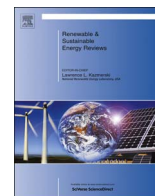




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Taiwan's renewable energy strategy and energy-intensive industrial policy

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ABSTRACT

Since Taiwan is a densely populated island with almost no fossil energy resources, the development of renewable energy is an important issue. In the past, industries with low energy productivity were encouraged for economic development, but this structure of low energy productivity industries should now be adjusted to promote renewable energy and energy efficiency. By analyzing the gross domestic product together with the energy consumption and CO₂ emissions for major industries in Taiwan, this paper considers what kinds of industries should be encouraged or discouraged for Taiwan's future development. In addition, the recommendations for Taiwan's renewable energy and energy-intensive industrial policy are presented.

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1. Introduction

Taiwan generates almost none of its own energy, with 98% of the total energy consumption (EC) depending on imports in 2014

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and almost all imported fossil fuel was from turbulent areas such as the Middle East. In that same year, the value of energy imports had increased from 2.6% of Taiwan's gross domestic product (GDP) in 1999 to 12.06% in 2014 [1]. This caused a large drag effect on Taiwan's economic development, particularly considering the rapid price increases for international fossil energy. In addition, even with the recently increased supply due to discoveries of new reserves, such as shale gas, and shale oil in North America, as well as shale oil in many other countries, the gradual depletion of fossil

fuels is inevitable. These issues increase the vulnerability of Taiwan's energy security. Fig. 1 shows the supply and consumption of energy in Taiwan in 2014, with the major energy sources being petroleum, 48.5%, and coal, 29.2%. The major energy consumers are industrial, 37.7%, and non-energy use, 21.3% [1]. Clearly, traditional use of fossil fuels in Taiwan aggravates environmental pollution and the greenhouse effect. At the end of 2013, Carbon dioxide (CO₂) emissions of Taiwan comprised 0.8% of the world's total emissions, and it ranked 22rd globally [2]. Thus, the development of renewable energy in Taiwan has become increasingly important for the objectives of energy independence and reduction of gas emissions. In addition, this has become a strategy essential to Taiwan's continued economic health.

Since the 2011 Fukushima nuclear disaster, Taiwan's government has been working towards a nuclear energy reduction policy. Influenced by this incident, Taiwan's earlier opposition to nuclear power was further intensified. Former Democratic Progression Party chairman Lin Yi-Hsiung started a hunger strike to protest against the construction of the fourth nuclear energy plant on April 22, 2014. Tens of thousands of protesters gathered in front of Taipei's main train station on April 27, 2014, to oppose the building of the fourth nuclear energy plant and urge the government to abandon nuclear energy. On the same day, President Ma Ying-jeou decided the fourth nuclear energy plant would have its first reactor sealed after the completion of safety checks and construction on the second reactor would be halted immediately in response to the demands of these protests. This decision pointed to a desire to achieve the goal of eliminating the use of nuclear energy and developing a nuclear-free homeland. Overall, it should be a top priority of Taiwan to develop clean, sustainable, and independent energy while achieving a balance between energy security, environmental protection (reduction of greenhouse gases), industrial competitiveness, and economic development. Sustainable energy development energy efficiency, economic development and environment protection (3E) should be balanced to achieve a win-win strategy. The goals of energy policy should be achieved to improve energy efficiency, develop clean energy, and develop a

secure energy supply. The relationship between the 3E is shown in Fig. 2. In sum, the development of renewable energy is the only way for Taiwan to survive in this competitive world.

Further, it is noteworthy that 3E have become more closely linked in the 21st century. In Taiwan, the south has sunny weather while the west coast has abundant wind resources and plentiful rainfall (annual average of about 90 billion tons). Its lack of energy endowment, sunny weather and abundant wind resources point to both a crisis and an opportunity for resolution so Taiwan may become a sustainable community. Taiwan attaches great importance to the development of energy-efficient and low-carbon industries. The government has set a target of energy efficiency of 33% by 2025, which is substantially higher than that of 25%~26% in Japan. Many other countries are also making increased investments in renewable sources of electricity. However, they also face the problem of higher energy prices due to the costs of developing renewable energy. For example, in Britain, electricity from wind farms costs is twice as much as that from traditional fossil fuel sources, and solar power is even more expensive. This has a drag effect on economic development in the more developed countries, and Taiwan will confront a similar problem in future.

The aim of this study is to know which industries should be encouraged in Taiwan because of their higher GDP/EC performance and lower gas emissions, and which industries should be removed entirely or discouraged in Taiwan because of their lower GDP/EC performance and higher gas emissions. Further, Taiwan's renewable energy policies are also addressed in this paper. Tsai [3] addressed the status and development policies on renewable technology in Taiwan. Tsai and Chou [4] concentrated on the utilization and development of renewable energy in Taiwan from the perspective of environmental impact. Wu and Huang [5] reviewed the energy perspective and support mechanisms related to renewable energy in Taiwan. Chen et al. [6] detailed the developing status and renewable energy strategy in Taiwan. Huang and Wu [7] addressed the energy policy in Taiwan, including historical developments, current status and potential improvements. Liou [8,9] investigated policies and legislation driving Taiwan's development of renewable energy and overviewed the photovoltaic technology status and perspective in Taiwan. Lu et al. [10] addressed the energy-saving potential for Taiwan's industrial sector. Chuang and Ma [11] discussed Taiwan's energy policy using multi-dimensional energy security indicators. Chen and Lee [12] reviewed the development of renewable energy in Taiwan. The policies investigated by previous studies in Taiwan are presented in Table 1.

2. Energy security challenges in Taiwan

Taiwan is a densely populated island with a land area of 36,190 km² and a population of 23.1 million. It has the world's second highest national population density with almost no energy

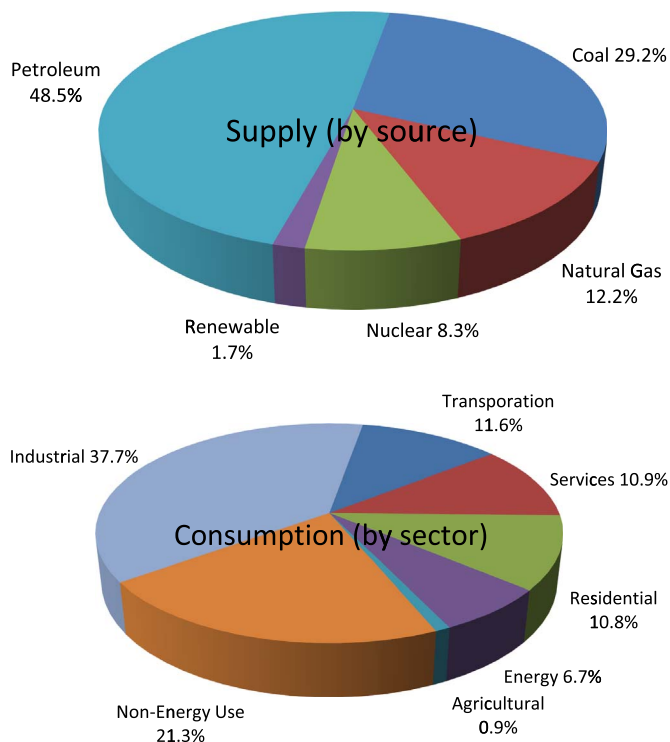


Fig. 1. Taiwan's energy supply and consumption in 2014 [1].

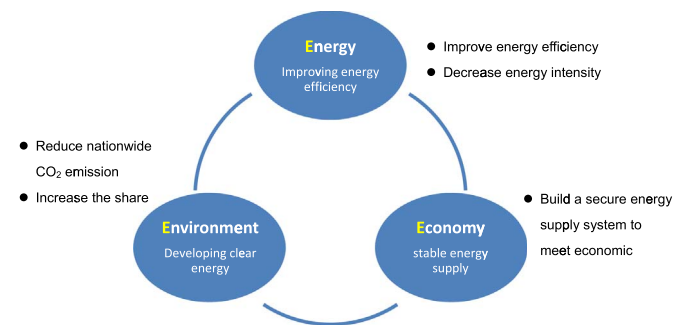


Fig. 2. Framework of Taiwan's Sustainable Energy Policy.

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