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The main support mechanisms to finance renewable energy development ☆

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ABSTRACT

Considering that the major part of greenhouse gases is carbon dioxide, there is a global concern aimed at reducing carbon emissions. In addition, major consumer countries are looking for alternative sources of energy to avoid the impact of higher fossil fuel prices and political instability in the major energy supplying countries. In this regard, different policies could be applied to reduce carbon emissions, such as enhancing renewable energy deployment and encouraging technological innovation and the creation of green jobs. This study compares three main support mechanisms employed by governments to finance renewable energy development programs: feed-in-tariffs, tax incentives, and tradable green certificates. Considering that many of the promising technologies to deploy renewable energy require investment in small-scale energy production systems, these mechanisms could be used to enhance renewable energy development at the desired scale. Employing a carbon emission tax or emission trading mechanism could be considered ideal policies to mitigate emissions at the lowest cost. The comparison of feed-in-tariffs and renewable portfolio standard policies showed that the former is good when a policy to develop renewable energy sources with a low level of risk for investors is considered. However, the latter is an appropriate policy when a market view policy is applied by the government. Finally, considering technological progress and the cost reduction for power generation by renewable energy sources, we suggest that support mechanism policies should be reconsidered from the financial point of view.

Contents

1. Introduction

Electricity consumption is predicted to comprise an increasing share of the global demand for energy over the next two decades. This is explained by the importance of electricity to industries. It is expected that the growth rate of electricity consumption will be more than that of the consumption of the other sources of energy, including liquid fuels, natural gas, and coal [22]. Due to ongoing concerns regarding climate change, the increasing price of fossil

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fuels, and political instability in major energy supplying countries, renewable energy (RE) sources have become an important topic of research in world energy demand.

The economic view is an essential part of renewable energy deployment and its progress. If they do not have an economic advantage, renewable energy technologies will not be able to compete with the conventional resource technologies. On the other hand, it is difficult to establish a transparent figure for the unit cost of renewable energy compared to conventional sources. External costs, such as the social and environmental costs, are included in the discussion of conventional sources. In addition, the subsidies paid for the consumption of fossil fuels act as a barrier for alternative sources, making it more expensive for these sources to compete. The aim of increasing the contribution of renewable energy to the total energy supply is of worldwide importance in mitigating the negative energy effects of climate change.

In reality, there is a gap between the actual share and optimal level of renewable energy consumptions in the world. Furthermore, a large amount of investment is spent on conventional energy sources compared to renewable energy sources. Alternative policies for environmental protection are applied in the form of economic incentives and non-incentive regulations. Examples of economic policies include incentives for using renewable energy and imposing taxes on emission generation or fossil fuel consumption. Although developed countries that import crude oil have imposed carbon taxes for many years, these taxes have not been applied for environmental purposes.

Three types of support mechanisms are widely used: feed-in-tariffs, tax incentives (including subsidies and tax deductions), and tradable green certificates. We do not consider direct supports paid to producers or consumers, because our purpose is to apply a mechanism to encourage the creation of a renewable energy market. Direct financial transfer may lead to the enhancement of renewable energy consumption, but the main target (i.e., market creation) is not achieved. Generally, different kinds of economic instruments, such as capital grants, grants to infrastructure, utility procurement, etc., are available for renewable energy technologies. However, most of them are not appropriate for electricity produced by individually distributed generators. Considering that many of the most promising technologies to deploy renewable energy to achieve targets for energy efficiency or carbon reduction require investment in small-scale energy production systems (such as residential building), these mechanisms could be used to enhance renewable energy development to the desired scale. In particular, they will be applicable to the renewable energy market, which is constituted by a large number of individual energy suppliers.

The rapid growth of renewable energy has been possible through decreasing technology costs, increasing fossil-fuel prices, and the continued payment of subsidies by the state. According to an IEA report in 2012, the subsidies are estimated to increase from $88 billion in 2011 to almost $240 billion in 2035 [23]. On the other hand, fossil-fuel consumption subsidies were estimated at $523 billion in 2011, nearly six times more than the financial support allocated to renewable energy. This means that the support given to conventional sources of energy overshadows the support given to renewable energy sources.

In this paper, we discuss the three main support mechanisms used to finance renewable energy development programs: feed-in-tariffs, tax incentives, and tradable green certificates. Finally, we explain the cross-national incentive policies for clean development mechanisms, which are based on the Kyoto Protocol.

2. Feed-in-tariff

A feed-in-tariff (FIT) is a policy used as a support mechanism to accelerate investment in renewable energy (RE) technologies. According to Couture et al. [12], a feed-in tariff (FIT) is an energy supply policy focused on supporting the development of new renewable energy projects. An FIT offers a long-term purchase agreement for the sale of RE electricity. Couture and Gagnon [11] pointed to three essential provisions for the success of FIT policies: guaranteed access to the grid, stable and long-term power purchase agreements, and prices should be calculated based on the unit costs of power generated by renewable energy sources. Technologies such as wind power are priced lower than solar photovoltaic (PV) because of the latter's higher cost. However, FIT policies could be considered a controlling regulation measure because of the ability of governments to direct the market according to the rates defined in the contracts. An expectation of lower rates in the future could cause a rush in the market to receive the existing FIT rate. The tariffs may be used as a fixed rate (higher than market price) or as a mark-up that is added to the current market price.

According to the Renewables Global Status Report (GSR 2012), at least 109 countries had used some type of FIT policy by early 2012. FIT policies that had been used were fully functioning in at least 65 countries and 27 states by 2012 [37]. In late 2011, Germany was successful in connecting its one-millionth PV systems, mainly driven by the low rate of FIT and the expectation that prices would continue to decrease. Based on the GSR 2012, this newly connected PV system (around 7.5 GW) increased the cumulative installed capacity to 24.8 GW, accounting for 3.1 percent of Germany's power generation and almost 8 percent of peak load demand. More evidence for using FIT contract rates as the stimulus for PV system installation are as follows: Italy brought 9.3 GW of PV to benefit from more advantageous rates in 2010; the UK increased its capacity to 1 GW, driven by two rounds of rate reductions; France operated more than 1.6 GW by changing its FIT rates; China's market has quadrupled mostly due to their national FIT policy, increasing its cumulative installed capacity to 3.1 GW and becoming the dominant player in Asia [37]. Fig. 1 shows the effects of FIT policy on developing renewable energy installation in the UK. As the figure shows, PV installation has been widely affected by an active FIT policy.

The UK government introduced an FIT supporting mechanism in April 2010 in order to enhance small-scale renewable energy deployment and low-carbon power generation technologies. This policy covers five technologies: solar PV, wind, hydro, anaerobic digestion, and micro-CHP plants. As Fig. 1 shows, almost 2 million kW have been installed based on the FIT supporting mechanism, and the majority of the installed capacity is from solar PV sources. Fig. 2 shows the number of cumulative installations in the same period.

Financial support mechanisms are gaining importance in the enhancement of renewable energy development. Conventional sources of energy could be replaced with renewable energy technologies (RET) in order to mitigate environmental damage caused by old electricity power generation technology. Ringel [45] examined the most common types of support systems in the European Union (EU), including FITs and green certificates, in order to evaluate their advantages and disadvantages in terms of effectiveness and efficiency. Based on this analysis, both mechanisms contributed to enhancing the share of power generation by renewable energy. However, many member states tried to shift from a feed-in system to green certificates while experiencing both systems. The results show that FITs are successful in encouraging individuals to use renewable energy sources, with wind energy in Denmark and Germany being the primary source. FITs have been an effective instrument in promoting renewable energy deployment in Europe. Fig. 3 shows the evolution of annually installed surfaces of solar thermal collections in the European Union since 1994 [17].