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A review on promoting share of renewable energy by green-trading mechanisms in power system



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ABSTRACT

In order to promote the development of renewable energy power generation, many countries have issued corresponding policies. Meanwhile, some green-trading mechanisms have been implemented in power industry. And this paper has mainly presented a review on promoting share of renewable energy by green-trading mechanisms in power system with a focus on promotion effects of three mechanisms: feed-in tariff, renewable portfolio standard and emission trading scheme. Apart from a review, summaries, comparisons, and an outlook for future study are also presented. Our review suggests that feed-in tariff and renewable portfolio standard can effectively increase the share of renewable energy power and lead to renewable resource diversity. In addition, emission trading also provides stimulus for development of renewable energy besides mitigation of carbon emission.

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1. Introduction

With the continuous development of economy and society, nowadays many environmental and energy problems have arose. With

regard to the environment, a series of issues about climate change, like global warming, have threatened human survival due to the large amounts of greenhouse gas emissions. Carbon emission issues in China are also in an urgent situation. Table 1 shows relevant data published by Global Carbon Project, and we can see that while per-capita emissions are not too high, total emissions in China are the highest globally, with a share of 27%. Therefore, the control of emissions of carbon dioxide and other greenhouse gases is very important and urgent.

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As for energy, the traditional fossil energy is running out and may be extinct in the coming decades. Considering its potential safety hazard, many countries begin to abandon or delay their construction of nuclear power plant. So faced with the increasingly severe global energy and environmental problems, there is a practical solution for all countries, to develop and utilize renewable energy for the sake of energy security and sustainable development.

Many countries have set clear development strategies for the development of renewable energy. The European Union has put forward a goal that the share of renewable energy in total energy consumption should reach 20% by 2020, and the goal for France, Germany and Britain is 23%, 18% and 15% respectively. Japan's objective is that the renewable energy power generations must meet 20% of its power demand by 2020 [2]. Besides, China aims to raise its renewable energy share to 20% by 2020.

As one of the major energy-consuming industries, power sector has an important role in the achievement of renewable energy target. However, the share of renewable energy in electricity mix is rather low. The data in Fig. 1 is published by China Electricity

Council, from which we notice that the figure we notice that the proportion of thermal power is as high as 69% [3], compared with low ratio of green power such as solar and grid-connected wind.

Corresponding to the overall target for development of renewable energy, each country has set goals for renewable energy generations. However, compared to conventional technologies, renewable energy power generations cost relatively higher and are less mature [4]. In order to promote the development of renewable energy power generation, many countries have issued corresponding policies. Meanwhile, some green-trading mechanisms have been implemented in power industry to promote renewable energy generation and increase proportion of green power in installed capacity by means of marketization. So it is necessary to study green-trading mechanism in power system, which aims to promote renewable energy share.

Generally, promotion policies for renewable energy include feed-in-tariff, tendering system, renewable portfolio standard, etc. Table 2 provides a classification of existing promotion strategies for renewables, in this paper, we focus on feed-in-tariff and tradable green certificate system and study their incentive effects on renewable energy generation. In addition, we discuss the impact of emission trading for the reason that it is one of green-trading mechanisms and besides mitigation of emission, it also provide benefits for renewable energy.

The remainder of this paper is organized as follows. Section 2 presents provisions and case studies of feed-in tariff together with a summary of its effect. In Section 3, we analyze the effects of renewable portfolio standard and tradable green certificates, and a comparison between renewable portfolio standard and feed-in tariff is also presented. Then the impacts of emission trading on renewable energy are introduced in Section 4. At last, Section 5 includes conclusions and an outlook for future work.

2. Feed-in tariff

Feed-in tariff (FIT) is a price-driven policy designed to accelerate investment in renewable energy technologies by offering guaranteed prices for electricity produced from renewable energy sources for fixed periods of time. These prices can be differentiated according to the type of technology, the size of the installation, the quality of the resource, and the location of the project. Table 3 presents feed-in tariff rate in Ukraine as an example.

Table 3
Average cost of electricity from renewables and feed-in tariff rates, Euro/kWh [6].

	Biomass CHP	Small hydro	Solar plants	Wind farms
Average cost	0.057	0.045	0.112	0.027
Feed-in tariff	0.127	0.044	0.243	0.066

Table 1
Major emitters of carbon dioxide in 2012 [1].

Countries	Share (%)	Per-capita emissions (tC)
China	27	1.9
the USA	14	4.4
the EU (28 member states)	10	1.9
India	6	0.5

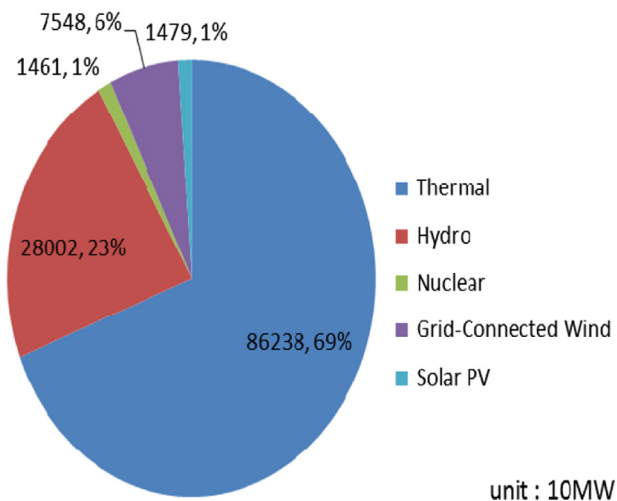


Fig. 1. National power generation capacity of China at the end of 2013.

Table 2
Fundamental types of promotion strategies [5].

	Direct		Indirect
	Price-driven	Quantity-driven	
Regulatory			
Investment focused	Investment incentives Tax credits Low interest/soft loans	Tendering system for investment grant	Environmental taxes Simplification of authorization procedures Connection charges, balancing costs
Generation based	(Fixed) Feed-in tariffs Fixed premium system	Tendering system for long term contracts Tradable green certificate system	
Voluntary			
Investment focused	Shareholder programs Contribution programs		Voluntary agreements
Generation based	Green tariffs		

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