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# Consideration about building energy-saving in Urban renewal

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## ABSTRACT

Domestic buildings are one of the main consumers of energy, as well as the main sources of environmental pollution especially in China, where 32% of the total energy consumed is related to buildings. The construction of domestic buildings at present, in China, is still of the extensive-type production mode, which is high in resources consumption, has a low level of technology integration, is high in energy consumption and has a high pollution emission during the building construction and operation processes. Consequently, it has becomes a burning issue for us to change the development methods of domestic building, and develop ecological, abstemious and sustainable society. This article explores the approaches to achieve the ecological domestic building (EDB) by integrally considering the building's whole life cycle.

## KEYWORDS

Consideration, Building Energy-saving, Urban Renewal

## INTRODUCTION

In China, Cityconstruction is a vigorous manner. Buildings consume large quantities of resources. The statistics data shows that: two billions square meters of new buildings are constructed every year in China and 80% of them are high energy consumption buildings; 95% of the existing 40 billions square meters of domestic buildings are high energy consumption buildings[8]. In China, energy consumption per unit of domestic building is 3~4 times of those in the developed countries; Meanwhile, the energy and resource consumption during the operation of buildings are 2~3 times of those in the developed countries. For instance, the average water consumption is 30% more than the developed countries (Wang J, 2005).

## PROMOTING THE CONCEPTS OF EDB DOMESTIC BUILDING CONSUMPTION MODEL

For domestic building, a compact, efficient and comfortable indoor space will be enough to meet the human’s natural needs and demands and will meanwhile greatly reduce the energy and resources consumption during the stages of construction, usage and maintenance. In Japan, it is a social norm and quite acceptable that a very good income family happily lives in an 80~90 $m^2$ house (Japan Statistical Yearbook, 2005). The average housing area per capita in China, which includes entire urban and rural population, is over 30 $m^2$, which is higher than in Japan and Korea. In Korea, the average housing area per capita is 19.8 $m^2$ and it is 19.6 $m^2$ in Japan (Average living area in the world, 2011). The average annual income per person in China is only $1100, which represents 3.2% of the Japanese average annual earnings. Japan would be a good reference for China to learn the concept of compact and comfortable domestic buildings and how to reduce consumption of the energy and natural resources, as well as how to decrease the environment pollution. In fact, with an appropriate structural design, 60 $m^2$ floor areas can be divided into three bedrooms, one sitting room, one kitchen and one bathroom. Or 40 $m^2$ floor areas can accommodate two bedrooms, one sitting room and kitchen, and one bathroom. These space layouts can be very cozy with fewer resources needed and with less energy consumption. If the same living functions can be accommodated with each house area decreased by 10 $m^2$, 10% more houses could be built up accommodating 10% more residents on the same land, (Zhouhui Z, 1986).

## CONSIDERATION OF ENERGY SAVING DURING THE PLANNING AND DESIGN PHASES

### Planning of residential areas

By scientifically planning and designing the residential areas it will be possible to save the earth resources and improve the efficiency of the earth usage. This can be achieved by taking into consideration of different factors such as: taking the full account of the elements of the area plan such as building layout, orientation, distances between buildings, vertical space, shape and body, space utilization and color, etc; considering the building physical characters such as temperature, humidity, air change rate, noise levels, daylight and indoor air quality; evaluating the possibility of using natural energy sources including the natural ventilation, natural heating/cooling and lighting, and expanding the underground/roof space application; reducing the building body mass, improving the internal space utilization rate; developing the vertical space direction rather than the horizontal, etc.

The average occupied built-up area of each house for multi-storey and high-rise building will be reduced by increasing the number of levels in the building. Statistics show that with an increase of one level, the built-up area will increase by 800~1000 $m^2$ per hectare of residential area[4]. However with increasing number of levels, the distances between two buildings need to be increased to enable sufficient exposure to sunlight. Thus, the building height is a directly related to the area-use rate, natural resources such as light, wind, temperature, etc.

If the storey height is decreased, sunlight space between buildings will be decreased too. In some cases, the effect of saving land by reducing the height of each layer is more effective than increasing the number of layers on the same land. According to the statistical analysis, increasing the number of building layers from five to seven, 7.5%~9.5% of land will be saved. But, if storey height is decreased from 3.2 to 2.8 metres, 8.3%~10.5% of land will be saved. For every 10 cm of layer's height reduction, 2% of land will be saved. In accordance to this principle, about 500 $m^2$ of built-up area per hectare will be saved by 10 cm decrease in each layer's height. If the number of building layers increased from 5 to 9, building density in a residential sub-district would rise to 35%, while, if the number of building layers increased from 6 to 17, more than 50% land would be saved whilst maintaining the same residential density[8].

## Building design

China is still in early stage of Zero/Low carbon building design. Although heating/cooling represents the main proportion of the building's energy consumption, the building designers have only just started realizing the correlation between the energy consumption and the design of the building's external/internal walls and structure, this development is far behind the countries such as Japan, EU and UK.

The essential considerations for the ecological building design include building facade treatment, shape coefficient, window to wall area ratio, window to ground area ratio, south to north window area ratio, levels height, construction depth, low carbon technologies and sustainable energy application etc. The relationships between the energy saving and the new design, building's function and the project capital cost should be carefully considered to ensure the building meet the required function whilst using less energy and with less capital cost. Optimal calculation should be carried out to identify the best energy and ground saving design by comprehensive consideration of the building layout, orientation, as well as shape, height, and insulation technologies of the building envelope. In order to achieve this a relevant building design software have been developed and applied to optimize the design, for example, the architecture shade simulation of Tianzheng Architecture[8] can help designing with the building orientation, district roads, greenery and grass area and outdoor recreational area; Computational Fluid Dynamics (CFD) software, such as PHOENICS and Fluent, are used to simulate the indoor and outdoor air movement; Integrated Environmental Solutions (IES) and Passivhaus Planning Package (PHPP) evaluate the building thermal and energy performance and yearly energy consumption. There is a huge gap of the building energy efficiency standards between China and the developed countries. At present, the external wall thermal performance of the domestic building in the majority of China's heating regions is much worse than that in developed countries. The investigation of a six floors brick and concrete structure building with four apartments at each floor was carried out, and it was found that the heat loss through the building envelope accounted for 77% of the total energy consumption, and infiltration heat loss through doors and windows was 23% (Reusing of Construction Waste View in Foreign Countries, 2010). In total envelop heat loss breakdown is as follows: 25% is lost through the external wall, 24% is through the windows, and 11% is via the internal wall to stairs, 9% is through the roof, 3% is via the door to the balcony, 3% is via the door to the corridor, and 2% is through the floor. Most of buildings in China are like this and in urgent need of energy efficiency transformation.

In order to save energy in buildings, the building layout should be optimized by maximum usage of the natural resources around site in order to reduce the heat gain/loss in summer/winter. The horizontal and vertical building layout should be manipulated with building orientation to increase the rate of indoor natural light in winter and reduce radiation gain in summer. For examples, the sitting room set in the south of the building shaded by a blind or a thick curtain can gain less solar energy in summer and store plenty of solar energy in the winter to create a comfortable leisure space for a family with less energy consumption.

The shape of building is a very important factor in energy-saving. In certain built up area, the round building has the most economical coefficient of all building shapes, the second one is square, the third one is rectangular, and the last one is L-shape or T-shape. Although, from the theoretical analysis, the round building should have the best shape coefficient with economical and lesser energy and resources consumption, but round external structure increases the construction cost by 20%~30%. It is generally acknowledged that square and rectangular shaped buildings are cheaper and easier to construct. The best rectangular shape is the one with 2:1 ratio of the length to width is due to the smaller exterior wall surface (Zhouhui Z, 1986). When the floor plan outline is concave and/or convex with many twists and turns, the construction cost, energy and resource consumption will be increased. This is because the construction cost per square meter for the corner unit is 5%~6% higher than the flat unit (Zhouhui Z, 1986). But in some cases, in order to satisfy the requirement for daylight and natural ventilation, a narrow deep gap between two residential units will be designed to solve the problem of opening windows for toilet and kitchen. This will increase the shape coefficient, the construction cost, the energy and recourse consumption, but is unavoidable. Generally, this design is acceptable for big deep houses, but only if the rate of width to depth of gap is less than 0.5.

Decreasing the area of windows is an important method to simplify the construction, and reduce the energy and resources consumption. Windows to wall area ratio is severely restricted in design standard for saving energy purposes, for example, the limitation for the public building is 0.7, for residential building facing north is 0.45, for residential building facing east without shading is 0.3[5]. The area of windows should be designed and standardized according to different orientation of each room. Domestic buildings with well adjusted windows to wall ratio, controlled building shape coefficient, and with a sufficient natural lighting and ventilation can save energy each day during the long building life cycle. Therefore, synthesized consideration of windows to wall ratio and building shape coefficient has as significant effect on energy saving especially for the operating energy consumption. Studies of the impacts of external windows area to the building energy consumptions have been carried out by researchers in Zhejiang University in China. It has been found that for the same room orientation, the thermal resistance, thermal capacity and shading coefficient, the room with a window to wall area ratio of 50 % consumed 17 % more cooling energy and 8 % more total energy per day compared to a room with a windows to wall area ratio of 30%[6]. The building annual and HVAC energy consumption has the linear relationship with the ratio of windows to wall area as shown in Figure 1 Different ratio of windows to wall area has different effect on building energy consumption when buildings have different orientations as shown in Figure2[7].

Integration of the multi-level stereoscopic green concept into the architectural design achieves ecological domestic building. For example, Enlarging the green area in the residential district; Developing green roof for the domestic buildings; or using green external walls rather than concrete, stone or brick materials to improve the buildings' thermal performance. Eleftheria Alexandria and Phil Jones have indicated in their researches that the cooling energy can be saved by 32%~100% in the hot climates if the green wall and roof techniques are applied on a city scale (Eleftheria A and Phil J, 2008).

## DEAL WITH CONSTRUCTION WASTE CORRECTLY

In urban renewal, how to treat construction waste is very important. At present, in every city, large demolition and construction are seen often. But in developed countries, they pay more attention to construction waste. Construction waste recycling rate is 83.4% in South Korea, in America it is more than 70%. For the old building, remove and reconstruction approach are not always correct, for some buildings which are still in the life of the building inside, we can take the measure of changing their functions, we can keep the building's origin frame, just pull down its walls, and we need classify the garbage, and then transported them to the garbage disposal station, and recycle some construction of garbage to a large extent. During urban renewal, we should produce waste as little as possible and make good use of waste as more as possible.

## CONCLUSION

This paper analyzed how to save energy from building design, construction plan, and construction waste in urban renewal simply. It comprehensively analyzed the energy and resources consumption as well as the environmental influences. The domestic building can only be accomplished by overall consideration of each stage and by saving the energy and resources at every step. We should stand in a higher angle and overall situation to treat Urban renewal, we should protect the city characteristics and retain the context of the city as the premise, from the architectural design, city planning, ecological carrying capacity, economics, ethics and other aspects.

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