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Assessing feed-in tariffs on wind power installation and industry development in Taiwan

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ABSTRACT

This study assesses the policy effects of feed-in tariffs (FITs) on Taiwan's use of wind power and the growth of the country's wind power industry. This study uses the system dynamics approach to develop a simulation model to assess the FIT policy. The simulation, covering 2013 to 2025, shows that the FIT scheme impacts Taiwan's installed wind power capacity significantly before the targeted capacity is achieved. On average, a 10% increase in the FIT price (based on the 2013 price) results in a one-year early achievement of the target. By contrast, a 10% reduction in the FIT price (based on the 2013 price) delays the achievement of the target by two to three years. Moreover, the FIT scheme can facilitate growth in Taiwan's wind power industry: every 10% increase or decrease in the FIT increases or decreases industry growth by 1.12%. When the FIT is increased by 10% from 2.6258 NT/kW h, the 2020 cumulative output value of Taiwan's wind power industry increases from NT$105.81 billion to NT$107.00 billion, an increase of NT$1.19 billion. The findings of this study indicate that the FIT scheme is a policy tool that can achieve reductions in carbon emissions and facilitate the development of Taiwan's wind power industry.

Contents

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1. Introduction

Many nations have considered the need to help slow global climate change by reducing carbon emissions and establishing an environment for sustainable development. Governments have set domestic energy conservation objectives and policies for achieving them. In Taiwan, carbon emission levels are expected to reach 467 million tons by 2020 if energy conservation policies are not implemented. The government has committed to reducing this amount to the 2005 level of 257 million tons, which requires a reduction of 210 million tons, or 45% [1]. The government has established a variety of policies, measures, and programs to achieve this goal.

As indicated by Stern [2] and Thoma [3], when a country's energy consumption decreases, its GDP also declines. Delinking energy consumption, economic growth, and CO_2 emissions are very important for Taiwan's long-term development. One of the Taiwanese government's major policy goals is developing emission-reduction industries and associated applications. Accordingly, the Green Energy Industry Program was proposed by the Ministry of Economic Affairs (MOEA) in April 2009. This policy singles out the photovoltaic, LED lighting, wind power, biofuel, hydrogen energy, fuel cell, energy information communication technology, and electric car industries as key development programs.

Wind energy is one of the world's cleanest energy resources, and it does not worsen global warming. It is often considered an alternative to fossil fuels such as oil and coal. Many countries are promoting wind power. By the end of 2011, the cumulative global installed wind power capacity reached 238 GW [4]. Taiwan, an island country lying in the ocean east of Asia, is rich in wind power. By the end of 2012, Taiwan's cumulative installed on-land wind power capacity was approximately 560 MW. Before 2020, Taiwan is expected to increase its cumulative installed wind power capacity to 1200 MW, the target set by the government [5].

Renewable energy usage is relatively low because the initial cost of developing it is higher than it is for conventional fossil fuel in the early stage. This high cost has caused countries to implement various policy measures, including technology R&D, subsidies for installation, preferential tax treatment, and FITs [6–9]. These can be divided into two types. One type is intended to facilitate the development of the wind power industry and reduce costs, thus increasing installed capacity. The other type promotes the installation of domestic wind power systems, such as through an FIT scheme, installation cost subsidies, a demonstration system, or wind turbines sourced either overseas or locally. These types of policy measures can create a domestic market and facilitate industry development. However, most support mechanisms involve only a simple form of renewable energy promotion [10–13]. No study has explored the effects on both carbon emission reduction and domestic industrial development. The results of such a study should help decision makers formulate relevant policy measures for environmental and economic development.

Thus, this study constructs an assessment model for analyzing the effects of FITs on wind power installation and industry growth. This paper constructs a simulation system and analyzes Taiwan's wind power in the following stages. The next section reviews the policy assessment methods used. Section 3 constructs the simulation model. Section 4 shows the results of the simulation, and Section 5 concludes the paper.

2. Methods

Econometric models and cost-benefit analysis are among the quantitative methods most often used to assess policy effectiveness. Econometric models require sufficiently long-term data. Cost-benefit analyses require the identification of the actual costs and benefits of the policies being implemented. However, high-quality data are frequently difficult to obtain [14]. These two methods emphasize the direct relationship between the parameters and the effectiveness of the model. This study is particularly concerned with the process shifts policies can cause.

Wind power installation depends on numerous factors that interact with each other in several ways. For example, increasing the FIT price facilitates a higher return on investment (ROI) for wind farms, and an increase in ROI for wind farms attracts private sector investment in installed wind power capacity. An increase in installed wind power capacity via the private sector can help achieve the target capacity, which would reduce the FIT price. Moreover, a loop exists between domestic installation and industry growth. For example, the FIT price increases domestic installation demand, which in turn attracts private sector investment in wind power generation manufacturing. Private sector investments in wind power generation manufacturing help reduce installation costs, and lower installation costs reduce the FIT price. Thus, feedback relationships exist among the relevant factors, and these factors have not only feedback relationships but also causal nonlinear relationships.

System dynamics (SD) is an approach to understanding the behavior of a complex system through its components; it assumes that a change in any component of a complex system affects its overall behavior. A social system-related management concept developed by Jay W. Forrester at the Massachusetts Institute of Technology, SD deals with the non-linearity and complexity of systems. Their causal feedback can be analyzed through dynamic systems thinking. Using computer simulations, the real influence of a social system on policy can be observed in a laboratory as a way to understand the implied causal feedback in the system [15]. A “policy laboratory” can be constructed using SD to help decision makers simulate possible scenarios for different policies, and the results can be used to assist their decision making.