國立政治大學 亞太研究英語博士學位學程

博士論文

中國太陽能發展模式研究: 以甘肅、山東為例

A Study of Chinese Solar Developmental Pattern: Case Study of Gansu and Shandong in China

指導教授: 王振寰 博士

研究生: 賴俊魁 撰

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[1] 由於政治大學亞太研究博士班的博士論文與口試規定以英文做撰寫與進行，故此論文以英文作為主要書寫語言。

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致給我的父母

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賴俊魁於土城

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摘要

對能源安全的關注已經引起了世界上大多數國家的關注，包括已開發國家和發展中國家。由於飽受污染之苦，中國從另一個角度展示了促進新能源生產和發展的意圖。隨著經濟的快速發展和對傳統化石燃料供應電力和熱力的依賴，中國飽受燃煤造成的空氣污染之苦。在巨大壓力下，中國將發展新能源和環境治理作為國家發展的重點，包括可再生能源法（2005）、新版可再生能源法（2010）以及一系列連續五年計劃（FYP）。

然而，在中央同樣的引導和刺激下，不同省份的行為和結果也不盡相同。省份中，西部內陸甘肅和沿海省份山東呈現出兩種不同的光伏發展模式。本研究要探索的核心研究問題是:“中央與地方互動中的利益捆綁如何塑造中國太陽能發展格局?”為了回答研究問題，本研究的主要研究方法是通過環境捆綁經濟利益法對甘肅和山東的發展模式進行比較。

關鍵字: 太陽能發展模式、社會發展、中國、甘肅、山東

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Abstract

The concern of energy security has attracted most of the countries around the world, including developed countries and developing countries. Suffering from pollution, China demonstrated the intention from another perspective to promote the production and development of new energy. With the rapid economic development and dependence on the supply of traditional fossil fuels to provide electricity and heat, China suffered from the air pollution caused by coal burning. Under great pressure, China turned the development of new energy and environmental governance into the priority of their national development, including Renewable Energy Law (2005), New version of Renewable Energy Law (2010), and a series of continuous Five Year Plan (FYP).

However, followed by the same guidance and stimulus from the central, different provinces resulted in different behaviors and results. Among the provinces, the inner province Gansu from the western part and the coastal province Shandong presented two diverse models on photovoltaic development. The core research question that this dissertation is going to explore is: "**How bundled interests during the central-local interaction shaped the solar power development pattern in China**?" To answer the research question, the main research method of this dissertation will conduct the comparison development model in Gansu and Shandong through Environmental Bundled Economic Interest Approach.

Key words: Solar Power Developmental Pattern, Social Development, China, Gansu, Shandong

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Chapter I Introduction

Research Background

As the rise of China has attracted the attention of the world, it represents the rapid economic development behind it. However, as China enjoyed the interests and benefits from the fast-growing economic development, at the same time China suffered a lot from overdependence on thermal power generation, especially the air pollution from the traditional thermal power plants. Under the pressure to decrease pollution, China decided to promote renewable energy in order to get rid of the overdependence on traditional thermal power. Thus, a series of central policies were released and persuaded the local governments to follow. However, following the same guidance from the center under the same guidance and interests from the central policies, the result presented quite differently in inner province (Gansu) and the coastal province (Shandong), which has aroused the attention of this dissertation.

Concern and Discussion of Renewable Energy

In the academic discussion of development, the discussion on economic development and environmental governance has been a historical long debate. However, during the process of development, economic development has been prioritized to environmental governance. Several energy crises have reminded developed and developing countries of the importance of energy, such as the Chernobyl disaster in 1986 and the recent Fukushima crisis in 2011, the concern of energy security has attracted most of the countries around the world, including developed countries and developing countries.

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China demonstrated the intention from another perspective to promote the production and development of new energy. With the rapid economic development and dependence on the supply of traditional fossil fuels to provide electricity and heat, China suffered from the air pollution caused by coal burning. Under great pressure, China turned the development of new energy and environmental governance into the priority of their national development, including Renewable Energy Law (2005), New version of Renewable Energy Law (2010), and a series of continuous Five Year Plan.

With the rapid industrial development of China, the requirement on energy as well as the pollution and possible cost to deal with the pollution forces China to review its energy structure and strategy. China still relied greatly on coal as the major driving source for the energy supply. However, the dependence on coal has led to severe air pollution and further caused health issues and other social costs. The high cost has fostered China to search for other energy as the alternative, such as hydropower, wind power, and solar power. Compared to the other two renewable energy which requires large land and space for turbine-generator settlement, solar power adopted dispersed generation and could be settled on the roof of house and farm. As a result, China has viewed solar power development as one of the priorities on reducing coal dependence, and a series of policies have been released to promote solar power promotion (Ding et al., 2016; Zhang & Ji, 2014; Zhang et al, 2015).

As the solar power development began in China, China has different strategies toward different areas for energy developmental plans. In the Western part of China, owing to

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the advance in solar radiation and large space for territory, China planned provinces in the western part as the base for renewable energy generation, such as Gansu, Inner Mongolia, and Xinjiang (NDRC, 2016). On the other hand, in the coastal area of China, due to the rapid industrial development provinces in coastal areas required high demand on energy consumption, and received electricity from the outside. These provinces include Beijing, Tianjin, Shandong, and so on. However, as a result of the rise of the Chinese economy, the gap between the poor and the rich has become wider and wider. Therefore, what is the relationship of energy and economic development? Through the following discussion, this dissertation is going to explore the relationship between them.

Purpose and Importance of Research

The main purpose of this dissertation is to study the Photovoltaic (solar power) development pattern regarding the change of the role and social development in China. Especially, it focuses on the interaction between the policy of the central government and the implementation of local governments on the development of solar power development and social development of the local community in Gansu and Shandong Province. This dissertation takes Gansu, Shandong as the case study to present through the policy how the interaction between the central government and the implementation of the local governments, as well as the change of the role of solar power development and social development toward the change.

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This dissertation focused on the role of solar power development as well as the social development from the central and local government relationship in China. Due to the severe air pollution caused by rapid industrial development, China came to realize the importance of energy structure as well as implementation policy and strategy. As a result, China has organized and implemented a series of policies to promote.

In 2001, China has promoted Guang Ming Gong Cheng Project (光明工程計畫) to solve the issue of electricity shortage in remote mountain areas through photovoltaic development. Since 2007, solar power development has moved forward to marketization, which leads to great growth in installation capacity and categories of solar power applications. In 2009, the central government of China has formulated the Renewable Energy Regulation of People's Republic of China (可再生能源法) and Jin Tai Yang Shi Fan Project (金太陽示範工程) to provide general guidance and incentive on accelerating the solar power development in China. In 2013, the State Council of People's Republic of China has released Guan Yu Cu Jin Guang Fu Chan Ye De Ruo Gan Yi Jian (關於促進光伏產業健康發展的若干意見). Under the guidance of the policy, within a decade, the growth of solar power development in China has surpassed many developed countries, such as the U.S., Germany, and other European countries, and ranked one of the leading countries in terms of the installed capacity and generation.

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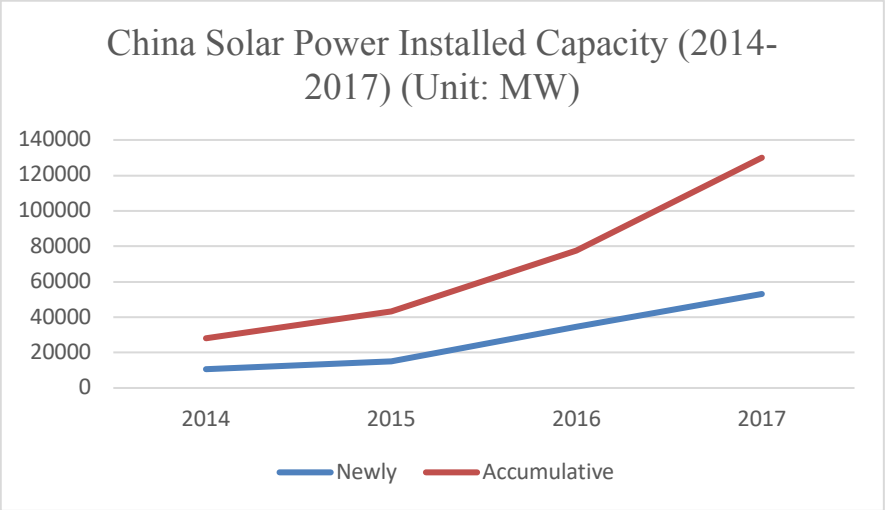

Figure 1: China Solar Power Installed Capacity (2014-2017)

During the growing process, China has listed the mission of promoting solar power development in the Five Year Plan and achieved several changes in the industry and social development. Through the guidance from the central, different local government has different way on policy implementation. In the western part of China, under the guidance of *the Renewable Energy Regulation of the People's Republic of China* and *Golden Sun Demonstration Project*, in 2015 Gansu Province has promoted solar power development and successfully constructed the large wind power base construction and further developed concentrated solar power station through wind power and solar power hybrid system. Meanwhile, in a coastal area, the solar power development in Shandong Province has utilized the wasted land and rooftop of infrastructure to develop dispersed solar power generation systems. In Shandong, the poor population has received subsidies to change their economic condition and way of living (NEA, 2011). However, under the guidance of the central policy, different provinces create different patterns in solar power development, which draws the attention of this dissertation. Therefore, this dissertation targeted to explore the role of

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solar power development in different provinces (Gansu, Shandong), and the social development from the local society and community.

As the policies for renewable energy development have been forward, the role of agents in Chinese energy development has also become even more complicated. Before the policy of renewable energy was demonstrated in 2006, the past preliminary studies focus more on the technique of solar power development. As the renewable energy policy presented, the literature review came to discuss the bureaucracy central government. However, as the renewable policy keeps forwarding, the agents in renewable energy development could not be only focused on one side of the actor. The discussion of solar power development should include the relationship between central government, local government, local energy actors (such as manufacturer and grid companies), as well as the users. As a result, the importance of this dissertation is to fulfill the gap between the preliminary studies and the current development.

Empirically, this dissertation plans to contribute the academic discussion on policy evaluation and implementation, the impact of central-local relations on solar power development, and the impact on social development, and finally the developmental pattern that has been formed. To explore the above contribution, this dissertation explores the central-local relations; the agents involving in solar power development (including central government, local government, solar power manufacturer, local farmers, and the poor); and the social development and support toward central-local interaction, which constructed the developmental pattern in solar power development.

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Through the analysis of policy implementation and central-local government interaction, this dissertation aims at presenting how has the role of solar power development in China changed and the social development toward it. To achieve the above goals, this dissertation will adopt Wang et al (2015).'s approach on Environmental Bundled Economic Interest to create a dialogue to Oi (1992, 1995)'s research on the Chinese central-local relations on local governance and move forward on the social interaction on solar power development in China.

Same Policy, Different Stories in Gansu and Shandong

On the topic of renewable energy development in China, Gansu and Shandong Provinces represent the two sides of renewable energy development in China. As an inland province, Gansu represents the inland province that enjoys a great number of natural resources, such as wind power and solar radiation. With the great natural resource, Gansu was selected as the pilot program in renewable energy development base. In 2008, the Jiuquan Wind Power Industrial Park, which started from scratch, has become the country's largest wind power industrial base. However, in 2015 the prosperous renewable energy development resulted in a high curtailment rate, which did harm to the local industry and energy development in Gansu. On the other hand, as one of the coastal provinces, Shandong did not have sufficient natural resources such as Gansu or other inland provinces. Instead, Shandong utilized its limited land resources and develop dispersed generation on renewable energy. While Gansu and other inland provinces are suffering from a high curtailment rate in renewable energy,

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Shandong combined the solar power development with its local agriculture, which in turn supports its local farmers and the poor. From the renewable development in China, the same central policy resulted in different behavior and developmental pattern in the inland province (Gansu) and coastal province (Shandong), which has aroused the interest of this dissertation. In the following, this dissertation will further explain solar power development and the difference between Gansu and Shandong.

Why Gansu and Shandong Matter?

Suffered from the pollution pressure resulted from rapid economic development, the Chinese government was forced to make a determination on policy to promote renewable energy. Therefore, followed the guidance of the central government, different provinces actively developed renewable energy accordingly. Interestingly, different provinces adopt different strategies to meet their economic interest. As a result, the energy development pattern of China could be divided into basically two parts: inner region and coastal region. The characteristic of the former presents the features such as wide range of space and less density of population. On the other hand, the characteristics of the latter demonstrate the feature such as limited space on land and high density of population. Among the performance of the inner region, Gansu contains the highest development of solar power, which ranked the top in capacity installation as well as the newly increased installation. However, the rapid growth of solar power installation brings not only the advantage of the boom of the power generation from solar radiation and solar power industry but also the negative

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impact of high solar curtailment rate, which lead to the shutdown of solar power generation.

On the other hand, Shandong presented another unique feature that is Shandong was ranked the top on power generation, However, the majority of the generation came from thermal power plants, which lead to severe air pollution to the local environment. As one of the coastal provinces, Shandong not only ranked the first province in power consumption but also the growth of agriculture production. Followed the guidance of the central government, Shandong has actively promoted solar power in order to pursue the subsidy from the central. However, the active behavior of chasing solar power development instead leads to complementary through photovoltaic and agriculture phenomenon, which presented a totally different path from Gansu.

Followed by the guidance and target from the central government, local provinces in China presented a strong potential for solar power development. Among these provinces, the performance of Gansu attracted the attention of this dissertation as Table 1 presented. In Table 1, Gansu ranked the top 1 in the centralized solar power station as well as the total number of installed capacity, which presented sufficient solar radiation and policy guidance for solar power development. Table 1 also presented the top 5 provinces are mainly located in the western part of China, which indicated the potential of western provinces on the centralized solar power station and solar radiation.

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Table 1: The Installation of Accumulated Solar Power Capacity of Different Provinces in China by 2015 (Unit: 10 MW), and illustrated by the author

Source: ESCN Database, 2016

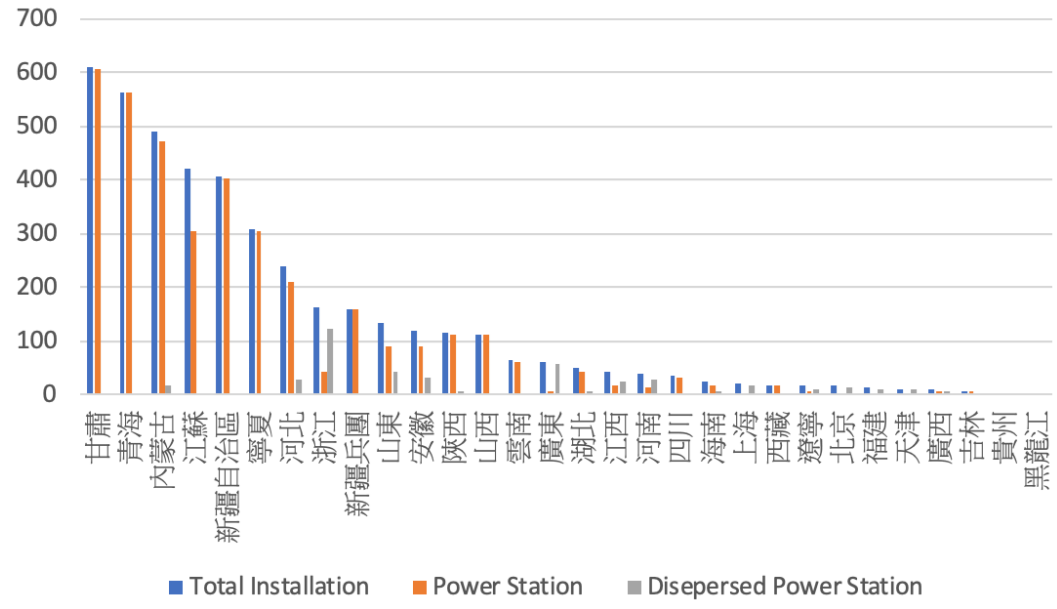

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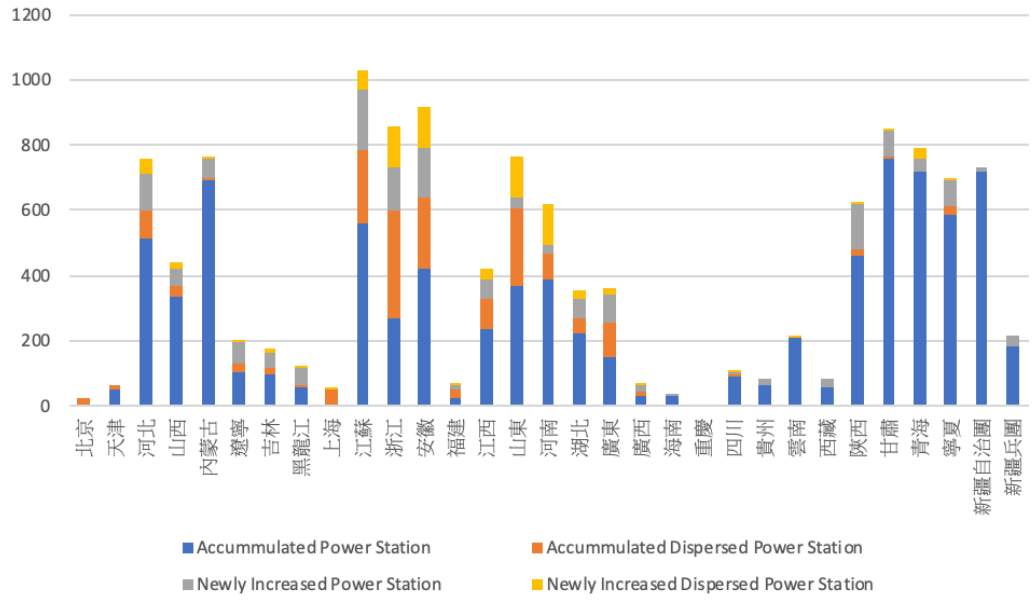
Table 2: The General Situation of Different Provinces Solar Power Generation in 2017

(Unit: 10MW) Source: National Energy Administration, 2017 and illustrated by the author



On the other hand, in coastal provinces, they presented another trend in solar power development as Table 2 presented. In Table 2, the top three provinces in the dispersed solar power station are Anhui, Zhejiang, and Shandong. Although Anhui and Zhejiang, provinces are ranked top two in newly increased installed capacity and dispersed solar power installed capacity, the newly increased capacity of Anhui and Zhejiang came equally from the solar power station and dispersed solar power. Compared to Anhui and Zhejiang, the among of newly increased capacity of Shandong came directly from dispersed solar power installed capacity, which presented the feature of coastal provinces in solar power development. As a result, in order to explore solar power developmental patterns in China, this dissertation plans to adopt Gansu and Shandong as the case study of provinces in the inner region and coastal region, which has conducted the field research.

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From the above situation, the role of renewable energy in China has been changed. Through the process of role changing from energy provider against air pollution to poverty alleviation coordinator for the poor in village and remote areas, the development of renewable energy undergone a series of changes under the interaction between the central and local government relations in China. In the next section, this dissertation will discuss how the preliminary studies worked on poverty alleviation and the perspectives that this dissertation will adopt as the theoretical framework.

Difference between Gansu and Shandong

In Hexi Corridor of Gansu, endless wind turbines and photovoltaic panels are located in the desert Gobi, and the silver line of the iron tower extends far away along the Qilian Mountains. The reserve of effective wind energy resources in Gansu Province is 237 million kilowatts, and the installed capacity is about 82 million kilowatts with the total solar radiation is 4800-6400 MJ/m2. It is conservatively estimated that the technologically developable volume of the Hexi area alone is as high as 100 million kilowatts or more, which can be called "unlimited scenery. However, many wind turbines did not start; a large number of photovoltaic equipment is also in a state of idleness-the vast new energy projects have failed to bring rich economic returns to Gansu, but they are deeply trapped in the "tragic way" of abandoning wind, solar and electricity (China Wind Energy Resource Assessment Report, 2009).

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In 2015, the situation turned out to be worse, the province's wind power utilization hours were only 1,184 hours, the wind curtailment rate reached 39%, the solar radiation utilization hours were only 1061 hours, and the solar curtailment rate reached 31%. Solar power is as high as 10.8 billion kilowatt-hours, accounting for 36.97% of the renewable energy generation. Gansu is the province with the most serious wind and solar abandonment problems in the country. Wind and solar abandonment seriously restrict the healthy operation of the new energy industry.

In Shandong, since 2006, Shandong has promoted solar power development. State Grid Shandong Electric Power Company, in the process of in-depth advancement of targeted poverty alleviation and targeted poverty alleviation, has given full play to the industry's advantages, taking photovoltaic poverty alleviation as an important starting point, and has served 9,390 photovoltaic poverty alleviation projects and connected to the grid with an installed capacity of 1.7 million kilowatts. Among them, the installed capacity of poverty alleviation is 945,100 kilowatts, giving 326,000 poor households so-called a "sunshine passbook."

By 2016, Shandong Province still has 3,035 key villages for poverty alleviation work, with a rural poor population of 2.424 million, during the Sessions of Shandong Province in 2018 Said that Shandong is a major solar energy application province. Water heaters and photovoltaics are ranked first in the country. Photovoltaics now ranks first in the country with 10.35GW of installed capacity. Faced with a solid industrial foundation and mature national subsidy policies, Shandong province takes

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advantage of the trend and makes good use of the dividends of the national policy to benefit more localities and the people to lift themselves out of poverty and increase income.

In recent years, Shandong has made full use of rural wasteland, barren slopes or roofs, and adopted measures to local conditions. In poor areas with good lighting resources, power supply companies have been used to build village-level centralized photovoltaic poverty alleviation power stations for poor villages and household dispersed photovoltaics for poor households. Carrying out photovoltaic precision poverty alleviation in other modes, Shandong sends more than 200,000 poor people a "sunshine passbook" for alleviating poverty and increasing income. When the sun comes out, the users with solar power generation devices can generate electricity. The solar power station can increase the collective income of the village by nearly 30,000 RMB a year.

1-2 Theoretical Framework

With the rise of China, the phenomenon has aroused a number of studies regarding policymaking and implementation in different fields and different levels of administration. Reviewing the past preliminary studies on renewable energy development, this dissertation found that the role of renewable energy has been shifted from a clean energy provider, which balanced the overdependence on thermal energy to a poverty alleviator, which activated the local economic development and social issues.

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Owing to the low cost of traditional thermal generation, the promotion of renewable energy could not easily change the pattern of overdependence on generation from coal-burning. In addition, the generation through renewable energy depends heavily on the weather to generate green energy from solar and wind power, which become quite unstable on generation during the peak of consumption. Therefore, the role of renewable energy development started to serve as a poverty alleviator, which provided electricity to the local farmers as well as the poor, generated extra revenue from surplus generation, and activated the local economic activities, such as farming and aquaculture fishery. Therefore, in the following paragraphs, this dissertation is going to explore how poverty alleviation in renewable energy development changed the role of renewable development and central-local government relationship, local economic activism as well as bundle economy in order to have a more comprehensive discussion on the topic.

1.2.1 Literature: Central-Local Relations and Poverty Alleviation

The role of government plays an essential part in the study of governance and development in China. The behavior pattern of local government has been deeply influenced by the higher administration and the embeddedness of the central and the local government in bureaucracy of China. Therefore, the central-local relations have been one of the major issued by a great number of scholars. In terms of central and local government relation in China, scholars have debate on the interaction through different perspectives, including fragmented authoritarianism and local corporatism.

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In terms of fragmented authoritarianism showed that power and responsibility delegated downward to provincial and local levels of government, as well as horizontally between state ministries with different, often competing functional responsibilities (Liberthal & Okesenberg, 1998; Martha, 2008, 2009). In addition, local state corporatism provides another aspect to view China's growth, which is the driving upsurge in rural industry like agriculture and state own enterprises. Local government is responsible for much of this growth that treat enterprises within their administrative purview as one component of a larger corporate whole. As for local officials, they act as the equivalent of a board of directors and sometimes more directly as the chief executive officers. Local state corporatism explained that the way in local state governance acts just as how private company manages their business, which pursues the profits and benefit their own development (Oi, 1992, 1995; Walder, 1995; Lin, 1995).

However, very few studies have focused on renewable energy and the central-local relations on environmental governance. However, no matter it is fragmented authoritarianism or local government capitalism cannot explain the situation in solar power development in China regarding the changing role of solar power development, the autonomy of local government as well as the participation of the local community. Therefore, this dissertation plans to include the local government and local agents in solar power development (such as manufacturers, grid companies, as well as the

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development from the local society and community) in order to have a more comprehensive discussion on this issue.

Dialogue with Political Interest Bundled (Authoritarianism)

Ran (2017) pointed out that local officials can shift responsibility for environmental pollution to lower-level officials, and the provincial party committee secretary is not easy to be punished even for poor environmental performance. The secretary of the provincial party committee is the most powerful role in local politics. They can shift responsibility for pollution to the less powerful local environmental protection bureau. In other words, if local officials can shift the responsibility to other units, the reform of the performance appraisal system may not be enough to make local officials more willing to protect the environment. In addition, China's current performance system encourages local officials to focus on some environmental protection policies that can achieve quantifiable results in the short term (such as planting trees in cities), but for some complex policies that require long-term planning (such as energy efficiency, or Introducing renewable energy technologies), local officials will lack incentives to innovate or implement (Ran, 2017; Shin, 2018)

The Environmental Bundled Economic Interest Approach believes that the Central Government of the Communist Party of China binds the political benefits of promotion of officials with the responsibility of environmental governance through the performance appraisal system. The secretary of the provincial party committee is the most powerful role in local politics so that they can shift responsibility for pollution to the less powerful local environmental protection bureau.

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1.2.2 Literature: Economic Activism and Poverty Alleviation

In terms of exploring the discussion between economic development as well as environmental governance, in addition to central-local government relationship, the photovoltaic development and policy implementation visualize the communication between central and local government in solar power development of China. In terms of the photovoltaic development and policy implementation, as the Chinese Five Year Plan (FYP) moves forward, the focus of scholars changes accordingly. During the 11th Five Year Plan, due to the starting point of the development of solar power, some scholars have studied the strategy, implementation, and policy effectiveness on solar power development. Peidong et al. (2009) has viewed the opportunity and challenges for the Solar power development in China. Liu and Wang (2009) have explored the practice and application from the wind-solar energy hybrid generation systems. Wang (2010) has examined of the effectiveness of the policy toward solar power development from the lesson of wind power toward photovoltaic power in China.

During the 12th Five Year Plan period, a few scholars turned the focus on industrial development and the evaluation of the policy. Zhang et al.(2013) viewed the trajectories of renewable energy from the comparison and contrast in terms of the developmental policy and their trend. They examined the status quo, problems, and approaches to solar photovoltaic industry development. Zhang et al. (2014) explored

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the pattern for renewable policy evaluation from the perspective of government and investors.

During the 13th Five Year Plan, different from the previous periods, scholars tended to shift their research interest on incentive and applicable function on solar power. Zhang (2016) analyzed the dispersed solar photovoltaic development on policy change and incentive behind. Ramos et al. (2017) explored hybrid photovoltaic-thermal solar systems in urban environments. Geall and Shen (2018) investigated poverty alleviation through solar energy in local development.

However, few studies have focused on the discussion of the policy implementation in solar power development through the interaction and participation of governments, private sectors as well as local residents. Therefore, this dissertation will explore the solar power development and policy implementation in China through the role of local government and local agents especially on the increased autonomy and how they interact under the implementation of the policy and interaction in between.

Dialogue with Economic Interest Bundled Approach

Since the reform and opening up, in order to promote economic development, the central government of the Communist Party of China has delegated many powers to local governments and used the performance appraisal system to establish positive incentives for local officials to promote economic development. If local officials can create higher economic growth or taxation within their jurisdiction, the more

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opportunities they have for promotion in the bureaucracy. However, many studies have pointed out that this decentralized governance structure is not conducive to environmental protection. In order to pursue economic growth and taxation, local governments often choose to protect the interests of local manufacturers, sacrifice environmental protection goals, and fail to effectively implement the environment. Regulations and controls form a kind of "local protectionism" (Ran, 2013; Kostka & Mol, 2013; Qi & Zhang, 2014)

1.2.3 Literature: Bundled Interest Approach and Poverty Alleviation

Based on the observation and findings from the preliminary interviews, this dissertation defined the response and new function of photovoltaic power as social development. From the previous interview, this dissertation observed that due to the feature of high cost and unstable provide on photovoltaic development, on one hand, the local government has to reach the environmental targets from the central. On the other hand, local government has to meet the objective of its own economic development. Therefore, solar power development turns out to be a role in providing benefit for social development—poverty alleviation through the local industry. As a result, to explore the above phenomenon and answer the research question, this dissertation defined social development as the third perspective to explore the comprehensive discussion of the solar development of China.

As time went by, the role of solar development has turned out to be not only a role as a power generator but also a role walks in the society to foster local development.

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Therefore, toward the discussion of economic development and environmental governance, in addition to central-local government relationship and photovoltaic development and policy implementation, the photovoltaic development and social development from the local community also plays an unavoidable part in the discussion. In terms of photovoltaic development and social development, as the Chinese Five Year Plan moves forward, the main research focus of scholars changes accordingly. During the 11th Five Year Plan, the focus of solar power development and social development aims at the role of solar power as an alternative to environmental pollution. Qian et al. (2007) examined the role of the impact of adopting solar power on the effect of air pollution. Another group of scholars, Qian et al. (2008) analyzed the impact of using dispersed generation on bringing environmental benefits. Wang (2010) found that through lessons from wind power, the effective policies of solar power could bring benefits to reduce pollution to the environment.

During the period of the 12th Five Year Plan, the discussion of social development turned out to be the generation on social consumption. Xingang et al. (2011) investigated the relationship between the dispersed solar photovoltaic and the electricity price. Fang and Wei (2013) examined the importance of solar energy utilization for rural households. Zhao et al. (2015) explored the benefits that dispersed solar photovoltaic brought on society. During the period of the 13th Five Year Plan, as eliminating the gap between the poor and the rich has become the focus of the Chinese government, some scholars focused on the photovoltaic development and the

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social development on poverty alleviation. Sheikh and Lutzenhiser (2016) discussed the social and political impact of poverty alleviation with solar power development. Ockwell et al. (2017) study the state-led solar energy for poverty alleviation program in Kenya and China. Geall and Shen (2018) explored the state ambitions, bureaucracy, interests, and local realities in Chinese solar energy for poverty alleviation.

Reviewing the preliminary studies on the discussion between economic development and environmental governance, they have covered part of it. However, as the development of solar power evolved and changed, without enough research covered or discussed the interaction between the three, including the role of government, the role of private sectors in local energy development, as well as development from the local residents. As a result, this dissertation will adopt and further extend Wang et al. (2015)'s "Environmental Bundled Economic Interest Approach" as the main theory, which illustrates renewable energy development through analyzing the relationship between government agents and local manufacturers from the perspective of bundle interest, and in this dissertation, it will further contribute on the discussion of economic development and environmental governance from the role of government, energy company and local community from the two selected cases.

Environmental Bundled Economic Interest Approach was extended from the discussion of "interest bundling" (Kostka & Hobbs, 2012), which has pointed out the fact that officials in local government are able to create new mechanisms to integrate

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policy implementation with local economic interest. Environmental Bundled Economic Interest Approach, which highlights the behavior of the local government in integrating environmental policy implementation with local economic interests, and therefore to further illustrate the reaction from local government to central state's environmental policy objective. From the research of the development of Small Hydro Powers (SMP) at the local level, the local state bureaucrats have been responding to the environmental demands from above by binding private firms' engagement in the SHP business with other local state-controlled and profitable projects, such as real estate, as financial compensation.

However, Environmental Bundled Economic Interest Approach has argued that owing to the fact that local governments prefer to develop their own SHPs without having a comprehensive river-shed development plan at different levels and occasions, which paradoxically results in unpredicted environmental disasters. Furthermore, Environmental Bundled Economic Interest Approach argued that although the Chinese central state has begun to impose new social and environmental missions on local governments, the local governments still prefer to interpret the political mission in a way that can be integrated with local economic development and to collaborate closely with private interests. Through this collaboration, local state bureaucrats simultaneously fulfill the central state's environmental and political mission and local economic development demand, which presents the autonomy of the local government.

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Due to the 2002 market reform in the electricity industry, SHPs' profit margins have been radically declined. However, the shrinking of profits has further enhanced the local government officials' alliances with the SHPs by allowing these SHPs to develop other profitable projects in order to fulfill the political mission. Through the above interaction, the collaboration has led to the situation that the hydropower stations in the upper, middle, and lower streams of the rivers may belong to different companies that have conflicts of interest in terms of utilizing the rivers for generating electric power (Zhou, 2010, 163). Although the construction of a large number of SHPs in rural areas has resulted in environmental disasters, the Chinese government's promotion of SHPs as being a positive part of its climate change policy and rural poverty alleviation for its low cost and direct implementation. However, it was the uncoordinated development that has resulted in environmental damages.

From the above discussion, this dissertation will divide the "interest" into economic interests (local development), political interests (promotion of officials), and social interests (the benefits of poverty alleviation to the local area) to discuss the case study such as Gansu Province and the case of coastal Shandong Province. Discuss how these interests are bundled in the local photovoltaic development, which has caused the overcapacity and poverty alleviation in Gansu to fail to form an effective photovoltaic development model in the local area. And how does the bundling model in Shandong produce a positive model that complements agriculture and light, and allows poverty alleviation to take root in the ground? The Environmental Bundled Economic Interest Approach concluded that in order to benefit from the development

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of SHP, China has to have a more coherent bureaucracy and comprehensive bureaucratic procedures to coordinate and review the applications of SHPs in order to rescue the rural economy from bankruptcy and save the environment.

In this dissertation, the contribution is to further distinguish the "interest" in environmental bundled economic interest into political interest (which causes an impact on the promotion of local officials to the central system), economic interest (which causes impacts on local economic activities), and finally social interest (which unbundles the limitation generated from the policy implementation and political and economic interest on the poverty alleviation project in the case study). As a result, this dissertation tries to contribute one step further on the application of the Environmental Bundled Economic Interest Approach from the two selected cases, and try to argue that in terms of the discussion between economic development and environmental governance, the bundled did not only result in the challenge and obstacle in solar energy development. Instead, through the increased autonomy of the energy agencies (such as the government, the energy companies, and the local community) the bundle economic interest could lead to a positive reaction in energy development.

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1-3 Research Methods and Procedure

1-3-1 Research Question, Hypothesis, and Main Argument

Through the above navigation on the above discussion, the construction of solar power in China has been regarded by not only the center but also local government officials as a political task in the past decade. Thousands of new solar power stations have been constructed in not only remote mountains as well as remote areas, and the electricity generated by solar photovoltaic has reached tremendous achievement in installed capacity within a decade. However, owing to the interest provided by government policy, from the preliminary observation and field research in Gansu and Shandong, these local governments (Gansu and Shandong) in different areas adopt diverse behaviors toward the development of solar power and further has created an impact on local society, ranging from "Solar curtailment and electricity limitation (棄光限電)" "Complementary through solar power and agriculture (農光互補)." and "Poverty alleviation with solar power (光伏扶貧)." 'The construction of a solar power station has led to a variety of societal and developmental concern including solar curtailment and electricity limitation (in Gansu), complementary through photovoltaic and agriculture (in Shandong, photovoltaic poverty alleviation. The same policy to solar power development but result in different local government behavior, which has aroused the interest of this dissertation.

Research Question

Owing to the above discussion and issue, the main research question of this dissertation is:

How bundled interests during the central-local interaction shaped the solar power development pattern in China?

a. What is the chronological development of solar power in China? What are the agents in central and local relations?
b. What types of bundled interests are involved in the solar power development? How these types of bundled interests result in different types of developmental pattern (棄光限電、光伏扶貧、農光互補)?"

Hypothesis

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Toward the above research questions, this dissertation includes the corresponding hypotheses. First of all, in terms of the factors and agents regarding policymaking and implementation in solar power development in China, this dissertation hypothesized that through the central and local government relationship, the policy implementation on solar power development received the subsidy and resources from the central, and pursued the interest-oriented behaviors on solar power development. According to O'Brien and Li (1999), the locals received interest from the central government and pursued the assigned objectives targeted by the central. In terms of the solar power development, while the central provide incentives for solar power development, the local government not only received benefits and resources but also gained alternative on energy consumption through solar power development. Therefore, this dissertation hypothesized that to pursue the incentive provided by the central, the local governments would adopt the interest-oriented behavior on solar power development.

Second, regarding the solar power developmental pattern in China, this dissertation hypothesized that the solar power developmental pattern in China was greatly shaped by the central and local relationship. However, the policy implementation of local government did not take all the commands or orders from the central. Instead, the local government selects the priority and pursued the maximum of its own interest in local development. Based on Oi's (1992, 1995) research, she argued that the behavior of the local government in China presented a way that is similar to corporatism in pursuing the maximum interest on its own governance. Instead, it pursued the maximum interest in its own governance. Later in 2012, Kostka and Hobb (2012)

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analyzed the issue of Chinese environmental governance through policy and interest, which pointed out that by policy implementation, the “bundle approach” balance the interest from the local to meet the target from the central. However, in terms of energy development patterns in solar power, the above existing theory and approaches could not adequately answer the question of the reaction of the central-local relationship for social demand. Finally, in 2015, Wang et al. (2015) further extended the discussion of government relationship and behavior through the “Environmental Bundled Interest Approach”, which argued the behavior of the local government in integrating environmental policy implementation with local economic interests. As a result, this dissertation hypothesized that although the local government received the incentive from the central, the local government did not take all the orders. Instead, it is the bundled interest that drives their behaviors.

Third, in terms of the social community response to the interaction between central and local government and the pattern, this dissertation hypothesized that the social development will reflect the requirement and consumption pattern on its development. According to Ockwell et al. (2017), through the positive impact of policy implementation and social interaction, the solar power policy and project could bring benefit to the local society and receive supportive feedback. Therefore, this dissertation hypothesized that the local society will support and provide a positive response to the local government policy when the requirements are met.

Main Argument

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The main arguments of this dissertation include the following three statements: First of all, in terms of policymaking and implementation, it is argued that the central government provides the guidance and present the top-down mechanism for the local to pursue and reach the goal. However, in photovoltaic development, the process of policymaking and implementation involves local autonomy. The local government would take not all the order and targets from the central, but actions based on their own priority to pursue the maximum of their interests. In addition, the development of the local society also reflects on the policy implementation to force the local government or the central to adjust and modify the targets and ways of implementation.

Second, regarding photovoltaic development in China, the preliminary studies argued that top-down bureaucracy and party-oriented centralization limited the development of the local government on energy development. The destiny of the local province depended on the arrangement and list from the central to decide the priority. However, this dissertation argued that the central and local government relations and interactions shaped the solar power developmental pattern locally. The local development is not always limited by the central instead mutually bundled. Through mutual beneficial interaction between the central-local relationship, the local development on solar power could gain positive development and increase the autonomy. On one hand, it could meet the target from the central. On the other hand, it could stimulate local development through solar power.

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Third, in terms of social development in solar power development in China, the previous studies argued that the top-down relationship shaped the engagement of the local community. However, this dissertation argued that in the issue of solar power development through positive central-local government relationship, the active local government could bring benefit to the local community and increase the participation and support from the farmers and the poor at the county and township level.

Based on the approach of "Environmental Bundled Economic Interest," this dissertation argued that the relationship and behavior of local government, local energy agents (such as manufacturers) local community (farmers and the poor) were driven by the interest provided by the policy. Therefore, this dissertation explored the central-local government relationship and the development from the local community toward the relationship through the following framework (the black line presented the interaction between different agents in solar power development while bundled interest was illustrated in red circle) as Figure 2 showed. In the case study of Gansu and Shandong, this dissertation will further provide a detailed analysis.

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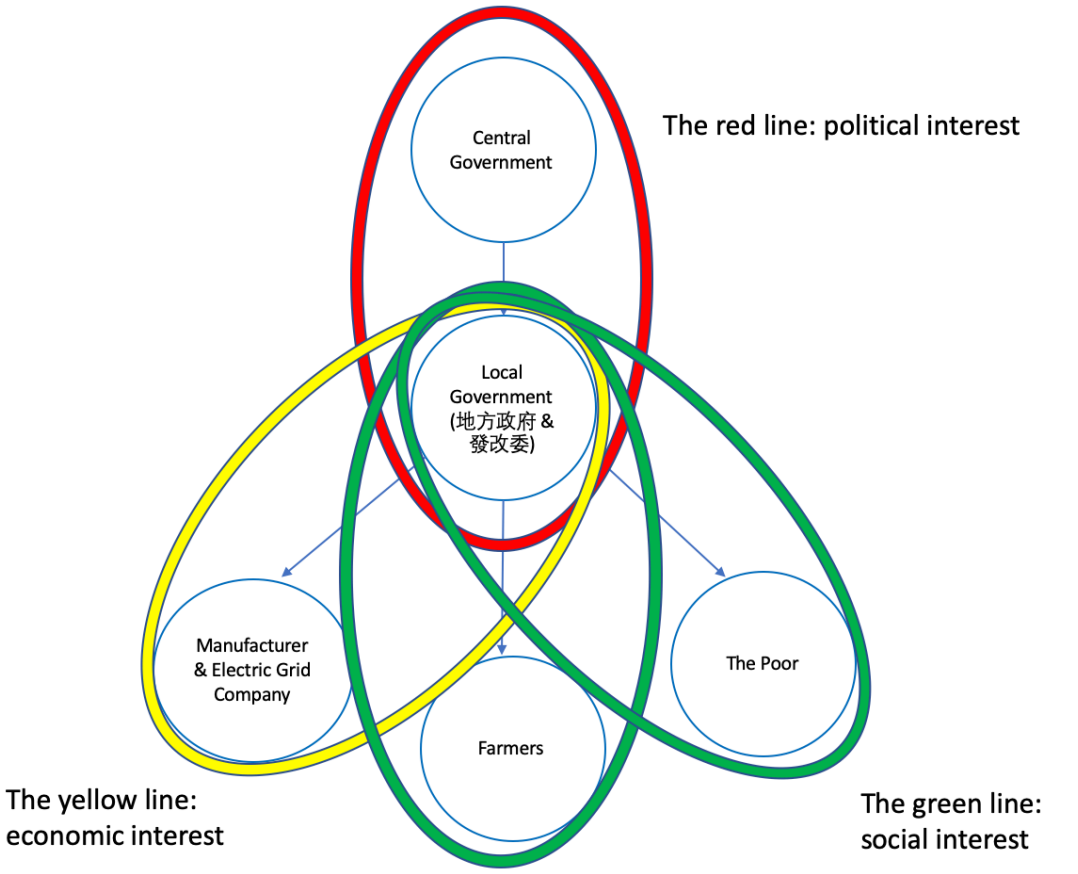

Figure 2: Analytical Framework in Environmental Bundled Economic Interest Approach

1-3-2 Research Methods

The present research analyzes the policy of solar power development regarding the central-local relationship and social development in China. This dissertation will adopt two major research approaches, including documentary research of government documents of China and solar power companies document and statistics analysis, as well as in-depth interviews with relevant stakeholders.

Data Collection

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In the following paragraphs, this dissertation will present the detailed research method and the source of the data. To follow the above theory and approach, the data collection of this dissertation will include a variety of sources.

First of all, in terms of the documentary research, the data collection will collect secondary data, including preliminary research findings, documents from government agencies, private-sector documents, and news resources. Second, in terms of in-depth interviews, this dissertation has already collected some data from conducting in-depth interviews with government officers, state-run agencies, solar power manufacturers and generators, and local agents regarding solar power development in Gansu and Shandong from 2015 to 2018, and would plan to collect more data in the following months. To prevent the privacy issue of the interviewees, this dissertation will remove the personal names and replace them with code numbers. Third, in terms of comparison studies, this dissertation will build up a consistent research framework on solar power development, including policy, factors, and agents. Through these aspects, this dissertation will adopt the research framework and explore the developmental pattern on solar power development in Gansu and Shandong Provinces. The field of the interview location range from government agents, including the development and reform commission of Beijing (central government), Gansu government officers and Shandong government officers; solar power relevant actors, including solar power manufacturers, national grid and local grid companies; and local society, including local resident who received the impact from the solar power development.

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Thanks to the support from MOST on a research project, this dissertation has collected preliminary data from Gansu and Shandong. From 2015 to 2018, Professor Wang Jenn Hwan research team has conducted in-depth interviews with government officials from Beijing (National Grid), Gansu (development and reform bureau), Shandong (development and reform bureau). In addition to government officials, the field research also includes interviews with local energy manufacturers and generators as well as the local users. For the follow-up data, this dissertation may require further information from Gansu and Shandong if the field research to China could be arranged, or the interview would be conducted through online conference meetings with local government officials and energy agents when necessary.

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1-4 Contribution

Create a Dialogue to the Existing Academic—the Discussion on Cultivating on Environmental Governance

The existing dialogue on energy study could be shown from the discussion of economic activism (Lin, 1995; Oi, 1992, 1995) and fragmented authoritarianism (Lieberthal & Oksenberg, 1988; Mertha, 2008, 2009) in Asia, they presented that in China the central-local relationship was the core for renewable energy development.

In 2012, until the research of Kostka and Hobb (2012), they analyzed the issue of environmental governance in China through the aspect of policy and interest. They pointed out that by policy implementation, the "bundle approach" balance the interest from the local to meet the target from the central. However, in terms of the more comprehensive discussion on energy development patterns in solar power, the above existing theory and approaches could not adequately answer the question of the interaction of the central-local relationship for social demand.

In 2015, Wang et al. (2015) further discussed and extended the approach on interest and formed the "Environmental Bundled Interest Approach", which argued the behavior of the local government in integrating environmental policy implementation with local economic interests. The major contribution of this dissertation is to further extend the "Environmental Bundled Interest Approach" to have an in-depth analysis and discussion on the interaction between central, local government, and local society. From their requirement and behavior, this dissertation expected to illustrate the relationship between these different energy agents and the bundled interests

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among them in order to fulfill the gap between the above existing theories and approaches as well as the related academic discussion.

Fulfill the Gap on Environmental Governance

As the previous discussion from the literature review, this research considered in terms of the role of renewable energy development has been changed (from an energy provider only to both energy provider and social development coordinator). Owing to dealing with the change, it is essential to include the interaction with the response from local communities. As a result, this research analyzed and discussed the solar power development from three layers of perspectives including government (central and local government), energy companies (including manufacturers), and finally the local communities (mainly the response from local users, such as farmers and the poor). The main contribution of this dissertation is the examination of the interaction between the above three actors, extend the existing discussion on solar power in Asia pacific studies, and one step further to fulfill the gap on the existing discussion.

Provide Experience and Suggestion for Taiwan in Terms of Go Green with Nuclear Policy and Related Energy Arrangement and Concern

One of the main policies of Tsai Ying-Wen government is the "2025 Nuclear-free Homeland", which means a restructuring of the current energy structure and the increase of renewable energy adaptation. Following the direction, in 2019 that the result of the referendum also indicated majority in Taiwan decided to cultivate green energy through adopting nuclear. Therefore, the importance of energy management and development increase as time went by. From the dialogue and experience of different case studies in China both inner province and coastal one alike, this dissertation wish to contribute those experience and practices to the planning of Taiwan, my home country and wish Taiwan to be the excellent model on renewable energy development in Asia Pacific area.

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Chapter 2: Literature Review—Central Local Interaction under Political Interest Bundle, Economic Interest Bundle, and Social Interest Bundle Approach

The literature review on Chinese renewable energy development as the development on the role of renewable energy has followed from the political, economic, and social development.

As the rise of China, this phenomenon has aroused a number of studies regarding policymaking and implementation in different fields and different levels of administration. Reviewing the past preliminary studies on renewable energy development, this dissertation found that the role of renewable energy has been shifted from a clean energy provider, which balanced the overdependence on thermal energy, to a poverty alleviator, which activated the local economic development and social issues.

Renewable energy development in China has developed from a balancer on traditional energy to coordinator on poverty alleviation on social development locally. To get rid of the overdependence on the traditional thermal plant, China has accelerated renewable energy at the full speed. In 2015, China's solar power capacity increased by 74% compared to the previous year, and wind power capacity increased by 34%. According to the National Bureau of Statistics of China, China's wind power installations in 2015 set a record in a single year in global history: 32.5 GW.

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According to data from the National Energy Administration of China, in the first half of 2016, the average curtailment rate of wind power in China was as high as 21%. The Xinjiang Uygur Autonomous Region Development and Reform Commission also pointed out that the curtailment rate in Xinjiang reached 43.9% and the curtailment rate reached 31.8%, an increase of 16% and 15.7% respectively over last year. The amount of abandonment of wind and light in the first half of this year is equivalent to the amount of abandonment of wind and light in the whole year of last year, and even exceeded the new electricity consumption of the country in 2015, which presents that the waste is astonishing.

Owing to the low cost of traditional thermal generation, the promotion of renewable energy could not easily change the pattern of overdependence on generation from coal-burning. In addition, the generation through renewable energy depends heavily on the weather to generate green energy from solar and wind power, which become quite unstable on generation during the peak of consumption. Therefore, the role of renewable energy development started to serve as a poverty alleviator, which provided electricity to the local farmers as well as the poor, generated extra revenue from surplus generation, and activated the local economic activities, such as farming and aquaculture fishery.

As the state development moves on, the central-local relationship in China leads to questions toward the traditional political system and a variety of aspects, including implementation of policy, the interaction between central and local government, and

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response from local society and community (Oi, 1992, 1995). As the state development moves faster, the demand for energy consumption becomes even higher. However, to pursue development, China suffered from the cost of its environment, which challenges the current political system to find an alternative on the balance between development and environment. Therefore, in order to understand the central-local relationship in the process of policy implementation on solar power, this dissertation is going to explore from the past preliminary studies on central-local relationship, policy-making and implementation, and social response.

Therefore, in the following paragraphs, this session is going to explore how central-local relations interacted with political interest, which has presented the process from top-down to bottom-up interaction between the central and local government and in turned shaped renewable energy development through policy implementation. Second, this dissertation is also trying to explore the literature review on central-local relations interacting with an economic interest, which as well as social in renewable energy development.

Category of Literature	**Theoretical Literature**	**Practical Application**
Bundled Political Interest	Local Cadre System Fragmented Authoritarianism,	The development of renewable energy policy has been shaped from top-down to bottom-up

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	Environmental Authoritarianism	interaction between central-local relations
Bundled Economic Interest	Economic Activism, Local State Corporatism	The development of renewable energy was organized by local officers which would be evaluated by the local cadre system and thus govern the local economy as the corporatism
Bundled Social Interest	Bundle Interest, Environmental Bundled Economic Interest Approach	The development of renewable energy was shifted from the role of energy provider to coordinator into local social development, and therefore, it forms the local poverty alleviation pattern

Table 2-1: Comparison of the preliminary studies on Chinese environmental governance. Sources: Lieberthal and Lampton (1992), Mertha (2008), Oi (1992, 1995), Kostka, Genia & Hobbs, William (2012), Wang et al., (2015)

In terms of renewable energy from the past preliminary studies, the studies have focused on the political aspects as well as economic perspectives. However, as the above discussion, the role of renewable energy in China has been moved from a pollution coordinator to a bridge in connecting poverty alleviation and development.

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In this section, this dissertation will review the past preliminary studies from political and economic, and extend the discussion on the social interest aspects. With the rise of China, the phenomenon has aroused a number of studies regarding policy-making and implementation in different fields and different levels of administration. Reviewing the past preliminary studies on renewable energy development, this dissertation found that the role of renewable energy has been shifted from a clean energy provider, which balanced the overdependence on thermal energy, to a poverty alleviator, which activated the local economic development and social issues.

Owing to the low cost of traditional thermal generation, the promotion of renewable energy could not easily change the pattern of overdependence on generation from coal-burning. In addition, the generation through renewable energy depends heavily on the weather to generate green energy from solar and wind power, which become quite unstable on generation during the peak of consumption. Therefore, the role of renewable energy development started to serve as a poverty alleviator, which provided electricity to the local farmers as well as the poor, generated extra revenue from surplus generation, and activated the local economic activities, such as farming and aquaculture fishery.

Therefore, in the following paragraphs, this dissertation is going to explore how environmental governance has interacted with the past preliminary studies, especially from political interest (central-local relations), economic interest (local economic

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activism) as well as social interest (poverty alleviation from the bundled economic interest) to discuss the renewable development.

2.1 Literature: Political Interests and Environmental Governance

The role of government plays an essential part in the study of governance and development in China. The behavior pattern of local government has been deeply influenced by the higher administration and the embeddedness of the central and the local government in the bureaucracy of China. Therefore, the central-local relations have been one of the major issues by a great number of scholars. The central local relations refer to how the policies from the central authority was implemented by local actors or agents within the political system. In terms of central and local government relations in China, scholars have a debate on the interaction through different perspectives, including Fragmented Authoritarianism (FA) and Cadre Performance Evaluation System (CPES).

First of all in Fragmented Authoritarianism, "fragmentation" originally meant that the whole thing was broken into many pieces (fragment). In the field of government management, "fragmentation" refers to the division of various issues within the department, the division between departments of the first-level government, and the division of local governments. The formation and development of the “fragmented” government management model have gone through a long period of time. If different departments are facing common issues in their own way, lack of mutual coordination, communication, and cooperation, resulting in the government. The overall policy goal

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of the government cannot be successfully achieved, so a fragmented government is formed.

Scholars used "fragmentation" to illustrate China's decision-making system and procedure to emphasize that bureaucrats in various government departments will make policy or influence policy formulation according to the interests of their departments. In the process, the various departments of the central government, between the central and local governments, and between the various levels of local governments in the project negotiation, through the process of disputing, compromising, and bargaining, and finally it formulates public policies (Lieberthal, 1997 ; Lampton, 1988).

The fragmented authoritarianism theory represented that power and responsibility delegated downward to provincial and local levels of government, as well as horizontally between state ministries with different, often competing for functional responsibilities (Liberthal & Okesenberg, 1998; Martha, 2008, 2009). On the other hand, the local cadre management and evaluation system provide another aspect to view China's central-local relations, which is the driving upsurge in the rural industries like agriculture and state own enterprises. The local government is responsible for much of this growth that treats enterprises within their administrative purview as one component of a larger corporate whole. As for local officials, they act as the equivalent of a board of directors and sometimes more directly as the chief executive officers. Cadre's performance evaluation system evaluated the performance

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of local government officials and further control the behavior and action them, which the central government could shape the policy implementation and the desired result (Lieberthal, 1997; O'Brien et al., 1999; Cai, 2004).

However, the past preliminary studies did not touch upon too much on the interaction of society and their involvement in environmental governance. No matter it is fragmented authoritarianism or cadre performance evaluation system cannot explain the situation in solar power development in China regarding the changing role of solar power development, the autonomy of local government as well as the participation of local society. Therefore, this dissertation tries to argue that the environmental governance in China could be discussed from the aspect of political interest include the local government and local agents in solar power development (such as manufacturers, grid companies, as well as the development from the local society and community) in order to have a more comprehensive discussion on this issue.

As the fragmented authoritarianism pointed out that China's bureaucracy, policy, and decision-making process after 1978 followed a model called "fragmented authoritarianism." Fragmented authoritarianism illustrated the Chinese bureaucracy with the "bar-block (the tiao and kuai)" structure. "Bar" refers to the vertical relationship from the central to the local level, and "block" refers to the horizontal relationship between various departments at each administrative level (national, provincial, prefecture, city, and county). From both vertical and horizontal directions,

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there are complex games that make decision-making more difficult. Therefore, China is not a highly centralized and prohibitive system that most people think of.

Close examination of provincial-government activities, both with the Center and with lower-level governmental units and enterprises under their jurisdictions, provides a clearer picture of the nature of China's political system. The number of units with some authority in any functional setting, their interlocking connections with central leading organs (tiao-tiao lingdao guanxi) and local leading organs (kuai-kuai lingdao guanxi), the relative inability to obtain resources easily (what some blame on a scarcity of these resources), the complexity of decisions demanded by modern commercial activity, the lack of formalized decision-making rules, and weak institutions—all constrain policymakers. The Center, lacking the capability to enforce policy choices, is thus forced to issue implementation guidelines that are vague and open to broad, conflicting interpretation by implementing agencies. Things get accomplished more often than not by bargaining among the many actors involved.

...modernization's demands for bureaucratic specialization has fragmented power within the county leadership. But findings here appear to confirm the control image offered by Lieberthal and Oksenberg and the argument that "vertical" (tiao-tiao) authority remains more powerful than "horizontal" (kuai-kuai) ties even under the reforms

In the decentralization that followed 1978, provincial governments have gained considerable decision-making authority, thereby enhancing the relative power of these kuai-kuai leaders. These locally based authorities have shown themselves (as have tiao-tiao authorities at the Center) to be quite resilient despite efforts designed to curtail their authority (such as periodic recentralization of foreign trade), in large measure because the Center is relying on these same kuai-kuai (and tiao-tiao) authorities to implement the reform policies that would replace administrative authorities with economic networks. (Lieberthal and Lampton, 1998, 285 and 357)

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The tiao-kuai relations demonstrate the interaction between the central and local relations in 1978 did not follow the long term top-down relations, but actually shows the decentralized relations between the central and local. The interaction between the central leaders (tiao-tiao) and the interaction between the local organizers (kuai-kaui) constitutes the complex policy-making procedure in Chinese political relations.

In recent years, fragmented authoritarianism was further applied into the governance on environmental and sustainable development issues.

Development of Political Interest Theory

Based on the fragmented authoritarianism proposed by Lieberthal and Lampton, several scholars have provided the revision and application on different cases in environmental governance. For instance, revised fragmented authoritarianism (fragmented authoritarianism 2.0) further argued and revised that the framework and structure in authoritarianism constrain the limitation of the central-local relation in environmental governance.

".. previously-excluded members of the policy-making process in China – officials only peripherally connected to the policy in question, the media, non-governmental organizations, and individual activists – have successfully entered the political process precisely by adopting strategies necessary to work within the structural and procedural constraints of the fragmented authoritarianism framework." (Mertha, 2009, 996).

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Revised fragmented authoritarianism accounted for the fact that although China remains authoritarian, it is nevertheless responsive to the increasingly diverse demands of Chinese society. Therefore, the rules of the policy-making process are still captured by the fragmented authoritarianism framework, but that the process has been gradually limited and pluralized: barriers to entry have been lowered, at least for certain actors identified here as “policy entrepreneurs.” With policy change as the variable of interest, the policy entrepreneurs' ability to limit the issue effectively explains variation in renewable policy outcomes (Mertha, 2009; Zhu, Y., 2012 Teets, 2013).

Further, the fragmented authoritarianism was further applied into the environmental governance and examine the interaction between the central and local governments. In environmental governance, authoritarianism examines from a non-participatory approach to public policy-making and implementation in the face of severe environmental challenges. From the case of China's climate change policy, the meaning, causes, and consequences of authoritarian environmentalism, authoritarian environmentalism is more effective in producing policy outputs than outcomes (Gilley, 2012; EF et. al, 2017, Howes et. al. 2017).

Environmental authoritarianism further pointed out the policy implementation and ways of interaction between policy-makers. that from a high turnover of leading officials at the local level may hinder state-led greening growth initiatives. In order to promote the implementation of central directives, frequent cadre turnover is intended

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primarily to keep local party secretaries and mayors. During the process, officials with short time horizons prefer to choose the path of least resistance in selecting quick, low-quality approaches to the implementation of environmental policies. The perverse effects of local officials' short time horizons give reason to doubt the more optimistic claims about the advantages of China's model of environmental authoritarianism (Eaton and Kostka, 2014; Lo, 2015; Kostka, 2016).

During the central and local interaction, Environmental authoritarianism adopted an evaluation system on local cadres. Development of renewable energy at the provincial level in China, modeling installed wind capacities as a function of both economics and politics. The top provincial officials desire to maximize their chances of promotion under the Chinese cadre evaluation system. Those with the strongest incentives to perform in order to achieve promotion would work harder to comply with the central government's policy agenda to promote renewable energy. From provincial leaders' characteristics, provinces governed by party secretaries, the political tournaments theory of Chinese politics. (Cao et al., 2016; Li et al., 2019).

Dialogue with Political Interest Theory

The theoretical framework of Lieberthal and Oksenberg provides another perspective on how the central government uses political power and officials' assessment to influence local behavior in the relationship between the central government and local governments. This thesis, this thesis argues that the local government's research points out the political interests in the relationship between the central and local

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governments. This dissertation refers to it as tied political interest. And how does this tied political interest affect the interaction between actors under the framework of environmental governance?

Through the discussion of political interest in environmental governance, the Chinese authority adopted the evaluation system to encourage and control the behaviors of local officials or agents on the promotion and development of renewable energy. Ran (2017) pointed out that local officials can shift responsibility for environmental pollution to lower-level officials, and the provincial party committee secretary is not easy to be punished even for poor environmental performance. The secretary of the provincial party committee is the most powerful role in local politics. They can shift responsibility for pollution to the less powerful local environmental protection bureau. In other words, if local officials can shift the responsibility to other units, the reform of the performance appraisal system may not be enough to make local officials more willing to protect the environment. In addition, China's current performance system encourages local officials to focus on some environmental protection policies that can achieve quantifiable results in the short term (such as planting trees in cities), but for some complex policies that require long-term planning (such as energy efficiency, or Introducing renewable energy technologies), local officials will lack incentives to innovate or implement (Ran, 2017; Shin, 2018)

From the discussion and development of authoritarianism, this dissertation argues that the central government of the Communist Party of China binds the political benefits

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of promotion of officials with the responsibility of environmental governance through the performance appraisal system. The secretary of the provincial party committee is the most powerful role in local politics. They can shift responsibility for pollution to the less powerful local environmental protection bureau.

2.2 Literature: Economic Activism and Environmental Governance

In this session, this dissertation will explain environmental governance from the aspect of economic activism. In terms of exploring the discussion between economic development as well as environmental governance, in addition to central-local government relationship, the solar power development and policy implementation visualize the communication between central and local government in solar power development of China, especially on economic activism and local state corporatism which explained that the way in local state governance acts just as how private company manages their business, which pursues the profits and benefits their own development (Oi, 1992, 1995; Walder, 1995; Lin, 1995; Guo, 2001; Zhu, 2004; Hsing, 2010).

Local state corporatism refers to the corporatization of local governments refer to the situation that local governments in their own administrative areas, with the goal of maximizing their own interests, with the control and domination of various administrative resources as the capital, and commercial behavior and super-economic coercion as the market transactions are the operating method, the use of cheap labor from the people is the employment and personnel management strategy, the so-called

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"organize and operate the local province" (in China) is the concept of the pseudo-public interest maximization, the official boss is the way of politics, and the "political achievement" and a set of officialdom rules system similar to the corporate system formed by performance and promotion.

Under the fiscal reform in the 1980s in China, local state corporatism provided localities with strong incentives and a heightened capacity to pursue industrial growth. Thus, local governments have responded vigorously to economic reform, managing rural collective-owned enterprises as diversified corporations, with local officials performing the role of a board of directors. The incentives that have led to the development of this form of local state corporatism and rapid rural industrialization, and describe the ways in which local governments coordinate economic activity and reallocate revenues from industrial production. On one hand, local government involvement in the economy does not necessarily decline with the expansion of market coordination. On the other hand, the local governments offer a successful model of reform that serves as a counterpoint to privatization proposals. As Oi further illustrated in the following paragraph,

> *"By local state corporatism, I refer to the workings of a local government that coordinates economic enterprises in its territory as if it were a diversified business corporation. I am not concerned with the role of the central state in the vertical integration of interests within society as a whole. Whereas the central state set the reform process in motion and provided localities with the incentives and the leeway to develop economically, it is local government that has determined the outcome of reform in China (Oi, 1995, 100-101)."*

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China's modernization since the reform has been a local government-oriented modernization. In the insufficiency of social resources, local governments have become the biggest driving force for development. The government that was supposed to be the night watchman in the process of economic development has suddenly become the protagonist. The government's interests are directly related to economic activities, and its behavior and motives have the characteristics of a company. Under the description of local state corporatism, the corporatization of Chinese local governments is a feature worthy of recognition and positive value, and it is one of the most important factors for the rapid development of China's economy. In the initial stage of China's modernization, the corporatization of local governments gave the government its own impulse for economic development, which greatly promoted the initiation and initial development of modernization. However, if the local government continues along this corporatization track, the further development of the market economy will do more harm than good, and even cause fatal destruction.

In different phrases of the Five Year Plan (FYP), the core and objective vary as well, which reflected in periods of research and focus. In terms of solar power development and policy implementation, as the Chinese Five Year Plan (FYP) moves forward, the focus of scholars changes accordingly. During the 11th Five Year Plan, due to the starting point of the development of solar power, the study focused on the strategy, implementation, and policy effectiveness of solar power development. has viewed the opportunity and challenges for the solar power development in China, the practice and

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application from the wind-solar energy hybrid generation systems, and examined of the effectiveness of the policy toward solar power development from the lesson of wind power toward photovoltaic power in China. (Peidong et al., 2009, Liu and Wang, 2009; Wang, 2010).

During the 12th Five Year Plan period, a few scholars turned the focus on industrial development and the evaluation of the policy. The research concentrated on the trajectories of renewable energy from the comparison and contrast in terms of the developmental policy and their trend, examined the status quo, problems, and approaches on solar photovoltaic industry development, and explored the pattern for renewable policy evaluation from the perspective of government and investors (Zhang et al., 2013; Zhang et al., 2014).

During the 13th Five Year Plan, different from the previous periods, scholars tended to shift their research interest on incentive and applicable function on solar power. They focused on analyzed the dispersed solar photovoltaic development on policy change and incentive behind; explored hybrid photovoltaic-thermal solar system in an urban environment; and investigated the poverty alleviation through solar energy in local development (Zhang, 2016; Ramos et al., 2017; Geall and Shen, 2018).

Development of Economic Interest Theory

Under the development Five Year Plan, the developmental policies have provided different economic interests. Therefore, economic activism has undergone different

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stages of development. During the 11th Five Year Plan, Economic activism in environmental governance focused on how the locals reaching the objectives and receiving subsidies from the central, especially on pollution control. During this period, China has developed its environmental policy by mainly focusing on industrial pollution control. Environmental policy in China was initiated by the central government under the leadership of top leaders in the Communist Party, and administrative and law systems have been strengthened gradually. The State Council, as the highest administrative body in China, has called all industries to comply with emission standards and has also issued implementation guidelines to order local governments to shut down small-scale industries which cause heavy environmental pollution. On the other hand, the government has further cooperated with the newly reformed People's Congress and the mass media, even though all media in China are still under the control of the government and the Communist Party, to supervise and inspect the policy process of meeting the command and control from the central government. (Otuska, 2007; Mori, 2011).

During the 12th FYP, the economic activism in environmental governance presented the environmental governance in the pilot cities (pilot states in China). Local administration in China remains a contested territory of environmental governance. During environmental governance, economic growth often comes with high environmental costs, but the central government's environmental regulations are implemented without even distribution among the local states. The experience of policy uptake and adoption of the National Model City of Environmental Protection

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program in the county-level cities of the Suzhou Municipality. Also, the rationales for these cities' adoption of the policy, and implications for the emergence of the "environmental state" in local China. While economic development remains an important priority of local officials, the preference of the local officials is not immutable but is now complemented in some areas by substantial local commitments to environmental good practice, often under the influence of local leaders as well as provincial authorities (Li et al., 2011; Lang and Xu, 2013).

During the 13th FYP, the economic activism in environmental governance presented the ecological development especially on increasing the environmental quality and solving the challenge in the local. Facing deep-rooted challenges, economic activism in environmental governance tries to focus on environmental quality improvement and solving the economic and environmental tensions that arise. Through the evolving environmental governance challenges at the city level economic activism in environmental governance conducted public policy delivery. During the 13th FYP, in major urban areas, problems of poor waste management, and pollution issues have been experienced by citizens for some time. Local governments are being assisted, which fosters to rethink environment and economy relations by a central government policy agenda that is moving from an overwhelming preoccupation with development to taking on board welfare and environmental concerns. Thus, on one hand, the local state is facing up to its polluted environment and seeking to steer its way towards a new, more ecologically friendly development pathway. On the other hand, the local

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state also has to promote economic development in order to receive the subsidy from the central (Flynn and Yu, 2020; Flynn and Hacking).

Dialogue with Bundled Economic Interest

During the 13th FYP, the economic activism in environmental governance presented the ecological development especially on increasing the environmental quality and solving the challenge in the local. Facing deep-rooted challenges, economic activism in environmental governance tries to focus on environmental quality improvement and solving the economic and environmental tensions that arise. Through the evolving environmental governance challenges at the city level economic activism in environmental governance conducted public policy delivery. During the 13th FYP, in major urban areas, problems of poor waste management, and pollution issues have been experienced by citizens for some time. Local governments are being assisted, which fosters to rethink environment and economy relations by a central government policy agenda that is moving from an overwhelming preoccupation with development to taking on board welfare and environmental concerns. Thus, on one hand, the local state is facing up to its polluted environment and seeking to steer its way towards a new, more ecologically friendly development pathway. On the other hand, the local state also has to promote economic development in order to receive the subsidy from the central (Flynn and Yu, 2020; Flynn and Hacking).

Oi's theoretical framework provides another perspective on the response of local governments to the central government in the relationship between central and local governments and the positive actions they have taken. In this paper, this paper

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believes that Oi's research points out the economic benefits in the relationship between the central and local governments. This paper refers to it as bundled economic benefits. And how does this bundled economic benefit affect the interaction between actors under the framework of environmental governance?

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2.3 Literature: Environmental Bundled Economic Interest Approach and Environmental Governance

Based on the observation and findings from the preliminary study, this dissertation defined the response and new function of photovoltaic power as social development. From the previous interview, this dissertation observed that due to the feature of high cost and unstable provide on photovoltaic development, on one hand, the local government has to reach the environmental targets from the central. On the other hand, local government has to meet the objective of its own economic development. Therefore, solar power development turns out to be a role in providing benefit for social development—poverty alleviation through the local industry. As a result, to explore the above phenomenon and answer the research question, this dissertation defined social development as the third perspective to explore the comprehensive discussion of the solar development of China.

Bundle interest refers to the concept of 'interest bundling' (Kostka & Hobbs, 2012) has pointed out the fact that local officials are able to create new mechanisms to integrate policy implementation with a local economic interest, it does not carry too much weight on the ways in which local government responses to central state's environmental policy demand. In fact, the bundled interest concept is not very different from the concept of local state's economic activism that describes local officials' creative role in developing local economies. Therefore, in order to precisely decipher the new political situation that stresses environmental improvement, we revise the concept into 'environmentally bundled economic interest' in this

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dissertation in order to highlight the local government's behavior in integrating environmental policy implementation with local economic interests.

As time went by, the role of solar development has turned out to be not only a role as a power generator but also a role walks in the society to foster local development. Therefore, toward the discussion of economic development and environmental governance, in addition to central-local government relationship and photovoltaic development and policy implementation, the photovoltaic development and social development from the local community also plays an unavoidable part in the discussion. In terms of photovoltaic development and social development, as the Chinese Five Year Plan moves forward, the main research focus of scholars changes accordingly. During the 11th Five Year Plan, the focus of solar power development and social development aims at the role of solar power as an alternative to environmental pollution. Qian et al. (2007) examined the role of the impact of adopting solar power on the effect of air pollution. Another group of scholars, Qian et al. (2008) analyzed the impact of using dispersed generation on bringing environmental benefits. Wang (2010) found that through lessons from wind power, the effective policies of solar power could bring benefits to reduce pollution to the environment.

During the period of the 12th Five Year Plan, the discussion of social development turned out to be the generation on social consumption. Xingang et al. (2011) investigated the relationship between the dispersed solar photovoltaic and the

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electricity price. Fang and Wei (2013) examined the importance of solar energy utilization for rural households. Zhao et al. (2015) explored the benefits that dispersed solar photovoltaic brought to society.

During the period of the 13th Five Year Plan, as eliminating the gap between the poor and the rich has become the focus of the Chinese government, some scholars focused on the photovoltaic development and the social development on poverty alleviation. Sheikh and Lutzenhiser (2016) discussed the social and political impact of poverty alleviation with solar power development. Ockwell et al. (2017) study the state-led solar energy for poverty alleviation program in Kenya and China. Geall and Shen (2018) explored the state ambitions, bureaucracy, interests, and local realities in Chinese solar energy for poverty alleviation.

Reviewing the preliminary studies on the discussion between economic development and environmental governance, they have covered part of it. However, as the development of solar power evolved and changed, little research has covered or discussed the interaction between the three, including the role of government, the role of private sectors in local energy development, as well as development from the local residents. As a result, this dissertation will adopt and further extend Wang et al. (2015)'s "Environmental Bundled Economic Interest Approach" as the main theory, which illustrates renewable energy development through analyzing the relationship between government agents and local manufacturers from the perspective of bundle interest, and in this dissertation, it will further contribute on the discussion of

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economic development and environmental governance from the role of government, energy company and local community from the two selected cases.

Environmental Bundled Economic Interest Approach was extended from the discussion of "interest bundling" (Kostka & Hobbs, 2012), which has pointed out the fact that officials in local government are able to create new mechanisms to integrate policy implementation with local economic interest. From Professor Wang and Professor Tseng's Environmental Bundled Economic Interest Approach (Wang et al., 2015), which highlights the behavior of the local government in integrating environmental policy implementation with local economic interests, and therefore to further illustrate the reaction from local government to central state's environmental policy objective. From the research of the development of Small Hydro Powers (SMP) at the local level, the local state bureaucrats have been responding to the environmental demands from above by binding private firms' engagement in the SHP business with other local state-controlled and profitable projects, such as real estate, as financial compensation.

Environmental Bundled Economic Interest Approach has argued that owing to the fact that local governments prefer to develop their own SHPs without having a comprehensive river-shed development plan at different levels and occasions, which paradoxically results in unpredicted environmental disasters. Furthermore, Environmental Bundled Economic Interest Approach argued that although the Chinese central state has begun to impose new social and environmental missions on

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local governments, the local governments still prefer to interpret the political mission in a way that can be integrated with local economic development and to collaborate closely with private interests. Through this collaboration, local state bureaucrats simultaneously fulfill the central state's environmental and political mission and local economic development demand, which presents the autonomy of the local government.

Development of Social Interest Theory

Due to the 2002 market reform in the electricity industry, SHPs' profit margins have been radically declined. However, the shrinking of profits has further enhanced the local government officials' alliances with the SHPs by allowing these SHPs to develop other profitable projects in order to fulfill the political mission. Through the above interaction, the collaboration has led to the situation that the hydropower stations in the upper, middle, and lower streams of the rivers may belong to different companies that have conflicts of interest in terms of utilizing the rivers for generating electric power (Zhou, 2010, 163). Although the construction of a large number of SHPs in rural areas has resulted in environmental disasters, the Chinese government's promotion of SHPs as being a positive part of its climate change policy and rural poverty alleviation for its low cost and direct implementation. However, it was the uncoordinated development that has resulted in environmental damages.

From the above discussion, this dissertation will divide the "interest" into economic interests (local development), political interests (promotion of officials), and social interests (the benefits of poverty alleviation to the local area) to discuss the case study

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such as Gansu Province and the case of coastal Shandong Province. Discuss how these interests are bundled in the local photovoltaic development, which has caused the overcapacity and poverty alleviation in Gansu to fail to form an effective photovoltaic development model in the local area. And how does the bundling model in Shandong produce a positive model that complements agriculture and light, and allows poverty alleviation to take root in the ground?

As the development of renewable energy proceeded, the environmental governance did not only exist in political and economic interaction between the central and local governments but also present in the social interest. The social interest approach presented in the situation when the local society suffered from great pressure such as disasters (natural and man-made). Through the institutional arrangements in environmental governance, local governments employed local cadres to meet the objective from the center under the environmental governance structure. With different levels of economic development and natural resource access, local states presented the current institutional arrangements – including those regulating local cadre performance and the procedures to apply for project funding from higher-level governments, which sets obstacles for the efficient use of infrastructure investment. As a result, local states use their authority to channel funding to local society with a positive track record of project applications (Habich, 2015; Wilmsen and Van, 2017; Rousseau, 2017).

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Through social interest, local governments have improved the economic development as well as social development in local environmental governance. In Chinese local states, certain renewable facilities are privately-own and operated and approved by local governments, which provides the local state with incentives to construct larger systems to generate as much electricity as possible. However, under the incentive-oriented structure, this has led to the over-development of renewable energy which has brought negative environmental and social impacts. Under this kind of structure, the local state operates in a semi-autonomous way in electricity management and industrial planning is most prone to over-develop renewable energy because they have to depend on hydropower revenues from electricity generation and local energy-intensive industries. Finally, the over-development in renewable development further causes streamflow reductions and unstable electricity generation, and in some areas, drives an increase in environmentally destructive mineral processing and reduces irrigation water access (Hennig and Harlan, 2018, Cheng et al., 2018; Liu et al., 2019).

2.3.2 Dialogue with Social Interest Theory

The theoretical framework of Bundled Interest and the following development provides another perspective on how the central government uses bundled interest to explain and discuss how the local officials reach the social objective (poverty alleviation) as well as other social developments from the central. In this dissertation, this thesis argues that the local government's research points out the social interests in the relationship between the central and local governments. Environmental Bundled Economic Interest Approach pointed that in order to benefit from the development of

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SHP, China has to have a more coherent bureaucracy and comprehensive bureaucratic procedures to coordinate and review the applications of SHPs in order to rescue the rural economy from bankruptcy and save the environment. This dissertation tries to contribute one step further on the application of the Environmental Bundled Economic Interest Approach from the two selected cases, and try to argue that in terms of the discussion between economic development and environmental governance, the bundled did not only result in the challenge and obstacle in solar energy development. Instead, through the increased autonomy of the energy agencies (such as the government, the energy companies, and the local community) the bundle of economic interest could lead to a positive reaction in energy development.

Reviewing the preliminary studies on the discussion between economic development and environmental governance, they have covered part of it. However, as the development of solar power evolved and changed, little research have covered or discussed the interaction between the three, including the role of government, the role of private sectors in local energy development, as well as development from the local residence. As a result, this dissertation will adopt and further extend Wang et al. (2015)'s "Environmental Bundled Economic Interest Approach" as the main theory, which illustrates the renewable energy development through analyzing the relationship between government agents and local manufacturers from the perspective of bundle interest, and in this dissertation, and this dissertation will further contribute on the discussion of economic development and environmental governance from the role of government, energy company and local community from the two selected

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cases. In this dissertation, the contribution is to further distinguish the "interest" in environmental bundled economic interest into political interest (which causes impact on the promotion of local officials to the central system), economic interest (which causes impacts on local economic activities), and finally social interest (which unbundles the limitation generated from the policy implementation and political and economic interest on the poverty alleviation project in the case study).

As a result, this dissertation tries to contribute one step further on the application of the Environmental Bundled Economic Interest Approach from the two selected cases, and try to argue that in terms of the discussion between economic development and environmental governance, the bundled did not only result in the challenge and obstacle in solar energy development. Instead, through the increased autonomy of the energy agencies (such as government, energy companies, and local community) the bundle of economic interest could lead to a positive reaction in energy development.

Conclusion

In this chapter, this dissertation has illustrated the preliminary studies and discussed the preliminary studies regarding central-local relation, including fragmented authoritarianism (FA), local state corporatism (LSC), and bundle interest (BI) to examine how the interaction between the central government and local government could shape the renewable development in China. This dissertation, contributed from another angle to view the environmental governance, especially from the political interest, economic interest, and social interest to discuss and explain the interaction

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between the central government, local governments, and the actors from the local society.

From political interests' perspective, it pointed out the importance of local government and the increase of autonomy of local government at the provincial level. On the other hand, the economic interest pointed out that even though during the central-local relation process, local government will manage its resource as the private sector to pursue the maximum of its interest. Finally, the bundled interest examined the past preliminary studies on central-local relations and analyzed the interaction between the central and local government from the aspect of interest. Further, Environmental Bundled Economic Interest approach further pointed out the local government was limited by the subsidy from the central government. However, due to the role changing on renewable energy, from energy generator to social development coordinator, this dissertation argued that in terms of the discussion on central-local relation should include the social development in order to have a comprehensive discussion. As a result, this dissertation suggested adopting Environmental Bundled Economic Interest approach to be applied in solar development and central-local relation in China.

The next chapter is going to introduce how the solar power development initiate and how central-local relations result in impact and changes during 11th Five Year Plan (FYP) (2005-2010) to 13th Fve Year Plan (2015-2020).

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Chapter 3 Development of Solar Power in China

The Chinese development of new energy follows the Five Year Plan (FYP). Since the reform and opening up in 1978, China's economy has developed rapidly over the past 30 years. In 1986, China's GDP exceeded RMB 1 trillion for the first time, reaching 1,000 billion RMB, reaching RMB 60,000 billion by 2014. China surpassed Japan in 2010 to become the world's second-largest economy. The rapid economic development has brought a huge demand for energy.

In 1980, the total global power generation amounted to 300.6 billion kWh. In 2014, it reached 543.8 billion kWh, China has reached an increase of 17 times. China's traditional energy power generation still accounts for the main share, and nearly 70% of the energy comes from coal-fired power generation. The massive use of fossil fuels has led China to become the country with the largest carbon emissions in the world. According to data from the International Energy Agency (IEA), China's carbon emissions accounted for 29% of the world's total carbon emissions in 2014. The development of renewable energy has attracted the attention of the Chinese government and has established the policy of "Developing renewable energy and improving the energy structure". The Chinese government has made a commitment to peak greenhouse gas emissions by 2030 and strives to achieve it earlier than that. Therefore, further development of clean energy is an inevitable choice. The Chinese government's goal is to increase the proportion of clean energy, including renewable energy and nuclear energy, to 15% by 2030, and then to 20% by 2030.

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Under this kind of circumstance, China promulgated the "Renewable Energy Law" in February 2005, laying a legal foundation for the development of renewable energy. Since 2006, China's new energy has undergone extremely rapid development and changes. China implemented the Renewable Energy Law of the Republic of China in January 2006, and listed the development and utilization of renewable energy as a priority area of energy development, increasing energy supply, improving energy structure, and ensuring energy safety, protecting the environment, realizing sustainable economic and social development, and promoting the establishment and development of renewable energy markets.

Since 2006, in order to encourage and support the development of the solar power industry, the National Development and Reform Commission (NDRC), the Ministry of Finance, the Ministry of Information, the National Energy Administration, the Ministry of Housing and Urban-Rural Development, and other institutions have intensively issued policy documents supporting and regulating the development of the solar power industry. Its scope includes all relevant aspects of industrial development such as production, sales, fiscal and taxation, subsidies, and land policies. By 2006, solar power generation was developing rapidly with more than 10 megawatt-level solar power generation systems have been built in the world. In June 2007, the Chinese government issued the “China’s National Plan to Address Climate Change.” In September 2007, it also released the “Chinese Medium and Long-term Development Plan for Renewable Energy”, which put forward the national renewable

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energy development goals that include wind, and solar energy, material energy are included.

In 2011, the total global installed solar power generation capacity reached 67GW. China is one of the countries rich in solar energy. More than 75% of the land, especially the Qinghai-Tibet Plateau, Northwest China, Yunnan, and Hainan, contains high radiation in solar power. With the support of the Chinese government, China's solar power industry has developed rapidly in the past decade. According to the National Energy Administration of China, the total installed capacity of solar power in China was 700,000 kilowatts in 2005. By 2014, the total installed capacity had increased to 28.05 million kilowatts, and a 40-fold increase has been achieved in less than a decade.

In 2014, the new solar power generation capacity reached 10.6 million kilowatts, accounting for about one-fifth of the world's new installed capacity. The annual solar power generation capacity increased from 9 billion kWh in 2013 to 25 billion kWh, an increase of 178%. More than 700 large-scale solar power generation projects have been connected to the grid in all provinces and regions across the country, mainly dispersed in the northwest and east coastal areas of China. The top three in terms of cumulative installed capacity are Gansu Province, Qinghai Province, and Xinjiang Autonomous Region. The total installed capacity of the three provinces exceeds 60% of the national total. The top three in dispersed solar and grid-connected capacity are Zhejiang, Guangdong, and Hebei provinces, accounting for 40% of the total grid-

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connected capacity in the country. China has also become the world's largest producer of solar power equipment. In 2014, the solar power cell module production capacity was 63GW, and the output was 35.6GW, accounting for 70% of the world's total. It has ranked first in the global solar power cell module production for eight consecutive years. Among the top 10 solar power equipment manufacturers in the world, China accounts for six. In the following session, this chapter will further describe that China's renewable energy development can be divided into the following stages:

Solar Power in Stage of Renewable Energy Development

Stage 1 Initial Stage of Renewable Energy Development (1949-1990)

The first stage is the early development stage of new energy (1949-1990). During this stage, solar power was still in the initial stage. New renewable energy policy focusing on solving rural energy consumption. In the early days of the founding of New China, in order to make up for the shortcomings of traditional energy supply, China actively carried out research and development and utilization of various new energy sources. At that time, with the exception of small hydropower which already had a certain foundation for development, other new energy resources (such as nuclear energy) were all in the research and development and primary utilization stage.

The focus of financial subsidies is mainly on demonstration and promotion projects of small scale of renewable energy development in the rural area, such as biogas systems, small hydropower, and small wind turbines. In 1985, the State Council pointed out that 100 million RMB will be allocated each year to support small hydropower projects, and low-interest loans will be implemented. The three to five

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years are extended to ten years. In 1987, the State Council decided to invest from the central government and provide loans for small wind turbine manufacturing, wind power plant construction, solar power cell production lines, and bagasse power generation projects at 50% of the commercial bank's interest rate. On the whole, due to the constraints of technology and capital, the level of new energy development during this period was generally not high, and the focus was mainly on small hydropower and rural biomass energy. The purpose was to solve the problem of insufficient rural energy supply (Wang, 2020).

This stage is characterized by development and utilization of new energy has not yet reached the commercial stage and an industry has not yet formed. From the statistical data, commercialized new energy accounts for zero proportion of terminal energy consumption. Most of the technologies are still in the preliminary stage of research and development.

Stage 2 Generation-oriented Development (1990-2010)

The second stage is the rapid development stage of the new energy industry (1990-2010). New energy policy centered on electricity. In the 1980s, China put forward a general policy of “Power-oriented” and actively encouraged power generation from multiple sources. In the "11th FYP (2006-2010)", and its main contents included the scientific development, replacing external demand with domestic demand and replacing investment driven by consumption. In the past five years of development,

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although China's exports are still growing rapidly, its dependence on foreign trade has dropped from the highest level of 67% in 2006 to 45% in 2009.

Under the national industrial policy, the development of the new energy industry has entered a rapid development track, and three important changes have occurred: First, the use of new energy has expanded from rural to urban areas. Second, the development of equipment from small to large and medium, and finally from research and development to marketization and industrialization, which shifted from focusing on increasing energy supply to improving the environment as the main goal (Zhou &Wang, 2002). In this stage, the amount of new energy development and utilization increased from 600,000 tons of standard coal in 1990 to 32.6 million tons of standard coal in 2010. New energy resources such as wind and solar already have a strong industrial foundation and become the world's largest manufacturer of complete machines and solar power modules, and have made great progress in the technical field.

During the 11th FYP, a total of 72.1 million kilowatts of small thermal power plants were shut down during the "11th FYP" period, 140% of the planned shutdown target was completed, and the structure of the power industry was optimized. In the country's in-service thermal power units, the proportion of units with 300,000 kilowatts and above has increased from less than half in 2005 to more than 70% of the current level. The coal consumption per kilowatt-hour for power supply has dropped from 370 grams to 340 grams, saving more than 300 million raw coal. " Zuò Dà Yì

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Xiǎo (做大抑小)" (increasing the efficiency and replacing the inefficient small thermal power plants) has embarked on a scientific development direction of the electric power industry.

The 11th FYP conducts the first step on carbon emission. The optimization and upgrading of the energy structure has made important contributions to the completion of the 11th FYP energy conservation and emission reduction targets. Energy consumption per unit of GDP dropped by 19.1%, saving nearly 700 million tons of standard coal. Vigorously develop non-fossil energy, the proportion of installed capacity in 2010 accounted for 26.6% in total, an increase of 1.6% from the end of the 10th FYP. Non-fossil energy accounted for 8.6% of primary energy consumption, 1.8 percentage points higher than in 2005. Hydropower, nuclear power, and wind power generated more than 3 trillion kilowatt-hours within five years, replacing 1.5 billion tons of raw coal and reducing carbon dioxide emissions by nearly 3 billion tons. Through the above support of the policies, China accelerated the development and utilization of natural gas and upgrading the quality of refined oil products, increased coal recovery rates and oilfield recovery rates, reducing power grid line losses, and carried out energy-saving dispatching and power generation rights trading.

Under the guidance of 11th FYP, in 2007, the Development and Reform Commission (DRC) of the Chinese Government issued the "Medium and Long-term Development Plan for Renewable Resources". The plan stated that China's annual renewable energy utilization will reach 270 million tons of standard coal by 2010. Among them, solar

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power generation reaches 300,000 kilowatts; the total heat collection area of solar water heaters reaches 150 million square meters. From 2010 to 2020, China's renewable energy will have greater development. Among them, solar power generation reached 1.8 million kilowatts.

Under the 11th FYP, in order to effectively develop solar power resources, the central government will divide the country into five areas for solar power development based on the distribution of solar radiation content of solar energy. The first category is the regions with the most abundant solar energy resources and the total annual solar radiation is 6,680 to 8,400 MJ/㎡, equivalent to 5.1 to 6.4KWh/㎡ of daily radiation, including northern Ningxia, northern Gansu, eastern Xinjiang, western Qinghai and western Tibet. The second type of solar energy resources is relatively abundant, the total annual solar radiation is 5850-6680 MJ/㎡, which is equivalent to the daily radiation of 4.5 to 5.1KWh/㎡, including northwestern Hebei, northwestern Shanxi, southern Inner Mongolia, southern Ningxia, Gansu Central, eastern Qinghai, southeastern Tibet, and southern Xinjiang. The third category is areas with medium solar energy resources. The total annual solar radiation is 5,000 to 5,850 MJ/㎡, which is equivalent to 3.8 to 4.5KWh/㎡ per day. It includes Shandong, Henan, southeast Hebei, southwest Shanxi, northern Xinjiang, Jilin, Liaoning, Yunnan, northern Shaanxi, southeastern Gansu, southern Guangdong, southern Fujian, northern Jiangsu, and northern Anhui. The fourth category is areas with poor solar energy resources. The total annual solar radiation is 4,200 to 5,000 MJ/㎡, which is equivalent to the daily radiation quantity of 3.2 to 3.8KWh/㎡. The last category is the

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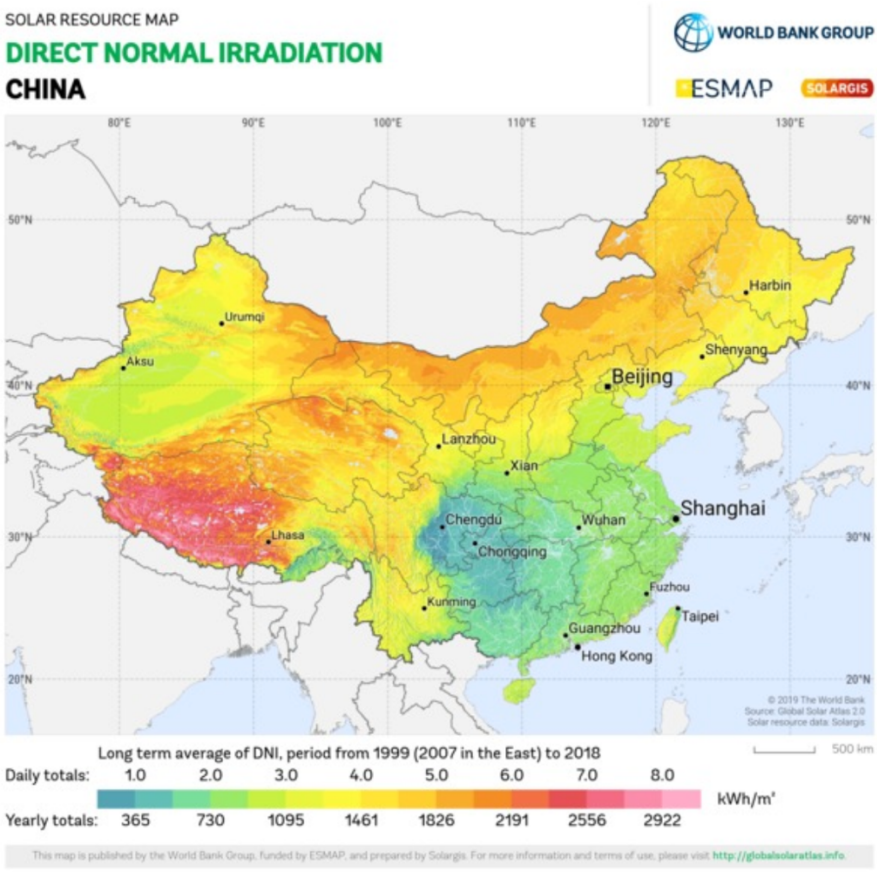
regions with the least solar energy resources. The total annual solar radiation is 3,350 to 4,200 MJ/㎡, which is equivalent to only 2.5～3.2KWh/㎡ per day, including Sichuan and Guizhou. The direct normal radiation in China is as the graph below (Energy Trend database, 2018).



Graph 3-1: Direct Normal Irradiation in China

Source: World Bank Group. 2011.

Due to the distribution of solar radiation, the development of China's solar power has also formed a different development model between inland provinces and coastal provinces. Areas with abundant solar energy resources, such as the inland areas with large and sparsely populated areas such as the first and second categories, mostly use

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centralized solar power, while the third and fourth types of densely populated coastal areas mostly use decentralized solar power. The development of China's solar power has also formed a different development model between inland provinces and coastal provinces. Areas with abundant solar energy resources, such as the inland areas with large and sparsely populated areas such as the first and second categories, mostly use centralized solar power, while the third and fourth types of densely populated coastal areas mostly use decentralized solar power.

From the above graph, due to the distribution of solar radiation, the development of China's solar power has also formed a different development model between inland provinces and coastal provinces. Areas with abundant solar energy resources, such as Type I and Type II inland areas with sparsely populated areas, mostly use centralized solar power station, while Type III and Type IV densely populated coastal areas mostly use dispersed solar power.

Stage 3 Diversification-oriented Development (2011-2015)

The third stage is the rapid development stage of the new energy industry. Mainly take the 12th FYP as the core of development. Driven by the market environment, policy environment and international climate environment, renewable energy industry in China has entered a stage of rapid development. At this stage, the characteristics of the development of the new energy industry are mainly: the formation of a policy system that supports the rapid development of new energy; new energy equipment manufacturing capacity ranks among the top in the world, and breakthroughs have

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been made in key technologies; although it was once ignored due to rapid development, curtailment of wind and solar power, and equipment manufacturing overcapacity.

In the 12th FYP, development focuses on the utilization of wind, solar, and biomass energy, and vigorously develops renewable energy, which optimizes the layout of wind power development, orderly advance the construction of wind power in resource-rich regions such as North China, Northeast and Northwest, and accelerate the decentralized development and utilization of wind energy resources. Chinese government coordinates the development and construction of supporting power grids and wind power, rationally lay out energy storage facilities, and establish a power dispatch system that guarantees wind power grid-connected operation. The local government actively carried out the demonstration of offshore wind power projects and promote the large-scale development of offshore wind power.

During the process, it accelerated the diversified utilization of renewable energy, promoted the merger and reorganization and optimization of the solar power industry, vigorously developed solar power generation integrated with buildings, increased the scale of dispersed utilization, built large-scale solar power plants based on local consumption, and actively carry out solar thermal power generation demonstrations. To develop material energy in an orderly manner, Chinese government focused on non-grain fuel ethanol and biodiesel, and accelerated the development of bio-liquid fuels, which further encourages the use of municipal waste and waste from large-scale

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farms to construct biogas or power generation projects. By 2015, the installed capacity of wind power will reach 100 million kilowatts and the installed capacity of solar power will reach 21 million kilowatts.

During the "12th FYP" period, the application market for solar thermal utilization in China will continue to expand. The engineering market, rural market and international market are the three major application markets for solar thermal utilization. The engineering market includes solar energy. There are two major categories of supporting projects combined with buildings and solar central heating projects. During the "12th FYP " period, China's solar thermal power generation will make significant progress. With the support of Chinese government policies and research and development, breakthroughs will be made in the key technologies of solar thermal power stations. At the end of the "12th FYP " period, China's solar thermal power generation will begin preliminary Commercial operations. In 2011 and 2020, the phased development indicators of solar power generators are as follows: The installed capacity of solar power generation will reach 2 million kilowatts and 20 million kilowatts respectively. However, under the 12th FYP, policy encouragement and rapid development, the solar power industry has also encountered many problems, especially the issue of curtailment (abandonment of wind power and solar power) and overcapacity. These issues will be illustrated as below:

High Curtailment Rate in Inner Part of China

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The issue of curtailment has plagued China's new energy power industry for many years, and concerns about this issue reached its peak last year. According to data from the Renewable Energy Professional Committee of China Circular Economy Association (CREIA), the curtailment rate of solar power in China reached 20% in 2016, a record high. In northern provinces such as Gansu and Ningxia which are rich in renewable energy resources, this figure is even as high as 60%. Wind power that cannot be connected to the grid is as high as 33.9 billion kWh, and the loss can reach 18 billion RMB.

In view of high curtailment rate issue, the CREIA has filed a lawsuit against some local governments, accusing them of protecting coal-fired power plants for protectionist behavior. Government departments and local power grid dispatching departments in Xinjiang, Gansu, and other places have also been accused of abusing administrative power to disrupt solar power production. The protective measures adopted by these provinces include: levying fees from solar power companies to subsidize coal-fired power plants; reducing the purchase price of renewable energy power generation and compressing the profit margin of the solar power industry, which violates the guaranteed purchase principle stipulated in the China Renewable Energy Law. However, there is still no effective way to solve the issue of high curtailment rate. Even if the "Renewable Energy Law" stipulates that grid companies should sign a grid connection agreement with renewable energy power generation companies to fully purchase the grid coverage of renewable energy grid-connected

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power generation power. However, the key is still lack of sanctions to support mandatory purchases.

Solution to Curtailment Issue

Although the State Grid intends to adopt the "West-to-East Power Transmission" project to provide solutions to the abandonment problem, the slow progress in the construction of the grid and the loss of power in the process cannot effectively solve the abandonment problem, and it has even worsened. The west-to-east power transmission project is to develop power resources in western provinces such as Guizhou, Yunnan, Guangxi, Sichuan, Inner Mongolia, and Shanxi, and transmit them to Guangdong, Shanghai, Jiangsu, Zhejiang, Beijing, Tianjin, Tangshan and other regions. Through the integration of large-scale energy bases: the use of ultra-high voltage and other large-capacity, efficient and long-distance power transmission technology. Further, the central government developed Southwest energy bases: power transmission channels to East China, Central China, and Guangdong Province, and power transmission channels from Ordos Basin, Shanxi, and Xilin Gol League energy bases to North, Central, and East China.

However, China's natural energy is unevenly distributed. Most of China's wind and solar resources are concentrated in the sparsely populated western and northern remote areas. To transmit the electricity produced in these areas to the eastern coastal cities where energy is scarce, long-distance and large-capacity transmission capacity are required. To solve this problem, China plans to upgrade transmission lines and

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build the world's most powerful ultra-high voltage transmission network. Generally speaking, lines with voltage levels above 800 kilowatt are called ultra-high voltage transmission lines; China's goal is even more ambitious, and the voltage level of the ultra-high voltage transmission lines it plans to build is above 1,000 kilowatt.

According to the National Energy Administration of China, a total of 12 such ultra-high voltage transmission lines connecting northwestern provinces and coastal areas are currently under construction. The newly constructed line connects Changji Hui in Xinjiang and Xuancheng City in Anhui Province in eastern China. The line has a total length of 3,324 kilometers and a design voltage level of 1100 kV. It is expected to be put into use in 2018 and will become the world's longest ultra-high voltage transmission line. However this kind of mega project is not only expensive, but also time-consuming. The construction time of an ultra-high voltage transmission line is at least 3 years. In this regard, foreign experts have proposed a quick method, through the grid connection within the local power grid will be a more feasible solution in the short term. Therefore, for provinces with curtailment rate issue in renewable energy resources in China, local grid connection is the starting point. The renewable energy is locally connected to the grid as much as possible; the next step is the connection between provinces (EIC, 2016).

Overcapacity Issue in Solar Power Development

From 2011 to 2012, China's solar power companies went bankrupt on a large scale. Since the 11th FYP, the rapid development and expansion of solar power

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development, in 2012, European and American countries imposed anti-dumping duties and countervailing duties on China's solar power industry and conducted a series of investigations, which hindered the export of Chinese solar power products and led to overcapacity. In 2012, China’s solar power module production capacity reached 45 million kilowatts. However, due to trade barriers in overseas markets, the price of solar power products has fallen, which has caused many Chinese solar power companies to suspend production and close down. The number of polysilicon companies has dropped from 50 to 8, and most solar power companies have declared bankruptcy, which represents the development of the solar power industry is at a stagnant stage.

The excess solar power capacity is transferred to the middle and lower reaches of the industry and overseas markets. In the traditional solar power industry chain, crystalline silicon is manufactured in the upper reaches of the industry chain, solar power components are manufactured in the middle reaches, and solar power plants are operated in the downstream. However, due to trade barriers in overseas markets, most of the upstream polysilicon solar power products have suffered serious losses. Therefore, some Chinese solar power companies have begun to shift to the development and operation of downstream solar power components and solar power stations, which in turn led to the growth of solar power installed capacity. From 2.5 million kilowatts in 2013 to 11.3 million kilowatts in 2013. Excessive production capacity has also been transferred to overseas solar power stations to meet the goal of digesting production capacity in response to trade barriers. Therefore, many Chinese

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solar power companies also invest in overseas solar power stations, such as the United States, Germany and other countries.

After the tariff barriers in Europe and the United States passed, most of the solar power industry concentrated grid solar power stations, and local governments provided various discounts, loans and other preferential conditions to drive local taxation and employment, and further encouraged solar power equipment manufacturers to concentrate on the downstream power generation industry. In coastal provinces, these concentrated manufacturers have invested more in dispersed solar power generation in response to the densely populated coastal environment. The installed capacity of dispersed solar power along the coast has grown from 3.1 million kilowatts in 2013 to 8 million kilowatts in 2014. The stable return on investment of solar power plants also further enhance manufacturers' continuous investment in solar power plants, and further accelerate the development of solar power plants. In response to the positive development of solar power stations, the National Energy Administration further issued the “Notice of the National Energy Administration on Further Strengthening the Construction and Operation Management of Solar Power Stations” in 2014 to promote the construction of large-scale solar power stations, and provide 20 years of subsidies for the development of solar power stations, which stabilize the construction of solar power plants and effectively reduce the uncertainty of development.

Stage 4 Integration-oriented Development (2016-now)

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During this stage, the development of renewable energy mainly followed the 13th FYP, which focused on two parts, the environmental governance as well as the poverty alleviation.

In terms of environmental governance, the 13th FYP effectively reduced reliance on traditional thermal power generation and resolves the issue of abandoning wind and light in inland provinces. In terms of total energy consumption, the 13th FYP limited total energy consumption to 5 billion tons. Within standard coal, the total coal consumption is controlled within 4.1 billion tons; the total electricity consumption is expected to be 6.8-7.2 trillion kilowatt-hours. In terms of energy security, the energy self-sufficiency rate was maintained at more than 80%, and the ability to ensure strategic energy security has been enhanced, energy utilization efficiency and the level of clean energy substitution will be improved. At the same time, the 13th FYP has increased energy supply capacity and maintain stable growth in energy supply. China's primary energy production is about 4 billion tons of standard coal, including 3.9 billion tons of coal, 200 million tons of crude oil, 220 billion cubic meters of natural gas, and non-fossil energy (ITRI, 2016).

The 13th FYP is to further adjust the energy consumption structure and increase the proportion of non-fossil energy consumption to over 15%, the proportion of natural gas consumption to reach 10%, the proportion of coal consumption to less than 58%, and the proportion of coal consumption for power generation to increase to more than 55%. In terms of energy system efficiency, the 13th FYP reduces energy consumption

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per unit of gross domestic product by 15% compared with 2015. The average coal consumption of coal-fired power will be reduced to less than 310 grams of standard coal per kilowatt-hour of electricity, and the grid line loss rate will be controlled within 6.5%. Finally, in terms of energy, environmental protection and low carbon, the 13th FYP has reduced carbon dioxide emissions per unit of gross domestic product (GDP) by 18% compared to 2015. The environmental protection level of the energy industry has been significantly improved, and the pollutant emissions of coal-fired power plants have been significantly reduced, and the conditions for transformation are met. By 2015, all coal-fired power generating units in China achieve ultra-low emissions (ITRI, 2016).

In 2020, the main reason for the rise in coal-fired power generation is that coal-fired power generation approval power is delegated to various provincial agencies, which has become a way to ensure GDP growth for provinces that are highly dependent on coal development. According to the calculation of the projects that have started, approved, and are under construction, if they are not controlled, it will reach more than 1,250GW by 2020. Therefore, the planning plan will adopt three measures. One is to establish a risk warning mechanism, and the red zone can never be rebuilt and approved; the other is to take measures to cancel and postpone a batch, postpone the nuclear process, and postpone the construction of a batch. The construction will reach more than 150GW; the third is to eliminate 20GW of backward production capacity. Regarding the problem of abandoning wind and light in the past, the planning plan will start to solve the problem from three aspects, one is orderly development,

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appropriately slowing down the scale, decentralized construction, and nearby consumption; the second is to strengthen the construction of the transmission and distribution network, and the transmission capacity of power transmission from west to east. An increase of 130GW to reach 270 GW; the third is to improve the peak-shaving capacity of the power system, with pumped storage capacity of 17GW and construction of 60GW started, and peak-shaving gas-fired power generation construction of 5GW (ITRI, 2016).

Therefore, the Chinese Energy Administration is expected to invest RMB 2.5 trillion during the "13th Five Year Plan" period. The goal is to reduce annual carbon dioxide emissions by 1.4 billion tons by 2020 and discharged 5.8 million tons. At the same time, the energy transition during the 13th FYP period is expected to save 3.8 billion cubic meters of water and create 13 million jobs every year. To further adjust the energy structure, the proportion of non-fossil energy consumption should increase to over 15%, the proportion of natural gas should be over 10%, and the proportion of coal consumption should be reduced to less than 58%. Increasing the use of clean and low-carbon energy will be an important goal of the energy transition during the "13th FYP" period. In terms of balancing energy distribution, most of China's current power plants are located in the northwest, but the main power demand is in the southeast. The goal is to balance them during the "13th FYP" period. In terms of wind power and solar powers, we strive to move to the east and middle of the country; the newly-added wind and solar installations target 58% wind power and 56% solar power in the

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middle and east, and promote local consumption and the construction of decentralized systems.

In terms of environmental installation targets, the focus is on the energy transition and the balance of power consumption. The development of decentralized solar power and the promotion of parity on the grid will become the most important goals. Therefore, the goal is to improve the efficiency of energy generation and to transform existing coal-fired generating units, which targets energy distribution with strategic safety thinking, strengthens energy independence, promotes oil substitution, and develops new energy vehicles. During this stage, the role of new energy has shifted from a clean energy provider to a society coordinator, in the following sub-issues.

Power generation, transmission, and distribution

As of the end of 2019, the national installed capacity of power generation was 201 billion kilowatts, a year-on-year increase of 5.8%. Among them, the installed capacity of thermal power is 119 billion kilowatts, accounting for 59.2% of the total installed capacity; the total installed capacity of clean energy such as hydropower (356.4 million kilowatts), nuclear power (48.74 million kilowatts), wind power (210.5 million kilowatts), and solar power (204.68 million kilowatts) It has reached 81.87 million kilowatts, accounting for 40.8% of the total installed capacity.

The development of new energy in China has basically formed an energy production system driven by coal, oil, gas, electricity, nuclear, new energy and renewable energy.

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China's total primary energy production in 2019 reached 3.97 billion tons of standard coal, making it the world's largest energy producer. Coal is still the basic energy source that guarantees energy supply. Since 2012, the annual output of raw coal has remained at 3.41 billion to 3.97 billion tons, which maintain the stability of crude oil production. Since 2012, the annual crude oil output has remained at 190-210 million tons. The production of natural gas has increased significantly, from 110.6 billion cubic meters in 2012 to 176.2 billion cubic meters in 2019. The power supply capacity continues to increase, with a cumulative installed capacity of 2.01 billion kilowatts (Guangfu, 2020).

The power generation in 2019 was 7.5 trillion kilowatt-hours, an increase of 75% and 50% respectively over 2012. The scale of renewable energy development and utilization is rapidly expanding, and the cumulative installed capacity of hydropower, wind power, and solar power generation ranks first in the world. Significant improvement in energy utilization efficiency. Since 2012, energy consumption per unit of GDP has been reduced by 24.4%, which is equivalent to reducing energy consumption by 1.27 billion tons of standard coal. From 2012 to 2019, an average annual growth of 2.8% in energy consumption supported an average annual growth of 7% in the national economy (Guangfu, 2020).

Poverty Alleviation with Solar Power

There are still more than 70 million people living below the poverty line in China, mainly in remote rural areas where energy is difficult to obtain. Under the presidency

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of Xi Jinping, China planned to completely eradicate poverty by 2020. In order to achieve this goal, relevant government departments have begun to formulate plans since the second half of last year.

Poverty alleviation with solar power is one of the governance priorities during the "13th FYP " period. Poverty alleviation with solar power refers to the investment by the government or enterprises to set up decentralized solar power plants for poor villages or poor households in the field and improve their lives. Poverty alleviation with solar power has the advantages of promoting poverty alleviation, creating demand for the solar power industry, increasing solar power generation to improve the environment, and can even be developed into a the so-called "Solar power pension" model. After the poor have a solar power generation system, they can choose to go online in full, self-use or surplus with more plans can enjoy the benefits of solar power.

Poverty alleviation with solar power is mainly set up on the roofs of poor households, courtyards or open spaces in poor villages, but various forms of "agriculture plus new energy" such as agriculture and solar power, fishing and solar power complementation have gradually emerged, allowing solar power energy and other industries to complement each other. In addition, small hydropower, biogas and other clean energy power generation have also been included in poverty alleviation measures. In addition to poverty alleviation with solar power related to the construction of solar systems, it must also be coordinated with rural power grid

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renovation projects. In 2016, State Grid Corporation and China Southern Solar Power Grid announced that they would invest 700 billion RMB in rural power grid transformation and upgrading projects; the National Energy Administration will also carry out a new round of rural power grid transformation and upgrading in 2017. However, solar power plants have strict requirements for terrain environment and weather conditions. The location needs to consider various environmental factors, and evaluates the maintenance costs and operational risks in the later period before setting up. From the perspective of the construction of power stations, a certain amount of security deposit should be allocated for investment in poverty alleviation solar power stations for subsequent maintenance. At the same time, technicians are trained in various places to carry out on-site repairs, inspections and maintenance (EnergyTrend, 2017).

The population of poor villages in China decreased by 12.4 million people through poverty alleviation and relocation in 2016. In 2017, the State Council expects to reduce the poverty population by another 13.4 million. Through policy documents such as the "Implementation Opinions on Accelerating Energy Development and Construction in Poverty Areas and Promoting Poverty Alleviation" issued by the National Energy Administration in 2015 and the 2017 "2017 Energy Work Guidance" and other policy documents, poverty alleviation with solar power will also become a major means of poverty alleviation. In October 2016, the National Energy Administration officially launched the first batch of 5.16GW poverty alleviation with solar power indicators, requiring grid connection before June 30, 2017. The 8GW

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indicator issued in 2017 will benefit 840,000 poor households with registered cards. During the 13th FYP, poverty alleviation with solar power projects will be launched in 35,700 poor villages in 451 poverty-stricken counties in 15 provinces and regions across the country. It is expected to benefit 2.8 million households and each household will receive RMB 3,000 per year extra income (NEA, 2015).

Currently, there are two existing mechanisms of poverty alleviation with solar power: financial guarantee and overall planning. Because of the government's financial difficulties and difficult financing, enterprises are actually the main investors in poverty alleviation with solar power, but this policy lacks sustainability. Aiming at the target of 8GW in 2017, the required funds are as high as 50 billion RMB, and the source of funds is also a major issue. There are about 75% of the funds for poverty alleviation solar power stations need to be obtained through financing, but the Bank of China currently does not have a special loan plan for this, and the interest rate is also high, which can easily affect the construction progress, or the developer will bear the financial pressure on its own. Poverty alleviation with solar power measures did not have a unified leadership unit in the implementation process, resulting in complicated project application procedures, delays in power generation subsidies, backward power grid facilities, abandonment of solar power, uneven quality of power stations, and excessive tax burdens.

Enterprises, governments, and platform companies share a common operating model. Hebei Province announced in 2017 poverty alleviation solar power station project

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application notice. It has built 3,000 village-level poverty alleviation solar power stations in 45 key poverty alleviation counties in poor villages with the total scale reaching 900MW. The scale of these power stations will be between 100 and 300kW, and they will be connected to the grid with a voltage of 10kV and below in rural areas, which can guarantee the annual income of 3,000 RMB per household for poor households. The notice encourages the government to invest in full, while the assets are owned by rural collectives; and if there are power stations built in three modes: corporate investment, PPP mode operation, and platform company operation, the government's investment ratio must not be less than 40% (Energytrend, 2017).

Subsidy and Reform

During the development in different phases, the development also pointed out the determination of Chinese government in getting rid of the overdependence. China's energy sector has adopted economic incentives to encourage the development of coal-fired power plants at the beginning of the design. Currently, the coal subsidy provided by the central government is twice that of renewable energy. According to the China Electricity Council, coal is still China's main source of electricity. In 2015, coal-fired power generation accounted for 67% of the country's total power generation.

Even if China has determined to reduce its dependence on coal, the issue is not likely to change in the short term. Local government departments are worried that rashly phasing out coal power generation will cause economic losses and unemployment in the short term. This also explains why many local governments even support the

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development of coal-fired power plants at the expense of hindering the growth of renewable energy. In 2015, China's electricity consumption as a whole rose by only 0.5%, a record low in decades. Declining electricity demand and excess production capacity are threatening the survival of coal-fired power plants, so local governments have to take special protective measures.

The business model for renewable energy takes a long time. Renewable energy must directly contribute to the local economy, and it usually takes 4 to 5 years for the installed capacity to be smoothly integrated into the power grid. As long as the coal-fired power plant starts production, which can bring a large amount of tax revenue to the government. In other words, the temptation to bring tax revenues quickly is quite attractive for local governments to turn this request down. What's worse, coal-fired power is priced lower than wind or solar power, even if the marginal cost of wind and solar power is very low. The pricing of coal-fired power generation does not take into account the environmental costs of coal-fired power plants. "The price of coal-fired power generation is 0.45 RMB per kilowatt-hour, but this price does not include the cost of waste disposal. A large amount of waste is used in the process of coal-fired power generation. For example, a large part of Beijing's water supply comes from the South-to-North Water Diversion Project, and the actual cost is close to 30 RMB per ton. Coal-fired power plants can settle their electricity bills in full with the local power grid or power load center each month, while wind and solar power plants, but only one-third of the payment will be received. In some extreme cases, the remaining

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costs may be owed for two to three years. Therefore, this issue reflects whether renewable energy and coal energy cannot compete on an equal basis.

The Development of the Grid

The State Grid Corporation of China is the main body of investment and operation of State Grid, which owns 5 large power grids in Northeast, Northwest, North China, East China and Central China and 3 independent provinces or regional power grids. The State Grid Corporation of China insists on sustainable development and the principle of organic integration of corporate interests, social benefits and environmental protection, in order to accelerate the promotion of west-to-east power transmission, north-south mutual supply, nationwide networking, simultaneous and continuous construction of urban and rural distribution networks, and actively promote the marketization of electricity. Strengthening technological innovation and informatization is the company's development focus. The State Grid Corporation of China has been responsible for the investment, construction and operation of cross-regional power transmission and transformation projects and interconnection projects, the construction and management of the Three Gorges power transmission and transformation projects, and the investment, construction and operation of frequency modulation and peak-regulation power plants for China’s electric power industry.

From 2016 to 2019, the total investment in the transformation and upgrading of rural power grids reached 830 billion RMB, the average power outage time in rural areas was reduced to about 15 hours, and the electricity conditions of rural residents were

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significantly improved. From 2013 to 2015, implement the action plan to solve the problem of electricity consumption for the population without electricity, and complete the task of having all the population using electricity by the end of 2015. The implementation of poverty alleviation with solar power projects and other energy poverty alleviation projects, prioritizing the layout of energy development projects in poverty-stricken areas, and implementing energy-benefit projects have promoted economic development in poverty-stricken areas and increased incomes of the poor. On the other hand, the poverty alleviation also improves the construction of natural gas utilization infrastructure, expands natural gas supply areas, and upgrades the ability to guarantee the use of gas for people's livelihood. Significant progress has been made in clean heating in the northern region, which has improved the energy use conditions and living environment of urban and rural residents.

From 2013 to 2015, the state arranged an investment of 24.78 billion RMB to realize the problem of power grid extension projects in low areas without electricity, and energize 1.545 million people with electricity. The construction of solar power independent power supply projects was implemented, and 1.185 million people without electricity were energized. At the end of 2015, the problem of electricity consumption for the population without electricity will be fully solved, and the full coverage of the population with electricity will be achieved. China attaches great importance to the transformation and upgrading of rural power grids, and strives to make up for the shortcomings of rural power grid development, which implements special projects for the transformation and upgrades of rural power grids in central

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villages in small cities and towns, the power supply of pumped wells in plain rural areas, and the power supply of poor villages.

Starting in 2018, China has focused on promoting the transformation and upgrading of rural power grids in deeply impoverished areas and villages in the border areas. The local government speeded up the construction of natural gas branch pipeline network and infrastructure, and expanded the coverage of the pipeline network, which promoted the construction of supply networks for liquefied natural gas, compressed natural gas, and liquefied petroleum gas in areas not covered by the natural gas pipeline network, develop and utilize renewable energy in accordance with local conditions, and improve rural energy supply conditions.

Poverty Alleviation Project with Renewable Energy Development

China has accelerated the improvement of rural energy infrastructure enabling the local to have access to electricity is a basic condition for building a society in the current arrangement. A three-year action plan to comprehensively solve the problem of the population without electricity was implemented, and the problem of electricity consumption by the population without electricity was fully solved by the end of 2015. China attaches great importance to the transformation and upgrading of rural power grids and strives to make up for the shortcomings of rural power grid development, which implement special projects for the transformation and upgrading of rural power grids in central villages in small cities and towns, the power supply of pumped wells in plain rural areas and the power supply of poor villages. Starting in

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2018, China will focus on promoting the transformation and upgrading of rural networks in deeply impoverished areas and villages in the border areas, and speed up the construction of natural gas branch pipeline network and infrastructure, and expand the coverage of the pipeline network, which promotes the construction of supply networks for liquefied natural gas, compressed natural gas, and liquefied petroleum gas in areas not covered by the natural gas pipeline network, develop and utilize renewable energy in accordance with local conditions, and improve rural energy supply conditions.

The government accurately implemented energy poverty alleviation projects. Renewable energy is not only a driving force for economic development, but also an important support for poverty alleviation. China rationally develops and utilizes energy resources in poverty-stricken areas, actively promotes the construction of major energy projects in poor areas, enhances the so-called "blood-making" capabilities in poverty-stricken areas, and adds new momentum to the economic development of poor areas, which prioritize the deployment of energy development projects in old revolutionary areas, ethnic areas, border areas, and poverty-stricken areas, and build clean power delivery bases to make important contributions to the economic growth of the regions. In the development and construction of hydropower, a sustainable development model of removable, stable, and rich for reservoir immigrants has been formed, allowing the poor to share more of the benefits of resource development. China strengthened financial investment and policy support to support the development of clean energy such as biomass energy, wind energy, solar

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energy, and small hydropower in poverty-stricken areas, and promotes various forms of integrated solar power and agricultural development models, implementing poverty alleviation with solar power projects, and building thousands of the so-called "sunshine banks" spread across impoverished rural areas.

Local governments promote clean heating in winter in northern rural areas. Clean heating in winter in the northern region has a bearing on the lives of the broad masses of people, and is a major livelihood project and a popular project. In order to ensure that the broad masses of the people in the north are warm during the winter and reduce air pollution, clean heating will be carried out in the northern rural areas according to local conditions. In accordance with the policy of enterprise-oriented, government-driven, and affordable for residents, we will steadily promote the "coal-to-gas" and "coal-to-electricity" policies, and support the use of clean biomass fuels, geothermal energy, solar heating, and heat pump technology applications. As of the end of 2019, the clean heating rate in northern rural areas was about 31%, an increase of 21.6 percentage points from 2016; the northern rural areas have replaced about 23 million households with scattered coal, including Beijing-Tianjin-Hebei and surrounding areas, and the Fenwei Plain. Approximately 18 million households have been replaced by cleaning (Chinese State Council, 2020). The key policies from Five-Year Plans are listed as below:

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Policy of Solar Development

Time	Policy	Content
2005.02	Renewable Energy Law	Laid a legal foundation for the development of renewable energy
2007.09	China's mid- and long-term development plan for renewable energy	Put forward the national renewable energy development goals, including wind energy, solar energy, biomass energy, etc
2007.09	The National Development and Reform Commission issued the "11th Five-Year Plan for the Medium and Long-term Development of Renewable Energy"	To provide the guideline for medium and long-term development of renewable energy
2008.03	Implementation Opinions on Accelerating the Application of Solar Power Buildings	To facilitate the construction process of buildings with solar power panels facilities
2012.09	The National Development and Reform Commission issued the "12th Five-Year Plan for the Medium and Long-term Development of Renewable Energy"	To provide the guideline for medium and long-term development of renewable energy, which follows the structure of 11th FYP

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2017.07	Opinions on the Implementation of the 13th Five-Year Plan for the Development of Renewable Energy	To announce the 2017-2020 new construction plan for wind power and solar power plants and the layout plan for the 13th FYP for biomass power generation. The cumulative installed capacity of the solar power leading technology base from 2017 to 2020 is 32 million kilowatts.
2017.07	Notice on improving the technical indicators of main solar power products and strengthening supervision	Starting from January 1, 2018, suppliers of solar power products that are newly put into production and connected to the grid should meet the requirements of the solar power manufacturing industry specifications
2017.09	Opinions on supporting solar power poverty alleviation and regulating the land use of solar power generation industry	To strengthen the land guarantee for poverty alleviation with solar power, and effectively strengthen the supervision of the land for solar power generation projects
2018.03	Notice on Issuing "Management Measures for Poverty Alleviation Solar Power Plants"	To standardize the construction and operation management of solar power poverty alleviation power stations, ensure the effect of solar power poverty alleviation, and promote the healthy and orderly development of solar power poverty alleviation

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2018.05	Notice on solar power development in 2018	Arrangement and deployment of matters related to the development of solar power generation in 2018; First, grasp the development rhythm of ordinary power stations. Second is to support dispersed and orderly development. Third is to continue to support solar power poverty alleviation projects. Fourth is to advance the construction of the leading base in an orderly manner. Fifth is to encourage projects that do not require state subsidies.
2018.08	Guiding Opinions on Winning the Poverty Alleviation and Occupying the Three-Year Action	In areas where conditions are suitable, poverty alleviation will be implemented with village-level solar powers in poor villages. Support poverty-stricken counties to integrate financial agriculture-related funds to develop characteristic industries.
2018.09	Notice on Accelerating the Work Related to the Advancement of Wind Power and Solar Power Generation at Level-Price Grid	The annual construction scale management will no longer be implemented for projects that meet the renewable energy construction plans of various provinces (and regions), implement the conditions for connection and consumption, and meet the requirements of relevant monitoring and early warning management.
2018.11	Notice on the implementation of the	To accelerate the construction of a clean, low-carbon, safe and efficient energy system, promote

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	renewable energy power coordination system	the development and utilization of renewable energy, and set renewable energy quotas for electricity consumption
2018.11	Notice of the National Development and Reform Commission and the National Energy Administration on Issuing the Clean Energy Consumption Action Plan (2018-2020)	By 2020, the problem of clean energy consumption will be basically solved, and clean energy consumption targets in various provinces will be stipulated.

Source: Policy White Paper, National Bureau of Statistics

From the above a series of policies, the government provides subsidies for solar power development. First of all, for solar power stations across the country, the policy divides the country into three types of solar resource areas. The annual equivalent utilization hours are greater than 1,600. The equivalent utilization hours are between 1400-1600 hours as the second-class resource area, and the annual equivalent utilization hours between 1200-1400 hours are the third-class resource area, and different solar power benchmark on-grid tariffs are implemented. They are 0.9 RMB/kWh for the first-class resource area, 0.95 RMB/kWh for the second-class resource area, and 1.0 RMB/kWh for the third-class resource area. The part of the benchmark on-grid electricity price of solar power stations that is higher than the

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benchmark on-grid electricity price of local coal generating units will be paid by the National Renewable Energy Development Fund. Secondly, in dispersed solar power generation in various places, the policy implements a policy of full power subsidy for dispersed solar power generation. The electricity price subsidy standard is 0.42 RMB per kilowatt-hour (tax included). Among them, the electricity surplus to the grid for self-use by the dispersed solar power generation system will be purchased by grid companies at the benchmark on-grid electricity price for local coal-fired generating units. Various localities have introduced their own support policies based on their own energy advantages and development goals, and the content and standards of subsidies are not the same (Chinaland, 2015).

From the above development, it presents that China's current solar power industry incentive policies have two important characteristics: First, the solar policy in China has formed policy system that includes a combination of national basic regulations and local supplementary regulations, which not only reflects the country's principled requirements, but also takes care of the actual conditions of various regions, which stems from the implementation and mobilization of local enthusiasm.

Second, the policy content covers everything from initial investment subsidies to subsidies for solar power plants, dispersed solar power subsidies, tax incentives, and supporting services. It is a "combined" policy incentive that provides a systematic way in policy support for the development of the solar power industry.

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Conclusion

The current chapter has discussed the development of solar power in China in the two decades especially through renewable policy development as well as the interaction between the government and the local agents. It has presented that among different developmental stages have foster the role of renewable energy development in China into a coordinator for social development. Through the development of solar power, the poverty alleviation could be conducted into the local development, especially for the poor and the local agriculture workers. Among the renewable energy development in the past, this chapter pointed out the solar development has aimed at different objectives and reaching into different phases in each Five year Plan.

First of all, during the 11th FYP, the thermal power plant was shut down and the solar power installed capacity and the solar power industry begins to grow. During the "11th Five Year Plan" period, a total of 72.1 million kilowatts of small thermal power plants have been shut down, 140% of the planned shutdown target has been completed, and the optimization of the power industry structure has been accelerated. In the country's in-service thermal power units, the proportion of units with 300,000 kilowatts and above has increased from less than half in 2005 to more than 70% of the current level. The coal consumption per kilowatt-hour for power supply has dropped from 370 grams to 340 grams, saving more than 300 million raw coal. Ton. "Going big and suppressing the small" has embarked on a new path for the scientific development of the electric power industry. On the other hand, the solar power generation market started in an orderly manner, the Golden Sun demonstration project was implemented,

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and a 270,000 kilowatt demonstration project was completed. The installed capacity of solar power generation across the country has reached 600,000 kilowatts, and a relatively complete solar power cell industry chain has been formed. The annual output has exceeded 8 million kilowatts, and the export volume accounts for half of the global market. The scale of installation and use of solar water heaters continues to expand, with a possession of more than 170 million square meters.

Second, during the 12th FYP, the layout and planning of the overall energy development focus on traditional energy, promote the renewable energy industry, encourage hydropower, wind power, biogas power generation, etc., and develop electric vehicles and biomass energy industries, especially for shale oil and gas that is still in the development stage. The plan is a key development project, and clearly set goals to increase domestic oil and gas production. The government replaced the traditional coal with high-standard coal development and utilization to develop low-grade mining areas with high environmental protection standards, and use the strategy of "power transmission from west to east" to distribute to other areas. The limited development of high-grade coal encouraged the integration and operation of large-scale enterprises to provide backbone grids and inter-provincial interconnection projects for power transmission areas and receiving end areas, rephased sthe transmission and distribution network structure, and improved the division and layered power supply capabilities. The government also implemented urban and rural power distribution network construction and renovation projects: promote smart power distribution, and comprehensively improve comprehensive power supply

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capacity and reliability. In order to reduce the production and use of coal, alleviate the increasingly serious air pollution problem. Reducing the degree of dependence on foreign oil and natural gas and transportation risks: domestically, the main goal is to develop shale oil and gas, while overseas, foreign oil companies are acquired through diplomatic and commercial channels to obtain overseas crude oil rights and interests, and obtain the right to operate important international ports, and cooperate with the transportation policy to reduce risks.

Third, during the 13th FYP, control the total energy consumption and consumption intensity. During the "13th Five-Year Plan" period, the national average annual growth of energy consumption is estimated to be 2.5%, 1.1 percentage points lower than that of the "12th Five Year Plan" period; energy consumption per unit of GDP during the period will drop by more than 15%. With the adjustment of the energy structure, the proportion of non-fossil energy consumption should be increased to over 15%, the proportion of natural gas should be over 10%, and the proportion of coal consumption should be reduced to less than 58%. Increasing the use of clean and low-carbon energy will be an important goal of the energy transition to balance energy distribution. during the 13th Five-Year Plan period. Currently, most of China's power plants are located in the northwest, but the main power demand is in the southeast. The goal is to balance them during the "13th Five-Year Plan" period. In terms of wind power and solar power, China strived to move to the east and middle of the country; the newly-added wind and solar installations target 58% wind power and 56% solar power in the middle and east, and promote local consumption and the

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construction of decentralized systems to improve the efficiency of energy generation and transform existing coal-fired generating units and plan energy distribution with strategic safety thinking, strengthen energy independence, promote oil substitution, and promote new energy vehicles. Leading innovation and developing a smart energy system for energy production, transmission, use, energy storage, and system integration. In particular, in response to the issue of power curtailment, the ratio of total energy consumption to renewable energy is established according to districts, reliable indicators are established, and the minimum annual guaranteed purchase hours for wind and solar power are set according to the conditions of each region, so as to formulate a guaranteed full purchase system.

To sum up, the development of renewable energy mainly followed the path of Five Year Plan and reach its objectives in different phases. From 11th to 13th FYP, the transformation indicates that the role of renewable energy has shifted from the role of clean energy provider, which aims at getting rid of the overdependence on the traditional thermal generation, to the role of development coordinator between different agents in the local society, including government, energy manufacturers, the grid companies as well as the local farmers and the poor, which further fosters the poverty alleviation with new energy development. During the interaction between government, energy manufacturer and providers as well as local users (farmers and the poor), through poverty alleviation with solar power development, on one hand government transferred the overcapacity into the local community. On the other hand, the local community could also benefit from the solar panels from the renewable

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energy manufacturers, which further develops into different patterns in different provincial levels in China. Therefore, in the next chapter, this dissertation is going to explore the interaction between government and the local agents in the case of Gansu.

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Chapter 4 High Curtailment Rate, Late Poverty Alleviation Project, and Solar Power Development in Gansu

As mentioned in the previous chapter, the problem of overcapacity has caused huge losses and impacts on China's new energy. In order to explore the research questions of this dissertation-- **"How bundled interests during the central-local interaction shaped the solar power development pattern in China?"** The current chapter will discuss the development model of the inland province Gansu in the framework of the economic benefits of bundled environmental policies, and discuss how the central government, local governments, power grid companies, new energy equipment vendors, and local people interact during the process.

4-1 Introduction

According to the data at the end of December 2020, the installed capacity of new energy in Gansu Province was 23.69 million kilowatts, accounting for 42% of the total installed capacity of the province, and the utilization rate of new energy reached 95.28%, an increase of 35 percentage points from the beginning of the "13th Five-Year Plan" period. Ranked the top in China, Gansu is rich in new energy resources such as wind and solar energy. In particular, the Dunhuang Solar Energy Comprehensive Utilization Demonstration Project in Gansu Province, with a total estimated investment of 1.8 billion RMB, was completed at the end of 2013. It is the largest solar power generation project in Gansu Province and one of the key new energy projects in Gansu Province. "At the end, the installed capacity of solar power generation in Dunhuang reached 1 million kilowatts, making Dunhuang a million-

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kilowatt solar power demonstration base and a national new energy demonstration city. In terms of investment and income, in 2015, wind and solar power generation led to an investment of 400 billion RMB, accounting for about 0.7% of the total investment of the whole society, and directly employed 450,000 people; it will grow to 495.4 billion RMB in 2030, and the employed population will reach 240 thousand people (Anue, 2021).

Gansu's solar power development is consistent with China's five-year plan. During the 12th Five-Year Plan (2010-2015) the focus of solar power development in Gansu concentrated on the boost of installed capacity. During the 12th Five-Year Plan (2010-2015), according to the "12th Five-Year Plan for New Energy and Renewable Energy in Gansu Province", it is expected that by the end of 2015, the installed capacity of wind power will reach 17 million kilowatts in Gansu, and the installed capacity of solar power generation will reach more than 6 million kilowatts. By 2015, 21GW of installed solar power capacity will be achieved, including 15GW of rooftop solar power systems. Its solar power generation installed capacity target accounted for nearly one-third of China's planned capacity at that time. Gansu has built 20 grid-connected solar power stations with a total installed capacity of 285,000 kilowatts (EnergyTrend, 2012).

During the 13th Five-Year Plan (2016-2020), the focus of solar power development in Gansu concentrated on the poverty alleviation. In 2016, Gansu clarified the electricity price and grid connection method of solar power poverty alleviation projects,

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supporting grid services, integration with facility agriculture, relaxation of land use conditions, complementary forests and sunlight, and determination according to local conditions Solar power poverty alleviation model. The Gansu Provincial Development and Reform Commission, the Poverty Alleviation Office, the Department of Finance, the Department of Land and Resources, and the Department of Forestry promoted "Notice on Further Clarifying the Support Policies for Solar power Poverty Alleviation Projects".

The next year, 29 counties in Gansu Province built 767 poverty alleviation power stations, with a construction scale 428,462 kilowatts. The National Energy Administration and the State Council's Poverty Alleviation Office further implemented the "Notice on Issuing the First Batch of Solar Power Poverty Alleviation Projects in the 13th Five-Year Plan". The project plan is broken down to each year from 2018 to 2020. The Gansu Provincial Development and Reform Commission and the Poverty Alleviation Office "Notice on Decomposing the First Batch of Solar power Poverty Alleviation Projects in the 13th Five-Year Plan", and standardizing the construction, operation and management of solar power poverty alleviation power stations in the province, as well as the "Gansu Province Implementation Rules for Poverty Alleviation with Solar Power (IN-EN, 2020).

During the coming 14th Five Year Plan (2021-2025), the 14th Five-Year Plan for new energy focuses on power grid projects and power distribution. The Lanlin Power Transmission and Transformation Project is a key project in Gansu Province in 2021,

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and is the responsibility of the State Grid Gansu Electric Power Company. The Lanlin 750kV power transmission and transformation project is the first energy project newly built in Gansu Province during the "14th Five-Year Plan" period, and it is also the largest planned 750kV power grid project in Gansu. After the project is completed, 4.2 million kilowatts of substation capacity will be added to effectively solve the problem of 330 kV multi-section heavy load and short-circuit current exceeding the standard in the central Gansu power grid, and provide strong power guarantee for local economic and social development. The Lanlin Transmission and Transformation Project aims to improve Gansu's local power transmission and peak shaving capabilities during peak hours (Solarbe, 2020).

At the beginning of the year, the COVID-19 epidemic raged, which had a greater impact on social production and life, and the electricity consumption of the whole society continued to decline. However, with the effective control of the epidemic situation, the order of production and life in the province has gradually returned to normal and "recovered" continuously, and the demand for electricity continues to rise. State Grid Gansu Electric Power adopts multiple parallel operations to ensure stable power consumption during the winter peak power consumption period in the province. It also analyzes the changes in power consumption and new energy generation in the whole society in a timely manner, and optimizes and adjusts the power-on method of thermal power in combination with the reduction of Liujiaxia’s outgoing flow. Market-oriented means guide the switching of charging and discharging modes of energy storage power stations in the grid and the replacement of

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power from self-provided power plants, actively promote the consumption of new energy, and ensure the completion of the annual power transmission task of the Gansu Power Grid (State Grid Co., 2020).

With the progress of a series of five-year plans, Gansu continues to promote the construction of a large-scale new energy base in Hexi, further expands the scale of Jiuquan 10 million kilowatt wind power base, builds Jinchang, Zhangye, Wuwei 10 million kilowatt wind power base, and actively develops silver composite Preliminary work for the construction of a type energy base. Gansu also speeds up the construction of key projects such as Power Transmission to Shandong supporting external wind and solar power projects. Gansu continued to expand the scale of solar power generation and promoted the diversified development of "Solar Power Plus". By promoting further reduction of energy storage costs and diversified utilization, Gansu has launched pilot demonstrations of integrated commercial applications such as wind storage, solar storage, dispersed micro-grid storage and large-scale grid storage, and built a big data center for clean energy transactions (EnergyTrend, 2021).

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4-2 High Curtailment Rate in Solar Power

Northwestern regions such as Qinghai, Ningxia, Gansu, Shaanxi, and Xinjiang in mainland China have developed relatively early solar power plant construction projects due to their vast territory and abundant sunlight resources. They are also the main demand areas. The growth rate has been large in the past few years. However, due to the low local power consumption and insufficient cable transmission capacity, solar power cannot be properly used after power generation and is abandoned, leading to the problem of abandoning solar power and limiting electricity. However, due to the instability of new energy and other reasons, in 2016, the new energy industry in Gansu Province was listed by the National Energy Administration as a "wind and solar power red warning area". This dilemma is mainly caused by the following three factors:

First, the construction period of new energy electric fields is pretty short, and the speed of new energy development far exceeds the speed of supporting power grid construction. In the past ten years, especially during the "12th Five-Year Plan" period, China's new energy development momentum has been rapid. According to the information released by the Gansu Provincial Development and Reform Commission, in Gansu Province alone, since 2010, the installed capacity of new energy has soared from 1.47 million kilowatts to 23.69 million kilowatts, which is 16 times higher, including thermal power and hydropower, Gansu is currently The province’s total installed power supply capacity is 56.2 million kilowatts. The installed capacity of new energy accounts for 42% of the total installed capacity of the province. The

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installed capacity ranks top 7th in China and surpasses thermal power to become the largest power source in the province. As a result, the Gansu power grid has developed into a so-called "Green Grid."

Second, Gansu's industrial development level is low, electricity consumption is limited, and Gansu New Energy's installed capacity and power generation capacity are obviously surplus. From 2010 to 2020, the maximum load of the Gansu power grid only increased from 11 million kilowatts to 17.31 million kilowatts. Due to the overall economic downturn in a few years in between, the electricity sales in Gansu Province also experienced negative growth. It can be seen that the growth rate of electricity load in Gansu Province is much lower than the growth of new energy installed capacity, and the space for new energy consumption in the province is seriously insufficient, which presents that it is necessary to open up markets outside the province to increase the consumption space.

Third, Gansu has insufficient power transmission and transformation channels to transport surplus electricity to other provinces. Because of the features of large scale, small amount, and undeliverable as well as its underdeveloped economy, Gansu's own consumption capacity is limited, and a large amount of surplus electricity needs to be sent out, but it has encountered difficulties. Among them, the most critical factor is that the speed of power development far exceeds the speed of power grid construction. Due to various factors at the time, the degree of matching between the two has not been well planned. This situation was particularly prominent around

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2010. It is understood that the period from project approval to approval of new energy is short, and even if the approval of the relevant power grid construction is completed, the fastest construction period will take 2 to 3 years. In addition, because the new energy is concentrated in the Hexi area of Gansu, the grid structure of the power grid is weak, and the new energy is only sent out through the northwest-Xinjiang network transmission channel. Affected by the stability of the power grid at that time, limited transmission capacity, and sharing channels with Xinjiang thermal power and new energy transmission, one can go and the other, the new energy in Gansu is experiencing development pains (IN-EN, 2021).

From Grid War to Grid Alliance

The inter-provincial transmission capacity of the Northwest, Northeast and North China regions classified as the "Three Norths" is only 22% of the installed capacity of new energy. If the electricity generated cannot be returned through cables, it means that the owners of the power plants cannot obtain income through the sale of electricity, which will be detrimental to the operation of the industry and harmful to the development of the industry. In order to obtain income from the sale of electricity, there has formed a Grid War in the Northwest (EnergyTrends, 2017)."

To cope with the serious problem of abandoning solar power and limiting electricity, Gansu has adopted energy external transmission as the main way of consumption. The State Grid Gansu Electric Power Company actively organized nationwide consumption, and successively sent Gansu electric power to Qinghai, Tibet, Central

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China and East China. Recently, it has reached a cooperation intention with China Southern Power Grid. According to statistics, in the first half of this year, Gansu exported 13 billion kWh of electricity, an increase of 50.6% year-on-year, of which 7.16 billion kWh was sent from new energy sources. At the same time, Gansu uses the national power spot trading platform of the State Grid Corporation of China, and Gansu actively implements new energy spot trading. All new energy power plants in Gansu Province are connected to the spot trading system. In 2017, Gansu new energy spot transactions were 3.27 billion kWh., accounting for 46.1% of the national transaction volume (People, 2018).

Conflict in Central-Local Relations and Local Agents

The power curtailment problem in the five northwestern provinces is becoming more and more serious. In 2016, the abandonment of solar power and the curtailment caused economic losses of 5.6 billion RMB for related enterprises. In 2016, the Gansu Industry and Information Technology Commission issued the "Notice on Issuing the Priority Power Generation Plan for 2016". The notice mentioned that in 2016, the priority of new energy generation capacity was 10 billion kWh, and the minimum guaranteed annual average utilization hours of solar power acquisition was 400 hours. As this notice conflicts with the "Notice on in the Full Guaranteed Acquisition Management of Wind Power and Solar Power Generation" issued by the National Development and Reform Commission and the Energy Administration, however, this notice was stopped by the Energy Administration. Gansu also made a statement and

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adjusted the relevant issues in a timely manner, which makes the policy consistent with the national authorities.

Although the curtailment policy, from the perspective of the rate of abandonment of solar power, contributes to the decline in the rate of abandonment solar power and the amount of abandoned solar power in the northwestern provinces each year, in the case of a serious shrinkage of guarantee hours, local governments will require solar power companies to “actively (under the command from the local government)” participate in direct power purchase transactions, "actively" reduce electricity prices, and cooperate with the competent authorities and grid companies to complete the utilization hours target. The transaction price of only a few cents cannot cover the cost of solar power generation. In order to reduce the pressure, solar power companies can only continue to reduce the operation and maintenance personnel and costs, and even the weeds under the modules have no time to take care of. Thus, solar power companies are not able to cover, which lead to be willing to trade is without receiving possible revenue, but no one dares to offend government departments and power grid companies.

In May 2017, Gansu Province issued the "Implementation Plan for New Energy Consumption in Gansu Province." In early 2018, the State Grid Gansu Electric Power Company's 2018 working conference put forward the goal of "Vigorously Implement Electric Energy Substitution and Promote Clean Energy Consumption." In June 2018, the Gansu Provincial People's Government issued the "Special Action Plan for the

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Development of Clean Energy Industry in Gansu Province". According to Article 14 of the "Renewable Energy Law", grid companies should sign grid connection agreements with renewable energy power generation companies that have obtained administrative licenses or filed for the record according to law, and purchase all renewable energy grid-connected power generation projects within their grid coverage and provide online services for renewable energy power generation. However, under such a mechanism, the responsibility and risk of solar power development are borne by the competent department of energy companies and the grid company. The uneven distribution of responsibilities and power makes solar power development in Gansu difficult.

Under the problem of abandoning solar power and limiting electricity, another problem has also arisen, which is the serious loss and exit of investment manufacturers. Some shareholders of a 20MW power station in Dunhuang, Gansu could not bear the pressure of repaying the loan, and began to look for opportunities to sell the power station equity. There are two main reasons: the first is that the subsidy is in arrears for too long, and the new batch of renewable energy subsidies is far away; the second is that the electricity curtailment is severe, and only 40 hours of power generation per month can be purchased at a price of 0.9 RMB/kWh, and the rest must be approved. Transaction complete. However, the income of power generation is too low, and many investment manufacturers participate in the construction of solar power plants. Even though Gansu has good power generation

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conditions, too much power cannot be sent out, making the investment manufacturers bear losses and then withdraw from the solar power generation ecosystem in Gansu.

In 2015, Gansu Province added 930,000 kilowatts of solar power installations, reaching a total of 6.1 million kilowatts, ranking the top in China. However, the abandonment rate in Gansu that year had reached 30.7%, and the annual abandonment amount of solar power was 2.619 billion kWh, which was more than half of the total abandonment rate. But such a serious abandonment has not stopped the progress of investment enterprises. In 2016, Gansu Province added 760,000 kilowatts of solar power installed capacity. Without new delivery channels and absorption channels, and without solving the problem of absorption, blindly invest and build together, and finally have to bear serious losses and exit (Solarbe, 2018).

Reviewing at the above development, the losses of some enterprises in Gansu are not unpredictable and timely controlled. From the overcapacity issue in Gansu, the dissertation argued that the interaction between local government and local agents resulted in the high curtailment rate in solar power. To pursue the policy interest and subsidy from the government, the local energy manufacturers actively generated solar power instead of considering the consumption ability on these generation from solar power. The local government even recruited high-consumption on electricity manufacturers to consume these extra power, which increase the local economy development, but resulted in higher pollution in Gansu.

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4-3 Poverty Alleviation Project with Solar Power

To standardize the construction, operation and management of poverty alleviation solar power stations in China, the central Chinese authority continued to drive the income of the poor in rural areas, and supported poverty-stricken villages to increase collective economic income, according to the "Opinions on the Implementation of Solar Power Poverty Alleviation Work" by the National Development and Reform Commission and the National Energy Administration , The "Administrative Measures for Solar Power Poverty Alleviation Power Stations" issued by the State Council's Poverty Alleviation Office, and the "Management Measures for the Distribution of Revenues from Solar Power Poverty Alleviation Power Stations at the Village Level" issued by the State Council's Poverty Alleviation Office, which is provided by the State Development Office and other regulations.

Poverty alleviation solar power plants are aimed at poverty alleviation. In areas with the conditions for implementing solar power poverty alleviation, the property rights of solar power plants invested and constructed with government funds are owned by the village collective, and all the proceeds are used for poverty alleviation. The targets of solar power poverty alleviation are the registered poor households in the registered poor villages that are included in the national solar power poverty alleviation implementation scope, and priority is given to the deeply impoverished areas and poor people with weak working capacity. The construction and management of solar power poverty alleviation projects follow the ideas of “provincial guidance, city-state coordination, county-level responsibility, policy support, technical specifications, and

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focus on actual results". The county-level government shall be the main body of implementation, in accordance with "planning, design, construction, and acceptance. Where conditions permit, cities and prefectures can uniformly carry out equipment procurement and construction project bidding. Poverty alleviation solar power stations are constructed by localities based on their financial resources and may raise funds, must not be built with debts, and enterprises must not invest in shares. In areas with favorable conditions, it is encouraged to implement projects in a combination of agricultural with solar power, animal husbandry, and fishery with solar power to improve land utilization and poverty alleviation benefits.

Organization in Charge

In Gansu, the project is in charge of solar power poverty alleviation. The Gansu Provincial Solar power Poverty Alleviation Work Leading Group is responsible for the planning, guidance, supervision and management of solar power poverty alleviation projects in the province. The Provincial Development and Reform Commission and the Provincial Poverty Alleviation Office are responsible for the organization, guidance, overall coordination, and project supervision of solar power poverty alleviation projects, as well as supervision of poverty alleviation effects. Provincial power companies are responsible for the power connection and grid-connected operation of solar power poverty alleviation power stations. Municipal and prefecture governments are responsible for comprehensive coordination services and project construction supervision of solar power poverty alleviation projects in the region. County and city governments are responsible for implementing the

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implementation of solar power poverty alleviation power stations Project construction conditions, organize and implement the construction, operation and maintenance and management of solar power poverty alleviation power stations, and do a good job in the distribution of solar power poverty alleviation benefits.

After the completion of the preparation of the solar power poverty alleviation implementation plan in each county, urban area, the local development and reform commission (National Energy Bureau) and the poverty alleviation office are responsible for collectively reporting to the provincial development and reform commission and the provincial poverty alleviation office. After the Provincial Development and Reform Commission and the Provincial Poverty Alleviation Office have reviewed the implementation plan, they will prepare the province's solar power poverty alleviation implementation plan and report the project plan to the National Energy Administration and the State Council's Poverty Alleviation Office. After the National Energy Bureau and the State Council's Poverty Alleviation Office have issued the solar power poverty alleviation project plan, the Provincial Development and Reform Commission and the Provincial Poverty Alleviation Office shall forward it in a timely manner. When transmitting it, it shall determine the annual construction tasks according to the province's poverty alleviation work deployment.

Generation and Finance

In Gansu, the scale of village-level poverty alleviation solar power stations is configured according to the number of poverty-stricken households assisted by an

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average household of about 5 kilowatts, and the maximum is no more than 7 kilowatts. The scale of a single power station does not exceed 300 kilowatts, lowering down to 500 kilowatts. The voltage level of the external transmission line of the village-level combined power station shall not exceed 10 kV, and the construction scale shall not exceed 6,000 kV.

The county-level government can coordinate all levels of fiscal funds, east-west collaboration, fixed-point assistance, social donation funds, and provincial-level special subsidies arranged by the province to support the construction of solar power poverty alleviation projects in various regions. When arranging provincial subsidy funds, Gansu government will give preferential support to deeply impoverished areas. According to the "Notice of the General Office of the People's Government of Gansu Province on Further Increasing Capital Investment to Support Industrial Development to Ensure Winning the Fight against Poverty", all central, provincial, municipal, and county-level fiscal special poverty alleviation funds and more than 70% of integrated agriculture-related funds should be made for the establishment of files to support poverty-stricken households and household-to-person support projects, of which more than 70% of the household-to-house funds should in principle be used to increase income in industries such as planting and breeding and solar power poverty alleviation sorted out by "one household, one policy" project.

Starting from the formal acceptance of the connection application by the power grid companies in all parts of Gansu, the solar power poverty alleviation power stations

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with voltage levels of 0.4 kV and below will complete the grid connection within one month, and the solar power poverty alleviation power stations with voltage levels of 10 kV will be completed within 6 months, and grid-connected work is completed within. The Provincial Development and Reform Commission and the Provincial Poverty Alleviation Office evaluated solar power poverty alleviation power stations in various counties and cities in accordance with the requirements of the poverty alleviation with solar power policy, and formed a written report on the total experience receipts and evaluations and submitted it to the National Energy Administration and the State Council's Poverty Alleviation Office.

Operation and Management

The village-level poverty alleviation solar power station in Gansu uses the county as a unit to conduct centralized operation and maintenance management. The county-level government should use a market-based approach to entrust professional institutions to undertake the operation and maintenance of solar power poverty alleviation power stations to ensure the long-term effective operation of poverty alleviation projects with solar power and long-term stable benefits for poor households. Conditional county-level governments can pay land transfer fees, lease fees, and operation and maintenance fees with financial funds, and can also draw from the income of village-level solar power plant projects.

Village-level poverty alleviation solar power station operation and maintenance units should give priority to hiring local poor households with labor capacity to participate

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in the daily maintenance of the power station. Poverty alleviation solar power plants do not participate in bidding, and implement the solar power poverty alleviation price policy formulated by the state. The solar power station for poverty alleviation built by village clusters will be implemented according to the electricity price of the village-level solar power poverty alleviation power station after the assets are confirmed by the county and municipality to the village collectives. The provincial power company is responsible for formulating a unified solar power poverty alleviation project connection and electricity bill settlement flow chart to ensure that the project completes the power connection and electricity bill settlement in a timely manner. The provincial power company takes the role to ensure the priority dispatch and full consumption of solar power poverty alleviation projects, and promptly settle electricity bills and transfer state subsidy funds (Gansu, 2018).

Poverty alleviation with solar power is an innovative measure for targeted poverty alleviation and poverty alleviation, which can effectively guarantee the long-term stable income increase of the poor and solve the problem of the lack of industries in poor villages and the weak collective economy of the villages. From the perspective of the work development in the province, solar power poverty alleviation has opened up a new path, cultivated new momentum, and provided new support for poverty alleviation in poverty-stricken areas of Gansu, especially in remote and resource-poor areas to solve the deep-seated contradictions of weak industrial carrying capacity. Since the National Energy Administration and the State Council's Poverty Alleviation Office designated Gansu as the first batch of pilot provinces for solar power poverty

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alleviation projects in China, the province has implemented solar power poverty alleviation projects in 41 counties and districts with a total installed capacity of 850,000 kilowatts (Gansu, 2018).

By 2020, the national financial subsidy for household solar power projects will be about 2.9351 million kilowatts. The state has issued a total of 19.1 million kilowatts of solar power poverty alleviation and helped 4.07 million poor households. The solar power poverty alleviation project in Gansu Province has a scale of 1.276 million kilowatts. Among them, 921,000 kilowatts of village-level power stations benefited 3,896 filed and registered poor villages, and 189,200 filed and registered poor households. Calculated based on the annual utilization hours of 1,100 hours, the electricity price is 0.75 RMB/kWh, and the annual income of the village-level power station can reach 760 million RMB (IN-EN, 2020).

Poverty Alleviation Project in Gansu

Solar power plants not only bring additional income to impoverished families, but also inject incentives into the development of the collective economy. "The more sunshine, the higher amount of electricity generated, the higher the income of the village collective. Solar power generation solves the problem of collective poverty alleviation in remote villages in Gansu and realizes the so-called "blood-making" poverty alleviation. The first batch of total installed capacity of the "13th Five-Year Plan" is 428,500 767 solar power poverty alleviation village-level power stations with kilowatts have been fully started and are expected to be connected to the grid by the

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end of the year. The province's 1,431 filed and registered poor villages and 74,384 filed and registered poor households will be helped (F. China, 2018).

In order to further promote the province’s poverty alleviation action, vigorously implement the targeted poverty alleviation strategy, and effectively promote the income of the poor, according to the "Notice of the National Energy Administration and the State Council Poverty Alleviation Office on Printing and Distributing the Implementation of the Solar power Poverty Alleviation Project" and the spirit of the “Notice of the National Energy Administration and the State Council’s Poverty Alleviation Office on Organizing and Carrying out Solar power Poverty Alleviation Projects”, the pilot project with solar power has developedin Tongwei County, Qingshui County, Dongxiang County, Lintan County, Li County, and Minle County.

Through the support and guidance of the Gansu government and the general principle of voluntary participation of local farmers to promote. The three levels of province, city, and county are in accordance with the overall planning at the provincial level, the city and state coordinate and supervise, and the county is responsible for the division of labor for the implementation. There are no less than 200 households in each county, and each household has an installed capacity of 3000 watts. The village worked as the basic unit for overall promotion, covering all eligible poor households in the village at one time. In terms of the construction mode of solar power generation facilities, Gansu’s solar power poverty alleviation model uses the roofs of poor households or the open spaces inside and outside the hospital to install dispersed solar

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power generation facilities nearby, or poor households jointly use barren hills and slopes, planting greenhouses, both sides of the road, used land and other spaces to build small solar power plants.

In terms of fund-raising and income distribution, Gansu's solar power poverty alleviation model is within 200 households per county. The Provincial Poverty Alleviation Office arranges provincial financial poverty alleviation funds at 1/3 per household. The self-raised amount of poor households is determined by the pilot county, and the remaining funds are raised, from which the pilot counties adopt various methods such as enterprise participation to study and solve the problem. The provincial and county-level governments can expand the scope of the experiment according to their own financial resources. If poor households use their own funds as loans, the interest will be discounted by the provincial fiscal poverty alleviation funds. Government supports and farmers' self-raised methods are adopted for construction. In principle, all income from electricity sales shall be owned by poor households; if market-based methods are used to raise funds for construction, in principle, the distribution shall be carried out according to the principles of marketization, and the specific distribution methods shall be proposed by the pilot counties.

In actual operation, Gansu's solar power poverty alleviation model is organized and implemented in the county as a unit. A solar power generation company is selected and determined by bidding as the implementation unit, responsible for project design, construction, execution and maintenance. The selected solar power generation

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company should have financial strength, technical capabilities and good reputation. The provincial power company provides grid guidance to ensure that the solar power poverty alleviation project is completed and connected to the grid and the full amount of on-grid electricity is purchased. The electricity bills are settled in time according to the meter reading cycle and the state subsidy funds are transferred. At the same time, the Gansu government encourages and supports powerful new energy companies to actively participate in the pilot work, and supports the implementation of solar power poverty alleviation projects for poor households through various means of funding and assistance. Pilot cities and prefectures as well as county governments should ensure the economic benefits of enterprises participating in the pilot work through a variety of methods (DRCG, 2018).

In the 13th Five-Year Plan, the poverty-stricken areas of Gansu Province have realized the transition from utilizing electricity to utilizing electricity, with a total investment of 12.364 billion RMB, and successively implemented villages-to-villages electricity transmission, wells and small towns transformation and upgrading of rural power grids, completed ahead of schedule the poverty alleviation power grid projects of the so-called "two states and one county" and 18 provincially designated deeply impoverished counties, and the power grid adopted the so-called "two rates and one household" indicator reached the national poverty alleviation standards. Gansu promoted the transformation of poverty alleviation from power transmission to local power generation, which gives full play to the technological and professional advantages of power grid enterprises, and ensure that solar power poverty alleviation

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projects are connected to the grid and benefited early. A total of 1.26 million kilowatts of solar power poverty alleviation projects have been connected to the grid, benefiting 188,000 poor households every year, which can generate stable income of about 560 million RMB (DRCG, 2018).

Gansu's solar power promotion operations are in charge by the Gulang Company, comprehensively sorting out the carrying capacity of the grid, intensifying the transformation of the rural power grid in poverty-stricken areas, and incorporating solar power project construction into the grid planning, and successively newly built 0.71 kilometers of 10-kV lines and 14.68 kilometers of 0.4-kV lines. Gansu erected 17 distribution transformers with a total capacity of 2,100 kVA, making sufficient preparations for the “landing” of the solar power poverty alleviation project, which fully implemented various work measures for new energy consumption, and formulate reasonable grid-connected operation of solar power poverty alleviation projects and power consumption plans (People, 2020).

At the same time, Gulang Company divides the settlement of solar power poverty alleviation subsidies into five stages: electricity collection, financial verification, fund scheduling, payment feedback, and owner return visits, and strives to create a “green channel” for electricity bill settlement to achieve fast and efficient payment of solar power subsidies for poverty alleviation. The follow-up service method is adopted,

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focusing on the line and platform area where the solar power poverty alleviation power station is located, and the customer manager is arranged to visit regularly to ensure reliable power supply and minimize the power loss caused by power outage (People, 2020).

In recent years, Gulang County has successively built 7 Liancun power stations in the Huanghuatan resettlement area and the southern mountainous area, including Sunshine, Gaofeng, and Qiduntai. The cumulative power generation capacity is 87.7081 million kWh and the on-grid power is 87.321 million kWh. The electricity bill was 26 million RMB, and the settlement subsidy amount was 18 million RMB, which drove 122 poor villages to increase the collective economy of the village, and 4,955 poor households established files and registered cards to increase their incomes, which promoted the county's poverty alleviation work process, in order to win poverty alleviation, which helps the whole county to get rid of poverty has laid a solid industrial foundation (People, 2020).

Challenge in Poverty Alleviation in Gansu

While alleviating the problems of local poor households, Gansu's solar power poverty alleviation is also facing many problems and challenges, mainly in the aspects of operation and maintenance management, income distribution, and upgrading.

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First of all, in terms of solar power operation and maintenance management, the state currently provides directional guidance, local governments formulate specific operation and maintenance management methods, and there is a lack of unified standardized management standards, which also faces challenges in terms of operational management costs. In the beginning, the distribution of household and village-level power stations in most mountainous areas is relatively scattered, which increases the difficulty of operation and maintenance management. Then, the operation and management costs of third-party operation and maintenance companies are relatively large. Also, the level of network communication infrastructure in mountainous areas limits the efficiency and practical effects of electronic operation and maintenance, and the connection between some mountainous solar power sites and the network detection system is unstable. Finally, the dual-track solar power monitoring system is parallel, which increases the workload of the grassroots.

The second is the issue of the income distribution mechanism. Some solar power models have differences in the income distribution mechanism. Issues such as the bundling of income from household solar power stations and the interest binding of participating in dividend power stations pose a challenge to the inclusiveness and fairness of solar power income distribution. Therefore, it is necessary to solve the problem of binding benefits arising from the solar power construction and right confirmation stage, ensure the fair and inclusive solar power revenue distribution, and realize the dynamic adjustment of solar power revenue distribution.

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Third, in terms of job employment and supervision and management, the scientific nature and efficiency of the establishment of public welfare posts still needs to be improved. Generally, the number of public welfare posts is determined by the percentage of solar power income, rather than the population status, poverty status and job demand status of the solar power village as the core criteria. On the other hand, the system of job setting, job functions, job rights and responsibilities, appraisal and supervision, and performance incentives for public welfare jobs are not perfect. It is necessary to further improve the system and mechanism of public welfare posts, change the post for money to post for people, and post for things, so as to improve the actual effect of public welfare posts.

Finally, it is the issue of follow-up maintenance and development. Solar power technology is iteratively fast. The current policy is still unclear on how to update and upgrade solar power equipment. The challenges faced by equipment renewal are the high cost pressure of renewal and the disposal of discarded solar power panels. Waste solar power modules have potential environmental pollution risks, which requires scientifically plans to deal with the issue. At the same time, solar power poverty alleviation is also facing the problem of diversified industrial development. Power generation revenue and corresponding government subsidies constitute the main body of the solar power poverty alleviation industry. The exploration of expanding the industrial chain and increasing non-power generation revenues such as "PV+" is still in the early stage. The fundamental path of solar power poverty alleviation is to extend the solar power industry chain, promote the diversification of the solar power

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industry's benefits, improve the ability to resist risks, and establish a more stable benefit connection mechanism between villages, farmers and the market to ensure farmers continue to increase revenue steadily (CBAD ,2021).

Under the model of solar power poverty alleviation in Gansu, through comparison with solar power development models in other provinces, this dissertation also found that the Gansu Provincial Government, under the environmental policy incentives of the central government to encourage poverty alleviation, introduced local development policies and related policies in 2014. However, the success of the solar power poverty alleviation model will not actually take root in various poverty-stricken counties until 2018. This dissertation believes that from the poverty alleviation with solar power in Gansu, the dissertation argued that the reason why even with better natural conditions to develop solar power, the poverty alleviation with solar power in Gansu begins slower than other provincial provinces. This dissertation argued that the bundled economic interest also occurred in the interaction between local government and local agents. Even with much sufficient solar radiation (compared to the coastal provinces), this dissertation argued that without sufficient incentives provided by the policy, the local energy companies prefer the bundled interests from the environmental policies in solar power generation transaction instead of fostering the poverty alleviation project with the local poor and local farming activities.

Conclusion

Chapter 4 has introduced the solar power development in Gansu as well as the interaction between governments, energy manufacturers, grid companies, as well as

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the local users. Since 2006, China has actively promoted solar power in different provincial levels domestically. Gansu, as one of the inner provinces with sufficient resources on solar power development, received a series of guidance and subsidies from the central policies. During the development, local government officials in Gansu are facing the pressure on one hand catering the objective from the central on increasing solar power installation capacity and generation. On the other hand, the local officials also had the pressure perusing the local development on economy.

Under the pressure of meeting the target from the central and pursuing the economic development in the local, the local government officials coordinated the grid companies and energy manufacturers as well as the local farmers and the poor. In the current Chapter, this dissertation presented from overcapacity to poverty alleviation with solar power, how local government interacted with different agents and actors in the process to shape the solar power development in Gansu.

From the overcapacity issue in Gansu, the dissertation argued that the interaction between local government and local agents resulted in the high curtailment rate in solar power. To pursue the policy interest and subsidy from the government, the local energy manufacturers actively generated solar power instead of considering the consumption ability on these generation from solar power. The local government even recruited high-consumption on electricity manufacturers to consume these extra power, which increase the local economy development, but resulted in higher pollution in Gansu.

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To sum up, the bundled interests from the policy resulted in the interaction between the local government and local energy companies. Under the interaction, local agents will evaluate the interests from the incentives and behave accordingly, which has resulted in the high curtailment rate and slow development in poverty alleviation with solar power.

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Chapter 5 Manufacture Overcapacity, Solar Poverty Alleviation with Agriculture and Solar Power Development in Shandong

As the previous chapter mentioned the problem of overcapacity has caused huge losses and impacts on China's new energy Gansu, in order to explore the research questions of this dissertation-- **"How bundled interests during the central-local interaction shaped the solar power development pattern in China?"** Chapter 5 will adopt the approach of environmental bundled economic interest approach and examine the central and local relations and its application in solar power development in Shandong province, and discuss how the central government, local governments, power grid companies, new energy equipment vendors, and local people interact during the process.

5-1 Introduction

As the leading policy initiated the development of solar energy, the central state of China has regional strategy on the different local provinces. With the large space and less density population, the Western provinces such as Gansu and Inner Mongolia have been selected as the base for centralized solar power generation. On the other hand, with the limited space arrangement and high-energy consumption capacity, the coastal province, such as Shandong, Zhejiang, and Jiangsu have implemented dispersed solar power generation as the major way on solar power development. Among the coastal provinces, the growth of solar power installed capacity in Shandong has reached tremendous achievement compared to other coastal provinces,

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and result in the “complementary of agriculture and solar power development” (Nong Guang Hu Bu 農光互補).

Compared to the Western provinces like Inner Mongolia and Gansu, solar power development application in coastal areas has transformed differently. Due to the limitation on natural resources, such as solar radiation and land resources, solar development in Shandong adopt solar dispersed power generation system. Solar dispersed generation power system refers to smaller scale of solar power generation, and the main function of it is to generate electricity through PV system with limited land resources, such as top of the building, and the pond in mountain area.

Located in coastal area of China, Shandong is a province with great agriculture development as well as high energy consumption. The growth of agriculture development has ranked top 1 among Chinese provinces, which accounts for the food support for domestically (Finance Sina, 2015). Additionally, as one of the fast-developing coastal provinces, Shandong requires strong energy supply for its own development. With the incentive promoted by the central state, Shandong government cooperated with the local solar companies to construct solar power plant and solar panel targeting in the rural area. Under the stimulation, the number of installed capacity of solar power has growth dramatically. By 2016, solar power has provided 1/4 of the electricity for the green energy in Shandong, offering electricity for more than households in rural area.

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In terms of the grid construction, solar power relied on dispersed solar power generation system in rural areas. Owing to the local government's plan and strategy, the solar power grids were designed and managed by the cooperation between the local government and the local solar power company in Shandong, fulfilling the demand of electricity for the villagers and farmers in rural areas. The circle between the local government (Shandong), the solar power company as well as the local users in rural area (famers and the poor) provided the local sustainability in rural development through solar power.

In 2016, the installed capacity of ground-based power stations in China reached 90%, and the dispersed installed capacity accounted for 10%. In 2017, the installed capacity of ground-based power stations was 62.5%, and the dispersed installed capacity increased to 37.5%; in 2016, the newly added solar capacity nationwide was 34.54GW, dispersed It is 4.24GW, and the cumulative installed capacity is 77.42GW (Aolar, 2017).

At the end of October 2017, the total number of grid-connected data received by State Grid Shandong Electric Power showed that it was 91,929 households; in 2017, there were 63,875 new households with 2.89 million kilowatts, and the capacity increased by 4.5 times year-on-year. (Among them, low-voltage grid-connected 1.12 million kilowatts and high-voltage 1.77 million kilowatts), 10600 households, with an installed capacity of 774,500 kilowatts. The average installed capacity is 7.3 kilowatts per household (Aolar, 2017).

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At the end of 2020, Shandong has become the first province in China to have a total installed solar capacity of more than 21 million kilowatts. In the whole year, the number of newly installation solar capacity increased by 194,000, and the newly added residential solar installed capacity was 4.66 million kilowatts, ranking first in the country. Shandong government provided the so-called "Solar Passbook" was issued to 453,000 households, which provide the local users with extra revenue from solar power generation from their rooftop (Dazhong, 2021).

Five Year Plan (FYP) and Solar Power Policy in Shandong

Shandong's solar development basically follows the pace of China's five-year plan. During the 11th Five-Year Plan (2006-2010), with the central government's pace of optimizing energy, positive progress was made in eliminating outdated production capacity, accelerating the development of the solar energy industry, and Strengthen the construction of rural power grids. In terms of eliminating outdated production capacity, Shandong and other provinces have promoted the alliance of coal enterprises, which greatly promoted the merger and reorganization of coal enterprises and the integration of resources. Over the past five years, more than 9,000 small coal mines have been shut down nationwide, 450 million tons of outdated production capacity has been eliminated, and low-efficiency coal-fired power generation units have been shut down gradually.

In accelerating the development of the solar energy industry, the solar power generation market was launched in an orderly manner, with the implementation of the Golden Sun Demonstration Project and the completion of a 270,000 kilowatt

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demonstration project. The installed capacity of solar power generation nationwide has reached 600,000 kilowatts, and a relatively complete solar cell industry chain has been formed. The annual output has exceeded 8 million kilowatts, and exports account for half of the global market. The scale of installation and use of solar water heaters continues to expand, with a possession of more than 170 million square meters.

In strengthening the construction of rural power grids, implementing rural grid transformation and power construction projects in areas without electricity, a total of 32.3 billion RMB was allocated in the central budget for five years, with a total investment of 145.5 billion RMB, which improved the rural power supply capacity and the level of electricity consumption, and reduced the number of farmers. The burden of electricity consumption is about 35 billion RMB per year, solving the electricity problem of more than 30 million people without electricity. In remote rural areas, promote the use of solar cookers, solar houses and solar water heaters (CPGPRC, 2012).

Since 2005, the central state of China has officially launched the guiding policy and objective for renewable energy development in national developmental plan. First of all, during the Hu period, local governments are encouraged to increase the percentage in solar power installed capacity, and to reduce the dependence on traditional coal burning from thermal power plant. However, the implementation of the guiding policy did not run smoothly due to the unclear subsidy and details. Owing

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to requirements from the fast development the central state of China further promoted *Renewable Energy Law of People's Republic of China* to support the guiding policy and to solve the increasing energy consumption in coastal provinces (include Shandong). According to the National Bureau of Statistics of China, the newly installed capacity on solar power development has reached 34.54GW by 2016 (Chinapower, 2017), and coastal provinces have amazing growth among the provinces (Newsinen, 2017). Due to the fast development of China economic, the demand of coastal province on energy consumption and the determination of getting rid of the dependence on coal burning, the installed capacity in solar power in coastal province has achieved amazing growth in the following decade as Figure 1illustrated bellowed:

Since 2006, the central state has promoted a series of policies to encourage the local government like Shandong to meet the goal on dependence on thermal plant and determination on solving air pollution. Starting from Renewable Energy Law of People's Republic of China, the central state provides the general guideline for the development of renewable energy, including resource investigation and development, the industrial guidance and technique, promotion and application, price management and cost-sharing system, incentive and supervision, relative law and responsibility (State Council of PRC, 2005). Followed by the Renewable Energy Law of People's Republic of China, the central state further formulated relevant policies and regulations in 11th Five Year Plan (FYP) to stimulate the solar power development in Shandong.

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The rapid development of China brings not only the significant economic growth, but also challenges to environment and rural society. Thus, since 2006 the central state of China has listed the renewable energy into the 12th Five Year Plan (FYP). As National Energy Administration mentioned, the priority for the target includes constructing solar power station, promoting dispersed solar power generation system, constructing power grid engineering, piloting new energy demonstrative city, improving solar power generation technique, increasing the competitiveness of solar power products, supporting solar power development, exploring international cooperation (NEA, 2011).

In the 12th Five-Year Plan (2011-2015), after the infrastructure in the previous Five-year Plan is complete, the 12th Five-Year Plan will focus on the construction of dispersed solar power generation systems in urban industrial parks, economic development zones, and large-scale industrial parks in the central and eastern regions. Grid-connected solar power generation systems will be built in areas where public facilities and other building roofs are relatively concentrated, which established dispersed solar power generation systems in major urban industrial parks and large-scale industrial enterprises in central and southern Hebei, central and southern Shanxi, Shandong, Sichuan, and Northeast China. With the Xinjiang Production and Construction Corps as the main support unit, a dispersed power supply system with multi-point high-density solar power generation is implemented in the Corps power grid. In conjunction with the construction of new energy demonstration cities, the construction of dispersed solar power generation systems supported by smart grid technology will be carried out (NEA, 2012).

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First, in promoting dispersed solar and applications, Shandong Province vigorously promotes rooftop solar power generation, and continues to carry out the construction of dispersed solar power generation application demonstration areas. By 2020, hundreds of dispersed solar application demonstration areas will be built, and 80% of the new building roofs in the park , 50% of the existing buildings have solar power generation installed on the roofs. In public buildings such as industrial parks, economic development zones, large industrial and mining enterprises, shopping malls, schools, hospitals and other public buildings that have development conditions, Shandong adopts enterprise voluntary, financial support, and social participation" to uniformly plan and organize the implementation of rooftop solar projects. In rural areas and small towns with good solar energy resources and good grid connection and consumption conditions, promote residential rooftop solar projects, combined with new urbanization construction, old town reconstruction, new rural construction, and relocation to plan and build rooftop solar projects in a unified manner, which has formed several solar towns and new solar villages.

Secondly, in expanding the comprehensive utilization of solar power projects, Shandong encourages comprehensive utilization of barren hills and wastelands and coastal beaches, treatment of abandoned land such as coal mining subsidence areas, facility agriculture, fisheries and other methods, and develops various solar power application projects based on local conditions. Shandong further promoted the organic integration of solar power generation with other industries, and open up new ways for the value-added utilization of land through solar power generation. Through exploring

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various integrated development models of solar agriculture to improve agricultural benefits, Shandong encouraged the construction of solar power stations in combination with modern and efficient agricultural facilities.

Finally, in terms of innovative dispersed solar application models, Shandong combined with the reform of the power system to carry out dispersed solar power generation market-oriented transactions, encouraging solar power generation projects to be built close to the power load, and connected to the low-voltage power distribution network to achieve power consumption nearby. With various distribution network enterprises providing services for the operation of dispersed solar power generation connected to the grid, Shandong prioritized the consumption of dispersed solar power generation, built a technical support system for dispersed power generation grid-connected operation, and organized dispersed power transactions. Shandong promoted the market-based sales model of dispersed solar power generation projects to power users, and the transmission and distribution prices paid to grid companies are reasonably determined in accordance with the principle of promoting the nearby consumption of dispersed solar power.

In the 13th Five-Year Plan (2016-2020), the central government's main force in its solar development is to optimize the layout of solar power plants, innovate construction methods, and carry out various solar poverty alleviation methods. First of all, in optimizing the layout of solar power stations and innovating construction methods, Shandong rationally deploys solar power stations, and comprehensively

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considers solar energy resources, grid access, consumption market, land use conditions and costs, and arranges for the development of the national solar industry. The annual construction scale of solar power generation in various provinces (including regions and municipalities) rationally arrange centralized solar power stations. Shandong standardized the distribution of solar projects and the order of market development, realized the optimal allocation of projects through a comprehensive competition mechanism, and accelerated the progress of solar technology. In areas with severe solar abandonment and electricity curtailment, Shandong strictly controlled the construction scale of centralized solar power stations, speed up the solution of the existing solar abandonment and electricity curtailment problems, and adopt a combination of local consumption and expansion of external transmission to improve the utilization of established centralized solar power stations to reduce the proportion of abandoning light and limiting electricity.

Second, Shandong has built solar power generation bases in combination with power transmission channels, and use the existing and planned UHV power in the “Three Norths” area in accordance with the layout idea of “multi-energy complementarity, coordinated development, expansion of consumption, and efficiency improvement”. Based on the principle of prioritizing the stock and optimizing the increase in the transmission channel, Shandong orderly constructed solar power generation bases, increased the proportion of renewable energy in the power transmission channel, and effectively expand the scope of solar power consumption in the "Three North" area. In Qinghai, Inner Mongolia and other regions with sufficient solar energy resources and

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land resources, the center government has built power generation bases that complement solar power and other renewable energy sources in stages. In order to slow down the excessive power supply in Gansu, Inner Mongolia and other regions where power curtailment has resulted in overcapacity in the western part, the State Grid used the UHV grid to send the excess power in the west to Shandong Province (outside power into Shandong), and built three UHV grids to transmit remained power from the western to Shandong, including Ximeng-Shandong UHV AC Transmission Project, Shanghaimiao-Shandong UHV DC Transmission Project, Zalut-Shandong UHV DC Transmission Project.

Furthermore, in the implementation of the solar leading plan, Shandong has set up standards for leading solar products and system efficiency that have reached the advanced technological level, and built a leading technology base that adopts the so-called "leader" solar products to provide advanced technologies and products. Combining coal mining subsidence area and desertification land management, Shandong unified planning and orderly construction of leading solar power generation technology bases in areas that have the conditions for sending out and absorbing the market, adopting a competitive method to select investment and development enterprises, and uniformly organizing construction in accordance with the "leading runner" technical standards. Through organizing the construction of a cutting-edge technology support base that has reached the most advanced technology level, Shandong accelerated the industrialization of new technologies, improved the testing,

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certification, acceptance and guarantee system of leader products to ensure that the solar products used in the leader base meet advanced indicators.

Finally, in the development of various ways of solar poverty alleviation, in terms of innovative solar poverty alleviation models, Shandong aims to solve the problem of filed and registered poor households who are unable to work, and promote the construction of various forms of solar poverty alleviation projects in phases and batches according to local conditions. Covered 2.8 million impoverished households with established files and registered cards, with an average annual increase of 3,000 RMB in cash income per household, Shandong ensured that the key equipment for solar poverty alleviation meets advanced technical indicators and is of reliable quality, and encouraged the establishment of specialized platform companies to implement unified operation and monitoring of solar poverty alleviation projects to ensure long-term reliable quality, stable performance and lasting benefits of solar poverty alleviation projects.

In order to vigorously promote dispersed solar poverty alleviation, Shandong prefers to adopt the solar poverty alleviation model of village-level power stations (including household systems) in areas where land resources are scarce in the central and eastern regions. A single household system is about 5 kilowatts, and a single village-level power station generally does not exceed 300 kilowatts. Village-level poverty alleviation power stations are given priority to be included in the scale of solar power generation, and priority is given to the state's additional subsidies for renewable energy prices. In the connection of rural power grid transformation and upgrading and

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dispersed solar poverty alleviation projects, Shandong ensured that the electricity generated by solar poverty alleviation projects is connected to the nearest and all consumed. With the construction of a village-level poverty alleviation power station construction and later operation supervision and management system, Shandong integrated relevant information into the national solar poverty alleviation information management system to monitor and encouraged all regions to build a unified operation monitoring and management platform to ensure long-term reliable operation of the power station and stable income for poor households.

In order to build solar agricultural projects, Shandong encourages all regions to integrate modern agriculture and characteristic agricultural industries to develop solar poverty alleviation, which jointly built solar agricultural projects by government investment and financing entities and commercial investment enterprises. The project assets are shared by the government investment and financing entities and the commercial investment enterprises, and the income is divided according to the share ratio. The government investment and financing entities share conversion would be distributed to eligible poverty-stricken villages and poor households, representing the poverty alleviation objects to participate in project investment and operation, and the asset income is dispersed to the poor villages and poor households on a monthly or quarterly basis. Solar agricultural projects should give priority to the use of labor from poor households with established files, and play a leading role in the development of local characteristic agriculture (NEA, 2016).

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5-2 Manufacture Overcapacity in Shandong

There is a contradiction between the overcapacity of solar capacity and the insufficient absorption capacity of the market. According to data from the State Grid Corporation of China, the current installed capacity of wind power in some provinces (regions) of the "Three Norths" (Northeast, North China and Northwest China) has exceeded the 2020 planning target. The latest data from the China Solar Association show that China is showing signs of overcapacity in the fields of polysilicon, silicon wafers, cells, and modules. In 2017, the new installed capacity for the whole year was about 53GW, a year-on-year increase of more than 50%, and the cumulative installed capacity was about 130GW. As of the end of 2017, the installed capacity of solar power generation nationwide reached 130 million kilowatts. In the global solar market, China's growth rate of 53.6% has ranked first in the world for five consecutive years, and its cumulative installed capacity has also ranked first in the world for three consecutive years (Xinhua, 2018).

Under such environmental influences, many solar manufacturers suffered bankruptcy. In 2012, the global solar capacity was 60GW (1GW or one billion watts), but the demand was only 35GW, and there was a serious overcapacity of solar manufaction. China's 2012 PV output was 23GW, but the total installed capacity in China was only 4.5GW. It is overly dependent on the international market, especially European and American countries where the total installed capacity accounts for 75% of the global market. Since 2011, countries such as Europe and the United States have successively initiated "dumping and countervailing" (anti-dumping and countervailing)

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investigations on China's solar products, and China's solar exports are facing major challenges (Semi, 2013).

Shandong Province is a large province in the solar energy industry, but low-end products have overcapacity. The capacity utilization rate of vacuum tubes and water heaters is less than 50%. The average capacity utilization rate of solar modules in the province is only about 30%. The phenomenon of blind investment and redundant construction still exists, which leads to the low industry concentration. There are more than 300 solar energy companies in the province, and only about 6 companies could reach the sales income of 3 billion RMB, and most of the companies have sales income below 50 million RMB (Semi, 2013).

The upstream and downstream industrial structure is also unreasonable. There are few marketable high-end products and solar building integrated products, especially the safe, reliable and easy-to-use products suitable for high-rise buildings, which are difficult to meet the needs of emerging markets. From the perspective of enterprise innovation capabilities, investment is insufficient, innovation capabilities are not strong, flat panel solar water heaters do not master the core technology, the solar industry lacks core original technologies, and most of the solar manufacturing equipment is imported from abroad. From the perspective of the terminal application market, the policies are not perfect, the market supervision is insufficient, the relevant standards are lagging behind, the solar energy engineering design, construction, acceptance and after-sales service standards are not matched, and the supervision and inspection and accountability mechanisms are not solid.

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A power grid company in a large solar province and several cities in East China issued an internal notice to suspend the filing of new industrial and commercial dispersed and ground-based solar power plants due to peak shaving problems. After the scale of solar bidding was determined in 2019, the province's thermal power peak shaving has almost reached its limit. According to the "13th Five-Year Development Plan for Solar Energy in Shandong Province", Shandong's solar installed capacity will be 10GW in 2020. In fact, as of the first quarter of 2019, Shandong's cumulative installed capacity of solar power plants has reached nearly 13.96GW, making it the province with the largest cumulative scale of solar power plants in the country. Shandong is faced with tremendous pressure from power grid peak shaving and absorption. The installed capacity of solar power generation in Jiangsu Province also soared to 13.69GW, second only to Shandong, ranking second in the country.

The Role of the Shandong Government in Manufacture Overcapacity

Owing to the authoritarian party-state political regime of China, Chinese Communist Party (CCP) controls and distributes the main resource of the entire state. The local cadre system provides the central state with the personnel management system and major driving force in local development in the local government. On one hand, through the local cadre system, the central state evaluated the performance of the officials in local government (Liang & Langbein, 2015). In order to get promotion, those local officials pursue the objective and standard of the central state. On the other hand, the local cadre system stimulates the local officials to pursue the objectives from the central and reach the annual plan, which provides the driving forces for the

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local development to meet the expectation of the central. However, the local economic development and the environmental protection are contradictory in the case of China.

Under the evaluation of local cadre system, both economic development and the environmental protection have been viewed as the priority of the central state. However, it has been a challenge for local officials in Shandong government to promote the economic development and meet the objective of environmental protection at the same time. From the field research in 2016 in Shandong, this chapter found that the interaction between the central state and local government (Shandong) has been intensified in the solar power development over the past decade.

Although these actions and policies indicate the determination of the central state on solving the issue of air pollution and possible threat on environmental protection, these strategies also cause challenge to the economic development in local government like Shandong, which still relies heavily upon the thermal power plant as the driving force for its infrastructure. The contradictory between the economic development and environmental protection result in challenge for local officials in Shandong.

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On developing the solar energy, the solar power generation relied much upon the natural condition, such as the weather and the geography condition. Compared to other renewable energy power generation, although the solar power generation is not limited by the distribution of resource, such as hydro power generation was limited by the distribution of the water and wind power generation, solar power generation was limited by the territory and land resource. Especially in Shandong, the urban areas were narrowed and limited with high population, which further limited the development of concentrated solar power generation with high requirement on land and space. Therefore, the Shandong government turned the focus of development on the rural areas, and also utilized the subsidy from the central state policies, such as the 11th and 12th Five Year Plan.

Facing the above challenge from the contradictory on economic development and environmental protection as well as the limitation from the space, Shandong government combined the solar power development and poverty alleviation. The combination of these two elements provide a solution to the above challenges. On one hand, the combination between solar power development and poverty alleviation aims at the wasted mining area to settle solar power station and connected grid, which avoid the space and development conflict with the urban area. On the other hand, the combination also offers a solution to contradictory embedded in the local cadre system, which increase the performance and the evaluation in the conflict between the economic development and environmental protection in Shandong. The combination targets at poverty situation in rural area by providing infrastructure of solar power

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equipment such as solar panels and power station to aid the local farmers and the poor. For local farmers, they installed those solar panels on the greenhouse to generate electricity the consumption of the agricultural products. For the poor, they settled the solar panels on the rooftop and generated electricity to meet their daily consumption, and sell the surplus to the national grid to earn extra profit.

5-3 Poverty Alleviation with Solar Power in Shandong

Taking advantage of the surplus power from external electricity to Shandong, solar poverty alleviation in Shandong will lay solar panels on the roofs of houses and agricultural greenhouses for “self-use and redundant Internet access”. Local farmers and poor households can use the electricity themselves and sell the excess electricity to the national grid. Through dispersed solar power generation, every household will become a miniature solar power station. Poverty alleviation with solar power mainly includes three modes: solar ground power station, solar greenhouse power station and rooftop power station. In addition to using the roof to generate electricity, solar greenhouses can develop under-forest economy, increase the multiple cropping index, and change the planting mode, such as vegetable planting; poultry and livestock breeding can also be carried out to comprehensively promote industrial upgrading.

Complementary Model of Agriculture with Solar Power

Since 2016, State Grid Shandong Electric Power Company, in the process of in-depth promotion of targeted poverty alleviation and targeted poverty alleviation, has given

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full play to its industry advantages, taking solar poverty alleviation as an important starting point, and has served 9,390 solar poverty alleviation projects connected to the grid, with an installed capacity of 1.7 million kilowatts Among them, the installed capacity of poverty alleviation is 945,100 kilowatts, giving 326,000 poor households a the revenue from solar generation. Located in Binzhou Shandong, Liguo Township is located in the Lubei Plain. Because the land is mostly saline beaches, the road to poverty alleviation and prosperity is extremely difficult. In order to get rid of the predicament, the township has coordinated poverty alleviation funds, revitalized collective assets, and activated social capital. A total of 20.2 million RMB has been raised, focusing on the development of the animal husbandry industry. The township has not only built 53 breeding sheds in Wumiao Village, but also formed a large-scale breeding community. Solar panels have been installed on the roof of the breeding shed, and a solar power station with a capacity of 2,500 kilowatts has been built, which fosters the combination with solar roof construction with the farming under the shed, Wumiao Village will be lifted out of poverty as soon as possible.

Solar power generation projects must be integrated into the large power grid to turn the sunshine into cash flow. For many years, State Grid Shandong Electric has conscientiously implemented the national solar precision poverty alleviation policy, and arranged an investment of 41 million RMB in the construction of grid connection projects in accordance with the principle of "synchronous grid connection of power stations, full consumption of electricity, monthly payment of electricity fees, and timely payment of profits" High-quality completion of the grid connection service

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work of solar poverty alleviation projects in the national plan. The coordination and unification of project placement and grid planning has been realized, grid connection projects have been completed at the same time, and all completed projects have been connected to the grid.

In order to ensure early completion of solar poverty alleviation projects, early connection to the grid, and early benefits, the State Grid Binzhou Power Supply Company opened a "green channel" for solar power station access, simplifying the settlement and payment process, improving the efficiency of on-grid electricity and subsidy payment, and providing value-added services for solar power stations , Improve project power generation revenue. With a total of 258 million kilowatt-hours of on-grid electricity consumed, and 169 million RMB of electricity purchase fees and subsidies settled, the green channel ranked second in Shandong, which fosters solar power generation has become a real economic benefit for poor households. Through the solar power station on the breeding shed, the poor households in Liguo Township can increase their income by more than 3,000 RMB per household each year, and the collective income of all 28 villages has reached more than 50,000 RMB.

Solar Passbook Mode

In 2018, State Grid Shandong Power donated 5.361 million RMB to Juye County, Heze City, a support contact point, to build the Sixingtun solar power station on the original site of the abandoned kiln factory. The power station covers an area of 7,300 square meters and has a total installed capacity of 947.66 kilowatts. In early November of the same year, the power station was connected to the grid to generate

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electricity. Since then, poor households in 12 villages including Wanglou Village, Tianqiao Town, Juye County have a common "sunshine passbook." As of the end of this year, the Liouingtun solar power station had settled a total of 1,694,400 kilowatt-hours of electricity and 669,100 RMB in electricity costs. Among the beneficiaries, 687 people have achieved a guaranteed poverty alleviation goal.

In order to ensure that solar poverty alleviation power stations are well built, managed and used, the State Grid Juye County Power Supply Company took the initiative to cooperate with the government to create a poverty alleviation industrial park with solar poverty alleviation power stations as the power supply center. State Grid Shandong Electric donated 11.623 million RMB of poverty alleviation funds to Juye County, of which 8.02 million RMB was used for the construction of poverty alleviation workshops and rooftop solar projects in the poverty alleviation industrial park. The new poverty alleviation workshop covers an area of 6,000 square meters and the installed capacity of solar power plants, among which 300 kilowatts are used for poverty alleviation and rural revitalization.

The Poverty Alleviation Industrial Park has attracted 6 labor-intensive enterprises into the park, creating nearly 2,000 jobs, greatly stimulating the endogenous motivation of surrounding villages, and nearby villagers have become "office workers." Moreover, all the electric energy used in the poverty alleviation industrial park comes from clean energy provided by solar power stations, which truly achieves the dual goals of helping poverty alleviation and promoting development. Up to now, State Grid Shandong Electric Power has donated a total of 36.35 million RMB to build 163 solar

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power stations with a capacity of 5,670 kilowatts and 3,690 bases of solar street lights. The income of the solar power station is all owned by the village collective, which provides the people with a stable funding guarantee for poverty alleviation and effectively prevents the poverty-stricken areas of the designated assistance areas from returning to poverty and the emergence of new poverty.

In the process of implementing solar poverty alleviation, State Grid Shandong Electric makes full use of the national solar poverty alleviation information management system, actively monitors the technical monitoring of solar poverty alleviation power stations, and normalizes grid-side safety management to ensure that grid-side problems do not affect the solar poverty alleviation power stations. normal operation. At the same time, optimizing the electricity bill settlement and service process, fully consuming the power of solar poverty alleviation power stations, realizing the on-grid settlement on time and the timely payment of solar subsidies. The cumulative on-grid power is 3.578 billion kWh, the state subsidy is 2.022 billion RMB, with 100% the payment rate, which ensures that the poor can enjoy the results of solar poverty alleviation as soon as possible (IN-EN, 2020).

The Role of Solar Power Company in Shandong

In terms of the solar power development in Shandong, the role of solar power company play a vital role. However, the process of it did not go smoothly at the very beginning. The manufacturer for solar panels has suffered from the overcapacity from the development. In the past, the export of solar panels relied heavily on the Europe and American market. Therefore, when the 2008 financial crisis happens, which

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further leads to the shrinking of demand on solar panels from Europe and American market. After 2008, owing to the shrinking demand, the manufacturers in Shandong has produced more solar panels than demand. As a result, the overcapacity and extra solar panels have become the concern of the Shandong government.

Before 2006, solar panel companies in China did not have strong incentives on solar power generation. Compared to economic development, environmental protection and evaluation are not viewed as the core criteria by the local governments in different provinces. As the pollution issue been targeted in the Five Year Plan by the central government, the solar power development has been listed as one of the priority promoted by a series of environmental policies. In order to pursue the incentive provided by the central state and local government, solar power companies accelerated the promotion of solar power development.

In order to accelerate the solar development in local provinces, since 2013 the national energy bureau has promoted "*Notice for Working Plan for Dispersed Solar Power Generation from National Energy Administration*" and selected 30 places as the demonstration area for solar power development from 11 local provinces, including Beijing, Shanghai, Tianjin, Hebei, Jiangsu, Zhejiang, Anhui, Jiangxi, Shandong, Henan, and Guangdong (Solar of Week, 2016). Followed the policy, as one of the demonstration areas, Shandong government constructed 2 National New & Hi-Tech Industrial Development Zone and attracted qualified solar companies to

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accelerate the solar power development in Shandong. To further enhance the process of development, since 2010 Shandong government offered subsidy on electricity for grid companies 0.3 RMB per kW/h for solar power station, and 0.05 RMB per kW/h grid connected (Solarbe, 2016). Under the circumstance, solar power companies gain support from both the central and Shandong government.

Under the stimulation from the central's objective on environmental protection and the challenge of space limitation, as well as the great population of farmer and the poor, the Shandong government promoted the supplementary of agriculture and solar development to achieve the goal and solve the problem. Through the support of solar energy company, Shandong successfully promoted supplementary of agriculture and solar development, Shandong promoted agriculture with solar power in Quingdao and Weifang.

In Qingdao, Chang Sheng Solar Power Technology Company invested 2.5 billion RMB in 2014, and constructed a township with electricity provided by solar power. In Pudong Town of Jimo City, Qingdao, the farmers could generate the electricity through the solar panel on the top of their house and planted vegetable in the greenhouse. Due to the weather condition, the greenhouse in local mainly plants mushroom and other agriculture product with higher value, such as vegetable, tea, flower and Chinese medicine. Compared the situation before this policy, the local farmers in Shandong could only earn around 1,000 RMB for over the year. Through

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the supplementary of agriculture and solar development, by turning the land into greenhouse with solar panel, the local farmers could receive the salary as the worker and receive the extra profit resulted from the high value agriculture product, such as mushroom. The net profit turned out to be 60,000 RMB for the entire year (Solar of the Week, 2016). As the local operators in energy company said, “the supplementary of agriculture and solar development could bring multiple benefits to the local community, increase of the income, eco-friendly environment, and poverty alleviation.”

The role of local energy company in solar power development presented in three ways: First of all, through the subsidy from the government, Chang Sheng Solar Power Technology Company constructs the greenhouse for the local farmers and provide jobs for the poor nearby their community. Second, Chang Sheng Solar Power Technology Company supports the poverty alleviation by categorization. On one hand, the poor with working ability could enter the greenhouse to receive the salary while the poor with lower working condition could apply for joining the project and share the profit. Finally, through the supplementary of agriculture and solar development, Chang Sheng Solar Power Technology Company combines the goal of poverty alleviation and economic development of agriculture to reach poverty alleviation and develop agriculture in Shandong with local unique feature.

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In Weifang, Shangyu Solar Technology Company constructed the full living environment in Anqiu. (Soalrbe, 2018). Anqiu located in Weifang City, is the home to many agriculture product in Shandong, including garlic, bamboo, strawberry and cherry, and was selected as the demonstration city for agriculture. Therefore, it has been selected as one of the cities in Shandong for supplementary of agriculture and solar development. The role of solar power company in Shandong presented in three different aspects, including greenhouse with solar panels and solar inverter village, as well as industry development with solar power (Interview Data 2016-0806-1).

First of all, under the subsidy from the Shandong government, Shangyu Solar Technology Company adopted its own PV inverter for the greenhouse with solar panels and constructed infrastructure for solar development in local community. The local farmers in Weifang could not only receive revenue from vegetable-planting, but also gain benefits by selling extra electricity from solar power station in their farm. According to the local officials, this combination could not only solve the difficulty in the solar industry, but also stimulate the transformation for local agriculture and product-planting (Interview Data 2016-0806-2).

Second, through the interaction between the Shandong government and Shangyu Solar Technology Company, it helps to construct the solar power village in Anqiu and reached 1.5 MW in local solar power development. In this village, more than half of the household installed solar power system. Through the solar power system, the

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villager could generate electricity through the dispersed solar power system on their rooftop and also earn extra revenue by selling surplus to the national grid. The construction of the rooftop dispersed solar power system brings not only the extra revenue for the local, but also provide a clear alternative for energy consumption compared to coal and petroleum.

Finally, in addition to solar power green house and solar power village, Shangyu Solar Technology Company combined the local industry with the solar power system. Owing to the advantage on agriculture, Anqiu has lots of processing factories for agricultural products, which will need to consume lots of energy, especially the electricity and water. Shangyu Solar Technology Company targeted these processing factories and installed solar power station on the rooftop and generate electricity. On one hand, this combination make good use of the extra space on the rooftop. On the other hand, the solar power generation reduced the cost on electricity for these factories and generated income for electricity surplus (Solarbe, 2018).

The above cases in Shandong to promote supplementary of agriculture and solar development showed the interaction between the solar power companies as well as the local government. On one hand, the policy solved the difficulty on over-dependence on coal burning and the limitation of the space for a province with limited land resource like Shandong. On the other hand, the policy serves as a converter to turn the poverty into revenue for the poor and the farmers, which solves the conflict

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between pursuing the goal on economic development of local government (Shandong) and reaching the objective on environmental protection using solar power from the central state. As one of the interviewed data showed:

"The supplementary of agriculture and solar development makes the connection become possible. Local farmers in Shandong could grow electricity on the rooftop and grow vegetables and other high value agricultural products under the greenhouse. On one hand, this combination between the solar power generation system and agriculture could provide lower cost for local agriculture to run. On the other hand, it could also provide sufficient solar radiation for agricultural products to grow better, which completely make good use of the local resource and generate the maximum of the benefit. (Interview Data 2016-0806-3)"

From the above discussion, the role of solar power company in Shandong played an essential role in integrating the resource from the local government and the local users (farmers and the poor), which not only work as an indispensable element in the circle among the solar development in Shandong to connect Shandong government and local farmers and the poor. The circle between local government, the solar power company, and the local users further stimulate the solar development as well as the economic development, which foster three dynamics.

First of all, in order to follow the objective from the central government on the goal to pursue green energy and reduce the dependence on traditional thermal power, Shandong government further promote policy to enhance the incentive for energy

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company in Shandong to pursue solar power development. Under the incentive of Shandong government, solar energy companies in Shandong take the responsibility and construct the infrastructure for local users.

The second dynamic lies in solar energy companies and their response and behavior. Under the subsidy and backup from the Shandong local government, solar energy companies provided solar panels for local farmers in remote mountain areas to generate their own electricity and provide basic energy consumption for their agriculture. On one hand, local solar power companies received the incentives from the Shandong government. On the other hand, these solar power companies offer resources for the local users such as farmers and the poor to change their way of living.

The last dynamic is the response of the local users (the farmers and the poor). Farmers and the poor installed the solar panels provided by the local solar companies on their rooftop, which not only provides them the basic requirement for electricity consumption, but also empowers them to earns extra living by selling surplus of the electricity from those solar panels.

Conclusion

Chapter 5 has introduced the solar power development in Shandong as well as the interaction between governments, energy manufacturers, grid companies, as well as the local users. Since 2006, China has actively promoted solar power in different provincial levels domestically. Shandong, as one of the inner provinces without

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sufficient resources on solar power development, but could develop the solar pattern successfully in poverty alleviation with solar power project, especially in local agriculture. During the development, local government officials in Shandong are facing the pressure on one hand catering the objective from the central on increasing solar power installation capacity and generation. On the other hand, the local officials also had the pressure perusing the local development on economy.

Under the pressure of meeting the target from the central and pursuing the economic development in the local, the local government officials coordinated the grid companies and energy manufacturers as well as the local farmers and the poor. In Chapter 5, it presented from overcapacity to poverty alleviation with solar power, how local government interacted with different agents and actors in the process to shape the solar power development in Shandong.

Chapter 5 argues that through the supplementary of agriculture and solar development, Shandong could react to the objective and goals for social and environmental governance from the central government, and on the other hand pursue its local economic development. From the aspect of the approach of 'environmentally bundled economic interests, the supplementary of agriculture and solar development bundled the incentive from the new energy policies of the central state as well as the need to reach poverty alleviation. Therefore, for the local government (Shandong) the promotion of new energy is no longer an obstacle for the local economic development, instead it turned out to be a successful solution for the conflict between

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economic development in the local as well as the environmental protection objective from the central.

From the overcapacity issue in Shandong, the chapter argued that the interaction between local government and local agents resulted in the overcapacity in solar power manufacturer, especially on solar panels. To pursue the policy interest and subsidy from the government, the local energy manufacturers actively generated solar power instead of considering the consumption ability on these generation from solar power. However, through the coordination between local agents, including Shandong government, local solar power manufacturers, as well as the farmers and the poor in remote villages, Shandong government consumed the overcapacity in solar panels manufacturers into the poor and farmers, which on one hand consume the waste suffering from manufacture overcapacity. On the other hand, it provides a solid foundation for the local farmers and the poor for the poverty alleviation project with comprehensive grid and generation system on solar power.

On the other hand, from the poverty alleviation with solar power in Shandong, the chapter argued that the reason why even not with better natural conditions to develop solar power, the poverty alleviation with solar power in Shandong could foster and result in different poverty alleviation models, which is beneficial for the local . This chapter argued that the bundled economic interest also occurred in the interaction between local government and local agents. Even without sufficient solar radiation (compared to the inner provinces), the autonomy from local government could combine the local economy activities (agriculture and farming) and further foster the

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poverty alleviation project into different models, including the solar passport and supplementary of agriculture and solar development model.

From the above discussion, this chapter demonstrated that the local government of Shandong played an essential role in stimulating the supplementary of agriculture and solar development and reacting to the conflict between the economic development and the environmental protection. This dissertation extends the approach of 'environmentally bundled economic interests (Wang et al., 2015)' to explain the conflict and solution from the above questions. Through the approach of 'environmentally bundled economic interests, this dissertation found that in the solar power development, the role of Shandong government serves as a vital role in solving the conflict between the reach the objective from the central as well as the pursue for its own economic development. Under the supplementary of agriculture and solar development, Shandong government could effectively bundle objective of implementing the environmental protection from the central and the pressure of promoting economic development in the local, and further solve the conflict between the central and the local.

To sum up, this chapter argues that due to the land and space conflict in Shandong as well as contradictory embedded in the local cadre system, Shandong government combined solar power development and poverty alleviation to solve the conflict. On one hand, the combination aims at the wasted mining area to settle solar power station and connected grid, which avoid the space and development conflict with the urban area. On the other hand, the combination also offers a solution to contradictory

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embedded in the local cadre system, which increase the performance and the evaluation in the conflict between the economic development and environmental protection in Shandong.

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Chapter 6 Comparison the Solar Power Developmental Pattern between Gansu and Shandong: Policy, Overcapacity, and Poverty Alleviation

6-1 Introduction

In the previous chapters 4 and 5, this dissertation has respectively discussed the plight and model of photovoltaic development in Gansu and Shandong. Gansu and Shandong respectively represent the different development models of inland and coastal areas in photovoltaic development, and two extremely different development processes. However, there are many similar experiences during their development. First, in terms of development policies, China's central government has been eager to reduce the air pollution pressure on traditional thermal power generation.

Since 2006, it has issued a series of new energy development policies to encourage local governments. The government responds to the photovoltaic development policy. Then, in the initial development process, the local government pursued the central environmental policy dividend. Finally, from overcapacity to photovoltaic poverty alleviation, Gansu and Shandong experienced different obstacles, and finally took poverty alleviation as a new development direction for solar power. Although there are so many similarities between Gansu and Shandong in the development process, the final photovoltaic model is very different. This dissertation believes that the key lies in the interactive model of actors in their photovoltaic development. Therefore, this chapter will explore the solar power development model of inland Gansu and coastal Shandong province in the framework of the economic benefits of environmental binding. From the aspects of its own conditions and policies,

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overcapacity and photovoltaic poverty alleviation, it will explore the central government and local governments in the process. How the government, power grid companies, new energy equipment vendors, and local people interact, resulting in extremely different photovoltaic development models.

6-2 Development and Policy

As China's photovoltaic development is closely related to the five-year plan, this chapter compares the solar power development between Gansu and Shandong from the 11th Five-Year Plan (2006-2010), the 12th Five-Year Plan (2011-2015), and the 13th Five-Year Plan (2016-2020).

11th Five Year Plan (2006-2010)

Gansu

Gansu's photovoltaic development basically follows the central government's 11th Five-Year Plan, the 10-MW grid-connected photovoltaic power generation project in Dunhuang. In September 2004, the Gansu Provincial Development and Reform Commission and the Dunhuang Electric Power Bureau held the "Dunhuang 8 MW Grid-connected Photovoltaic Power Generation System". The National Development and Reform Commission's Energy Administration sent a special person to participate in the review meeting for the "Pre-Construction Research Report", and more than 70 Chinese and foreign experts in the photovoltaic industry attended the meeting (IN_EN, 2009).

In 2008, the Dunhuang Electric Power Bureau completed the "Dunhuang 10MW Grid-connected Photovoltaic Power Generation System Construction Preliminary

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Research Report" and was included in the National Development and Reform Commission's the "11th Five-Year Plan" for renewable energy development. This marked the achievement of the Dunhuang photovoltaic power generation project. The 10-MW grid-connected photovoltaic power plant in Dunhuang, Gansu is initially selected to be located on the north side of National Freeway, Qili Town, Dunhuang City, 13 kilometers away from the downtown area of Dunhuang. Covering an area of 1 million square meters, with a total investment of about 500 million RMB, the project design adopts a technical solution combining solar concentrating photovoltaic power generation and conventional flat-panel solar power generation. According to the principle of "centralized installation and construction, multiple branches to connect to the Internet", solar power will be built five major components: array, direct AC inverter equipment, boost grid-connected facilities, control and detection system and auxiliary equipment. The total designed installed capacity is 10 megawatts, and the average annual power generation is 16.37 million kilowatt-hours. In the electronic information industry adjustment and revitalization plan reviewed and approved in principle by the State Council in February, it is clearly stated that the support policy for encouraging photovoltaic power generation will be introduced, the domestic photovoltaic power generation market will be launched, and the demonstration of photovoltaic grid-connected power generation applications will be launched (IN_EN, 2009).

Shandong

Shandong's solar development basically follows the pace of China's five-year plan. During the 11th Five-Year Plan (2006-2010), with the central government's pace of

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optimizing energy, positive progress was made in eliminating outdated production capacity, accelerating the development of the solar energy industry, and Strengthen the construction of rural power grids. To eliminate outdated production capacity, Shandong and other provinces have promoted the alliance of coal enterprises, which greatly conducted the merger and reorganization of coal enterprises and the integration of resources. Over the past five years, more than 9,000 small coal mines have been shut down nationwide, 450 million tons of outdated production capacity has been eliminated, and low-efficiency coal-fired power generation units have been shut down gradually (CPGPRC, 2012).

To accelerate the development of the solar energy industry, the solar power generation market was launched in an orderly manner, with the implementation of the Golden Sun Demonstration Project and the completion of a 270,000 kilowatt demonstration project. The installed capacity of solar power generation nationwide has reached 600,000 kilowatts, and a relatively complete solar cell industry chain has been formed. The annual output has exceeded 8 million kilowatts, and exports account for half of the global market. The scale of installation and use of solar water heaters continues to expand, with a possession of more than 170 million square meters. In order to strengthen the construction of rural power grids, implementing rural grid transformation and power construction projects in areas without electricity, a total of 32.3 billion RMB was allocated in the central budget for five years, with a total investment of 145.5 billion RMB, which improved the rural power supply capacity and the level of electricity consumption. The burden of electricity

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consumption is about 35 billion RMB per year, solving the electricity problem of more than 30 million people without electricity. In remote rural areas, promote the use of solar cookers, solar houses and solar water heaters (CPGPRC, 2012).

12th Five-Year Plan (2011-2015)

Gansu

Gansu's photovoltaic development is consistent with China's five-year plan. During the 12th Five-Year Plan (2010-2015) the focus of solar power development in Gansu concentrated on the boost of installed capacity. During the 12th Five-Year Plan (2010-2015), according to the "12th Five-Year Plan for New Energy and Renewable Energy in Gansu Province", it is expected that by the end of 2015, the installed capacity of wind power will reach 17 million kilowatts in Gansu, and the installed capacity of photovoltaic power generation will reach more than 6 million kilowatts. By 2015, 21GW of installed photovoltaic capacity has been achieved, including 15GW of rooftop photovoltaic systems. Its photovoltaic power generation installed capacity target accounted for nearly one-third of China's planned capacity at that time. Gansu has built 20 grid-connected photovoltaic power stations with a total installed capacity of 285,000 kilowatts (EnergyTrend, 2012).

Shandong

During the 12th Five-Year Plan, after the infrastructure in the previous Five-Year Plan was complete, the 12th Five-Year Plan will focus on the construction of dispersed solar power generation systems in urban industrial parks, economic development zones, and large-scale industrial parks in the central and eastern regions. Grid-connected solar power generation systems will be built in areas where public

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facilities and other building roofs are relatively concentrated, and established dispersed solar power generation systems in major urban industrial parks and large-scale industrial enterprises in central and southern Hebei, central and southern Shanxi, Shandong, Sichuan, and Northeast China. With the Xinjiang Production and Construction Corps as the main support unit, a dispersed power supply system with multi-point high-density solar power generation is implemented in the Corps power grid. In conjunction with the construction of new energy demonstration cities, the construction of dispersed solar power generation systems supported by smart grid technology will be carried out. However, in the 12th Five-Year Plan, Shandong's anti-dumping and anti-monopoly policies in Europe and the United States made it difficult for Shandong's solar power panel manufacturers to export, resulting in a large number of photovoltaic panels overcapacity. (NEA, 2012).

First, in promoting dispersed solar and applications, Shandong Province vigorously promotes rooftop solar power generation, and continues to carry out the construction of dispersed solar power generation application demonstration areas. By 2020, hundreds of dispersed solar application demonstration areas will be built, and 80% of the new building roofs in the park , 50% of the existing buildings have solar power generation installed on the roofs. In public buildings such as industrial parks, economic development zones, large industrial and mining enterprises, shopping malls, schools, hospitals and other public buildings that have development conditions, Shandong adopts the method of enterprise voluntary, financial support, and social participation to uniformly plan and organize the implementation of rooftop solar

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projects. In rural areas and small towns with good solar energy resources and good grid connection and consumption conditions, promote residential rooftop solar projects, combined with new urbanization construction, old town reconstruction, new rural construction, and relocation to plan and build rooftop solar projects in a unified manner, which has formed Several solar owns and new solar villages.

Secondly, in expanding the comprehensive utilization of solar power projects, Shandong encourages comprehensive utilization of barren hills and wastelands and coastal beaches, treatment of abandoned land such as coal mining subsidence areas, facility agriculture, fisheries and other methods, and develops various solar power application projects based on local conditions. To promote the organic integration of solar power generation with other industries, and open up new ways for the value-added utilization of land through solar power generation, Shandong explored various integrated development models of solar agriculture to improve agricultural benefits, and encouraged the construction of solar power stations in combination with modern and efficient agricultural facilities.

Finally, in terms of innovative dispersed solar application models, Shandong combined with the reform of the power system to carry out dispersed solar power generation market-oriented transactions, encouraging solar power generation projects to be built close to the power load, and connected to the low-voltage power distribution network to achieve power consumption nearby. WIth various distribution network enterprises providing services for the operation of dispersed solar power

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generation connected to the grid, Shandong prioritized the consumption of dispersed solar power generation, built a technical support system for dispersed power generation grid-connected operation, and organized dispersed power transactions. Shandong government promoted the market-based sales model of dispersed solar power generation projects to power users, and the transmission and distribution prices paid to grid companies are reasonably determined in accordance with the principle of promoting the nearby consumption of dispersed solar power.

13th Five Year Plan (2016-2020)

Gansu

In the early stage of the 13th Five-Year Plan, Gansu suffered from overcapacity problems. According to the data published by the Northwest Energy Regulatory Bureau of the National Energy Administration of China, Gansu was one of the provinces most affected by this problem in 2016. Gansu's wind curtailment rate and solar abandonment rate are 43.11% and 30.45% respectively. The curtailment of electricity caused by abandoning light and wind will directly impact the healthy development of the industry. The National Energy Administration of China has approved 12 UHV cable construction projects to assist power transmission from west to east. Provinces such as Gansu, Xinjiang, and Ningxia will not issue new photovoltaic power generation indicators in the short term, and will limit the growth of installed capacity by formulating guaranteed acquisition hours. (EnergyTrend, 2017).

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Affected by the overcapacity, under the restrictions of abandoning solar power and limiting electricity, Gansu can only use excess photovoltaic power to assist remote areas in addition to power transmission from west to east. Therefore, in 2016, Gansu clarified the electricity price and grid connection methods of photovoltaic poverty alleviation projects, supporting grid services, integrating with facility agriculture, relaxing land conditions, complementing forests with sunlight, and determining photovoltaic poverty alleviation models based on local conditions. The Gansu Provincial Development and Reform Commission, the Poverty Alleviation Office, the Department of Finance, the Department of Land and Resources, and the Department of Forestry "Notice on Further Clarifying the Support Policies for Photovoltaic Poverty Alleviation Projects." By the end of 2017, 29 counties in Gansu Province built 767 poverty alleviation power stations, with a construction scale 428462 kilowatts. The National Energy Administration and the State Council's Poverty Alleviation Office further implemented the "Notice on Issuing the First Batch of Photovoltaic Poverty Alleviation Projects in the 13th Five-Year Plan" (IN-EN, 2020).

Shandong

In the 13th Five-Year Plan (2016-2020), the central government's main force in its solar development is to optimize the layout of solar power plants, innovate construction methods, and carry out various solar poverty alleviation methods. First of all, in optimizing the layout of solar power stations and innovating construction methods, Shandong rationally deploys solar power stations, and comprehensively considers solar energy resources, grid access, consumption market, land use

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conditions as well as costs, and arranges for the development of the national solar industry. The annual construction scale of solar power generation in various provinces (autonomous regions and municipalities) shall rationally arrange centralized solar power stations. To standardize the distribution of solar projects and the order of market development, Shandong realized the optimal allocation of projects through a comprehensive competition mechanism, and accelerated the progress of solar technology. In areas with severe solar abandonment and electricity curtailment, Shandong strictly controlled the construction scale of centralized solar power stations, speeded up the solution of the existing solar abandonment and electricity curtailment problems, and adopted a combination of local consumption and expansion of external transmission to improve the utilization of established centralized solar power stations Reduce the proportion of abandoning light and limiting electricity.

Second, Shandong has built solar power generation bases in combination with power transmission channels, and use the existing and planned UHV power in the “Three Norths” area in accordance with the layout idea of “multi-energy complementarity, coordinated development, expansion of consumption, and efficiency improvement”. Based on the principle of prioritizing the stock and optimizing the increase in the transmission channel, Shandong orderly constructed solar power generation bases, increased the proportion of renewable energy in the power transmission channel, and effectively expanded the scope of solar power consumption in the "Three North" area. In Qinghai, Inner Mongolia and other regions with good solar energy resources and rich land resources, research, demonstrate and build power generation bases that

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complement solar power and other renewable energy sources in stages. In order to slow down the excessive power supply in Gansu, Inner Mongolia and other regions where power curtailment is serious in the west, the State Grid used the UHV grid to send the excess power in the west to Shandong Province (outside power into Shandong), and built three UHV grids to curtail power in the west Power is sent to Shandong, including Ximeng-Shandong UHV AC Transmission Project, Shanghaimiao-Shandong UHV DC Transmission Project, Zalut-Shandong UHV DC Transmission Project.

Furthermore, in the implementation of the solar leading plan, Shandong has set up standards for leading solar products and system efficiency that have reached the advanced technological level, and built a leading technology base that adopts the so-called "leader" solar products to provide advanced technologies and products. Combining coal mining subsidence area and desertification land management, Shandong unified planning and orderly construction of leading solar power generation technology bases in areas that have the conditions for sending out and absorbing the market, adopting a competitive method to select investment and development enterprises, and uniformly organizing construction in accordance with the "leading runner" technical standards. Through organizing the construction of a cutting-edge technology support base that has reached the most advanced technology level, Shandong accelerated the industrialization of new technologies, improved the testing, certification, acceptance and guarantee system of leader products to ensure that the solar products used in the leader base meet advanced indicators.

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Finally, in the development of various ways of solar poverty alleviation, in terms of innovative solar poverty alleviation models, Shandong aims to solve the problem of filed and registered poor households who are unable to work, and promote the construction of various forms of solar poverty alleviation projects in phases and batches according to local conditions. Covered 2.8 million impoverished households with established files and registered cards, with an average annual increase of 3,000 RMB in cash income per household, Shandong ensured that the key equipment for solar poverty alleviation meets advanced technical indicators and is of reliable quality, and encouraged the establishment of specialized platform companies to implement unified operation and monitoring of solar poverty alleviation projects to ensure long-term reliable quality, stable performance and lasting benefits of solar poverty alleviation projects.

	Gansu	**Shandong**
11th Five Year Plan (2005-2010)	Speed up the infrastructure construction of photovoltaic power generation Launch the Dunhuang photovoltaic grid-connected project	Eliminate low-efficiency thermal power projects Strengthen the construction of agricultural power grid Start the Golden Sun Demonstration Project
12th Five Year Plan (2011-2015)	Promote centralized photovoltaic power plants	Overcapacity Issue Promote dispersed solar power Utilize abandoned wasteland and coal mining land to develop photovoltaic applications Import electricity price trading system

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13th Five Year Plan (2016-2020)	Overcapacity issue Solar Curtailment Issue Clarify photovoltaic poverty alleviation projects and specifications	Conduct a variety of photovoltaic poverty alleviation models Three UHV lines from foreign power to Shandong are connected to solar power generation bases Attract investment and improving the employment of poor households

From the 11th Five-Year Plan to the 13th Five-Year Plan, both Gansu and Shandong pursued the political benefits given by the central government from the photovoltaic development policy. During the 11th Five-Year Plan, Gansu Photovoltaic Development first optimized the local development conditions and launched the Dunhuang grid-connected project. Shandong eliminated low-efficiency thermal power generation projects, strengthened the construction of agricultural power grids, and launched the Golden Sun demonstration project. During the 12th Five-Year Plan period, Gansu greatly promoted centralized photovoltaic power plants and accelerated the installation and power generation of renewable energy. However, Shandong encountered the problem of overcapacity when promoting dispersed solar power, so it used abandoned wasteland and coal mining land to develop photovoltaic applications and introduced an electricity price trading system. During the 13th Five-Year Plan period, Gansu clarified photovoltaic poverty alleviation projects and regulations, and carried out poverty alleviation targets and implementation rules. Shandong has established a variety of photovoltaic poverty alleviation models. Three UHV lines from foreign power to Shandong connect photovoltaic power generation bases to attract investment and improve the employment of poor households.

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From the perspective of environmental bundling economic benefits theory, this dissertation believes that during the 11th Five-Year Plan period, photovoltaic development follows a top-down model, and local provinces in China such as Gansu and Shandong are chasing the central policy dividend. Under the model, as mentioned in the second chapter of this dissertation, the central personnel performance appraisal system also allows local officials to abide by such a set of rules of the game, so that local behavior in the early stages of development conforms to the central plan. However, during the 12th Five-Year Plan period, due to the central political dividend, Gansu is still actively pursuing the development of solar power. The problem of overcapacity in Shandong has put Shandong under development pressure. Therefore, the development model has shifted to digestion of excess photovoltaic panels, seeking wasteland and waste coal production sites, and actively developing photovoltaic applications. During the 13th Five-Year Plan period, Gansu began to abandon solar power and limit electricity due to the problem of excess capacity, and the development of photovoltaic poverty alleviation took shape relatively late. Shandong, on the other hand, has successfully promoted photovoltaic poverty alleviation in remote mountainous areas due to the construction of stable basic photovoltaic power for agriculture, helping poor households and farmers in remote mountainous areas to integrate with strong local industries.

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6-3 Overcapacity

Gansu

There is a contradiction between the surplus of power resources in the western region and the insufficient capacity of external transmission. Data show that in 2016, the abandonment rate of the five northwestern provinces (regions) in China was 19.81%, and Xinjiang and Gansu photovoltaic power generation operations were more difficult, and the abandonment rates were 32.23% and 30.45%, respectively. The National Energy Administration held a regular press conference at the beginning of this year to announce that in 2017, 7.3 billion kilowatt-hours of solar energy was discarded, and the rate of solar abandonment was 6%, a year-on-year decrease of 4.3%. "Although the high curtailment rate issue has improved, it is still a great challenge to achieve the goal of controlling the rate of curtailment of wind and light within 5% by 2020 (Xinhuanet, 2018)."

Large-scale ground-based power stations are mainly built in the northwest region, where local absorption capacity is limited, and the construction of long-distance transmission and distribution facilities is not perfect, resulting in an imbalance between power supply and demand in areas rich in light resources and between the northwest inland and southeast coastal areas. The administrative manager of the base of a listed photovoltaic company in the coastal province saying that the accumulated funds amounted to billions of dollars when the power station was completed and not connected to the grid. If the generated electricity can't get online, energy company can't repay the loan, and the bank has to collect the loan. They have no choice but to raise funds through market institutions, with interest rates reaching 12% to 15%,

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which increase the financial burden of the solar power development (Xinhuanet, 2018).

Although there is power transmission from west to east, the results are not satisfactory because it is difficult to control the scale of new energy development and the flexibility of coal power transformation. The State Grid Corporation stated that the construction of Chinese power market is still in its infancy, and there are great challenges in building a unified national power market during the 13th Five-Year Plan. From the production side, it is difficult to control the scale of new energy development within the national planning goals, the scale and progress of the flexible transformation of coal power are difficult to meet expectations, and the progress in Northwest and North China is slow. From the consumer side, the effect of the green policy system that encourages the use of new energy has not yet appeared.

Second, breakthroughs in energy storage, transmission and prediction capabilities are difficult. After investigating the energy storage technology of more than a dozen market players, it is found that due to the large initial investment, the commercial operation mainly relies on the peak-to-valley price difference, the internal rate of return is low, the payback period is long, and the operation is not cost-effective. In August 2017, State Grid sent solar power to Jiangsu through a point-to-point transfer from the northwest to the southwest, and then to Shaoxing, Zhejiang. However, this channel is mainly used for hydropower transmission in the west, and it is basically occupied during the wet season. The west is also inadequate in its ability to predict new energy power generation, and the east is often caught off guard. The problem of

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mismatch between the sending and receiving curves is serious. In addition, cross-provincial power transmission also squeezes out the space of the receiving end to save power generation. If there is no price advantage, it is difficult to digest on a large scale (State Grid Corporation, 2018).

Third, it is difficult for the grid to match the rapid development of new energy. The relevant person in charge of the State Grid Corporation stated that some key power grid projects related to power grid safety and new energy consumption have not yet clear plans. If they cannot be completed and put into operation in 2019, some UHV DC projects cannot be operated at full power. At present, there are a large number of photovoltaic and wind power projects, and they belong to different construction owners. The local government level lacks a unified overall layout plan and schedule coordination. Some use photovoltaic poverty alleviation policies to focus on the construction of village-level and household photovoltaic power stations. The construction period is short. The construction of supporting power grid projects has brought greater difficulties (State Grid Corporation, 2018).

Fourth, there are still many bottlenecks in the photovoltaic industry's progress toward high-end, and there are many difficulties in moving toward high-end. In the complete set of solar cell production line equipment, more than 80% of the equipment has been domestically produced. China’s solar power equipment has achieved rapid development. However, compared with the international advanced level, some high-end key equipment in the production of solar photovoltaic cells in China there is still a big gap in the international advanced level. At present, the localization of some high-

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end and key equipment has not yet achieved a substantial breakthrough, and it still relies on imports (State Grid Corporation, 2018).

Northwestern regions such as Qinghai, Ningxia, Gansu, Shaanxi, and Xinjiang in mainland China have developed relatively early solar power plant construction projects due to their vast territory and abundant sunlight resources. They are also the main demand areas. The growth rate has been large in the past few years. However, due to the low local power consumption and insufficient cable transmission capacity, solar power cannot be properly used after power generation and is abandoned, leading to the problem of abandoning solar power and limiting electricity. However, due to the instability of new energy and other reasons, in 2016, the new energy industry in Gansu Province was listed by the National Energy Administration as a "wind and solar power red warning area." This dilemma is mainly caused by the following three factors:

First, the construction period of new energy electric fields is pretty short, and the speed of new energy development far exceeds the speed of supporting power grid construction. In the past ten years, especially during the "12th Five-Year Plan" period, China's new energy development momentum has been rapid. According to the information released by the Gansu Provincial Development and Reform Commission, in Gansu Province alone, since 2010, the installed capacity of new energy has soared from 1.47 million kilowatts to 23.69 million kilowatts, which is 16 times higher, including thermal power and hydropower, Gansu is currently The province’s total installed power supply capacity is 56.2 million kilowatts. The installed capacity of

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new energy accounts for 42% of the total installed capacity of the province. The installed capacity ranks seventh in the country and surpasses thermal power to become the largest power source in the province. As a result, the Gansu power grid has developed into a typical green grid.

Second, Gansu's industrial development level is low, electricity consumption is limited, and Gansu New Energy's installed capacity and power generation capacity are obviously surplus. From 2010 to 2020, the maximum load of the Gansu power grid only increased from 11 million kilowatts to 17 million kilowatts. Due to the overall economic downturn in a few years in between, the electricity sales in Gansu Province also experienced negative growth. It can be seen that the growth rate of electricity load in Gansu Province is much lower than the growth of new energy installed capacity, and the space for new energy consumption in the province is seriously insufficient. It is necessary to open up markets outside the province to increase the consumption space.

Third, Gansu has insufficient power transmission and transformation channels to transport surplus electricity to other provinces. Because of the features of large scale, small amount, and undeliverable as well as its underdeveloped economy, Gansu's own consumption capacity is limited, and a large amount of surplus electricity needs to be sent out, but it has encountered difficulties. Among them, the most critical factor is that the speed of power development far exceeds the speed of power grid construction. Due to various factors at the time, the degree of matching between the two has not been well planned. This situation was particularly prominent around

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2010. It is understood that the period from project approval to approval of new energy is short, and even if the approval of the relevant power grid construction is completed, the fastest construction period will take 2 to 3 years. In addition, because the new energy is concentrated in the Hexi area of Gansu, the grid structure of the power grid is weak, and the new energy is only sent out through the northwest-Xinjiang network transmission channel. Affected by the stability of the power grid at that time, limited transmission capacity, and sharing channels with Xinjiang thermal power and new energy transmission, one can go and the other, renewable energy in Gansu is suffering from development pains (IN-EN, 2021).

The inter-provincial transmission capacity of the Northwest, Northeast and North China regions classified as the "Three Norths" is only 22% of the installed capacity of new energy. If the electricity generated cannot be returned through cables, it means that the owners of the power plants cannot obtain income through the sale of electricity, which will be detrimental to the operation of the industry and the development of the industry. To obtain income from the sale of electricity, different energy companies competed with each other with the grid connection and the price, from which a Grid War has begun in the Northwest (EnergyTrends, 2017)."

The Role of the Gansu Government in Overcapacity

To cope with the serious problem of abandoning light and limiting electricity, Gansu has adopted the external transmission energy policy as the main way of consumption. The State Grid Gansu Electric Power Company actively organized nationwide consumption, and successively sent Gansu electric power to Qinghai, Tibet, Central

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China and East China. Recently, it has reached a cooperation intention with China Southern Power Grid. According to statistics, in the first half of this year, Gansu sent 13 billion kWh of electricity, an increase of 50.6% year-on-year, of which 7.16 billion kWh was sent from new energy sources. At the same time, Gansu uses the national power spot trading platform of the State Grid Corporation of China, and Gansu actively implements new energy spot trading. All new energy power plants in Gansu Province are connected to the spot trading system. In 2017, Gansu new energy spot transactions were 3.27 billion kWh., accounting for 46% of the national transaction volume (People, 2018).

In order to accelerate the on-site consumption of wind power to achieve comprehensive utilization of resources and reduce the pressure on power grid transmission, the Gansu government even sought policy support and breakthroughs in attracting investment. A batch of 1 million tons of high-purity silicon material series and 1.2 million tons High-energy projects represented by cement and 10 million square meters of stone processing have settled in the Guazhou Resource Comprehensive Utilization Park. However, in order to consume these clean energy, high-energy-consuming projects are vigorously introduced, and these high-energy-consuming projects are often accompanied by high pollution, presenting a development contradiction (Sina, 2013).

Shandong

Shandong Province is a large province in the solar energy industry, but low-end products have overcapacity. The capacity utilization rate of vacuum tubes and water

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heaters is less than 50%. The average capacity utilization rate of photovoltaic modules in the province is only about 30%, which is lower than the international reasonable capacity utilization rate 75%, representing the phenomenon of low industrial concentration, blind investment and redundant construction still exists. There are more than 300 solar energy companies in the province, and only about 6 companies have a sales income of 3 billion RMB, and most of the companies have sales income below 50 million RMB.

The upstream and downstream industrial structure is also unreasonable. There are few marketable high-end products and solar building integrated products, especially the safe, reliable and easy-to-use products suitable for high-rise buildings, which are difficult to meet the needs of emerging markets. From the perspective of enterprise innovation capabilities, investment is insufficient, innovation capabilities are not strong, flat panel solar water heaters do not master the core technology, the photovoltaic industry lacks core original technologies, and most of the photovoltaic manufacturing equipment is imported from abroad. From the perspective of the terminal application market, the policies are not perfect, the market supervision is insufficient, the relevant standards are lagging behind, the solar energy engineering design, construction, acceptance and after-sales service standards are not matched, and the supervision and inspection and accountability mechanisms are not solid enough.

In response to the problems in the solar industry, Shandong Province actively cultivates market demand and strive to achieve three changes, from a capacity-

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expanding enterprise to a quality and efficiency enterprise, a traditional imitation enterprise to an innovative enterprise, and a manufacturing enterprise to the transformation of service-oriented enterprises. Shandong strives to significantly improve the technology and product quality and energy efficiency of the solar energy industry in our province, and further strengthen the overall strength.

Under such environmental influences, the solar giant suffered bankruptcy. In 2012, the global solar capacity was 60GW (1GW or one billion watts), but the demand was only 35GW, and there was a serious overcapacity of solar manufaction. China's 2012 PV output was 23GW, but the total installed capacity in China was only 4.5GW. It is overly dependent on the international market, especially European and American countries where the total installed capacity accounts for 75% of the global market. Since 2011, countries such as Europe and the United States have successively initiated the dumping and countervailing investigations on Chinese solar products, which leads to a negative impact on exports (Semi, 2013).

A power grid company in a large solar province and several cities in East China issued an internal notice to suspend the filing of new industrial and commercial dispersed and ground-based solar power plants due to peak shaving problems. After the scale of solar bidding was determined in 2019, the province's thermal power peak shaving has almost reached its limit. According to the "13th Five-Year Development Plan for Solar Energy in Shandong Province", Shandong's solar installed capacity has reached 10GW in 2020. As of the first quarter of 2019, Shandong's cumulative installed capacity of solar power plants has reached nearly 13.96GW, making it the

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province with the largest cumulative scale of solar power plants in China. Shandong is faced with tremendous pressure from power grid peak shaving and absorption. The installed capacity of solar power generation in Jiangsu Province also soared to 13.69 GW, second only to Shandong, ranking second in China.

The Role of the Shandong Government in Overcapacity

Owing to the authoritarian party-state political regime of China, Chinese Communist Party (CCP) controls and distributes the main resource of the entire state. The local cadre system provides the central state with the personnel management system and major driving force in local development in the local government. On one hand, through the local cadre system, the central state evaluated the performance of the officials in local government (Liang & Langbein, 2015). In order to get promotion, those local officials pursue the objective and standard of the central state. On the other hand, the local cadre system stimulates the local officials to pursue the objectives from the central and reach the annual plan, which provide the driving forces for the local development to meet the expectation of the central. However, the local economic development and the environmental protection are contradictory in the case of China.

Under the evaluation of local cadre system, both economic development and the environmental protection have been viewed as the priority of the central state. However, it has been a challenge for local officials in Shandong government to promote the economic development and meet the objective of environmental

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protection at the same time. From the field research in 2016 in Shandong, this chapter found that the interaction between the central state and local government (Shandong) has been intensified in the solar power development over the past decade.

Although these actions and policies indicate the determination of the central state on solving the issue of air pollution and possible threat on environmental protection, these strategies also cause challenge to the economic development in local government like Shandong, which still relies heavily upon the thermal power plant as the driving force for its infrastructure. The contradictory between the economic development and environmental protection result in challenge for local officials in Shandong.

On developing the solar energy, the solar power generation relied much upon the natural condition, such as the weather and the geography condition. Compared to other renewable energy power generation, although the solar power generation is not limited by the distribution of resource, such as hydro power generation was limited by the distribution of the water and wind power generation, solar power generation was limited by the territory and land resource. Especially in Shandong, the urban areas were narrowed and limited with high population, which further limited the development of concentrated solar power generation with high requirement on land and space. Therefore, the Shandong government turned the focus of development on

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the rural areas, and also utilized the subsidy from the central state policies, such as 11th and 12th Five Year Plan.

Facing the above challenge from the contradictory on economic development and environmental protection as well as the limitation from the space, Shandong government combined the solar power development and poverty alleviation. The combination of these two elements provide a solution to the above challenges. On one hand, the combination between solar power development and poverty alleviation aims at the wasted mining area to settle solar power station and connected grid, which avoid the space and development conflict with the urban area. On the other hand, the combination also offers a solution to contradictory embedded in the local cadre system, which increase the performance and the evaluation in the conflict between the economic development and environmental protection in Shandong. The combination targets at poverty situation in rural area by providing infrastructure of solar power equipment such as solar panels and power station to aid the local farmers and the poor. For local farmers, they installed those solar panels on the greenhouse to generate electricity the consumption of the agricultural products. For the poor, they settled the solar panels on the rooftop and generated electricity to meet their daily consumption, and sell the surplus to the national grid to earn extra profit.

During the development of solar power, both Gansu and Shandong encountered the problem of overcapacity. From the perspective of environmental bundling economic benefits, the overcapacity in Gansu stems from the active pursuit of central

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government policy subsidy dividends by power generation companies. In Gansu, even if the local power generation companies are able to alleviate the plight of abandoning light and limiting electricity, because the economic benefits of development are bound by policies, the introduction of energy-intensive industries can actually make manufacturers more profitable. As a result, Gansu has generated too much electricity, but the problem of overcapacity has not been solved.

On the other hand, Shandong's overcapacity also stems from the fact that photovoltaic manufacturers are actively pursuing the policy dividends of the central government to encourage photovoltaic manufacturing. This dissertation believes that in the case of Shandong, the local government of Shandong has played a key role and will be subject to anti-dumping solar power from Europe and the United States. The excess solar panels manufactured by manufacturers assist local farmers and poor households in establishing basic solar power generation facilities. Unlike Gansu, which is unable to act in the face of the central government's policy dividends and the profit-seeking behavior of manufacturers, the Shandong government first deployed a model of combining new energy and poverty alleviation before the central government's poverty alleviation policy came down. On the one hand, the Shandong government consumes excess manufacturing capacity, and on the other hand, it assists the already strong agriculture, solves the problem of rural land with poor infrastructure in remote areas, successfully resolves the bundled excess capacity, and further reduces the development gap. The relations of agents in solar power development is as Graph 6-1

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presented below:

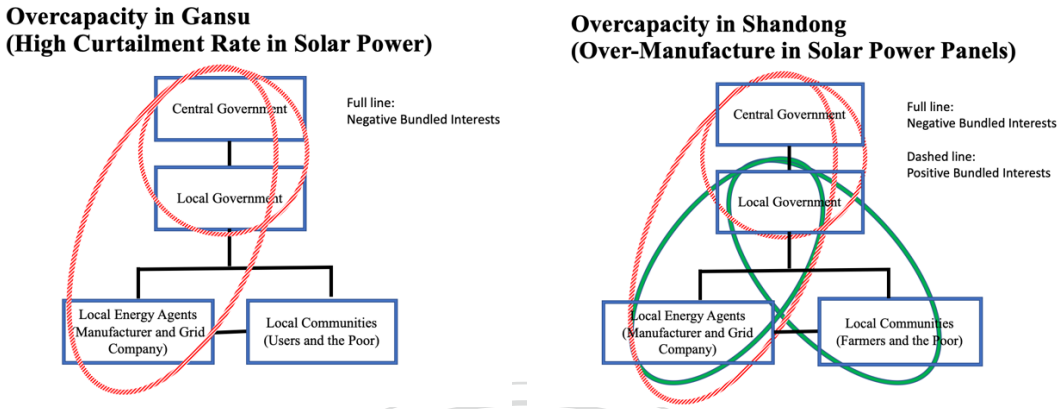

Figure 6-1 Overcapacity in Gansu and Shandong

Source: This Research

6-4 Poverty Alleviation with Solar Power

Gansu

While alleviating the problems of local poor households, Gansu's solar power poverty alleviation is also facing many problems and challenges, mainly in the aspects of operation and maintenance management, income distribution, and upgrading. First of all, in terms of solar power operation and maintenance management, the state currently provides directional guidance, local governments formulate specific operation and maintenance management methods, and there is a lack of unified standardized management standards, which also faces challenges in terms of operational management costs. In the beginning, the distribution of household and village-level power stations in most mountainous areas is relatively scattered, which increases the difficulty of operation and maintenance management. Then, the operation and management costs of third-party operation and maintenance companies are relatively large. Also, the level of network communication infrastructure in

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mountainous areas limits the efficiency and practical effects of electronic operation and maintenance, and the connection between some mountainous solar power sites and the network detection system is unstable. Finally, the dual-track solar power monitoring system is parallel, which increases the workload of the grassroots.

The second is the issue of the income distribution mechanism. Some solar power models have differences in the income distribution mechanism. Issues such as the bundling of income from household solar power stations and the interest binding of participating in dividend power stations pose a challenge to the inclusiveness and fairness of solar power income distribution. Therefore, it is necessary to solve the problem of binding benefits arising from the solar power construction and right confirmation stage, ensure the fair and inclusive solar power revenue distribution, and realize the dynamic adjustment of solar power revenue distribution.

Third, in terms of job employment and supervision and management, the scientific nature and efficiency of the establishment of public welfare posts still needs to be improved. Generally, the number of public welfare posts is determined by the percentage of solar power income, rather than the population status, poverty status and job demand status of the solar power village as the core criteria. On the other hand, the system of job setting, job functions, job rights and responsibilities, appraisal and supervision, and performance incentives for public welfare jobs are not perfect. It is necessary to further improve the system and mechanism of public welfare posts, change the post for money to post for people, and post for things, so as to improve the actual effect of public welfare posts.

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Finally, it is the issue of follow-up maintenance and development. Solar power technology is iteratively fast. The current policy is still unclear on how to update and upgrade solar power equipment. The challenges faced by equipment renewal are the high cost pressure of renewal and the disposal of discarded solar power panels. Waste solar power modules have potential environmental pollution risks, which requires scientifically plans to deal with the issue. At the same time, solar power poverty alleviation is also facing the problem of diversified industrial development. Power generation revenue and corresponding government subsidies constitute the main body of the solar power poverty alleviation industry. The exploration of expanding the industrial chain and increasing non-power generation revenues such as "PV+" is still in the early stage. The fundamental path of solar power poverty alleviation is to extend the solar power industry chain, promote the diversification of the solar power industry's benefits, improve the ability to resist risks, and establish a more stable benefit connection mechanism between villages, farmers and the market to ensure farmers continue to increase revenue steadily (CBAD ,2021).

However, under the model of solar power poverty alleviation in Gansu, through comparison with solar power development models in other provinces, this dissertation also found that the Gansu Provincial Government, under the environmental policy incentives of the central government to encourage poverty alleviation, introduced local development policies and related policies in 2014. However, the success of the solar power poverty alleviation model will not actually take root in various poverty-stricken counties until 2018. This dissertationbelieves that from the poverty

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alleviation with solar power in Gansu, the dissertation argued that the reason why even with better natural conditions to develop solar power, the poverty alleviation with solar power in Gansu begins slower than other provincial provinces. This dissertation argued that the bundled economic interest also occurred in the interaction between local government and local agents. Even with much sufficient solar radiation (compared to the coastal provinces), this dissertation argued that without sufficient incentives provided by the policy, the local energy companies prefer the bundled interests from the environmental policies in solar power generation transaction instead of fostering the poverty alleviation project with the local poor and local farming activities.

Shandong

Poverty Alleviation with Solar Power in Shandong

Taking advantage of the surplus power from external electricity to Shandong, Shandong's solar poverty alleviation will lay solar panels on the roofs of houses and agricultural greenhouses for "self-use and redundant Internet access". Local farmers and poor households can use the electricity themselves and sell the excess electricity to the national grid. Through dispersed solar power generation, every household will become a miniature solar power station. Poverty alleviation with solar power mainly includes three modes: solar ground power station, solar greenhouse power station and rooftop power station. In addition to using the roof to generate electricity, solar greenhouses can develop under-forest economy, increase the multiple cropping index,

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and change the planting mode, such as vegetable planting; poultry and livestock breeding can also be carried out to comprehensively promote industrial upgrading.

Complementary Model of Agriculture with Solar Power

Since 2016, State Grid Shandong Electric Power Company, in the process of in-depth promotion of targeted poverty alleviation and targeted poverty alleviation, has given full play to its industry advantages, taking solar poverty alleviation as an important starting point, and has served 9,390 solar poverty alleviation projects connected to the grid, with an installed capacity of 1.7 million kilowatts Among them, the installed capacity of poverty alleviation is 945,100 kilowatts, giving 326,000 poor households a the revenue from solar generation. Located in Binzhou Shandong, Liguo Township is located in the Lubei Plain. Because the land is mostly saline beaches, the road to poverty alleviation and prosperity is extremely difficult. In order to get rid of the predicament, the township has coordinated poverty alleviation funds, revitalized collective assets, and activated social capital. A total of 20.2 million RMB has been raised, focusing on the development of the animal husbandry industry. The township has not only built 53 breeding sheds in Wumiao Village, but also formed a large-scale breeding community. Solar panels have been installed on the roof of the breeding shed, and a solar power station with a capacity of 2,500 kilowatts has been built, which fosters the combination with solar roof construction with the farming under the shed, Wumiao Village will be lifted out of poverty as soon as possible.

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Solar power generation projects must be integrated into the large power grid to turn the sunshine into cash flow. For many years, State Grid Shandong Electric has conscientiously implemented the national solar precision poverty alleviation policy, and arranged an investment of 41 million RMB in the construction of grid connection projects in accordance with the principle of "synchronous grid connection of power stations, full consumption of electricity, monthly payment of electricity fees, and timely payment of profits" High-quality completion of the grid connection service work of solar poverty alleviation projects in the national plan. The coordination and unification of project placement and grid planning has been realized, grid connection projects have been completed at the same time, and all completed projects have been connected to the grid.

In order to ensure early completion of solar poverty alleviation projects, early connection to the grid, and early benefits, the State Grid Binzhou Power Supply Company opened a "green channel" for solar power station access, simplifying the settlement and payment process, improving the efficiency of on-grid electricity and subsidy payment, and providing value-added services for solar power stations , Improve project power generation revenue. With a total of 258 million kilowatt-hours of on-grid electricity consumed, and 169 million RMB of electricity purchase fees and subsidies settled, the green channel ranked second in Shandong, which fosters solar power generation has become a real economic benefit for poor households. Through the solar power station on the breeding shed, the poor households in Liguo

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Township can increase their income by more than 3,000 RMB per household each year, and the collective income of all 28 villages has reached more than 50,000 RMB.

The Role of Solar Power Company in Shandong

In terms of the solar power development in Shandong, the role of solar power company play a vital role. However, the process of it did not go smoothly at the very beginning. The manufacturer for solar panels has suffered from the overcapacity from the development. In the past, the export of solar panels relied heavily on the Europe and American market. Therefore, when the 2008 financial crisis happens, which further leads to the shrinking of demand on solar panels from Europe and American market. After 2008, owing to the shrinking demand, the manufacturers in Shandong has produced more solar panels than demand. As a result, the overcapacity and extra solar panels have become the concern of the Shandong government.

Before 2006, solar panel companies in China did not have strong incentives on solar power generation. Compared to economic development, environmental protection and evaluation are not viewed as the core criteria by the local governments in different provinces. As the pollution issue been targeted in the Five Year Plan by the central government, the solar power development has been listed as one of the priority promoted by a series of environmental policies. In order to pursue the incentive provided by the central state and local government, solar power companies accelerated the promotion of solar power development.

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In order to accelerate the solar development in local provinces, since 2013 the national energy bureau has promoted “Notice for Working Plan for Dispersed Solar Power Generation from National Energy Administration” and selected 30 places as the demonstration area for solar power development from 11 local provinces, including Beijing, Shanghai, Tianjin, Hebei, Jiangsu, Zhejiang, Anhui, Jiangxi, Shandong, Henan, and Guangdong (Solar of Week, 2016). Followed the policy, as one of the demonstration areas, Shandong government constructed 2 National New & Hi-Tech Industrial Development Zone and attracted qualified solar companies to accelerate the solar power development in Shandong. To further enhance the process of development, since 2010 Shandong government offered subsidy on electricity for grid companies 0.3 RMB per kW/h for solar power station, and 0.05 RMB per kW/h grid connected (Solarbe, 2016). Under the circumstance, solar power companies gain support from both the central and Shandong government.

Under the stimulation from the central’s objective on environmental protection and the challenge of space limitation, as well as the great population of farmer and the poor, the Shandong government promoted the supplementary of agriculture and solar development to achieve the goal and solve the problem. Through the support of solar energy company, Shandong successfully promoted supplementary of agriculture and solar development, Shandong promoted agriculture with solar power in Quingdao and Weifang.

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In Qingdao, Chang Sheng Solar Power Technology Company invested 2.5 billion RMB in 2014, and constructed a township with electricity provided by solar power. In Pudong Town of Jimo City, Qingdao, the farmers could generate the electricity through the solar panel on the top of their house and planted vegetable in the greenhouse. Due to the weather condition, the greenhouse in local mainly plants mushroom and other agriculture product with higher value, such as vegetable, tea, flower and Chinese medicine. Compared the situation before this policy, the local farmers in Shandong could only earn around 1,000 RMB for over the year. Through the supplementary of agriculture and solar development, by turning the land into greenhouse with solar panel, the local farmers could receive the salary as the worker and receive the extra profit resulted from the high value agriculture product, such as mushroom. The net profit turned out to be 60,000 RMB for the entire year (Solar of the Week, 2016). As the local operators in energy company said, "the supplementary of agriculture and solar development could bring multiple benefits to the local community, increase of the income, eco-friendly environment, and poverty alleviation."

The role of local energy company in solar power development presented in three ways: First of all, through the subsidy from the government, Chang Sheng Solar Power Technology Company constructs the greenhouse for the local farmers and provide jobs for the poor nearby their community. Second, Chang Sheng Solar Power Technology Company supports the poverty alleviation by categorization. On one hand, the poor with working ability could enter the greenhouse to receive the salary

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while the poor with lower working condition could apply for joining the project and share the profit. Finally, through the supplementary of agriculture and solar development, Chang Sheng Solar Power Technology Company combines the goal of poverty alleviation and economic development of agriculture to reach poverty alleviation and develop agriculture in Shandong with local unique feature.

In Weifang, Shangyu Solar Technology Company constructed the full living environment in Anqiu. (Soalrbe, 2018). Anqiu located in Weifang City, is the home to many agriculture product in Shandong, including garlic, bamboo, strawberry and cherry, and was selected as the demonstration city for agriculture. Therefore, it has been selected as one of the cities in Shandong for supplementary of agriculture and solar development. The role of solar power company in Shandong presented in three different aspects, including greenhouse with solar panels and solar inverter village, as well as industry development with solar power (Interview Data 2016-0806-1).

First of all, under the subsidy from the Shandong government, Shangyu Solar Technology Company adopted its own PV inverter for the greenhouse with solar panels and constructed infrastructure for solar development in local community. The local farmers in Weifang could not only receive revenue from vegetable-planting, but also gain benefits by selling extra electricity from solar power station in their farm. According to the local officials, this combination could not only solve the difficulty in the solar industry, but also stimulate the transformation for local agriculture and product-planting (Interview Data 2016-0806-2).

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Second, through the interaction between the Shandong government and Shangyu Solar Technology Company, it helps to construct the solar power village in Anqiu and reached 1.5 MW in local solar power development. In this village, more than half of the household installed solar power system. Through the solar power system, the villager could generate electricity through the dispersed solar power system on their rooftop and also earn extra revenue by selling surplus to the national grid. The construction of the rooftop dispersed solar power system brings not only the extra revenue for the local, but also provide a clear alternative for energy consumption compared to coal and petroleum.

Finally, in addition to solar power green house and solar power village, Shangyu Solar Technology Company combined the local industry with the solar power system. Owing to the advantage on agriculture, Anqiu has lots of processing factories for agricultural products, which will need to consume lots of energy, especially the electricity and water. Shangyu Solar Technology Company targeted these processing factories and installed solar power station on the rooftop and generate electricity. On one hand, this combination make good use of the extra space on the rooftop. On the other hand, the solar power generation reduced the cost on electricity for these factories and generated income for electricity surplus (Solarbe, 2018).

The above cases in Shandong to promote supplementary of agriculture and solar development showed the interaction between the solar power companies as well as

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the local government. On one hand, the policy solved the difficulty on over-dependence on coal burning and the limitation of the space for a province with limited land resource like Shandong. On the other hand, the policy serves as a converter to turn the poverty into revenue for the poor and the farmers, which solves the conflict between pursuing the goal on economic development of local government (Shandong) and reaching the objective on environmental protection using solar power from the central state. As one of the interviewed data showed:

"The supplementary of agriculture and solar development makes the connection become possible. Local farmers in Shandong could grow electricity on the rooftop and grow vegetables and other high value agricultural products under the greenhouse. On one hand, this combination between the solar power generation system and agriculture could provide lower cost for local agriculture to run. On the other hand, it could also provide sufficient solar radiation for agricultural products to grow better, which completely make good use of the local resource and generate the maximum of the benefit. (Interview Data 2016-0806-3)"

From the above discussion, the role of solar power company in Shandong played an essential role in integrating the resource from the local government and the local users (farmers and the poor), which not only work as an indispensable element in the circle among the solar development in Shandong to connect Shandong government and local farmers and the poor. The circle between local government, the solar power company, and the local users further stimulate the solar development as well as the economic development, which foster three dynamics.

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First of all, in order to follow the objective from the central government on the goal to pursue green energy and reduce the dependence on traditional thermal power, Shandong government further promote policy to enhance the incentive for energy company in Shandong to pursue solar power development. Under the incentive of Shandong government, solar energy companies in Shandong take the responsibility and construct the infrastructure for local users.

The second dynamic lies in solar energy companies and their response and behavior. Under the subsidy and backup from the Shandong local government, solar energy companies provided solar panels for local farmers in remote mountain areas to generate their own electricity and provide basic energy consumption for their agriculture. On one hand, local solar power companies received the incentives from the Shandong government. On the other hand, these solar power companies offer resources for the local users such as farmers and the poor to change their way of living.

The last dynamic is the response of the local users (the farmers and the poor). Farmers and the poor installed the solar panels provided by the local solar companies on their rooftop, which not only provides them the basic requirement for electricity consumption, but also empowers them to earns extra living by selling surplus of the electricity from those solar panels.

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In the development process of photovoltaic poverty alleviation, Gansu and Shandong have both suffered the impact of overcapacity on the development of photovoltaic industry. However, the time point of Gansu photovoltaic poverty alleviation model successfully assisting poor households is much later than that of Shandong. From the above discussion, we find that, What's interesting is that Gansu has excellent solar radiation. The installed capacity of solar power and new additions are among the top in the early stages of photovoltaic development in all provinces in China. However, the efficiency and results of photovoltaic poverty alleviation development in Gansu are not as good as the low solar radiation and the narrow land. Thick Shandong. From the perspective of environmental bundling economic benefit theory, this paper argues that Gansu, which has suffered from overcapacity, is encouraged by the political dividend of the central government's development of photovoltaic policies and actively pursue development subsidies. These overcapacity power cannot be effectively used by local agriculture. It is digested with the users of animal husbandry, so the surplus electricity cannot be eliminated. The Gansu government can only use electricity curtailment and send it to the eastern coastal provinces to consume the excess electricity. Not only that, energy manufacturers tied up by economic interests, in order to obtain more economic benefits for development, have introduced more energy-intensive and high-polluting industries to digest excess electricity. The social benefits that can actually help the local photovoltaic poverty alleviation are sacrificed under the bundled structure. Recently, Gansu has to alleviate the problem of solar abandonment and electricity rationing. The local photovoltaic poverty alleviation

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model has gradually emerged, which resulted in the late poverty alleviation model sprouted in Gansu.

On the other hand, although the impact of overcapacity is also affected, the Shandong government can effectively transfer the excess energy to the impoverished provinces in remote mountainous areas, and assist local farmers and poor households in generating electricity. The excess electricity produced in poverty alleviation is sold to the national grid to subsidize living expenses, and the local agriculture or fishery is further combined with solar power. From the perspective of environmental bundling economic benefit theory, this paper believes that although photovoltaic manufacturers were once tied up by the political dividend of the central photovoltaic policy and actively produced photovoltaic energy panels, they were subject to anti-dumping policies in Europe and the United States. Manufacturers of photovoltaic power generation and photovoltaic energy panels combine economic and social benefits through photovoltaic poverty alleviation models. Among the limited land resources, they choose unsuitable coal mining sites to erect photovoltaic power stations, and extend the grid to farmers in remote areas. The roofs of poor households help farmers to generate electricity, transmit electricity, and sell electricity in a series of processes, and gradually let the local develop its own photovoltaic poverty alleviation model, which is combined with agriculture and fishery to form a complementary model of solar power. The key is that the Shandong government can effectively combine excess capacity with strong local industries, and through photovoltaic poverty alleviation models, it combines the political interests of the central government, the economic

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interests of the local, and the social interests of local farmers and poor households instead of binding each other. A new photovoltaic utilization model was born. The relations of agents in solar power development is as Graph 6-2 presented below:

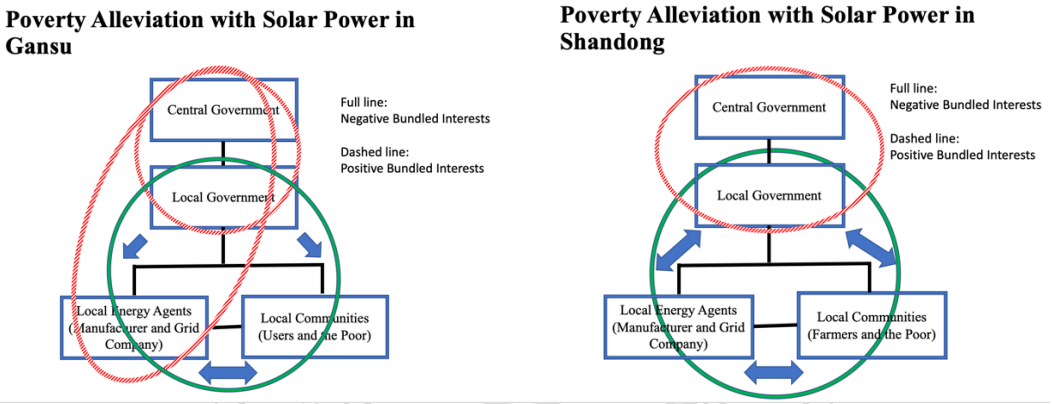

Figure 6-2 Poverty Alleviation with Solar Power in Gansu and Shandong
Source: This Research

Conclusion

From the perspective of environmental bundling economic benefits theory, this dissertationbelieves that during the 11th Five-Year Plan period, photovoltaic development follows a top-down model, and local provinces in China such as Gansu and Shandong are chasing the central policy dividend. Under the model, as mentioned in the second chapter of this dissertation, the central personnel performance appraisal system also allows local officials to abide by such a set of rules of the game, so that local behavior in the early stages of development conforms to the central plan. However, during the 12th Five-Year Plan period, due to the central political dividend, Gansu is still actively pursuing the development of solar power. The problem of overcapacity in Shandong has put Shandong under development pressure. Therefore, the development model has shifted to digestion of excess photovoltaic panels, seeking

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wasteland and waste coal production sites, and actively developing photovoltaic applications. During the 13th Five-Year Plan period, Gansu began to abandon solar power and limit electricity due to the problem of excess capacity, and the development of photovoltaic poverty alleviation took shape relatively late. Shandong, on the other hand, has successfully promoted photovoltaic poverty alleviation in remote mountainous areas due to the construction of stable basic photovoltaic power for agriculture, helping poor households and farmers in remote mountainous areas to integrate with strong local industries.

In the development process of photovoltaic poverty alleviation, Gansu and Shandong have both suffered the impact of overcapacity on the development of photovoltaic industry. However, the time point of Gansu photovoltaic poverty alleviation model successfully assisting poor households is much later than that of Shandong. From the above discussion, we find that, What's interesting is that Gansu has excellent solar radiation. The installed capacity of solar power and new additions are among the top in the early stages of photovoltaic development in all provinces in China. However, the efficiency and results of photovoltaic poverty alleviation development in Gansu are not as good as the low solar radiation and the narrow land. Thick Shandong. From the perspective of environmental bundling economic benefit theory, this paper argues that Gansu, which has suffered from overcapacity, is encouraged by the political dividend of the central government’s development of photovoltaic policies and actively pursue development subsidies. These overcapacity power cannot be effectively used by local agriculture. It is digested with the users of animal husbandry,

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On the other hand, although the impact of overcapacity is also affected, the Shandong government can effectively transfer the excess energy to the impoverished provinces in remote mountainous areas, and assist local farmers and poor households in generating electricity. The excess electricity produced in poverty alleviation is sold to the national grid to subsidize living expenses, and the local agriculture or fishery is further combined with solar power. From the perspective of environmental bundling economic benefit theory, this paper believes that although photovoltaic manufacturers were once tied up by the political dividend of the central photovoltaic policy and actively produced photovoltaic energy panels, they were subject to anti-dumping policies in Europe and the United States. Manufacturers of photovoltaic power generation and photovoltaic energy panels combine economic and social benefits through photovoltaic poverty alleviation models. Among the limited land resources,

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they choose unsuitable coal mining sites to erect photovoltaic power stations, and extend the grid to farmers in remote areas. The roofs of poor households help farmers to generate electricity, transmit electricity, and sell electricity in a series of processes, and gradually let the local develop its own photovoltaic poverty alleviation model, which is combined with agriculture and fishery to form a complementary model of solar power. The key is that the Shandong government can effectively combine excess capacity with strong local industries, and through photovoltaic poverty alleviation models, it combines the political interests of the central government, the economic interests of the local, and the social interests of local farmers and poor households instead of binding each other. A new photovoltaic utilization model was born.

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Chapter 7 Conclusion—Central-location Relations in Inner and Coastal Model of the Solar Power Development

The Purpose of the Research

As the rise of China has attracted the attention of the world, it represents the rapid economic development behind it. However, as China enjoyed the interests and benefits from the fast-growing economic development, at the same time China suffered a lot from overdependence on thermal power generation, especially the air pollution from the traditional thermal power plants. Under the pressure to decrease pollution, China decided to promote renewable energy in order to get rid of the overdependence on traditional thermal power. Thus, a series of central policies were released and persuaded the local governments to follow. However, following the same guidance from the center under the same guidance and interests from the central policies, the result presented quite differently in inner province (Gansu) and the coastal province (Shandong), which has aroused the attention of this dissertation.

The main purpose of this dissertation is to study the solar power development pattern regarding the change of the role and social development in China. Especially, it focuses on the interaction between the policy of the central government and the implementation of local governments on the development of solar power development and social development of the local community in Gansu and Shandong Province. This dissertation takes Gansu, Shandong as the case study to present through the policy how the interaction between the central government and the implementation of

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the local governments, as well as the change of the role of solar power development and social development toward the change.

Through the above navigation on the above discussion, the construction of solar power in China has been regarded by not only the center but also local government officials as a political task in the past decade. Thousands of new solar power stations have been constructed in not only remote mountain as well as remote areas, and the electricity generated by solar photovoltaic has reached tremendous achievement in installed capacity within a decade. However, owing to the interest provided by government policy, from the preliminary observation and field research in Gansu and Shandong, these local governments (Gansu and Shandong) in different areas adopt diverse behaviors toward the development of solar power and further has created an impact on local society, ranging from "Solar curtailment and electricity limitation (棄光限電)" "Complementary through solar power and agriculture (農光互補)." and "Poverty alleviation with solar power (光伏扶貧)." The construction of a solar power station has led to a variety of societal and developmental concerns including solar curtailment and electricity limitation (in Gansu), complementary through photovoltaic and agriculture (in Shandong, photovoltaic poverty alleviation. The same policy to solar power development but result in different local government behavior, which has aroused the interest of this dissertation.

Research Questions, Main Findings, and Contribution

Research Questions, Main Findings and Contribution

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Owing to the above discussion and issue, the main research question of this dissertation is **"How bundled interests during the central-local interaction shaped the solar power development pattern in China?"** What is the chronological development of solar power in China? What are the agents in central and local relations? What types of bundled interests are involved in the solar power development? How these types of bundled interests result in different types of developmental patterns? Solar curtailment and electricity limitation (棄光限電)" "Complementary through solar power and agriculture (農光互補)." and "Poverty alleviation with solar power (光伏扶貧).

Hypothesis

Toward the above research questions, this dissertation includes the corresponding hypotheses. First of all, in terms of the factors and agents regarding policymaking and implementation in solar power development in China, this dissertation hypothesized that through the central and local government relationship, the policy implementation on solar power development received the subsidy and resources from the central, and pursued the interest-oriented behaviors on solar power development. According to O'Brien and Li (1999), the locals received interest from the central government and pursued the assigned objectives targeted by the central. In terms of the solar power development, while the central provide incentives for solar power development, the local government not only received benefits and resources but also gained alternative on energy consumption through solar power development. Therefore, this dissertation

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hypothesized that to pursue the incentive provided by the central, the local governments would adopt the interest-oriented behavior on solar power development.

Second, regarding the solar power developmental pattern in China, this dissertation hypothesized that the solar power developmental pattern in China was greatly shaped by the central and local relationship. However, the policy implementation of local government did not take all the command or order from the central. Instead, the local government selects the priority and pursued the maximum of its own interest in local development. Based on Oi (1992, 1995)'s research, she argued that the behavior of the local government in China presented a way that is similar to corporatism in pursuing the maximum interest on its own governance. Instead, it pursued the maximum interest in its own governance. Later in 2012, Kostka and Hobb (2012) analyzed the issue of Chinese environmental governance through policy and interest, which pointed out that by policy implementation, the "bundle approach" balance the interest from the local to meet the target from the central. However, in terms of energy development patterns in solar power, the above existing theory and approaches could not adequately answer the question of the reaction of the central-local relationship for social demand. Finally, in 2015, Wang et al. (2015) further extended the discussion of government relationship and behavior through the "Environmental Bundled Interest Approach", which argued the behavior of the local government in integrating environmental policy implementation with local economic interests. As a result, this dissertation hypothesized that although the local government received the

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incentive from the central, the local government did not take all the orders. Instead, it is the bundled interest that drives their behaviors.

Third, in terms of the social community response to the interaction between central and local government and the pattern, this dissertation hypothesized that the social development will reflect the requirement and consumption pattern on its development. According to Ockwell et al. (2017), through the positive impact of policy implementation and social interaction, the solar power policy and project could bring benefit to the local society and receive supportive feedback. Therefore, this dissertation hypothesized that the local society will support and provide a positive response to the local government policy when the requirements are met.

Main Argument and Contribution

The main arguments of this dissertation include the following three statements: First of all, in terms of policymaking and implementation, it is argued that the central government provides the guidance and present the top-down mechanism for the local to pursue and reach the goal. However, in solar power development, the process of policymaking and implementation involves local autonomy. The local government would take not all the order and targets from the central, but actions based on their own priority to pursue the maximum of their interests. In addition, the development of the local society also reflects on the policy implementation to force the local government or the central to adjust and modify the targets and ways of implementation.

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Second, regarding solar power development in China, the preliminary studies argued that top-down bureaucracy and party-oriented centralization limited the development of the local government on energy development. The destiny of the local province depended on the arrangement and list from the central to decide the priority. However, this dissertation argued that the central and local government relations and interactions shaped the solar power developmental pattern locally. The local development is not always limited by the central instead mutually bundled. Through mutual beneficial interaction between the central-local relationship, the local development on solar power could gain positive development and increase the autonomy. On one hand, it could meet the target from the central. On the other hand, it could stimulate local development through solar power.

Third, in terms of social development in solar power development in China, the previous studies argued that the top-down relationship shaped the engagement of the local community. However, this dissertation argued that in the issue of solar power development through positive central-local government relationship, the active local government could bring benefit to the local community and increase the participation and support from the farmers and the poor at the county and township level.

Based on the approach of "Environmental Bundled Economic Interest," this dissertation argued that the relationship and behavior of local government, local energy agents (such as manufacturers) local community (farmers and the poor) were

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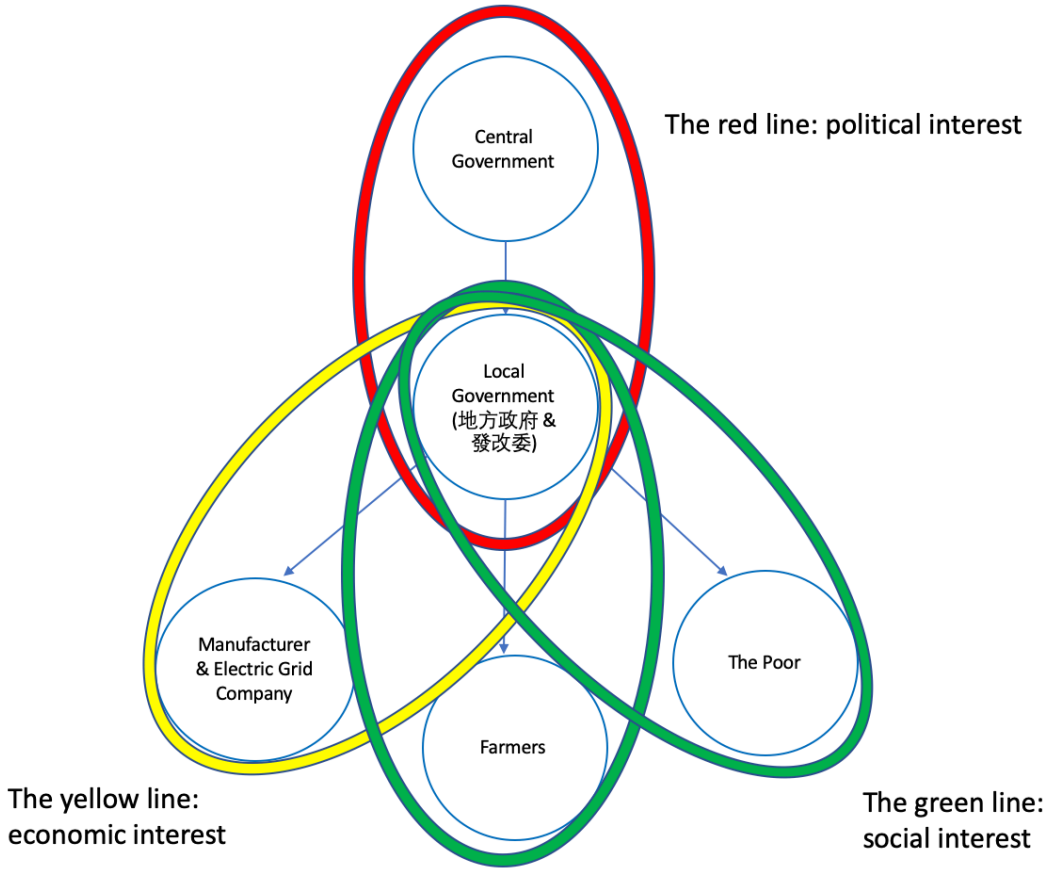
driven by the interest provided by the policy. Therefore, this dissertation explored the central-local government relationship and the development from the local community toward the relationship through the following framework (the black line presented the interaction between different agents in solar power development while bundled interest was illustrated in red circle) as Figure 2 showed.



Chapter Review

In the past six chapters, this dissertation has discussed the overall chapter arrangements, the literature review, the solar development in China over the past decade, solar power development in Gansu, solar power development in Shandong, and the comparison of solar power models between Gansu and Shandong. In Chapter

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One, this dissertation has presented the introduction, background, significance, research question, hypothesis, main arguments, and case studies.

In Chapter 2, this dissertation has illustrated the preliminary studies and discussed the preliminary studies regarding central-local relation, including fragmented authoritarianism (FA), local state corporatism (LSC), and bundle interest (BI) to examine how the interaction between the central government and local government could shape the renewable development in China. This dissertation contributed from another angle to view the environmental governance, especially from the political interest, economic interest, and social interest to discuss and explain the interaction between the central government, local governments, and the actors from the local society.

From political interests' perspective, it pointed out the importance of local government and the increase of autonomy of local government at the provincial level. On the other hand, the economic interest pointed out that even though during the central-local relation process, local government will manage its resource as the private sector to pursue the maximum of its interest. Finally, the bundled interest examined the past preliminary studies on central-local relations and analyzed the interaction between the central and local government from the aspect of interest. Further, Environmental Bundled Economic Interest (EBEI) approach further pointed out the local government was limited by the subsidy from the central government. However, due to the role changing on renewable energy, from energy generator to

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social development coordinator, this dissertation argued that in terms of the discussion on central-local relation should include the social development in order to have a comprehensive discussion. As a result, this dissertation suggested adopting Environmental Bundled Economic Interest approach to be applied in solar development and central-local relation in China.

Chapter 3 has discussed the development of solar power in China in the two decades especially through renewable policy development as well as the interaction between the government and the local agents. It has presented that different developmental stages have fostered the role of renewable energy development in China into a coordinator for social development. Through the development of solar power, poverty alleviation could be conducted into the local development, especially for the poor and the local agriculture workers. Among the renewable energy development in the past, this chapter pointed out the solar development has aimed at different objectives and reaching into different phases in each Five-Year Plan.

The development of renewable energy mainly followed the path of the Five Year Plan and reach its objectives in different phases. From 11th to 13th FYP, the transformation indicates that the role of renewable energy has shifted from the role of clean energy provider, which aims at getting rid of the overdependence on the traditional thermal generation, to the role of development coordinator between different agents in the local society, including government, energy manufacturers, the grid companies as well as the local farmers and the poor, which further fosters the

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poverty alleviation with new energy development. During the interaction between government, energy manufacturer and providers as well as local users (farmers and the poor), through poverty alleviation with solar power development, on one hand, the government transferred the overcapacity into the local community. On the other hand, the local community could also benefit from the solar panels from the renewable energy manufacturers, which further develops into different patterns at different provincial levels in China.

In Chapter 4, this dissertation has introduced the solar power development in Gansu as well as the interaction between governments, energy manufacturers, grid companies, as well as local users. Since 2006, China has actively promoted solar power at different provincial levels domestically. Gansu, as one of the inner provinces with sufficient resources on solar power development, received a series of guidance and subsidies from the central policies. During the development, local government officials in Gansu are facing pressure, on one hand, catering to the objective from the central on increasing solar power installed capacity and generation. On the other hand, the local officials also had the pressure perusing the local development on the economy. Under the pressure of meeting the target from the central and pursuing the economic development in the local, the local government officials coordinated the grid companies and energy manufacturers as well as the local farmers and the poor. In Chapter, this dissertation presented from overcapacity to poverty alleviation with solar power, how local government interacted with different agents and actors in the process to shape the solar power development in Gansu.

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From the overcapacity issue in Gansu, the dissertation argued that the interaction between local government and local agents resulted in the high curtailment rate in solar power. To pursue the policy interest and subsidy from the government, the local energy manufacturers actively generated solar power instead of considering the consumption-ability of this generation from solar power. The local government even recruited high-consumption electricity manufacturers to consume this extra power, which increases the local economic development but resulted in higher pollution in Gansu.

On the other hand, from the poverty alleviation with solar power in Gansu, the dissertation argued that the reason why even with better natural conditions to develop solar power, the poverty alleviation with solar power in Gansu begins slower than in other provincial provinces. This dissertation argued that the bundled economic interest also occurred in the interaction between local government and local agents. Even with much sufficient solar radiation (compared to the coastal provinces), this dissertation argued that without sufficient incentives provided by the policy, the local energy companies prefer the bundled interests from the environmental policies in solar power generation transaction instead of fostering the poverty alleviation project with the local poor and local farming activities. The bundled interests from the policy resulted in the interaction between the local government and local energy companies. Under the interaction, local agents will evaluate the interests from the incentives and

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behave accordingly, which has resulted in the high curtailment rate and slow development in poverty alleviation with solar power.

Chapter 5 has introduced the solar power development in Shandong as well as the interaction between governments, energy manufacturers, grid companies, as well as local users. Since 2006, China has actively promoted solar power at different provincial levels domestically. Shandong, as one of the inner provinces without sufficient resources for solar power development, but could develop the solar pattern successfully in poverty alleviation with solar power projects, especially in local agriculture. During the development, local government officials in Shandong are facing pressure, on one hand, catering to the objective from the central on increasing solar power installed capacity and generation. On the other hand, the local officials also had the pressure perusing the local development on the economy.

Under the pressure of meeting the target from the central and pursuing the economic development in the local, the local government officials coordinated the grid companies and energy manufacturers as well as the local farmers and the poor. Chapter 5 presented overcapacity to poverty alleviation with solar power, how local government interacted with different agents and actors in the process to shape the solar power development in Shandong.

Chapter 5 argues that through the supplementary of agriculture and solar development, Shandong could react to the objective and goals for social and

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environmental governance from the central government, and on the other hand pursue its local economic development. From the aspect of the approach of 'environmentally bundled economic interests, the supplementary of agriculture and solar development bundled the incentive from the new energy policies of the central state as well as the need to reach poverty alleviation. Therefore, for the local government (Shandong) the promotion of new energy is no longer an obstacle for the local economic development, instead, it turned out to be a successful solution for the conflict between economic development in the local as well as the environmental protection objective from the central.

From the overcapacity issue in Shandong, chapter 5 argued that the interaction between local government and local agents resulted in the overcapacity in solar power manufacturers, especially on solar panels. To pursue the policy interest and subsidy from the government, the local energy manufacturers actively generated solar power instead of considering the consumption-ability of this generation from solar power. However, through the coordination between local agents, including Shandong government, local solar power manufacturers, as well as the farmers and the poor in remote villages, the Shandong government consumed the overcapacity in solar panels manufacturers into the poor and farmers, which on one hand consume the waste suffering from manufacture overcapacity. On the other hand, it provides a solid foundation for the local farmers and the poor for the poverty alleviation project with a comprehensive grid and generation system on solar power.

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On the other hand, from the poverty alleviation with solar power in Shandong, chapter 5 further argued that the reason why even not with better natural conditions to develop solar power, the poverty alleviation with solar power in Shandong could foster and result in different poverty alleviation models, which is beneficial for the local. Chapter 5 argued that the bundled economic interest also occurred in the interaction between local government and local agents. Even without sufficient solar radiation (compared to the inner provinces), the autonomy from the local government could combine the local economy activities (agriculture and farming) and further foster the poverty alleviation project into different models, including the solar passport and supplementary agriculture and solar development model.

From the above discussion, this chapter demonstrated that the local government of Shandong played an essential role in stimulating supplementary agriculture and solar development and reacting to the conflict between economic development and environmental protection. This dissertation extends the approach of 'environmentally bundled economic interests (Wang et al., 2015)' to explain the conflict and solution from the above questions. Through the approach of 'environmentally bundled economic interests, this dissertation found that in the solar power development, the role of Shandong government serves as a vital role in solving the conflict between the reach the objective from the central as well as the pursuit for its own economic development. Under the supplementary of agriculture and solar development, Shandong government could effectively bundle the objective of implementing the environmental protection from the central and the pressure of promoting economic

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development in the local, and further solve the conflict between the central and the local.

Chapter 5 further argues that due to the land and space conflict in Shandong as well as contradictory embedded in the local cadre system, Shandong government combined solar power development and poverty alleviation to solve the conflict. On one hand, the combination aims at the wasted mining area to settle solar power station and connected grid, which avoid the space and development conflict with the urban area. On the other hand, the combination also offers a solution to contradictory embedded in the local cadre system, which increases the performance and the evaluation in the conflict between the economic development and environmental protection in Shandong.

In Chapter 6, this dissertation has explored the comparison of the solar power development models between Gansu and Shandong, this dissertation has respectively discussed the plight and model of solar power development. Gansu and Shandong respectively represent the different development models of inland and coastal areas in solar power development and two extremely different development processes. However, there have been many similar experiences during its development. First, in terms of development policies, China's central government has been eager to reduce the air pollution pressure on traditional thermal power generation. Since 2006, it has issued a series of new energy development policies to encourage local governments. The government responds to the solar power development policy. Then, in the initial

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development process, the local government pursued the central environmental policy dividend. Finally, from overcapacity to solar power poverty alleviation, Gansu and Shandong experienced different obstacles and finally took poverty alleviation as a new development direction for solar powers. Although there are so many similarities between Gansu and Shandong in the development process, the final solar power model is very different. This dissertation believes that the key lies in the interactive model of actors in their solar power development. Therefore, chapter 6 explored the solar power development model of inland Gansu and coastal Shandong province in the framework of the economic benefits of environmental binding. From the aspects of its own conditions and policies, overcapacity, and solar power poverty alleviation, it explored the central government and local governments in the process. How the government, power grid companies, new energy equipment vendors, and local people interact, resulting in extremely different solar power development models.

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Research Limitations and Future Suggestions

First of all, different new energy sources will have completely different development models. There are new energy poverty alleviation models based on the energy used. From the perspective of China's new energy development process, the pursuit of economic growth in the past, and the pursuit of relying on thermal power plants. The pollution caused makes China have to think about the development of new energy. With different development models and restrictions of different new energy sources, the core of this dissertation is solar power. The development of solar power will be affected by natural conditions such as topography, length of sunshine radiation, the distance of the power grid, and the location of the power station, and the local users' modes are different. However, whether the development model discussed in this dissertation could be applicable to other types of new energy, or to the development model of other regions or countries, still requires time and relevant field investigations to verify.

Secondly, one of the limitations in conducting China research is that the central authorities' remarks often report good news but not bad news. Because of the sensitive nature of issues such as energy, it is difficult to follow up on the dissatisfaction of the central government during interviews with China's development and reform. From the interview, this dissertation collected as much information as possible (central, local, energy companies, local users) in the field survey process to find out the contradictions and problems in the development, so as to explore different behaviors as completely as possible in the solar power development model, the

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behavior of all actors in pursuit of benefits and how benefits bind and shape their behavior.

Finally, due to the global disaster of COVID-19 during the writing of this dissertation, which affected part of the data acquisition, fortunately, the main interviews and data collection have been completed. Regarding the follow-up on the development of solar powers in the coastal and inland areas of China, this dissertation hopes to make further investigations and discussions in the form of the different journal articles in the future. Also, this dissertation wishes that the future related research will explore the impact of uncertain factors such as the epidemic on energy development and whether it has different forms of impact on energy development actors (stakeholders) to have a comprehensive discussion and exploration in the solar power development issue.

DOI:10.6814/NCCU202200360

Reference

Anue. (2018). Gansu's Largest Solar Power Generation Project Started Construction in Dunhuang. https://news.cnyes.com/news/id/2337328

Aolar. (2017). The Basic Situation and Outlook of the Development of Shandong Solar power in 2017. https://kknews.cc/agriculture/x3ogeeg.html

Bell, A. (2017). Cultural Factors Influencing Chinese Residents and Students' Views on Solar Solar power Rooftop Adoption.

Cao, X., Kleit, A., & Liu, C. (2016). Why invest in wind energy? Career incentives and Chinese renewable energy politics. Energy Policy, 99, 120-131.

CBAD. (2021). Case Study of Solar power Poverty Alleviation. http://m.banyuetan.org/fpdxal/detail/20210426/1000200033138961619407069478366150_1.html

Cheng, C., Chen, F., Li, G., Ristić, B., Mirchi, A., Qiyu, T., & Madani, K. (2018). Reform and Renewables in China: The Architecture of Yunnan's Hydropower Dominated Electricity Market. Renewable and Sustainable Energy Reviews, 94, 682-693.

China Electric Power Knowledge Database. (2019). New installed Capacity and Power Generation in Each Province.

Chinaland. (2015). China Solar Power Incentive and Subsidy Policy Standards. http://www.chnland.com/news/zhengcewenjian/show-337.html

Chinapower: Solar Power Industry Annual Report. (2017).: http://www.chinapower.com.cn/informationzxbg/20170517/77254.html

CPGPRC. (2012). Overview of China's Energy Development in the "Eleventh Five-

DOI:10.6814/NCCU202200360

Year" Period. http://big5.www.gov.cn/gate/big5/www.gov.cn/test/201206/26/content_2169887.htm

Dazhong. (2021). Shandong's Solar power Installed Capacity Continues to Rank First in the Country. New Installed Capacity in the First Quarter Increased by 583% Year-on-year. https://news.cnstock.com/industry,rdjj-202105-4701032.htm

Ding, M., Xu, Z., Wang, W., Wang, X., Song, Y., & Chen, D. (2016). A Review on China′ s Large-scale PV Integration: Progress, Challenges and Recommendations. *Renewable and Sustainable Energy Reviews*, *53*, 639-652.

DRCG. (2018). Notice of the Development and Reform Commission of the Gansu Poverty Alleviation Office on Reporting the Implementation Plan of the Solar Power Poverty Alleviation Pilot. https://www.luoow.com/dc_tw/106702037

EnergyTrend. (2021). Gansu’s 14th Five-Year Plan: Wind-solar Installed Capacity of More Than 50 Million Kilowatts Will Account for 65% in 2025 https://www.energytrend.cn/news/20210315-93387.html

EnergyTrends. (2017). China: Grid Investment Hits a New High, and the Amount of Solar Abandonment Has Not Been Alleviated. https://www.energytrend.com.tw/news/20170321-14307713.html

EIC. (2016). China's Wind Power Is in the Dilemma of Wind Curtailment Rate

Energy Trend. (2017) Several Advantages in Poverty Alleviation with Solar Power Policy. https://www.energytrend.com.tw/features/20170317-14307698.html

EnergyTrend. (2012). Gansu's "Twelfth Five-Year" Solar Power Development "Big

DOI:10.6814/NCCU202200360

Ambition" Plan Installed Capacity Accounted for One-third in China. http://guangfu.bjx.com.cn/news/20121123/403665.shtml

Energy Trend Database. (2018). Solar Radiation Distribution in China: https://www.energytrend.cn/knowledge/20180409-27769.htm

Fang, Y., & Wei, Y. (2013). Climate Change Adaptation on the Qinghai–Tibetan Plateau: The Importance of Solar Energy Utilization for Rural Household. Renewable and Sustainable Energy Reviews, 18, 508-518.

Finance Sina. (2015) Major Agriculture Province in China. The Province with Great Population like Shandong Come to the Top: http://finance.sina.com.cn/china/20150812/012922938906.shtml

Fang, Y., & Wei, Y. (2013). Climate Change Adaptation on the Qinghai–Tibetan Plateau: The Importance of Solar Energy Utilization for Rural Household. Renewable and Sustainable Energy Reviews, 18, 508-518.

F. China. (2018). The First Batch of Village-level Solar Power Poverty Alleviation Power Stations in Gansu Province during the 13th Five-Year Plan Period Achieved Grid-connected Power Generation. http://f.china.com.cn/2018-07/16/content_57296408.htm

Flynn, A., & Yu, L. (2020). The Protean Environmental State in Dongguan: Reconceptualizing the local state and ecological development in China. Environment and Planning C: Politics and Space, 38(3), 443-463.

Flynn, A., Xie, L., & Hacking, N. (2020). Governing People, Governing Places: Advancing the Protean Environmental State in China. Journal of Environmental Policy & Planning, 22(5), 724-744.

DOI:10.6814/NCCU202200360

Geall, S., & Shen, W. (2018). Solar Energy for Poverty Alleviation in China: State Ambitions, Bureaucratic interests, and local realities. Energy Research & Social Science, 41, 238-248.

Gansugov. (2018). The Notice of "Gansu Province Solar Power Poverty Alleviation Implementation Rules" http://www.gansu.gov.cn/art/2018/7/19/art_4786_387698.html

Geall, S., & Shen, W. (2018). Solar Energy for Poverty Alleviation in China: State Ambitions, Bureaucratic Interests, and Local Realities. Energy Research & Social Science, 41, 238-248.

Guo, Xiao-lin (2001). "Land Expropriation and Rural Conflicts in China." The China Quarterly, Vol. 166:422-439.

Guanfu. (2020). The Current Development of Solar Development in China. http://guangfu.bjx.com.cn/news/20200210/1041073.shtml).

Habich, S. (2015). Dams, Migration and Authoritarianism in China: The Local State in Yunnan. Routledge.

Han, J., Mol, A. P., Lu, Y., & Zhang, L. (2009). Onshore Wind Power Development in China: Challenges behind A Successful Story. Energy Policy, 37(8), 2941-2951.

Hang, Q., Jun, Z., Xiao, Y., & Junkui, C. (2008). Prospect of Concentrating Solar Power in China—the Sustainable Future. Renewable and Sustainable Energy Reviews, 12(9), 2505-2514.

Hennig, T., & Harlan, T. (2018). Shades of Green Energy: Geographies of Small

DOI:10.6814/NCCU202200360

Hydropower in Yunnan, China and the Challenges of Over-development. Global Environmental Change, 49, 116-128.

Hsing, You-tien (2010). The Great Urban Transformation: Politics and Property in China. New York: Oxford University Press.

Howes, M., Wortley, L., Potts, R., Dedekorkut-Howes, A., Serrao-Neumann, S., Davidson, J., ... & Nunn, P. (2017). Environmental sustainability: a case of policy implementation failure?. Sustainability, 9(2), 165.

Ho, P., & Edmonds, R. (Eds.). (2007). China's Embedded Activism: Opportunities and Constraints of a Social Movement. Routledge.

IN-EN. (2020). Research on the Status Quo and Related Development of Solar power Poverty Alleviation Industry in Gansu Province. https://www.in-en.com/finance/html/energy-2244236.shtml

IN-EN. (2020). The Status Quo and Related Development of Solar Power Poverty Alleviation Industry in Gansu Province. https://www.in-en.com/finance/html/energy-2244236.shtml

IN-EN. (2020). State Grid Shandong Electric Power Actively Carries out Solar power Poverty Alleviation Work. https://solar.in-en.com/html/solar-2368024.shtml

IN-EN. (2021). Gansu: A ten-year breakthrough in a province with great scenery

ITRI. (2016). Energy Development in 13th FYP https://km.twenergy.org.tw/Data/share?hkY9a72NxaV5I9DAf1g5sA==

Kostka, Genia & Hobbs, William (2012). Local Energy Efficiency Policy

DOI:10.6814/NCCU202200360

Implementation in China: Bridging the Gap Between National Priorities and Local Interests. The China Quarterly, 211, 765–785.doi:10.1017/S0305741012000860

Kostka, G. (2016). Command without Control: The Case of China's Environmental Target System. Regulation & Governance, 10(1), 58-74.

Lang, G., & Xu, Y. (2013). Anti-incinerator Campaigns and the Evolution of Protest Politics in China. Environmental Politics, 22(5), 832-848.

Li, Q., Zhou, L., Liu, Q., Zhang, F., & Wu, J. (2008). Simulative Research of MPPT for Solar Power system [J]. Electric Power Automation Equipment, 7, 008.

Li, R., & Li, G. M. (2008). Solar Power Generation Output Forecasting Based on Support Vector Machine Regression Technique. Electric Power, 2, 031. ISO 690

Liang, J., & Langbein, L. (2015). Performance Management, High-powered Incentives, and Environmental Policies in China. International Public Management Journal, 18(3), 346-385. ISO 690

Liu, L., de Jong, M., & Huang, Y. (2016). Assessing the Administrative Practice of Environmental Protection Performance Evaluation in China: the Case of Shenzhen. Journal of Cleaner Production, 134, 51-60.

Liu, S., Yang, Q., Cai, H., Yan, M., Zhang, M., Wu, D., & Xie, M. (2019). Market Reform of Yunnan Electricity in Southwestern China: Practice, Challenges and Implications. Renewable and Sustainable Energy Reviews, 113, 109265.

Lieberthal, Kenneth G. (1992). “Introduction: The ‘Fragmented Authoritarianism’ Model and Its Limitations.” In Bureaucracy, Politics, and Decision Making in

DOI:10.6814/NCCU202200360

Post-Mao China. (Eds.) Kenneth Lieberthal and David Lampton. Berkeley and Los Angeles: University of California Press.

Lin, N. (1995). Local Market Socialism: Local Corporatism in Action in Rural China. Theory and Society, 24(3), 301-354.

Liu, L. Q., & Wang, Z. X. (2009). The Development and Application Practice of Wind–solar Energy Hybrid Generation Systems in China. Renewable and Sustainable Energy Reviews, 13(6-7), 1504-1512.

Li, Y. W., Miao, B., & Lang, G. (2011). The Local Environmental State in China: A Study of County-level Cities in Suzhou. The China Quarterly, 115-132.

Li, X., Yang, X., Wei, Q., & Zhang, B. (2019). Authoritarian Environmentalism and Environmental Policy Implementation in China. Resources, Conservation and Recycling, 145, 86-93.

Lang, G., & Xu, Y. (2013). Anti-incinerator Campaigns and the Evolution of Protest Politics in China. Environmental Politics, 22(5), 832-848.

Liu, S., Yang, Q., Cai, H., Yan, M., Zhang, M., Wu, D., & Xie, M. (2019). Market Reform of Yunnan Electricity in Southwestern China: Practice, Challenges and Implications. Renewable and Sustainable Energy Reviews, 113, 109265.

Lieberthal, Kenneth G. (1992). “Introduction: The ‘Fragmented Authoritarianism’ Model and Its Limitations.” In Bureaucracy, Politics, and Decision Making in Post-Mao China. (Eds.) Kenneth Lieberthal and David Lampton. Berkeley and Los Angeles: University of California Press.

Lin, N. (1995). Local <arket socialism: Local Corporatism in Action in Rural China. Theory and Society, 24(3), 301-354.

DOI:10.6814/NCCU202200360

Liu, L. Q., & Wang, Z. X. (2009). The Development and Application Practice of Wind–solar Energy Hybrid Generation Systems in China. Renewable and Sustainable Energy Reviews, 13(6-7), 1504-1512.

Li, Y. W., Miao, B., & Lang, G. (2011). The Local Environmental State in China: a Study of County-level Cities in Suzhou. The China Quarterly, 115-132.

Li, X., Yang, X., Wei, Q., & Zhang, B. (2019). Authoritarian Environmentalism and Environmental Policy Implementation in China. Resources, Conservation and Recycling, 145, 86-93.

Lo, K. (2015). How Authoritarian Is the Environmental Governance of China?. Environmental Science & Policy, 54, 152-159.

Ma, L., & Liang, J. (2018). The Effects of Firm Ownership and Affiliation on Government's Target Setting on Energy Conservation in China. Journal of Cleaner Production, 199, 459-465. ISO 690

Mai, H. (2016). Research on Applications of Solar Power in Countryside. ISO 690

Mori, A. (2011). Overcoming Barriers to effective environmental aid: a comparison between Japan, Germany, Denmark, and the World Bank. The Journal of Environment & Development, 20(1), 3-26.

Mertha, Andrew C. (2009). "Fragmented Authoritarianism 2.0': Political Pluralization in the Chinese Policy Process." China Quarterly 200: 995-1012

New http://www.newenergy.org.cn/fn/fndt/201606/t20160603_337901.html

National Energy Administration. (2016). 2016 Implementation on Grid-Connected Wind Power Generation. www.nea.gov.cn/2017-01/26/c_136014615.htm.

National Energy Administration. (2016). The Increased Wind Curtailment Rate Was

DOI:10.6814/NCCU202200360

As High As 21%. http://finance.sina.com.cn/roll/2016-07-28/docifxunyya2505920.shtml

NDRC (National Development and Reform Commission). (2016). 13th Five Year Plan For Western Development. http://www.ndrc.gov.cn/zcfb/zcfbtz/201701/W020170123326950412269.pdf

National Science and Technology Commission "New Energy and Renewable Energy Development Outline (1996-2010)" Chinese State Council. (2020). "China's Energy Development in the New Era" White Paper

NEA (National Energy Association). (2011): 12th Five Year Plan on Solar Power Generation Development: https://goo.gl/Yzvs8N

Newsinen. (2017). Ranking of Installed Power Station in Solar Power of China Provinces (Power Station + Dispersed Generation System): http://www.in-en.com/article/html/energy-2259260.shtml

NEA (National Energy Association). (2011). China PV Development for 12th FYP. http://zfxxgk.nea.gov.cn/auto87/201209/P020120912536329466033.pdf

NEA. (2012). The Twelfth Five-Year Plan for Solar Power Development. https://policy.asiapacificenergy.org/sites/default/files/Solar%20Power%20Development%2012th%20FYP.pdf

NEA. (2016). The 13th Five-Year Plan for Solar Energy Development. https://policy.asiapacificenergy.org/sites/default/files/IEA_PAMS_China_China13thSolarEnergyDevelopmentFiveYearPlan20162020.pdf

Ockwell, D., Newell, P., Geall, S., Mbeva, K., Shen, W., & Ely, A. (2017). The

DOI:10.6814/NCCU202200360

Political Economy of State-led Energy Transformations: Lessons from Solar PV in Kenya and China.

Oi, J. C. (1992). Fiscal Reform and the Economic Foundations of Local State Corporatism in China. World Politics, 45(1), 99-126.

Oi, J. C. (1995). The Role of the Local State in China's Transitional Economy. The China Quarterly, 144, 1132-1149.

Otsuka, K. (2007). Environmental Policy under Multi-stakeholder Governance in China: Focusing on Implementation of Industrial Pollution Control. In Development of Environmental Policy in Japan and Asian Countries (pp. 199-226). Palgrave Macmillan, London.

Peidong, Z., Yanli, Y., Yonghong, Z., Lisheng, W., & Xinrong, L. (2009). Opportunities and Challenges for Renewable Energy Policy in China. Renewable and Sustainable Energy Reviews, 13(2), 439-449.

People. (2018). State Grid Assists Gansu's Wind Curtailment Rate "Double Drop" Year-on-year. http://energy.people.com.cn/BIG5/n1/2018/0727/c71661-30172668.html

People. (2020). A Total of 1.26 million Kilowatts of Solar Power Poverty Alleviation Projects in Gansu Have Been Connected to the Grid. http://gs.people.com.cn/BIG5/n2/2020/0806/c183348-34210002.html

People. (2020). Solar Power Poverty Alleviation and People's Livelihood, Plant a "Sun" and Run for a Well-off. http://gs.people.com.cn/BIG5/n2/2020/1015/c221817-34351295.html

Qian, Y., Wang, W., Leung, L. R., & Kaiser, D. P. (2007). Variability of Solar

DOI:10.6814/NCCU202200360

Radiation under Cloud-free Skies in China: The Role of Aerosols. Geophysical Research Letters, 34(12).

Qian, K., Zhou, C., Yuan, Y., Shi, X., & Allan, M. (2008, July). Analysis of the Environmental Benefits of dispersed generation. In Power and Energy Society General Meeting-Conversion and Delivery of Electrical Energy in the 21st Century, 2008 IEEE (pp. 1-5). IEEE.

Qian, Y., Wang, W., Leung, L. R., & Kaiser, D. P. (2007). Variability of Solar Radiation under Cloud-free Skies in China: The Role of Aerosols. Geophysical Research Letters, 34(12).

Qian, K., Zhou, C., Yuan, Y., Shi, X., & Allan, M. (2008, July). Analysis of the Environmental Benefits of Dispersed Generation. In Power and Energy Society General Meeting-Conversion and Delivery of Electrical Energy in the 21st Century, 2008 IEEE (pp. 1-5). IEEE.

Ramos, A., Chatzopoulou, M. A., Guarracino, I., Freeman, J., & Markides, C. N. (2017). Hybrid Solar Power-thermal Solar Systems for Combined Heating, Cooling and Power Provision in the Urban Environment. Energy Conversion and Management, 150, 838-850. ISO 690.

Rousseau, J. F. (2017). Does Carbon Finance Make a Sustainable Difference? Hydropower Expansion and Livelihood Trade-offs in the Red River Valley, Yunnan Province, China. Singapore Journal of Tropical Geography, 38(1), 90-107.

Sheikh, N. J., Kocaoglu, D. F., & Lutzenhiser, L. (2016). Social and Political Impacts

DOI:10.6814/NCCU202200360

of Renewable Energy: Literature Review. Technological Forecasting and Social Change, 108, 102-110. ISO 690

State Council of People's Republic of China. (2005): http://www.gov.cn/ziliao/flfg/2005-06/21/content_8275.htm.

Solar of Week. (2016). Do You Remember the 30 Dispersed Solar Power Generation Systems? https://solar.ofweek.com/2016-01/ART-260009-8500-29055764.html)

Solar of the Week. (2016). Solar Power Greenhouse in Qingdao Serves as National Sample: https://kknews.cc/finance/vzrvvq.html

Solarbe. (2016). Provincial Subsidy for Solar Power Generation. Shandong Government Confirmed to Continue this Policy: https://news.solarbe.com/201609/09/102486.html

Solarbe. (2018). Supplementary of Agriculture and Solar Power + Solar power Village+ Combination between Solar Power and Industrial Development: the Comprehensive Model in Weifang, Shandong: https://news.solarbe.com/201808/17/294710.html

Solarbe. (2018). Solar Power Development in Anqiu: https://news.solarbe.com/201808/17/294710.html)

Solarbe. (2018). Gansu Solar Power Station Suffered a Serious Loss. https://www.solarbe.com

Solarbe. (2020). Gansu 2021 Key Power Transmission and Transformation Project Starts. https://m.solarbe.com/21-0-332042-1.html

State Grid Co. (2020). Gansu Power Grid's Load Power Has Repeatedly Hit New

DOI:10.6814/NCCU202200360

Highs, and the Increase in Power Sales Ranks First on the State Grid. https://power.in-en.com/html/power-2380085.shtml

Teets, J. C. (2013). Let Many Civil Societies Bloom: The Rise of Consultative Authoritarianism in China. The China Quarterly, 19-38.

Tracy, E. F., Shvarts, E., Simonov, E., & Babenko, M. (2017). China's New Eurasian Ambitions: the Environmental Risks of the Silk Road Economic Belt. Eurasian Geography and Economics, 58(1), 56-88.

Wilmsen, B., & Van Hulten, A. (2017). Following Resettled People Over Time: the Value of Longitudinal Data Collection for Understanding the Livelihood Impacts of the Three Gorges Dam, China. Impact Assessment and Project Appraisal, 35(1), 94-105.

Wang, Q. (2010). Effective Policies for Renewable Energy—the Example of China's Wind Power—Lessons for China's Solar Power. Renewable and Sustainable Energy Reviews, 14(2), 702-712.

Walder, A. G. (1995). Local Governments as Industrial Firms: An Organizational Analysis of China's Transitional Economy. American Journal of Sociology, 101(2), 263-301.

Wang, J.-H., Tseng, S.-W., and Zheng, H. (2015). "The Paradox of Small Hydropower: Local Government and Environmental Governance in China," Journal of Developmental Studies, 51(11) (November), 1475-1487

Wang Lei. (2020). Review and Prospect of New Energy Industry Development. China Development Observation.

World Bank Group. 2011. Direct Normal Irradiation in China

DOI:10.6814/NCCU202200360

https://www.energytrend.com.tw/research/20110325-1490.html

Xingang, Z., Xiaomeng, L., Pingkuo, L., & Tiantian, F. (2011). The Mechanism and Policy on the Electricity Price of Renewable Energy in China. Renewable and Sustainable Energy Reviews, 15(9), 4302-4309.

Zhang, S., Zhao, X., Andrews-Speed, P., & He, Y. (2013). The Development Trajectories of Wind Power and Solar PV Power in China: A Comparison and Policy Recommendations. Renewable and Sustainable Energy Reviews, 26, 322-331.

Zhang, S., Andrews-Speed, P., & Ji, M. (2014). The Erratic Path of the Low-carbon Transition in China: Evolution of Solar PV Policy. *Energy Policy*, *67*, 903-912.

Zhang, M., Zhou, D., & Zhou, P. (2014). A Real Option Model for Renewable Energy Policy Evaluation with Application to Solar PV Power Generation in China. Renewable and Sustainable Energy Reviews, 40, 944-955.

Zhang, F., Deng, H., Margolis, R., & Su, J. (2015). Analysis of Dispersed-generation Solar Power Deployment, Installation Time and Cost, Market Barriers, and Policies in China. *Energy Policy*, *81*, 43-55.

Zhang, S. (2016). Analysis of DSPV (Dispersed solar PV) Power Policy in China. Energy, 98, 92-100. ISO 690

Zhao, X., Zeng, Y., & Zhao, D. (2015). Dispersed Solar Powers in China: Policies and Economic Performance. Energy, 88, 572-583.

Zhu, Y., (2012). Policy Entrepreneur, Civic Engagement and Local Policy Innovation in China: Housing Monetarization Reform in Guizhou Province. Australian Journal of Public Administration, 71(2), 191-200.

DOI:10.6814/NCCU202200360

Zhou Fengqi, Wang Qingyi. (2002). "50 Years of Energy in China", China Electric Power Press.

Zhang, S., Zhao, X., Andrews-Speed, P., & He, Y. (2013). The development Trajectories of Wind Power and Solar PV Power in China: A Comparison and Policy Recommendations. Renewable and Sustainable Energy Reviews, 26, 322-331.

Zhang, M., Zhou, D., & Zhou, P. (2014). A Real Option Model for renewable energy policy evaluation with application to solar PV power generation in China. Renewable and Sustainable Energy Reviews, 40, 944-955

Zhao, X., Zeng, Y., & Zhao, D. (2015). Dispersed Solar Powers in China: Policies and Economic Performance. Energy, 88, 572-583.

Zhang, F., Deng, H., Margolis, R., & Su, J. (2015). Analysis of Dispersed-generation Solar Power Deployment, Installation Time and Cost, Market Barriers, and Policies in China. Energy Policy, 81, 43-55.

Zhang, S. (2016). Analysis of DSPV (dispersed Solar PV) Power Policy in China. Energy, 98, 92-100. ISO 690

Zhang, O., Yu, S., & Liu, P. (2015). Development Mode for Renewable Energy Power in China: Electricity Pool and Dispersed Generation Units. Renewable and Sustainable Energy Reviews, 44, 657-668. ISO 690

Zhu, Jie-ming (2004). “Local Developmental State and Order in China’s Urban Development during Transition.” International. Journal of Urban and Regional Research, Vol. 28 No. 2: 424-447.

DOI:10.6814/NCCU202200360