

## **SOME PRINCIPLES AND SOLUTIONS FOR THE GREEN ARCHITECTURE DEVELOPMENT IN VIETNAM**

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**Abstract:** *Currently, like many other countries, Vietnam is facing a serious imbalance between supply and demand for energy, in the face of rapid socio-economic development and urbanization, there is a wasteful and inefficient way of using energy in all aspects of social life. Green architecture not only brings economic, environmental and health benefits to the people, but also contributes positively to reducing climate change. It can be asserted that green architecture is a right direction and very suitable for countries in tropical regions with developing economies like our country. Green architecture ensures the most comfortable conditions for people to live and work in which it consumes the least energy and resources, generates the least amount of waste, meets the requirements of environmental protection and ensures a harmonious relationship between man and nature. For the green architecture model to be widely applied in order to use energy economically and efficiently, we need to conduct surveys, research and learn from experiences to come up with reasonable and practical mechanisms and policies, and it is very important to have consensus between the architecturer, the builder, the manager and the community.*

**Keywords:** Green architecture, green buildings, green urban areas, green spaces.

### **1. BACKGROUND**

The country's industrialization and modernization are demanding more and more energy and resources consumption, this process is also generating environmental pollution. Vietnam is in the process of rapid urbanization, socio-economic development with GDP growth rate higher than 6.7% per year. The country's industrialization and modernization are demanding increasing consumption of energy and resources. Construction is one of the industries that consumes a lot of energy and natural resources and also generates many environmental pollution. The construction and urban development sector of Vietnam currently consumes about 60% of natural materials, about 30-35% of the total national energy consumption, 30% of clean water sources, similar to the generation of about 30% of CO<sub>2</sub> emissions, causing greenhouse

effects, create impacts on climate change and sea level rise. Green architecture development is an urgent direction and trend to economically and efficiently use energy and resources in the construction process, limit environmental pollution, contribute to the sustainable urban development. However, the current construction and urban development in Vietnam still has many shortcomings, it is facing the challenges of unsustainable development, the research on green architecture in Vietnam mainly focuses on projects with small scale, there are almost no green architecture studies for large-scale projects or architectural complexes. Green architecture development programs should be considered by urban governments as a priority strategic development goal for the moment ... The article clarifies the role and summarizes the values of green architecture, as the basis for forming principles and solutions for broad application of green architecture. (Nguyen Huu Dung, 2011).

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## **2. CONCEPTS AND CURRENT STATUS OF GREEN ARCHITECTURE IN VIETNAM**

### **2.1. Concept**

Green Architecture is a building that operates with the cost of using energy at an economical, optimal level, it has little impact on the environment, ensures maximum comfort for the operation of the building. Green architecture should be distinguished from the image of luxurious tree-shaded resorts or modern Hi-tech buildings. The concept of "green architecture" also requires that the buildings are built to operate in harmony with the surrounding natural and social environment. On the other hand, it should not only the concept of "green" that is just increasing the density of trees, completely not using equipment, such as air conditioners, heaters, etc, but it also should understand that the design must use good insulation solutions, good sun shielding, so the air conditioning and ventilation system works optimally and highly efficient. Green architecture requires constructions to be designed to create a hygienic and healthy living environment for people, while it will protect the living environment, create a balanced and stable development of the urban ecosystem. Green architecture must ensure maximum exploitation of solar, wind and rainwater sources to provide energy and meet water demand of users, and reserve ground for green space. Green architecture ensures the most comfortable conditions for people to live and work, but it consumes the least energy and resources, produces the least amount of waste, in which it meets the requirements of environmental protection and ensures a harmonious relationship between man and nature.

### **2.2. Current status of green architecture in Vietnam**

The development trend of green buildings, green cities, eco-cities and smart cities began to be implemented in the early decades of the twenty-first century, but so far it is not really appreciated. There are many managers,

investors, businesses and building owners who still more value economic factors and profitability than environmental and ecological factors. According to the overall assessment of the Asia-Pacific Green Building Network, the number of constructions that meet the Green criteria and be certified Green Building in Vietnam that is currently at a very modest level (about 155 works) compared with other countries in the region and in the world. Our cities still have many shortcomings in urban planning, inadequate and weak technical and social infrastructure systems. In recent times, there is a number of projects, scientific researches, some compiled documents on "Economical and efficient use of energy in constructions", the project "Improving energy efficiency in small and medium enterprises", "Energy efficient building" contest ect.

Many development investors, investors and building owners do not attach importance to the requirements of environmental protection, saving resources and energy, and they are concerned that green investment will increase the total investment cost or associating green investment with increased returns (in fact green investment only increases by about 3-8% compared to conventional investment and green investment solutions will increase real estate value).

## **3. RESEARCH FACILITIES**

### **3.1. Approach direction**

Green architecture can be approached in three aspects: technology, architectural solutions and society:

- The technology is the first aspect that advanced countries are aiming for: saving energy with technologies using renewable energy, solar power, Energy-saving intelligent control system for buildings, heat-resistant glass systems, unburnt materials and a common image of green on high-rise roofs and walls. It will be very difficult in the current economic conditions of Vietnam when it is required to apply modern technologies to save energy for architectural works, even for high-rise

buildings, investment habits according to the immediate benefits, cheap and popular investment rates are still more competitive.

- Meanwhile, the approach to architectural solutions is capable of creating immediate effects without costly investment. Even going back to traditional housing solutions, we can learn many things to apply without modern technologies. With housing architecture, building high-rise houses with directions for the apartment to access light, good ventilation, the house has cool wind direction, limit the West's sun, create ventilation slots, ventilated green core ...

- In the social aspect, it is necessary to conceive that Green architecture is a living trend, it is not just an architectural or technological trend. The trend of living in energy saving, utilizing natural energy that is a good living environment for the whole community.

### 3.2. Research bases

Research bases are on the following criteria:

- Having a plan, select the construction site, choosing the appropriate work direction. Meeting the requirements for maximum natural lighting and ventilation.

- Using natural building materials, especially traditional local building materials. Limit the use of energy-consuming means and techniques.



- Giving maximum priority to the use of natural energy sources (solar energy, wind energy, geothermal energy ...). Use energy economically and effectively.

- Minimizing waste, emissions, waste water.

- Saving natural resources, we use greenery on water surface as a factor to create environmental landscape, clean the air. Arranging green trees where possible, turn cover (walls, roofs ...) into green spaces. Expanding water surface area. (Pham Ngoc Dang, Nguyen Viet Anh, Pham Thi Hai Ha, Nguyen Van Muon, 2014).

## 4. EXPERIENCES OF SOME COUNTRIES IN THE WORLD

### 4.1 The Interlace Eco Apartment (Singapore)

The architecture of The Interlace apartment building has been harmoniously combined with nature, so that the residents' living space is in harmony with nature. To improve community living space and harmony with nature, which is often quite limited in apartment design. The Interlace has up to 8 gardens interwoven between buildings. In addition, there are gardens on the roof of each building, creating a landscape of "floating" gardens. The Interlace is an apartment building that feels like a village with modern architecture, respecting green and sustainable development (Figure 1,2).



Figure 1, 2. The Interlace Eco Apartment (Singapore)

### 4.2 Parkroyal Hotel (Singapore)

Parkroyal hotel has a green hotel icon on the facade. It is a symbol of delicate green architecture with a system of green trees that

was designed in many levels of tropical plants and vines, it makes visitors here feel like they are living in the middle of the beautiful nature. Along with that is an

energy-saving and extremely efficient cooling system, rain water treatment system, wastewater, sensor light system and solar

glass ... all like to bring to visitors a tropical forest located in the middle of the center of the capital (Figure 3).



*Figure 3. Parkroyal Hotel (Singapore)*



*Figure 4. The Crystal London (UK)*

#### **4.3 The Crystal London (UK)**

The Crystal is built in London. This is really a spectacular green architecture because it is sustainable and it can generate energy to operate the electronic devices inside. The US Leading Environmental and Energy Design Assessment System (LEED) awarded the certificate for this project. The Crystal does not use fossil fuels but uses alternative electricity sources. The roof has a sloping surface that stores rainwater to operate the generator for the whole building (Figure 4).

#### **4.4 Lewis Adam Joseph Center for Environmental Studies in Oberlin, Ohio, USA**

This center does not use any external energy sources, but it is equipped with solar panels to self-supply lighting power and operate electronic devices. In addition, the smart lighting system helps the building to minimize the amount of lighting electricity. There is also a geothermal heating and cooling system which was installed for air conditioning in the building. On the other hand, it is also equipped with a wastewater filtration system and treat the waste by biodegradation method so as not to create pollution (Figure 5,6).



*Figure 5,6. Lewis Adam Joseph Center for Environmental Research in Oberlin, Ohio, USA*

#### **4.5 Wind Tower in United Arab Emirates**

The cooler wind blowing at higher altitudes is pushed down through longitudinal crevices, which then push the hot indoor air up and out through an opening on the opposite side that starts the wind.

Even in the absence of cool breezes, the wind-receiving towers will run as solar chimneys, creating a pressure slope to push the hot air up and out of the tower, making the inside of the house feel cooler than the outside (Figure 7,8).

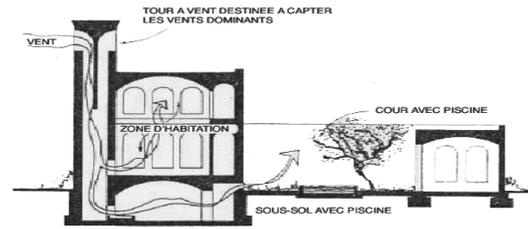
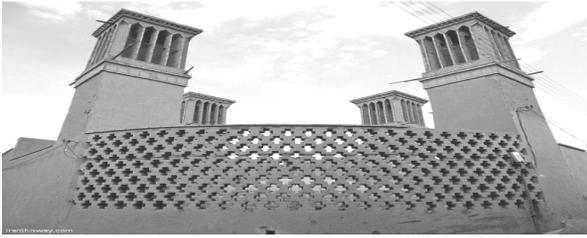


Figure 7.8. Wind tower in the United Arab Emirates

## 5. PRINCIPLES AND SOLUTIONS FOR GREEN ARCHITECTURE DEVELOPMENT IN VIETNAM

### 5.1 Principles

#### Principle 1: Planning on rational urban land use, ensuring necessary green space

Green urban planning must respect natural ecosystems, create green spaces and water-surface spaces, so that people walking on the street are not covered by concrete, can see the sky, water surface and access to parks according to the shortest service radius. It is necessary to focus on preserving and expanding the area of the park and water surface, meeting the provisions of National Standards (QCVN). The norm of greenery land and water surface should be  $\geq 50\%$  of the urban land area.

#### Principle 2: Green architecture

Urban architectural constructions should be newly built and renovated in the direction:

- Greening of greenery, ground cover, greenery on the building's surface, greenery in the building, biodiversity in courtyards, terraces and mezzanines, to prevent glare from the glass surface.

- Saving and rationally using energy: minimizing energy consumption in the architectural space layout of the building, in the design of the covering structure (insulation, sun protection, building materials), taking advantage of natural light, natural ventilation, energy saving for air-conditioning systems and artificial lighting systems, home cooling, using renewable energy (solar cells for electricity, wind energy, solar water heating, ...)

- Water saving: efficient water consumption, reuse of wastewater for cleaning and watering, storing and using rainwater;

- Minimizing the project's waste sources (waste gas, wastewater, solid waste), waste from the building operation to the surrounding environment; (Nguyen Huu Dung, 2016).

#### Principle 3: Green urban traffic

- Reasonable planning urban space, arranging residential areas, working areas, service-commercial centers, resorts, entertainment, schools, hospitals ... to reduce people's travel needs;

- Planning the technical infrastructure system of transportation to satisfy people's travel needs. There are three important criteria to consider:

- + Ratio of total traffic area to total urban area. This rate in modern cities in the world is 15-25%.

- + Ratio of the land area for parking lots. Currently, this rate of Hanoi is only about 0.3% of the area of construction land, while up to 3-6% in the developed cities in the world.

- + Development of public transport (bus, tram, ...). Only development of public transport (meeting over 40% of travel demand) will meet the criteria for green urban transport; creating conditions for urban people to walk and cycle (motorbikes and cars cause air pollution per capita, 15-20 times more than traveling by bus).

#### Principle 4: Green industry (Ken Yeang, 1995).

- Using energy, raw materials economically and efficiently to generate the least amount of waste, produce the most products;

- Developing industries with low CO<sub>2</sub> emissions;
- Carrying out a cycle of reuse and recycling of wastes in industrial production to minimize waste discharged into the environment;
- Using clean energy, renewable energy to replace fossil fuel energy.

**Principle 5: Complete the system of waste collection, treatment, recycling and reuse**

- Expanding and completing a waste treatment and recycling plant; minimizing the waste that must be buried;
- Streets and sidewalks of ecological urban areas are regularly kept clean, cleaned, and watered and washed during hot, dry days.
- To well manage the surface water drainage system and the urban wastewater drainage system; construction of rainwater collection systems, domestic wastewater treatment and reuse systems to use for car washing, road washing, tree watering, ...;

**5.2 Green Architecture Development measures**

**5.2.1 Architectural planning measures**

a. Choosing the building direction

- In the hot and humid climate of Vietnam, choosing the direction of the building in the south-north direction is the most beneficial direction for solar radiation, it allows to reduce the cost of shading, effective ventilation and meeting necessary requirements of natural lighting.

- The building direction is also determined according to the main wind direction of the construction site that ensures good ventilation in summer and limit cold winds in winter. Therefore, to determine the best direction, it is necessary to combine wind and sun. For example, the best direction in Hanoi is from East to South, while it is to the South in Lao Cai, Mong Cai...

b. Determine the reasonable distance between buildings: In tropical climate

conditions, the solar radiation is usually highly intense, the annual solar height is usually high, so natural lighting for buildings is often satisfied. Therefore, the distance between buildings must ensure ventilation, natural lighting and safety in case of fire.

c. Natural ventilation for the building: To organize good natural ventilation for the buildings, we need to solve some basic problems such as: layout, design direction, choice of location, door area, door structure ect., The rooms should be arranged in a way that is ventilated through the room. House corridors can be arranged either side or two depending on local climatic features. The partition walls should not be arranged perpendicular to the dominant wind direction. The window area on both sides of the room is equal. To enhance natural ventilation in the room, a window height which is 0.4-0.5 as high as the room height is the most reasonable. However, choosing the size, shape, and position of the window needs to be balanced with the natural lighting as well as the solution of architectural solidity.

d. Anti-heat, sunshade and anti-glare, anti-rain for the buildings: The structure of the structure against heat, sunshade and anti-glare is to reduce the amount of outdoor radiation entering the room. The basic requirement for shading is to minimize direct solar radiation to the room, it prevents glare and improves indoor microclimate conditions. Sunshade structures, in addition to the function of shading, must also satisfy the following functions: rain shading, anti glare, architectural design. It is necessary to combine design solutions for the covering system (roof, wall ...) with the solar energy collection system for the lighting of the building.

e. Resists heat absorption through the enclosure structure: The amount of heat absorbed by the building in hot and humid climates depends not only on the insulation

properties of the enclosure but also on the size and shape of the building.

In hot and humid areas, the building has a narrow and long rectangular box, the east and west facades of the building are strongly affected by solar radiation and the outside air temperature in these areas is often special. high. Lower heat transfer into the home through the enclosure. Wall structure has decisive effect against heat for buildings. Flat walls receive a greater amount of radiation compared to walls with folded shapes. Choosing the materials for the roof and wall should be chosen with a high reflectivity, which allows to reduce the amount of heat absorbed into the building through the enclosure. It is equally important that when designing the buildings, it is necessary to solve the problem of roof insulation well.

f. Create the necessary shade

In hot and humid conditions, trees are one of the best ways to improve the microclimate and also improve the aesthetic efficiency of the building. Trees limit the temperature fluctuations of the climate near the ground and lower the air temperature from 1.5-2.5 degrees C, reducing the intensity of solar radiation by 40-50%. When the sun's rays hit the leaf layer, 70-75% of the solar energy is absorbed by trees. Trees also significantly reduce the heat emission of the surrounding environment, contributing to preventing pollution and noise. Using sunshades is as good as using sunshades.

### **5.2.2. Building material solutions**

Materials used in construction from exploitation, processing and use all have an impact on human health. Therefore, great care should be taken in designing, constructing and managing them.

We need to pay attention to the development and use of eco-friendly green architectural materials that are traditional, energy-saving local materials. Materials need to be recovered and reused in a maximum way that does not

endanger health, the environment and brings efficiency.

The State needs to promulgate standards of building materials to ensure energy saving, material saving and environmental friendliness such as wall coverings, roof insulation materials, glass materials used in architecture...

### **5.2.3 Solutions for designing, operating and managing energy-saving technical equipment systems**

a. Air-conditioning system (A/C): Architectural design solutions can save 35% of energy, so it is necessary to consider architectural solutions as the first solution, only in case of necessity, do they need to use the A/C system. In order to save energy for the A/C system, we need to pay attention to the design, management and operation stages of the A/C as well as choosing the direction and shape of the building.

- When designing, it is necessary to pay attention to choosing the calculated parameters of indoor and outdoor air so that it is reasonable.

- Operating and managing the A/C system is a very important stage to save energy, therefore the operator of the A/C system needs to know about the comfortable thermal conditions of the human body. When installing the air conditioning system, it is necessary to invest in an automatic control and adjustment system to turn on / off the machine or increase or decrease the capacity according to the weather conditions.

- Energy used for the air conditioning system depends heavily on the amount of heat transmitted into the house by solar radiation. Therefore, when designing, it is necessary to pay attention to using a cover structure with good reflectivity, limiting glass doors, using a sunshade structure. (Ngo Viet Hung, Nguyen Huu Dung, 2011).

b. Natural and artificial lighting system: It is necessary to make the most of natural lighting

for buildings, only when natural lighting is not available or at night, additional artificial light must be used. You need to know how to combine natural and artificial lighting well to save energy. In artificial lighting, the following issues should be noted:

- Replace the old fluorescent bulb with a new one with high efficiency.

- Replace the tungsten lamp with a thin fluorescent lamp.

- Replace filament bulbs with compact bulbs, Arrange and place properly the lighting system.

c. Elevator system, hot water supply, mechanical ventilation ect,

- Select an elevator with high energy efficiency. Select and arrange a reasonable number and systems of elevators.

- Adopt appropriate lift control systems, water heaters, and mechanical ventilation.

- Design the A/C equipment system, mechanical ventilation, pay attention to the characteristics of the local climate.

- Applying measures to install, operate and manage equipment systems with high energy efficiency. (KupasswamyLyengar, 2015).

## 6. CONCLUSION

Humans cannot exist in isolation from the environment. All that people have is taken from the environment: air to breathe, food, water,

arable land, land to build houses, factories, hospitals, schools ect., and materials for the production of facilities for work and learning. In the context of climate change, energy crisis and so on, the problem of living environment is increasingly polluted under the impact of urbanization. The lakes and lagoons were leveled and encroached upon for land construction. Parks, flower gardens etc., green lungs of the city are narrowed. The precious water resources seem to be endless, being polluted and in danger of being degraded etc. Therefore, green architecture has a great significance and is extremely important to people, green architecture ensure the most complete facilities for people to live and work in but consume the least energy and resources, generate the least amount of waste, meet the requirements of environmental protection and ensure the harmonious relationship between man and nature. Within the scope of the article, the author gives basic solutions for the green architecture model to be widely applied in order to use energy economically and efficiently, not only bringing the benefits of economy, environment and health for the people but also actively contribute to reducing climate change - which all countries in the world are aiming for.

## REFERENCES

- Nguyen Huu Dung (2011). *Saving energy and resources - an important criterion for sustainable urban development and architecture*. Construction Magazine, Issue 3.
- Nguyen Huu Dung (2016). *Building criteria for the model "Green Urban Village"*. Journal of Vietnamese Architecture, Issue 198.
- Pham Ngoc Dang, Nguyen Viet Anh, Pham Thi Hai Ha, Nguyen Van Muon (2014). *Green building design solutions*. Construction Publishing House.
- Ngo Viet Hung, Nguyen Huu Dung (2011). *Development of green building design guidelines (for office buildings) in Vietnam*. Ministry level topic, Account 09-09.
- Ken Yeang (1995). *Design with Nature - the Ecological Basic for Architectural Design*. McGraw - Hill.
- KupasswamyLyengar (2015). *Sustaiable Architectural Design*. Taylor & Francis.

**Tóm tắt:**  
**MỘT SỐ NGUYÊN TẮC VÀ GIẢI PHÁP**  
**PHÁT TRIỂN KIẾN TRÚC XANH TẠI VIỆT NAM**

*Hiện tại ở Việt Nam, cũng như nhiều quốc gia khác, đang đứng trước sự mất cân đối nghiêm trọng giữa cung và cầu về năng lượng, trước tốc độ phát triển kinh tế - xã hội và đô thị hóa đang diễn ra nhanh chóng, tồn tại cách tiêu dùng lãng phí và kém hiệu quả về năng lượng trong mọi mặt của đời sống xã hội. Kiến trúc xanh không những mang lại lợi ích kinh tế, môi trường, sức khỏe cho người dân mà còn đóng góp tích cực làm giảm sự biến đổi khí hậu. Có thể nhận định rằng kiến trúc xanh là một hướng đi đúng đắn và rất phù hợp với các nước thuộc khu vực nhiệt đới với nền kinh tế đang phát triển như nước ta. Kiến trúc xanh là kiến trúc đảm bảo điều kiện tiện nghi đầy đủ nhất cho con người sống, sinh hoạt và làm việc trong đó nhưng lại tiêu phí năng lượng và tài nguyên ít nhất, thải ra ít chất thải nhất, đáp ứng yêu cầu bảo vệ môi trường và đảm bảo được mối quan hệ hài hòa giữa con người và thiên nhiên. Để mô hình kiến trúc xanh được ứng dụng rộng rãi nhằm sử dụng năng lượng tiết kiệm và hiệu quả, chúng ta cần tiến hành khảo sát, nghiên cứu, học hỏi kinh nghiệm để đưa ra cơ chế, chính sách hợp lý, thiết thực và một vấn đề không kém phần quan trọng đó là phải có sự đồng thuận giữa nhà thiết kế, nhà xây dựng, nhà quản lý và của cả cộng đồng.*

**Từ khóa:** Kiến trúc xanh, công trình xanh, đô thị xanh, không gian xanh.

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