# Overall review of feed-in tariff and renewable portfolio standard policy: A perspective of China

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**Abstract.** A major share of China's total carbon dioxide ($CO_2$) emissions is from the electric power sector. To solve this problem, Chinese government has implemented many renewable energy policies in the electric power sector. In China, the most popular renewable energy policies are Feed-in tariff (FIT) and renewable portfolio standard (RPS). This paper first introduces the current development of renewable electricity generation. Second the design plan and implement of FIT and RPS in China's thermal electricity generation sector are summarized in this paper. Third this paper establishes a complementary mode of FIT and RPS which can provide a stable environment to make the FIT and RPS work together. Finally, based on the above analysis, this paper proposes relative suggestions for the implementation of FIT and RPS in China making recommendation for the development of electricity generation from renewable energy.

## 1. Introduction

Electricity not only plays a major role in the sustainability of social but also is the important component for a country's economic development. In China, electricity consumption rose from 77.63 Mtce in 1991 to 427.37 Mtce in 2009, with an average annual growth rate of about 9.93% [1]. After rapid growth since the early 1990s, China overtook the US in 2011 as the largest electricity consumer. In 2014, thermal power account for an estimated 73% of China's electricity production, and about 90% of that thermal power was coal-fired, resulting in massive quantities of $CO_2$ emissions and great pressure to reduce it. According to the International Energy Agency, China is the world's largest producer of $CO_2$ emissions, passing the US in 2007. During the 2015 Paris United Nations Climate Change Conference, Chinese government announced that the country would decrease its $CO_2$ emissions per unit of gross domestic product (GDP) by 60% - 65% between 2005 and 2030. China also pledged to peak $CO_2$ emissions by around 2030 and try to achieve it as soon as possible. For China, this pledge meant that the Chinese government promised a maximum level of $CO_2$ emissions, and China would endeavor to control its $CO_2$ emissions and develop the renewable energy industry's scale to build a competitive renewable energy industry system. Compared with other sectors, the electric power sector is one of main sectors for the Chinese $CO_2$ emissions. In 2010, almost 40% of all $CO_2$ emissions in China are from this sector. To meet China's targets for the reduction of $CO_2$ emissions, Chinese government has begun to implement the renewable energy power generation.

It is widely known that the Chinese government has made great efforts to develop renewable energy electricity generation. Recently, China is striving to increase its investment in renewable. In 2014,

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China's investment in renewable was up to US$89.5 billion increasing almost 32% compared with the previous year. China is now the largest investor in renewable and its investment for renewable is nearly 73% more than the second largest investor, the US. Chinese government also implemented some renewable energy policies to reduce $CO_2$ emissions from its electric power sector. The development of renewable energy policies in China can be tracked back to 2004, when Chinese government announced to formulate a renewable energy policy to develop renewable energy. The renewable energy polices used in the electricity power sector can be summarized here as follows:

- Promote the implementation of FIT policy in the electricity power sector, and the Chinese government provides a fixed price based on the learning curve associated with a particular technology.
- Make clear a specific fraction of renewable generation in power.
- Government financial support for renewable energy projects.
- Encourage various demand side management (DSM) programs.

Although these renewable policies have help increase the energy efficiency of the electric generation sector, China still faces with many increasing problems in the electricity generation, such as energy security, environmental pollution. The reasons for these problems are the high generation cost, the uneven distribution resource situation and immature technologies.

The balance of this paper can be organized as follows. Section 2 presents a literature review on the renewable energy policies. Section 3 presents the current situation of renewable energy development in China's power sector. Section 4 discusses the implementation of FIT and RPS in China and presents arrangements when FIT and RPS work together. Section 5 concludes the paper.

## 2. Literature review

### *2.1. FIT*

FIT is a policy mechanism designed to encourage the generator to increase investment in renewable energy technologies. Currently, FIT is the most popular renewable energy policy in the world. FIT is account for a greater share of renewable energy development than RPS policy. In the FIT scheme, the power grid operators require to purchase electricity produced by renewable energy sources at a price determined by the regional public authorities and guaranteed for a specified period of time [2]. FIT is represented by Germany, Denmark, Spain, and China. These countries have made a great progress in renewable energy industry by implementing FIT scheme. In the European Union between 2000 and the end of 2009, more than 15,000MW of solar photovoltaic (PV) power and more than 55,000 MW of wind power has been developed under the FIT scheme [3]. In total, FIT promote approximately 75% of global PV and 45% of global wind deployment. That means that FIT can help to solve the energy security and environmental pollution at the same time.

Currently, many scholars propose that FIT is the most widely used renewable energy policy and efficient at rapidly developing the renewable energy. In the literature, some researches focus on how to design more efficient FIT mechanism. Lesser and Su propose an innovative two-part FIT which is easy to implement considering the strengths of traditional FIT and based on market mechanism [4]. del Río González P provides an overview of Spain's FIT system in the last ten years and uses a political economy approach to interpret the practical consequences of serial FIT reforms and their main design principles [5]. Couture and Gagnon present an overview of seven different FIT payment models for electricity produced by renewable energy sources and suggest that different FIT payments methods have important impacts on investor risks, and total rates of renewable energy development [6]. Sijm proposes that FIT is an effective implement to promote the development of electricity produced by the renewable energy sources in the short term but may become hard to sustain as it may suffer from some major drawbacks in the long term [7]. Sun makes a comparison between three regulation types of FIT by using a three-stage game model and assesses their differences of optimal regulated price and social welfare [8].

In fact, different countries and regions execute different types of FIT policy. In general, they can be summarized as market dependent and market-independent FIT models [6]. The market-independent

FIT which is called as fixed-price policies, because it provides a fixed or minimum price for electricity produced by renewable energy sources delivered to the grid [9,10]. Market-dependent FIT is known as premium price policy, or feed-in premiums, since additional premium payment is added on the market price [9,10]. Most countries with FIT policy select the market-independent FIT, such as Germany, Denmark and Spain. However, market-dependent FIT policy contributes to an increased integration of renewable energy source into the electricity market, resulting in a more efficient combination of electricity supply with demand [11]. Therefore, market-dependent FIT policy has been introduced in several European Union countries in the past few years, such as Czech Republic, Denmark, Germany (since 2012) and Italy. In China, power grid operators are required to purchase electricity produced by registered renewable energy sources at a fixed price set by the National Development and Reform Commission (NDRC).

*2.2. RPS*

RPS is a regulation which requires electricity supply companies to provide electricity produced by renewable energy sources, which as a percentage of total energy use, to their customers. RPS is implemented by several countries, including UK, Italy, Poland and 29 of 50 US states. Although RPS is relatively new among the renewable energy policies, it has developed rapidly in recent years. The reason is that RPS maintains an incentive for electricity supply companies to improve their renewable energy technologies and reduce generation cost, reduces the government involvement, and can help to combine the regulated market outcome with an environmental target [12-16]. The researches about the RPS policy mainly focus on renewable energy target, tradable green certificate, renewable energy technologies and the impact of RPS on the carbon emissions.

In the literature, Bird et al. examine the impacts of RPS on the US electricity sector with three different renewable energy targets [17]. UK has been a pioneer in the use of RPS with the introduction of Renewable Obligation Certificates (ROCs). In UK, the electricity supply companies require to buy ROCs with a percentage of total energy sales [18]. Berry and Jaccard think that it is a main challenge to determine the renewable energy target in RPS scheme. They suggest that during the process of setting target the government should take into consideration the impacts of renewable energy target on generation cost, electricity price and the level of competition among fuels and technologies [19].

Tradable green certificate (TGC) is a supporting policy for the RPS scheme. Renewable energy target or quota support scheme based on TGC involves a renewable energy electricity quota set by the national, regional or local government. The electricity supply companies must show that they have obtained the renewable energy quotas. The electricity supply companies either producing renewable energy electricity by themselves or buying green certificates from the other electricity providers to obtain the quotas. In different countries, TGC scheme pursue different targets. Generally, the objectives of different countries are concentrated on increasing the electricity produced by renewable energy sources, driving investment in renewable energy electricity by a cost-efficient manner, and inducing innovation and technical changes [20-23]. At present, several scholars highlight that TGC is an efficient scheme to increase the electricity produced by renewable energy sources and reduce $CO_2$ emission. Bergek and Jacobssonanalyze the outcome of the Swedish TGC system and point out that TGC is an effective scheme for increasing the supply of "green electricity" and decreasing social cost [20]. Morthorst introduces the international TGCs to an open power market and analyzes the cost effectiveness and the contribution on greenhouse gas reduction [24]. MátyáTamás et al. make a comparison between FIT and TGC about their implementation effects by using the data from the UK market, the results show that TGC is more efficient in social welfare than FIT [25].

However, implementation of TGC always faces with many problems and market risks. In addition, performance of TGC scheme suggests that not all the goals, which are made by the government and electricity supply companies, are satisfied [26-28]. Amundsen and Mortensen assess the implementation of Denmark TGC scheme and point out that an increase in the minimum requirement will result in the increase of electricity price and the decrease of total supply [29]. Lemming analyzes financial risk of TGC market from existing renewable energy sources and potential investors and points out that TGC price fluctuations are efficient in decreasing the financial risk [30]. And Nielsena

et al. point out that it is difficult to build a unified TGC market because of the different types of TGC in Europe [31,32].

As can be seen from the literature review, a lot of work has been done towards the FIT and RPS, which concentrate on the impact of FIT and RPS on economic, technology and environment. However, few studies exist for the relationship between FIT and RPS. Richkerson et al. consider that FIT and RPS can be formed to work together synergistically [33, 34]. There is no research made in-depth study on the arrangement of the implementation of FIT and RPS in developing countries. At present, China is in a critical period to reform electric system and drive investment in electricity generated by renewable energy sources. China began to use FIT in 2005 and RPS in 2007, respectively. What's effects of the implementation of FIT and RPS? Does FIT and RPS can work together in China? What's the arrangement if FIT and RPS work together in China? These problems will be discussed in the rest of this paper.

## 3. Renewable energy development in China's power sector

As China's economic development continuously growing, China's power sector develops rapidly. China has become one of the largest energy production and consumption countries [35]. Coal is the dominant fuel in China's power sector which leads to huge pressure to solve environmental problems. On March, 2016, China's thirteenth "Five-Year Plan" was approved. It is the first plan to include specific guidance on energy consumption control. In this plan, China announces that it would limit its overall energy use to 5 billion-tonne coal equivalent by 2020. It indicated that China should endeavor to develop renewable energy electricity in the next five years. At present, China already owns the largest installed capacity of wind and hydroelectric power, as well as the vast majority of solar heating and biogas installations in the worldwide. In 2013, China overtook the whole of Europe and become the largest country in installed capacity. China is also the world's leading investor in renewable energy industry.

### *3.1. Hydropower*

China is one of the world's leading investors in hydropower. At the end of 2013, China's installed hydroelectricity generating capacity is 280 gigawatt (GW) [36]. In China, almost three-quarters of the total installed renewable energy electricity are hydro. China increased 19,370 megawatt (MW) of new hydropower generating capacity which helps China's total installed capacity achieve to 320 GW in 2015.

Figure 1 shows the hydropower generating capacity in China between 2000 and 2015. Due to the implementation of effective policies, China's installed capacity of hydropower increased from 79 GW in 2000 to 320 GW in 2015. The percentage of hydropower in China's total power generation increased from 16.4% in 2000 to 17.4% in 2012, as shown in Figure 2. China has almost met the objectives about its hydropower development which is set in the twelfth "Five-Year Plan". However, the pumped storage capacity has not been developed at the same rapid rate as the traditional hydropower. In 2015, China's installed pumped storage capacity is 23 GW which is lower than the planned goal of 40 GW in the twelfth "Five-Year Plan". This means that there exists considerable developing space for China's hydropower generation. Chinese government promised that the installed capacity of hydropower would reach to 420 GW by 2020 which include 70 GW of pumped storage capacity [37].

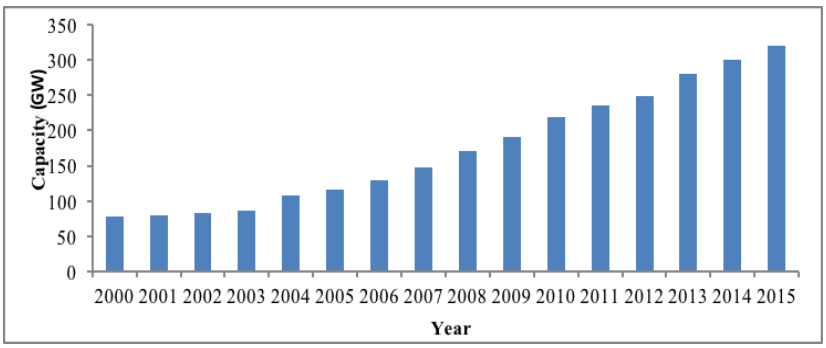

**Figure 1.** China's hydropower generating capacity from 2000 to 2015

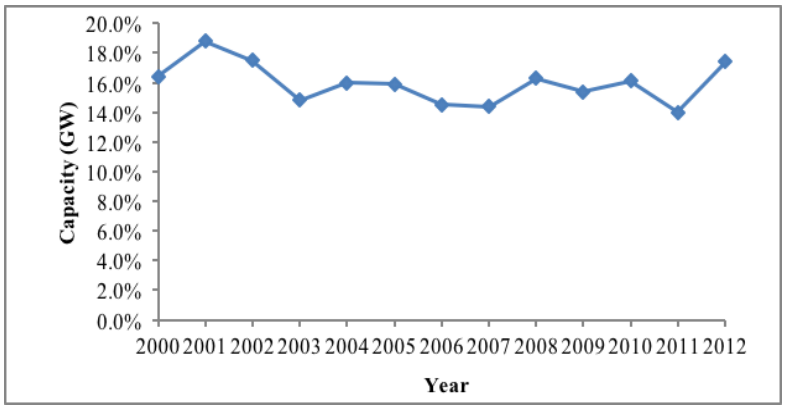


**Figure 2.** The proportion of China's hydropower from 2000 to 2012

*3.2. Wind power*

At present, China's wind energy resources can produce about 1 billion kW of wind power. However, the current exploitation of wind resource only generates 0.26 million kW [38]. This suggests there is considerable space for the wind power developing. Figure 3 shows China's on-grid wind power installed capacity between 2006 and 2012. The cumulative wind power installed capacity increased from 2.67 GW in 2006 to 62.66 GW in 2012, which is an annual growth rate of 69.2%. With the high development rate, China overtook the US and become the main user of wind energy in the world. Although the percentage of wind power in China's total electricity generation was only 2.02% in 2012, wind power had become the third largest source of Chinese electricity generation after thermal and hydro.

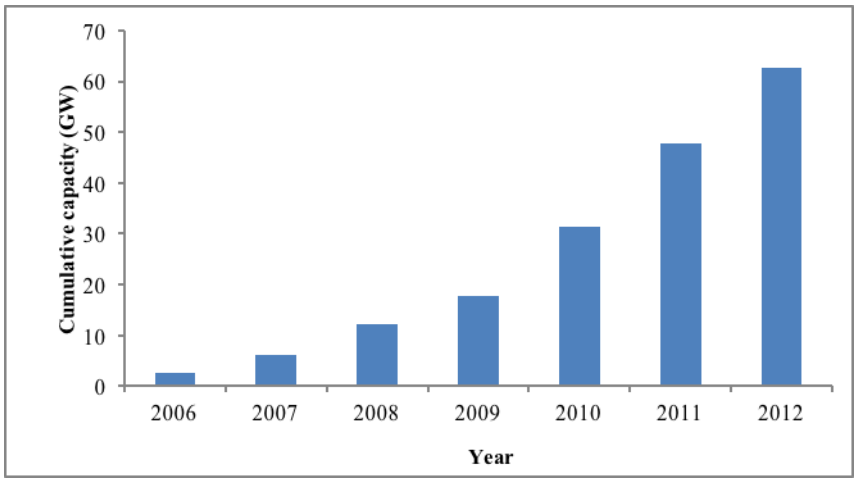


**Figure 3.** China's on-grid wind power installed capacity from 2006 to 2012

About 80% of the total wind capacity in the wind power sector is state-owned, and the state-owned wind power installed capacity reached to 50.77 GW by 2012. Sino-foreign joint venture invested 8.83 GW in 2012, accounting for 14% of total. However, only 1% (5%) of the total wind capacity results from the foreign (private) ownership. In China, the main producers of wind energy resources consist of the north, northeast, southeast coastal areas and local island areas [39]. Among these areas, the north China generates almost 70% of the total installed wind capacity. In addition, Hebei and Gansu provinces keep their installed wind capacities at a high level.

*3.3. Solar power*

China is also having a great boom in solar photovoltaic (PV) projects. In the end of 2008, China began to develop the solar PV. Recently, installed solar PV has increased quickly. The installed solar PV increased from 0.8 GW in 2010 to 7 GM in 2012, and about 4 GW were added in 2012. In 2013, China become the world's leading user of solar PV, and the total installed solar PV capacity reached to 35.78 GW by end-June 2015. At present, more than 66% of solar energy resources in China are concentrated in Qinghai, Xinjiang, Tibet, Inner Mongolia, Sichuan and Gansu provinces.

The country's National Energy Administration recently said that China aims to triple its solar PV generation capacity to 143 GW by the year 2020. This means that annual increments of solar PV generation capacity must maintain over 15 GW.

### *3.4. Biomass power*

China is rich in biomass energy resources that can be categorized into forestry, energy crops, animal and sewage, and waste of agricultural. Table 1 lists the provinces with top ten biomass energy installed capacity in 2012. From the table, we conclude that China's biomass energy resources are unevenly distributed.

**Table 1.** The provinces with top ten biomass installed capacity in 2012

| ID | Province | MW |
|---|---|---|
| 1 | Shandong | 1,089 |
| 2 | Henan | 640 |
| 3 | Jiangsu | 554 |
| 4 | Heilongjiang | 524 |
| 5 | Hubei | 475 |
| 6 | Guangdong | 442 |
| 7 | Anhui | 388 |
| 8 | Hebei | 367 |
| 9 | Inner Mongolia | 320 |
| 10 | Zhejiang | 290 |

Figure 4 is China's biomass power installed capacity and generation from 2000 to 2012. Figure 4 shows that installed biomass power capacity increased from 1.0 GW in 2000 to 7.7 GW in 2012, with an annual growth rate of 18.54%. Figure 4 also shows that the installed biomass power generation increased from 2.2 Terawatt Hour (TWh) in 2000 to 33.7 TWh in 2012, which is an annual growth rate of 25.53%. Before the wind power caught up, biomass power is the second largest source of Chinese renewable energy power capacity.

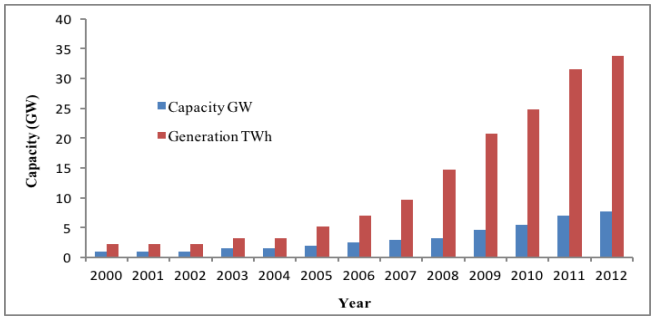


**Figure 4.** China's biomass power installed capacity and generation from 2000 to 2012

## 4. The problems of the implementation of FIT and RPS and complementary mode

The above analysis indicates that China has great success in the development and utilization of renewable energy, and developing renewable energy electricity in the future is very prospective. The

development of renewable energy contributes to the supporting of renewable energy policies. However, in the process of implementing FIT and RPS in China, there exist some crucial barriers.

*4.1. The problems of the implementation of FIT*

In early 2003, FIT was introduced in China to support the development of wind power. Under the FIT, power grid operators have to purchase energy generated from registered renewable energy producers where the buying price is set by the NDRC.

The tariff amount at first was determined by bidding or negotiation based on a case-by-case basis. However, the prices with and without bidding may be far from each other. In particular, the former is about 0.38-0.5 RMB/kWh, while the latter is about 0.5-0.8RMB/$_k$Wh. This may result in intense competition among large state-owned renewable power generators, and speculative bids that are usually not sufficient to implement the project [41]. In July 2009, the NDRC proposed the "Notice on Improving the Pricing Policy for On-Grid Wind Power Prices" to solve this problem. In the notice, the NDRC divided the country into four wind energy resources areas and provided a wind power price ranging from 0.51 RMB/kWh to 0.61 RMB/kWh in the different areas.

In 2014, NDRC raised the hydropower price in the "Notice on improving the Pricing Mechanism for Hydropower Prices". According to the notice, the hydropower tariffs will be determined by the average electricity price of power demand regions. This plan can help improve the investment to the hydropower sector and achieve the goals of twelfth "Five-Year plan" and thirteenth "Five-Year plan".

In 2011, NDRC proposed the first solar FIT policy in the "Notice of Improving the Pricing Policy for On-Grid Solar Photovoltaic Power Prices". This notice provided a solar PV tariff ranging from 1.0 RMB/kWh to 1.15 RMB/kWh based on the data in the PV project. However, the 2011 notice did not consider the intensity of solar radiation in different areas of China. Solar projects always focused on the western part of China, such as Gansu and Qinghai, where the energy demand is not as high due to lower population density and level of economic development [42]. To improve this situation, the NDRC proposed the "Notice on Promoting the Healthy Development of the Solar PV Industry through the Price Leverage Effect" in 2013.

Governmental designated price and governmental guided price are the two stages of China's biomass power tariff. At first, Chinese government applied governmental designated price as its biomass power tariff. In this stage, the government set the biomass power tariff of the area where the facility was located for fifteen years. And the value of this kind price was the sum of 0.25 RMB/kWh and the 2005 benchmark desulfurized coal price in the area [38]. In July 2010, NDRC proposed the "Notice on Improving the Pricing Policy for Biomass Power Prices". This notice provided a unified price of 0.75 RMB/kWh for biomass power projects.

Although Chinese government endeavored to improve renewable energy policies to develop its FIT, it still faces with a few problems. First, China's FIT scheme did not take into consideration the China's uneven resources distribution. In China, the resources are concentrated in the regions of Northwest, North, and South, and the developed administrative regions are short of resources. Therefore, some electricity supply companies in the developed administrative regions have little interest to produce the renewable power, which hinders the implementation of FIT scheme. Second, China's tariff for renewable power was insufficient to provide incentives for generators compared with the international average level. The private generators are reluctant to get involved in other energies to produce power. Third, the permanent benchmark tariff can not provide guidance for the generators to obtain certain return on investment. It's hard for the generators to make a response to market price signals which result in increasing peak-valley deviation and obvious anti-peaking effect [43].

*4.2. The problems of the implementation of RPS*

In China, RPS is a relatively new policy to promote the development of renewable energy. To meet the mid-term (2007-2010) and long-term (until 2020) development objectives for renewable energy, NDRC introduced the RPS scheme in 2007. Under RPS scheme, China's power generators require to produce a certain fraction of renewable energy electricity in their total electricity generation, especially wind, solar and biomass. Table 2 shows the renewable energy goals of RPS in China. Table 2 indicates that China's biomass power would achieve to 30 GW by 2020, with an annual growth rate

of 18.2%. The hydropower, pumped hydro, solar PV and on-grid wind power would increase to 350 GW, 70 GW, 100 GW and 230 GW by 2020, respectively.

In the process of developing the RPS scheme, there are four factors that influence the renewable power. They are targets, eligible technologies, penalty and monitor mechanism, and TGC. At present, many aspects of these factors are left undeveloped in China.

**Table 2.** The overview of China's renewable energy goals

| Items | Current | Goals |
|---|---|---|
| | 2012 | 2020 |
| Biomass power | 8 GW | 30 GW |
| Hydropower | 249 GW | 350 GW |
| Pumped hydro | 20 GW | 70 GW |
| Solar PV | 5.4 GW | 100 GW<br>(70 GW by 2017) |
| Concentrated solar power | 0.014 GW | 3 GW |
| On-grid wind power | | 200GW onshore<br>30 GW offshore |

First, with regard to the renewable energy target, the thirteenth "Five-Year Plan" sets ambitious targets about non-fossil fuel which increase from 12% in twelfth "Five-Year" Plan to 15%. In order to make the RPS scheme working, the targets need to be widely accepted. Although thirteenth "Five-Year Plan" has set the explicit target, it did not divide the long-term target into smaller short-term targets. For the electricity supply companies, the local government cannot verify the percentage of renewable energy electricity in their total electricity generation.

Second, the high cost of the renewable power technologies would hinder implementation of RPS. For instance, the generation costs for wind is 500-600 RMB/MWh. However, the wind farms that are far away from the local power grids must pay higher cost for their electricity transportation and construction. Therefore, low-cost renewable energy sources would like to control the market and prevent the development of emerging and more expensive renewable energy sources.

Third, there is a lack of thorough policy system in the renewable energy industry to encourage the investor's confidence in China. In particular, the lack of incentive mechanisms and supervision mechanisms in China indicate that the RPS scheme is still weak or voluntary. In fact, a lack of incentive mechanisms will influence the renewable power capacity, the motivation of market participants and the formation of the market. In addition, the lack of supervision mechanisms would result in unfair competition in the RPS scheme.

The last but not the least, China has not established the TGC trading market net. In March 2016, the National Energy Administration (NEA) announced that China is planning to build its TGC trading market in the future. The new plan aims to support the RPS scheme and trade the renewable power among the registered renewable energy sources. NEA estimated that the solar PV and wind power will obtain great benefit from the TGC mechanism. The lack of TGC will hinder the fulfillment of renewable energy target in RPS scheme. In TGC trading market, generators falling to fulfill the target can choose to purchase green certificate to meet targets. Hence, the TGC trading market is an important support mechanism in the process of implementing the RPS successfully.

### *4.3. Complementary mode of FIT and RPS*

From the above analysis, China has made a great progress in increasing renewable power by implementing of FIT and RPS. However, there exist a lot of problems in the process of implementing the renewable energy policies. Both the FIT scheme and RPS scheme have the advantages and disadvantages. In fact, FIT scheme plays an important role in meeting targets of RPS scheme. This paper establishes the complementary mode of FIT scheme and RPS scheme based on China's power market structure. The complementary mode takes into account three interactions, as described below.

*4.3.1. Renewable power price under FIT and RPS.*
In the complementary mode, the renewable power price is determined by the FIT scheme. Price is the most effective instrument to adjust the mechanism in a market economy. In practice, reasonable price can help to ensure the profit of renewable energy sources. The government should improve the attractive price policy and adjust the price when the cost of power generation changes. FIT scheme provides enough profit to the renewable energy sources and make sure that the sufficient supply can come online. The complementary mode of FIT and RPS would use the power price which is set by the State Electricity Regulatory Commission based on the FIT.
*4.3.2. The quota allocation under FIT scheme and RPS scheme.*
There are abundant renewable energies, huge potential of renewable energy development and market demand in China. However, due to the uneven distribution resource situation and no penalty in FIT scheme, the electricity supply companies have no motivation to generate renewable power. The complementary mode of FIT and RPS require the electricity supply companies to satisfy the minimum percentage of renewable energy electricity in the total power generation under FIT scheme. That means that the electricity supply companies have to obey the RPS scheme. At the same time, the power grid operators have to purchase renewable energy electricity generated from registered renewable energy sources at a buying price set by FIT scheme.
*4.3.3. Support for renewable energy technologies under RPS and FIT.*
Although there exist long-term utility contracts, new or emerging technologies still cannot secure finance [11]. In complementary mode of FIT and RPS, a renewable energy subsidy fund would be built. This fund is mainly supplied by a fixed surcharge for total electricity purchases. This fund is established to compensate the electricity supply companies with new renewable energy technologies. The subsidy should be enough high to support the additional investment risk faced by the electricity supply companies. Appropriately structured FIT scheme will take into consideration the risk premium for new renewable energy technologies and provide the long-term assurance that the electricity supply companies require.

## 5. Conclusions
It is necessary to promote sustainable economic growth by using renewable energy. Currently, Chinese government has proposed a series of renewable energy policies to solve its environmental problems and support the renewable energy development. Among these policies, the FIT and RPS are the two most popular renewable energy policies. This paper elaborates and presents three issues about the FIT and RPS. They are the current situation of renewable energy development in China's power sector, the problems of the implementation of FIT and RPS, and the complementary mode of FIT and RPS. The main conclusions drawn from the analysis are summarized as follows.

First, China already owns the largest installed capacity of wind and hydroelectric power, as well as the vast majority of solar heating and biogas installations in the worldwide. In the twelfth "Five-Year Plan", renewable energy resources were identified as an emerging strategic. This plan also set overall targets for renewable energy sources. In the plan, China's biomass power would increase to 30 GW by 2020, with an annual growth rate of 18.2%. The hydropower, pumped hydro, solar PV and on-grid wind power would increase to 350 GW, 70 GW, 100 GW and 230 GW by 2020, respectively.

Second, although Chinese government endeavored to improve renewable energy policies to develop its FIT, it still faces with a few problems. With regard to the FIT scheme, there exist three problems faced by the Chinese government: (1) China's FIT scheme did not take into consideration the China's uneven resources distribution; (2) China's tariff for renewable power was insufficient to provide incentives for generators compared with the international average level; (3) the permanent benchmark tariff cannot provide guidance for the investment.

Third, for the RPS scheme, the problems can be summarized as: (1) the thirteen "Five-Year Plan" did not divide the long-term target into smaller short-term targets; (2) the high cost of the renewable power technologies can have an important effect on implementation of RPS; (3) there is a lack of thorough policy system in the renewable energy industry to encourage the investor's confidence in China.

From the future perspective, there exists considerable space for the development of renewable energy. Due to the technology development and improvement in renewable energy policies, the renewable energy will be gradually moving into high gear in the next thirteenth "Five-Year Plan". We suggest that the policy-markers establish the complementary mode of FIT and RPS that can provide a stable environment to make the FIT and RPS work together. In the complementary mode, the electricity supply companies have to obey the RPS scheme. At the same time, the power grid operators are required to purchase energy generated from registered renewable energy sources at a buying price set by FIT scheme. This complementary mode plays an important role in promoting a low-cost, diversified and large-scale development for renewable energy. This mode also can help China built the TGC trading market and meet emission reduction targets.

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