

# The Application of Energy Saving Technology to Green Buildings

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**Abstract:** Generalize the basic definition and development background of green building and its development status at home and abroad, introduce the application of energy saving technology to green building. Combined with the project example at home, explain the application status of the technology. Point out the development foreground of green building which provides the opportunity for progress and development of the energy saving technology, and the development of the technology has very important meanings to promote the sustainable development of green building.

**Keywords:** Green building; Indoor air quality; energy saving technology

## 1. INTRODUCTION

### 1.1 The basic definition of green building

Green building is the resource efficient buildings, four "R" were summarized to describe the green buildings, there were as follows:

- (1) Reduce: Reduce the utilization of building materials, reduce the damage of the resource and environment, and reduce the utilization of non-renewable resources.
- (2) Renew: utilize the renewable and unexploited resources; waste materials, waste water and building rubbish being handled should be used for two or more times.
- (3) Recycle: Recycle wastes, waste heat, heat elimination, waste materials and waste water, use repeatedly and circularly.
- (4) Reuse: Reuse old materials; remake and meanwhile reuse the old building.

In all, Green building making use of reproducible materials and resources sufficiently did not destroy environment and culture traditions, which protect the health of the habitation and embody sufficiently the scheme of the continuance development and backing to the nature. Indoor air quality was paid more attention to green building. The human-oriented indoor environment of green building which should harmonize with the earth environment satisfy biology characteristic of the person which was energy saving and environment protection firstly, not influence the health and work efficiency of the habitation as the cost. Thus, green building is the comfortable, healthy and safe building which use efficiently resources and energy sources and protect environment<sup>[1]</sup>.

### 1.2 The development background of green building

#### 1.2.1 The request of indoor air quality

Statistic indicates that about 80% of the time was spent in the building, so indoor environment was one of the most important factors impacting the physiology and mentality health of people. Industrial revolution not only brought the firm, bright, comfort and convenient building, but also the fatal illness such as building

syndrome and Legionnaires disease. From 1970s, two important issues aggravated the ill-building problems, on the one side, energy crisis strengthened the building's hermetization to reduce energy consumption, on the other side, building syndrome with bad IAQ became increasing severity, because of deleterious and poisonous gases emissions from furnishings and decorative material. The green building concept which appeared in the 1990s embodied people's attention to IAQ, we need to adopt more energy saving and environmental protection principle to improve IAQ<sup>[2]</sup>.

#### 1.2.2 The main characters<sup>[3]</sup>

(1) The geographical condition of the place where the building was located, needed non-poisonous material on the soil, preference surface temperature, pure groundwater and moderate earth's magnetism.

(2) The natural materials were adopted sufficiently on ecological buildings, such as wood, bark and stone, the materials must be checked for making sure the non-poison and had heat-proof quality, and also can improve heat efficient and energy saving and reduce heat transfer and radiation from outdoor high temperature to indoor lower temperature.

(3) The ecological building set up solar energy or wind force equipments according to the local environment in order to utilize natural and renewable resources.

(4) Request the decrease of waste discharge in ecological housing.

### 1.3 The development status of green building

#### 1.3.1 About foreign green building<sup>[4-7]</sup>

The housing with their own characters and the public buildings which had been built are paid extensive attention to, from 1990s, the developed countries begun to explore the road of sustainable development, called "green building challenge". The details were shown in Table 1.

#### 1.3.2 About green building at home

The implement and assessment of green buildings in china should take the situation of china

into consideration that china is a country with great region diversity, large population and resources shortage, thus we should be practical and realistic adjust measures to local conditions and apply proper technologies with attention to whole benefits and part benefits<sup>[9]</sup>. From the 1992, building energy saving pilot projects and pilot areas in eight cities such as Beijing, Hebei, Liaoning had been carried out. In china, the rule about green buildings had been or will be issued, including JGJ26—95 "civil building energy saving design standard", GBJ121—88 "building sound insulation assessment standard", JBJ11—82 "housing sound insulation assessment standard", 50189—93 "traveling hotel building hot working and air-conditioning energy saving design standard", DBJ/T01-38—98 "exterior wall thermal insulation engineering techniques regulations", "Beijing green house adornment engineering acceptance regulation"(trial implementation), the standards will be the behavior criterion obeyed during building operation.

With the stepwise appearance of new technology, new standard will be set up continuously to renovate old standard<sup>[10]</sup>.

**Table 1:** Foreign green building general situation

## 2.THE APPLICATION OF HVAC TECHNOLOGY TO GREEN BUILDING<sup>[1]</sup>

### 2.1 Active method

The method that uses the building and natural resource to protect IAQ is active method. Both solar radiation and natural ventilation should be done well to improve indoor ecological environment.

(1) Controlling solar radiation: One side is, increasing radiation can use day lighting to reduce the electrical energy and summer cooling load of air-conditioning and winter thermal load. Another side is increasing the radiation going into the house also can bring the increase of insolation cooling load. There

| Classification                              | Construction locus                                                                                                                                                  | Illustration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Solar house                                 | Germany,<br>America,<br>Sydney in Australia                                                                                                                         | Momentum energy of sport village of Sydney Olympic Games in 2000 including illumination and heating came from the solar light plants installed on the roof, in the news center, the solar transfer equipments can exert air conditioning effect through the ventilation of the roof <sup>[8]</sup> .                                                                                                                                                                                                                                                                                       |
| Ecology house                               | America Nords university,<br>Britain,<br>Japan Hyogo Prefectural                                                                                                    | The details about ecology house in America Nords university were that, heat insulation performance was good, heat energy came from the quantity of heat produced from the manpower thermolysis, sunshine and family electrical equipment. Family power utilization was provided by wind power generating plants and solar battery installed in the alcove; water utilization was rain water from the eave, stored in basement, was filtrated by sand bed before using, and dejection and waster water would afflux the compost hole to provide the fertilizer for garden after fermenting. |
| Plant construction and ecological adornment | Germany Hanoverian city ,<br>America Chicago                                                                                                                        | Rel meadow uptown in Germany Hanoverian city was built according to plant ecological building principle, that is, planting many plants to keep the ecological balance, which was the product combined with old building and young ecology.                                                                                                                                                                                                                                                                                                                                                 |
| Zero-energy house                           | Germany,<br>Nottingham university<br>BedZED Zero-energy ecological village                                                                                          | The house depended on the solar energy, not needing electricity, coal gas, wood or coal, also didn't have poisonous gas emissions, can keep the environment around clear. The design of sector plane which opened south can obtain high solar energy.                                                                                                                                                                                                                                                                                                                                      |
| Resource protection house                   | America                                                                                                                                                             | Building company in America built the house using reclaimable garbage for environment protection and saving energy, which named resource protection house. Building the house using waster materials can reclaim 65% of metal, cardboard, timber rubbish and so on, can settle preferably the problem of waster comprehensive utilization and environment protection.                                                                                                                                                                                                                      |
| Green office                                | America national resource protection committee HQ office building,<br>Carnegie Mellon University<br>Homo sapiens office,<br>Britain building research establishment | The walls of America national resource protection committee HQ office building were made from reed stalk stifle and high-tech machining, other plants were made of waster glasses, office desk were made of waster newspaper and soybean residue. Most characteristic is sorts of ramblers e.g. Boston ivy overspreading the outer wall, which made office more beautiful and clean, and can modulate the air, keep indoor with warm winter and cool summer which was good at physical and mental health.                                                                                  |

are detailed methods to control solar radiation: 1) Choose energy saving glazing. For example, choose the glazing filled with inert gases between two layers and coated by Low-E in the inner layer in the heating district; choose the glazing coated by Low-E in the outer layer or single-layer coated glazing. The integrated window using liquid crystal technology was adopted overseas, which used the principle that crystal changed the character of spread geometry under different voltage, which can change the transparence according to the outdoor insolation intensity. 2) Adopt introduce visible light to the inner zone of building, meanwhile keep out the perpendicular incidence and insolation. 3) Adopt ventilating window technology, introduce the return wind to interlayer space of double window, therefore, bring out the convective heat flow of shutter temperature in the mesosphere caused by insolation. The shutters in the mesosphere change automatically the angle under the photo-electricity control to keep out direct light and permeate the visible light. 4) Introduce daylight to inner zone of building using atrium of building. 5) Introduce light energy to inner zone using light-guide fiber, keeping out heat energy in the outdoor. 6) Simplest and most efficient method is setting sun-shield outside the building, also can be combined the outer sun-shield with solar battery (named photovoltaic battery), not only it can reduce air-conditioning load, but also provide the subsidiary energy for indoor illumination. The measures settle the contradiction between daylight illumination and air conditioning load.

(2) Using organized natural ventilation: natural ventilation is a technologic measure adopted abroad in the ecological building. It introduces outdoor fresh air to indoor and discharges the indoor air polluted to outdoor using the nature pressure (wind pressure, heat pressing), consequently, reach the effect of reducing indoor pollutant concentration. Because nature ventilation system need not using the fan, it can save initial cost and mechanical energy, accord with the request that green building to saving energy, environment protection and economy. Meanwhile, the system without complicated air conditioning handle system which is managed conveniently used outdoor cool and thermal load at the maximum in the transitional season. Otherwise, people enjoyed more nature airflow distribution from the comfortable side. Therefore, natural ventilation is worth researching and can be adopted in large quantities in the green building design [2].

## 2.2 Passive method

The passive method is creating indoor environment which exert the advantage of natural environment and avoid the disadvantage of natural environment depend on the establishment such as

mechanism and electric. Because of the scale and the complexity of inner in-serve behavior of the building, we can't adopt completely active method to keep the good IAQ in the majority climatic region. Therefore, we should adopt mechanism and electric technology to improve the indoor ecology environment according to the rule that "human-oriented". under the presupposition that not only ensuring the saving energy, but also ensuring IAQ, there are some popular air-conditioning schemes in the green office building overseas, such as displacement air supply system with air regulation, cold emission ceiling system, hypothermia air supply system combined with ice storage, evaporation cooling air conditioning system, earth source heat pump and dehumidification air conditioning system.

## 3. ILLUSTRATION THE APPLICATION OF ENERGY SAVING TECHNOLOGY TO GREEN BUILDING

The author visited the domestic green office building in 2004, the building plane which was compact and integrated presents fundamentality rectangle, major axis located in east-west direction, accidental place such as staircase, elevator, entrance hall, conference room lay on both east and west sides in order to release the effect of insolation in the east and primary work area in the west.

There are large scale suntan wall in the west of building, which comes away completely with the building, can keep out the perpendicular incidence sunshine with a western exposure in the summer and transition season, thereby, release efficiently the effect of exterior air temperature to the interior of building.

The south is greening cortile with three floors height, on the one hand, which provides a good sight and the space for rest and movement, on the other hand, releases efficiently the effect of exterior environment to office space. In winter, the cortile was totally enclosed big greenhouse which became thermal buffer layer of large space office environment, improve effectively office thermal environment and saved the energy consumption of the heating under "greenhouse effect". In transition season, it was an open space which made the air circulation, improving effectively the microclimate of workroom. In summer, shutter sun-shield system of southern window of the cortile can keep out effectively the sunshine, which made the cortile be the big pergola, the transition space had benign buffer action to work space. The south of the cortile was glass external wall, clearstory was set on the top, using reflecting decorative plates to ensure the utilization of natural light of open office.

"Light corridor" can use a part of sky beam to assist in improving the daylight illumination. Much green vegetation was planted in cortile, the greening with

certain area can reduce the indoor temperature through evaporation effect and increase 10%~20% of air relative humidity in summer. Through the photosynthesis, greening system can release much oxygen and absorb CO<sub>2</sub>, meanwhile eliminate harmful substance such as formaldehyde, benzene and bacterium, thereby improve IAQ of office environment. The vegetation such as lawn and tree can exert efficient effect on promoting air clean and fresh and improving air humidity condition and so on<sup>[11]</sup>.

The roof of building set up overhead sunshade, which has effect evidently on thermal buffer on the roof in summer. The solar electrical energy generation system set on the roof can use completely the solar radiant energy and shield the direct light through solar energy plate, in addition, which can carry off heat quantity quickly and reduce the surface temperature on the roof through air flow on the overhead layer.

In addition, the designer also knew the effect of natural ventilation, combined with local perennial wind direction and own character of the building, brought in manual clearstory, inlet air window, ventilation dooryard etc whiling designing, carried through the air distribution of natural ventilation consciously, exerted certain effect on the improvement of IAQ and saving energy in the transition season with good outdoor air. The importance of integral discussion and integral design principle went without saying for greening problem of office building. Therefore the green illumination system also was adopted in the design, which reached the power save effect through a series of measures such as saving energy lamps and lanterns, classification design, zone control, scene setting; adopted a set of water-water heat pump plant and a set of piston refrigeration plant, heat pump plant can reclaim heat quantity of inner zone to provide the heating of outer zone in winter, which can reduce 20% of heating load. For eliminating the secondary pollution of bacterial reproduction to the air, runner dehumidifier unit was set in air system and fresh air system which settled the bacterial contamination on the air; adopted building automatic control system, including building automatic management control, water saving and power saving automatic control system, fire fighting automatic control system, public security automatic control system.

In all, the design of green building embodied completely four concepts, there were as follows: (1) thermal buffer layer concept; (2) the utilization of natural energy; (3) innocent and healthy concept; (4) integration concept, therefore embody the importance of energy saving technology in the building. Seen from the usage situation of the building for about four years, anticipative energy saving effect had been reached, it proved that the program design was successful example combined with national conditions, which adopted common technology and green building

concepts, therefore it had actual reference value to promote the design and research of green office building<sup>[12]</sup>. Based on the concept of sustainable development, we believe that the appliance foreground of energy saving technology in green building is quite broad.

#### 4. CONCLUSION

With the development of society, the advancement of technology, the abundance of material life and the improvement of mental demand, people who haven't satisfied with simple office condition anymore but hope to have comfortable inhabited environment and high performance office environment, and the development and improvement of energy saving technology can satisfy step by step the demand of closing to the nature and having comfortable and healthy building. With the known and discovery of the living environment, new technology and new materials are applied to modern building in time and make the building become ecological building and green building. The rising of green building brings the opportunity for the improvement and development of energy saving technology, meanwhile, the stepwise development of energy saving technology also impel sustainable development of modern building and bring vitality for the development of modern building<sup>[1]</sup>.

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