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## Development strategy of green energy industry for Taipei—A modern medium-sized city

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### HIGHLIGHTS

- Building energy conservation and electrified transportation are top priorities.
- SWOT analysis applied to systematically conclude four green energy industrial items for Taipei.
- Specifically, electric vehicles, LED lighting, inverter air conditioning, and ESCO.
- 13,040 GWh electricity would be generated per year from Taipei's rich renewables.
- The derivative business opportunities would exceed 700 billion yuan.

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### ABSTRACT

Taipei, a subtropical modern medium city, is essentially featured with high population density, scarce land, and large traffic flow. Moreover, there are abundant green energy resources reserved in Taipei. If they were fully developed, there would be 13,040 GWh electricity generated per year, resulting in a total of 9.37 million tons of carbon dioxide emissions abatement. The development of the green energy industry in this city not only can bring significant energy-saving and carbon-reducing benefits, but also may create huge derivative business opportunities. For example, the total output values of the solar PV and electric vehicles industries would be as high as 700 billion yuan. In this study, through Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, we concluded that the top priorities for Taipei for the development of green energy industries are building energy conservation and electrified transportation, specifically, the following four items: electric vehicles, Light-Emitting Diode (LED) lighting, inverter air conditioning, and Energy Service Company (ESCO). Meanwhile, Taipei is a domestic and international key of politics, transportation, technology, commerce, and finance. Taipei is very likely to become an internationalized green energy industrial hub, achieving the “3E” goals of economic prosperousness, environmental protection, and energy security.

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### 1. Introduction

“Green energy” means clean energy featured with the merits of environmental protection and being pollution free. Here, “green energy” also means no or less pollution for the environment in the processes of energy production and consumption. In other words, after being consumed, the green energy can be naturally regenerated with almost no pollution, like the renewables of solar, wind, hydro and so on. According to the Green Energy Industry Sunrise Program released by Bureau of Energy, Ministry of Economic

Affairs (BOEMOEA) in October 2009 (BOEMOEA, 2009), the narrow sense of the green energy industry may include the following seven energy technologies: solar photovoltaics, LED lighting, wind power, biofuel, hydrogen energy and fuel cells, energy-related information and communication, and electric vehicles. However, under the globally prevalent trends of carbon reduction and energy conservation in order to combat climate change and protect natural environment, the green energy industry covers a further wide range, in addition to the issue of environmental protection. Therefore, the comprehensive definition of the green energy industry should include the all low-carbon energy technologies. Although covering a wide technical range, it does not deviate from the following two major areas: energy conservation and clean energy, for example, the efficiency improvement in the industrial sector and the renewable energy development in the

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energy sector. In terms of the cost effectiveness of GHG emissions abatement, the energy conservation is superior to clean energy. In the essence of green energy industry, the economic benefits of decreased expenditures are far larger than those of increased income.

In 2009, Taiwan launched the Green Energy Industry Sunrise Program (BOEMOEA, 2009). Since then, total 138.4 billion yuan has been invested in 3 years. Overall, Taiwan's green energy industry is globally competitive, including: in 2010, overtaking Japan's 2.5 GWp, Taiwan produced 3 GWp of solar cells, ranked as the world's second place. The yield of Taiwan's LED lighting source is number one in the world, while its output value is ranked second. Moreover, in the industries of LED lighting and solar PV, the entire chains have been established in Taiwan, including the technology development, the system integration, and the application-related services. Moreover, after the domestically complete production of a wind turbine of 2 MWp, Taiwan has become the eighth largest wind turbine manufacturer in the world.

According to the statistics of Ministry of Economic Affairs (MOEA), in 2010, the total output value of green energy industry in Taiwan was 380 billion yuan, representing a growth of 1.3 times by comparing with that of 2008. Meanwhile, at the end of 2010, the employment of green energy industry reached 55,900, increasing 39,900 from 16,000 in 2008. In 2009, Taiwanese government launched a national science-and-technology development plan that had been the biggest ever, called the "National Science and Technology Program-Energy (NSTPE)", with a total budget up to 30 billion yuan for five years from 2009 to 2013. In deep conjunction with the green energy industry development trends and demands at home and abroad, by means of the research and development of basic and applied science and technology, the main purpose of NSTPE is to break through the technologic bottlenecks in the development of Taiwan's green energy industry. In addition, the MOEA has continued driving industrial development such as the new energy storage technology, other key applications, cross-domain integration and innovation of science and technology, and the implementations of solving the difficulties and helping the management in terms of enterprise investment.

Since the Fukushima nuclear disaster in Japan, the promotion of renewable energy has been surging significantly and globally. Ministry of Economic Affairs has proposed two plans, namely, One Million Rooftop PV Systems and One Thousand Offshore Wind Turbines, to expand the domestic renewable energy development and utilization. However, the sound setup of offshore wind power generation has close relationship with the environmental regulations and administrative procedures. Particularly, the interdepartmental cooperation is very important, such as among the Environmental Protection Department, the Council of Agriculture, the Ministry of Interior, the Ministry of Defense, and the Ministry of Transportation. Passed in July 2009, the Renewable Energy Development Act set 6500 MW as the installed capacity goal of RE in the next 20 years (namely, by the year 2025), while that for the year 2030 is 12,500 MW. At the same time, the Green Energy Industry Sunrise Program had targeted 1.158 trillion yuan as the annual output value in 2015, accounting for 6.6% of that in the manufacturing sector (BOEMOEA, 2009). Following the domestic and international trends, this study herein proposed a policy analysis for the development of the green energy industry in a modern medium-sized city, by taking Taipei as example.

## 2. The status and development potential of green energy industry of Taipei

The power generation status of green energy in Taipei was described as the following: hydropower—227.93 GWh/yr; refuse

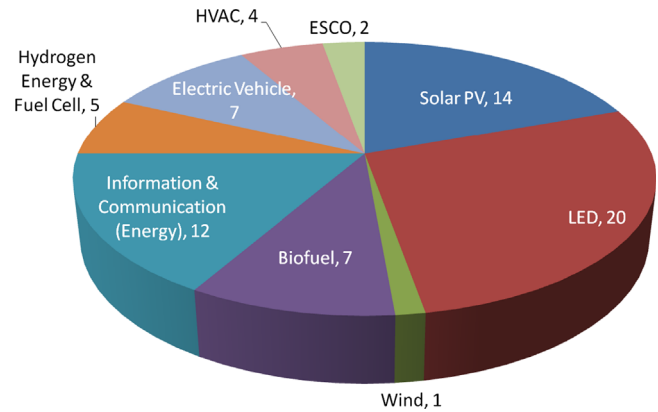


Fig. 1. Taipei's green energy industrial structure. Source: BOEMOEA, 2012.

incineration—245.7 GWh/yr; refuse landfill biogas—19.98 GWh/yr; and Solar PV—0.23 GWh/yr (28 systems). The total power generation of the above green energies is 493.84 GWh, accounting for 3.05% of the city's entire electric consumption (16,168 GWh). The total power consumption of Taipei further accounted for about 9.22% of that of the country. In 2010, the average electric consumption of Taipei—22.23 kWh per day per capita—was much lower than that of Taiwan (28.3 kWh per day per capita). However, the electric demand of Taipei is still increasing. Under this trend, if the share of RE (6%) does not improve, it is quite difficult for Taipei to meet the RE development goal (16%) set by MOEA for 2030 (NCKU, 2011).

### 2.1. Status analysis on green energy industries in Taipei

As shown in Fig. 1, the total of green energy-related companies in Taipei is 72, including 14 for solar PV, 20 for LED lighting, one for wind power, seven for biofuel, 12 for energy-related information-and-communication, five for hydrogen energy and fuel cell, seven for electric vehicles, four for HVAC, and two for energy services (BOEMOEA, 2012). Their products are mostly exported. Thirteen companies are located in Neihu Technology Park, six in Nankang Software Park, and the rests are scattered in various areas. If distinguished by industrial categories, most of them belong to the solar PV and LED lighting industries. Like other enterprises in Taiwan, the offices of green energy industries are mostly located in Taipei, while their production facilities are built in other regions. Currently, the industrial park is divided into Zone A (13.43 ha), Zone B (68.52 ha), and the Great South Bay region. To cluster the green energy industries, a specific zone can be set up in the park or other places, providing more incentives and concessions (such as tax incentives, protection of investor's interests, governmental investment to help raise funds, and other measures) to attract the domestic and international green energy industries. When the manufacturers are increasing, following the establishment of the bunching effect, the green energy industrial cluster can be thereby created.

Currently, there are three science and technology parks in Taipei: Neihu, Nankang, and Beitou-Shilin. Wherein, the turnover of Neihu Technology Park exceeded 3.5 trillion yuan in 2011, while the manufacturers were over 3000. Municipal Government will further integrate the adjacent industrial zones and the small business mixes into a Great Neihu Technology Park occupying a total area of 542 ha, expecting to inject new energy into the research and development of Taipei's industrial technologies. By attracting a greater presence of green energy industries, green energy technology will further improve and the output value of the park will also increase (Wikipedia, 2011).

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