

# 中国的能源发展与 中国-中亚能源合作展望

Overview of China's  
energy development and  
prospects of China-CAREC  
energy cooperation

November 2023



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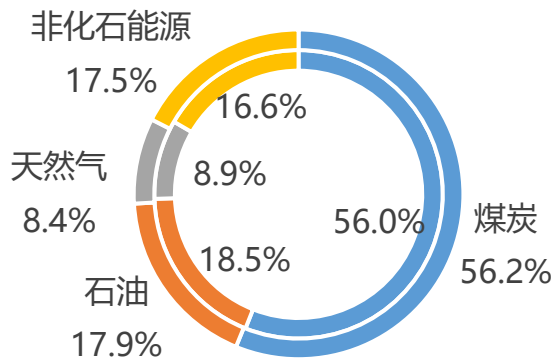
### I. Current Status and Strategic Goal of China's Energy Development

## 二、中国-中亚能源合作展望

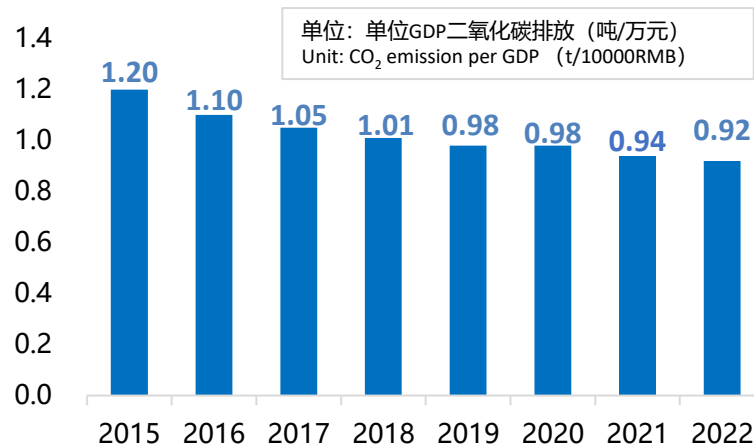
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# 1. 中国能源转型现状 China's energy transition status

**能源绿色转型加快推进。** 2022年，中国非化石能源消费比重达到17.5%，较上年均提高了0.8个百分点，碳排放强度下降了2.1%。**China has been accelerating its paces in green energy transition.** In 2022, the percentage of non-fossil energy consumption reached 17.5%, which has 0.8 percents over 2021. The carbon emission intensity decreased by 2.1% compared to the last year.



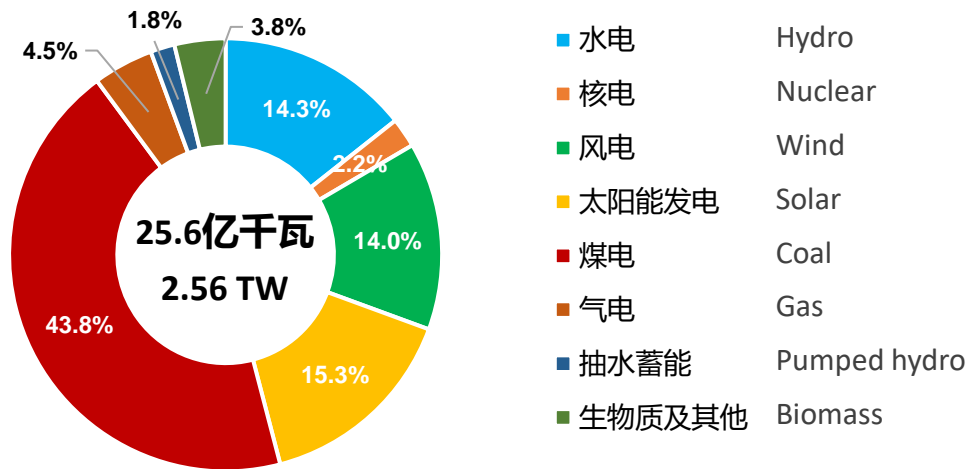
2021年、2022年能源消费结构  
Energy consumption structure in 2020 and 2021



中国2015-2022年碳排放强度  
China's carbon emission intensity in 2015-2022

# 1. 中国能源转型现状 China's energy transition status

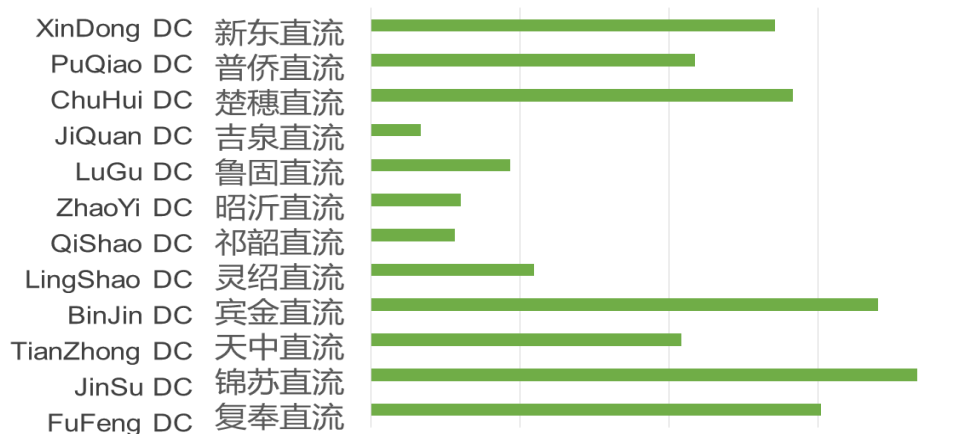
**电力供应保障能力逐步夯实。** 2022年，中国发电装机达到25.6亿千瓦，同比增长7.6%，其中非化石能源装机占比达到51.7%。截至2023年上半年，中国可再生能源装机达到13.22亿千瓦，占比达到48.8%。In 2022, China's installed power capacity reached 2.56TW, with a year-on-year growth of 7.6%, in which non-fossil energy generation percentage reached 51.7%. Up to H1 2023, China's RE capacity reached a new record of 1.322TW, which is 48.8% in the total capacity.



2022年中国电源发电装机 China's Power Capacity by Source in 2022

# 1. 中国能源转型现状 China's energy transition status

**绿色资源配置能力不断加强。** 中国资源禀赋与能源需求呈现逆向分布，为了实现绿色能源在全国范围内的优化配置，中国建成了世界上规模最大、远距离输送能力最强的电力系统，每年将约3000亿千瓦时的绿色电力由西部地区送至东部负荷中心。**China's capacity in ultra long electricity transmission has been constantly enhanced.** To realize the optimal allocation of RE nationwide, China has built the world's largest power system, transmitting about 300TWh of RE yearly from the west to the east of China.



中国主要跨省区域输电通道可再生能源输送电量 Renewable Energy Transmitted by Cross-Provincial Transmission Channels in China

# 1. 中国能源转型现状 China's energy transition status

**电力系统灵活性持续提升。**通过煤电灵活性改造、扩大抽水蓄能和电化学储能装机、提升完善需求侧管理和响应能力等方式有效提升了电力系统灵活性。**China's power system flexibility has been constantly enhanced** by flexibility retrofitting of coal power plants , expanding pumped hydro storage & electrochemical energy storage, and improving demand-side response.



## 煤电灵活性改造超8000万千瓦

**Over 80 GW** coal power has been retrofitted for flexibility.

**6000千瓦及以上火电厂供电标准煤耗降至302.5克/千瓦时**  
Standard coal consumption of coal power unit ( $\geq 600\text{MW}$ ) has been reduced to **302.5 g/kWh**.



## 电力需求侧管理措施不断完善

Demand-side management has been continuously improved.

## 需求侧响应能力持续增强

Demand-side response capacity continues to be enhanced.

## 新能源友好电站、虚拟电厂建设稳步增长

Construction of "system-friendly" renewable power stations and virtual power plants is steadily increased.



## 抽水蓄能装机3669万千瓦

The installed capacity of pumped storage reached **36.69GW**.



## 电化学储能装机400万千瓦

The installed capacity of electrochemical energy storage reached **4GW**.

# 2.中国能源科技创新进展

## Advances in China's Energy Science and Technology Innovation

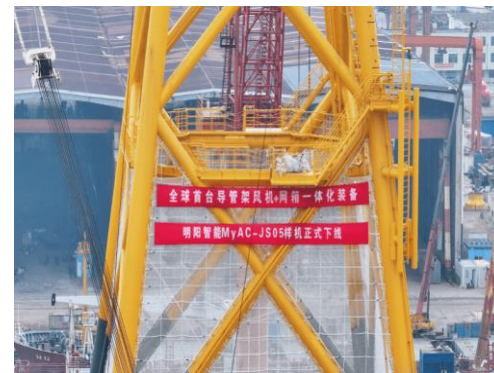
中国大容量风机制造技术国际领先，海上风电技术不断取得突破。一是18MW海上风机已研制成功，多台深远海漂浮式风机已并网。二是正在开展海上风电耦合制氢、海洋牧场等示范项目。China is one of world's leading forces in large-capacity wind turbines manufacturing and offshore wind generation technology. Including 18MW offshore wind turbine, deep-sea floating wind turbines, and offshore wind generation coupling with hydrogen production.



18MW海上风电机组  
18MW offshore wind turbine



7.25MW漂浮式风电机组  
7.25MW floating wind turbine



风渔一体化风电导管架  
Wind-fishery integrated wind power jacket

# 2.中国能源科技创新进展

## Advances in China's Energy Science and Technology Innovation

中国晶硅光伏技术国际领先，钙钛矿光伏产业化进程快速推进，光伏技术在多元化场景中广泛应用。一是TOPCon电池和异质结电池等N型电池已实现规模化生产，BC电池正在实现产业化。二是钙钛矿电池效率达到世界最高的26.1%，已建成百兆瓦级钙钛矿组件中试线。三是光伏电站在荒漠、水面、建筑等场景广泛建设。

China has leading technology in crystalline silicon photovoltaic generation. The industrialization process of perovskite PV is making rapid advances, of which efficiency has reached the world's highest 26.1%. And PV is widely applied in diversified scenarios, including deserts, water surfaces, buildings and others.



异质结电池生产

Heterojunction Cell  
Production



钙钛矿光伏组件

Perovskite Photovoltaic  
Module



水面漂浮式光伏电站

Floating Solar Power Plant



# 2.中国能源科技创新进展

## Advances in China's Energy Science and Technology Innovation

中国先进高参数燃煤发电技术处于国际领先水平，煤电机组灵活调节运行能力和清洁低碳水平正在加快提升。

一是630°C 二次再热煤电机组等高参数煤电机组正在建设。二是煤电机组调峰深度最低达到10%，煤电机组耦合抽汽蓄能等技术提升灵活性。三是正在研发超临界二氧化碳循环发电等新技术。China has leading high-

parameter coal-fired power generation technology. Also, China has been committed to improving the flexibility and carbon emission level of coal-fired units. . First, high-parameter coal-fired power units such as 630°C double-reheat

ultra-supercritical units are under construction. Second, the minimum load of coal-fired power plant reaches as low as 10%. Third, new technologies such as supercritical CO<sub>2</sub> cycle power generation are being developed.



630°C 1000MW超超临界二次再热煤电机组  
630°C 1000MW Double Reheat Ultra-Supercritical  
Coal-fired Power Unit



4MW氨/煤混燃试验台  
4MW Ammonia / Coal Co-combustion  
Test Bench



5MW超临界二氧化碳循环发电机组  
5MW Supercritical CO<sub>2</sub> Cycle Generator

# 2.中国能源科技创新进展

## Advances in China's Energy Science and Technology Innovation

中国已形成世界上输送容量最大、输电电压等级最高、多区域电网交直流混联的电力系统。一是建成世界首个 $\pm 800\text{kV}$ 特高压柔性直流工程。二是开展了 $35\text{kV}$ 柔性低频 $20\text{Hz}$ 交流输电工程示范。三是研制并应用了世界首套 $1100\text{kV}$ 特高压交流气体绝缘金属封闭输电线路 (GIL) 装备等先进电网装备。China has formed a power system with the world's largest transmission capacity, the highest voltage grade, and a mixed AC and DC connection of multiple regions. China has developed its technologies in ultra high voltage AC and DC transmission and flexible DC transmission. First, the world's first  $\pm 800\text{kV}$  flexible ultra high voltage direct current (UHVDC) power transmission system has been constructed. Second,  $35\text{kV}$  flexible  $20\text{Hz}$  low-frequency AC power transmission system has been realized. Third, the world's first  $1100\text{kV}$  ultra high voltage alternating current (UHVAC) gas insulated metal enclosed transmission line (GIL) equipment has been produced and applied.



$\pm 800\text{kV}$  柔性直流输电工程

$\pm 800\text{kV}$  Flexible DC Transmission Project



$35\text{kV}$  柔性低频输电 (20Hz) 工程

$35\text{kV}$  Flexible Low-Frequency Transmission (20Hz) Project



$1100\text{kV}$  特高压GIL装备

$1100\text{kV}$  UHV GIL Equipment

# 2.中国能源科技创新进展

## Advances in China's Energy Science and Technology Innovation

中国以锂离子电池、液流电池和压缩空气储能为代表的新型储能技术国际领先。一是容量300Ah以上的储能电芯已实现规模化生产和应用。二是世界首个百兆瓦级压缩空气储能电站、百兆瓦级全钒液流电池储能调峰电站已投运。三是压缩二氧化碳储能、重力储能等先进储能技术正在开展示范。**Energy storage technologies are developing fast in China, including lithium-ion batteries, flow batteries and compressed air energy storage.** First, the energy storage batteries with a cell capacity of more than 300Ah have achieved large-scale production and application. Second, the world's first 100MW compressed air energy storage power station and 100MW vanadium flow battery energy storage power station have been put into operation. Third, advanced energy storage technologies such as compressed CO<sub>2</sub> energy storage and gravity energy storage are being demonstrated.



100MW压缩空气储能电站

100MW Compressed Air Energy Storage

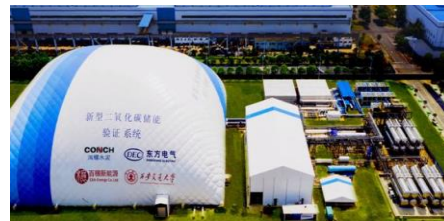
Power Station



100MW/400MWh全钒液流电池储能电站

100MW/400MWh Vanadium Redox Flow

Battery Energy Storage Power Station



10MW/20MWh压缩二氧化碳储能系统

10MW/20MWh Compressed CO<sub>2</sub> Energy

Storage System

## 2.中国能源科技创新进展

### Advances in China's Energy Science and Technology Innovation

中国正在致力于发展绿氢产业，促进绿氢的多场景应用，充分发挥绿氢的碳减排和可再生能源消纳作用。一是万吨级光伏制氢项目已投运。二是世界首个海水无淡化直接电解制氢漂浮式平台海上试验成功。三是氢能正在逐步实现在交通、工业等领域的应用。China is committed to developing green hydrogen (hydrogen generated from renewables) industry, promoting multi-scenario application of green hydrogen. First, the 10,000-ton PV hydrogen production project has been put into operation. Second, the world's first floating platform for direct electrolysis of seawater without desalination was successfully tested. Third, hydrogen energy is gradually being applied in transportation, industry, and other fields.



**万吨级光伏制氢项目碱性电解水制氢厂房**  
10000-ton Solar-coupled Alkaline Electrolysis  
Water Hydrogen Production



**海水无淡化原位直接电解制氢平台**  
Platform for In-Situ Direct Electrolysis of  
Seawater without Desalination



**氢燃料电池动力船**  
Ship Powered by Hydrogen Fuel Cell

### 3. 中国能源转型战略目标 Strategic Goal of China's Energy Development



- 2020年9月22日，习近平主席在第七十五届联合国大会一般性辩论上向世界宣布了中国的碳达峰目标与碳中和愿景：“中国将提高国家自主贡献力度，采取更加有力的政策和措施，二氧化碳排放力争于2030年前达到峰值，努力争取2060年前实现碳中和。”
- At the general debate of the 75th session of the United Nations General Assembly in 2020, president Xi Jinping announced China would aim to achieve **peak CO<sub>2</sub> emissions before 2030 and carbon neutrality before 2060.**

### 3. 中国能源转型战略目标 Strategic Goal of China's Energy Development

到2030年，非化石能源占一次能源消费比重将达到25%左右，风电、太阳能发电总装机容量将达到12亿千瓦以上。

By 2030, China will see significant accomplishments from the comprehensive green transformation in economic and social development, with energy efficiency in key energy-consuming industries reaching advanced international levels.

单位国内生产总值二氧化碳排放将比2005年下降**65%**以上

Carbon dioxide emissions per unit of GDP will drop by more than 65% from 2005

非化石能源占一次能源消费比重将达到**25%**左右

Non-fossil energy will account for 25% of primary energy consumption

森林覆盖率达到**25%**左右，森林蓄积量达到**190**亿立方米

The forest coverage rate will have reached about 25%, and the forest stock volume will have reached 19 billion cubic meters

风电、太阳能发电总装机容量将达到**12**亿千瓦以上

Total installed capacity of wind power and solar power will reach over 1200 GW.

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### I. Current Status and Strategic Goal of China's Energy Development

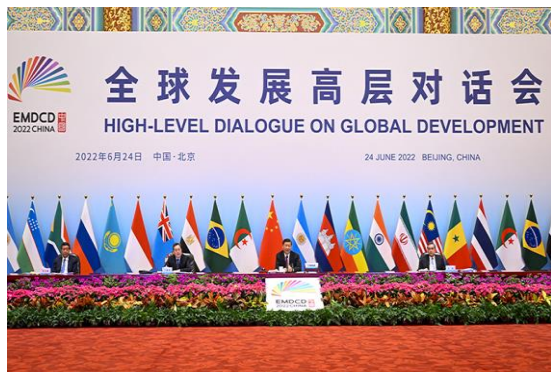
## 二、中国-中亚能源合作展望

### II. Prospects of China-CAREC energy cooperation

# 1. 全球清洁能源合作伙伴关系 GloCEP

2022年6月，习近平主席主持召开全球发展高层对话会，提出推动建立全球清洁能源合作伙伴关系。2023年国际能源变革论坛发起成立国际能源变革联盟，发布《全球清洁能源合作伙伴关系倡议》，为推动全球清洁能源务实合作、助力实现能源安全奠定了坚实基础。

In June 2022, during the High-Level Dialogue on Global Development, President Xi Jinping proposed the initiative of Global Clean Energy Partnership (GloCEP). During the 2023 International Forum on Energy Transition, China released the initiative document of GloCEP and established the International Coalition for Energy Transitions.





## 2. 合作展望 Cooperation Outlook

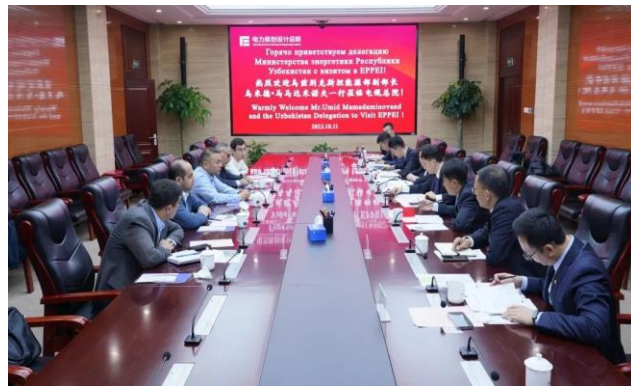
**加强政策沟通。** 建议在双边合作机制下，建立清洁能源联合工作组，做好清洁能源合作的顶层设计和规划；鼓励企业和智库机构搭建清洁能源合作平台，推进全方位、多层次的交流合作。

**Enhance policy communication.** To establish bilateral cooperation mechanisms and joint working groups on clean energy. To sign agreements on clean energy cooperation. To launch government-business forum covering enterprises and think tanks.



## 2. 合作展望 Cooperation Outlook

中国智库单位协助开展乌兹别克斯坦国家电力系统规划研究。受乌兹别克斯坦共和国能源部委托，电规总院将与乌能源部、乌国家电网公司等成立联合工作组，对乌全国电源和电网发展开展系统分析和规划研究工作，重点聚焦电源装机结构优化、适应高比例可再生能源消纳的电网升级规划、多类型储能规划、高压直流输电技术适应性研究等，为乌电力系统转型发展提供技术、政策、标准等专业化建议。Chinese think tanks assisted in research on Uzbekistan's national power system planning. The two sides will set up a joint working group focusing on the optimization of the installed power capacity mix, the high percentage RE-integrated grid upgrading, the energy storage deploying planning, and the adaptability of HVDC transmission technology.



## 2. 合作展望 Cooperation Outlook

**进一步深化清洁能源全产业链合作**，探索清洁能源产业合作和投资、建设、运营合作相结合的模式，助力中亚国家搭建具有竞争力的清洁能源产业链。

**Deepen cooperation across the clean energy industry chain.** Explore cooperation models that combined industrial and investment, engineering, and operating cooperation in clean energy, so as to help Central Asian countries build a competitive clean energy industry chain.



## 2. 合作展望 Cooperation Outlook



**Nur Navoi Solar Power Project, Navoi District, Uzbekistan**  
**乌兹别克斯坦纳沃伊地区努尔纳沃依太阳能发电项目**

1

2



**Photovoltaic Power Station Project**  
**in Gobustan, Azerbaijan**  
**阿塞拜疆戈布斯坦光伏电站项目**

3

4



**Zhanatas 100 MW Wind Farm, Kazakhstan**  
**哈萨克斯坦扎纳塔斯100兆瓦风电项目**

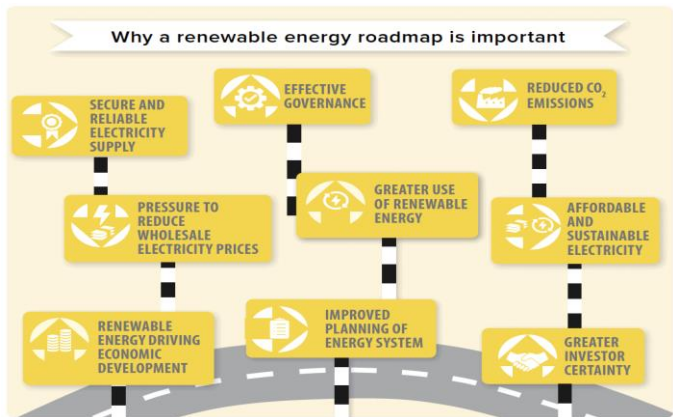


**Karot Hydropower Project, Pakistan**  
**巴基斯坦卡洛特水电项目**

## 2. 合作展望 Cooperation Outlook

**加强能力建设和技术交流**，围绕清洁能源合作议题开展经验交流和互学互鉴，助力中亚国家增强绿色能源领域人才的全方位储备，为中亚清洁能源快速发展提供人才支撑。

**Capacity building and technology communications.** It's necessary to exchange experience and learn from each other on clean energy cooperation issues so as to provide talent support for the rapid development of clean energy in CAREC countries.



**谢谢!**

**Thanks!**