Introduction to Green Building Policy in Taiwan

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Abstract

This paper briefly introduces the green building policy and its practices in Taiwan. The policy includes the establishment of the green building evaluation system and labeling system that can accommodate subtropical and tropical climatic conditions and a series of green building promotion programs. The promotion programs cover a wide range of implementation on new buildings, existing buildings, building materials, education, training, as well as international cooperation and exchange. The promotional experiences in Taiwan can be provided as a strong reference in policy-making, budgeting, and administration for national green building development, particularly for subtropical and tropical countries.

Keywords

Green Building, Policy, Subtropical

1 Background

Over the past decade, green building has become one of the most efficient measures to pursue a sustainable built environment. Various evaluation methods, assessment tools, and certification systems were developed worldwide. Taiwan, such as some developed countries, confronted with both global and local challenges of climate change and environmental impact. Therefore, the government had to take concrete actions to ensure a better living environment and the nation's sustainable development. In 1995, the Architecture and Building Research Institute (ABRI), established under the supervision of the Ministry of the Interior, was the organization dedicated to be in charge of architectural research in many aspects, including planning, disaster prevention, fire safety, structural engineering, construction technology, as well as building environmental control. In response to the public concern of the deteriorating living environment, the ABRI proposed the Green Building and Living Environment Technology Research Plan that initiated green building related research projects, including energy saving, water conservation, waste reduction, and ecological environment protection. One major outcome of the research plan is to establish a green

building evaluation system that is capable of accommodating subtropical/tropical climate and local environmental issues in Taiwan. The system was announced in 1998. One year later, a labeling system for green building certification was established as well. The evaluation and labeling system was thus adopted by the Ministry of the Interior as a national standard for green building certification. It was still a voluntary mechanism in the very first two years, however.

The turn point was in 2001 that the evaluation and labeling system became a mandatory regulation. The Green Building Promotion Program ratified by the Executive Yuan, which is the major green building policy in Taiwan, required green building certification for all new buildings in the public sector. The mandatory requirement started from the central government buildings and extended to all public-owned buildings in 2003. Furthermore, the green building regulation was officially involved into the Building Regulation in 2004 and has been effective since January 2005, which means compulsory green building design was extended to the private sector. In addition to green building design, building materials are one of the major components of the entire building industry. Therefore, a green building material evaluation and labeling system was established and implemented in 2004. In July 2006, at lease five percent of green building material utilization was adopted in the Building Regulation too. All the efforts that have been lasting around ten years reveal a new opportunity for constructing a more sustainable living environment and upgrading the traditional building industry.

Prior to discussing the Green Building Policy in Taiwan, several local environmental issues should be addressed. First of all, recent studies showed that the climate in the cities of Taiwan was getting warmer and warmer because of inappropriate policies for urban environment and building industry in the past. Overcrowded urban population, shortage of green spaces, impermeability of the living environment, and inefficient building design for energy consumption have all caused the very climatic problem. The higher temperature of the urban environment significantly aggravates cooling energy consumption and carbon dioxide emissions, and accelerates the green house effect in the city. Besides, Taiwan is highly dependent on imported energy, which percentage is over 97. The building industry accounts for almost 29 percent of nation's total energy consumption. Therefore, the green building evaluation system and policy needs to be incorporated with proper building energy saving techniques and regulations.

Second, Taiwan receives abundant rainfalls that the average annual precipitation is more than 2,500 mm. The amount of water per capita, however, only reaches one sixth of the world's average. According to the United Nation's records, Taiwan is typically one of the areas lacking of water. Therefore, from water resources perspectives, the green building policy and its related strategies in Taiwan should be focused on water conservation and reuse issues.

Third, the immense market of reinforced concrete building, that occupies more than 90 percent of the entire construction market, is one of the biggest environmental killers in Taiwan. Reinforced concrete construction is essentially considered as a high-polluted building method for its enormous energy and resource uses. Despite the aggregate market of 110 million tons per year in Taiwan, legal aggregate excavation can only supply 42% (46 million tons) of the actual demand. It implies that 58 percent aggregate

is obtained from illegally excavated sources. Even worse, 80 percent of the alleged illegal aggregate is reported excavated from rivers. The fact not only makes Taiwan the second highest rank of cement consumption in the world, but also indirectly brings on many disasters, such as flooding, landslides, and bridge collapses. The large amount of cement uses also results in the generation of 11 million tons of construction wastes per year.

With respect to the evaluation system for building environments, a variety of environmental assessment methods have been proposed over the last decade. The compatibility of these systems that are developed within temperate or frigid regions with Subtropical Taiwan, however, needs to be investigated. The evaluation system for green buildings in Taiwan should be simplified and localized, in order to accommodate with the climatic characteristics (high humidity and high temperature), and correspond to Taiwan's local environmental issues, energy saving and water conservation, in particular.

2 Green Building Evaluation System

Green building is now a specific term for environment-friendly and sustainable buildings in Taiwan. Its definition is a healthy and comfortable building that is capable of efficiently reducing the consumption and natural resources, and the pollution caused by wastes during the life cycle of the building. In this way, Green Building does not only mean to put plants around buildings, but also reveal an overall and sustainable design concept.

In order to examine the environmental performance of the building, an appropriate evaluation system that is accommodating with the subtropical/tropical climate in Taiwan should be developed. Therefore, the ABRI came up with an evaluation system for Green Buildings that was first announced in 1998 and comprised of seven evaluation categories, green, soil water content, energy saving, water conservation, CO2 emission reduction, construction waste reduction, and sewer and garbage improvement. Over the past few years, the ABRI modified the evaluation system via further introducing two new indicators in addition to the original ones, Biodiversity and Indoor Environment Quality. An evaluation system, integrated with nine categories, was thus established in 2003. These indicators can be divided into four categories, Ecology, Energy Conservation, Waste Reduction, and Health (known as EEWH system). The evaluation indicators are listed in Table 1.

Table 1 - Indicators for Green Building Evaluation in Taiwan

Climate	Water	Soil	Energy	Materials	Indicators	Evaluation Items (unit)
*	*	*	*		1.Biodiversity	Ecological net, biological habitat, plant diversity
*	*	*	*		2.Green	CO2 absorption（kg-CO2/(m2.40yr))
*	*	*	*		3.Soil water content	Water contentment of the site (-)
*	*		*	*	4.Energy conservation	ENVLOAD、Req、PACS、energy saving techniques
*		*	*	*	5.CO2emission Reduction	CO2 emission of building material（kg-CO2/m2）
		*		*	6.Construction waste reduction	Waste of soil, construction, destruction(-), recycling material(-)
		*	*	*	7.Indoor Environment Quality	Acoustics, Light and Ventilation, Building Materials
*	*		*		8.Water conservation	Water usage (L/person), hygienic instrument with water saving (-)
	*			*	9.Sewage and garbage	Sewer plumbing, sanitary condition for garbage gathering

Source: Chen et al, 2004

The above nine indicators are evaluated independently in order to reply to the various environmental impacts upon the earth. Each category has some quantitative calculation methods, equations and criteria for the evaluation judgment. This system has been simplified, quantified and localized for the subtropical climate of Taiwan and is regarded as a standard evaluation method for Green Buildings by the Taiwan Government. Quantitative indicators and the corresponding criteria are described as follows.

2.1 Biodiversity

Biodiversity is the first indicator of the revised evaluation system. The evaluation items include ecological nets, biological habitats, plant diversity, and soil ecology. Since the purpose of this indicator is to protect biodiversity and environmental balance in a large-scale ecosystem aspect, the indicator is not applied for the development site that is less than two acres. The standards for passing the indicator's requirements vary by the area where the site is located. The environment surrounding the site is more sensitive; the qualifying threshold for this indicator is higher.

2.2 Green

The Green indicator introduces the CO_2 absorption factor as the conversion unit for different types of plantings, such as trees, shrubs, climbers etc. The CO_2 absorption factor, which is evaluated over a building life cycle of 40 years, can quantify any types of green design because the total planting effect can be converted into a single CO_2 absorption index. As a qualified green design for Green Building, the total CO_2 planting absorption should reach a high level, with a planting rate greater than 50% of its open space and a CO_2 absorption efficiency higher than 600 kg-CO_2/(m^2.40yr).

2.3 Soil Water Content

The Soil Water Content indicator is introduced for maintaining water retention and

infiltration of the building site. An index for the permeable ratio λ of a constructed site in comparison to a bare site is adopted to evaluate the water content capacity of the site. The calculation of the permeable ratio λ is expected to encourage permeable pavement, ponds, permeable lowlands, and gardens on impermeable floors or rooftops in the site design. A building project can pass the requirement of the indicator if the permeable site design is greater than 80% of its open space.

2.4 Energy Conservation

The Energy Conservation indicator is the most sophisticated field in the Green Building evaluation system. This indicator mainly focuses on the energy performance of the building envelope, cooling, and lighting, which occupy over 80% of the total building energy consumption. The building envelope energy performance evaluation is quite convincing because the evaluation method, ENVLOAD (thermal load of envelope) and Req. index, have been involved in the Building Regulation of Taiwan. The PACS (Performance of Air Conditioning System) method is also well established in the air conditioning field in Taiwan. The lighting energy can easily be evaluated based on the average illumination usage calculation per square meter of floor area. In the Green Building evaluation, the energy saving rates for these three indices, the building envelope energy performance, cooling and lighting, should be greater than 20% of the average energy consumption.

2.5 CO_2 Emission Reduction

The CO_2 Emissions Reduction indicator is an important tool for reducing pollution emissions through a clean building materials and construction design. A Green Building candidate should emit 10% lower than the average CO_2 emissions from reinforced concrete buildings through a more logical and efficient design for the structural system and low energy materials. This evaluation can especially encourage lower environmental impact structures, such as lightweight steel structured buildings, industrialized construction methods or wooden buildings.

2.6 Construction Waste Reduction

The Construction Waste Reduction indicator is utilized in evaluating solid waste and particle pollution, from basement excavation, construction and demolition in the life cycle of the building. A certified green building or project is required to cut 10% of the soil waste, construction waste, destruction waste, and to reduce 40% of the construction particles, in comparison with the average waste emissions from reinforced concrete buildings. This evaluation can encourage more natural site design with fewer landscape changes, less basement excavation, and low pollution construction, such as industrialized building methods and steel or wooden buildings. Recycled materials, such as recycled blocks, tiles, aggregate, are particularly encouraged in the destruction waste evaluation.

2.7 Indoor Environment Quality (IEQ)

The Indoor Environment Quality indicator focuses on the evaluation concerning

building acoustic environments, lighting and ventilation environments, as well as building materials. The indicator also encourages the utilization of green building materials, which are natural, ecological, and recycled. The criteria are developed based on an expert system approach. The summation of the score of each evaluation item multiplying by its corresponding weight factor can be calculated. The full score, without extra credits, is 108 points. A building obtaining 60 points can be considered passing the IEQ indicator.

2.8 Water Conservation

The Water Conservation indicator is aimed at saving water resources. Many types of water saving hygienic instruments, such as water closets, bathtubs, showers, etc., are encouraged in the evaluation. Water recycling systems for wastewater or rainwater are especially encouraged in the calculation as well. As a certified green building or project, the calculated saving rate for water resources should be greater than 20%, or the adoption rate of water saving instruments should be greater than 80%.

2.9 Sewage and Garbage Improvement

The Sewage and Garbage Improvement indicator does not evaluate sewer and garbage biotechnology but focuses on the landscape design or detailed improvements for sewer plumbing and sanitary condition of garbage holding areas. This indicator involves stringent regulations for proper sewer and daily use water plumbing, and evaluates the landscape environment and garbage recycling system in residential communities.

In addition to the evaluation system, the ABRI also developed a Green Building Labeling system for green building certification. The Green Building Labeling System consists of two parts: Green Building Label for completed buildings, and Green Building Candidate Certificate for building projects. The minimum requirement for Green Building certification is to pass two prerequisites (energy conservation and water conservation), and two optional indicators from among the other seven indicators. To date, 115 buildings have been certified as Green Buildings, and 937 projects have received Candidate Certificates. Total building floor areas reached 12.30 million m2, electricity saving 333 million KWH that equals to 219 million CO_2-kg, and water saving 13.57 million ton per year.

3 Green Building Promotion Program

Since sustainable development became the major policy of Taiwan government, the Executive Yuan of Taiwan established the Commission on Sustainable Development in 1996 to come up with related guidelines and programs. The concept of Green Building and its corresponding policies were thus initiated and being involved into the National Development Plan-Challenge 2008 as one of the major priority works. The objective of the program is to promote green buildings that can protect ecological environment so as to build Taiwan as a “Green Silicon Island.” These policies essentially forge a comprehensive mechanism providing resources, research, guidance, training, and education to support the adoption of green building in Taiwan. The major work emphasizes on site ecological environment technology, construction waste reduction, building energy conservation, natural resource usage, indoor environmental quality

control, and green building demonstrative projects. The contents of the Green Building Promotion Program in Taiwan are summarized as follows.

3.1 Mandatory Green Building design for all new buildings

The promotional strategy is to initiate green building design with public buildings and to encourage private sectors to adopt the green building concept, so as to gradually evolve a mechanism for the entire building industry. Mandatory green building design for all new governmental buildings of central government was required in 2001, and for local government buildings in 2003. These regulations have shown a significant saving on electricity and water consumption. In comparison with the governmental budget for green building certification, only 43,750 US dollars per year, the benefit cost ratio is actually great than 110. The policy proves to be a very efficient measure to promote green building and to enhance the performance. Further in 2004, the Building Regulation involved a green building chapter and became effective since 2005. The overall green building regulations was thus completed.

3.2 Subsidize Green Building Improvement Projects for Existing Buildings

Existing buildings possess a dominated percentage of all buildings in Taiwan. Therefore, the green building remodeling work is one of the major promoting items in the Green Building Promotion Program. By the end of 2005, 64 green remodeling projects have been undertaken for official buildings and public schools. The green remodeling projects include (1) the building envelope energy saving improvement work, such as rooftop heat insulation and installation of sun shading devices, (2) the ecological protection work, such as the increase of permeability and the application of constructed wetlands combined with the function of wastewater treatment and reuse, (3) the adoption of water efficient appliances, etc.

Several remodeling cases are illustrated as below. Figure 1 presents one of the green remodeling projects for governmental buildings in a before-and-after context. The left picture shows that the original planting area, and the right one shows that the utilizing the crushed waste concrete as permeable pavement materials of parking lots. This is one of the strategies to adopt recycled materials and to remain the permeability and capability of water retention of the building site.

Figure 1- Example of green remodeling project

From 2002 to 2005, the projects also replaced with more than 3,000 water-saving

faucets and toilets that totally conserved 30% to 60% water resources, shown in Figure 2, and installed rainwater reuse facilities. One example in Chiang Kai Shek Memorial Park shows the water reuse for irrigation can save 3,000 USD water bills and slow down the storm water for about 1.5 hours, as Figure 3.

Figure 2-Utilization of water-efficient appliance in all remodeling projects

Figure 3- Installation of rainwater reuse irrigation facilities

The other important program of the Green Building Policy is the HVAC improvement project. By the end of 2005, the ABRI has completed 62 buildings with air-conditioning improvement projects. Its procedure is, first, to measure the performance of existing systems. The second step is to analyze the air-conditioning load and its type. The optimal capacity for efficient operations can thus be estimated. Total energy saving can reach 40 percent. In addition to green remodeling and HVAC improvement projects, three pilot projects for IEQ and energy saving have been completed as well. Besides, 257 projects for building envelope and heat insulation and more than 10 projects for indoor air quality improvement were completed over the past four years as well.

3.3 Technology Development, Promotion, and Commercialization for Recycling Building Materials

The ABRI established the testing and processing laboratories for recycling building materials and initiated with plans for product promotion and commercialization. A variety of recycling building materials have been developed under the support of this program, including compressed concrete paving units, recycled grid bricks, wood-like building materials, fire resistance boards, etc. The program will focus on the mechanism for technology transfer and mass production of recycled building materials in the next stage.

3.4 Establish Green Building Material Evaluation and Labeling System

The Green Building Material Evaluation and Labeling System was launched in March

2004. Four types of materials can be considered as green building materials, which are able to agree with ecological, healthy, recycled, and high-performance (for example, high permeability and noise insulation) concepts. Supported by this system, the indoor environment quality of buildings can be gradually enhanced through the increasing adoption of green building materials.

3.5 Promote Green Building Concepts to Architects, Professionals, and the Public

The ABRI promotes the green building concept through a series of activities, including seminars, training courses, conferences, technical tours, excellent Green Building Award competition, and Green Building Expo. All of these efforts are expected to efficiently transform the built environment in Taiwan.

3.6 Green Building Chapter in the Building Regulation

Following the mandatory regulation of green building in the public sector, the green building design requirement was officially involved into the Building Regulation in 2004 and has been effective since January 2005, which means compulsory green building design was extended to the private sector. At the first stage, the design standard in the Building Regulation is slightly less than that of the green building evaluation system in order to achieve a wider promotion and application. Moreover, at lease five percent of green building material utilization has been adopted in the Building Regulation since July 2006.

3.7 International Cooperation and Knowledge Transfer

In order to promote the development experiences and latest research of green building, the ABRI assisted in forming Taiwan Green Building Council as an exchange platform and joined World Green Building Council. Through actively participating in major international events, working meetings, presentations, and discussions, the green building evaluation tool and design concepts for subtropical regions can be shared with the international communities. The ABRI also regularly conducted green building forums and annual subtropical green building international conference, so that the information of the advanced research and innovative technology undertaken by many scholars and professionals in the countries of subtropical and tropical climate zones can be transferred and learned from each other.

4 Conclusions

All the regulations and projects derived from the green building policy are expected to carry out a dramatic conversion in the traditional building and material industries. The policy also brings out many opportunities for architects, professional consultant services, and the entire construction industry. For example, for architects and professionals, today we may declare that “know nothing about green buildings, get no cases for your business.” Moreover, in the building market, we can hardly find any 12-litre toilet since it has been replaced by new water efficient appliance. The market of water efficient appliance has actually been rising about 40%. In conclusions, for promoting green building design, the government has developed some relevant programs. For example, a

standard manual for Green Building evaluation was published and distributed widely to building designers, teachers, architects and contractors trained in Green Building design. Meanwhile, all of new buildings in Taiwan, both in the public and private sector, are required with mandatory green building design. Based on the promotion program, many green remodeling and improvement projects for existing public buildings and schools are currently in progress. Significant savings on electricity and water resources have been achieved year after year. The Green Building policy in Taiwan has proved to be a crucial path toward a lower environmental impact and more sustainable future for our descendants. The ABRI will continue strengthening and extending the green building policy to green community, green city, and, ultimately, green country.

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6 Presentation of Authors

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