

The Environment Impact Assessment of Renewable Energy in Taiwan

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Abstract

In order to ensure that decision-makers consider environmental impacts before deciding whether to proceed with new projects, the 'Standards for Determining Specific Items and Scope of Environmental Impact Assessments for Development Activities' were formulated and promulgated by Taiwan Environmental Protection Administration (EPA). These were done under the Environmental Impact Assessment Act (1994). This paper examines the requirements that the Environmental Impact Act (1994) places on energy projects.

Introduction

The Republic of China, popularly known as 'Taiwan', is located in the West Pacific between Japan and the Philippines (Figure 1). With a population of around 23 million, Taiwan covers an area of 36,193 km² at about the size of the Netherlands (Ministry of Foreign Affairs, 2012). As an island, 395km from north to south and 144km from east to west, Taiwan has more than its share of natural splendor. 57% of its area is forested foothills with volcanic mountains, tablelands, coastal plains and basins, and many mountains reach over 3,000 m along the central line from north to south (Ministry of Foreign Affairs, 2012). However, Taiwan lacks energy resources and depends heavily on imports.

While no country is immune to the adverse impacts of climate change, research suggests that Taiwan will face above-average risks of global warming if it continues at the current pace. Aware of the conse-

quences of business as usual, Taiwan has taken measures to deal with these. Apart from promoting the development and use of renewable energy, the nation's scientists have teamed up with their foreign counterparts to map out carbon emission concentrations across the globe.

Established in 1987, the Cabinet-level Environmental Protection Administration (EPA) has helped Taiwan to improve the living environment, conserve the nation's natural heritage and raise environmental awareness. Today, Taiwan boasts one of the world's highest recycling rates (45.49% in 2009), an efficient waste management system, and a wide range of wildlife refuges for its endemic species (EPA, 2010).

People of Taiwan have made some of the greatest contributions to environmental protection. The cumulative effect of small lifestyle adjustments has made itself seen in Taiwan's improved track record in environmental protection.

Taiwan's energy supply increased from 58.33 million kiloliters of oil equivalent (MKOL) in 1991 to 138.24 MKOL in 2011, representing average annual growth of 4.41% (Bureau of Energy, 2012b). Fossil fuels (oil, coal and natural gas) constituted 89.33% of all energy supplies in 2011 while nuclear power contributed 8.82%; renewable energy including hydro, biomass, geothermal, solar and wind power accounted for 1.85% as shown in Table 1 (Bureau of Energy, 2012b).

Figure 1: Location of Taiwan



(Source: Ministry of Foreign Affairs, 2012)

Table 1: Energy Supply in Taiwan in 1991 and 2011

Source	1991	2011
Solar Thermal	0.00%	0.08%
Solar Photovoltaic & Windpower	0.04%	0.11%
Nuclear Power	0.00 %	8.82%
Conventional Hydro Power	17.52 %	0.28%
Biomass and Waste	0.63%	1.38%
Natural Gas (inc LPG)	5.05%	11.78%
Crude Oils & Petroleum Products	53.91%	46.17%
Coal & Coal Products	22.84%	31.38%
Total (KLOE)	58.33m	138.24m

(Source: Bureau of Energy, 2012b)

On the demand side, at an average annual growth rate of 3.78% between 1991 and 2011, annual domestic energy consumption has more than doubled from 53.25 MKOL to 111.92 MKOL (Bureau of Energy, 2012). The industrial sector remains the largest user, consuming 45.78% of the total in 2011, followed by transportation at 12.08%, residential at 11.16% and the service sector at 11.06%. Agriculture sector consumed just 0.86% of the total (Bureau of Energy, 2012b). Table 2 provides the comparative figures for 1991 and 2011.

Table 2: Energy Consumption by Sector in Taiwan for 1991 and 2011

Use	1991	2011
Non-Energy Use	10.02%	19.05%
Residential	12.11%	11.16%
Services	10.27%	11.06%
Agricultural	2.63%	0.86%
Transportation	14.73%	12.08%
Industrial	41.11%	38.56%
Energy Sector Own Use	9.13%	7.22%
Total (KLOE)	53.25m	111.92m

(Source: Bureau of Energy, 2012b)

Taiwan relies on imports for most of the energy resources. In 1990, 95.84% of the nation’s energy resources were imported; an amount that

rose to 97.93% in 2011 (Bureau of Energy, 2012b). To remedy this situation, the government is working to raise energy efficiency and to expand the role of renewable resources in Taiwan’s energy portfolio.

The following are the three major targets laid out in the *Framework of Taiwan’s Sustainable Energy Policy*: (1) energy efficiency is to be improved by more than 2% per annum, and by 2015, energy intensity should be 20% greater than 2005 levels; (2) by 2025, carbon-free renewable energy should be the source for at least 8% and low-carbon natural gas for at least 25% of Taiwan’s total electricity supply; (3) nuclear power, as the most readily available source of low-carbon energy at present, should be reconsidered as a viable option (Bureau of Energy, 2012a).

The promulgation of the Renewable Energy Development Act in June 2009, reaffirmed the Taiwanese government’s determination to promote sustainable energy. The act has set a target of increasing the island’s renewable power generation Environmental Protection capacity to between 6,500 and 10,000 megawatts within 20 years (Bureau of Energy, 2012a). In 2011, US\$13.8 billion was allocated to bolster the green energy industry (Bureau of Energy, 2012a). Related measures adopted by the Bureau of Energy (BOE) include providing subsidies for the installation of renewable energy generating facilities, and supporting producers of renewable energy by raising the mandatory purchase price for the electricity they sell.

Solar Power

Taiwan is at the forefront of the production of photovoltaic cells, which convert sunlight into electricity. With around 160 companies engaged in the pursuit of better harnessing the solar power, the nation has become a major exporter of the cells. In 2011, Taiwan’s global market share grew by up to 14.1%, making it the second-largest producer of solar cells globally, after mainland China (Bureau of Energy, 2012c).

Taiwan is also the 5th largest country by installed density of solar water heaters in the world. In January 2009, BOE bumped up subsidies for installing solar water heaters from US\$45 to US\$68 per square meter of solar panel. In 2011, around 530,000 households (6.97% of the nation’s total) had installed over 2.14 million square meters. Official estimates suggest that by 2012, around 570,000 households will be equipped with a total of 2.29 million square meters of solar panels (Bureau of Energy, 2012a).

At the end of 2011, 907 solar power systems with a combined capacity of 88 MW have been installed on structures around Taiwan.

Among these is the stadium that hosted the 2009 World Games in the southern city of Kaohsiung. The 100,000 Solar Rooftops Program launched in late 2009 aims to further capitalize on Taiwan's ample sunshine and warm climate, giving a boost to the photovoltaic industry. By 2012, when the first phase of the program concludes, at least 20,000 buildings will be equipped with solar cells, generating 72,000 megawatt-hours of electricity annually (Bureau of Energy, 2012c).

In December 2009, Taiwan took a big stride towards energy sustainability by opening Asia's largest, and the world's second largest, high-concentration photovoltaic (HCPV) solar power plant in Kaohsiung County. Designed by the Cabinet-level Atomic Energy Council, the plant's 141 large solar cells have a combined annual capacity of 1 megawatt. Yet this structure soon will be dwarfed by a similar system. Also in sunbathed Kaohsiung County, a 4.6-megawatt solar power plant comprising 4,600 photovoltaic panels is being built by the state-run Taiwan Power Company. The inauguration of the plant in summer 2011 was expected to nearly double the nation's installed solar capacity (Bureau of Energy, 2012c).

Wind Power

Since the first commercial wind turbine was installed in Taiwan in 2000, now about 288 sets of wind turbines have been installed by the government and private firms on the west coast of Taiwan and the Penghu Islands, areas seen as 'gold mines' for wind. Data compiled by the Global Wind Energy Council shows that in 2011, Taiwan's installed wind power capacity grew fast to 563.8 MW, the fourth-highest in Asia (Bureau of Energy, 2012c).

To stimulate growth in wind power supply and spur investment in the field, the mandatory purchase price for wind produced electricity (off-shore) was US\$ 0.245/kWh for 1 to 10 kWh and US\$0.0866/kWh for more than 10 kWh in 2012, and the guaranteed trading period, in which utility companies are obliged to purchase electricity from these producers was extended from 15 to 20 years (Bureau of Energy, 2012c).

Biofuels

Around the world, nations are turning to biofuels produced from plant materials as renewable alternatives to fossil fuels. Among the wide variety of biofuels used around the world, Taiwan is focusing on biodiesel and bioethanol.

In July 2008, Taiwan became the first country in Asia to require all diesel vehicles to use 'B1' - a 1-percent biodiesel blend. According to the BOE, the use of this fuel will lower diesel consumption by 3.85 million liters a year and GHG emissions by 126,000 tonnes. In June 2010, the BOE raised the bar again by doubling the percentage of biodiesel, making 'B2' the standard fuel for all diesel-powered vehicles (Bureau of Energy, 2012c). It estimates that this plan will boost the consumption of biodiesel in Taiwan from 40 million litres to 100 million litres annually. Since most biodiesel consumed in Taiwan is produced from waste cooking oil or agricultural waste (such as rice straw) rather than from cultivated maize or sugarcane, it does not threaten food security.

With respect to the development of bioethanol, the Council for Economic Planning and Development has announced that by 2011 a 3% ethanol-blended gasoline (E3) will be available nationwide. Expanded use of this fuel, enabled by an increasing number of E3 fueling pumps around Taiwan, is expected to lower CO₂ emissions by 210,000 tonnes per year (Bureau of Energy, 2012c).

Environmental Impact Assessment System

The Environmental Impact Assessment Act of Taiwan was promulgated in December 1994. EIA involves the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to making major decisions and commitments. The purpose of the assessment is to ensure that decision-makers consider environmental impacts before deciding whether to proceed with new projects. The processes and goals of EIA are noted below.

First it is a requirement that a simple EIA system be established and regulations formulated. This requires the government to formulate and promulgate relevant regulations, such as 'Environmental Impact Assessment Act Enforcement Rules', 'Standards for determining specific items and scope of environmental impact assessments for development activities', and 'Guidelines for environmental impact assessments for development activities' to form the legal basis for EIA. To standardize EIA procedures, items and scope of air pollution, water pollution, noise, vibration, plant ecology, animal ecology, marine ecology, cultural assets and risk assessment of poisonous substances, a set of EIA standard operation procedures are to be provided for development/construction companies. Regulations governing the EIA of industrial zone developments, the establishment of cultural, educational or healthcare agencies, and extraction of earth and gravel are required to be formulated for the reference of envi-

ronmental protection departments when they review and process applications.

Second, the government is to ensure that environmental consequences of a government policy are identified and assessed before authorization is given for implementation. This is aimed at helping competent authorities to reasonably employ measures of quota control and environmental resources, and enhance the implementation of the EIA and the management system.

Third, after the EIA reports are completed, the government needs to follow up, monitor, and ensure that the development/construction companies fulfill environmental management programs. Also, the government is required to organize professional training courses for environmental protection staff so they can enforce management more effectively.

Fourth, information regarding the EIA is to be publicized and available to the public. Construction/development companies are required to hold public conferences or hearings when conducting evaluations. When the construction/development applications are submitted to competent environmental protection authorities, the written EIA report is to be uploaded to websites for the public or interest groups to give and share their comments, which will serve as references for the Environmental Impact Assessment Committee.

Since it has been promulgated, more than 1,200 development projects have been reviewed. In order to sound the EIA implementation and management system, the Health Risk Assessment Technical Standards have been formulated and announced in 2010. A supervisory committee has also been set up to handle large-scale development projects. Through the EIA expert panel mechanism, related meetings are held to obtain expert recommendations regarding controversial aspects pertaining to the environmental impact assessment review process in order to raise its quality and efficiency. In this study, the effects of EIA on development of renewable energy in Taiwan were investigated and some suggestions were proposed.

EIA Regulations

Strategic Environmental Assessment (SEA)

A new government energy policy under the strategic environmental assessment (SEA) aims to avoid the destruction of natural ecosystems and to protect public health or safety. A SEA is to be conducted with respect to energy policies when there is any adverse environment impact concern,

evidenced by any one of the following circumstances which may result from policy implementation:

1. The ability to handle environmental impact at the local level is exceeded.
2. There is damage to a natural ecological system.
3. Public health or safety is endangered.
4. Reasonable exploitation of natural resources is jeopardized.
5. Water resource systems are altered, affecting water quality and hindering the use of water bodies.
6. The harmony of the natural scenery is impaired.
7. Other situations arise involving violations of international environmental standards or which impede sustainable development of the environment and ecology.

Policies on environmental impact assessment shall also duly consider the interconnectivity and cumulative outcome of all such circumstances. The organizations shall provide an assessment report and record the following items:

1. The names of the policy research organization and of other related organizations.
2. The name and purpose of the policy.
3. The background and constituent matter of the policy.
4. Alternative plans and analyses.
5. An appraisal of the possible environmental impact of the policy itself.
6. Response strategies for the mitigation or prevention of any adverse environmental impacts.
7. Conclusions and recommendations.

Standards for Determining Specific Items and Scope of Environmental Impact Assessments for Development Activities

In order to ensure that decision-makers consider environmental impacts before deciding whether to proceed with new projects, the 'Standards for Determining Specific Items and Scope of Environmental Impact Assessments for Development Activities' were formulated and promulgated by Taiwan Environmental Protection Administration (EPA). Under these, where one of the following circumstances applies with respect to the development of renewable energy sources, an EIA shall be conducted:

1. The construction or expansion with additional generating units, of a hydroelectric power plant, and one of the following conditions ap-

plies (EPA, 2009):

- a. The site is located in a national park.
 - b. The site is located in a wildlife preserve or an important wildlife habitat environment.
 - c. The site is located in the national wetland.
 - d. The site is located in the Taiwan coastal nature reservation area.
 - e. The site is located more than 1,500 meters above sea level.
 - f. The site is located in water catchment area of a dam or reservoir.
 - g. The site is located in a tap-water water source quality and volume protection area.
 - h. The amount of power to be generated amounts to 20 thousand kilowatts or more.
2. The installation of wind power generation units and one of the following conditions apply:
- a. More than 20 wind turbines in the same preservation or protection area.
 - b. The site is located in a protection forest.
 - c. The straight-line distance between the nearest building and the wind turbine is within 250 meters.
 - d. All offshore wind turbines.

In order to encourage the development of renewable energy, there are some exclusions, such as, energy plants from tides, currents, waves, and ocean thermal energy conversion (OTEC), and solar panels or geothermal energy in pilot scale.

EIA Review Focus Points-Wind Turbines Focus

Noise Control: Noise control can be divided into construction period and operational period. Developers are required to evaluate noise sources in planting, underground transmission and distribution line construction, pile construction, and assembly work, and should be able to simulate the equivalent sound level or the day-night equivalent sound noise during construction period. If the simulation value exceeds the noise control standards, developers have to develop control strategies to reduce noise during the construction period. Low-frequency noise is the most important environmental factor during the operation period. Developers should simulate the maximum low-frequency noise from all wind turbines. If the simulation value exceeds the noise control standard, developers are to put in place control strategies to reduce it or to buy the nearest building. Developers who do nothing will see their project not approved.

Vibration Control: Developments may cause varying degrees of impact on humans and buildings. Vibrations may lead to serious cracking in buildings and cause conditions that do not enable people to sleep or which cause other negative physiological phenomena. Developers would be allowed to proceed only during day time if vibration risks affect humans. The vibration increment during the operation period would be requested to have no influence to the nearest household.

Shadow Flicker: Shadow flicker is the visual impact of wind turbines during the operation. Due to sunshine and blade rotations, wind turbines cause intermittent shadows to have visual impacts on nearby areas, causing discomfort to human beings. Shadow flickers are also considered an important factor in EIA review.

Communication Interference: Any large structure can cause electromagnetic interference. The electromagnetic interference signals would be caused by refraction from wind turbine blades. The Doppler Effect from blade rotation is the main interference. Most metal blades would likely lead to electromagnetic interference, so glass fibre reinforced plastic material is better for fabricating blades; the more glass fibres there is, the less the interference. In addition, wind turbines would not be allowed to be located in the main communication transmission path.

The Impact on Birds: The impact of wind turbines on birds, mainly to reduce the bird habitats, changes in flight path and collision casualties caused directly or indirectly, cause changes in the bird population size (Everaert, 2007). Birds may be hurt mainly from migratory flight collision; their habitats may also be destroyed (Kerlinger, 2005). Therefore, the location and height of wind turbines would be considered a critical factor to bird ecology.

Concluding Remarks

Faced with global and domestic challenges, Taiwan is entering a transformation point in its sustainable development. Working under the vision of 'blue skies and green earth, verdant mountains and pristine water, and health and sustainability', the EPA has developed concrete measures based on its five core policies including (1) building a sound structure to promote sustainability, (2) saving energy and reducing carbon emissions to cool the earth, (3) recycling resources to achieve zero waste,

(4) eliminating pollution to protect the ecosystem, and (5) cleaning neighborhoods and promoting lifestyles of health and sustainability.

Taiwan is willing to abide by international conventions and shoulder its responsibilities and duties. Through this, it hopes that the international community will support Taiwanese EPA's participation in international conventions so that it could share its experiences with the world, and contribute more towards the international community. The EIA Promulgation and the regulations thereunder are aimed to provide concrete evidences of Taiwan's seriousness in this regard.

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