

Clean Energy Contributes to Poverty Alleviation in China

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Abstract. Poverty has long plagued humanity. The main factors affecting the gap between the rich and the poor are natural resources, human resources, information resources and science and technology. Using data from various clean energy industries and historical research methods, this paper shows that the clean energy industry is a new way to reduce poverty in developing countries. In the history of agricultural development, land and water resources are the important sources of wealth growth. In the history of industrial development, mineral resources, coal and oil energy have become the material basis for getting rich. In the 21st century with the great development of artificial intelligence, the importance of power resources is becoming more and more prominent, and clean energy such as solar energy and wind energy has become a new natural resource to create social wealth. Chinese successful practice in the development of clean energy industry shows that the clean energy industry is an effective way to get out of poverty. The results of the cooperation between China and African countries in developing clean energy industries show that the energy industry plays an increasingly important role in helping developing countries out of poverty. Although the development of clean energy industry is still restricted by market competition and monopoly organizations, the development road is still tortuous and long, it has a very bright future.

1. Introduction*

Since the 17th century, technological innovation has always led the pace of energy transition. Energy technology is one of the three cutting-edge technologies in the world. Clean energy is an innovative science and technology in the 21st century. As can be seen from Figure 1, in recent years, the clean energy industry has risen rapidly under the promotion of energy technology innovation. Especially after 2007, the research of the clean energy industry is gradually active and continues to heat up, focusing on solar and wind energy, especially solar photovoltaic technology.

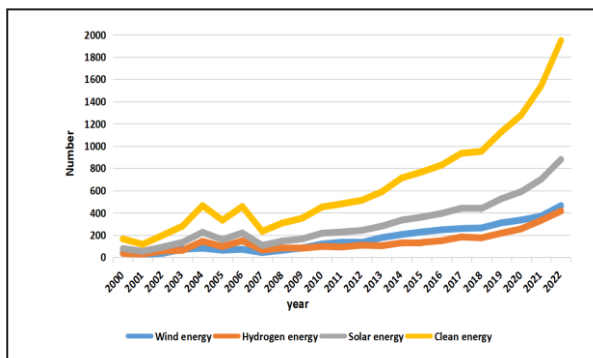


Figure 1. Statistics of different types of clean energy data from 2000 to 2022

Source: Elsevier Science

The existing research on clean energy covers many disciplines, such as energy, new energy materials, environmental science, chemistry, engineering technology and economics. Most of the research results are more than 100 papers. However, in the field of social sciences, clean energy research results are only 67, the number is small, the proportion is low, accounting for less than 5%. At present, most of the academic research focuses on green energy economy [1], the relationship between clean energy and environmental protection [2], the application of a certain material or technology in the clean energy industry [3], and solving energy poverty [4-5], etc., but they neglect clean energy as a new form of energy for human sustainable development. The clean energy is also an important strategic resource for national economic development. This paper breaks through the fields of energy and climate, and focuses on the perspective of clean energy industry as a new way of poverty alleviation in developing countries, which is of vital strategic significance for the development of developing countries. It helps developing countries to get enough attention in clean energy and helps human society realize the fourth energy transition. This study mainly explores a new path of poverty alleviation in developing countries through the clean energy industry, which has very important practical significance.

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2. Materials and Methods

There are two main database resources in this paper: one is government agencies, such as World Bank (IMF), International Energy Agency (IEA), National Bureau of Statistics (NBS), China Renewable Energy Engineering Institute (CREEI); the other is academic electronic library, such as Elsevier Science (SD) and Statista global statistical database.

This paper is a combination of quantitative and qualitative research with a historical and logical systematic review approach through data, journals, books and other publications closely related to energy, economics, technology, etc.

3. Natural Resources are very Important for Wealth Growth

Human life cannot be separated from material goods. With the development of society and the change of production mode, the sources of wealth growth are more and more extensive and rich.

3.1 In the Agricultural Age

Natural resources are important basis for human survival and development. In the age of agricultural civilization, the quantity and quality of land and water had a decisive influence on the growth of wealth. China, India, the Two River basin, Egypt and other areas with rich fertile land and water sources are often able to produce more food and other agricultural products, which are economically developed and have a prosperous society. On the contrary, areas with poor land and poor water sources are often unable to develop agricultural production, leading to social poverty and economic backwardness. In feudal times, China, relying on its vast region and affluent water sources, created rich material wealth and became a country with strong economic power.

3.2 In the Industrial Age

The growth of wealth in the era of industrial civilization mainly depended on industrial production, and energy was an important material basis of industrial production. Firstly, the Industrial Revolution began in Britain in the 18th century and it was based on energy sources and raw materials such as coal, iron and oil, which were the key elements of industrial production. With the industrial revolution, the demand for natural resources was increasing, especially for energy and raw materials such as coal, oil and iron. The large exploitation and utilization of these resources has promoted the rapid growth of industrial production. Secondly, the wealth growth in the industrial age was also closely related to the development and utilization of natural resources. The exploitation and utilization of natural resources have created great wealth for human beings. The exploitation of oil, coal and other energy sources has driven the development of oil and coal industries, thus promotes the economic growth. Kuwait in the Middle East, Saudi Arabia, Iraq, Qatar and other

countries get rich by exporting oil. Saudi Arabia relying on high oil prices became the fastest growing country among G20. Saudi Arabia's oil revenue is \$326 billion, and its oil export revenue accounted for more than 70% of Saudi Arabia's export revenue in 2022. Australia is the world's largest iron ore resource country, accounting for 29% of the world's economic resources. Australia is also the world's largest gold resource country, with an economic resources of 11,000 tons, accounting for one-fifth of the world's total. Mining is an important part of Australia's national economy, accounting for about 7% of its gross national product (GDP). Mining exports accounted for more than 60% of its total exports. Figure 2 shows that the nine of the top 10 countries in the world in total resources (according to statista2021) are in the top 20 in world economic GDP (according to the World Bank)

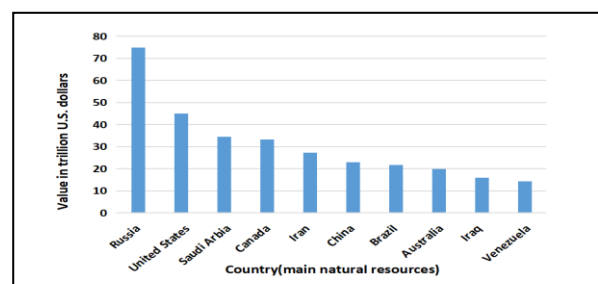


Figure 2. Leading countries worldwide based on natural resource value as of 2021 (in trillion U.S. dollars)

Source: statista

3.3 In the Artificial Intelligence Age

In the 21st century of the great development of artificial intelligence, electric power is the core driving force supporting artificial intelligence's development. Clean energy is used in the power, information technology and transportation industries, and it has emerged as a new industrial system. Clean energy is seen as a new natural resource, which is one of the important resources such as coal, oil and gas, driving wealth growth [6]. Firstly, developing countries can vigorously develop the solar and wind energy industries in the solar and wind-rich areas by developing clean energy industries. Secondly, clean energy provides a large amount of power for industrial intelligent manufacturing. In the era of artificial intelligence, the large application of industrial intelligent manufacturing enables factories to improve production efficiency and reduce production costs. Finally, with the continuous development of high-speed railway and electric vehicle technology, electric power energy will play an increasingly important role in the future field of transportation [7]. The world's mainstream economies mainly generate electricity by coal, oil and natural gas, while developing countries can vigorously promote the new energy vehicle industry and use clean energy in automobile power. The clean energy industry provides a new way for developing countries without or lack of natural energy such as oil and natural gas.

4. The Development Profile of the Clean Energy Industry

In the historical process of the development of clean energy industry, the research and development and application of clean energy undoubtedly occupy a pivotal position. Clean energy refers to those advanced technology systems that have clean, efficient and systematic application, represented by solar energy, wind energy and hydrogen energy. The world is paying increasing attention to accelerating the transition to clean energy, and investment in clean energy is increasing. Figure 3 shows the authoritative statistics of the International Energy Agency, the total global energy investment in 2023 is about \$2.8 trillion, of which more than \$1.7 trillion will be invested in clean energy, while the investment in fossil energy is only \$1.1 trillion, which is far more invested than fossil energy[8]. This undoubtedly marks that clean energy is leading the world into a new era of sustainable development and becoming the main direction of human energy development in the future.

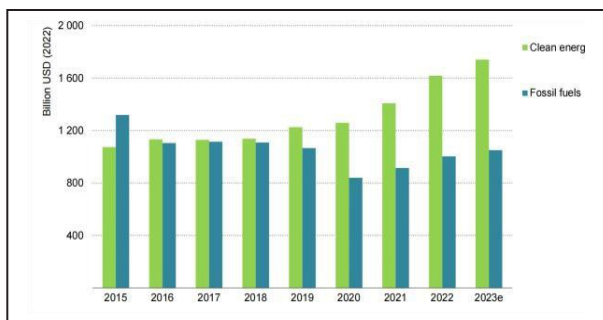


Figure 3. Global energy investment in clean energy and in fossil fuels, 2015-2023e.

Source: The International Energy Agency

The utilization of solar energy has a history of more than 3,000 years, at present, it is mainly used by photovoltaic power generation. In 1954, the American Bell Laboratory invented the mono-crystalline silicon solar cell. In 1996, the United Nations held the World Solar Summit in Zimbabwe. In 2004, under the pressure of a series of energy problems and environmental trends, Europe and the United States began to promote the energy transformation, and this year was called the first year of the world's photovoltaic industry. In 2013, China became the world's largest PV market. Today, solar energy is widely used in the domestic, commercial and industrial fields. Solar panels, solar water heaters, solar cars and other products are gradually popularized, making an important contribution to the alleviation of poverty in developing countries. In the early 20th century, German engineers invented the world's first wind turbine. In the 1960s and 1970s, wind power generation was used on a large scale. Since the 1980s, with the continuous progress of technology and the cost reduction, wind power generation has been widely used worldwide. Since 2000, as the global climate change problem becoming increasingly serious, countries have begun to strengthen international cooperation in the wind energy industry.

China, Germany, the United States and other countries are vigorously developing the wind energy industry. In the future, with the continuous progress of technology, the wind energy industry will continue to develop, the global wind power generation is expected to reach more than 400GW by 2030, and the development potential is huge.

5. Chinese Clean Energy Achievements in Poverty Alleviation

Since hydrogen manufacturing technology is not as mature as solar and wind technology, the cost is relatively high, solar and wind are the first choice for poverty alleviation. The global installed cost of solar PV in 2021 fell by about 82% from 2010, the installed cost of onshore wind turbines and offshore wind power fell by about 35% and 41%, respectively, the cost of power generation also fell significantly.

China has now formed a complete clean energy supply chain and led to huge job growth. Global clean energy jobs have surpassed fossil fuels, and the Asia-Pacific region is expected to grow from about 33 million clean energy jobs today to nearly 55 million by 2030[9].

5.1 In the Solar Photovoltaic

In 2009, China launched the Golden Sun Project for poverty alleviation and power generation, and has made significant progress in terms of market, technology and raw materials. In 2013, China became the world's largest PV market. After nearly 30 years of development, China now leads the world in solar energy production and technology. These variations are shown in Figure 4.

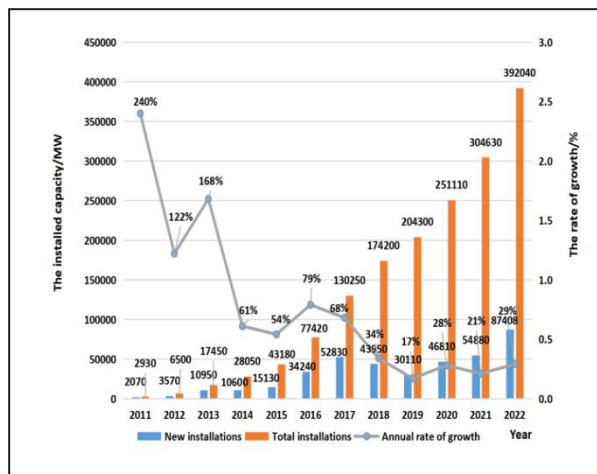


Figure 4. Trends of installed PV power capacity in China from 2011 to 2022.

Source: China Renewable Engineering Institute

Today, as can be seen from Figure 5, China is not only the world leading supplier of clean energy technologies, but also a net exporter of many clean energy technologies. China has at least 60 percent of the world manufacturing capacity for mass production technologies. Such as solar PV, wind energy systems and batteries, and 40 percent of its electrolytic cell manufacturing capacity[10]. In 2022, the total output

value of China photovoltaic manufacturing side exceeded 1.4 trillion yuan, the export of photovoltaic products exceeded 51.2 billion US dollars, and the output of polysilicon and photovoltaic modules ranked first in the world for 12 consecutive years and 16 years respectively[11].

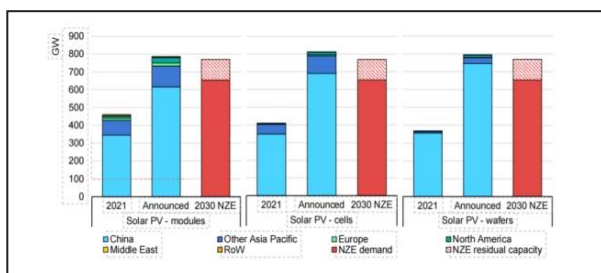


Figure 5. Chinese solar PV manufacturing capacity
 Source: The International Energy Agency

China's western region shows significant advantages in the development of solar energy, with its vast territory, low population density and abundant sunlight. The distribution of solar photovoltaic power output in the western region to the eastern region can not only meet the electricity demand in the eastern region, but also achieve economic growth in the western region. In China's poverty alleviation plan, photovoltaic poverty alleviation is one of the top ten targeted poverty alleviation projects. According to the white paper Chinese Energy Development in the New Era released by The State Council of China, from 2014 to 2020, various forms of photovoltaic poverty alleviation projects will be promoted in accordance with government funding. A total of 26.36 million kilowatts of photovoltaic poverty alleviation power stations have been built, benefiting 60,000 poor villages and 4.15 million poor households, generating electricity benefits of about 18 billion yuan per year, and placing 1.25 million public welfare jobs accordingly[12].

5.2 In the Wind Energy

China is one of the world's largest markets for wind power. In 1966, China implemented the Wind Riding Plan and built 19 wind farms. As the technology of flexible grid scheduling becomes more and more mature, battery energy storage facilities can largely solve the problem of wind power instability. By 2023, Chinese installed wind power capacity has exceeded 500 gigawatts, accounting for nearly half of the world's total wind power installed capacity. This shows that China has become a major force in global wind power. These variations are shown in Figure 6. With more than two decades of development, China has a well-established supply chain for the wind power industry. The production of wind turbine nacelles and key components accounts for 60-70% of the global market share, which makes China a crucial contributor to the global response to climate change[13].

The Chinese government has been vigorously promoting wind power projects in western China to solve local energy problems, boost economic development, and help achieve sustainable development goals. These projects have played a key role in poverty alleviation in

the western region. The Chinese government sees the western wind project as an important way to achieve its sustainable development goals.

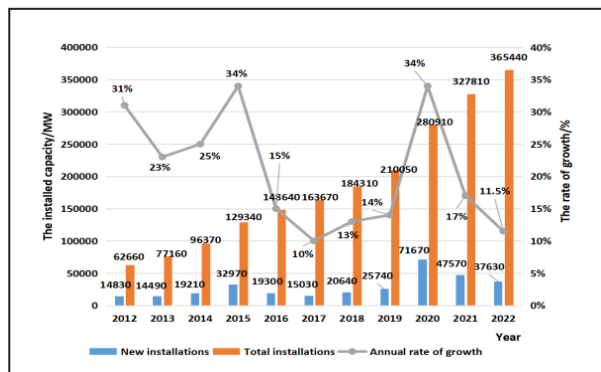


Figure 6. Chinese installed wind power capacity and its change trend from 2011 to 2022
 Source: China Renewable Engineering Institute

5.3 In the High Speed Train

China has become the world's largest new energy vehicle production and sales country, As shown in Figure 7, China's 2022 international trade in electric vehicle exports accounted for 35% of global exports. The electric vehicle industry system has greatly increased the GDP growth brought by the automobile industry. While promoting economic growth, Chinese electric vehicle industry system also provides important support for global green mobility. With the continuous advancement of technology and the support of policies, the performance of electric vehicles has been significantly improved in the past few years, making them increasingly competitive in the global market. According to statistics, Chinese new energy vehicle production in 2022 more than 3 million, compared to 2012 more than 10 times[14].

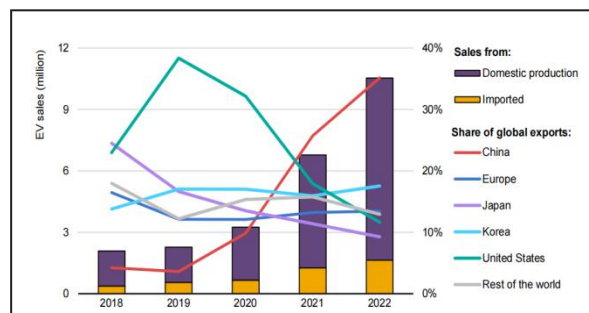


Figure 7. Global electric car sales and share of selected regions in global trade, 2018-2022.
 Source: The International Energy Agency

6. Clean Energy in Cooperation between China and Developing Countries

China is a firm supporter and important partner of Africa's green transformation. By 2021, China has helped African countries build hundreds of clean energy and green development projects, and supported African countries to better leverage their advantages in clean energy such as solar and wind power to help Africa achieve poverty

alleviation. The Garissa photovoltaic power generation project undertaken by Chinese enterprises in Kenya is currently the largest photovoltaic power station in East Africa. After the Garissa Photovoltaic Power Plant was put into operation in 2019, the annual electricity generation exceeded 76 million KWH, meeting the electricity demand of 70,000 households and more than 380,000 people, effectively alleviating the problem of electricity shortage in Kenya. The Dea Wind Farm in South Africa's Cape Province is China's first wind power project in Africa that integrates investment, construction and operation. The project provides a stable supply of about 760 million KWH of clean electricity to the local area every year, creating local jobs and driving the development of surrounding communities.

According to the latest report Africa Energy Outlook 2022 released by the International Energy Agency, 600 million people in Africa live without electricity, accounting for about 48% of the total population in Africa. The proportion of people without electricity is large. Although Africa has 60% of the world's solar energy resources, it only has 1% of the world's photovoltaic power generation installations, indicating that the development of renewable energy, especially solar energy, has a broad prospect in Africa.

7. Conclusion and Discussion

The development of clean energy industry has been the trend of the period, and now the World Energy Organization has recognized that clean energy is the best choice for the future. On the one hand, human needs a lot of energy for development, and clean energy can cope with the energy crisis and achieve sustainable development. On the other hand, the potential of clean energy is huge. The developing countries can combine their actual situation, and learn from China's advanced clean energy technology, because China's clean energy technology has gradually realized the use of affordable energy.

In the electric power era, The developing countries should catch the opportunity to utilize and vigorously develop the clean energy industry, occupy a dominant position in the energy transformation, and drive the development of related industries to get rid of poverty.

Acknowledgement

This work is supported by the Key Research and Development Program of Guilin University of Electronic Technology [Grant No.YXKSZ05]; Research Program of Guilin University of Electronic Technology [Grant No.YJSZS23] and [Grant No.YJSZS1V].

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