



Promoting China–Africa
Cooperation in Renewable Energy
Industry:
**Opportunities, Challenges and
Pathways**

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ABSTRACT

Africa has a large and rapidly growing population, and energy demand will gradually increase with economic development and improved living standards. Moreover, Africa is rich in renewable energy resources and has the conditions necessary to achieve leapfrog development in the energy sector. Currently, responding to climate change and achieving energy transformation are common tasks for all countries. The renewable energy industry is considered an important stimulator for economic development, helping Africa address the dual challenges of energy shortage and climate crisis, while promoting long-term, efficient, and green development.

Chinese renewable energy development has undergone a process of transformation "from zero to one, from weak to strong," accumulating a wealth of industry development experience. From the perspective of industry cooperation, China can provide effective development experience and valuable enterprise resources for African countries. China–Africa cooperation in renewable energy has significant potential and can contribute positively to both Africa's development and global low-carbon growth. Firstly, China proposed the "Global Development Initiative" with the aim to build a global community of shared development and to accelerate the implementation of the 2030 Agenda for Sustainable Development. Secondly, as the largest developing economy, China, like Africa, cannot follow the path of development first and emission reduction later, as adopted by developed countries. China needs to consider improving the quality of development and achieving high-level economic growth with low emissions. Finally, the cooperation experiences can provide references for other developing economies, accelerating global energy transition, and enhancing climate resilience.

This report aims to analyze the advantages and challenges of renewable energy industries in typical African countries, in conjunction with the development

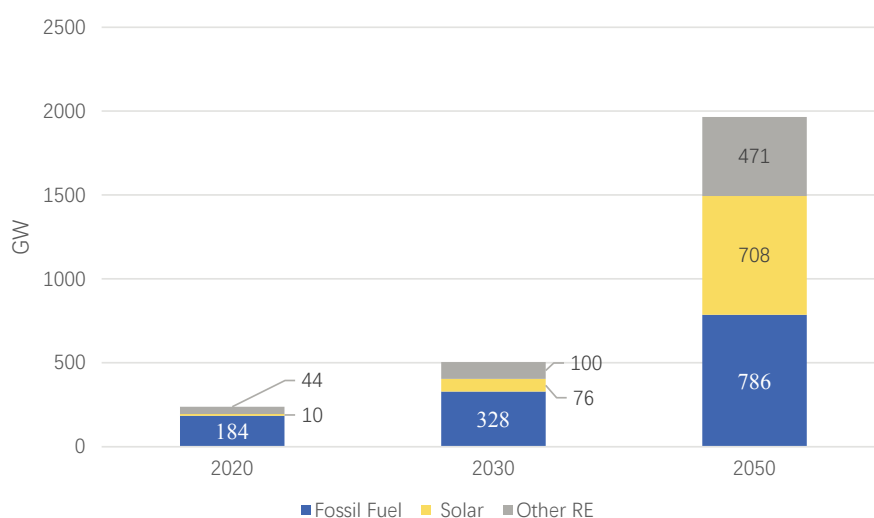


of local renewable energy industries in Africa and China's experience in renewable energy industries. Based on this analysis, the report proposes relevant ideas and suggestions for China–Africa cooperation to promote Africa's leapfrog development in the energy sector. This report is a concise presentation of the phased research results of the "African Renewable Energy Industry Development Initiative." In the subsequent work, we will delve deeper into African countries' abilities to develop renewable energy industries and the paths of China–Africa cooperation, and publish the complete research results.

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I. Africa has huge renewable energy development potential; large-scale development of renewable energy industry will promote economy, energy, employment, and other multiple growth in Africa.

With a rapidly increasing population and economic growth, urbanization and industrialization in Africa will significantly boost energy and electricity demand. Renewable energy will play the most crucial role in Africa's future energy and power development due to its rapidly falling cost, the global commitment to tackle climate change, and the significant power needs of nearly 600 million people who remain without access to electricity in Africa. According to the forecast, Africa's installed electricity capacity will reach 1,965 GW by 2050, more than eight times that of 2020. This includes 1,179 GW of renewable energy capacity, which is 1,125 GW more than in 2020.




Source: Enerdata.

* Other RE include hydropower, bioenergy, and geothermal energy

Forecast for installed electricity capacity in Africa, 2020–2050

In addition to providing clean energy, proactive development of renewable energy and appropriate planning of its related industries will bring significant benefits to Africa¹, including:

¹ Source: McKinsey & Co

	<p>Stimulating economic growth</p>	<p>Africa's average annual GDP growth rate from the energy transition is about 6.4% between 2021 and 2050.</p>
	<p>Creating employment opportunities</p>	<p>By 2030, Africa is expected to create between 8 million and 14 million employment opportunities.</p>
	<p>Promoting trade balance</p>	<p>Sub-Saharan Africa's fuel imports are equivalent to about 2% of its GDP. Achieving energy self-sufficiency would reduce the trade deficit of many African countries.</p>
	<p>Improving living standard</p>	<p>Currently, about 60 million people in Africa have access to electricity through off-grid solutions. Improved electricity accessibility will further boost agriculture, modern medical service, education, and industrial development in Africa.</p>

II. Different African countries have similarities and differences in terms of renewable energy resources, industrial foundations, and economic and environmental conditions. Six representative countries are selected to analyze the advantages and challenges of developing a renewable energy industry in Africa and to provide corresponding cooperation recommendations.

The numerous countries in Africa have significant differences in resources, development characteristics, and economic conditions. Based on a preliminary study on the developmental basis and implementation conditions of Africa's renewable energy industry, this report selects six representative countries – South Africa, Egypt, Kenya, Morocco, Ghana, and Nigeria for further analysis. The advantages and challenges of implementing renewable energy manufacturing industry in these countries are analyzed in terms of market demand, raw material availability, labor productivity, human resources, infrastructure, technology accessibility, capital intensity of each industrial unit, supporting policies and regulations, production competitiveness, access to electricity, trade relationships with China, and the maturity

of complex manufacturing.

South Africa	
<ul style="list-style-type: none"> · South Africa's total primary energy consumption has been on a fluctuating upward trend since 2012, reaching a peak in 2019. In recent years, South Africa's power tension has become increasingly serious, with repeated power cuts and restrictions. In 2021, South Africa's power generation capacity of 214,437 GWh fell to the lowest level in recent years. · South Africa's power structure is dominated by fossil fuels, with coal power accounting for 85.6%. The installed capacity of renewable energy generation has gradually increased, and its contribution to power generation has steadily risen. · South Africa has released a renewable energy white paper, feed-in tariff policy, Renewable Energy Independent Power Producer Programme (REIPPP), and set renewable energy development targets and low carbon emission reduction strategy to promote the development of renewable energy. 	
Advantages	Challenges
<ol style="list-style-type: none"> 1. Abundant Solar energy resources and great potential for RE development; 2. The government places importance on the construction of power infrastructure. There has been rapid growth in investment in clean energy power generation; 3. Emphasis on the localization of the manufacturing industry. Several renewable energy manufacturing plants have been established; 4. Frequent trade cooperation with China. South Africa is a key investment country of China in Africa. 	<ol style="list-style-type: none"> 1. The business environment, security, and government decision-making efficiency still need improvement; 2. The economic growth rate has slowed down in recent years, and economic development faces certain challenges. There is high exchange rate volatility, and a deep debt crisis for the national power company; 3. Aging power infrastructure limits South Africa's ability to expand power supply; 4. Inadequate supply of talents in the renewable energy industry.
Recommendations	
<ol style="list-style-type: none"> 1. Provide more opportunities for private companies and foreign investors to participate and simplify the bidding and regulatory process. 2. Create a favorable business environment, improve the efficiency of project approval, speed up the approval process, and eliminate corruption. 3. Enhance the knowledge and skills of South African workers in the renewable energy area. 4. Strengthen investment in the infrastructure of the national power sector to meet the demand for renewable energy generation and ensure stable and secure power supply. 	

Egypt

- Egypt's total primary energy consumption has been on a gradual upward trend since 2012, with a significant rise in total energy consumption.
- Egypt has a large and continuously growing population and a surge in electricity demand. Its power generation structure is dominated by natural gas. The single electricity structure is not conducive to a safe and stable power system and low carbon development.
- Egypt's Strategy for Sustainable Energy 2035 proposes that by 2035, more than 42% of electricity in Egypt will be generated by renewable energy.
- Egypt has introduced competitive bidding, feed-in tariffs and independent power producer models for private development of renewable energy projects.

Advantages

1. Favorable business environment and reduced exchange restrictions;
2. Abundant wind and solar energy resources;
3. Emphasis on green investment, including the establishment of green investment plans and issuance of green bonds;
4. Better and complete infrastructure. The power grid has basically covered the whole country and achieved universal access to electricity. Emphasis on cross-border power grid construction;
5. Sufficient human resources with both low-end and high-end labor. Competitive salary.

Challenges

1. The political environment faces challenges;
2. Aging electricity transmission lines;
3. Poor construction conditions due to its desert location and hot weather;
4. High level of localization requires better matching between an enterprise's labor demand and the local labor resources;
5. A mature business model with high market competition, the cooperation model between China and Africa in renewable energy is singular.

Recommendations

1. Implement design optimization, technological innovation, intelligent control systems, and flexible project construction management to improve construction efficiency and equipment performance.
2. Improve the technical and management skills of laborers in the renewable industry and build localized management teams.
3. Expand the scale of participation of Chinese enterprises in the Egyptian renewable energy industry. Chinese financial institutions are suggested to provide more financing support to renewable projects.

Kenya	
<ul style="list-style-type: none"> · Kenya primarily relies on hydropower and geothermal power generation, while importing petroleum to meet the growing demand for electricity. There are rainy and dry seasons in Kenya, the periodic droughts lead to an unstable supply of hydropower. · Kenyan government is gradually increasing the proportion of geothermal, wind, and solar power in the energy structure, while reducing expensive heavy oil–fired generation to provide more power and reduce electricity costs. · In 2018, Kenyan government launched the "Kenya National Electrification Strategy", which gives priority to the development of off–grid power, microgrids, and independent solar power systems, highlighting the key role of the private sector in providing off–grid solutions to remote areas. · Kenya has a strong commitment for clean energy development and plans to achieve 100% renewable energy generation by 2030. 	
Advantages	Challenges
<ol style="list-style-type: none"> 1. About one–third of installed capacity is owned and operated by independent power producers in Kenya, which is very active; 2. Abundant solar resources and high potential community demand for off–grid solar power; 3. Well–developed logistics hub with extensive air connections to the rest of Africa, Europe and Asia. 	<ol style="list-style-type: none"> 1. Investment inconvenience. Excessive investment requirements create obstacles to the entry of foreign investment; 2. Infrastructure needs to be upgraded and renovated, large electricity losses due to aging transmission and distribution network; 3. Complex land ownership regulations; opposition from community residents creates obstacles to renewable development; 4. Less competitiveness for high energy demand industries due to high electricity prices.
Recommendations	
<ol style="list-style-type: none"> 1. Optimize its investment and financing environment, improve relevant laws and regulations, simplify investment entry procedures, and reduce administrative approval steps. 2. Introduce incentive policies for renewable energy development. 3. Focus on active cooperation with local communities, increase community participation in renewable energy projects, and achieve a win–win result. 4. It is suggested to adopt a multi–energy complementary power supply to tackle the power insufficiency, such as a wind–solar complementary power supply system, hydropower and photovoltaic complementary power generation, hydropower and wind energy storage, to increase power supply and power stability. 	

Morocco	
<ul style="list-style-type: none"> · Morocco's energy and electricity consumption is on a continuous growth. From 2011 to 2020, Morocco's energy consumption increased by 11.5% while the electricity consumption increased by 29%². · The Moroccan government has set an aggressive renewable energy development goal and implemented it effectively. In 2021, Morocco's installed renewable energy capacity reached 37.69%, including 1,460 MW of wind power, 787 MW³ of photovoltaic, and 1,322 MW of hydropower. Morocco's current renewable energy development goal is that the installed renewable energy capacity will account for 52% by 2030 and 80% by 2050. · After the COVID–19 pandemic, Morocco has formulated the "Industrial Recovery Plan 2021–2023" and "Tatwir Green Growth Program" to stimulate economic recovery and development, promote the renewable energy sector development and industrial decarbonization. 	
Advantages	Challenges
<ol style="list-style-type: none"> 1. High market potential. Positive domestic development goals, and a broad export market prospect; 2. The political situation, economic prospects, business environment and other macro and external conditions are stable and promising; 3. Good manufacturing foundation. They already have green manufacturing links such as solar photovoltaic modules, wind turbine blades, electric vehicle assembly and etc; 4. High quality and sufficient labor force. 	<ol style="list-style-type: none"> 1. Restrictions on the local content of exported products. The value–added rate of processing trade must reach 40% or more before it is considered a Moroccan product; 2. Labor constraints, including a lack of skilled workers, and uncompetitive labor costs as a developing country; 3. Government efficiency needs to be improved; 4. Foreign investment enterprises face certain barriers due to local protectionism.
Recommendations	
<ol style="list-style-type: none"> 1. Increase the localization proportion by introducing industrial chain links with higher processing added value. 2. Strengthen the training of local skilled workers and take comprehensive consideration of labor costs. 3. Priority is suggested to be given to export processing industries for foreign markets or industries that help Morocco extend its industrial chain. 4. Promote the cooperation between internationally advanced companies and local companies. 	

² Source: IEA

³ Source: Bloomberg NEF

Ghana	
<ul style="list-style-type: none"> · Ghana's energy and electricity consumption is on a rapid growth. From 2011 to 2020, Ghana's energy consumption increased by 57.4% and electricity consumption grew by 140%⁴. · The share of installed natural gas has increased significantly and the share of installed renewable energy has decreased, while the solar photovoltaic installation is growing rapidly. To address the power shortage, Ghana has dramatically increased natural gas power generation from 2018, leading to a decline in the share of large-scale hydropower installations. However, in the same period, PV has rapidly expanded from 6 MW in 2014 to 249 MW in 2021⁵. · Since 2019, "Renewable Energy Overall Planning" and subsequent policies have been introduced to promote the large-scale development of renewable energy in Ghana and encourage local manufacturing of renewable energy products. 	
Advantages	Challenges
<ol style="list-style-type: none"> 1. Political stability and good governance; 2. Sufficient labor forces and competitive labor prices; 3. Excellent manufacturing foundation. Ghana's medium and high-technology manufacturing industry is valued at about USD 7 billion, including green manufacturing industries such as conductors and cables. 	<ol style="list-style-type: none"> 1. Basic Infrastructure needs improvement; 2. Limited financing capacity to enhance the scale of renewable energy development; 3. Lack of technical talents in the renewable energy sector; 4. Exchange rate fluctuation.
Recommendations	
<ol style="list-style-type: none"> 1. Consider giving priority to renewable energy products at ports to facilitate the import of renewable energy products or components. 2. Innovate financing mechanisms, improve laws and regulations related to renewable energy financing, and enhance financing capacity. 3. Promote technical personnel training through international cooperation, demonstration projects, and partnerships to meet the demand for renewable energy talents at multiple levels. 	

⁴ Source: IEA

⁵ Source: Bloomberg NEF

Nigeria

- Nigeria's energy and electricity consumption shows a continuous growth. From 2011 to 2020, Nigeria's energy consumption increased by 21.6% and electricity consumption increased by 18.4%. The share of electricity consumption in total energy consumption was as low as only 1.7% in 2020⁶.
- Electricity generation installation is dominated by natural gas, and the rapid growth of photovoltaic installation drives up the overall share of renewable energy. In 2021, 708 MW of installed photovoltaic capacity in Nigeria was 4.3 times more than in 2018. The rapid increase in photovoltaic installation drives the share of renewable energy from 16.3% in 2018 to 19.8% in 2021⁷.
- Nigeria has set aggressive emission reduction and renewable energy development goals, but with poor implementation. Nigeria is committed to achieve net zero emissions by 2060, its renewable electricity installation will account for 23% by 2025, including 2,000 MW of installed small hydropower, 500 MW of installed solar PV, 400 MW of biomass power, and 40 MW of wind power. However, due to delays in supporting policies by government, Nigeria currently has a long way to achieve its renewable energy goals.

Advantages

1. Large market volume and potential. Nigeria is the most populous country in Africa, with a low electricity access rate. The lack of electricity supply creates a huge demand for distributed renewable energy systems;
2. The Nigerian government encourages foreign investment with fewer restrictions;
3. Close trade relations with China and a solid cooperation foundation;
4. Low labor cost.

Challenges

1. Government efficiency in policy-making needs improvement;
2. National and social security risk;
3. Infrastructure conditions need improvement;
4. Foreign investment restrictions in the power sector;
5. Difficulties in financing utility-scale projects;
6. Exchange restrictions.

Recommendations

1. Accelerate the formulation and introduction of renewable energy-related policies through international cooperation, learning from other countries' experiences, and process simplification.
2. Implement the electricity pricing reform policy as soon as possible while improving the financial structure and reducing debt of utilities and enhancing the guarantees and credibility of utilities as counterparties.
3. To assess the amount of funding needed to meet renewable energy goals and actively innovate financing strategies and channels.
4. Strengthen the training of security guards, technical workers, and maintenance personnel.

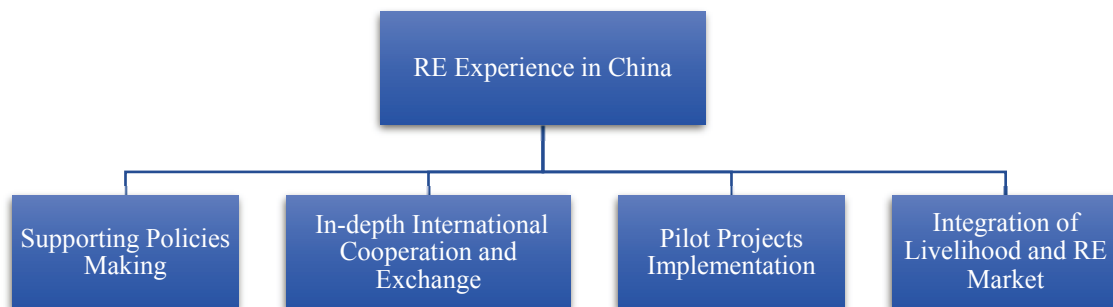
⁶ Source: IEA

⁷ Source: Bloomberg NEF

III . China's experience in renewable energy development, its advantages within the renewable energy industry chain, and its close multi-level, multi-field cooperation with Africa position China as an important partner in supporting Africa's renewable energy industry development. This partnership allows China to provide talent, technology, financing, and additional support to Africa.

(1) China's experience in renewable energy development and its reference to Africa.

China has achieved remarkable success and amassed valuable experience in providing clean energy to rural communities, developing renewable energy on a large scale, and achieving global leadership in renewable energy development. China's experiences offer a robust example for African countries dealing with similar challenges.



● **Supporting policies making**

Policy Name	Policy Summary	Main Points
<p>The Renewable Energy Law</p>	<p>The Renewable Energy Law was formally implemented on January 1st, 2006 and amended in 2010. The law contains five key systems and introduces preferential tax and funding policies. These policy incentives have increased the rate of return on investment for renewable energy projects, attracting more investors to build renewable energy projects, and promoting the development of the wind power and photovoltaic industry chain.</p>	<p>Renewable Energy Target Policy: The renewable energy target policy conveys a clear signal to developers, investors, and other market participants about the expected growth of the renewable energy market.</p> <p>Mandatory Grid Connection/Full Purchase Guarantee System: Requires all power grid companies to fully purchase and integrate renewable energy into the transmission system.</p> <p>Classification Electricity Tariff System: Guarantee the “on–grid electricity price”⁸ for renewable energy provides sufficient returns on investment for investors and developers.</p> <p>Expenses sharing/Compensation System: Users share the cost burden by charging additional fees per kWh of electricity.</p> <p>Special Funds/Fund System: Set up special funds to enhance the attractiveness of renewable energy to investors through user fees and national budget contributions.</p> <p>Tax and Funding Preferential Policies: Including value–added tax preferential policies, income tax preferential policies, and land–use tax exemptions.</p>

⁸ When the Renewable Energy Law was implemented on January 1, 2006, there was no on–grid electricity price. The on–grid electricity price here refers to the price of electricity sold by power plants to the power grid, which is approved by the National Development and Reform Commission on a case–by–case basis. The on–grid price replaced the biomass grid price in 2006, the wind energy in 2009, and the solar photovoltaic in 2014.

Policy Name	Policy Summary	Main Points
RE Development Plan	<p>The "Medium and Long–Term Renewable Energy Development Plan" clearly outlines the guiding principles, main tasks, key areas, safeguard measures, overall goals, and the target of achieving a 15% renewable energy consumption rate in China by 2020.</p>	<p>During the period of "11th to 14th Five–Year Plans" for renewable energy development, the Chinese government has implemented various policies, including grid subsidy prices for several renewable energy technologies and national and provincial–level funding subsidies, to promote the development of renewable energy. In addition, the Chinese government:</p> <p>I: Adjusted policies and incentives by adopting quality standards, improving grid specifications, reducing interference with the grid, and overcoming resistance from existing public utilities.</p> <p>II: Increased research and development efforts by developing wind turbines that are suitable for the unique characteristics of wind power generation in China and meeting international standards.</p> <p>III: Cultivated design and operation capabilities for wind and solar power stations.</p> <p>These measures have addressed issues such as product quality, engineering quality, curtailment, and power station operation, laying the foundation for sustained and healthy development of renewable energy in China on a large scale.</p>

Policy Name	Policy Summary	Main Points
Renewable Energy Standard	China has developed renewable energy standards, which ensure the quality of renewable energy products and renewable energy projects. The standardization has lowered the costs of renewable energy products than before.	<p>In May 2010, the National Energy Administration released the "Wind Power Standard Construction Work Rules", the "Wind Power Standardization Technical Committee Charter", and the "Wind Power Standard System Framework" to promote the healthy and rapid development of the wind power industry and to establish and improve the wind power standardization system. The Energy Industry Wind Power Standardization Technical Committee is tasked with organizing and managing wind power standardization technology.</p> <p>In April 2017, the Ministry of Industry and Information Technology issued the "Comprehensive Standardization Technical System for the Solar Photovoltaic Industry", mandating the preliminary development of the photovoltaic industry standardization system by 2020. The framework primarily includes seven directions and 35 sub-categories, encompassing basic standards, photovoltaic manufacturing equipment, photovoltaic materials, photovoltaic cells and modules, photovoltaic components, photovoltaic power generation systems, and photovoltaic applications. Presently, there are approximately 200 existing national and industry standards for China's photovoltaic industry.</p>

● In-depth International Cooperation and Exchange

Continuous and in-depth international cooperation has played an essential role in the development of China's renewable energy industry. Through bilateral and multilateral international exchanges and collaborations, China has accessed advanced policy concepts and leading technological knowledge, cultivating a strong core team of renewable energy experts who continue to participate in Chinese policy–

making and project implementation related to renewable energy.

Overview of Important International Cooperation Projects and Achievements in Different Periods in China.

Project	International Technology Cooperation Projects	China’ s Renewable Energy Scale Development Project Phase I (CRESP I)	China–Denmark Renewable Energy Development Project
Period	1986–1990	2000–2011	2009–2014
Partnership	UNDP, Canada, Germany	World Bank, Global Environment Facility	Denmark
Key Achievements	The project pursued a development path that involved absorbing foreign advanced technology, which led to the successful development of copper and aluminum vacuum tube collectors. This significantly boosted the utilization and popularization of solar water heaters in China.	The project made a series of important progress: 1. By adopting measures such as cost–sharing, secondary grants, and establishing standards, it played a pivotal role in fostering the rapid growth and quality improvement of wind power in China. 2. It contributed significantly to the establishment of laws, regulations, and policy frameworks related to the large–scale development of renewable energy in China. This prompted the government to increase its investment and support for renewable energy development during the Eleventh Five–Year Plan period.	The project enhanced the Chinese government's capacity for policy–making in renewable energy development and climate change response, leading to the establishment of the National Renewable Energy Center (CNREC). Serving as a national renewable energy decision–making body, CNREC has completed significant works since 2012, such as the "Twelfth Five–Year Plan for Renewable Energy Development" and the "2050 China Sustainable Energy Development Strategy."

● Large–scale RE development promoted by pilot projects

The Chinese government advances renewable energy development through the

construction of large–scale wind power bases and pilot projects such as the "Golden Sun" and "Leadership" programs. These initiatives aim to increase the development scale and drive technological innovation in renewable energy.

Large Wind Power Bases. In 2009, China initiated preparations for large–scale wind farms with plans to build seven 10 GW–level wind energy bases across six provinces and regions. These large wind energy bases have created a substantial market for wind power in China, propelling the development of the wind turbine manufacturing industry and subsequent technological and industrial advancements.

Golden Sun Demonstration Project. Initiated in 2009, this project aims to promote technological advancement and scaling up of solar photovoltaic, accelerate innovative photovoltaic applications, support the demonstration of solar photovoltaic in various fields, and expand the photovoltaic market to encourage the manufacturing of higher quality equipment. The Golden Sun Demonstration Project has attracted many developers and energy service companies and has fostered a burgeoning photovoltaic manufacturing industry.

Leadership Plan. In 2015, the National Energy Administration launched the "Leadership" program to support experimental and innovative photovoltaic demonstration projects. This plan has reduced investment costs and hastened the adoption of technology breakthroughs and technological innovations in a rapidly growing market.

● **Integration of livelihood and RE market development**

The development of renewable energy in China emphasizes a close integration with people's livelihood. The implementation of photovoltaic projects in rural areas without electricity supply provides market opportunities for production enterprises. This widens production scale, enhances technology and management levels, reduces costs, and drives the development of other industries in townships.

"Agri–Photovoltaic Complementarity" Helps Rural Revitalization, Dongxiang, Gansu⁹



Dongxiang County in Gansu Province adopts the cooperation mode of "enterprises + farmers" and actively promotes the construction of "agri–photovoltaic complementarity" project according to local conditions. "Photovoltaic power generation plus agricultural planting" can generate clean power, also develop agriculture facility, flowers planting, vegetables and other crops, improve the efficiency of land output, effectively increase farmers' income, and contribute to rural revitalization.

(2) Advantages of China's renewable energy industrial chain can facilitate the development of local manufacturing in Africa

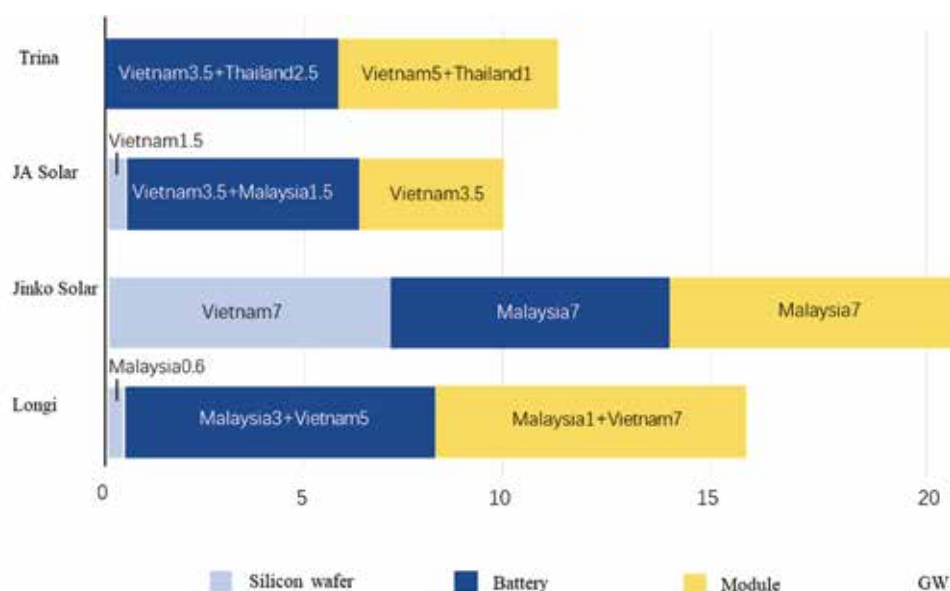
China's renewable energy industry leads the world in terms of development and utilization scale, technology, equipment, and diversified applications. Its competitive advantages, such as low cost and strong applicability, can meet the diverse needs of Africa's renewable energy sector development.

China owns comprehensive renewable energy industry chains with global competitiveness. China has formed a relatively complete wind and solar power technology and industry system, with world–leading independent design and manufacturing capacity. A fully integrated manufacturing industry chain has effectively driven the sustained reduction of wind and photovoltaic power generation costs. China's abundant technology, talent, and production capacity reserves in the renewable energy industry can assist Africa in establishing a green manufacturing

⁹ "Agri–Photovoltaic Complementarity" Helps Rural Revitalization, Dongxiang, Gansu, http://www.gov.cn/xinwen/2021-05/13/content_5606266.htm#1

industry based on local resource conditions and market demand.

China is already building production capacity overseas. Since 2015, Chinese companies have been enhancing renewable energy production capacity overseas, mainly in Southeast Asia. As of early 2022, China's four leading suppliers of clean energy components: Longi, Trina, JA Solar, and Jinko Solar, all have manufacturing capacities in Southeast Asia. Additionally, Chinese companies have begun to address Africa's renewable energy manufacturing. In 2022, the 325MW PV module production base, jointly built by Talesun PV and ARTsolar, was put into operation in South Africa¹⁰. In 2023, the China YaHua Group signed a cooperation agreement with South Korea's LG New Energy to build a joint venture plant in Morocco for producing lithium hydroxide¹¹.



Source: CaiJing Magazine.

Production capacity of China's leading photovoltaic enterprises in Southeast Asia

China is transferring renewable energy technology through South–South cooperation and other projects. In 2016, China launched the Ten Hundred Thousand Initiative on Climate Change for South–South Cooperation. This initiative aims to promote low–carbon development and international cooperation in developing

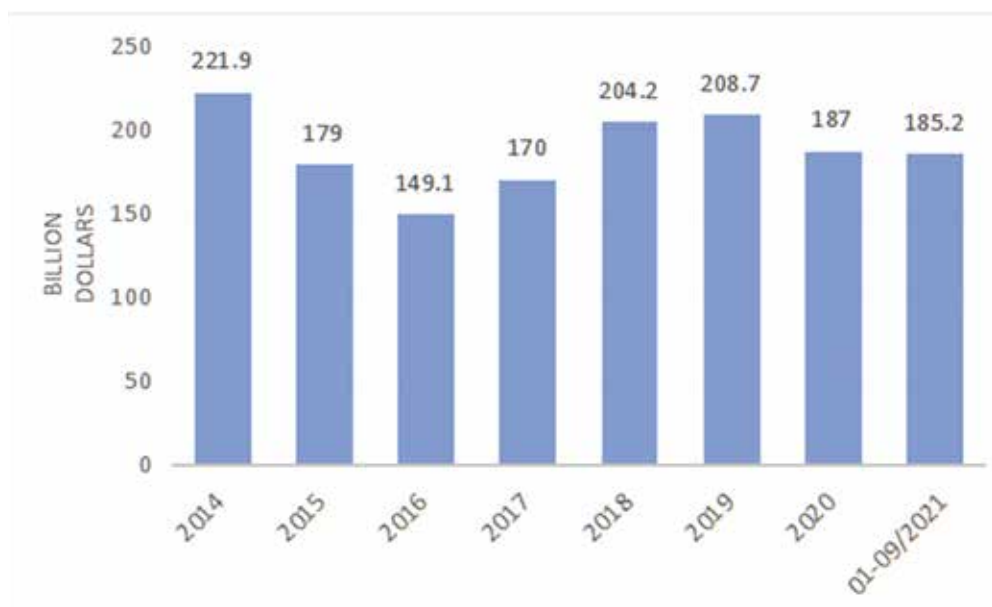
¹⁰ South Africa ARTsolar and Talesun PV Strengthen Deep Cooperation. <https://www.talesun.com/%e6%90%ba%e6%89%8b%e5%89%8d%e8%a1%8c%ef%bc%81%e5%8d%97%e9%9d%9eartsolar%e4%b8%8e%e8%85%be%e6%99%96%e5%85%89%e4%bc%8f%e5%8a%a0%e5%bc%ba%e6%b7%b1%e5%ba%a6%e5%90%88%e4%bd%9c%ef%bc%81/>

¹¹ LG New Energy signed an agreement with China YaHua to jointly produce lithium hydroxide in Morocco. <https://www.investgo.cn/article/yw/alfx/202304/663759.html>.

countries while enhancing their financing capacity. In 2019, China established the Technology Transfer South–South Cooperation Center, which provides sustainable development technology solutions to its South–South partners. The center aims to create a technology demonstration and promotion hub and share China's technological innovation and development experience with countries participating in the Belt and Road Initiative.

(3) China and Africa have close trade relations and a solid foundation for cooperation

The robust economic and trade ties between China and Africa provide a solid basis for promoting cooperation in the renewable energy sector. China has been Africa's top trade partner for 13 consecutive years since 2009, and its share in Africa's overall international trade has consistently increased, surpassing 21% in 2020. By the end of 2020, Chinese companies had accumulated over 43 billion U.S. dollars in direct investment in Africa, with private companies gradually becoming major investors.



Data source: "China–Africa Cooperation in the New Era" White Paper.

China–Africa trade volume from 2014 to 09/2021

China and Africa have political mutual trust and have established an effective cooperation mechanism. China and Africa have signed agreements

between 160 pairs of friendly provinces and cities, and nearly all African countries with diplomatic relations with China have entered into cooperation agreements to jointly participate in the "Belt and Road" initiative.

China and Africa are strengthening their cooperation on production capacity. In 2015, the China–Africa Industrialization Cooperation Plan was introduced, followed by the Industrial Promotion Action Plan and China–Africa Agricultural Modernization Cooperation Plan in 2018. These initiatives aim to enhance capacity cooperation between China and Africa, and their implementation is already underway. The Forum on China–Africa Cooperation–Dakar Action Plan 2022–2024 further proposes measures to promote production capacity cooperation between China and Africa.

IV. Critical pathways for Africa's renewable energy industry involve developing the sector in stages based on the current development situation in Africa, with the aim of overall improvement of the renewable energy industry.

The renewable energy development in Africa is in its primary stage. The scale and layout of the industry cannot support the goal of large–scale development of renewable energy. Unless Africa can gather all kinds of production factors according to the local situation, develop a renewable energy sector integrating research, production, sales, service, application, and talent training, it will not be able to realize local production and application of renewables and increase endogenous power and sustainable development in Africa.

Considering the advantages of abundant renewable energy resources, the development of the renewable energy sector in Africa needs to be practiced gradually with certain goals based on economic and energy demand. It is a process of discovering and enhancing value. Based on improvements in the industrial chain, functional characteristics, and influence scope, we can divide the development of the renewable energy sector in Africa into three stages.

Starting stage: Focus on a core link and establish production capacity through technology introduction and international cooperation to meet local electricity development needs.

Growth and Maturity Stage: The cultivation of the renewable energy industry will extend to upstream and downstream sectors, with overlapping and integrating functions. The degree of specialization and automation in the production of renewable energy products will be strengthened, improving the scale and quality of products. This will create employment opportunities and stimulate local economic development.

Cluster Integration Stage: The renewable energy industry can be upgraded through scaling and branding, which will not only meet local energy demand but also attract more industries to invest. Additionally, it will achieve integrated development between renewable energy and other industries, forming a complete industrial chain.



	Starting Stage	Growth and Maturity Stage	Cluster Integration Stage
Development Goal	We need to set up some links of renewable energy industrial chain according to local conditions and initially develop markets.	Promoting the integration of upstream and downstream of the industrial chain and creating a complete industrial chain.	Integrated and sustainable development with other industries.
Path	Development of some links of RE industrial chain I Development of PV module assembly. II Energy storage battery material production III Solar product manufacturing. IV Planning and development of key PV projects.	<ul style="list-style-type: none"> Strengthen the development of upstream industries such as steel, chemicals, materials and equipment manufacturing to build a more complete industrial system. Improve the whole photovoltaic industry chain of silicon materials, wafers, cells, modules, and expand wind power industry chain of fan towers, blades. Expanding downstream markets. 	<ul style="list-style-type: none"> Scale-up, Branding, and Integration with Other Industries. Cultivate a group of large-scale renewable energy enterprises with outstanding brand reputation. Deeply integrate with upstream and downstream industries. Deeply integrates with industries such as chemicals, materials, and steel, becoming one of the main users of these industries; deeply integrates with industries such as energy storage, power grid, automobiles, and construction, achieving clean energy use. Renewable energy has become a mainstay connecting various industries, driving local energy and economic development.

Important measures	<ul style="list-style-type: none"> · Demonstration projects: By promoting the landing of demonstration projects in key countries and establishing a complete set of feasible landing schemes and business models, including technology transfer partnerships, capacity building, industry standards, policy formulation communication and consulting mechanisms, financing and guarantee mechanisms. · Promote improvement of the business environment: Through continuous dialogue, cooperation, and policy adjustments, promote the improvement of the overall business environment of renewable energy industries in corresponding countries. · Fill in funding and technology gaps through international cooperation: Obtain funding and technical support through international cooperation, lead the development of the renewable energy industry to overcome funding and technological thresholds. 	<ul style="list-style-type: none"> · Leveraging Africa's advantages in renewable energy resources and huge market potential, build integrated renewable energy industrial zones, and promote regional clean energy supply and economic development. · Based on the renewable energy industry cultivation, improve the construction level of power infrastructure and the quality of public services, and enhance life quality of residents. 	<ul style="list-style-type: none"> · Excavate the internal driving force of industrial development, promote national or regional independent development mechanism through the development of renewable energy, and make sustainable development of regional industries. · To integrate the renewable energy industry into Africa's economic development, strengthen the localization of the industry and enhance its sustainable development capacity in the context of energy transition and climate change.
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Based on the abundant renewable energy resources, rapid innovation in renewable energy technology, and continuous cost reduction, renewable energy will play a crucial role in addressing Africa's energy shortage, climate crisis, and unlocking development potential. However, the development of renewable energy in Africa still faces significant challenges in terms of policy, financing, talent, and experience. China and other developing countries can provide valuable references to Africa in these areas. Green manufacturing offers opportunities for local communities to benefit from

the transition to a sustainable energy structure. China and Africa can actively engage in renewable energy cooperation in the following areas, providing essential support for Africa's large-scale development goals.

Personnel Training

Enhance the talent pool in Africa's green manufacturing industry through personnel training. Offer training programs for local green manufacturing engineers and technicians, along with employment and career development guidance, to strengthen the talent reserve.

Policy Interconnection

Foster a favorable market environment for the renewable energy industry through policy collaboration. Provide information, training, and technical support to local policymakers to expedite the development of policies that facilitate the growth of green manufacturing.

Escort Projects

Attract outstanding Chinese green manufacturing companies to develop in Africa through flagship projects. Offer consulting and financing services to exemplary renewable energy manufacturing companies, fostering a robust and sustainable green manufacturing ecosystem in Africa.

Accelerator Projects

Incubate green manufacturing projects in Africa through accelerator initiatives. Provide support for renewable energy and related green manufacturing projects in Africa, covering aspects such as project planning, investment and financing, project construction and operation, and product sales.

Electricity Access

Cultivate the renewable energy application market in Africa through electrification projects. Provide power solutions for local communities lacking electricity, improving their living conditions and fostering acceptance of renewable energy. This lays the foundation for the future large-scale deployment of renewable energy.