

# Research on the Impact of Policy Subsidies on the Development of Photovoltaic Industry

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**Abstract.** This paper takes China's photovoltaic industry as the core issue, and deeply discusses how policy subsidies have a profound impact on the rise and growth of the industry. First, the article clearly defines the concept of policy subsidies, and divides its various types in detail, and builds the basic framework for readers to understand the subsidy mechanism. Subsequently, through a comprehensive review of the history of China's photovoltaic industry policy subsidies, it reveals the three key stages of the initial exploration, rapid expansion and current optimization and upgrading of the industrial development. The analysis process pointed out that although the policy subsidies in different stages caused some problems such as overcapacity, dependence, but its core role is to greatly promote the photovoltaic industry's technological progress and market expansion, so that China quickly jumped to the global photovoltaic field leader. At the end of the article, it puts forward strategic suggestions such as improving the subsidy policy system, strengthening the supervision evaluation and incentive mechanism, to further stimulate the technological innovation ability of the photovoltaic industry, accelerate the optimization and upgrading of the industrial structure, and lay a solid foundation for the long-term sustainable development of the photovoltaic industry.

**Keywords:** PV industry, policy subsidies, industrial development.

## 1. Introduction

With the increasingly severe greenhouse effect and the reduction of fossil fuel resources, the development and utilization of renewable energy has become an indispensable part of global energy development. In June 2024, the Energy Institute (EI) of the United Kingdom released the Statistical Review of World Energy 2024, which pointed out that China has achieved remarkable results in adjusting its energy structure. In addition, the report explains that the Chinese government had actively pushed forward the adjustment of the energy structure and increased its efforts to develop and utilize clean energy. According to the data from the Statistical Review of World Energy 2024, in 2023, the world's solar energy increased by 346 GW, of which a quarter came from China, and wind energy will increase by 115 GW, with China accounting for about 66% of the new installed capacity. On this basis, China is in a leading position in nuclear power projects. In 2020, China proposed the goals of "carbon peak" and "carbon neutrality". Since then, the Chinese government has further strengthened its support for green development and renewable energy. Photovoltaic energy is a sustainable renewable energy with almost no negative impact on the environment, low maintenance cost of collection equipment, and long service life. Photovoltaic energy is of great significance for reducing carbon emissions, responding to climate change, and achieving dual carbon goals.

Because the market has problems such as imperfection, asymmetric information flow, and external spillover in the process of development, there are many problems in market regulation and even uncontrollable phenomena. Therefore, government intervention policies came into being to solve these problems [1]. The Chinese government has promulgated several policies to foster the development of the photovoltaic industry. Government subsidies are of inalienable significance in the evolution of the photovoltaic industry. In the nascent stages of the PV industry's growth, there were substantial investment risks because of the immature PV industry's rudimentary technology and exorbitant costs. Government subsidies provide companies with certain economic guarantees, which can reduce investors' investment costs and thus increase investors' investment enthusiasm [2]. They have attracted many companies and funds to enter the PV industry, enabling the PV industry to

expand rapidly in a short period and form a complete industrial chain. Tong Guangrong and Gao Jie found that fiscal subsidies can induce companies to invest in research and development [3]. After companies obtain policy subsidies, they occupy a dominant position in the market and will invest the subsidy funds in technology research and development, which will promote the technological progress of the PV industry. Policy subsidies can also encourage enterprises to cooperate with scientific research institutions, universities, etc. Scientific research institutions and universities are responsible for providing scientific research results, while enterprises transform scientific research results into actual products and technologies, thus improving the technical level and innovation ability of the PV industry.

This article mainly explores the impact of government policy subsidies on the development of the PV industry. This article is divided into three parts. The first part explores the status of policy subsidies for Chinese PV industry. The second part analyzes the impact of policy subsidies on the development of the PV industry. The third part expounds on the policy suggestions for the development of the PV industry.

## **2. Overview of Policy Subsidies**

### **2.1. Definition and Classification of Policy Subsidies**

Fiscal subsidies refer to a type of subsidy provided by the government to enterprises or individuals for designated matters by special funds arranged by the government to achieve specific political and economic goals. According to the classification of the objects of subsidies, they can be divided into enterprise subsidies and personal subsidies. Among them, enterprise subsidies are divided into qualification certification subsidies, equipment subsidies, research and development subsidies, loan interest subsidies, employment subsidies, etc. according to the size of the subsidized enterprises and the purpose of using subsidies. At present, China's subsidies for the PV industry mainly include investment subsidies, research and development subsidies, and consumption subsidies.

### **2.2. Overview of Chinese PV industry Policy Subsidies**

China's policy subsidies for the PV industry can be traced back to 2010. China is facing limited reserves of traditional fossil energy and a high energy demand. The long-term use of traditional fossil fuels has brought about environmental pollution, greenhouse gas emissions, and other problems, which have put enormous pressure on China's ecological environment and are very detrimental to sustainable development. Therefore, the development of renewable energy has become an inevitable choice to achieve sustainable energy supply and reduce dependence on traditional fossil energy. China has provided a series of subsidies that are conducive to renewable energy, and policy subsidies for the PV industry are also among them. The Notice on Strengthening the Construction Management of the Golden Sun Demonstration Project and Solar Photovoltaic Building Application Demonstration Project mentioned that the subsidy ratio for user-measured PV power generation projects in 2010 is temporarily set at 50%, and the subsidy ratio for independent PV power generation projects in remote areas without electricity is 70% [4]. First, the direct purpose of the policy subsidies for the PV industry is to attract enterprises and social capital to invest in PV project construction through policy subsidies, and thereby rapidly expand the scale of the PV industry, encourage enterprises to increase R&D investment, improve the quality and performance of PV products, narrow the gap between Chinese PV industry and the international advanced level, and increase Chinese PV industry's share in the global market.

Until 2016, Chinese PV industry had acquired a preponderant position within the global photovoltaic domain. In 2016, China's polysilicon production reached 194,000 tons, with a year - on - year growth ratio of 17.5%. The production of silicon wafers was approximately 63 gigawatts, signifying a year - on - year accumulation rate of 31.2%. Additionally, the production of PV cells was about 49 gigawatts, manifesting a year - on - year expansion percentage of 20.7%. In 2021, the Chinese government promulgated the "Notice on Matters Related to the 2021 New Energy Grid -

connected Electricity Price Policy", stipulating that the central government would halt subsidies for newly - registered centralized PV power stations and industrial and commercial distributed PV projects and implement grid - connected electricity at parity. China has metamorphosed into the world's largest manufacturer of PV products, with the production scale of each link in the industrial chain ranking foremost globally. Nevertheless, subsidy policies persist in certain localities. For example, Beijing announced the first batch of distributed PV projects in 2021. The relevant projects will receive a subsidy of 0.3 yuan / kWh or 0.4 yuan / kWh according to power generation for five years. Its objective is to achieve grid - connected electricity at parity, gradually diminish the PV industry's dependence on policy subsidies, promote the reduction of PV power generation costs, augment the proportion of PV power generation in China's energy structure, optimize the energy structure, and establish the foundation for achieving energy transformation and the goals of "carbon peak" and "carbon neutrality". Through continuous policy support and industrial development, Chinese PV industry will hold a leading position globally and contribute to global energy transformation and climate change mitigation.

To date, China has emerged as the world's largest purveyor of PV products. In 2023, China's exports of PV products are characterized by: silicon wafers at 70.3 GW, with a year - on - year increment surpassing 93.6%; battery exports at 39.3 GW, with a year - on - year augmentation of 65.5%; and module exports at 211.7 GW, with a year - on - year growth of 37.9%. Chinese PV industry is at the vanguard of the world in terms of technology, encompassing PV cell conversion efficiency, module lightweighting, equipment concordance, and system integration. Chinese firms are vigorously engaged in formulating international standards and perpetually augmenting their clout in the international PV technology arena. Chinese enterprises also enthusiastically participate in the construction of international PV projects, collaborate with companies and governments of other nations, and jointly undertake research and development of the global PV industry. For example, under the "Belt and Road Initiative", Chinese companies have erected a multitude of PV power station projects in the countries along the Belt and Road, contributing to local energy provision and economic development.

### **2.3. Review of the Development of Chinese PV Industry**

The development of Chinese PV industry can be divided into three important stages, namely the initial stage, the rapid development stage, and the international competition and adjustment stage.

#### **2.3.1. Initial stage**

To solve the problem of increasingly depleted fossil fuel resources, China followed the development trend of renewable energy. In 1958, China successfully manufactured the first monocrystalline silicon. During the period from 1958 to 1975, China successfully developed satellite solar panels, solar cell arrays, and corresponding surface versions, laying the foundation for China to successfully build PV power stations and become a major exporter of PV products. Since China built a 10kWp village-level solar PV power station in 1983, the Chinese government began to pay attention to solar power generation in 1998. In 1999, Baoding Yingli undertook China's first annual production of 3MW polycrystalline silicon cells and application system industrialization demonstration project, filling the gap in the commercial production of solar cells.

#### **2.3.2. Rapid development stage**

Since 2000, the Chinese government has launched a series of support projects, such as power - to - village transmission and bright - lighting projects, to encourage enterprises to invest in the PV industry and promote the growth of Chinese PV industry. In 2004, Germany revised the Renewable Energy Law, which brought international market demand to Chinese PV industry and provided a solid foundation for China to become the world's largest PV manufacturer and for the Chinese government to carry out the "Golden Sun Project" and "PV Building Application Demonstration" projects.

### **2.3.3. Initial Subsidy Period (March 2009-June 2013)**

With the aim of accelerating the exploration of China's PV application market and promoting the development of Chinese PV industry, the Chinese government promulgated the "Opinions on Accelerating the Application of Solar PV Buildings" in March 2009, which quickened the application of the PV industry in the construction field. In July 2009, the "Notice on the Implementation of the Golden Sun Demonstration Project" was issued, and China began to promote the "Golden Sun Project". China's PV application market was opened due to the successful implementation of these two projects. on this basis, from 2009 to 2012, corresponding policies were issued according to the construction of PV power stations in previous years to standardize the requirements for receiving subsidies. However, because the subsidy policy during this period adopted the form of initial subsidy, the subsidy focus was on the preliminary work of PV power station construction, ignoring the grid connection and acceptance work after the completion of the power station construction, resulting in frequent fraudulent subsidies, and the quality of some power plants did not meet the standards, failing to meet the expectations of building PV power plants. The "Notice on the Liquidation of Financial Subsidy Funds for the Golden Sun Demonstration Project" issued in June 2013 officially ended the initial installation subsidy period of the PV industry subsidy.

### **2.3.4. Electricity subsidy period (August 201- May 2018)**

In July 2013, the Chinese government proposed "Several Opinions on Promoting the Healthy Development of the PV industry", which expounded the necessities of further expanding the Chinese PV application market, enhancing the PV technology level, and speeding up the transformation and upgrading of the PV industry. The Notice on Leveraging Price to Promote the Healthy Development of the PV industry, released in August 2013, formally commenced the subsidy period for electricity consumption in Chinese PV industry. This policy classifies China's solar energy resources into three kinds according to the construction costs of PV power plants and solar energy resources in various regions of China and stipulates diverse on - grid electricity prices. During this period, Chinese PV industry developed stably and speedily.

### **2.3.5. Bidding Subsidy Period (May 2018-Present)**

In May 2018, the Chinese government issued the "Notice on Matters Related to PV Power Generation in 2018", which strictly restricted the scale of new PV installations and stipulated that many PV projects in the second half of 2018 would no longer enjoy state subsidies. This caused many companies to fall from full of hope for the future to facing a life-and-death crisis. It was not until November 2018 that Chinese PV companies finally overcame the difficulties. The "Notice on Issues Related to Improving the PV Power Generation Grid-connected Electricity Price Mechanism" issued in 2019 included centralized power stations and industrial and commercial distributed power stations into the subsidy scope based on the actual situation, adopting a market bidding model based on not exceeding the guidance price, and household distributed and PV poverty alleviation projects will still be carried out according to the original subsidy method.

### **2.3.6. Review of the Development of Chinese PV industry Policy Subsidy**

With the development of the PV industry, Chinese PV industry policy subsidies can also be divided into three important periods: the initial installation subsidy period, the kilowatt-hour subsidy period, and the bidding subsidy period [5].

## **3. Analysis of the Impact of Policy Subsidies on the Development of the Pv Industry**

The impact of policy subsidies on Chinese PV industry during the initial installation subsidy period was mainly reflected in opening China's PV application market, attracting private capital to participate in the development of Chinese PV industry, and laying a corporate foundation for the rapid development of Chinese PV industry. At the same time, it also reduced the cost of power generation

and solved the problem of electricity use in areas without electricity. However, due to the shortcomings in policy design and the imperfection of supporting facilities and related policies, problems such as substandard power station quality and insurance fraud have occurred. The impact of policy subsidies on Chinese PV industry during the kilowatt-hour subsidy period was mainly reflected in the rapid growth of China's PV application market, the improvement of PV industry concentration, and the reduction of power generation costs and grid-connected electricity prices. Although the problems that occurred during the kilowatt-hour subsidy period have been improved through policy adjustments, problems such as abandoned PV and power rationing, subsidy arrears, and poor quality of some power stations have reappeared. During the competitive bidding subsidy period, the impact of policy subsidies on Chinese PV industry was mainly manifested in decelerating the growth rate of the subsidy gap and curtailing power generation costs and grid-connected electricity prices during the kilowatt-hour subsidy period. Since the 531 new policy and the competitive bidding subsidy policy came suddenly and the adjustment range was large, there was no appropriate buffer period for PV companies, which had a great impact on Chinese PV industry [5].

In general, throughout the three periods, policy subsidies were generally favorable and vigorous for the development of Chinese PV industry. Although certain issues existed, they did not invalidate the fact that policy subsidies enabled Chinese PV industry to prosper into a global leader. Policy subsidies have played a crucial role in impelling the development of Chinese PV industry and have affected the future developmental course of Chinese PV industry.

#### **4. Policy Recommendations**

By summarizing the impact of policy subsidies on the PV industry at different stages, it can be found that even though the policy subsidies implemented by China at various stages have caused some negative effects, in general, China's subsidy policies at various periods have been successful. The PV subsidy policies at various periods have achieved their policy goals. Therefore, China should improve the subsidy policy system based on adhering to the current PV policy subsidies, improve the accuracy and effectiveness of the policy, and strengthen the supervision and evaluation of the PV industry, such as establishing and improving the PV project grid-connected supervision system and raising the renewable energy surcharge standard. At the same time, it is also necessary to ensure the efficient use of subsidy funds to promote PV industry technology innovation and industrial structure upgrading and get closer to grid parity. For this, grid parity demonstration projects can be established and subsidy policy formulation can be further market-oriented. In addition, people must learn from the lessons of the 531 new policy and the bidding subsidy policy to steadily promote the decline of PV subsidy policies, moderately slow down the decline of PV subsidies, and leave a buffer and adaptation period for enterprises.

#### **5. Conclusion**

This paper initiates from the effect of policy subsidies on Chinese PV industry and analyzes the influence of policy subsidies on the development of the PV industry. Initially, relevant theoretical literature is collated and the concept of policy subsidies is defined. Subsequently, the policy subsidies for Chinese PV industry are recapitulated. Thereafter, the development history of Chinese PV industry and the development history of policy subsidies for Chinese PV industry are sorted, and the impact of policy subsidies on the development of Chinese PV industry is analyzed. Eventually, it is found that policy subsidies have founded the basis for the development of the PV industry, attracted private capital, and propelled technological development and progress. Nevertheless, the defects in the design of policy subsidies and the inadequacies of supporting facilities and related policies have also resulted in issues like non-compliant quality, insurance fraud, and subsidy arrears in early PV power stations. It is believed that in the future, policies that are continuously adjusted according to actual circumstances will facilitate Chinese PV industry to enter a new stage.

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