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A New Trinity Idea of Energy Conservation, Emission Reduction, Poverty Alleviation to Break Poverty Circle and Boom Economy for the Shaanxi-Gansu-Ningxia Region

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***Abstract*—The poverty alleviation task in China has entered a decisive stage, but in terms of the poor areas currently, there are still problems with insufficient endogenous power, high rate of poverty returns in the implementation for poverty alleviation. The study starts from the reality that the resources in Shaanxi-Gansu-Ningxia area are rich but the economic development is not smooth, considering its resource endowment and economic structure and has an analysis on present situation and reasons for regional poverty. Meanwhile it attempts to have a discussion on that with an effective utilization of Clean Development Mechanism (CDM) and the help of the carbon trading market, it should give an introduction to advanced technology with combination of research and development on its own, so as to improve the efficiency of thermal power generation and resource utilization, as well as to reduce carbon dioxide emissions. In this way, it can improve economic efficiency, develop local economy, enhance poverty endogenous power and build a new path of poverty alleviation of the trinity of energy conservation, emission reduction, and poverty alleviation in Shaanxi-Gansu-Ningxia region.**

Keywords—ecological poverty alleviation; energy conservation and emission reduction; clean development mechanism (CDM); carbon trading

I. INTRODUCTION

In 2017, the Central Economic Work Conference confirmed that, in accordance with the requirements of the 19th National Congress of the Communist Party of China, it is necessary to focus on the three major battles of preventing and resolving major risks, precision poverty alleviation and pollution prevention and control in building a well-off society in an all-round way from 2018 to 2020. 2019 is the decisive year of the tough battle. To strike a good fight against poverty, it is necessary to reduce the number of poor people while ensuring the quality of poverty alleviation, providing accurate assistance, focusing on deep poverty areas, and stimulating the endogenous motivation of the poor. It will be of great significance to fight pollution prevention and control, one must reduce the discharge of major pollutants and improve the quality of the ecological environment; the second is to adjust the industrial structure and increase energy conservation. But the two are not completely separated. They are related to each other and promote each other. Energy conservation and emission reduction and green development can be a means of precision poverty alleviation. Strengthening poverty alleviation and helping out of poverty can also be a way to alleviate the greenhouse effect.

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II. LITERATURE REVIEW

Since General Secretary Xi Jinping proposed the concept of precise poverty alleviation in 2013, the government has increased its investment in poverty alleviation and achieved remarkable results in the fight against poverty. However, as the rural poor population continues to decrease, the impact of the ecological environment on many poverty-prone factors is becoming more and more prominent [1]. Therefore, some scholars have combined ecological protection and poverty alleviation work, and proposed new ideas for ecological poverty alleviation, and conducted in-depth research. Yu Fawen [2] (2018) proposed that because the green principle has not been implemented in precision poverty alleviation, it has produced some negative ecological impacts, so it is necessary to implement ecological poverty alleviation at the level of top-level design. Chen Xu'ao [3] (2016) studies the ecological environment protection and the industry's precise poverty alleviation and interactive development. Zhang Yuqing [4] et al (2016) give relevant advice on the improvement of the policy guarantee, capital investment, mechanism application, condition guarantee, industrial development and other aspects of ecological poverty alleviation. Lei Ming [5] (2017) divides ecological poverty alleviation into in-situ ecological poverty alleviation model and ex-situ ecological poverty alleviation model, and explores the realization path of ecological poverty alleviation from these two models.

For the study of the causes of poverty, some scholars attribute the reasons to lack of human capital, weak infrastructure, poor ecological environment, and poor market economy awareness. He Renwei [6] et al. (2017) combed and summarized the research progress of rural poverty governance in China from two aspects: livelihood capital (human capital, financial capital, social capital, physical capital, natural capital) and livelihood strategy. Yan Hongxia's [7] research in 2017 et al. (2017) clarifies the five elements of ecological poverty alleviation, and proposes the concept of resource-oriented supply — combining the resources of poverty-stricken areas with the development of related industries to achieve ecological poverty alleviation. However, having abundant resources does not mean having the ability to promote economic growth and promote poverty alleviation. Research by scholar Yang Yuwen [8] shows that in the case of economic development over-reliance on natural resources, natural resources can not only provide sufficient development momentum for the local, but will restrict the development of the economy and form a "resource curse" situation.

According to the existing literature, scholars' research on ecological poverty alleviation mainly focuses on the causes of poverty and poverty alleviation methods at the overall level. There are relatively few studies on how to achieve poverty alleviation in poverty-stricken areas where regional characteristics are not lacking. For example, in view of the problem of poverty alleviation in the typical resource enrichment of Shaanxi, Gansu and Ningxia, few scholars are involved. In the world's consensus on environmental protection, green economy, and reduction of greenhouse gases, for some areas where resources are concentrated but economic development is stagnant, by introducing advanced technologies and improving resource utilization efficiency, reducing carbon emissions and improving regional economic benefits, it is undoubtedly a green and environmentally-friendly road to poverty alleviation. Taking Shaanxi-Gansu-Ningxia region as an example, this paper attempts to explore the endogenous driving force of local economic development by introducing clean development mechanism, promoting technology integration and promotion, participating in carbon trading, and getting rid of the “resource curse” to achieve necessity and feasibility of the trinity of energy conservation emission reduction and poverty alleviation.

III. The Current Situation of Poverty in Shaanxi-Gansu-Ningxia Region

The three provinces of Shaanxi, Gansu and Ningxia are located on the Loess Plateau, with drought and little rain, extremely lack of water resources, poor ecological environment, inconvenient transportation, poor opening conditions, lack of rational development and efficient use of the fruitful resources, and the economic development in the region is relatively slow. From 1998 to 2016, the per capita GDP of Shaanxi-Gansu-Ningxia (see “Fig. 1”) is generally lower than the national average, with low per capita wealth and low living standards.

According to the income classification of the Social Security Inquiry Network,[1] it can be seen that in the past five years, although China’s poverty alleviation has achieved remarkable results, many poverty-stricken areas such as Shaanxi, Gansu and Ningxia have been completely renewed, and the average income level of residents has been increasing, its average income level is still far from the domestic average. According to the 2016 data, the average income level of Shaanxi-Gansu-Ningxia cities has just reached middle level, which is far lower than the average urban income level (see “Fig. 2”). The average rural income level has not reached the middle-low income level, that is, it has not reached the domestic average level (see “Fig. 3”), and there are still many villages and towns still in poverty.

Social security inquiry network (http://www.chashebao.com) announced in 2017 the classification of income classification: low income: 5,529 yuan of disposable income per capita; middle and lower income: 12,899 yuan of disposable income per capita; middle income: 20,924 yuan of disposable income per capita; middle and upper income: 3,1990 yuan of disposable income per capita; high income: 59,259 yuan of disposable income per capita.

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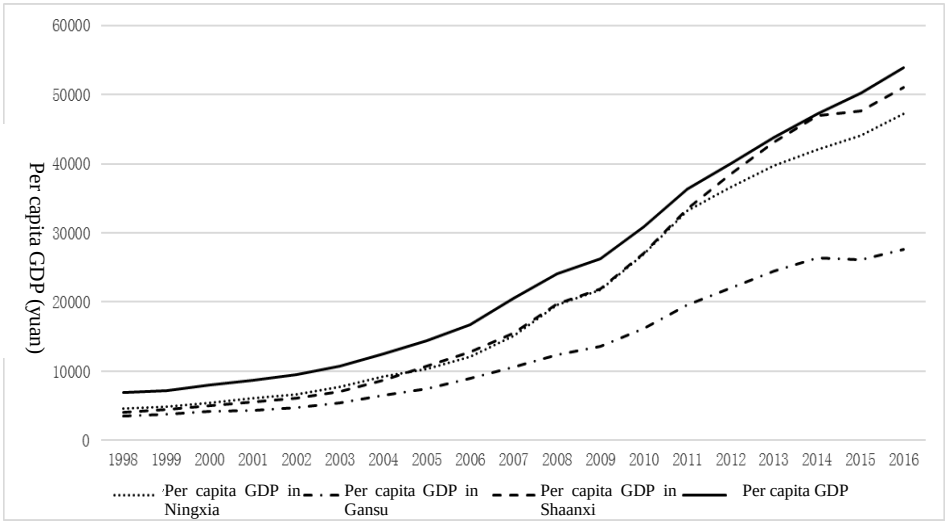

Fig. 1. Comparison of per capita GDP between Shaanxi, Ningxia, Gansu and the whole country from 1998 to 2016.

[a] Source: 1998-2016 Shaanxi, Gansu, Ningxia Statistical Yearbook, 1998-2016 China Statistical Yearbook.

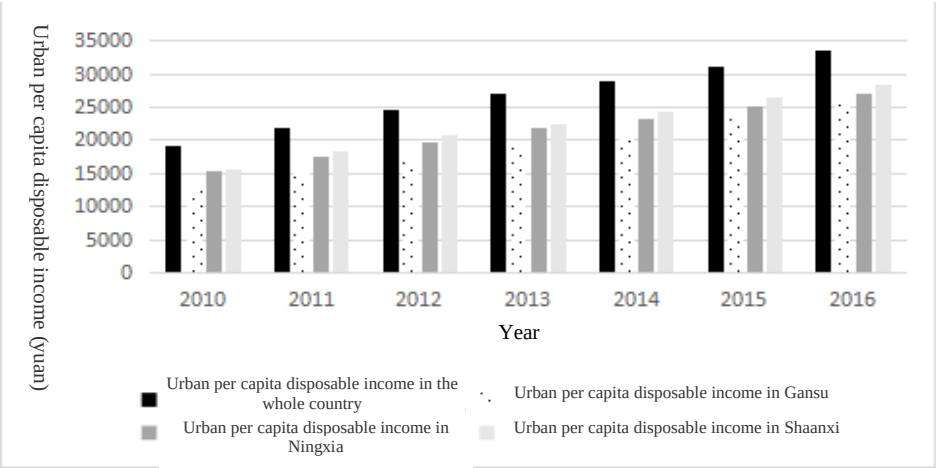

Fig. 2. Comparison of disposable income of urban residents in Shaanxi, Ningxia, Gansu and the whole country in 2010-2016.

[a] Source: 2010-2016 Shaanxi, Gansu, Ningxia Statistical Yearbook, 2010-2016 China Statistical Yearbook.

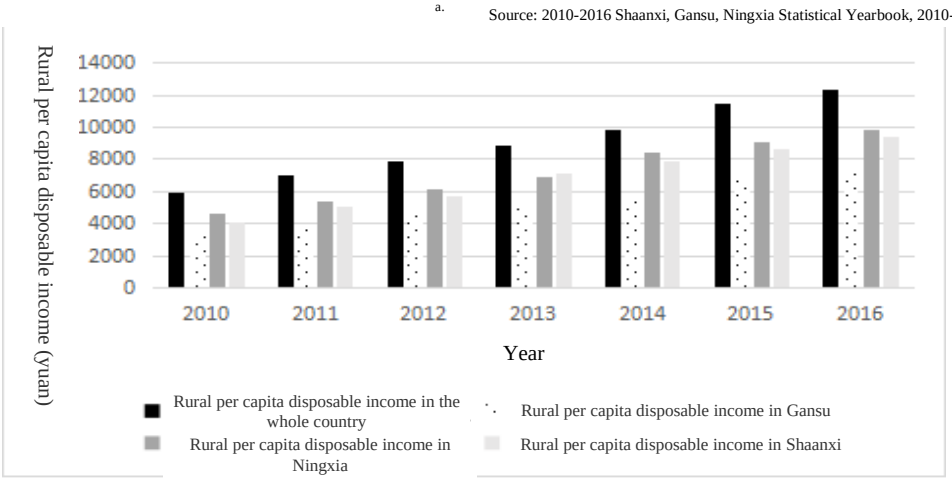

Fig. 3. Comparison of disposable income of rural residents in Shaanxi, Ningxia, Gansu and the whole country in 2010-2016.

[a] Source: 2010-2016 Shaanxi, Gansu, Ningxia Statistical Yearbook, 2010-2016 China Statistical Yearbook.

In addition, according to the national poverty-stricken population and rural residents' income in 2017 released by the National Bureau of Statistics on February 1st, 2018, the current national average poverty rate is 3.1%, while the incidence of poverty in Shaanxi was 9.45%, the incidence of poverty in Gansu was 9.6%, and the incidence of poverty in Ningxia was 6%. Although Shaanxi, Gansu and Ningxia have made great progress in recent years, the incidence of poverty is still much higher than the domestic average, and the proportion of poor people accounts for a large proportion of the total population. If there is no follow-up policy and support for measures, only through the "transfusion-type poverty alleviation" rather than mobilizing the enthusiasm of the poor households [9], it will lead to "cut-blood-type returning to poverty" for some low-income people [10]. This also confirms from the side that the effect of poverty alleviation obtained by relying solely on policies is not stable [9], and the effect of continuing to improve is not significant enough, especially for areas such as Shaanxi-Gansu-Ning, where there is a "resource curse", ecological construction and poverty alleviation. The combination of development and the introduction of new poverty alleviation methods are crucial for the development of poverty alleviation work.

IV. Causes of Poverty in Shaanxi-Gansu-Ningxia Region

A. Constraints of High Coal Energy Structure and Unreasonable Industrial Structure

China's energy structure is highly dependent on coal. The coal energy consumption accounts for about 70%, which is closely related to Chinese large coal reserves. Especially in the western region, due to the abundant coal resources, most of the pillar industries are driven by coal production capacity. In the past few decades, the Shaanxi-Gansu-Ningxia region has focused on the development of heavy industry, forming an industrial structure dominated by the second industry and highly dependent on energy resources for economic growth (see "Fig. 4"). The coal energy consumption ratio is as high as 80% (see "Fig. 5"). And the total consumption has been maintaining a growing trend.

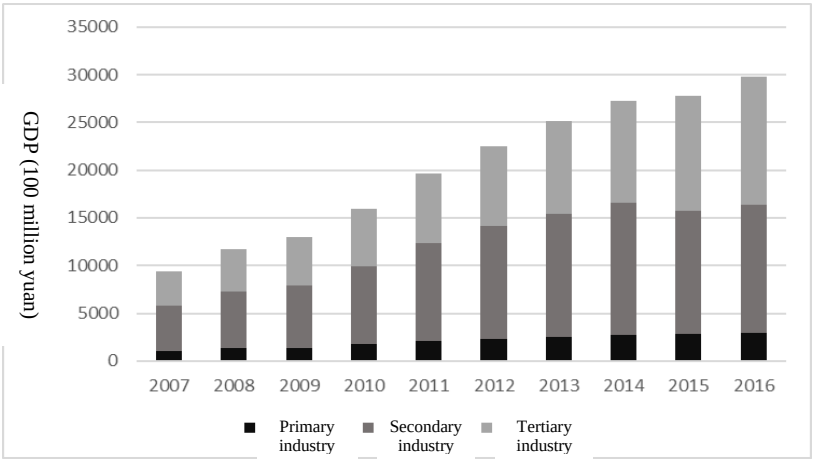

Fig. 4. 2009-2016 Shaanxi-Gansu-Ning Industrial GDP Stacked Column Chart.

a. Source: 2009-2016 Shaanxi, Gansu, Ningxia Statistical Yearbook Source: 2005-2016 Shaanxi, Gansu, Ningxia Statistical Yearbook.

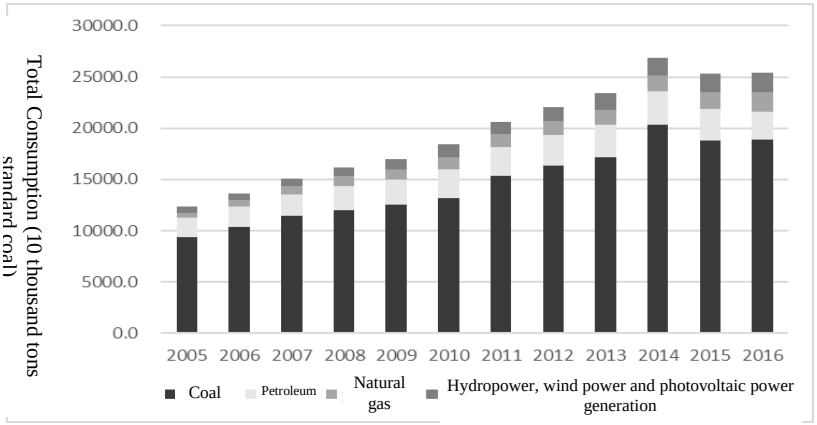

Fig. 5. 2005-2016 Shaanxi-Gansu-Ningxia Energy Consumption Ratio.

a. Source: 2009-2016 Shaanxi, Gansu, Ningxia Statistical Yearbook Source: 2005-2016 Shaanxi, Gansu, Ningxia Statistical Yearbook.

The abundant coal resources have given the opportunity for the rapid development of Shaanxi, Gansu and Ningxia. However, the problems of single industry, extensive resource exploitation, backward mining technology and unregulated management have seriously hindered the recent development model transformation of Shaanxi, Gansu and Ningxia from

high carbon low efficiency to clean effective mode. The richness of resources and the slowness of economic growth are in stark contrast. The "resource curse" from internal and the double challenge from external pressures have increased the difficulty of poverty alleviation in Shaanxi, Gansu and Ningxia.

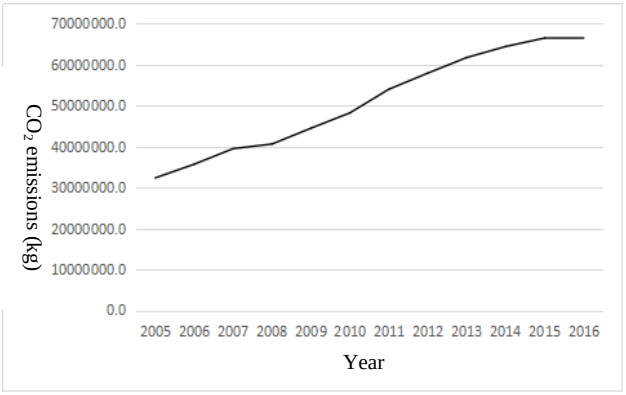

Fig. 6. CO_2 emissions in the three provinces of Shaanxi-Gansu-Ningxia from 2005 to 2016.

In addition, the black high-carbon energy structure, while driving economic growth, also emits a large amount of carbon dioxide [2] (see "Fig. 6"), resulting in great environmental pollution and severe greenhouse effect, so it is imminent to transform into a green and low-carbon production mode. However, although China is vigorously developing clean power generation industries such as natural gas, hydropower and wind energy. Due to the technical and financial constraints of China and the country where coal is the primary energy source, fossil energy is difficult to be replaced by other resources in the future. Thermal power will still dominate China's power production [11].

B. Thermal Power Generation Efficiency Is Low and Resource Utilization Is Not High

From the further comparison of the 2016 Shaanxi-Gansu-Ningxia thermal power generation efficiency and the national thermal power generation efficiency (see "Table I"), it can be seen that the thermal power generation efficiency of the three provinces of Shaanxi, Gansu and Ningxia is lower than the national average. However, the thermal power industry's dependence on coal is much higher than the national average. It can be seen that the dual goal of getting rid of the "resource curse" and realizing poverty alleviation and reducing carbon emissions can be considered from the perspective of improving the thermal power generation rate.

The low efficiency of thermal power generation is not caused by a single factor. The poor quality of coal, the unstable combustion of inferior coal, the lack of effective production management mechanism, and the high power consumption rate of the factory compared with the developed countries are all causing confusion in improving the efficiency of thermal power generation in Shaanxi, Gansu and Ningxia. However, the fundamentals are still caused by the low technical level. Inefficient power generation technology results in low power generation efficiency. Therefore, it is extremely urgent to introduce advanced scientific research results, overcome technical difficulties, and improve the efficiency of thermal power generation.

TABLE I. COMPARISON OF THERMAL POWER GENERATION EFFICIENCY AMONG SHAANXI, GANSU AND NINGXIA AND NATIONAL AVERAGE

Region	Coal consumption in the thermal power industry Proportion of total coal consumption (%)	Thermal power generation Effectiveness (%)
Ningxia	79.78%	42%
Shanxi	59.12%	39.41%
Gansu	48.33%	39.98%
The whole country	45.17%	44.22%

[a.] Source: 2016 China Statistical Yearbook, 2016 Shaanxi, Gansu Statistical Yearbook, 2013 Ningxia Energy Statistics Yearbook.

V. PROMOTING POVERTY ALLEVIATION THROUGH ENERGY CONSERVATION AND EMISSION REDUCTION, AND FOSTERING NEW DEVELOPMENT OF ENDOGENOUS DEVELOPMENT IN SHAANXI, GANSU AND NINGXIA

At present, the economic development of the Shaanxi-Gansu-Ningxia region has been deeply mired in the quagmire of "resource curse". The economic growth momentum is seriously insufficient, and poverty alleviation work has great resistance. At this time, the introduction, development and popularization of advanced technologies are decisive for improving energy efficiency and promoting economic green growth compared to resources. Therefore, from the developed countries that have made major breakthroughs in technology, the introduction of advanced technology and self-exploration, transforming into a production mode that adapts to the development status of Shaanxi, Gansu and Ningxia, and using the clean development mechanism and the carbon trading market to achieve energy conservation and emission reduction. The trinity of poverty alleviation is one of the feasible ways for the Shaanxi-Gansu-Ningxia economy to achieve sustainable development.

A. Introducing Advanced Technology and Self-development, and Greatly Improving the Efficiency of Thermal Power Generation

Due to the importance of coal in power engineering, research on improving the efficiency of thermal power generation has emerged in recent years. Judging from the current distribution pattern of thermal power generation technology in the world, the main research and application of modern coal power generation technology are ultra-

[2] The CO_2 emissions from 2005-2016 are calculated from the total energy consumption in the statistical yearbooks of Shaanxi, Gansu and Ningxia in 2005-2016 and the calculation standards provided by the National Development and Reform Commission: For every ton of standard coal burned, 2,620 kg of carbon dioxide 8.5 kg of sulfur dioxide, and nitrogen oxides 7.4 kg are produced.

supercritical coal-fired power generation technology, IGCC integrated gasification combined cycle power generation technology, CFB circulating fluidized bed technology, etc. [12] These technologies have greatly improved the power generation efficiency of thermal power, saved energy consumption and reduced greenhouse gas emissions.

Ultra-supercritical coal-fired power generation technology can be taken as an example. After nearly half a century of research, the 600℃ ultra-supercritical coal-fired power generation technology has become more mature internationally. At present, countries are working hard to carry out research on higher-level technologies such as 630℃, 700℃ and 780℃. For example, the "AD700 Plan" in Europe, the "A-USC" plan in the United States, and the "A-USC Project" in Japan. It is reported that Europe has made a major breakthrough in the technology of 700 ℃ [13], and the completion of work is three-quarters.

China has also actively explored this technology and achieved certain results. As early as 2012, China already had a relatively mature coal-fired supercritical power generation project (CFSC). For example, the North China Weibei Supercritical Coal-fired Power Generation Project (Phase II) uses a supercritical coal-fired generating unit instead of a conventional sub-critical generator set. The project's power generation efficiency is as high as 45%, which is 0.78% higher than the average China's thermal power generation efficiency in 2015. Even in some respects, China is already at the world's leading level, such as the world's first 1 GW ultra-supercritical secondary reheat coal-fired generating unit of State Grid Taizhou Power Plant. The coal consumption for power generation is only 6 g/kWh lower than the highest level in the world today, reducing carbon dioxide by more than 5%. Coal consumption, power generation efficiency and environmental protection indicators have reached world-class levels. However, although China has made some progress in some research fields of ultra-supercritical coal power generation technology, due to the late start and short materials science, the research and development of China's ultra-supercritical coal-fired power generation technology lags behind that of developed countries. The power generation efficiency of IGCC technology, which has an advantage in environmental protection indicators, has not yet reached 50% [12], and the efficiency is relatively low. Introducing foreign advanced technology is one of the methods to improve the follow-up technology research and development.

Thermal power companies in the Shaanxi-Gansu-Ningxia region should seize the opportunity to introduce the most advanced technologies from foreign or domestic universities and model enterprises to improve the utilization of coal resources and the efficiency of thermal power generation. It should also vigorously cultivate talents, encourage independent research and development, promote technology upgrades, promote energy conservation and emission reduction and introduce the clean development mechanism to obtain funds for the realization of the dual goals of precision poverty alleviation.

B. Using the Clean Development Mechanism (CDM) to Introduce Funds and Technologies to Achieve the Unification of Economic Green Growth and Ecological Poverty Alleviation

The Clean Development Mechanism (CDM) is a flexible implementation mechanism introduced in the Kyoto Protocol and an innovative model for the carbon trading market. Developed countries use their advanced technology to help developing countries reduce carbon emissions. Developing countries sell CERs ("Certified Emissions Reductions") to technology providers, which not only enable developed countries to fulfill their commitments at lower cost, can also help developing countries acquire advanced technologies and funds to achieve energy conservation and emission reduction based on incentive compatibility. As can be seen from "Fig. 7", among the emission reduction types approved by CDM in China, energy conservation and energy efficiency improvement accounted for 13%, ranking the second. Therefore, the use of energy-saving and energy-efficiency CDM projects to introduce technology and obtain funds has provided possibilities for promoting the economic green development of Shaanxi-Gansu-Ningxia region and obtaining poverty alleviation funds. At the same time, it is also conducive to realizing the commitments made by the central government in its "Twelfth Five-Year Plan" — by 2020, China's carbon dioxide emissions per unit of GDP will fall by 40%-45% compared with 2005.

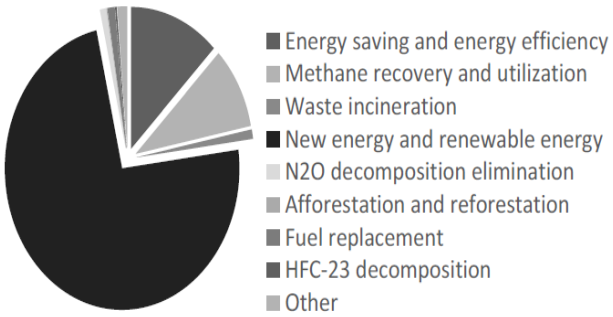

Fig. 7. Distribution of emission reduction types approved by CDM (statistics until 2016).

[a.] Source: http://cdm.ccchina.gov.cn

For example, in the CFSC project, the emission reduction benefits are brought by the increase in power generation efficiency. If the thermal power enterprises in Shaanxi, Gansu and Ningxia can introduce CFSC projects and further improve the efficiency of power generation, they can not only bring more capital and technical benefits to the main body of the project, but also reduce the excessive dependence on coal resources, so that the local can get rid of the "resource curse" dilemma to a certain extent. At the same time, the funds collected by the State through the CDM transfer transaction amount can be used as a special fund for ecological poverty alleviation according to the Clean Development Mechanism Project Operation Management Method (Revised), which can reduce local finance pressure to a certain extent.

C. Using the Carbon Trading Market to Optimize the Industrial Structure and Obtain Poverty Alleviation Funds While Saving Energy and Reducing Emissions

It is reported that as of December 1, 2017, the cumulative quota of seven pilots in Beijing and Shanghai exceeded 200 million tons of carbon dioxide, and the turnover exceeded 4.6 billion yuan. [3] The carbon market is booming. According to the "2017 China Carbon Market Forecast and Outlook" report, the Chinese market will become the world's largest carbon market, changing the world carbon market. According to the "National Carbon Emissions Trading Market Construction Plan (Power Generation Industry)" issued by the National Development and Reform Commission on December 19, 2017, the power company will take the lead in entering the market, and it is unstoppable that the thermal power industry be included in the carbon trading market. Shaanxi-Gansu-Ninghu Thermal Power Company should seize this opportunity to introduce CFSC projects to improve the efficiency of thermal power generation, accelerate the transition to a low-carbon production model, and use the carbon trading market to achieve emission reductions in exchange for potential benefits.

In order to achieve the goal of maximizing the benefits of technology introduction and R&D, the thermal power industry is inseparable from the guidance and support of the government when it enters the carbon trading market for trading. The government should comprehensively plan the carbon trading market of the thermal power industry, comprehensively plan, unify the actions and arrangements of the Shaanxi-Gansu-Ningxia Thermal Power Company, and build the thermal trading industry's own carbon trading industry chain (see “Fig. 8”). The government also should vigorously support the independent research and development of the CSFC project in the thermal power industry, provide funds and channel support for the introduction of foreign advanced technology, and promote the potential growth of enterprises. Thereby it can enhance local economic benefits, promote the adjustment of industrial structure and the improvement of economic structure, and may improve the government tax income. After the government has made up for the outflow of funds due to technology introduction, it will be also possible to set up a special fund for poverty alleviation fund for carbon trading, and to carry out precise poverty alleviation through ecological poverty alleviation, so as to achieve energy conservation, emission reduction and poverty alleviation.

As the operation of the carbon trading industry chain in the thermal power industry is gradually on the right track, the income from carbon trading will gradually exceed the payment cost of technological innovation investment. More thermal power companies will flow into the carbon trading market. At this time, the government should guide the free trade market mechanism to gradually be introduced, change the "government-based, market-supplemented" to "market-oriented, government-assisted". It should also attract other types of power companies to slowly enter the carbon trading market, expand the types of carbon sink projects, and form a diversified market, so that the green low-carbon industry will gain new development and progress. At the same time, thermal power companies with continuous technological advancement and continuous improvement in efficiency will bring more employment opportunities to the Shaanxi-Gansu-Ningxia region. “It is better to teach people to fish than to give people the fish.” Giving poor people jobs to get out of poverty is far more meaningful than just giving consumable materials and funds.

[3] Source: China Carbon Trading Network http://www.tanpaifang.com

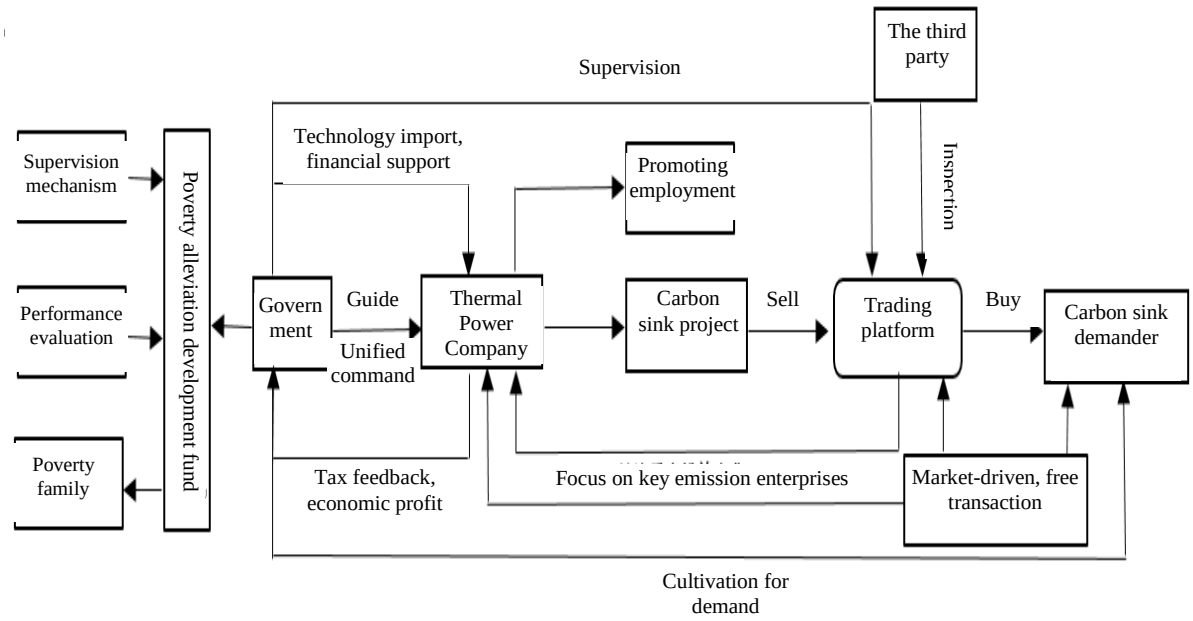

Fig. 8. Thermal trading industry carbon trading industry chain.

VI. CONCLUSION

In view of the current high coal energy structure and heavy industry-based industrial structure in Shaanxi, Gansu and Ningxia, and inefficient thermal power generation efficiency, the government should encourage and support local thermal power companies to introduce advanced thermal power generation technology and participate in the carbon trading market. While improving the utilization efficiency of coal resources, power generation efficiency, and reducing greenhouse gases, it will increase economic benefits and gain potential benefits, help poverty alleviation, provide employment, and truly achieve energy conservation, emission reduction, and poverty alleviation. To a certain extent, it will help the local to get rid of the "resource curse" and improve the endogenous development momentum. In addition, the introduction of advanced technologies to improve the efficiency of thermal power generation and the use of the Clean Development Mechanism to promote the operation of the carbon trading market has also provided a reference for poverty alleviation in other poverty-stricken areas where there is a “resource curse”.

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