onshore wind in Gansu — 434 GW of wind + solar added in 2025 alone

Solar PV



Tengger Desert Solar Park — solar PV grew $\times 1,350$ from 2010 to 2025

Grid



UHV transmission — moving clean power from the Three Norths to the east

Storage



Pumped-storage reservoir — total storage ≈ 202 GW by end-2025

Electric vehicles



EV charging — 16.49 million NEVs sold in 2025 (47.9% of new cars)

High-speed rail



Fuxing CR400 high-speed train — electrified mobility backbone

Photo credits (Wikimedia Commons): Wind — Guazhou wind farm © Popolon CC BY-SA 3.0; Solar — Tengger Desert Solar Park, USGS/NASA Landsat (public domain); Grid — power line near Tongling Bridge © 江上清风1961 CC BY 3.0; Storage — JiangNanTianChi © Doctoroftcm CC BY-SA 3.0; EV charger — PinTweaks CC0; HSR — Fuxing CR400 © Shihu7 CC BY-SA 4.0.

CONCLUSIONS

Key Conclusions: Four Takeaways for Cross-Country Comparison

×1,350

Solar scale

Solar PV grew from 0.7 GW in 2010 to 1,201.7 GW in 2025. Wind and solar together now exceed thermal capacity — but generate only 22.1% of electricity.

60–85%

Manufacturing dominance

China produces 60–85% of the world's solar modules, battery cells, EVs and wind turbines — output share, not export share.

0.73 → 1.23

Electricity re-coupling

GDP electricity intensity has risen for six straight years.

32% / 50%

The last mile

Coal is 32% of capacity but 50% of generation. Grid flexibility, data-centre demand and trade barriers now set the pace to 2060 neutrality.

Thank you — questions welcome.

Prof. Li Zheng · Tsinghua University · ICES Biennial Workshop VIII · Geneva · 29 September 2026