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Renewable energy in eastern Asia: Renewable energy policy review and comparative SWOT analysis for promoting renewable energy in Japan, South Korea, and Taiwan

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HIGHLIGHTS

- Japan, South Korea and Taiwan need to develop renewable energy (RE).
- These countries have been too conservative to achieve a notable share of RE.
- Pro-nuclear energy policies have hindered the RE development in these countries.
- The Fukushima disaster made these countries more favorable to RE.
- Joint cooperation for R&D and deployment of RE is recommended.

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ABSTRACT

Japan, South Korea, and Taiwan are deficient of domestic fossil energy sources and depend significantly on imported fuels. Since the oil shock in the 1970s, all three countries have promoted renewable energy as an alternative energy source to improve energy security. Currently, renewable energy is being promoted to build low-carbon economies. This study reviews the development of renewable energy policies and roadmaps. It also examines and compares strengths, weaknesses, opportunities, and threats (SWOT) of these countries in the context of advancing renewable energy policies and technologies and expanding domestic renewable energy installations, as well as strategically positioning themselves in the international renewable energy market as exporters of clean energy technologies. Through the SWOT analysis, this paper identifies a capacity for additional renewable energy deployment in these countries and highlights the necessity of increased cooperation between the three countries to strengthen their domestic and regional renewable energy sectors and compete in the global renewable energy market in the post-Fukushima era.

1. Introduction

Located in Eastern Asia, Japan, South Korea, and Taiwan have historically developed similar energy systems that primarily depend on fossil fuels. Fossil fuel energy sources constitute about 75 percent of total primary energy supply (TPES) in Japan and South Korea and 90 percent in Taiwan. Also, these countries similarly lack domestic fossil energy resources and depend mostly on imported fuels. Their energy dependency rates are as high as 96 percent or more. Over the past few decades, such fossil fuel-centered energy structures have commonly resulted in causing problems such as high greenhouse gas (GHG) emissions. According to U.S. Energy Information Administration (US EIA) (2014a,2014b), Japan, South Korea, and Taiwan were the 5th, 8th and 23rd largest CO_2 emitters in the world as of 2011, respectively. Moreover, dependence on foreign fossil fuels threatens national energy security in these countries.

As an alternative energy source to fossil fuels, renewable energy sources have long attracted considerable attention among these countries. The countries have identified renewable energy development as a means not only to mitigate the negative impacts

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of their fossil fuel use, but also to strengthen their national energy security. Accordingly, renewable energy markets have been expanding in all three countries. Furthermore, the Fukushima nuclear catastrophe has renewed interest in renewable energy as an alternative to nuclear power.

The primary purpose of this paper is to investigate renewable energy policies in Japan, South Korea, and Taiwan, analyze their advantages and shortcomings for renewable energy development, and provide possible guidance for future expansion of renewable energy in these countries. To achieve this goal, this paper individually discusses the development of renewable energy policies for these countries since the 1970s and their energy roadmaps in Section 3. This section also provides a comparative analysis by utilizing the Strength, Weakness, Opportunity, and Threat (SWOT) matrix as an analysis framework. This SWOT framework is applied to detect internal and external factors that affect renewable energy development in these three countries. SWOT is also utilized to identify how to maximize the strengths and overcome the weaknesses, while taking advantage of the opportunities to overcome the threats. Lastly, the paper makes suggestions to expand renewable energy operations in these nations in Section 4.

2. Methods

This study applies a SWOT analysis framework for a comparative analysis of renewable energy policies in Japan, South Korea, and Taiwan. The framework of SWOT was originally invented for business and marketing analysis and has been broadly adopted in other research fields including energy management (Terrados et al., 2007).

In general, the SWOT framework is composed of internal and external assessments. The internal assessment is conducted to illustrate strengths and weakness of an organization or a strategic plan; the external assessment is applied to discover opportunities and threats (Matthews, 2004). Strengths stand for any available resources that can be used to advance the performance. Weaknesses are flaws, which may decrease competitive advantages, efficiency, or financial resources. Opportunities are external changes that could contribute to an additional development and threats are outside factors that may cause problems (Paliwal, 2006). In the energy management field, SWOT has typically been used to analyze energy situations of a single region or system. However, this paper attempts to expand its application by employing the SWOT analysis to examine renewable energy policies and development in multiple nations.

3. Results and discussion

3.1. Renewable energy targets and policies

The two oil crises in the 1970s led to greater interest in the development of renewable energy as alternative energy sources to oil in Japan, South Korea, and Taiwan. The history of renewable energy development over the past forty years is first reviewed in this section in order to identify unique development strategies in each country.

3.1.1. Japan

Japan depended on oil for more than 75 percent of its energy production in 1973 and the oil crises unveiled the fragility of Japan's energy structure (Ministry of Economy Trade and Industry (METI), 2012). After the first oil shock, METI[1] promptly initiated a 25-year plan called the "Sunshine Project" to develop solar energy technologies. The "Law Concerning the Promotion of the Development and Introduction of Alternative Energy" came into effect in 1980 as a means to reduce Japan's oil dependency and to promote the development of alternative energy. The early stages of renewable energy development focused on geothermal energy and small hydropower (10 MW and smaller). As a result, about 95 percent of current small hydropower plants in Japan were constructed before 1990, and about 95 percent of the current geothermal energy capacity was attained by 1996 (Japan Renewable Energy Policy Platform (JREPP), 2010).

Recent renewable energy development has been promoted under various measures, including the 1993 "New Sunshine Project," which is a successor of the 1974 "Sunshine Project," the 1997 "Basic Guidelines for New Energy Introduction," the 1997 "New Energy Act," and the 2009 "Non-Fossil Energy Act". In addition, a Renewable Portfolio Standard (RPS) has been in practice since 2003 with an annual target set for electric retailers to utilize 16 TWh of electricity derived from renewable energy (excluding large hydropower) by 2014—equivalent to about 1.6 percent of the national electricity supply. In addition, net-metering was introduced for excess solar and wind energy in 1992. These renewable energy policies have contributed to the increase of the share of renewable energy, particularly solar photovoltaic (PV), wind energy, and biomass in Japan.

Solar PV holds the largest generation capacity among Japan's renewable energy technologies. Japan has successfully increased PV installations mainly through subsidies provided by the central and local governments. The growth of domestic PV markets had stagnated since 2005 when the provision of subsidies for households ended. However, it has recovered since 2009 after financial support through subsidies were reintroduced (Ministry of Economy Trade and Industry (METI), 2012).

Moreover, the implementation of the solar Feed in Tariff (FIT) scheme that began in November 2009 has played an essential role in the recent strong growth in solar PV installations. According to the program, utilities are required to purchase surplus solar electricity for ten years at a fixed rate of JPY48 (USD 0.60)/kWh—almost twice as high as the market price of electricity—for residential PV installations below 10 kW. The FIT program has been very successful; according to Ministry of Economy Trade and Industry (METI) (2012), the annual surplus solar electricity purchased by the utilities reached 1.4 billion kWh in 2010. At the end of 2011, Japan had the third largest solar PV capacity in the world after Germany and Italy, with an installed capacity of 4.9 GW (European Photovoltaic Industry Association, 2012).

Japan has also constantly increased wind energy capacity over the last decade. The government's support through programs, such as "Field Test" and "New Energy Business Support Programs," have played an important role in the development of the wind industry in Japan, along with purchase agreements and the RPS program. Japan had a wind capacity of 2661 MW at the end of 2013 (Global Wind Energy Council, 2014).

Japan has also attained rapid growth of biomass capacity. Having increased by a factor of 7.5 since 1990, biomass now accounts for about one-fourth of total renewable energy capacity (Renewable Energy Policy Network for the 21st Century (REN21), 2012). The increase is largely because electricity generation by waste incineration is considered as renewable energy and the majority of biomass facilities are certified by the RPS in Japan. In fact, power generation from waste accounts for about 95 percent

[1] METI was established in 1945 as the revival of the Ministry of Commerce and Industry. The METI designed crucial laws and implemented important projects to promote renewable energy in Japan. In 1973, METI established the Agency for Natural Resources and Energy and began its Sunshine Project, an R&D project on new energy in the following year.