Technology Collaboration Programme
by IEA

International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Analysis & Outreach

PVPS

National Survey Report of PV Power Applications in China

2024

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What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6.000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The 28 IEA PVPS participating countries are Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, India, Israel, Italy, Japan, Korea, Lithuania, Malaysia, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkiye, the United Kingdom and the United States of America. The European Commission, Solar Power Europe and the Solar Energy Research Institute of Singapore are also members.

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What is IEA PVPS Task 1?

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "Trends in photovoltaic applications" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2023. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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INTERNATIONAL ENERGY AGENCY

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

National Survey Report of PV Power Applications in China 2024

IEA PVPS
Task 1
Strategic PV Analysis & Outreach

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TABLE OF CONTENTS

Acknowledgements 5
1 HIGHLIGHTS 6
2 Installation Data 7
2.1 Applications for Photovoltaics 7
2.2 Total photovoltaic power installed 7
2.3 Key enablers of PV development 10
3 Competitiveness of PV electricity 11
3.1 Module prices 11
3.2 System prices 11
3.3 Financial Parameters and specific financing programs 12
3.4 Specific investments programs 12
3.5 Additional Country information 13
4 Policy Framework 14
4.1 National targets for PV 15
4.2 Direct support policies for PV installations 15
4.3 Self-consumption measures 20
4.4 Collective self-consumption, community solar and similar measures 21
4.5 Tenders, auctions & similar schemes 23
4.6 Other utility-scale measures including, floating and agricultural PV 24
4.7 Indirect policy issues 25
4.8 Financing and cost of support measures 26
4.9 Grid integration policies 27
5 Industry 30
5.1 Production of feedstocks, ingots and wafers (crystalline silicon industry) 30
5.2 Production of photovoltaic cells and modules (including TF and CPV) 31
5.3 Manufacturers and suppliers of other components 32
5.4 Recycling 34
6 PV In The Economy 35
6.1 Business value 35
7 Interest From Electricity Stakeholders 36
7.1 Structure of the electricity system 36
7.2 Interest from electricity utility businesses 36

7.3 Interest from municipalities and local governments 37
8 Prospects 38

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1 HIGHLIGHTS

In 2024, China added 277.57 GW_{AC} of new PV capacity, representing a 28% year-on-year increase from the previous year's high base. Utility-scale installations accounted for 159.39 GW (up 33% year-on-year), comprising 57% of total new additions. Distributed PV reached 118.18 GW_{AC} (up 23% year-on-year), making up 43% of new capacity. Within distributed PV, commercial and industrial installations totaled 88.63 GW_{AC} (up 68% year-on-year) and represented 32% of total new capacity, while residential installations reached 29.55 GW_{AC} (down 32% year-on-year), accounting for 11%.

During the same period, China's PV power generation reached 834.1 TWh, a 44% year-on-year increase, with a national utilization rate of 96.8%.

China's solar cell efficiency achievements in 2024 were particularly outstanding. As of March 2025, China holds efficiency records for 9 types of solar cells, spanning four out of six major cell categories-an increase of two cell types from the 7 listed in 2023. This marks the highest number of Chinese entries since the NREL "Best Research-Cell Efficiency Chart" was first published. Notable records include: Hybrid Tandem Cells: perovskite/silicon tandem cell developed by LONGi Green Energy with a record efficiency of 34.6% (renewed record); Crystalline Silicon Cells: monocrystalline back-contact heterojunction (HBC) cell by LONGi achieving 27.3% efficiency (renewed record), and a polysilicon (DS wafer) cell by Jinko Solar reaching 23.3% efficiency. These results highlight the growing research and development capabilities of China’s PV industry, driven by increased investment in research and encouragement of original innovation in recent years.

2 INSTALLATION DATA

The PV power systems market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, PV installations are included in the 2024 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2024, although commissioning may have taken place at a later date.

2.1 Applications for Photovoltaics

By the end of 2024, China's cumulative installed solar PV capacity reached 886 GW, representing 1.45 times the capacity recorded at the end of 2023. Within this total, distributed PV accounted for 375 GW of cumulative installed capacity.

In 2024, China added 277.57 GW of new PV capacity, representing a 28% year-on-year increase from the previous year's high base. Utility-scale installations accounted for 159.39 GW (up 33% year-on-year), comprising 57% of total new additions. Distributed PV reached 118.18 GW (up 23% year-on-year), making up 43% of new capacity. Within distributed PV, commercial and industrial installations totaled 88.63 GW (up 68% year-on-year) and represented 32% of total new capacity, while residential installations reached 29.55 GW (down 32% year-on-year), accounting for 11%.

The mix of new PV installations has shifted notably over the past three years. Benefiting from the construction and grid-connection of the first batch of large-scale base projects within14th National Five-Year Plan, utility-scale PV has expanded rapidly, with its share continuously increasing and surpassing that of distributed PV.

On a monthly data, new installations in January-February surged by 80.3% year-on-year to 38.6 GW, setting a record for the highest single-month growth rate. In March, however, new additions fell to 12.1 GW, down 32.1% year-on-year—the first monthly contraction in two years—due to module price fluctuations and adjustments in grid-connection quotas. A year-end installation rush in December drove monthly additions to 70.2 GW, reaching a historic monthly peak and exceeding the total annual installations of 2019.

2.2 Total photovoltaic power installed

Table 1: Annual PV power installed during calendar year 2024

		Installed PV capacity in 2024 [MW]	AC or DC
	Decentralized	118 180	AC
	Centralized	159 390	AC
	Off-grid	-	-
	Total	277 570	AC

Table 2: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	Decentralized: DC ≈ AC Centralized: DC=AC* 1.2
Is the collection process done by an official body or a private company/Association?	Data on annual and accumulated PV grid-connected installation capacity in 2024 were published by National Energy Administration. Off-grid installation accounts for a very small scale in China so the data was estimated by PV experts.
Link to official statistics (if this exists)	http://www.nea.gov.cn/

Table 3: The cumulative installed PV power in 4 sub-markets (In AC)

Year	Off-grid [MW]	Grid-connected distributed [MW]	Grid-connected centralized [MW]	Total [MW]
2010	0	190	283	800
2011	0	680	2 000	3 500
2012	0	890	2 630	7 060
2013	0	3 100	16 320	19 420
2014	0	4 670	23 380	28 050
2015	0	6 060	37 120	43 180
2016	0	10 320	67 100	77 420
2017	0	29 660	100 540	130 200
2018	0	50 620	123 840	174 460
2019	0	62 630	141 670	204 300
2020	0	78 310	174 790	253 100
2021	0	107 510	198 480	305 990
2022	0	157 620	234 420	392 040
2023	0	254 440	354 480	608 920
2024	0	374 780	510 890	885 680

Table 4: Other PV market information (In AC)

	2024
Number of PV systems in operation in your country	Total installed 277.57GW Distributed PV 118.18GW ; utility PV 159.39GW.
Decommissioned PV systems during the year [MW]	N/A
Repowered PV systems during the year [MW]	N/A

Table 5: PV power and the broader national energy market

	Data (2024)
Total power generation capacities [GW]	3 350 GW
Total renewable power generation capacities (including hydropower) [GW]	1 889 GW
Total electricity demand [TWh]	9 852 TWh
New power generation capacities installed [GW]	430 GW
New renewable power generation capacities (including hydropower) [GW]	372 GW (hyd. 13.78 GW, wind 79.82 GW, PV 277.57 GW, Bio 1.85 GW)
Estimated total PV electricity production (including self-consumed PV electricity) in [GWh] (or [TWh])	834.1 TWh
Total PV electricity production as a % of total electricity consumption	8%
Average yield of PV installations (in kWh/kWp)	940 kWh/kWp

2.3 Key enablers of PV development

Table 7: Information on key enablers.

	Description	Annual Volume	Total Volume	Source
Decentralised storage systems	/	/	/	/
Residential Heat Pumps (number)	/	/	/	/
100% Electric cars (number)	/	7.71 million	1 389 600 million 22.09 million	Traffic Administration Bureau of the Ministry of Public Security
Hybrid rechargeables (number)	/	5.14 million	1 292 400 million 9.31 million	Traffic Administration Bureau of the Ministry of Public Security

3 COMPETITIVENESS OF PV ELECTRICITY

3.1 Module prices

Table 6: Typical module prices

Year	Lowest price of a standard module crystalline silicon	Highest price of a standard module crystalline silicon	Typical price of a standard module crystalline silicon
2024	0.62 Yuan/W	0.98 Yuan/W	0.70 Yuan/W

3.2 System prices

Table 9: Turnkey PV system prices of different typical PV systems

Category/Size	Typical applications and brief details	Current prices [Yuan/W]
Residential BAPV 5-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes.	3.4
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	3.3
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	3.1
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	3.0
Small centralized PV 1-20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	2.8
Large centralized PV >20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	2.5

Table 7: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW **[Yuan/W]**	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW **[Yuan/W]**	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW **[Yuan/W]**	Centralized PV Grid-connected, ground-mounted, centralized PV systems 10-50 MW **[Yuan/W]**
2024	3.4	3.3	3.1	2.5

3.3 Financial Parameters and specific financing programs

Table 8: PV financing information in 2024

Different market segments	Loan rate [%]
Average rate of loans – residential installations	4.2%
Average rate of loans – commercial installations	3.5%
Average cost of capital – industrial and ground-mounted installations	2.5%

3.4 Specific investments programs

Financial Leasing

As non-banking financial institutions, financial leasing entities continue to deliver flexible and specialized integrated financial solutions tailored to renewable energy projects, with particularly prominent contributions in the photovoltaic sector. In 2024, alongside the robust expansion of the PV market, financial leasing institutions have further solidified their critical role in distributed PV, decentralized wind power, and commercial & industrial energy storage projects. Distributed energy projects, characterized by small scale, geographical dispersion, and management complexity, naturally align with the financial leasing model.

According to incomplete statistics, by the end of 2024, over ten domestic financial leasing companies had cumulatively provided approximately RMB 300 billion in funding for more than 70 GW of PV power plants, significantly accelerating the implementation and development of PV projects.

Industrial Investment Funds

In 2024, industrial investment funds continued to gain momentum in the PV sector, becoming a key financing channel for the industry. With the accelerated adoption of the "PV+" model, a growing number of industrial investment funds are deepening their involvement across the PV industry chain. This has facilitated the coordinated development of diversified applications such as agriculture-photovoltaic synergy and integrated wind-PV-storage projects.

Since the establishment of 30 provincial-level energy groups across China in 2023, local state-owned capital has further extended to municipal levels. By setting up industrial investment funds, regional resource advantages are being leveraged to deploy portfolios of distributed PV, rural wind power, C&I energy storage, and charging-swap stations. These initiatives contribute to enhancing the overall operational efficiency of the power system.

PV Plant Transaction

In 2024, the PV plant transaction market remained active, yet its structure evolved notably. According to incomplete statistics, acquired PV project capacity in China exceeded 6 GW during the year, with total transaction value surpassing RMB 25 billion.

In terms of counterparty composition, private enterprises continued to dominate the sell-side. However, some state-owned enterprises also began divesting renewable energy assets. As renewable energy participation in electricity market trading increases, power plants face dual challenges of volume and price volatility, leading to growing differentiation in asset performance. Consequently, the same state-owned enterprise may act as both a seller and a buyer, engaging in simultaneous acquisitions and divestments.

Meanwhile, alongside traditional central SOEs, locally state-owned energy platform companies have been steadily emerging as key players in the PV transaction market, contributing to a more diversified and dynamic competitive landscape.

3.5 Additional Country information

Table 9: Country information

Retail electricity prices for a household [Yuan/kWh]	0.38-1.15 Average price for Tier 1 user, as of 2025 Q2
Retail electricity prices for a commercial company [Yuan/kWh]	ToU: 0.09-1.71 No unified national data is available for commercial electricity prices, this range covers general C&I and large industry, two-part pricing and singly part pricing along all level of voltage in all provinces in China 2024

4 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

Table 10: Summary of PV support measures

Category	Residential			Commercial + Industrial			Centralized		
Measures in 2024	**Legacy**	**On-going**	**New**	**Legacy**	**On-going**	**New**	**Legacy**	**On-going**	**New**
Feed-in tariffs		Yes	-		Yes	-		Yes	-
Feed-in premium (above market price)		-	-		-	-		-	-
Capital subsidies		-	-		-	-		-	-
Green Electricity Certificates		Yes	-		Yes	-		Yes	-
Renewable portfolio standards with/without PV requirements		Yes	-		Yes	-		Yes	-
Income tax credits		-	-		-	-		-	-
Self-consumption		Yes	-		Yes	-	-	-	-
Net-metering	-	-	-	-	-	-	-	-	-
Net-billing	-	-	-	-	-	-	-	-	-
Collective self-consumption and delocalized net-metering	-	-	-	-	-	-	-	-	-
Sustainable building requirements		Yes	-		Yes	-		-	-
BIPV incentives		-	-		Yes	-		-	-
Merchant PV facilitating measures	-	-	-		-	-		-	-
Other (specify)		-	-		-	-		-	-

4.1 National targets for PV

China's goal of achieving a total installed capacity of over 1200GW for wind power and solar power by 2030 has been achieved six years ahead of schedule. By the end of July 2024, the combined installed capacity of wind power and PV power in China reached 1206GW.

4.2 Direct support policies for PV installations

4.2.1 Development measures of accommodation

The National Energy Administration issued the Notice on Effectively Conducting New Energy accommodation to Ensure High-Quality Development of Renewable Energy (NEA Power [2024] No. 44), mandating accelerated development of grid-connection infrastructure for renewable projects, active enhancement of system flexibility and grid-generation coordination, and full utilization of the grid's resource allocation function. The notice also requires scientific optimization of new energy utilization rate targets, institutionalized monitoring and analysis of renewable accommodation, and continuous improvement of the power system's accommodation capacity. These measures aim to maintain reasonable utilization levels amid large-scale renewable expansion and promote high-quality development of the new energy sector.

Concurrently, to promote renewable energy accommodation, the National Energy Administration, in collaboration with multiple ministries, issued the Guiding Opinions on Vigorously Implementing the Renewable Energy Substitution Initiative. The document assigned and promoted the allocation of renewable portfolio standards to key industries and major energy-consuming entities, specified green power accommodation share targets for the aluminum smelting industry with compliance verified through Green Electricity Certificate, and ensured coordinated advancement of renewable energy supply and green power accommodation in key sectors. These measures collectively facilitate the systematic replacement of traditional fossil fuels with renewable energy.

Enhancing Distribution Network Hosting Capacity for Distributed Renewables: The Guiding Opinions on High-Quality Development of Distribution Networks under the New Situation (NDRC Energy [2024] No. 187) issued by the National Development and Reform Commission and the National Energy Administration sets the target of enabling approximately 500 GW of distributed renewable integration capacity by 2025. Subsequently, the Action Plan for Accelerating the Construction of an Advanced Power System (2024-2027) (NDRC Energy [2024] No. 1128) released in July 2024, followed by the Implementation Plan for High-Quality Development of Distribution Networks (2024-2027) (NEA Power [2024] No. 59) issued in August, propose establishing a regular publication and early-warning mechanism for distribution network available hosting capacity. This mechanism requires quarterly public disclosure of integration capacity information at the county/city level, guiding the scientific planning, orderly development, and local integration and accommodation of distributed renewable energy.

4.2.2 Development measures of the construction and management PV installation

Regarding land use, the Ministry of Natural Resources, the National Development and Reform Commission, and the National Forestry and Grassland Administration jointly issued the Guidance Catalog on Supporting High-Quality Industrial Development with Natural

Resource Elements (2024 Edition) in 2024. The catalog specifies clearer requirements for PV project land use, providing explicit guidance on land utilization: PV power projects must avoid ecological protection red lines and culturally protected areas; large-scale PV base projects in deserts, Gobi, and barren areas, PV projects utilizing damaged land in coal mining subsidence areas, and projects developing facility agriculture or alternative industrial platforms are classified as encouraged categories; PV projects constructed on wetlands such as mudflats and marshes are listed as restricted categories; offshore PV projects are prohibited from being developed beyond provincial-administered maritime zones.

Regarding distributed PV development, the National Energy Administration formulated and implemented the Management Measures for Distributed PV Power Generation Development and Construction in January 2025. The measures adjust the scope of application for distributed PV and refine its classification, ensuring proper categorization of various PV project types. Registration, construction, grid connection, and operation procedures are clearly standardized. Specifically, the self-consumption ratio for general commercial and industrial distributed PV will be determined by local authorities based on regional development needs. Furthermore, distributed PV systems must meet the "four-ability" requirements of being observable, measurable, dispatchable, and controllable, thereby enhancing the power system's hosting capacity for distributed PV and laying the foundation for its participation in electricity markets.

In the rural PV sector, the “National Rooftop Solar Promotion Initiative” was launched. In March 2025, the National Energy Administration General Office issued the Notice on Further Effectively Implementing the “National Rooftop Solar Promotion Initiative” (NEA General Office New Energy [2025] No. 44), requiring coordinated integration of the initiative with energy and power development plans. The notice mandates balanced consideration of various renewable energy development needs and, based on grid hosting capacity, guides the scientific planning, orderly development, local connection, and local consumption of rural distributed PV. Grid companies and relevant entities are required to strengthen supporting grid upgrades and other measures to enhance integration capacity according to actual needs, ensuring the healthy and sustainable development of distributed PV in rural areas.

4.2.3 Development measures of Feed-in tariffs

According to data released by the National Energy Administration, with the continuous improvement of the market-based electricity pricing mechanism, over 50% of China's new energy generation is now integrated through market-based mechanisms.

On February 9, 2025, the National Development and Reform Commission and the National Energy Administration issued the Notice on Deepening Market-Based Reform of New Energy Feed-in Tariffs to Promote High-Quality Development of Renewable Energy (NDRC Price [2025] No. 136). The policy outlines a comprehensive approach to advance market-oriented feed-in tariff reforms based on the principles of market-driven price formation, equitable responsibility sharing, differentiated treatment for existing and new projects, and coordinated policy implementation. It mandates full market participation for all wind and solar power generation, with tariffs to be determined through market trading. Simultaneously, a sustainable pricing settlement mechanism will be established, applying differentiated measures to existing and new projects to foster high-quality industry development.

Regarding time-of-use electricity pricing, as of the end of April 2025, 19 regions in China had formulated and implemented midday off-peak tariffs (including draft versions). Among the top 15 provinces by installed PV capacity, 12 regions have either implemented or plan to introduce midday off-peak tariffs. The introduction of off-peak tariffs during noon hours will significantly reduce feed-in tariff levels for PV generation, particularly distributed PV, affecting the

investment returns of such projects. Consequently, PV + Storage configurations are gaining attention as a viable solution.

In 2024, China's procurement prices for grid proxy underwent frequent adjustments, with 17 regions newly issuing or beginning implementation of revised time-of-use pricing policies for commercial and industrial consumers. The modifications primarily involved changes in peak/valley/off-peak timing and duration, introduction or removal of super-peak/deep-valley pricing, and adjustments to peak-valley floating ratios.

4.2.4 Development measures of Green Certification

China continues to improve its green power consumption framework, vigorously cultivates the Green Electricity Certificate market, and stimulates demand for both green electricity and certificates. This year, guidelines were issued to promote high-quality development of the Green Electricity Certificate market, with a core focus on stimulating demand while ensuring stable certificate supply. Under the mandatory consumption mechanism, the policy calls for accelerated increases in the green power consumption share for enterprises in sectors such as steel, non-ferrous metals, building materials, petrochemicals, and chemicals, as well as data centers and other key energy-consuming entities and industries. It also advocates for creating green power factories and parks characterized by high-percentage green power consumption. Under the voluntary mechanism, government departments, public institutions, state-owned enterprises, industry leaders, multinational corporations and their supply chain partners, and export-oriented enterprises are encouraged to raise their green power consumption share and develop green power buildings and communities utilizing a high proportion of green electricity.

China has standardized the Green Electricity Certificate procedures to establish closed-loop management covering the entire lifecycle from issuance to cancellation. The Green Electricity Certificate issuance and trading system was officially launched on June 30, 2024. In August, the Renewable Energy Green Electricity Certificate Issuance and Trading Rules were promulgated, specifying the certificate cancellation regulations. To address practical market needs, the National Energy Administration General Office released the Implementation Rules for Renewable Energy Green Electricity Certificate Issuance (Trial) (Draft for Comment) at the end of March 2025, formally soliciting public feedback. These rules further clarify the scope for issuing tradable versus non-tradable Green Electricity Certificates. Specifically, they stipulate that renewable energy generation used for wind/solar-based hydrogen (ammonia/alcohol) production and coal-fired captive power plant replacement projects will receive non-tradable certificates, while discharge volumes from energy storage systems connected to renewable generation facilities will not be eligible for green certification.

Clear delineation has been established between the applicable scopes of Green Electricity Certificates and the China Certified Emission Reduction (CCER) scheme. The Notice on Coordinating the Renewable Energy Green Electricity Certificate and Voluntary Emission Reduction Markets issued in August 2024 stipulates that concentrating solar power and offshore wind projects may choose between obtaining tradable Green Electricity Certificates or applying for CCER credits. This measure prevents renewable energy projects from receiving double benefits through both certification systems.

Regarding Green Electricity Certificate supply, China issued 4.734 billion Green Electricity Certificates in 2024, representing a 28.36-fold year-on-year increase. The cumulative number of issued certificates reached 4.955 billion, marking a 21.45-fold growth from the previous year. Annual Green Electricity Certificate transactions totaled 446 million, up 3.64 times year-on-

year, while cumulative trading volume reached 553 million certificates, reflecting a 4.19-fold increase.

On the demand side, the number of entities participating in Green Electricity Certificate transactions reached 59 000 in 2024, a 2.5-fold year-on-year increase. This included 55 400 corporate buyers and 3 955 individual purchasers. These consumers spanned all 34 provincial-level regions nationwide, with manufacturing firms accounting for over 70% of the total purchase volume.

Green Electricity Certificate transaction volume exhibited exponential growth in 2024, with certificate prices experiencing significant fluctuations driven by supply-demand dynamics and relevant policies. Since the Green Electricity Certificate policy document was promulgated in July 2023, trading volumes have grown exponentially. Cumulative transactions increased from 136 million certificates at the end of 2023 to 553 million by the end of 2024, reaching 634 million by February 2025. Certificate issuance expanded rapidly, with cumulative issuance reaching 5.442 billion certificates by February 2025, including 3.991 billion tradable certificates. A substantial oversupply situation emerged, causing Green Electricity Certificate prices to plummet dramatically. While prices generally ranged around 10 yuan per certificate (equivalent to approximately 0.01 yuan/kWh) in early 2024, they fell to as low as 0.001 yuan/kWh by early 2025, severely deviating from the environmental value they represent and trading significantly below concurrent carbon market prices. Following the issuance of NDRC Price [2025] No. 136, which stipulates that electricity covered by the sustainable development pricing settlement mechanism cannot receive duplicate green attribute benefits, industry consensus indicates that the quantity of tradable certificates outside this mechanism will decline substantially. This may create supply shortages, particularly in some eastern and central provinces, driving recent price increases. By March 2025, prices had recovered to levels exceeding 0.005 yuan/kWh equivalent.

4.2.5 BIPV development measures

National-Level Policies:

In March 2024, the National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development issued the Action Plan for Accelerating Energy Conservation and Carbon Reduction in the Building Sector. The plan emphasizes promoting the low-carbon transition of building energy use by formulating and improving standards and technical guides for building-integrated photovoltaics (BIPV), advancing BIPV pilot projects in new industrial plants, public buildings, and residential structures, and strengthening the management of retrofitting existing buildings with PV systems. It also calls for accelerating the R&D and deployment of advanced energy-saving and carbon-reduction technologies. Support will be provided for the development of next-generation building technologies, including ultra-low energy, near-zero energy, low-carbon, and zero-carbon buildings, as well as for the application of thin-film solar technologies such as perovskite and cadmium telluride in the building sector. The plan further encourages the integrated use of reliable technical processes, products, and equipment.

The Management Measures for Distributed PV Power Generation Development and Construction issued by the National Energy Administration on January 17, 2025 establishes a systematic policy framework for distributed PV. It first designates core application scenarios including residential buildings, government and Communist Party organs, schools, hospitals, and industrial/commercial plants, legally defining the integration boundaries of PV systems with building structures. Secondly, it creates China's first national-level specialized statistical standards for distributed PV installed capacity, requiring BIPV projects to be included in an

independent statistical system—resolving long-standing project classification ambiguities and providing data support for scaled development. The policy also emphasizes deep integration of PV systems throughout the entire building lifecycle of design, construction, and operation/maintenance, specifically supporting the application of thin-film technologies like perovskite and cadmium telluride in buildings to guide the industry's transition from extensive installation to refined, functionally integrated operations. Finally, it constructs a comprehensive regulatory system covering scenario definition, technical standards, statistical management, and full lifecycle safety supervision, requiring new buildings to pre-install PV interfaces and existing building retrofits to undergo structural safety assessments, forming a closed-loop management mechanism of "policy guidance → standardized specifications → market application." Through scenario authorization, standardized unification, technological upgrading, and institutional safeguards, this policy provides a clear implementation pathway for distributed PV development, marking a crucial transition in China's building energy transformation from single-policy drives to systematic development, thereby strongly advancing energy structure optimization in the building sector and supporting the achievement of “carbon peaking and carbon neutrality” goals.

Local-Level Policies:

With continuous advancements in both the market and technology of building-integrated photovoltaics (BIPV), enhancing the penetration rate and increasing the installed capacity of PV systems on buildings have become priorities for relevant government departments. Energy authorities under provincial and municipal development and reform commissions, together with housing and urban-rural development departments, have successively introduced multiple policies to vigorously promote the application of PV systems in buildings.

The Ningbo Three-Year Action Plan for High-Quality Rooftop PV Development in the Building Sector (2025-2027) aims to add 4 GW of new rooftop PV capacity by the end of 2027.

The Implementation Opinions on Further Accelerating PV Project Development in Hangzhou (Hangzhou Development and Reform Energy [2022] No. 105) propose comprehensively promoting six major "PV+" initiatives, including industrial applications, public buildings, commercial sectors, and residential areas. By 2025, the city strives to achieve a rooftop PV coverage rate of 50% on newly constructed public buildings.

Additionally, several provinces have integrated BIPV policies into performance evaluation mechanisms or provided financial support to encourage adoption.

4.3 Self-consumption measures

Table 11: Summary of self-consumption regulations for small private PV systems in 2024

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	Savings on the electricity bill + bonus（some provincial level）
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	Yes
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Yes
	5	Maximum timeframe for compensation of fluxes	Real-time
	6	Geographical compensation (virtual self-consumption or metering)	Pilot programs for virtual self-consumption in some provinces
Other characteristics	7	Regulatory scheme duration	20 years
	8	Third party ownership accepted	Allowed in certain regions under new energy service models
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Strengthened grid compliance requirements; no major new taxes
	10	Regulations on enablers of self-consumption (storage, DSM…)	Yes, with support for storage and demand-side management (DSM)
	11	PV system size limitations	Generally no hard limit, but must match local grid capacity
	12	Electricity system limitations	Local grid constraints may apply in high-penetration areas
	13	Additional features	Digital metering and remote monitoring encouraged

4.3.1 Development measures of green electricity demands

For the first time, the responsibility weight for renewable energy consumption has been assigned to key energy-consuming industries and entities, thereby increasing the demand for green electricity from the end-user side. In 2024, the national renewable energy consumption guarantee mechanism will continue to be strengthened. On one hand, the binding nature of

the responsibility weight will be maintained as before. Provinces are required to actively promote the development of renewable energy projects within their regions, engage in cross-provincial and cross-regional electricity trading, and ensure that the responsibility weight is effectively assigned to the entities accountable for consumption. On the other hand, a new policy point for the 2024 responsibility weight is its initial application to key energy-consuming industries and entities. Specific targets for the proportion of green electricity consumption in the electrolytic aluminum industry have been set for 2024 and 2025, with compliance to be calculated using green electricity certificates. In 2024, performance will be monitored but not assessed, while subsequent years will incorporate it into the assessment framework.

On July 24, 2024, the NDRC and the NEA issued “the Basic Rules for Medium and Long-Term Electricity Trading—Chapter on Green Electricity Trading”, proposing that green electricity trading be promoted in an orderly manner in accordance with the principle of "primarily within provinces, supplemented by inter-provincial and inter-regional trading," to meet the green electricity procurement needs of power consumers.

4.4 Collective self-consumption, community solar and similar measures

4.4.1 Development measures of power generation, transmission, loading, and storage integration

In 2024, China maintained a high level of PV power integration and accommodation, with the annual utilization rate reaching 96.8%. Shanghai, Zhejiang, Fujian, and Chongqing achieved a 100% accommodation utilization rate. Efforts were strengthened to enhance grid integration and transmission infrastructure for renewables, optimize the main grid framework, and develop modern smart distribution networks, leading to continuous improvement in renewable energy resource allocation capabilities.

To increase system flexibility across generation, grid, load, and storage segments, China accelerated flexibility retrofits of coal-fired units, promoted the construction of pumped storage and natural gas peaking plants, and supported large-scale deployment of advanced energy storage systems. The revision of technical standards for renewables and upgrades to grid interaction performance of power stations were expedited to strengthen active support capabilities to the system.

Furthermore, power market mechanisms that facilitate renewable energy integration were rapidly advanced. Initiatives such as bundled wind-thermal power transmission, generation rights trading, and priority replacement with renewables were actively implemented. The development of electricity spot markets was accelerated, market transaction volumes expanded, and integration potential further unlocked.

China has steadily advanced the construction of UHV AC and DC transmission projects, strengthened key power transmission corridors, and accelerated the development of grid-connection facilities for large-scale wind and solar power bases. These efforts have enhanced the distribution network’s hosting capacity and further improved the optimized allocation of renewable energy resources.

To strengthen the active support capabilities of renewable energy, China is enhancing the controllability of distributed generation, optimizing power balancing strategies, and accelerating the development of electricity spot markets and the green power trading market.

Grid Infrastructure Development

In 2024, China accelerated power grid construction to enhance system support capabilities. Close monitoring was maintained on renewable energy planning and development, with regular thematic meetings convened on the construction of large-scale renewable bases in desert and Gobi regions. Progress of major base projects was tracked on a ten-day basis. Standardized working mechanisms for distributed renewable integration were established, and grid connection procedures were streamlined. Through the implementation of a "green channel" mechanism, funding and construction resources were prioritized to accelerate supporting transmission projects, achieving grid connection for all eligible renewable projects

Grid Dispatch and Operation

Throughout 2024, China strengthened unified grid-wide dispatch, advanced the development of spot markets, and enhanced renewable power forecasting accuracy under extreme weather conditions. These measures reinforced the active support capability of renewables, ensured their role in maintaining and increasing power supply, and provided solid support for high renewable integration and secure grid operation.

Enhanced Unified Dispatch and Improved Renewable Integration: Leveraging the advantages of large-scale power grids, China optimized the operational scheduling of thermal power units, refined their start-stop strategies, and enhanced deep peak-shaving capabilities. Inter-provincial mutual support and reserve sharing were strengthened to expand integration space for renewable energy and promote its full and maximum generation. Concurrently, renewable power forecasting under extreme weather was improved, with focused efforts on advancing primary frequency regulation and inertia response capabilities. Comprehensive technological initiatives were undertaken to enhance grid interaction performance and strengthen active support capabilities of renewables. These measures reinforce the role of renewable energy in ensuring and increasing power supply, providing solid support for high-percentage renewable integration and secure grid operation.

Enhanced Deep Peak-Shaving Capability of Thermal Power: In 2024, operational scheduling of thermal power units was optimized, with refined start-stop strategies and enhanced deep peak-shaving potential, further expanding integration space for renewable energy.

Maximized Role of Advanced Energy Storage: Dispatching principles for advanced energy storage were optimized, supported by the development of control platforms and improved operational strategies. These efforts strengthened the role of storage in ensuring power supply and integrating renewables.

Tapping into Demand-Side Response Potential: Demand response capabilities were continuously enhanced through cross-provincial virtual power plants, vehicle-grid integration, and air-conditioning load management, improving renewable energy utilization.

Improved Renewable Power Forecasting Accuracy: In 2024, AI technology was increasingly applied in renewable power forecasting and extreme weather identification. Day-ahead prediction accuracy for wind and solar power exceeded 97%.

Enhanced Renewable Energy Support During Extreme Weather: Monitoring and regulation of renewable power stations under extreme weather conditions have been strengthened to ensure reliable and increased power supply. In Henan Province, an ice-coating monitoring and alert platform for renewable energy units was developed and deployed. The province also launched targeted de-icing operations, establishing a data-driven, coordinated monitoring, and closed-loop forecasting mechanism for extreme weather management. This system enhances the accurate prediction of ice-related generation outages.

Improved Control of Distributed Renewable Energy: Intelligent dispatch systems are being developed to increase the power system's capacity to integrate distributed PV. Efforts to involve distributed PV in electricity markets have advanced, enabling minute-level full data collection and flexible control of distributed systems in pilot provinces.

Green Power Consumption Demonstration: Major events—including the Shanghai Import Expo, Summer Davos, and World Internet Conference Wuzhen Summit—have been fully powered by green electricity. These platforms help promote green power consumption, encourage corporate procurement of green power and certificates, and accelerate the transition to green, low-carbon energy use.

4.5 Tenders, auctions & similar schemes

The Year 2024 marked a pivotal transition for China's PV industry, shifting from quantity-driven expansion to quality-oriented transformation. While maintaining the general approach of equally emphasizing both large-scale projects (such as integrated wind-PV bases in desert, Gobi, and barren-rock areas, and hydro-PV complexes in the southwest) and distributed development, national policies became more refined in mechanism design and stricter in standards and requirements. The core objectives were to address the growing integration bottleneck and steer the industry toward high-quality development through market-based competition.

Large-Scale Base Projects: Enhancing Competitive Allocation and Multi-Energy Complementarity to Ensure Efficient Grid Integration

The core focus of large-scale base project policy in 2024 is to achieve full grid connection and operational status for existing projects (the first and second batches) while advancing new projects (the third batch and beyond) with high quality. Policy mechanisms have fully shifted from "planned allocation" to "market-based competitive allocation," accompanied by strict binding requirements.

The 2024 Energy Work Guidance called for "progressively launching the third batch of large-scale wind and solar base projects and ensuring the completion and grid connection of the first and second batches as soon as possible." This sets the overarching annual objective, requiring provincial authorities to develop detailed schedules and clarify responsibilities accordingly.

Provincial energy authorities organized competitive allocation for base projects in accordance with regulations such as the Management Measures for PV Power Station Development and Construction and the Notice on Regulating Investment and Development Order of PV Power Stations.

As outlined in the NDRC and NEA's Guiding Opinions on Promoting Integrated Power Source-Grid-Load-Storage and Multi-Energy Complementarity Development, 2024 priorities include: Bundling renewable bases in desert, Gobi, and barren areas with coal power and solar thermal projects. Leveraging hydropower regulation in southwest hydro-PV integrated bases to smooth PV output fluctuations. Policy mandates that supporting projects-including flexibility retrofits of coal power, solar thermal, and energy storage-must be commissioned simultaneously with renewable energy projects.

Furthermore, construction of UHV transmission lines such as Longdong-Shandong and Ningxia-Hunan is being accelerated, with clear provisions that "transmission capacity quotas shall be prioritized for large-scale RE base projects."

Distributed PV: Grid Hosting Capacity Assessments Rolled Out Nationwide, County-Wide Initiatives Deepened

The most significant policy shift in 2024 for distributed PV has been the transition from "encouraging vigorous development" to "promoting standardized and orderly growth." The central task has been scaling up pilot experiences from 2023 to overcome grid integration bottlenecks.

Comprehensive Implementation of Grid Hosting Capacity Assessments for Distributed PV: Building on the pilot experience under the Notice on Carrying Out Assessments of Distributed PV Grid Integration Capacity and Enhancement Measures (NEA General Office [2023]74), grid hosting capacity assessments were rolled out nationwide in 2024. A "alarm light"(green/yellow/red zones) publication mechanism has been implemented across the country, making it a prerequisite for development.

Standardization of County-Wide Rooftop Distributed PV Development: Follow-up requirements to the County-Wide Rooftop Distributed PV Pilot Program emphasize the "one county, one developer" principle. Selection through open bidding or competitive negotiation designates financially robust central or state-owned enterprises as the lead developer. Key evaluation criteria focus on the developer's financial strength, integrated O&M plan, benefit-sharing mechanism with households/businesses, and local consumption capacity—rather than competing solely on electricity price.

Breakthrough in Market Participation for Distributed PV (retail wheeling): According to the Notice on Accelerating the Development of the Electricity Spot Market and related market rules, policies in 2024 encourage C&I distributed PV to prioritize "self-consumption with surplus power fed into the grid," and explicitly support direct participation in the electricity market via the "wheeling" model. Detailed provisions on wheeling charges, trading rules, and settlement methods create potential for higher returns and new business models.

Tightened Grid-Integration Standards for Distributed PV: Under the newly revised Guidelines for Distributed Generation Grid Integration Capacity Assessment and other technical standards, new distributed PV projects must be equipped with power control capabilities (including active and reactive power regulation). Grid-tied inverters are required to comply with the latest technical specifications to meet grid dispatch needs and enhance hosting capacity.

4.6 Other utility-scale measures including, floating and agricultural PV

4.6.1 Development measures of offshore PV

Offshore PV has emerged as the next significant application scenario for photovoltaic power generation, leveraging its unique characteristics and advantages. Currently, offshore PV project development is primarily focused on research and demonstration applications, accumulating technical experience, testing equipment, and exploring models for large-scale implementation.

Guided by the "carbon peaking and carbon neutrality" strategy, national and regional authorities have intensified policy support to promote the high-quality development of offshore PV. To date, the pipeline of offshore PV projects under planning or construction in China has exceeded 10 GW.

In November 2024, Shanghai released the Implementation Plan for Competitive Allocation of Co-located Offshore PV and Wind Power Projects in 2024. The competitive allocation covers sites within the city's maritime zones where offshore wind farms are already built or under construction.

In December 2024, the Ministry of Natural Resources issued the Guidance Catalog on Supporting High-Quality Industrial Development with Natural Resource Elements (2024 Edition), which further specifies that project siting should be carried out within four types of already developed or utilized maritime areas under provincial jurisdiction: reclaimed aquaculture zones, offshore wind farm areas, designated thermal discharge areas of power plants, and long-term idle or abandoned salt pans.

In Dec., the Ministry of Natural Resources, the NDRC, and other relevant departments released the "Guiding Catalog for Natural Resource Elements Supporting High-Quality Industrial Development (2024 Edition)", mandating that new offshore wind power projects are required to be situated in areas either at least 30 km from the coast or in waters with depths exceeding 30 meters.

In December 2024, the Jiangsu Provincial Development and Reform Commission released the Jiangsu Province Offshore PV Development and Construction Implementation Plan (2025-2030). This plan optimizes and updates the previous 2023-2027 scheme by removing policy-incompatible offshore PV sites and prioritizing co-location with offshore wind farm areas, reclaimed aquaculture zones, and designated thermal discharge areas of power plants for offshore PV development.

4.7 Indirect policy issues

4.7.1 Rural electrification measures

The "National Rooftop Solar Promotion Initiative", one of the key actions outlined in China's "14th Five-Year Renewable Energy Development Plan", builds upon the success of the "county-wide PV development model". During the 14th Five-Year period, 56 pilot counties fully achieved their distributed PV development targets, establishing a strong foundation for broader implementation.

In March 2025, the National Energy Administration issued the Notice on Further Implementing the National Rooftop Solar Initiative (NEA General Office [2025]44), emphasizing coordinated planning with energy and power development strategies. The initiative promotes scientifically planned, orderly developed, locally integrated, and consumed rural distributed PV systems based on grid hosting capacity. Grid companies are required to upgrade distribution networks and enhance integration capabilities to support sustainable development.

The initiative also includes systematic rooftop resource surveys and the establishment of technical standards to create tailored design solutions for diverse rural environments. It is expected to play a key role in advancing new incremental distributed PV projects in rural areas under policies encouraging full renewable participation in electricity markets.

4.7.2 Support for electricity storage and demand response measures

In 2024, China's energy storage continued its rapid expansion. According to National Energy Administration statistics, the cumulative installed capacity of operational advanced energy storage projects reached 73.76 GW/168 GWh by year-end—approximately 20 times the level at the conclusion of the 13th Five-Year Plan and a 130% year-on-year increase from 2023. The average storage duration rose to 2.3 hours, up by about 0.2 hours from end-2023.

New energy pairing storage projects accounted for 15.6 GW/42.4 GWh of newly added capacity in 2024, representing 38% of total installations measured in MWh. These projects encompass seven main application scenarios: onshore wind + storage, onshore wind +

storage + hydrogen, offshore wind + storage, PV + storage, PV + storage + hydrogen, offshore PV + storage, integrated wind-PV-storage (with hydrogen). Among these, "PV + storage" emerged as the dominant segment, with 8.4 GW/22.3 GWh of deployments accounting for 53% of the MWh-scale capacity in new energy pairing storage projects during 2024.

A notable development in 2024 was the emerging requirement for energy storage pairing with offshore renewables. Coastal provinces such as Shanghai, Shandong, Jiangsu, Guangdong, and Liaoning began mandating storage integration for new offshore wind and offshore PV projects, positioning offshore renewables as a new frontier for storage applications.

In 2024, a total of 17 provinces/regions issued wind and solar development targets amounting to 263.41 GW. Multiple regions also introduced storage allocation policies for both utility-scale and distributed PV projects. Among these, Hebei (for market-oriented projects), Tibet, and parts of Gansu mandated the longest storage duration of 4 hours, while Shandong achieved the highest storage allocation ratio of 50%-80% for market-oriented projects, with durations of 2-4 hours. Distributed PV storage policies were implemented in regions including Guangdong, Hebei, Gansu, and Guangxi. Additionally, offshore PV projects in Shandong, Shanghai, and Jiangsu were also subject to storage allocation requirements.

4.7.3 Support for encouraging social acceptance of PV systems

In 2024, China's efforts to enhance social acceptance of PV demonstrated a distinct focus on multi-stakeholder participation and addressing grassroots needs. Through policy innovation incentives, corporate social responsibility fulfillment, financial mechanism empowerment, and effective community engagement and public education, a favorable social environment was collectively created for PV project expansion.

For instance, the "Carbon Inclusive" mechanism in Anji, Huzhou converts household PV generation into carbon reduction credits for market trading, providing residents with additional income, thereby creating a pathway for transforming "lucid waters and lush mountains" into "gold and silver mountains."

Beyond power generation, PV projects are also exploring "PV+" models integrated with agriculture and ecological restoration. For example, Wushan County in Chongqing has been actively developing integrated "PV+" pathways, which not only enhance land use efficiency but also deliver comprehensive benefits to local communities.

4.8 Financing and cost of support measures

In March 2024, the People's Bank of China (PBOC) and six other ministries and commissions jointly released the "Guidelines on Further Strengthening Financial Support for Green and Low-Carbon Development." The document proposes enhancing financial support for green and low-carbon development, synergistically advancing carbon reduction, pollution control, ecological expansion, and economic growth. It emphasizes a scientific and orderly approach to achieving carbon peak and carbon neutrality, leveraging China’s energy resource endowment, guiding financial resources to support the green and low-carbon transition of high-emission industries and the development of renewable energy projects, and promoting industrial green transformation and upgrading.

The document outlines that over the next five years, a world-leading financial system supporting green and low-carbon development will be essentially established. Financial infrastructure, environmental information disclosure, risk management, financial products and markets, policy support systems, and green finance standards will be continuously improved.

Regional reforms in green finance will be advanced in an orderly manner, international cooperation will be strengthened, and various resource elements will be systematically channeled into green and low-carbon sectors. By 2035, various economic and financial green and low-carbon policies will be synergistically and efficiently implemented. The standard systems and policy support systems for financial support of green and low-carbon development will be more mature, with enhanced functions in resource allocation, risk management, and market pricing.

On June 21, 2024, the Ministry of Finance, the National Development and Reform Commission, the People's Bank of China, and the National Financial Regulatory Administration jointly issued the "Notice on Implementing the Fiscal Discount Interest Policy for Equipment Renewal Loans." The notice explicitly states that business entities carrying out equipment renewal actions in accordance with the "State Council Notice on Issuing the Action Plan for Promoting Large-Scale Equipment Renewal and Consumer Goods Replacement" (State Council Document [2024] No. 7), which are included in the alternative project list determined by relevant departments, and whose loans issued by banks receive support from the People's Bank of China's relending facility for equipment renewal, will be eligible for central fiscal discount interest on their bank loans. If loans issued by multiple major banks to business entities meet the conditions for relending reimbursement, the central government will provide a 1-percentage-point discount on the principal of the bank loans, with the discount period not exceeding two years.

According to the "State Council Notice on Issuing the Action Plan for Promoting Large-Scale Equipment Renewal and Consumer Goods Replacement," exploring high-end equipment remanufacturing businesses in emerging fields such as wind power, photovoltaics, and aviation, accelerating the research and development of residual life assessment technologies for products and equipment like wind power, photovoltaics, and power batteries, and promoting the graded utilization of products, equipment, and key components in an orderly manner, as well as improving standards for the upgrading and decommissioning of wind turbines and photovoltaic equipment, are all eligible for fiscal discount interest policy support. This policy can help relevant industries reduce financing costs and encourage the development and exploration of markets such as photovoltaic recycling and graded utilization.

4.9 Grid integration policies

4.9.1 Grid connection policies

China's PV Grid-Integration Policy in 2024-2025 was characterized by a clear focus on standardization, market-orientation, and security enhancement.

Standardization: Through the Distributed PV Management Measures and the "Direct Green Power Connection" policy, various grid-integration models were subjected to refined categorization and clear regulatory definitions, moving away from unregulated development.

Market-Orientation: Policies strongly promoted the full participation of all renewable energy generation in market trading. By advancing the development of green power and certificate markets, the environmental value of renewables is increasingly reflected through market mechanisms.

Security Enhancement: Grid security was elevated to an unprecedented priority level. Measures, including mandating self-consumption for large-scale projects and comprehensively improving grid interaction security capabilities, were implemented to ensure system stability amidst the rapid expansion of renewable energy.

Direct Green Power Connection – A New Model

On May 21, 2025, the National Development and Reform Commission and the National Energy Administration issued the Notice on Orderly Promoting the Development of Direct Green Power Connections, permitting renewable energy sources such as wind, PV, and biomass power to supply electricity directly to a single user via dedicated lines, thereby achieving physical traceability of green power.

The policy stipulates that: The annual self-consumed green power must account for no less than 60% of the total available generation. The proportion of electricity fed into the grid shall generally not exceed 20%.Self-consumed power must constitute no less than 30% of the user's total electricity consumption (to be raised to 35% by 2030).This model offers a new pathway for localized consumption of renewable energy, particularly suited for export-oriented enterprises with decarbonization needs. By removing restrictions on investment entities and clarifying energy share and cost requirements, the policy has effectively stimulated market vitality.

New Distributed PV Grid-Integration Policy

On October 9, 2024, the National Energy Administration issued the Management Measures for Distributed PV Power Generation Development and Construction (Draft for Comment), classifying distributed PV into four categories: residential (natural persons), non-residential, general Commercial & Industrial (C&I), large-scale C&I. Large-scale C&I distributed PV must operate under full self-consumption mode, prohibiting electricity export to the public grid and requiring reverse power protection .General C&I distributed PV may choose either full self-consumption or self-consumption with surplus feed-in. Residential distributed PV may select from full feed-in, full self-consumption, or self-consumption with surplus feed-in modes. Investors must ensure projects are "observable, measurable, dispatchable, and controllable" to enhance grid hosting capacity and regulation capabilities. Distributed PV is permitted to fairly participate in electricity market trading through microgrids and virtual power plants.

By mandating self-consumption for large projects, the policy directly reduces grid impact and alleviates integration pressure. This requirement is expected to stimulate demand for supporting energy storage to increase self-consumption rates and balance generation with load profiles. Through categorized management and technical specifications, the policy guides distributed PV from extensive expansion toward refined and grid-friendly development.

Guaranteed Grid Access & Enhanced Market Mechanisms

On January 22, 2024, the National Energy Administration issued the Key Points for Energy Regulation in 2024, mandating that grid companies provide fair and non-discriminatory grid connection services to renewable energy projects. Specialized supervision was conducted to advance the registration and grid integration of distributed PV, with focused tracking of project filing, grid connection, trading, and settlement to streamline integration procedures. The policy also outlined steps to progressively increase the proportion of renewable energy in market-based trading. Efforts were intensified to establish a sound green power trading mechanism, addressing challenges such as strong corporate demand for green electricity and difficulties in cross-provincial/regional transactions. The development of green power and certificate markets was accelerated to better align market mechanisms with decarbonization goals.

Through targeted supervision, practical issues in distributed PV grid integration-such as prolonged delays, unjustified barriers, and delayed settlements-are being addressed to safeguard investor interests. Via market mechanisms, a broader trading platform for green electricity is established, meeting the green power demands of enterprises-particularly export-

oriented companies-and thereby promoting the absorption of renewable energy on a wider scale.

In February 2025, the National Development and Reform Commission and the National Energy Administration issued the Notice on Deepening Market-Based Reform of New Energy Feed-in Tariffs to Promote High-Quality Development of Renewable Energy. The policy mandates that all grid-connected electricity from renewable sources-including distributed PV-participate in electricity market trading, with tariffs determined by the market. Differentiated measures are applied to existing and new projects, supported by the establishment of a sustainable pricing and settlement mechanism for renewable energy. This reform marks the comprehensive transition of renewable power to market-based trading, enabling tariffs to more accurately reflect market supply-demand dynamics and integration costs. Market-driven pricing signals will guide renewable energy investment toward practical integration conditions and economic viability, thereby preventing uncontrolled development.

5 INDUSTRY

5.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Table 12: Silicon feedstock, ingot and wafer producer's production information for 2024

Manufacturers (or total national production)	Process & technology	Total Production	Product destination	Price
Total	Silicon feedstock [Tonnes]	$182.3*10^4$		
Total	sc-Si wafers [MW]	$775.8*10^3$		

Source : CPIA,2025.5

In 2024, there were 17 polysilicon manufacturers in operation in China, with a national effective polysilicon production capacity of 3.086 million metric tons per year. The top ten enterprises accounted for 87.7% of the total capacity and 92.0% of the total output. The capacity and output of the top ten enterprises increased by 43.8% and 19.5% year-on-year, respectively. Sichuan Tongwei remained the leading enterprise, with an output of 594 800 metric tons in 2024, an increase of 205 800 metric tons compared to the previous year. The combined output of the top six enterprises reached 1.4568 million metric tons, accounting for 79.9% of the national total, indicating a high degree of industry concentration.

By the end of 2024, the silicon wafer capacity of Chinese mainland enterprises reached 1 348.8 GW, accounting for 96.7% of the global total capacity, a decrease of 1.2 percentage points compared to 2023. Monocrystalline silicon wafers (p-type + n-type) held almost 100% of the market share, with p-type monocrystalline silicon wafers dropping to 27.5% and n-type monocrystalline silicon wafers increasing to 72.5%. As downstream demand for n-type monocrystalline products grows, the market share of n-type monocrystalline silicon wafers will continue to rise.

In 2024, the average thickness of p-type monocrystalline silicon wafers remained around 150 μm, consistent with the 2023 level. Due to the continuous decline in polysilicon prices, the impetus for silicon wafer thinning has slowed down. The average thickness of n-type silicon wafers used for TOPCon cells was 130 μm, an increase of 5 μm compared to 2023, while the average thickness of silicon wafers used for heterojunction cells was 110 μm, a decrease of 10 μm compared to 2023.

In 2024, the market shares of 166mm and below, 182mm square, and quasi-rectangular silicon wafers were 1.3%, 23%, and 30% respectively, while the market shares of 210 mm square and rectangular silicon wafers were 19.0% and 26.7% respectively. Currently, rectangular wafers may become the mainstream size in the future, with their market share expected to grow rapidly. However, this still requires continuous validation by the market.

5.2 Production of photovoltaic cells and modules (including TF and CPV)

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

Total PV cell and module manufacture together with production capacity information is summarized in Table below.

Table 13: PV cell and module production and production capacity information for 2024

Cell/Module manufacturer (or total national production)	Technology (sc-Si, mc-Si, a-Si, CdTe, CIGS)	Total Production [MW]		Maximum production capacity [MW/yr]	
		Cell	Module	Cell	Module
Wafer-based PV manufacturers					
Tongwei	**sc-Si**	$89.1*10^3$	$45.95*10^3$	$150.0*10^3$	$85*10^3$
JinkoSolar	**sc-Si**	$73.0*10^3$	$81.77*10^3$	$95.0*10^3$	$130*10^3$
Longi Green Energy	**sc-Si**	$54.3*10^3$	$65.15*10^3$	$105.0*10^3$	$150*10^3$
JA Solar	**sc-Si**	$66.2*10^3$	$67.7*10^3$	$72.0*10^3$	$93.9*10^3$
Trina Solar	**sc-Si**	$55.2*10^3$	$63.24*10^3$	$87.5*10^3$	$117.5*10^3$
Thin film manufacturers					
Hangzhou Longyan	CdTe			390	
Triumph Glass Holding	CdTe			600	
Mingyang Ruike	CdTe			100	

Source：CPIA,2025.5

In 2024, the total production capacity of solar cells in mainland China continued to grow, reaching 1 302 GW, a year-on-year increase of 40%. The actual output of solar cells was approximately 695.1 GW, representing a year-on-year growth of 17.6%. The combined output of the top ten enterprises reached 490.8 GW, accounting for about 70.6% of the nation's total production.

According to data from the “China PV Industry Development Roadmap (2024-2025)”, the conversion efficiency of solar cells in China reached a relatively high level in 2024. N-type cells will be the key battleground for cell manufacturers in the next five years. With advancements in the technical processes of various N-type cell routes and the reduction in production costs, N-type cells are expected to maintain their position as the mainstream cell technology for the foreseeable future, and their efficiency will continue to rise rapidly.

Meanwhile, the industry's relentless pursuit of higher cell efficiency and new product development continues unabated. In recent years, there have been growing discussions around tandem solar cells, with several companies in the sector having begun establishing pilot production lines for tandem cell technology.

In terms of modules, the production capacity in mainland China reached 1 156.5 GW in 2024, accounting for approximately 83.3% of the global total capacity. The output reached 627.5 GW, representing about 86.4% of the global total output, with a year-on-year increase of 109.4 GW in scale and a rise of 1.8 percentage points in share. From the perspective of enterprise production, the industry concentration in the module segment experienced a moderate decline. The market share of the top five enterprises decreased by 2.7 percentage points to 47.4%.

Since 2023, all segments of the China PV industry chain have embarked on a new cycle of technological iteration and capacity expansion centered on n-type cells. N-type cell technologies such as TOPCon, HJT, and xBC have successively achieved mass production. Coupled with the continuous increase in silicon wafer sizes and ongoing optimization of module designs, module power output has achieved remarkable improvement.

In addition to efficiency-enhancing technologies at the cell level, the industry has further improved module efficiency by leveraging advantages in module BOM materials, adopting advanced interconnection technologies, and optimizing module designs to enhance the CTM. Furthermore, technologies such as laser-assisted sintering, SMBB, 0BB, silver-coated copper, steel frames, and composite frames have been employed to reduce manufacturing and material costs of modules.

According to the “China PV Industry Development Roadmap (2024-2025)” released by the CPIA, in 2024, the power output of 72-piece TOPCon monocrystalline cell modules using 182mm square wafers reached 593W. For 66-piece TOPCon monocrystalline cell modules using 182*210mm wafers, the power output reached 619W, while 66-piece TOPCon monocrystalline cell modules using 210mm square wafers achieved a power output of 712W. The power output of 66-piece xBC cell modules using 182*210mm wafers achieved a power output of 645W. The power output of 66-piece HJT cell modules using 210mm square wafers reached 720W.

5.3 Manufacturers and suppliers of other components

After multiple rounds of industrial technological upgrades and market competition consolidation, a stable brand hierarchy has taken shape in China's inverter industry. Currently, there are over 20 active enterprises in the sector with sustained innovation capabilities and economies of scale. Leveraging the advantages of semiconductor industry clusters, R&D investment

intensity that exceeds the industry average, and lower supply chain costs, the Yangtze River Delta and Pearl River Delta regions have gathered over 90% of leading enterprises, including Sungrow Power Supply, Huawei, Sineng Electric, Ginlong Technologies, GoodWe, Growatt, and Deye.

On the pricing front, the domestic market continues to show positive trends, with centralized procurement projects for inverters by central and state-owned enterprises releasing encouraging signals. Meanwhile, the international market is gradually recovering amid adjustments in supply and demand structures. As overseas inventory reduction for inverters nears completion, the market price system is gradually stabilizing.

- **Storage batteries**

In 2024, China's energy storage sector continued to experience rapid growth. According to data from the NEA, by the end of 2024, the cumulative installed capacity of advanced energy storage projects put into operation nationwide reached 73.76 GW/168 GWh, approximately 20 times the level at the end of the 13th Five-Year Plan period and representing an increase of over 130% compared to the end of 2023.

In terms of single-station installed capacity, advanced energy storage power stations are gradually showing a trend toward centralization and large-scale development. By the end of 2024, projects with a capacity of 100 MW or above accounted for 62.3% of the total installed capacity, an increase of about 10 percentage points compared to 2023. Projects in the 10 MW-100 MW range accounted for 32.8%, while those with less than 10 MW accounted for only 4.9%.

In terms of energy storage duration, the share of installed capacity for advanced energy storage power stations with a duration of 4 hours or more has gradually increased, accounting for 15.4% by the end of 2024-an increase of about 3 percentage points compared to the end of 2023. Projects with durations of 2-4 hours accounted for 71.2% of the installed capacity, while those with less than 2 hours accounted for 13.4%.

In terms of technology, lithium battery technology in the new energy storage sector has reached a high level of maturity, accounting for 97.3% of the market. Energy storage technologies such as compressed air, flow batteries, and flywheels are in the promotion and application phase, with significantly rapid growth in installed capacity. In 2024, lithium iron phosphate (LFP) batteries maintained their dominant position in the domestic energy storage market as the leading technology, comprising up to 95.8% of the market. 300MW-level compressed air energy storage technology has entered the phase of large-scale application, while sodium-ion batteries and semi-solid-state lithium batteries have each achieved breakthroughs in hundred-megawatt-hour-scale applications

In 2024, the total installed capacity of energy storage in China's renewable energy pairing projects reached 15.6 GW/42.4 GWh, with the capacity measured in MWh accounting for 38%. In terms of specific application scenarios, "PV + storage" emerged as the largest segment in China's renewable energy pairing projects in 2024, with a scale of 8.4 GW/22.3 GWh, accounting for 53% of the total in MWh terms.

- **Supporting structures**

In 2024, conventional fixed mounting brackets accounted for approximately 8.6% of the total initial investment cost for ground-mounted PV systems in China, representing a year-on-year increase of about 7.5%. For commercial and industrial distributed PV systems, mounting structures constituted around 7.4% of the initial investment cost, showing a year-on-year growth of approximately 17.5%.

Judging from global shipment trends in recent years, tracking bracket manufacturers align more closely with localization patterns. The world's leading tracking bracket companies are predominantly clustered in the United States, Europe, and China.

- **BIPV products**

With the support of relevant national and local policies, the integration of PV power generation systems with buildings has shown a positive development trend. PV modules are also evolving toward building materialization and componentization. Many domestic manufacturers have launched building-integrated PV products. For instance, companies producing crystalline silicon-based building PV modules, such as LONGi, Trina Solar, Sunman, Gaine Solar, GoodWe, Jinko Solar, have developed rooftop PV components based on crystalline silicon technology, enabling the integration of PV modules with building roofs and facades. CdTe thin-film PV module manufacturers, including Longyan Energy, Chengdu CNBM, and Zhongshan Ruike, have also introduced PV modules suitable for building roofs and facades. These products can be customized in different colors and patterns according to architectural needs, with adjustable light transmittance to better meet indoor lighting requirements. Additionally, perovskite thin-film photovoltaic enterprises, represented by Microquanta, leverage material advantages to develop PV modules with colors and textures that align more closely with architectural aesthetics. They are steadily achieving mass production while addressing technical challenges related to product longevity and high stability, making them noteworthy in the industry.

5.4 Recycling

After more than two decades of rapid development, China's PV industry has begun facing module retirements during the 14th Five-Year Plan period as a result of industrial upgrading and equipment renewal, with a significant surge expected in the 15th Five-Year Plan period.

While official data on end-of-Life PV modules is not yet available, forecasts by the PV Recycle Industry Development Center under the PV Committee of the China Green Supply Chain Alliance indicate that under a baseline scenario, end-of-Life PV in China will reach 1 million metric tons by 2030, 12 million metric tons by 2040, and 55 million metric tons by 2050. Under an early retirement scenario, these figures are projected to reach 4 million, 23 million, and 66 million metric tons, respectively. These projections signal the emergence of a substantial recycling market in China in the near future.

On October 18, 2024, China National Resources Recycling Group Corporation Ltd. was established in Tianjin. As the 98th central state-owned enterprise (SOE) directly under the central government, it is the first large-scale enterprise dedicated to resource recycling in China. The group’s business covers the recycling of waste plastics, non-ferrous metal scrap, end-of-life batteries, and end-of-life wind turbines and PV equipment, along with the development of offline resource collection networks. It is positioned to become a primary driving force in advancing China’s PV recycling industry.

6 PV IN THE ECONOMY

This chapter aims to provide information on the benefits of PV for the economy.

6.1 Business value

Table 14: Rough estimation of the value of the PV business in 2024 (VAT is excluded)

Sub-market	Capacity installed [MW]	Average price [Yuan/W]	Value	Sub-market
Off-grid	–	–	–	36.00 billion Yuan
Grid-connected distributed	118 000	2.90	342.4 billion Yuan	342.4 billion Yuan
Grid-connected centralized	159 000	2.63	418.5 billion Yuan	418.5 billion Yuan
Value of PV business in 2024				796.9 billion Yuan

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

In 2024, China's total electricity generation reached 10 086.9 TWh, a year-on-year increase of 6.7%. The generation mix by source was as follows:Hydropower: 1 425.7 TWh, up 10.9%, accounting for 14.1% of the total.Thermal power: 6 374.3 TWh, up 1.7%, accounting for 63.2%.Nuclear power: 450.9 TWh, up 3.7%, accounting for 4.5%.Wind power: 997 TWh, up 12.5%, accounting for 9.9%.Solar power: 834.1 TWh, up 44%, accounting for 8.3%.Both wind and solar power maintained rapid growth. Their combined generation increased by 366.1 TWh year-on-year, contributing 58.1% of the total annual increment in power generation.[1]

7.2 Interest from electricity utility businesses

On February 9, 2025, the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) jointly issued the "Notice on Deepening the Market-Oriented Reform of New Energy Feed-in Tariffs to Promote High-Quality Development of New Energy" (NDRC Price [2025] No. 136) (hereinafter referred to as "Document No. 136"), marking the end of the "fixed tariff" era for new energy and the full entry into a market-driven tariff development cycle. This policy has significant implications for the distributed photovoltaic industry:

Categorized Measures and Grandfathering Policy. Document No. 136 proposes implementing differentiated approaches for existing and new projects, establishing a sustainable pricing settlement mechanism for new energy. It ensures policy continuity for existing projects while stabilizing revenue expectations for new projects.

All New Projects to Enter the Market. Document No. 136 requires that electricity generated from new energy projects (wind and solar power) enter the power market, with feed-in tariffs determined through market transactions. New energy projects can participate in trading by submitting quantity and price offers or accept market-formed prices.

Implementation of Contract-for-Difference Tariffs. Document No. 136 states that after new energy participates in power market trading, a differential settlement mechanism will be established outside the market. The tariff level (hereinafter referred to as the "mechanism tariff"), electricity volume, and implementation period for new energy included in this mechanism will be determined by provincial price authorities in conjunction with provincial energy and power operation departments. For electricity volumes included in the mechanism, the difference between the average market transaction price and the mechanism tariff (whether lower or higher) will be settled by grid companies according to regulations, with the settlement costs incorporated into local system operation expenses.

The introduction of this policy clarifies the direction of market-oriented feed-in tariffs for new energy, implements supportive measures for both existing and new projects, and guides the industry toward healthy and orderly development. The mechanism tariff provides a safety net for photovoltaic tariffs, stabilizing revenue expectations for photovoltaic power stations. However, the new policy may lead to significant changes in existing revenue calculation models, complicate the factors affecting new energy revenues, and impose higher

1 Source: CEC China Electric Power Industry Annual Development Report 2025, National Energy Administration

requirements on power station operations. Meanwhile, under the current new energy tariff mechanism, it will be challenging to replicate scenarios of excess returns for power stations.

7.3 Interest from municipalities and local governments

Different types of photovoltaic projects exhibit distinct regional distribution patterns. Utility-scale PV projects are primarily concentrated in large-scale base projects in Northwest and Southwest China, with significant contributions also from eastern provinces such as Hebei, Shandong, and Guangdong. From 2022 to 2024, the market concentration of newly installed utility-scale PV capacity increased, with the share of the top three provinces rising gradually from 25% in 2022 to 41% in 2024. The commercial and industrial distributed PV market shows a trend toward decentralization, mainly distributed in eastern provinces, with Zhejiang, Jiangsu, Shandong, and Guangdong ranking among the top. From 2022 to 2024, the share of the top three provinces in this segment declined from 54% to 34%. The residential distributed PV market also demonstrates a decentralized development trend, with the installation focus largely completed shifting southward from Henan, Hebei, and Shandong. During 2022-2024, the share of the top three provinces in this segment decreased from 64% to 50%.

8 PROSPECTS

The prospects for China's PV industry are anchored in the clear direction of the “carbon peaking and carbon neutrality” goals. Its pathway involves advancing toward a new phase characterized by more advanced technology, more grid-friendly integration, and more sustainable development, driven by both the national policy framework and market mechanisms. Future growth will place greater emphasis on synergy with the power system. The industry's focus will shift from pure capacity expansion to comprehensive development encompassing technological innovation, system integration, operational efficiency improvements, and global collaboration. China's PV industry remains committed to contributing products, technologies, and solutions for the global energy transition and climate change mitigation through continuous innovation and scaled deployment.

China Aims for Combined Wind and Solar Capacity to Reach 3 600 GW

In a video address at the UN Climate Change Summit, China President Xi Jinping highlighted that 2025 marks both the 10th anniversary of the Paris Agreement and a critical juncture for submitting the next round of nationally determined contributions, underscoring that global climate governance has entered a decisive phase.

By 2035, China aims to reduce economy-wide net greenhouse gas emissions by 7%-10% from their peak-with efforts to exceed this target-and increase the share of non-fossil energy in total energy consumption to over 30%. The combined installed capacity of wind and solar power is projected to reach at least six times the 2020 level, striving to achieve 3 600 GW. Additional goals include expanding forest stock to over 24 billion cubic meters, establishing new energy vehicles as the mainstream of new car sales, extending the national carbon market to cover key high-emission industries, and largely completing the development of a climate-resilient society.

Technological Advancement and Cost Competitiveness

Technological Iteration Continues to Accelerate: Based on industry consensus from the China Photovoltaic Industry Association (CPIA), high-efficiency N-type cell technologies are rapidly becoming mainstream. The industry will continue to focus on improving mass production efficiency. Research and development and pilot-scale production of next-generation cell technologies, such as perovskite/crystalline silicon tandems, will also be a key priority.

PV-Storage Integration Emerges as a Critical Development Pathway: With the implementation of the “14th Five-Year Plan” for New Energy Storage Development, pairing energy storage with PV has become essential for ensuring smooth grid integration and stable operation of projects. Technological advances will focus on achieving longer storage duration, higher safety standards, and more economically viable system solutions.

Digitalization and Intelligence Enable Deep Transformation: Technologies such as AI-powered smart O&M, power forecasting, and drone-based inspection are being widely adopted. These applications are becoming crucial tools for enhancing power plant lifetime generation benefits and reducing the Levelized Cost of Energy (LCOE).

Industry Consolidation and Global Collaboration

Industrial Chain Coordination and High-Quality Development: The PV industry is currently addressing near-term supply-demand structural pressures while promoting coordinated development of production capacity and technological innovation. Companies with advantages

in technology, branding, and capital will play an increasingly significant role through market-based mechanisms, driving optimization of the industrial structure.

Deep Integration into Global PV Supply Chains: As a vital component of the global clean energy supply chain, China's PV industry will continue supplying high-quality, high-efficiency PV products to the global market. Meanwhile, through international production capacity cooperation and technical exchange, Chinese enterprises will collaborate with partners worldwide to further reduce PV costs and advance technologies, contributing to global climate change mitigation.

Emerging Circular Economy Initiatives: As early PV projects gradually approach end-of-life, policy guidance from the Ministry of Industry and Information Technology and other departments is accelerating R&D and industrial-scale demonstration for recycling and reuse of end-of-life PV modules, aiming to establish a greener, more sustainable closed-loop industry.

System Integration Challenges and Solutions

System Integration as the Core Challenge: The fundamental challenge ahead lies in achieving efficient integration and reliable accommodation of high-penetration, variable PV power generation. Addressing this will require a systematic and comprehensive approach.

Grid Infrastructure Enhancement: Continue strengthening inter-regional transmission corridors and developing smart distribution networks.

Diversification of Flexibility Resources: Accelerate deployment of multiple regulatory solutions including new energy storage technologies, pumped hydro storage, coal power flexibility retrofits, and demand-side response.

Market Mechanism Refinement: Establishing mature electricity spot markets, capacity markets, and ancillary service markets represents the fundamental long-term, market-driven approach to addressing integration challenges.