

# **POPULARIZING ECO-BUILDING—AN EFFECTIVE WAY TO IMPROVE URBAN ECO-ENVIRONMENT AND IMPLEMENT SUSTAINABLE DEVELOPMENT**

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**Abstract** Eco-buildings, including eco-toilets, are green buildings that can recycle all organic wastes. It is defined in practice as a building equipped with biogas cleaning chamber, its roof and wall facet greened. The practice of eco-building in Jinhua demonstrates that it can save land, water and energy, and offer better harmony among economic, environmental and social benefits. It is very practical in both urban and rural areas with booming housing development. It is worthwhile to popularize the eco-building nationwide. The role of government is also very important in popularizing the eco-building. The popularization for eco-building is a long-term undertaking, it is therefore necessary to implement it with great care, efforts, intelligence and persistence.

**Keywords** Eco-building, Eco-toilet, Eco-environment, Sustainable development

## **1 Introduction**

Sustainable development is one that satisfies the development of the present generation but subject no potential harms to that of future generations.

To achieve urban sustainable development, we must pay attention, not only to economic development but also to controlling population growth, improving population quality, using resources properly, improving ecological environment, realizing harmonious development of economy, society and environment according to local conditions. Therefore, it is necessary to plan, implement and develop simultaneously the economic, urban and rural, as well as environmental construction, in order to increase simultaneously economic, social and eco-environmental benefits.

In urban sustainable development, a current remarkable problem is that the economic development and social undertakings are well strengthened, while environmental construction is partially ignored. Because the economic development demands various resources such as lands, water and air, etc., the ecological and environmental costs are very high. If we neglect ecological and environmental aspects, economic and social development will be slowed down.

Urban ecological and environmental constructions are a system engineering, it includes strengthening the ecological and environmental consciousness among both leaders and the public, designing the eco-environmental indicators, making eco-environmental economic policies, strengthening eco-environmental management, resolving remarkable eco-environmental problems, and so on. To popularize eco-building is an effective way.

## **2 The Concept and Benefits of Eco-building**

Eco-buildings, including eco-toilets, are green buildings that can recycle all organic wastes. It has three characteristics: (1) there is an underground bio-gas cleaning chamber. It is neither an ordinary bio-gas chamber, nor a usual faeces chamber, but the one comely aimed at cleaning; (2) the roof of the building is covered with soil for planting or small water ponds for raising fish, or equipped with solar energy apparatus; (3) the walls of the building are covered with vertical greenery. We define the concept

of eco-building as the one having all these characteristics, otherwise it can not be called eco-building. Anyway, it is possible that a building is constructed with one of the characteristics such as bio-gas cleaning chamber, roof & wall greenery.

The eco-building has two main merits: firstly, “three savings”, that is, land, water and energy savings. Land savings: since eco-building uses the surface of the roof for planting, fish raising, the land occupied by the building is compensated by exploring the roof space, the compensation rate is usually more than 70%, and sometimes as high as 128%. Water savings; the fresh water after human uses becomes polluted water and is put into the bio-gas cleaning chamber for anaerobic fermentation, the water released from fermentation can be pumped back on the roof for watering the plants or washing something. This makes water resource multi-utilities. Energy savings; the roof is equipped with water heating apparatus driven by solar energy, that saves fuels; bio-gas cleaning chamber produces bio-gas which can be used for cooking and boiling. Secondly, the better integration of “three benefits”, i.e. economic, environmental and social benefits, Economic benefits: (i) the three savings mentioned above can themselves produce economic benefits; (ii) construction cost reductions, the 20-25 cm soil covered on the roof for planting can save the heat-proof floor of the building, decrease the height of the building, and extend the longevity of the building; (iii) the incomes from vegetable and fruit planting, fish raising and warm water service; (iv) incomes from green space; and (v) the input-output effect is good. Environmental benefit; (i) warmer winter and cooler summer indoor. It has about 3 degrees C difference from ordinary buildings in winter and summer, and the top floor is 1 degree C lower than the ground floor in summer; (ii) air is fresh and clean; (iii) there is no bad smell in eco-toilet, and no fly swarms in the faeces chamber. Social benefits; the faeces and waste water are treated in the bio-gas cleaning chamber, and the water released from the chamber is better than State Water Discharge Standard III and very close to Standard II. It has set a new example for diluting and disinfecting the living waste water on the spot, and has stronger feasibility and broader developing prospect.

### **3 The practice of Eco-building**

Facing the increasingly remarkable circumstance of rapid economic development and the environmental problem, Jinhua Municipal Government proposed to let ecological considerations guide the urban and rural construction. We outlined gradually the eco-building concept, put it into practice and developed it continuously. The formation of eco-building concept is a process of learning, practicing, studying, re-learning, re-practicing and restudying, a process of coming from the mass and returning back to the mass with the insistence. We summarized some effective methods from the cadres and mass, improved and refined them and formed finally the framework of eco-building project with careful consideration of urban demands.

The concept of eco-building was first applied to public toilets. From 1990 on, 4 eco-toilets were set up in the urban area with great success, and they have been improved later out. In September 1992, Jinhua eco-toilet technique passed successfully the technological review by the Science and Technology Commission of Zhejiang Province, and was considered a new invention of the country. It was patented in April 1994 by China Patent Bureau. In May 1994, the Ministry of Construction held a conference-in-situ in Jinhua on eco-toilets for the medium and small cities of southern China. The Office Bureau of the State Construction Ministry issued on 6 June 1994 an official announcement Code (1994) 71 *On distribution of “Minutes of the Conference-in-situ at Jinhua on Eco-toilet of the medium and small cities of southern China”* to the Construction Commission or Bureau of every Province, Autonomous Region and Municipality and asking them “to follow the example and popularize the experiences

and techniques of Jinhua Eco-toilet by combining the local actual circumstances". The number of eco-toilets built in Jinhua urban area totals 106 up to the present.

The success of the pilot eco-toilet made a good start for the pilot eco-building development. We developed afterwards eco-buildings for different functions such as office, production, business, school and residential areas, from small volume to large volume, from a single building to a building block. More than 70 eco-building were setup up to November 1998. The Shan-jui-tou tap water of Jinhua is an outstanding eco-building block with 12 eco-buildings covering about 4,625 sqm. Its total floor area is 9,498 sqm, the roof greenery covers 3,553 sqm or 76.8% of the floor area. Fencing walls total 1,154 m length, all covered with vertical greenery. The factory area's green space totals 15,356 sqm, the green coverage rate is 56%. The factory was decorated with the white walls, red roof, clean water and green land that just like a beautiful garden. The factory was ratified as nation's 400 best units for greenery in 1998 by the National Commission for Greenery. In the factory, the faeces and waste water are treated by two bio-gas cleaning chambers of 35 cum, the water released is clean and harmless, the bio-gas can be produced for use.

The second example is Yan Jici Library and Museum, which covers 2,735 sqm, the floor area totals 12,000 sqm, the roofs on the 4<sup>th</sup> and 5<sup>th</sup> floor are planted with 726 sqm, or 26.5% of land occupation, the 2<sup>nd</sup> to 4<sup>th</sup> floors are planted vertically with support of grooves. There are two biogas cleaning chambers of 38 cum under the ground.

The third example is the multi-function eco-building of Jinhua tap water factory. It covers 985 sqm of land, with 8 floors, floor area totals 5,028 sqm. The roofs from the 3<sup>rd</sup> to 8<sup>th</sup> are all planted, and all daughter walls are planted vertically, total 702.3 sqm, or 78.5% of land occupation. Its basement is equipped with a 23 cum biogas cleaning chamber. Just opposite is the multi-function building group - Xinhua garden village, land occupation covers 651 sqm, floor area 80.03% of land occupation, and the basement is equipped a bio-gas cleaning chamber of 10cum.

Now a number of eco-buildings are under construction. For example, New Wujing village is planned, designed, and constructed according to the principles of eco-building. It occupies 13.24 hectares, the floor area totals 154,800 sqm, among which, 9 eco-buildings have been completed. They cover 5,130 sqm land, and the floor area totals 35,381 sqm, roof green space totals 1,125 sqm which is 21.93% land occupation. There are 9 bio-gas cleaning chambers in the basement total 149 cum. Another example is Wulitincun Residential Village renovation program, 80 buildings are to be built, more than 20 three-floor buildings have been set up. The shopping center renovation program, the construction cover about 42,000 square meters of land, and the floor area totals 75,000 sqm. It is under construction. Some other building are in the planning stage.

#### **4 Assessment of Eco-building**

The practice of eco-building proves thoroughly that the popularizing eco-building (including separate bio-gas cleaning chamber, vertical or roof greening) is very important to improve the urban environment. It is the application of sciences and technology in the environmental protection, or it is the application of science and technology to the environmental protection. Its roles in the environment protection demonstrate the following two main aspects:

Firstly, enlargement of the green and beautiful surface, that it to say, to increase the oxygen manufactories. In urban areas of today, the green space is decreasing and that

has negative influence on the environment, and greatly affects our living quality and is harmful to our health. Meanwhile there are a lot of roofs and walls, the lands around the buildings are not well utilized. If we popularize the roof and wall greening, we can increase greatly our green space. Jianshantou Highway Station's eco-building is an excellent example: its land occupation is 370 sqm, mainly 3 floors and partially 2 floors, total floor area is 969 sqm, roof greening 336.7 sqm, compensates 91% of land occupation. 5 years after completion of construction, vertical greening covers all walls. Based on the measurement made in Aug. 1998, the vertical greenery totals 926.71 sqm. Plus roof greenery, the total green space of the building is 1,263.41 square meters, compensates 341.4% of land occupation. That is to say, the greenery on the building is 3.4 times over land occupation by the building. Xinhuajie Eco-toilet is another excellent example: its land occupation is 85.74 square meters, its floor area is 84.89 square meters, roof greenery measures 108.91 sqm, compensates 127% land occupation. Three years after completion of construction, vertical greenery covers all walls. Based on the measurement made in Aug. 1998, the vertical greenery totals 212.5 square meters. Plus roof greenery, the total green space of the building is 321.41 square meters, compensates 374.8% of land occupation. That is to say, the greenery on buildings is more than 3.7 times over land occupation by the building.

Secondly, better treatment of living waste water, in another word, it is an equivalence to a small sewage treatment factory to reduce waste water. All new or extended construction projects in Jinhua must be equipped with bio-gas cleaning chambers since 1993. Up to September 1998, the approved construction projects total 1,030, the volume of waste water treatment chamber totals more than 20,000 cum. For example, about 20 residential buildings were constructed from 1993 to June 1998 at Xinhua Garden residential village with total floor area of 87,500 sqm, and they are equipped with 27 bio-gas cleaning chambers. Based on a test in September 1998 on the treated waste water from the chambers, the results reached State Discharge Standard II. The development of urban constructions, especially housing, is very rapid nowadays, that results in rapid increase in household waste water release. And the waste water is released before being well cleaned, it surely pollutes the water system and worsens water quality, and affects in turn the hygiene of environment and human health. To treat the waste water and faeces by biogas cleaning chamber is a way to dissolve and disinfect the household waste water on the spot. It is suitable for many cities and towns, especially in tourism areas, where no waste water treatment plants were built. For those where there have been or will be waste water treatment, the biogas cleaning chamber method can still share the cleaning work with them.

Popularizing eco-buildings is important to promote the harmony between economic development and environment protection, improvement of the urban environment, implementation of the Chinese Agenda for the 21<sup>st</sup> Century, follow the way of sustainable development, and the construction of socialism with Chinese characteristics.

## **5 The government's role in implementing Eco-building**

Governmental function is important in the practice of eco-building. Jinhua Municipal Commission of C.C.P, the Municipal Government, related departments and the Managing Commission for Development Zones have played an important role in the practice of eco-building from testing to popularizing. It states clearly in "The announcement of some opinions on carrying out 'The decisions by the State Council to strengthen further the environment protection'" issued as No.91 (1) by Jinhua People's Municipal Government, to guide the urban and rural construction from ecological viewpoint, to promote actively and popularize gradually the eco-building pilot projects guided by ecology, and to integrate the eco-building the eco-building pilot projects into

the administrative inspection for responsibility of environment protection. In 1994, further popularizing eco-building (including eco-toilet) was written in the Government Working Report of the Municipal People's Congress and in Proposals on implementation of socialist spiritual civilization construction of Jinhua Municipality (1994-2000). Popularizing eco-building (including eco-toilet) was included in 1996 in "the Ninth Five-year Plan" and in the "2010 Long-term Target Outlines". The Municipal Commission of C.C.P. integrated in 1997 "Largely popularizing eco-building and bio-gas cleaning chambers" into Proposals on implementation of socialist spiritual civilization construction of Jinhua Municipal (1996-2010). After the success by practice and enriching the experiences, the government issued a series of instructive documents, e.g. Announcement on popularizing eco-building at Jinhua City by Jinhua Municipal Commission for urban and rural construction and Jinhua Municipal Bureau for Environment Protection No. (1992) 271, Announcement on further popularizing eco-building at Jinhua City by Jinhua Municipal Commission for Construction No.(1993)394, Announcement on largely popularizing eco-building in the urban area by Jinhua People's Municipal Government No.(1994)102, Announcement on essential requirements in construction of eco-toilet by Jinhua Municipal Bureau for Urban Management. No.(1996)96, Announcement on distribution of "Construction and management of bio-gas cleaning chamber in Jinhua urban area and the project implementation" by Administrative Bureau of Jinhua People's Municipal Government No.(1997)23, etc. The standards defined by the Administrative Bureau of Development zone on planning and designing clearly require that the buildings be equipped with bio-gas cleaning chambers as well as roof and wall greening. They must appear on the architecture plans and designs, so as to promote the implementation of eco-buildings.

After the practice of eco-building from testing to popularizing, it is necessary to take "five cares"; plan with care, design with care, construct with care, manage with care and service with care. To plan is the very beginning of construction and management. It should fully follow the required eco-building specifications. The three characteristics should be well demonstrated in the design and construction. Roof and wall greening should be pay attention to the following; 1.Roof load, 2.Leak-proof, 3.Roof soil coverage time, thickness and quality, 4.Water and electricity facilities, 5.Grooves and furrows, 6.The species of plants and their planting and management, etc. The basement management should follow strictly *Implementation management of bio-gas cleaning chamber in Jinhua urban area* and *The notice on the management of bio-gas cleaning chamber*; bio-gas liquid, by-produced water and bio-gas should be well used. Bio-gas should be burnt, it should not be released into the air or into the water. The management should be supervised, good management system, operation rules, clarification management responsibility, so as to find and solve the problems opportunely, and make it run well. Concerning the sections and units of planning, design, construction, quality control, experiment, and management, there should be individual responsibility, and carry out well the service. The Institute of Eco-toilets, Institute of Eco-building design, Institute of Vertical greenery, Eco-building Engineering Company have been established in Jinhua. It is necessary to pay attention to the successful experiences and benefits, enlarge propaganda, study the problems occurred in the practice, find out the solution to the problems, continuously practice, summarize, improve and develop.

## **6 Conclusion and Discussion**

A building should be useful, beautiful and economical in respect to social, technical and aesthetic aspects. Eco-buildings have much higher requirements. It is therefore necessary to insist on scientific standpoints, to be down-to-earth, to adopt measures in the light of the realities of specific regions, to deal with the matters with the full

consideration of realities, to solve wisely the problems encountered, to keep on developing this fantastic undertakings.

Popularizing the eco-building is an ongoing project, and its implementation is encouraging. We believe that its prospect is broad and brilliant. It follows well the natural law and the demands of the masses. This way it is necessary and possible to march on and on. We must persistently, constantly and painstakingly make efforts, keep on learning, practicing, summarizing and improving, to realize the better harmony between economic development and environment protection, to promote the development of sustainable development strategy and the construction of socialism with Chinese characteristics.