

# Existing plant green building certification trends - in Taiwan

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**Abstract**—Economic development has resulted in densely constructed buildings in urban area, high energy consumption, global warming, and greenhouse gas. In order to mitigate the environmental impacts resulted from urbanization, the concept of environmentally-oriented "green building" has emerged, aiming at reducing pollution, saving energy and respecting the natural environment. The green building has been promoted in Taiwan since 1999, and the evaluation of Green Factory "GF" has been created since 2012. This paper reviews the cases of the existing technology factory buildings obtaining the green building label in Taiwan, and provides empirical learning in promoting green buildings based on the existing factory buildings according to the implementation strategy and problem solution.

**Keywords:** Green Building, Label certification, Existing plant, Green Factory

## INTRODUCTION

High-tech plant buildings are characterized by high energy consumption, which are the main object of active popularization of green buildings in many countries. Taiwan has been implementing the green building label certification system for 13 years. Until February 2013, 1,004 applications have obtained the "green building label", including 158 private sectors, which are mostly residential buildings. Take Hsinchu Science and Industrial Park as an example, there are 485 manufacturers in the park, but there were only 17 green building labels (excluding candidate labels) up to 2012. In other words, there is still a large room for improvement. This study reviews the high-tech plant buildings with the green building label in Taiwan as the subjects, and concludes the factors in success from the implementation strategy and problem solution. The findings can provide empirical suggestions on promoting green building label certification.

## INTERNATIONAL GREEN BUILDING DEVELOPMENT HISTORY AND TAIWAN'S EVALUATION AND CERTIFICATION SYSTEM

The advanced countries around the world have developed the originally integrated universal version applicable to all buildings into different types of green building certification systems. For example, the U.S. LEED aims at the improvement of energy efficiency and energy

saving, proper application of resources and materials, indoor environment quality and environmental carrying capacity, with nine evaluation versions. The Japanese CASBEE aims at "global environment preservation", "affiliation of surrounding environment" and "healthful and comfortable dwelling environment", with four evaluation versions. The British BREEAM has developed nine green building evaluation versions of European system, emphasizing sustainable development topics of ecological balance, conservation, species diversification, resource recycling, renewable energy and energy saving. Many countries have provided preferable technologies and techniques according to the characteristics of different block types, hoping to implement green building evaluation accurately, and achieve energy saving and carbon reduction effectively.

Green buildings in Taiwan are evaluated by four index groups and nine indicators evaluation system. The four index groups include Ecology, Energy Saving, Waste Reduction and Healthy "EEWH". The nine indicators include greening index; on-site water retention indicator; water resource index; routine energy saving index; CO<sub>2</sub> reduction index; waste reduction index; sewage and waste improvement index; biological diversity index and indoor environment index. They have been divided into five classes of evaluation since 2012, including BC, RS, RN, GF and EC. Taiwan has entered in the new age of green building classification. The system is graded by "overall performance", at least four of the nine indexes should be passed. "Routine energy saving" and "water resource" are two threshold indexes. The authenticator can judge comparative importance and select economical technical combination to attain the green building objective. In order to distinguish the quality of green buildings effectively, and to promote the enterprises to strive for good image and honor, the label grades are divided into qualified, bronze, silver, gold and diamond grades.

The EEWH-RN(Renovation Building) and EEWH-GF (Green factory) are main certification types for the existing technology factory buildings, considering the substantial energy-saving benefit of equipment investment, the special stress is laid on the "performance confirmation system" for building equipments, including EEWH-GF auditing TAB (The

test of the air-conditioning system to adjust the balance). The certification auditing of EEWH-RN is classified into "EEWH Performance Efficiency Assessment Act" and "Actual carbon reduction benefit assessment". This is the milestone in substantial equipment performance confirmation of Taiwan's green building policy.

#### KEY POINTS IN REBUILDING TECHNOLOGIES OF VARIOUS INDEXES

The technologies applicable to rebuilding of nine indexes in the certification process can be described by four index groups. As the reference of selecting indicator and improvement item, the common technologies are described below.

*A Ecological index group: including greening, on-site water retention, biological diversity, etc.*

(1) Multilayer greening, intergrowing jungle: the green area under arbor should be planted with dense shrub as possible, so as to meet the multilayer greening function; (2) three-dimensional greening, roof and balcony greening: perennial climbing plant grows onto the building elevation or roof, and the balcony is designed with artificial flower-stand to increase the greening; (3) ecological green network system continuity improvement: when the green area distribution is relatively dispersed, the continuity is improved by pergola, green pavement or lane greening; (4) increasing plant diversity and indigenous bird-attractive and butterfly-attractive plants: the priority is given to different species and indigenous or bird-attractive and butterfly-attractive plants at the indigenous site, to obtain higher preferential calculation; (5) shaping of inchling habitat: the inchling habitat shaping circles a small "eco-pool" and "concentrated nature" region on the existing green area, or rebuilds the original concrete wall into "eco-paling" and "eco-slope" with porous environment; (6) permeable pavement improvement: interlocking bricks, recycled gravels, waste tires and grass planting bricks are used for making permeable grass planting brick pavement, to improve the greening and on-site water retention capacity; (7) storage seepage pond: a part of idle space on the square at the site and on the green area as storage pond for slow permeation drainage can enhance the on-site water retention capacity.

*B Energy saving index group: including routine energy saving, green transport, renewable energy facilities, etc.*

(1) Shell sunshade improvement: the outside of the opening of external wall and roof is equipped with shading material to shield solar radiation, and to reduce indoor heat load; (2) improvement of external wall and roof insulation: the external wall or roof is equipped with fence flower shelf, and the roof is equipped with thermal insulating material or roof garden, so as to thicken the wall, the earth covering enhances the heat-shielding performance of the building; (3) using energy saving glass: Low-E glass or solar film is used for improvement; (4) plant equipment performance

improvement: new type of high efficiency host machine is installed, air conditioning energy-saving technology is used or machines with energy saving label are used; (5) lighting equipment performance improvement: the lamps with poor luminous efficiency are replaced by high efficiency light source and lamps with high luminaire efficiency; (6) using renewable energy: solar energy equipments can obtain preferential calculation in air conditioning and lighting energy saving evaluation; (7) green transport: the employees are provided with buses and site area shuttles.

*C Waste reduction index group: including water resource, CO<sub>2</sub> reduction, waste reduction, sewage and waste improvement, etc.*

(1) Reuse of old structures: the reserved major part of original primary structures (foundation, beam columns, bearing walls, floors, roof truss or roof) is regarded as the reused space of old structures, the performance improvement of waste reduction can be calculated; (2) durability improvement: the existing equipment pipelines are set up as exposed pipes to prolong the life of buildings and to reduce the difficulty level of maintenance of equipments; (3) pollution control in construction of betterment: the proportion of engineering imbalance earthwork and air pollution control in construction should be considered properly.

*D Health index group: including indoor environment, building materials decoration, staff leisure and health management, etc.*

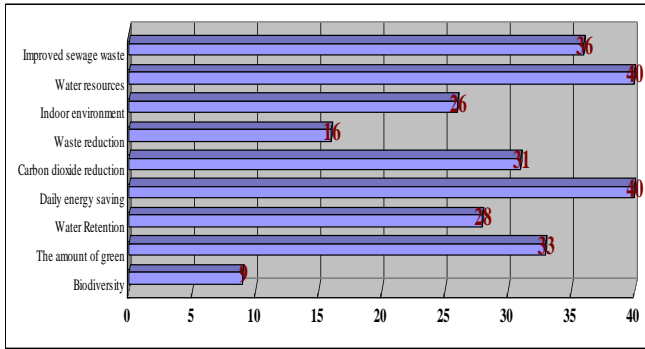
(1) Improving indoor sound, light and ventilation quality: the indoor sound environment can be improved by ceiling sound-absorbing tube, acoustical absorbent, floor buffer material and soundproof airtight window; the light environment can be improved by indoor glare prevention lamps; the ventilation environment can be improved by installing additional ventilating tower or changing fixed window to outward opening window; (2) reducing unnecessary room finishings: the mezzanine ceiling is replaced by exposed ceiling; (3) improving waste management and storage space: adequate space for waste storage, treatment and removal is planned at the site, or a greened or landscaped special centralized garbage field is set; (4) making remedies for large water consuming projects: for the buildings with large area of artificial grass and flower garden and for the large water consuming facilities of fountains, paddling pools and swimming pools, the corresponding water-saving irrigation system, rainwater catchment or reclaimed water utilization facilities are adopted.

#### ENTERPRISE CASE INDEXES AND EFFECT

*A General situation of green building certification classification and indexes of technology factory buildings .*

Various enterprises have their considerations in the existing environmental limit and cost, the expectation of chief

executive and corporate culture requirement, there is acceptability of optimal improvement range and applicability discussed in the certification process, the companies with high popularity mostly pass all of the nine major indexes, and the private enterprises mainly choose feasible index plans according to their abilities. The technology factory building certification indicator item analysis are shown in Figure 1. As seen, biodiversity and waste reduction indexes have more items of not selected indicators.



General situation of application for various indexes

**B Case of Plant 4 of Taiwan Semiconductor Manufacturing Co., Ltd.**

Plant 4 of Taiwan Semiconductor Manufacturing Co., Ltd. is the green factory of green building diamond level in Taiwan, the technologies for passing various indexes and benefits are described below:

1) *Biological diversity index*: the eco-pond and channel are set up, and the water is derived from recycled rainwater and reclaimed condensation water.

2) *On-site water retention indicator*: the permeable design reduces rigid pavement greatly, 100% recycled polypropylene rain plot brick (Figure 2) is used, the scenic trail is paved with plates, more bare land is reserved to restore the strength of moisture absorption of the land.



Rain plot brick

Rain plot brick assembling



Nonwoven fabric implementation

Fig. 2 construction procedures of Rain plot brick

3) *Water resource index*: the process recycling is divided into 25 kinds of recycling system according to the discharge water quality, the water-saving technology is used for industrial water and wastewater reduction, the tap water is

saved by 55%, the landscape watering control of irrigation system combined with rain sensor can save 6,000 tons of tap water for landscape watering and reduce 1,200 kg CO<sub>2</sub> emission annually.

4) *Sewage and waste improvement index*: total waste recovery was 91% in 2010.

5) *Routine energy-saving index*:

a). *The heat pump supplies hot water to the gymnasium, the cold air is supplied for ups electric plate cooling (Figure 3)*: the heat pump system efficiency value cop is as high as 2.5-5.0, the heating cost is reduced by 50-75%, the heat recovery is safe and convenient, the CO<sub>2</sub> emission is reduced as the atmospheric heat and the waste heat of recovery system are absorbed.

b). *Tertiary heat recovery of volatile organic waste gas treatment system (Figure 4)*: VOC stack emission temperature decreases from 250°C to 150°C, the annual gas cost is reduced by about 30,000 USD.

c). *Chiller heat recovery system (Figure 5)*: the initial cost is reduced by about 0.18 million NTD; the annual operating electric power is reduced by 32.1 million kWh, the 12°C chiller waste heat is recovered for 35°C warm water system, the 35°C warm water system is used for preheating outside air conditioning cabinet and reheating coil, exempting the setting and energy consumption of hot water boiler. [7]

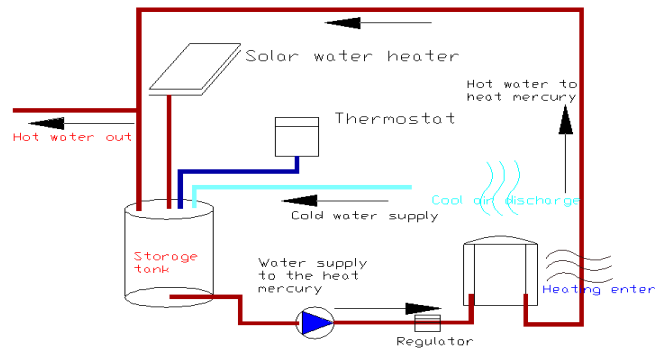


Fig. 3 Heat pump supply energy saving

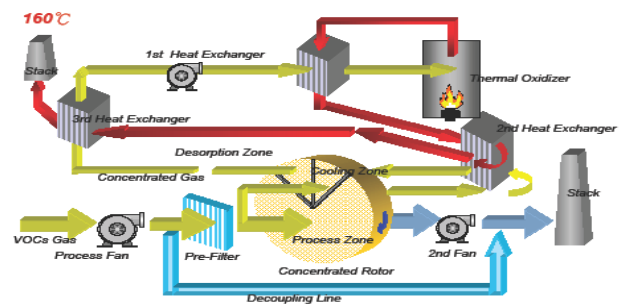


Fig. 4 Volatile organic waste gas treatment and recovery

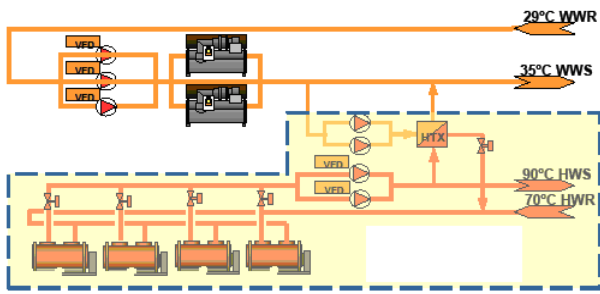


Fig. 5 Chiller heat recovery system

6) *Waste reduction*: the recycling rules are stipulated, the waste paper, glass, plastic, metal, empty material barrel and kitchen waste are classified and recovered.

7) *Indoor environment*: the outside air volume, discharge capacity and temperature and humidity should conform to EPA/ASHRAE 62.1, when the CO<sub>2</sub> content in the control room is greater than 1,000 ppm, the outside air supply is increased to maintain good indoor air quality.

8) *Amount of greening*: multi-level greening of arbor and shrub is adopted at the site, mostly of bird and butterfly-attractive plants.

9) *CO<sub>2</sub> reduction*: the concrete with recycled blast furnace cement is used for waste recovery and carbon reduction, the employees are provided with buses and site area shuttles to encourage ride sharing mechanism, the annual CO<sub>2</sub> emission is reduced by 9,570 MT.

#### CONCLUSION

The engineering of promoting green buildings based on the existing factory buildings should consider the existing conditions and facilities on site, to avoid influencing normal operation. It is difficult to be qualified for the green building label. The implementation and experience of success cases can be learned.

In order to upgrade international image and the plus benefits of foreign customers for enterprise environment energy saving auditing, multiple famous technology factories of Taiwan are certificated by Taiwan's EEWB and U.S. LEED labels, so as to meet international standard.

The building equipment "performance qualification

system" of EEWB-RN/GF reduces the electricity expense most efficiently. It should be developed and popularized actively by Taiwan government and business circles in the future, and should be improved continuously to let the enterprises implement 3E sustainable policy of sustainable environmental protection, sustainable energy and sustainable economy.

The achievement of ICT soft strength and green building are combined, and the information and communication system and equipment are used. The space thus has intelligent function of active perception, so as to implement sustainable energy saving, safe and healthful, convenient and comfortable intelligent green building and green factory industries. Sustainable operation of science and technology industry can thus be promoted.

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