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Feed-in tariff promotion and innovative measures for renewable electricity: Taiwan case analysis

Wen-Tien Tsai *

Graduate Institute of Bioresources, National Pingtung University of Science and Technology, Pingtung 912, Taiwan

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ABSTRACT

Taiwan, located in a subtropical area, is a high energy-importing nation with approximately 98% of our energy supplied by imported fuels since 2000. In this regard, renewable electricity systems from its richness of solar radiation and strong monsoon are thus becoming attractive due to the energy, economic, and environmental policies for pursuing clean electricity supply, sustainable development and greenhouse gases emission mitigation in Taiwan. The objective of this paper was to present an analysis of profitable promotion and innovative measures for renewable electricity in Taiwan because the photovoltaic (PV) power and wind power systems have rapidly increased the total installed capacity from 2.7 MW in 2000 to 1006.2 MW in 2013. The description in the paper was thus summarized on an analysis of renewable electricity supply since 2000 and its future goals up to 2030, and then centered on the new promotion legislation (i.e., Renewable Energy Development Act) in the measures of feed-in tariff (FIT) and tax/subsidy incentives. Current subsidiary and innovative programs to promote the development of renewable electricity technologies, including roof-type PV power, off-shore wind power and biogas-to-power, were also described. Due to its innovation promotion for renewable energy exploitation in recent years, Pingtung County, located in the southernmost of Taiwan, was introduced as a case study. Finally, some recommendations for promote renewable electricity development were addressed in the paper.

Contents

1. Introduction

Taiwan has a dense population (total area: 36,200 km^2; population: 23,300,000 people; population density: 640 people/km^2) but limited fossil resources with high dependence on imported

* Tel.: +886 8 7703202; fax: +886 8 7740134.
E-mail address: wttsai@mail.npust.edu.tw

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energy (about 98%). However, this country is located in a subtropical area with the richness of solar radiation and strong monsoon, implying that the island has a high potential for renewable energy development. In this regard, renewable energy sources in Taiwan will focus on off-shore wind power and solar energy like photovoltaic (PV) power. For example, it has been estimated that an enormous wind resource of more than 15 GW can be harvested in Taiwan. To accelerate the development of wind power industry, the government plans to shift the wind energy from onshore to offshore systems, and set up more than 1000 wind turbines by 2030. The accumulated capacity of wind will thus reach 4200 MW. Moreover, the current installed capacities of PV power and wind power in 2013 amounted to 392.0 MW and 614.2 MW, respectively [1]. However, the domestic energy consumption reached a total of 111.92 million kiloliters of oil equivalent (KLOE) in 2011, in contrast to 53.25 and 90.91 million KLOE in 1991 and 2001, respectively [1]. On average, the annual growth rate is about 3.8% during the period. Approximately in parallel with the energy consumption per capita, the electricity consumption and carbon dioxide (CO_2) emissions from the energy consumption remarkably increased from 4566.3 kW h and 5.7 MT per capita in 1991 to 10,494.7 kW h and 10.8 MT per capita in 2011. In recent years, the environmental issues such as global warming and sustainable development are consecutively arousing the concern of the public in response to the Kyoto Protocol adopted in December 1997 and coming into effect in February 2005. Regarding the public attitude toward renewable energy in Taiwan, for example, nearly 70% of people supported to replace nuclear energy with renewable energy based on the survey by the Public Opinion Research Center of Shih Hsin University. This survey was made targeting the people in the greater Taipei region during the first half of November in 2009, with 517 analyzable questionnaires, 95% confidence level, and error rate 4.5% [2]. Therefore, the energy strategies and policies for promoting energy saving and renewable energy in Taiwan have actively provided some environmental, financial, and economic incentives to pursue the energy sustainability during the period [3,4].

In 2008, the Executive Yuan of Taiwan issued the "Framework for Sustainable Energy Policy", which aimed at creating a new low-carbon economy and low-carbon society that balances economic development against environmental protection and energy security under the principles of "high efficiency", "high value-added", "low emission", and "low dependence (on foreign fuel sources)". In this regard, the policy for clean energy development is to pursue the following targets:

- Reducing nationwide CO_2 emissions by developing clean energy, so that total emissions could return to its 2008 level between 2016 and 2020, and further reduced to the 2000 level in 2025.
- The clean energy development is to achieve the share of zero carbon renewable energy in electricity generation system up to 8% in 2025.

To be in accordance with the Framework, the Legislative Yuan of Taiwan further passed the Renewable Energy Development Act in June 2009. The Act is comprised of 23 articles, and is enacted to promote the utilization of renewable energy, increase energy diversification, improve environment quality, energize the industrial development and drive the national sustainability. More significantly, the policies for developing renewable electricity supply prescribed by the Act include the feed-in tariff (FIT), subsidy for purchasing renewable generation equipment, and tax incentives. On the other hand, there have been a number of funds-supporting projects on renewable energy education in Taiwan in recent years. For example, the interdisciplinary green energy technology education program under the funding support by the Advisory Office of Ministry of Education (MOE, Taiwan) was a four-year project starting from 2007 to 2010, and designing for undergraduates of the College of Engineering. It aims at developing core and professional courses by integrating interdepartmental knowledge. Also, Taiwan has implemented 5-year (2009–2013) "National Science Technology Program: Energy Human Resource Development" project, which coordinated relevant government agencies, including MOE, National Science Council (NSC) and Environmental Protection Administration (EPA) to promote climate change and energy education.

Currently, the FIT scheme is the most popular procurement option for the development of renewable electricity such as wind power and PV power [5,6]. Many countries (e.g., Germany, UK, Spain, Italy, Japan, and France), or the states/provinces of countries (e.g., USA, Australia, and Canada) have established the FIT regime. Due to the geographical region and local energy security, the FIT policy has various dimensions and coverage in different countries. Furthermore, the FIT rates for the same renewable electricity source differ across these countries [6]. For example, the highest FIT payment belongs to the Victoria state of Australia, where the payment for wind, hydro, biomass, and solar energy was fixed at 0.8 US$/kW-h in 2013. By contrast, Argentina received the lowest FIT payment at almost US$0.001 for electricity generated from biogas, biomass, and wind power. In brief, it is a policy mechanism designed to accelerate investment in a variety of renewable electricity technologies and also offer long-term contracts to renewable electricity suppliers. The goal of FIT is to offer cost-based compensation to renewable power producers, providing the profitable price help finance renewable electricity investments. The FIT rates are typically based on the installation cost for each technology and other factors, including operation and maintenance cost and capital recovery factor. For example, wind power system is awarded a lower per-kW h price, while solar photovoltaic (PV) power is offered a higher price because of its higher installation cost. In addition, the FIT policy often includes "tariff decline", reflecting a decreasing trend in the costs of renewable electricity technologies, especially in PV power system. In other words, the FIT rate may be no longer a constant subsidy price within one year, but could decline over time.

According to the official survey on the renewable electricity since 2000 [1], the total installed capacities of PV power and wind power remarkably increased from 0.1 MW and 2.6 MW in 2000 to 392.0 MW and 614.2 MW in 2013, respectively. Because of the considerable progress in the renewable electricity development, the objectives of this paper will present a comprehensive analysis of the FIT promotion and innovative measures for renewable power system in Taiwan. The main subjects covered in this paper were described in the following key elements:

Current status of renewable electricity supply and its future goals.
Central regulations for promoting renewable electricity.
Taiwan's FIT evolution and its policy.
Current innovation promotion and measures for renewable electricity.
Case study of Pingtung County.

2. Current status of renewable electricity supply and its future goals

2.1. Current status of renewable electricity supply

In response to the Kyoto Protocol adopted in December 1997, promoting the renewable energy and thus supplying renewable electricity have been considered as one of the most