KIBV

GREEN SUSTAINABLE COMMUNITY

Green Sustainable Magazine

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#BUILDING GREEN - LIVING SUSTAINABLEE


Green
Sustainable
Magazine

GS MAGAZINE

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A KIBV project focuses on promoting green and sustainable construction initiatives.

INTRODUCTION

Under the impact of climate change and the depletion of natural resources, the adoption of sustainable energy solutions has become a top priority in modern construction. From renewable energy sources to passive design, the construction industry is undergoing a significant transformation to achieve optimal energy efficiency. Along with this, energy efficiency standards in Vietnam and alternatives to traditional concrete are playing a crucial role in this journey. Recognizing the current situation and the importance of these issues, this edition of the magazine will provide readers with practical and accessible information and suggestions to move toward a greener and more sustainable future.

We hope that the information provided in this issue of GS Magazine will offer readers valuable insights and knowledge, inspiring creative ideas in addressing environmental challenges and contributing to public health protection, while aiming for a cleaner, greener, and more sustainable future.

With the mission and vision of GS Community, this issue of GS Magazine has been meticulously compiled with the full dedication of the editorial team. We sincerely hope that the information shared in this issue reaches more young people, whether they are already engaged or not yet involved in environmental issues, sustainable living, and community health.

Although great efforts have been made in the content preparation process, mistakes are inevitable. GS Community sincerely welcomes feedback from our readers to help us improve future issues of the magazine. Sincerely thanks!

Please send any feedback to the email address: gscommunity.kibv@gmail.com.

SECTION 1

RENEWABLE ENERGY RESOURCES AND BENEFITS OF RENEWABLE ENERGY

1. Introduction

Today, the world remains reliant on fossil fuels, a finite source of energy that cannot be replenished at a significant speed. In addition, fossil fuels pollute the environment, deplete the ozone layer and contribute to climate change. In May, the International Energy Agency (IEA) warned that new investment in fossil fuel projects must end immediately if the world wants to achieve its goal of net zero carbon emissions by 2050 and maintain a chance of limiting global temperature rise to 1.5 degrees Celsius. This is a revolutionary statement from an organization established after the 1970 oil shock to ensure global energy security.

However, with increasing energy demand, the search for alternatives to depleting sources has become urgent. This has led to a shift to renewable energy, including solar, wind, hydropower and geothermal energy. These energy sources not only help reduce

greenhouse gas emissions but also enhance energy security and create new jobs. Advanced technology along with supportive policies are promoting the development of renewable energy, contributing to a green and sustainable future.
Since 2010, global renewable energy output has entered a period of high and stable growth, reaching over 4%. The International Energy Agency (IEA) estimates that renewable energy output will reach a record of more than 440 gigawatts in 2023, an increase of 107 gigawatts compared to the previous year. Therefore, renewable energy plays an increasingly important role in the energy industry, replacing finite fossil energy sources and being a necessary solution to protect the environment not only for the current generation but also for future generations.

2. Detail

2.1. Definition of renewable energy and some types of renewable energy

2.1.1. What is renewable energy?

According to the definition of the International Energy Agency (IEA), renewable energy is energy sources that can be regenerated and are not depleted during the process of use. This includes energy sources such as solar, wind, hydroelectric, geothermal energy, and biomass.

Renewable energy is considered as a sustainable energy source because it can be continuously renewed and does not cause as much negative impact on the environment as fossil energy sources (coal, oil) which produce greenhouse gases and other pollutants.

2.1.2. Some kinds of renewable energy

Solar energy: Solar energy is energy captured from the light and heat of the sun. It is an important, non-polluting, and readily available renewable energy source that also contributes to net emission reduction. Solar energy can be used in two ways: Using solar energy in the form of photovoltaics (PV) - also called solar panels. According to the IEA, photovoltaic solar power (PV) is a modular technology that can be produced in large factories, creating economic efficiency in terms of scale, but can also be deployed in extremely small quantities at the same time. This allows a wide range of applications, from small household rooftop systems to utility-scale power generation systems. And using solar energy in the form of heat for heating in thermal collectors. In residential buildings and especially in green buildings, it is possible to install solar panels on the roof to provide electricity and save money in the long run.

Image 1. Solar panels.
(Source: Britannica)

Nowadays, with increasing policy support, solar energy is becoming more popular and widely used, both reducing carbon emissions and protecting the environment towards net zero emissions (Netzero).

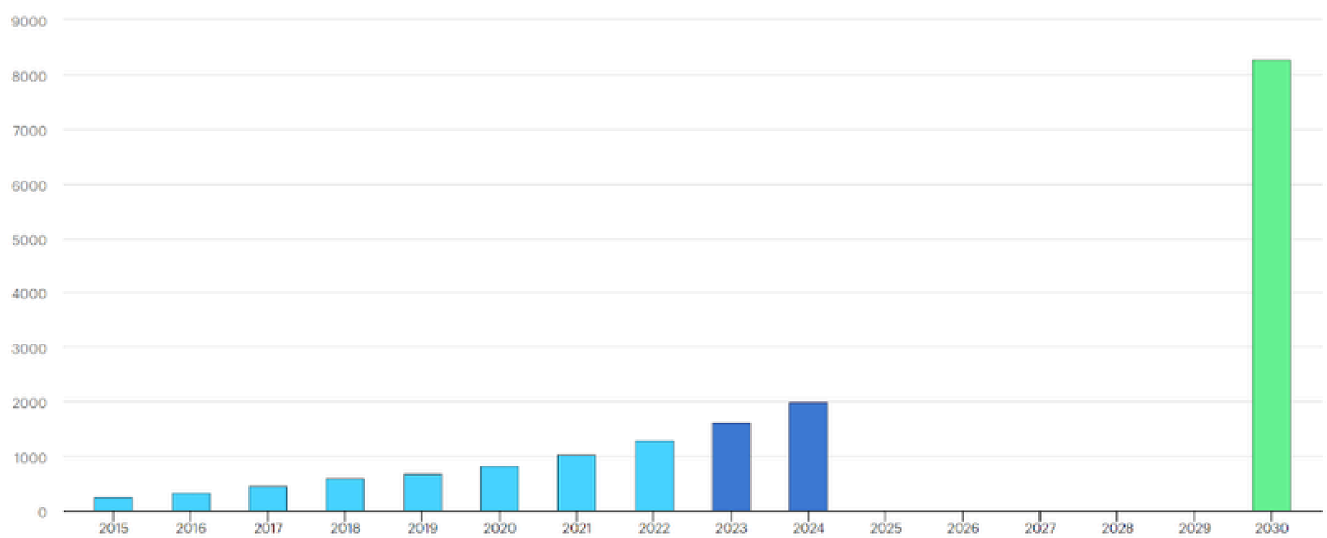
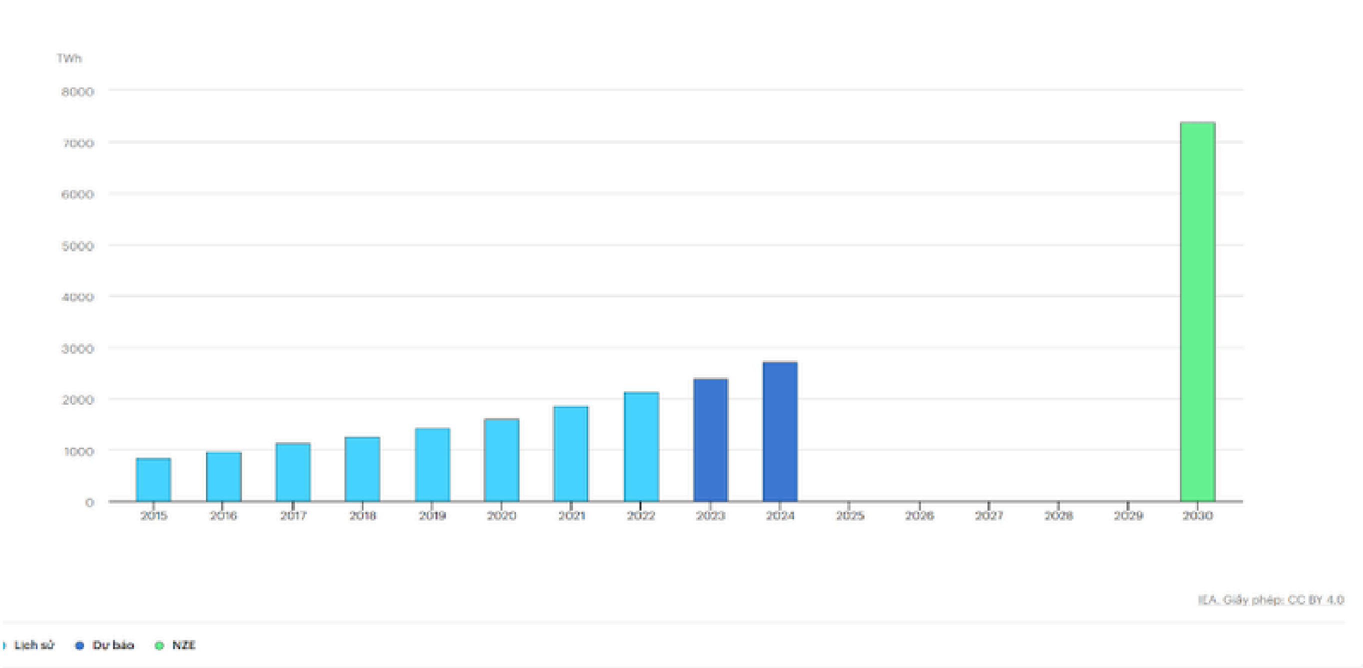


Image 2. Solar PV power generation in the Net Zero Scenario.
(Source: Solar - IEA)

Wind Energy: Wind is one of the potentials for energy growth of countries, using wind energy can also decarbonize the energy sector. Reduce dependence on electricity generation from fossil fuels. Wind energy is a form of renewable energy that is harnessed from the wind. Being used to generate electricity through wind turbines, wind energy does not pollute the environment and is a sustainable solution for the future. Wind turbines work by converting mechanical energy from the wind into electrical energy.

Wind energy is becoming increasingly popular, especially in areas with strong and stable wind conditions, such as coastal areas or highlands. In Vietnam, the potential for wind energy development is huge, especially in the Central and Central Highlands provinces, where wind speeds are high. According to the World Bank, Vietnam is the country with the largest wind energy potential among the four countries in the region. With more than 39% of Vietnam's total area which is estimated to have an average annual wind speed greater than 6m/s at the height of 65m, equivalent to the capacity of 512 GW. In addition, nearly 8% of Vietnam's area is ranked as possessing extremely good wind potential, with wind speeds at the height of 65m being 7 - 8 m/s.

Image 3. Wind turbines.
(Source: Environment Magazine)

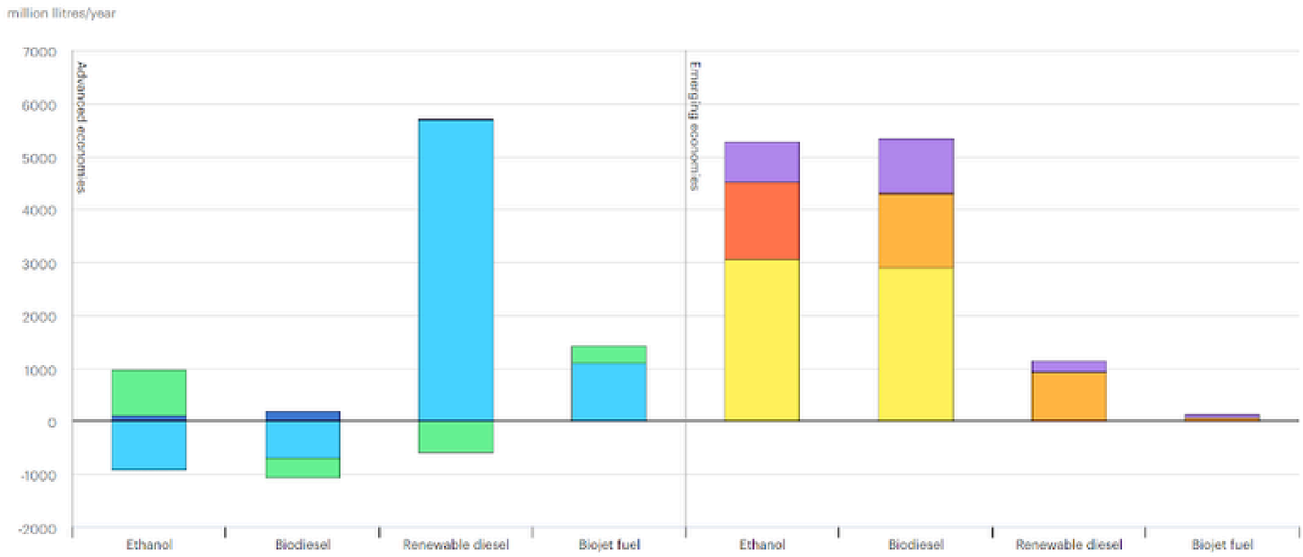


GNote: sky blue color: historical, blue color: the present, green color: forecast.
Image 4. Wind power generation in the Net Zero Scenario, 2015-2030
(Source: Wind - IEA)

Bioenergy (also known as biomass energy): According to EDGE, bioenergy is energy produced from organic energy such as wood, straw, agricultural residues, food waste, and other biological wastes. This is a kind of renewable energy because biological materials can be regenerated through natural processes such as photosynthesis, and is often used to produce heat, electricity, or biofuels.

Image 5. Algal biofuel.
(Source: Britannica)

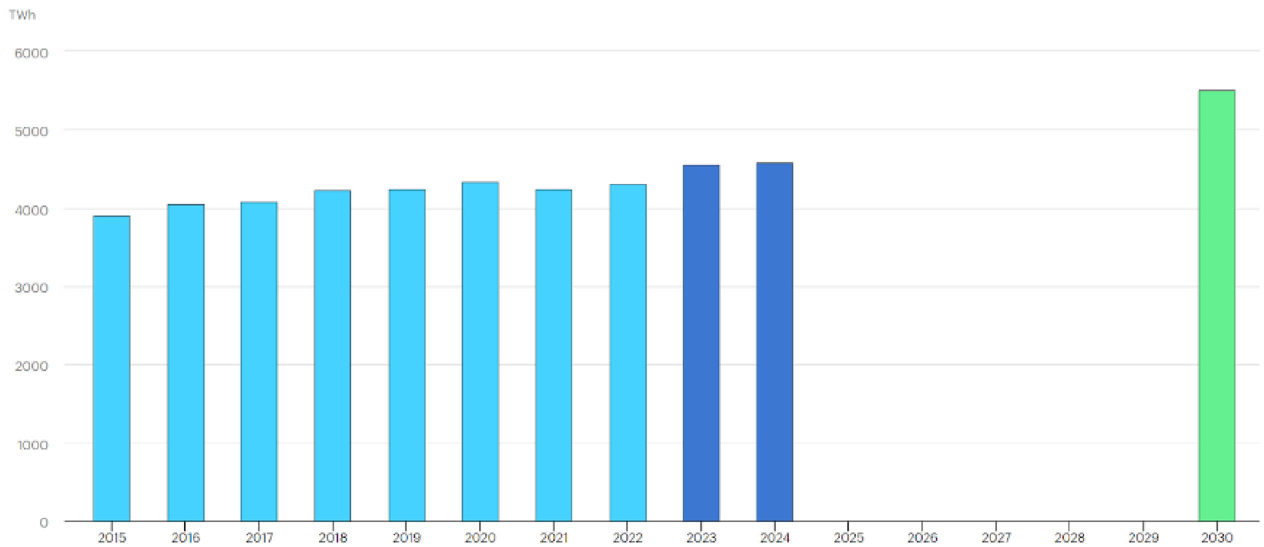
In production, bioenergy can be applied to make biofuels and can be used as an alternative energy substance to traditional fuels such as diesel or petroleum.



Note: sky blue color: United States, blue color: Canada, green color: Europe, yellow color: Brazil, waxen color: Indonesia, orange color: India, purple color: other emerging economies.
Image 6. Biofuel demand growth by fuel and region, 2022-2024.
(Source: Bioenergy - IEA)

Hydroelectric power: Next, a kind of renewable energy that is no longer strange to us, is hydroelectric power. It is generated by the water power in rivers and dams with large water flows.

Usually by the use of dams and turbines to convert the kinetic energy of flowing water into electrical energy. This is also a kind of energy that provides a clean and stable source of electricity.



Note: sky blue color: historical, blue color: the present, green color: forecast.
Image 7. Hydropower generation in Net Zero Scenario, 2015-2023
(Source: Hydropower - IEA)

2.2. Benefits of renewable energy

2.2.1. Environmental protection

In the context of the world facing increasingly serious climate change and depletion of natural resources, the use of renewable energy is a more suitable solution for the present and the future. This is not only an alternative energy source to traditional energy sources such as coal and oil, which are finite and potentially depletable energy sources. Renewable energy can also bring significant benefits to the environment and human society.

The biggest benefit we want to mention first is the ability to reduce greenhouse gas emissions. According to information from the website of Vietnam Electricity Group, the International Energy Agency (IEA), switching to renewable energy sources can help reduce CO2 emissions by up to 70% by 2050. Energy sources such as solar, wind and hydropower do not emit CO2, helping to minimize the greenhouse effect and protect the atmosphere. In addition, the World Health Organization (WHO) also said that if countries reduce greenhouse gas emissions according to the Paris Agreement, more than 1 million deaths per year due to air pollution could be prevented by 2050. Notably, in 2020, despite the Covid-19 pandemic, the world witnessed a record increase in renewable power capacity, reaching 260 gigawatts (GW), according to the International Renewable Energy Agency (IRENA). This has helped prevent the release of about 1.2 billion tons of CO2 into the atmosphere.

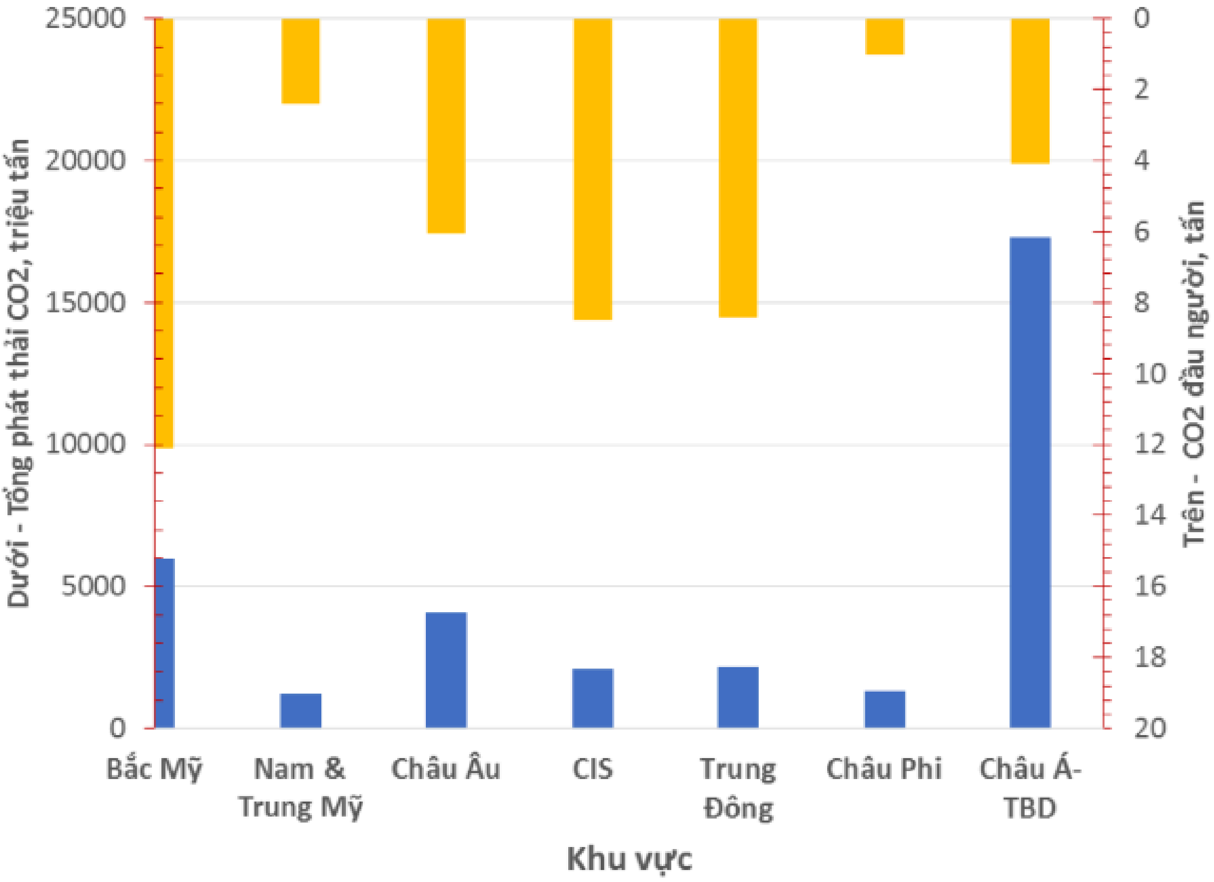


Image 8. Total CO2 emissions and CO2 per capita by region
(Source: Vietnam Energy)

Exploiting solar, wind, hydropower, etc. can reduce the consumption of energy such as coal and oil - energy sources that are at risk of being depleted. According to a report by the United Nations Environment Program (UNEP), switching to renewable energy can help save about 3.5 billion tons of coal and 2 billion barrels of oil per year by 2030. In Vietnam, according to data from the Ministry of Industry and Trade, the development of solar and wind power projects has helped reduce the use of more than 20 million tons of coal in the period 2015-2020. From the above specific evidence, we can witness great benefits, with long-term and sustainable impacts of switching to renewable energy to replace finite energy.

2.2.2. Economy and society

Not only does renewable energy bring great benefits to the environment, it can also bring surprising benefits to the economy and society. The renewable energy industry is growing strongly and creating new job opportunities. According to IRENA's report, the renewable energy sector created more than 12 million jobs worldwide in 2019 and is expected to create up to 30 million jobs by 2030, which is an impressive number. This contributes significantly to unemployment reduction. In Vietnam, according to statistics from the International Labor Organization (ILO), the renewable energy industry has created more than 100,000 new jobs in the past decade, especially concentrated in rural and coastal areas.

Image 9. Phu My solar power factory (Stage 2). (Source: Vietnam Enegry)

In addition, Vietnam and other countries are still dependent on energy imports. According to the Ministry of Industry and Trade, in 2021, Vietnam had to import about 54 million tons of coal and 9 million tons of crude oil to meet domestic demand, therefore, developing renewable energy can help reduce this dependence. Specifically, according to a report by the Vietnam Energy Institute, if the target of 20% of energy from renewable sources is achieved by 2030, Vietnam can reduce imports of about 15 million tons of coal and 5 million tons of crude oil each year, saving billions of dollars for the national budget.

Therefore, renewable energy not only helps in solving environmental problems but also promotes sustainable economic development. According to a United Nations report, investment in renewable energy can contribute about 2.5 trillion USD to the global economy each year from now until 2030.

2.2.3. Sustainable and long-lasting

It can be seen that renewable energy sources such as solar, hydroelectric, wind,... are unlimited energy sources, never exhausted. Bringing sustainable and long-term values. Exploiting and using renewable energy sources helps reduce risks from climate change, protect biodiversity and prevent the degradation of important ecosystems. According to a report by the World Meteorological Organization (WMO), if we continue to invest in renewable energy, we can reduce damage caused by climate-related natural disasters, saving about 200 billion USD per year in disaster recovery costs.

2.3. Potential for the application of renewable energy in green buildings

Vietnam, with its rich natural conditions such as solar radiation potential, strong sea breezes and geothermal potential, is an ideal location for the development and application of technology in green buildings.

For example, solar energy, according to the electronic magazine of the Ministry of Construction, Vietnam has a total solar radiation of about 5 kWh/m2/day in the Central and Southern provinces and about 4 kWh/m2/day in the Northern provinces. The number of sunshine hours per year in the North is about 1,500 - 1,700 hours and from the Central region to the South is about 2,000 - 2,600 hours (QCVN 02:2022/BXD).

With high average sunshine hours, solar panels can be integrated into buildings through roofs or facades to provide sustainable power and reduce energy costs. Then there is wind energy, with more than 3,000 km of coastline. According to research by the Danish Energy Agency (DEA) for the Ministry of Industry and Trade (2020): Through analysis and calculation, the technical potential for offshore wind power in Vietnam can reach 31,808 km2 equivalent to 162,200 MW. Green buildings in coastal areas or areas with strong wind potential can take advantage of small wind turbines to produce electricity.

If you are in a place with a stable wind source, installing a small wind power system can save costs and bring great benefits. According to the Ministry of Energy (Energy.GOV), a small wind power system can reduce electricity bills by 50-90%, avoid the cost of pulling power lines to remote areas, and reduce prolonged power outages. The wind power system includes: Turbines, towers, balancing components.

According to renewable energy experts, combining wind and solar power systems with a small hybrid system can be more efficient and advantageous. Because the time frame for taking advantage of these energy sources will vary at different times of the year. The “hybrid” power system referred to here is a hybrid system. According to the Department of Energy (Energy.GOV), a hybrid system is a stand-alone system that operates “off the grid” -- that is, not connected to the electricity distribution system. For times when neither the wind nor the solar system is producing electricity, most hybrid systems provide electricity through batteries and/or generators that run on conventional fuels, such as diesel. If the batteries run low, the generator can provide electricity and recharge the batteries.

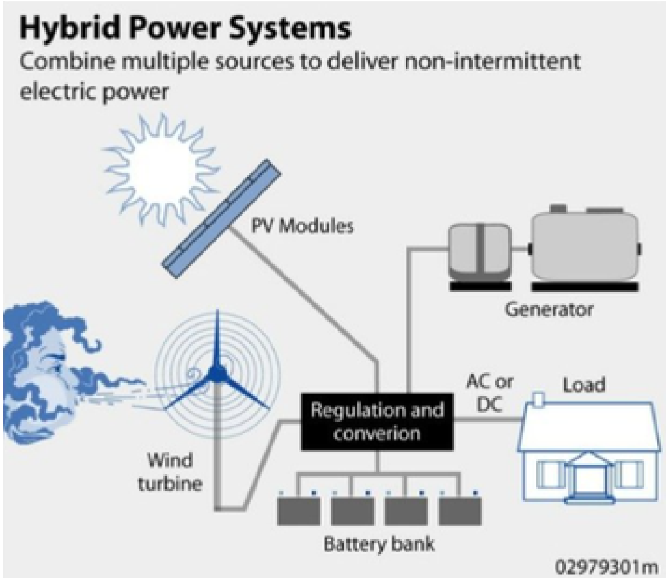


Image 10. Hybrid power systems (Source: Energy.GOV)

In addition, for green buildings, geothermal energy can also be applied, a sustainable energy source that can be used to regulate temperature in green buildings through geothermal heat pump systems.

2.4. Challenges and solutions for the use of renewable energy in Vietnam

Vietnam is on a strong development path, facing a great opportunity to become one of the pioneering countries in Southeast Asia in renewable energy. However, this transition is not easy when facing significant challenges. From limited technical infrastructure, to high investment costs and incomplete policy frameworks, each factor creates its own barriers to the development of renewable energy.

According to a report by the World Bank, only about 30% of installed solar power capacity can be fed into the grid due to the lack of transmission infrastructure. This leads to many renewable energy projects having to operate below their design capacity, wasting resources and reducing investment efficiency. In addition, Vietnam's energy storage capacity is very limited. Currently, Vietnam does not have many large-scale energy storage systems, which makes it difficult to maintain a stable power source when the weather is unfavorable, such as when it is cloudy or the wind is not strong enough.

In addition, the development of renewable energy requires a very large initial investment cost. This is a major barrier, especially for small and medium enterprises. In addition, access to preferential capital sources is still limited. According to a study by the Asian Development Bank (ADB), more than 50% of enterprises in Vietnam have difficulty mobilizing capital to develop renewable energy projects due to the lack of supporting financial mechanisms. Not only that, in Vietnam, the renewable energy industry is seriously lacking in specialized human resources, which means that Vietnam needs to import foreign experts, increasing costs and dependence on external parties.

Therefore, we need to come up with solutions to increase the conversion rate of renewable energy and bring Vietnam towards the goal of net zero emissions by 2050. The first solution, which also goes hand in hand with the first challenge, is to upgrade and expand infrastructure, encourage the development of energy storage technologies to ensure a stable power supply. Immediately following that is to improve the financial mechanism, the Government should create favorable conditions for businesses to access preferential capital and green credit, and at the same time introduce financial support policies such as tax exemptions or subsidies for renewable energy projects. Creating green investment funds and calling for the participation of international financial institutions is also an effective solution. Finally, human resource training and development are the foundation for long-term success. Vietnam needs to strengthen international cooperation in human resource training and technology transfer. At the same time, specialized training programs on renewable energy at universities and research institutes need to be developed more strongly.

3. Conclusion

Vietnam is on the threshold of an energy revolution, where renewable energy is not only an option but also an inevitable requirement to ensure sustainable development. In the context of increasingly serious climate change, investing in and developing clean energy sources such as solar, wind, and geothermal will not only help protect the environment but also open up new economic opportunities, from creating jobs to promoting technological growth and reducing dependence on fossil fuels.

However, this path is not without challenges, requiring determination from the government, businesses, and residents. By overcoming current barriers, we can open a new era, where renewable energy will become the main driving force to boost the economy and protect the environment for future generations.

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PART 2

PASSIVE DESIGN: PRINCIPLE AND SOLUTION

1. Overview of passive design:

The concept of “passive design” was first used in Darmstadt, Germany, called Passivhaus, which reduced heating needs by up to 90%. It was founded by Dr. Wolfgang Feist in 1996, and has since been adopted by architects and researchers in many countries such as Germany, Switzerland, Austria, and Central Europe. According to them, “passive design” is an architectural structure that maintains a comfortable indoor temperature in winter or summer, with low energy needs for heating or cooling the space. More specifically, Architectural Review defines “passive design” as a sustainable approach to building design that can help reduce the environmental impact of a building. It is based on the principles of bioclimatic architecture, which uses natural conditions to regulate the temperature and energy use of a building.

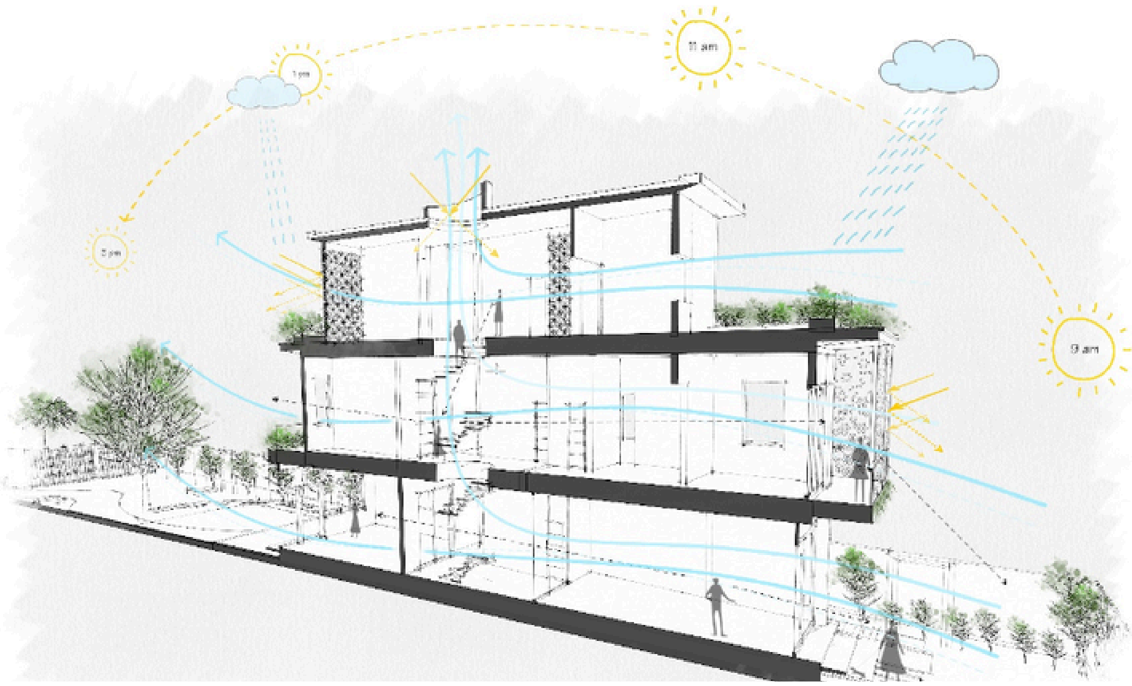


Image 1. Illustration of a passive design. (Source: K- Vila)

Passive design and active design are two different approaches to optimizing the energy performance of buildings. Passive design relies on the use of natural elements such as sunlight, natural ventilation, and insulation to regulate the internal microclimate without the need for complex mechanical and electrical systems. For example, optimizing the orientation of the building, using efficient insulation materials, and designing windows to take advantage of solar energy are key elements of passive design. Passive design focuses on high levels of insulation and air tightness, allowing them to operate with up to 90% less energy consumption.

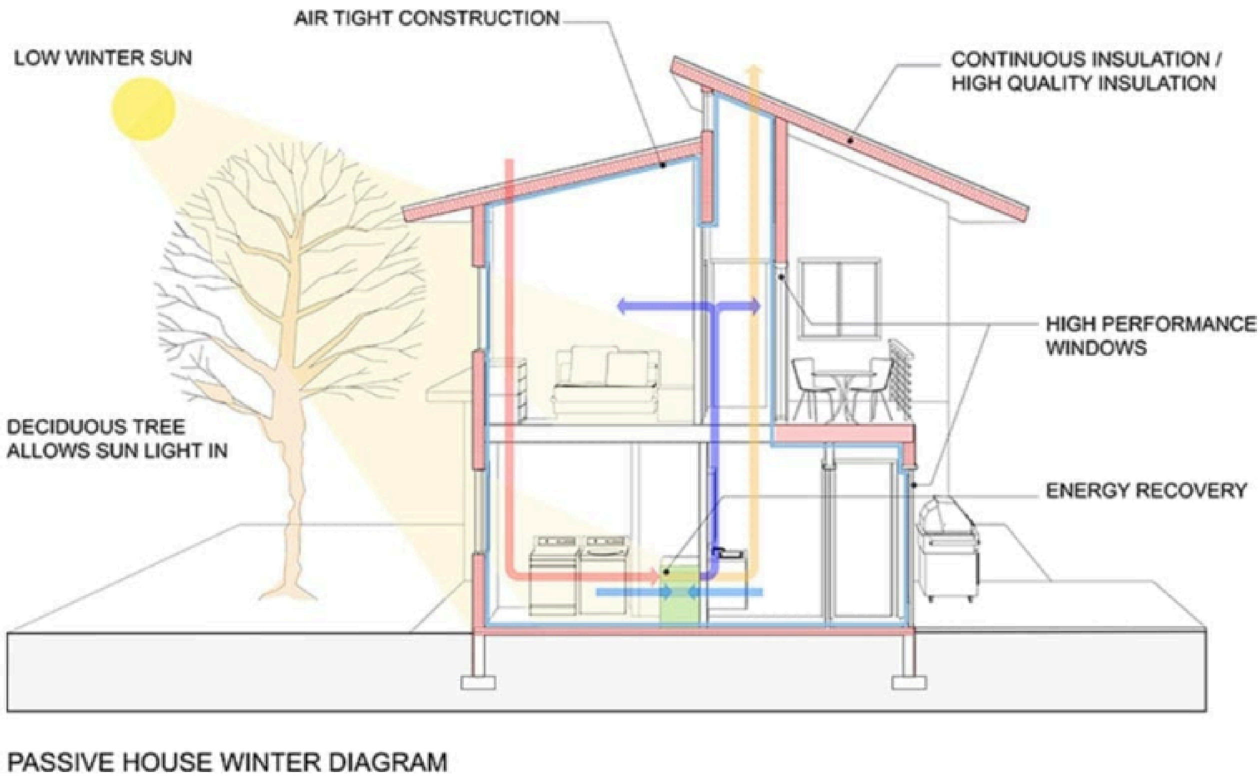


Image 2. Basic diagram of a house's active design. (Source: Fontan Architecture)

Active design, on the other hand, relies on engineering systems such as HVAC (Heating, Ventilating, and Air Conditioning), artificial lighting, and automated control technologies to maintain indoor comfort. Active solutions are typically capable of more precise control of temperature, humidity, and air quality, but require more energy and can lead to higher operating costs. Active design can also generate energy from sources such as solar, which can power the system and even generate surplus energy that can be fed back into the grid.

HImage 3. Illustration of an active design.
(Source: Active House)

In short, passive design aims to reduce energy demand through smart and sustainable design solutions, while active design focuses on controlling the living environment with technology, with greater operating costs and environmental impact.

2. Basic principle of passive design

The basic principle of passive design involves designing skylight openings to allow light to enter the building during cold months and vice versa to allow cool air circulation into the building during hot months.

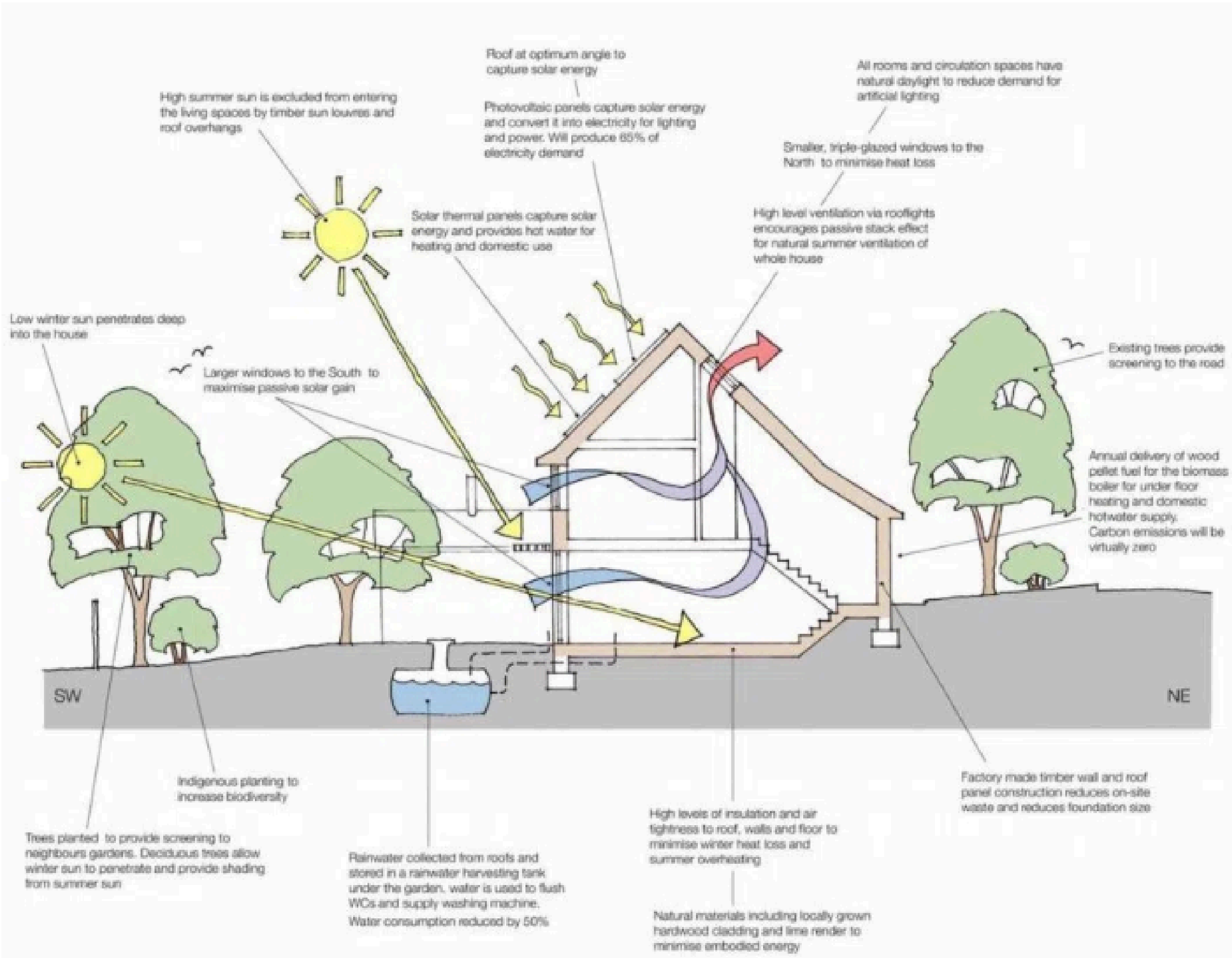


Image 4. Illustration of passive design strategy. (Source: Architecture Magazine)

2.1. Direction of the construction

Building orientation is one of the fundamental principles of passive design because it directly affects the energy efficiency of a building. When properly oriented, buildings can optimize sunlight collection and minimize energy consumption for heating and cooling. For example, in cold climates, orienting the main facade of a building to the south increases sunlight in the winter, naturally warming the interior space. Conversely, in hot climates, buildings can be designed to minimize direct sunlight, thereby reducing the need for air conditioning.

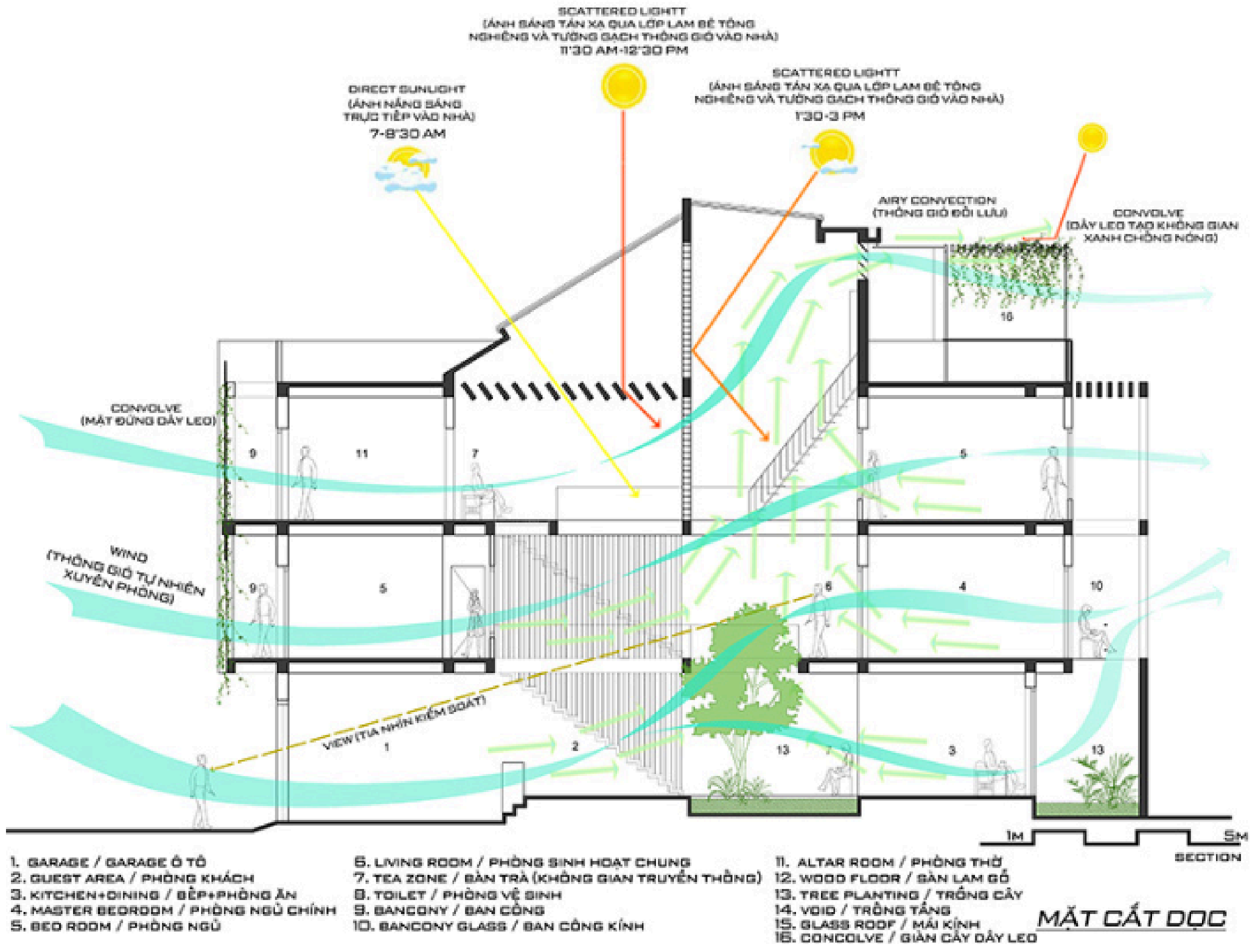


Image 5. Simulation of building design with wind direction.
(Source: Nội thất Kimi)

The main benefit of building orientation is the ability to reduce energy consumption and create a more comfortable living environment. However, if changing the building orientation is not possible, other measures such as the use of insulation materials or natural cooling systems can be applied to improve energy efficiency.

2.2. Optimal insulation

Optimal insulation is an important principle of passive design because it helps maintain a stable interior temperature and minimizes unwanted heat exchange between the inside and outside.

Effective insulation often involves the use of insulation materials such as foam, fiberglass, or other insulating materials in walls, roofs, and floors.

Image 6. Glasswool
(Source: Ngọc Tấn Phát)

Glass wool is an effective insulator, withstanding temperatures up to 350 °C, with a thermal conductivity coefficient of R-2.9 to R-3.8 per inch. In construction, glass wool is used in many forms such as plain, aluminum coated, or PVC plastic. In addition, glass wool also has good fire resistance and sound insulation properties, with thermal and sound insulation efficiency reaching 95%-97%.

These materials have the ability to reduce heat loss in winter and heat gain in summer, thereby reducing the need for heating and cooling systems. The benefits of optimal insulation are reduced energy costs and a more comfortable living environment. In case insulation cannot be improved, air conditioning or heating systems can be used as a supplement.

2.3. Natural ventilation

Natural ventilation is a passive design principle through which the air in a building is changed naturally without the use of fans or air conditioning. By properly designing windows, vents, and vents, outside air can enter and exit the building, creating air circulation and cooling the interior space. Natural ventilation not only reduces energy consumption but also improves indoor air quality by removing pollutants and providing fresh air.

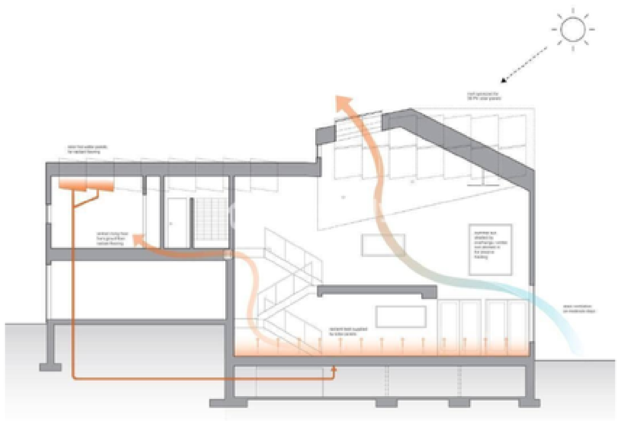


Image 7. Image of natural ventilation (Source: Homedy)

However, in temperate climates or in extreme weather conditions, natural ventilation may not be effective enough, and mechanical ventilation systems may need to be used in addition.

2.4. Vegetation

TPlanting in passive design is an essential principle because it can raise shadows, improve the air quantity, and decrease the radiant heat from the sun. Trees, gardens, or green walls can lower the temperature surrounding the building, and strengthen energy effectively by providing shadows and reducing heat absorption.

Vegetation also enhances comfortable feelings for users by creating a green living space and being friendly with nature. However, in some areas that are unsuitable to plant or do not have empty spaces, several replacement methods such as using materials that can prevent heat or conditional systems also can be used.

2.5. Canopy

By shielding the structure from the sun and rain, canopies lower temperature changes and maintain a regularly dry and cool interior. In order to reduce summertime solar radiation and increase wintertime sunlight, canopies are designed with inclination angles and suitable materials. It cuts down the need to run the heater and air conditioner. The ability to control the interaction between a building's structure and external weather conditions improves effective energy and safeguards building structure, which is the primary benefit of canopies.

In case, canopies cannot be designed, replacing measures like drapes or cooling systems can be applied to achieve the same purposes.

3. Apply new technology in passive design

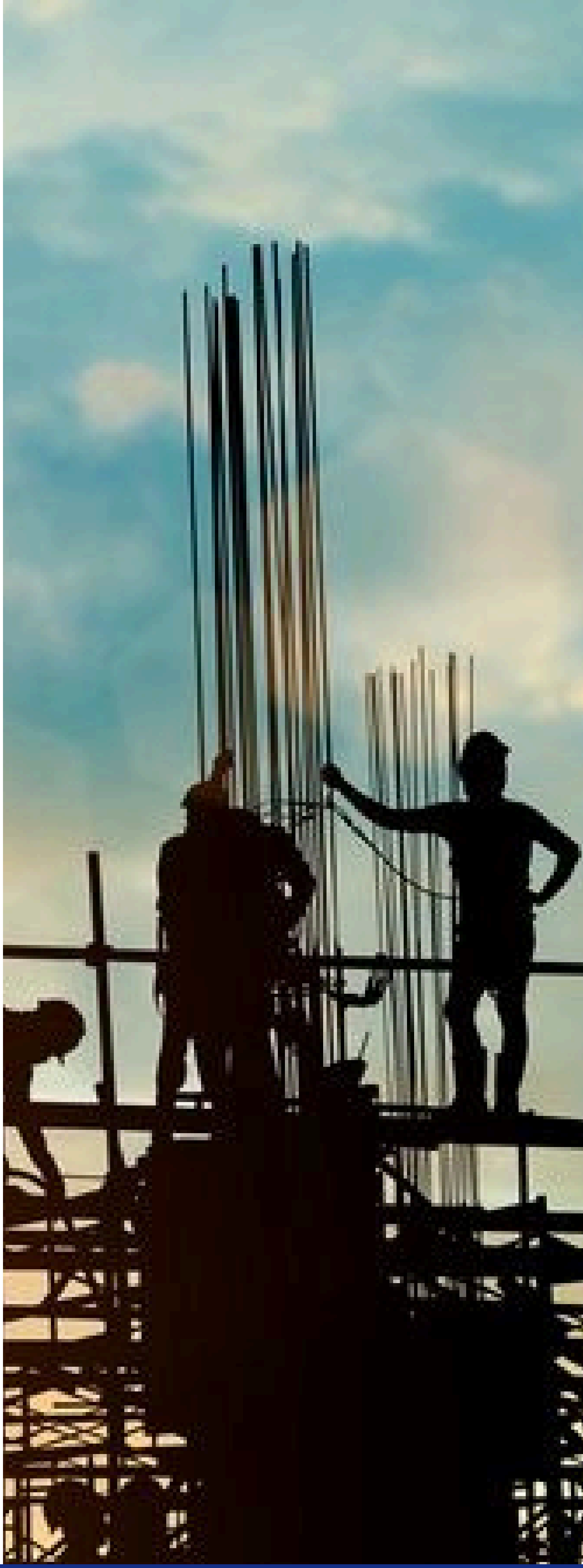
Apply new technology in passive design can create towers that not only save energy but also uplift the standard of living and lower bad effects on the environment. Paints that have less VOC and cabinets are do not contain formaldehyde are new technologies that are being used in passive design.

Image 9. Earth Tower, Canada
(Resource: Perkinswil)

Low-VOC paints (a paint that less easily evaporates organic compounds) are a kind of paint that contains low VOC content, helps to decrease the amount of chemicals evaporating in the air, and limits negative effects on human health and the environment.
Formaldehyde-free cabinets (cabinets which do not contain formaldehyde) are the types of cabinets that are made from materials that do not contain formaldehyde, a chemical that minimizes harmlessness when sniffing and are usually used in glues and industrial wooden products.

Image 8 . Harmless kitchen, low VOC content
(Resource: Puustelli USA)

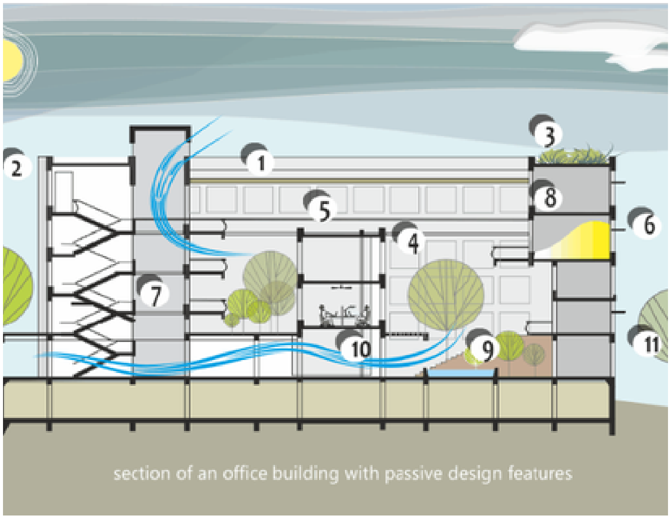
The 40-floor landmark in Canada has a more outstanding goal than other wooden skyscrapers worldwide. It was designed by Perkins+Will Company, and this tower is considered “the highest wooden tower in the world”. Building structural systems use the "Hybrid Approach" to reduce greenhouse gas emissions. For the walls, floors, and columns, they used sustainable materials like plywood, glulam wood, and plywood fastened with nails. Additionally, the gardens are integrated into each third floor of the tower's southern face, providing connective spaces where residents can enjoy natural light and fresh air.



4. Data, and statistics after applying measures that maximize effective energy in passive design.

According to Frontiers reports, the combination of passive design strategies can lower significantly the yearly consumption of energy to 35,4%. US Green Building Community (USGBC) reported that buildings that are certificated LEED had a CO_2 emission of less than 34%, and consumed less than 25% energy and 11% water.

The chances of reducing the consumption of construction energy and improving the temperature comfort for residents are two main aspects that can be enhanced through passive design solutions. In dry and humid subtropical climates like India, researching and simulating passive design



FImage 10. Description of passive design.
(Resource: Novatr)

methods to understand their effect on the need for energy and temperature convenience is still limited. The result of "Optimizing Passive Design Strategies for Energy Efficient Buildings Using Hybrid Artificial Neural Network (ANN) and Multi-Objective Evolutionary Algorithm Through a Case Study Approach" made by Tripti Singh Rajput and Albert Thomas illustrates that applying passive design solutions can cut down 46% of energy consumption and 7,58% uncomfortable time. These discoveries provide valuable information for designers and performances of raising the saving energy tower.

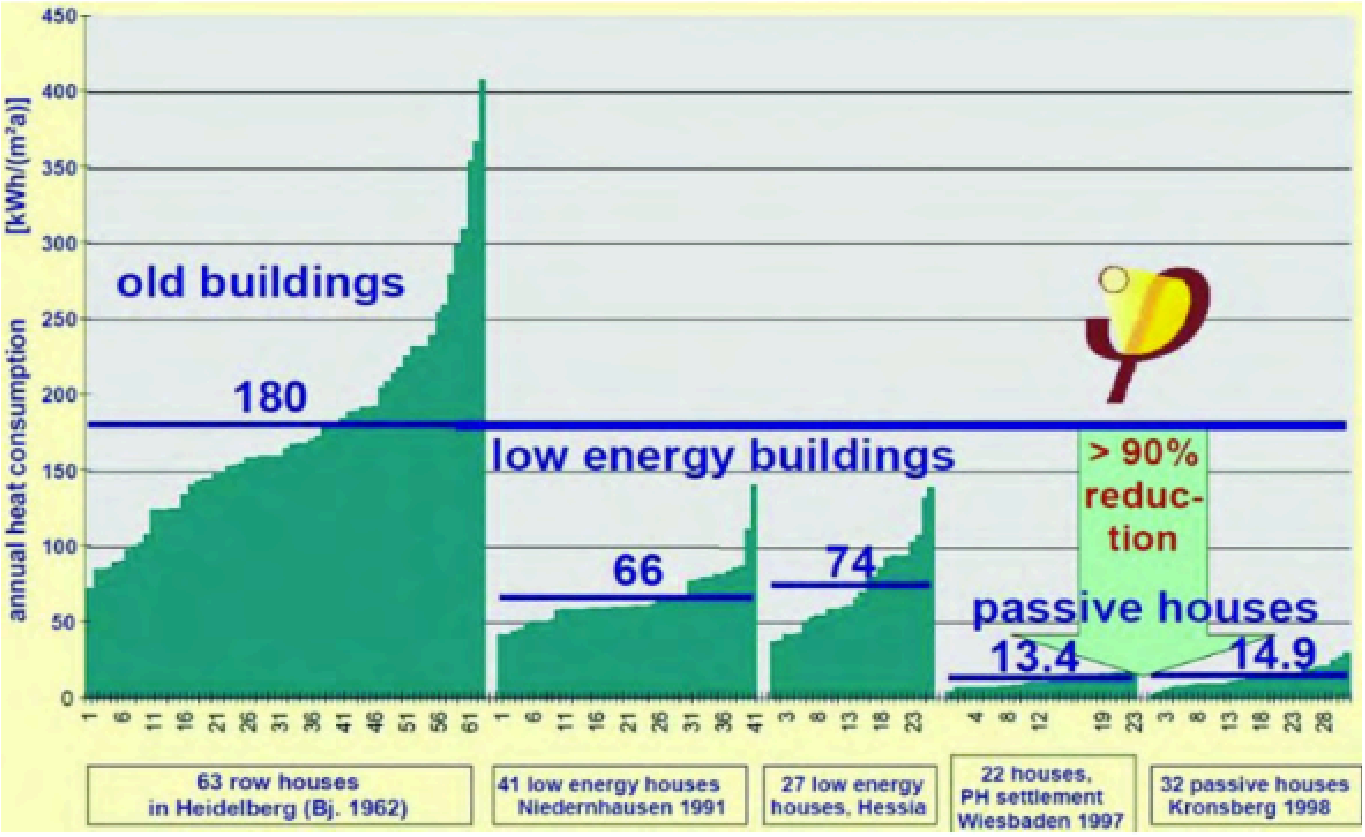


Image 11. The chart illustrates the levels of comfort by the ability to save considerable energy from different types of buildings.
(Resource: Foursevenfive)

These statistics evidently show the increase in sustainable needs in the process of designing and constructing. More and more organizations and companies are transferring to sustainable architecture and competing to be certificated in green construction for their project from prestige organizations such as USGBC, LEED, and GRIHA. These activities and certifications will lead to the appearance of sustainable quarters, and bring healthy and high-quality lives in the future.

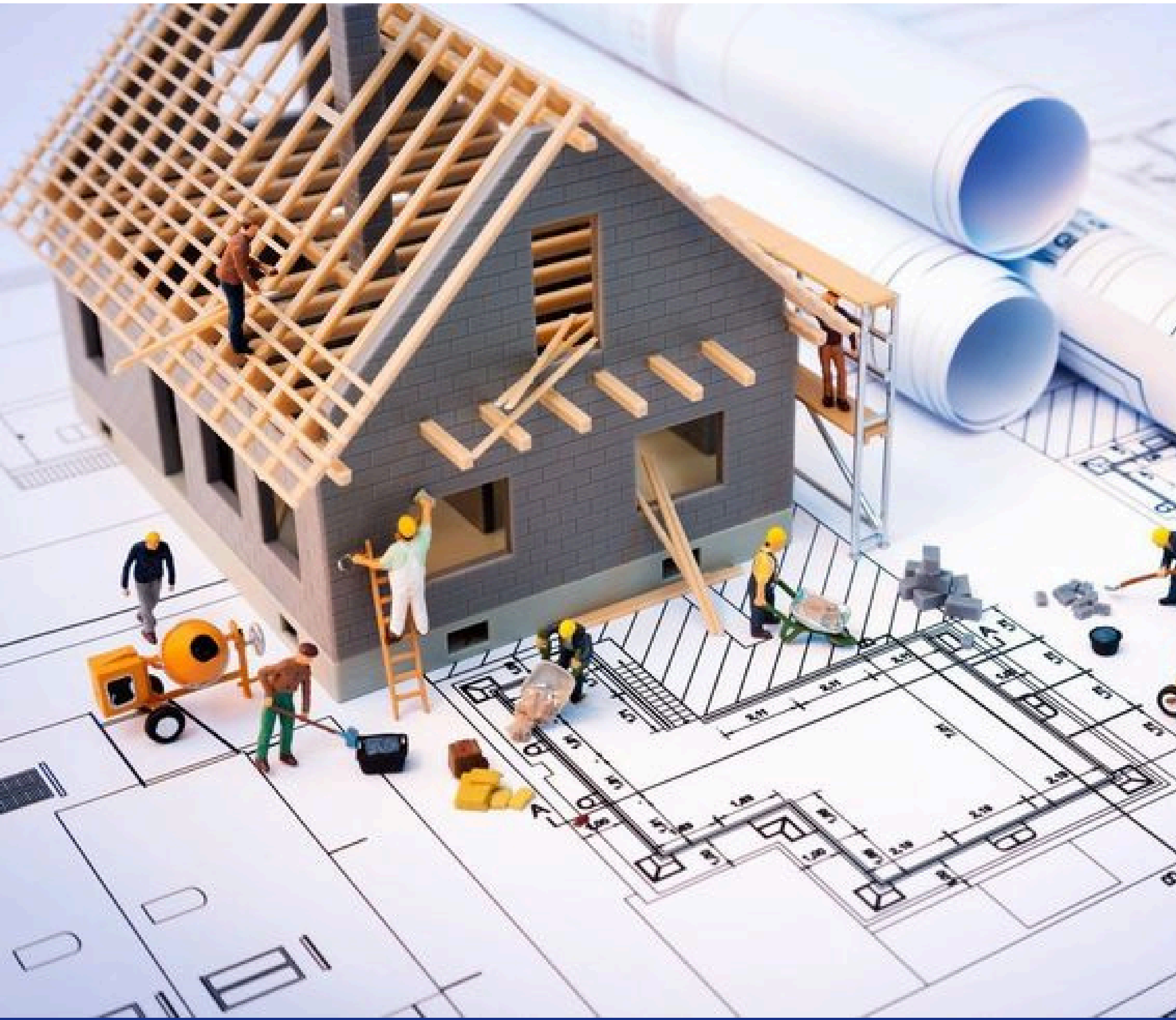
5. The tendency of developing and uplifting passive design in the future

Although passive design strategies should be considered from the very beginning of a construction project, it's never too late to incorporate passive design principles into existing buildings to improve quality of life. In short, methods such as planting trees, optimizing room layouts, or even simply installing new curtains can all contribute to reducing energy consumption in typical households.

However, passive design cannot shoulder all the basic needs of modern life. At a basic level, we still need active energy for hot water, lighting, and cooking. Hopefully, at least the active energy we use will come from sustainable sources.

As mentioned, regarding the world's development situation, the environment is facing increasing pressure from population growth and the rise in construction and architecture. Therefore, focusing on green buildings and passive design is urgent. Passive design technology is not limited to residential buildings. In recent years, other types of buildings, such as schools and offices, have also adopted passive design and technology, leading to high energy efficiency.

Promoting the implementation of passive houses also enhances the skills of the local construction workforce and improves construction and living standards for local residents. This leads to better job prospects, healthier communities, and a greener economy.



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PART 3

THE STANDARD OF EFFECTING THE ENERGY IN BUILDINGS IN VIETNAM AND SEVERAL SPECIFIC EXAMPLES

1. Introduce the overview

1.1. Background

Using energy in construction comprises most of the energy needs of Vietnam. The energy consumption overcomes the providing ability leading to the lack of energy occurring more regularly. In addition, the level of energy consumption rising contributes to the more serious climate change because most of the energy resources in Vietnam are produced by coal and natural gas.

1.2. Effecting the energy

QCVN 09:2017/BXD National Technical Regulations On Energy Efficient Construction Projects, illustrates the compulsory regulations on energy efficiency in designing, building, or renovating civil constructions (offices, hotels, hospitals, stores, services, houses, etc.) with a total area of 2.500 m2 above.

2. The compulsory requirements of QCVN 09:2017/BXD

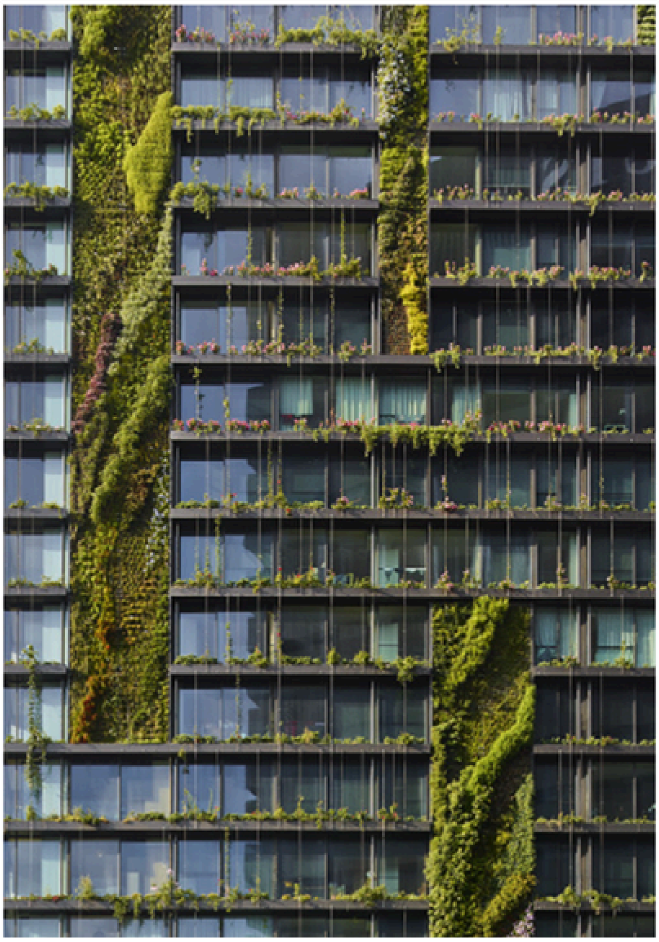
2.1. The cladding of constructions

* Requirements for outside walls and roof of constructions:
- Requirement of total thermal resistance R0 of non-translucent parts:
The exterior walls (non-transparent portions) of ground-level buildings that enclose air-conditioned spaces must have a minimum total thermal resistance (R-value) of R0.min not less than 0.56 m².K/W;
The total thermal resistance (R-value) of flat roofs and roofs with a slope less than 15 degrees that are directly above air-conditioned spaces must be at least 1.00 m²·K/W

- Requirement of translucent parts (glass doors, glass wall):
The largest value SHGC of glass walls and glass doors is identified privately for each side of walls according to Northern and Southern sides (Northern and Southern sides have the amplitude of oscillation approximately ± 22,50 compared to the main North or South axis), the other sides and have to satisfy values in the table 2.1. QCVN 09:2017/BXD.
The maximum SHGC for skylights is 0.3. For attic spaces utilizing natural light, the maximum allowable SHGC for skylights is 0.6;
In cases where a building facade has continuous vertical or horizontal shading structures, the SHGC value in Table 2.1 may be adjusted by multiplying it by factor A in Table 2.2a or 2.2b of QCVN 09:2017/BXD.
For buildings adjacent to streets, ground floor spaces designed for product display, service, and goods promotion are allowed to not comply with SHGC regulations when all of the following conditions are met:
a) The ground floor is not higher than 6 meters;

(b) The constant sun-proof structure with b/H > 0,5;
(c) The area of the glass wall and glass door is smaller than 75% of the total area of the wall and the ground floor on the street side.
- If the detailed regulations on R0 and SHGC mentioned above are not applied, it is allowed to determine the Overall Thermal Transfer Value (OTTV) of opaque and transparent building envelopes and their values are specified.
* Requirement of construction materials and installation for the wall and roof of the building
- The thermal conductivity of materials and the total thermal resistance R0 of walls and

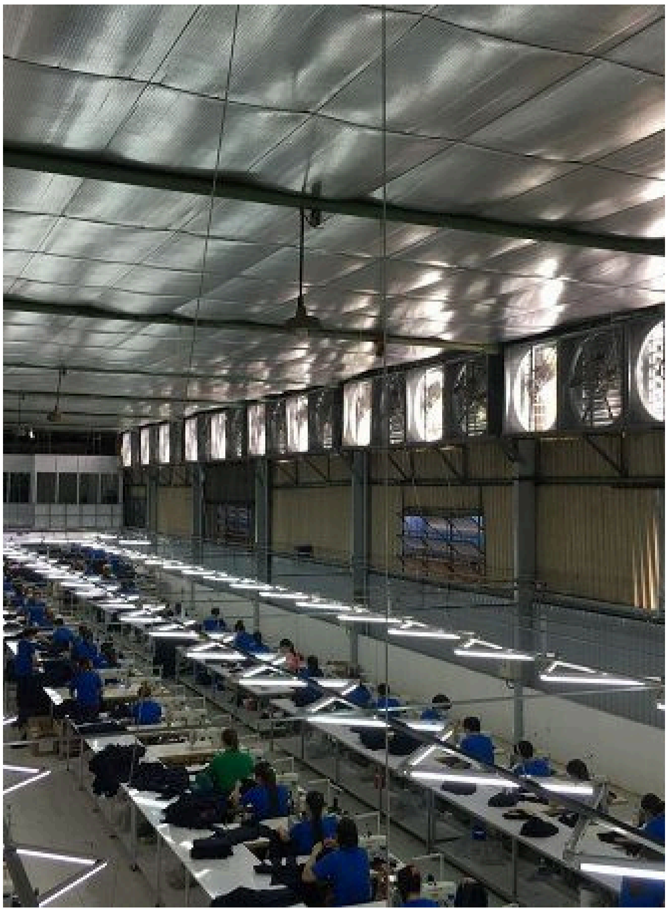
roofs are determined.
- Certification of the Solar Heat Gain Coefficient (SHGC) for glass and glass walls must be provided by the manufacturer. The SHGC value of glass and glass walls is determined according to the NFRC 200-2017 standard by independent testing laboratories.



2.2.Ventilation and air condition

* For natural ventilation:
- The total area of vents and operable windows on walls or roofs must not be less than 5% of the usable floor area of a room that adjoins an exterior space.
- Natural ventilation or combined with mechanical ventilation of the garage has to meet the requirements of QCXDVN 05:2008/BXD.
* For mechanical ventilation:
- Has to meet the ventilation requirements according to the Regulations QCXDVN 05:2008/BXD.
- Fans with motors larger than 0.56 kW must have automatic controls that allow the fan to be turned off when it is unnecessary.

* For air condition system:
- Air condition equipment and Chiller have to include the minimal effective index COP at the standard of evaluated conditions and not smaller than the values shown in Table 2.3, Table 2.4 QCVN 09:2017/BXD.
- Cooling equipment (Chillers), heating equipment, cooling tower fans, and pumps with a capacity of 5 horsepower (3.7 kW) or greater must have automatic controls to adjust capacity, and flow rate according to the cooling, heating, and water consumption demands.
- Fans in ventilation and air conditioning systems with a power rating of 5 horsepower (3.7 kW) or more must have an efficiency rating greater than FEG 67, as determined by the AMCA 205 standard.



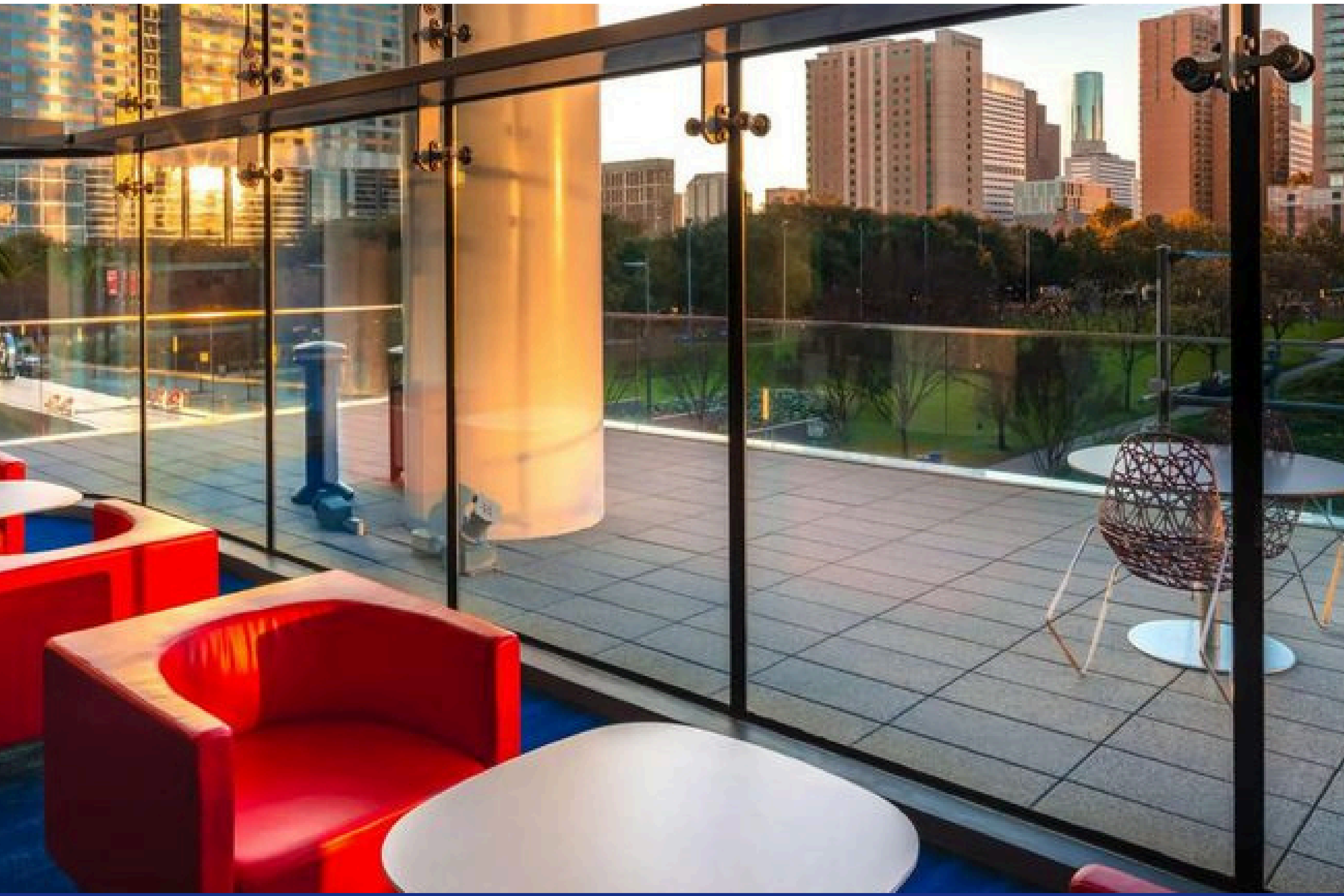
- Buildings using central air conditioning systems must have heat recovery equipment. The minimum heat recovery efficiency of the equipment is 50%.
- The materials and thickness of insulation for refrigerant pipes, chilled water pipes, and supply and return air ducts must be designed, installed, and inspected by the chosen technical standards for the project.
- The Coefficient of Performance (COP) or Seasonal Coefficient of Performance (CSPF) values specified in Tables 2.3 and 2.4, and the efficiency rating of FEG fans, must be verified by an independent laboratory. The manufacturer must provide test certificates verifying the technical specifications of all air conditioning system equipment before acceptance and installation at the construction site.

2.3. Lighting in the construction

* Natural lighting: In workspaces, classrooms, and reading rooms with natural lighting, there must be a solution to adjust artificial lighting. The lighting control requirements for areas with natural light do not apply to medical facilities, apartments, or buildings with special usage requirements.
* Artificial lighting:
- The minimum illumination requirements in residential and public buildings must comply with the national technical regulation QCVN 12:2014/BXD.
- The maximum allowable lighting power density (LPD) within the building must not be exceeded.

* Adjust the lighting:
- Adjust the lighting:
Equipment turns off the light when it is unnecessary and has to be designed and installed for the places that have a maximum area is 2500 m2 on a floor;
Each lighting equipment is designed and installed on a maximum area is 250 m2 for places wide of 1000 m2 and a maximum of 1000 m2 for places wide more than 1000 m2.

NOTE: This regulation does not apply to spaces that require 24/7 lighting or spaces that require ensuring security and safety when in use.



- Adjust the lighting of the garage in the house:
Automatically turn off lighting;
Lighting control devices must be installed to allow for a reduction of at least 30% of the lighting power of each light source when there is no activity in the illuminated area;
NOTE: This requirement does not apply to vehicle entrances and exits that lead directly to the outside of the building.
For areas within 6 meters of the external wall, with doors and glass walls with a Window-to-Wall Ratio (WWR) ≥ 40%, there must be a control device to allow for a reduction in lighting power.

2.4. Water heater and other electrical equipment

** Hot water heating systems:
- Efficiency requirements for water heating equipment
All water heaters and boilers used in construction projects must meet the minimum efficiency standards outlined in Table 2.7 of QCVN 09:2017/BXD;
Heat pumps for hot water supply must achieve a minimum COP as specified in Table 2.8 of QCVN 09:2017/BXD;
When using solar water heating systems, the minimum efficiency of the solar water heater is 60% and the minimum thermal resistance R0 of the rear side of the solar absorber plate is 2.2 m2.K/W.
- Control the boiling systems
- The control system is installed to limit the temperature of hot water when using is not more than 490C;
- The control system is installed to limit the maximum temperature of hot water that provides for the faucets of baths and sinks in public bathrooms not overcome 430C;
- Circulation pumps used to maintain the temperature in hot water tanks must be operated by the operating mode of the hot water supply equipment.

- For apartment buildings with a centrally designed and installed hot water supply system, renewable energy sources (solar, wind energy, heat recovery, etc.) must be used to supplement the energy source for supplying hot water.

* Other equipment:

- Three-phase electric motors, whether manufactured independently or as part of equipment installed in construction projects, must have a minimum efficiency at full load.

- The manufacturer's label on the motor casing must indicate the minimum efficiency at full load. The motor's efficiency must be determined in accordance with the NEMA MG-1 standard.
- When installing, for the inspection and acceptance of electric motors in construction projects, as per current regulations, it is mandatory to test the minimum efficiency of the electric motor as stated by the manufacturer on the motor's nameplate.

3. Strategies and Solutions for Designing Energy Efficiency

3.1. Building envelope

To optimize the thermal performance of a building envelope:
For air-conditioned buildings: the indoor environment is regulated by the HVAC system. The overall thermal transmittance (U-value) of the walls must be less than or equal to 60 W/m^2; the U-value of the roof must be less than or equal to 25 W/m^2.

- Limit the ability to absorb direct solar radiation by optimizing building orientation, arranging windows rationally, and using external shading structures, and materials with high solar reflectance.

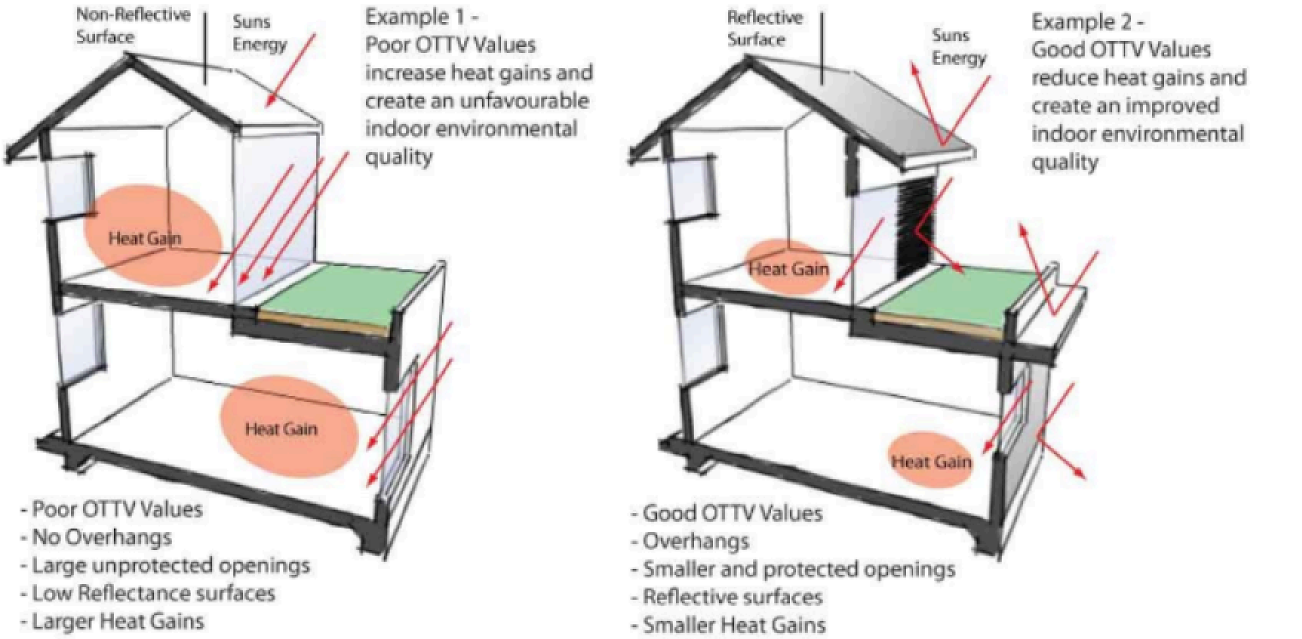
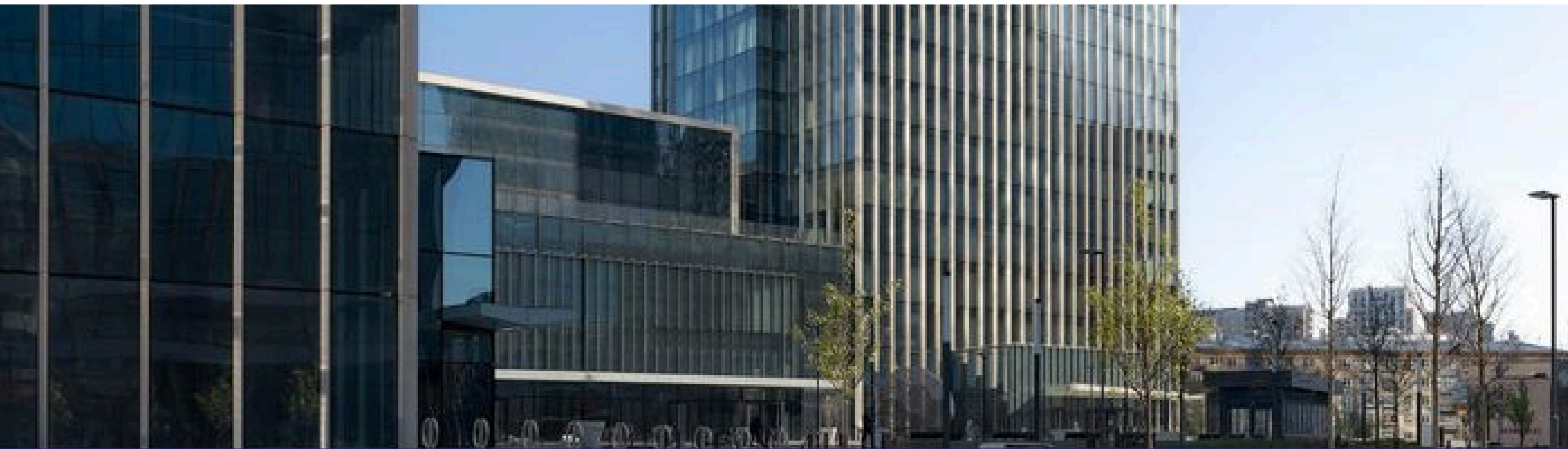


Image 1. Evaluations of the thermal insulation efficiency of a building envelope are based on OTTV (Resource: Week 2 gb course | PPT (slideshare.net))



3.2. Heating, Ventilation and Air-conditioning: HVAC

Image 2. Abbreviation of Heating, Ventilation, and Air-Conditioning
(Resource: iStock)

3.3. Lighting HVAC: Abbreviation of Heating, Ventilation, and Air-Conditioning

Artificial lighting: comprises a huge proportion of the total building's energy consumption. Adequate lighting is essential for maintaining occupant health and productivity while also enhancing the building's aesthetic appeal.
To decrease the lighting power density (LPD):
Use lighting equipment (fluorescent lamp T5, LED, etc.) and high-productivity ballast
Design lighting system to have a suitable level of lightening
Choosing types of walls and ceilings with high light reflectivity
Using reflective lamps or attaching light-reflecting parts inside the lamps
Use the adjusted lighting systems

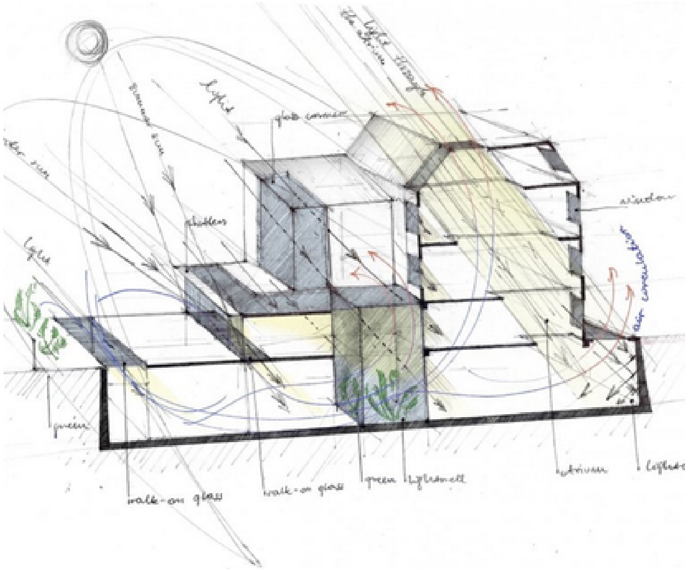


Image 3. Methods to create natural light in a room (Resource: www.btlpropertyltd.co.uk/ 10 Benefits of natural light in architecture - RTF | Rethinking The Future)

Natural lighting: It involves harnessing natural light to illuminate spaces, enhancing occupant comfort, and reducing the need for artificial lighting. This approach requires careful consideration of various factors, including solar heat gain, glare, illumination levels, visual comfort, and the requirements of users.

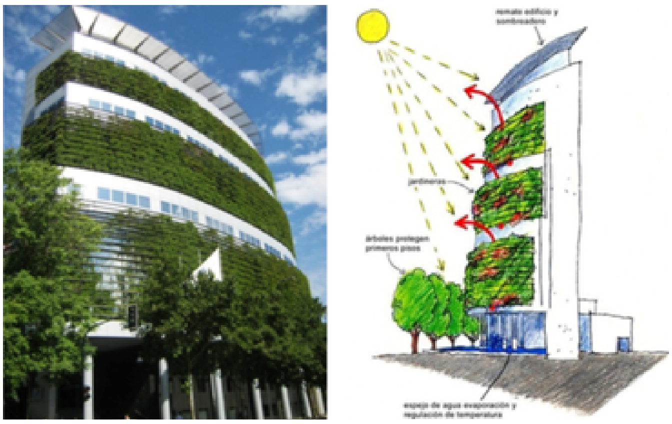
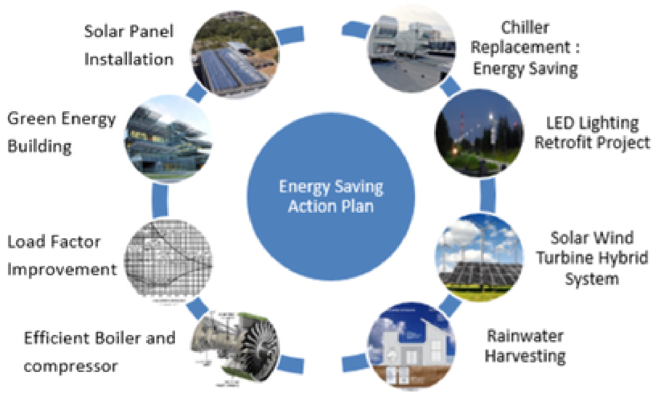


Image 4. Ways to reduce radiation duration in the building thanks to the green system (Resource: Đại học bách khoa Đà Nẵng)

-Lighting coefficients
-Lighting time-based

3.4. Manage energy: this is a comprehensive process to optimize energy consumption. To manage the optimal energy for construction need



3.5. Design the tower that is suitable for natural elements and conditions

This is an essential aspect of sustainable and energy-efficient architecture. However, this approach presents several challenges that must be analyzed and considered during the design and construction process. The following are some key issues and factors to consider based on the specific conditions of the site:

Image 4. Categories of acts to achieve Energy efficiency (Resource: https://www.synergyengineering.com/insights/energyaudit/)

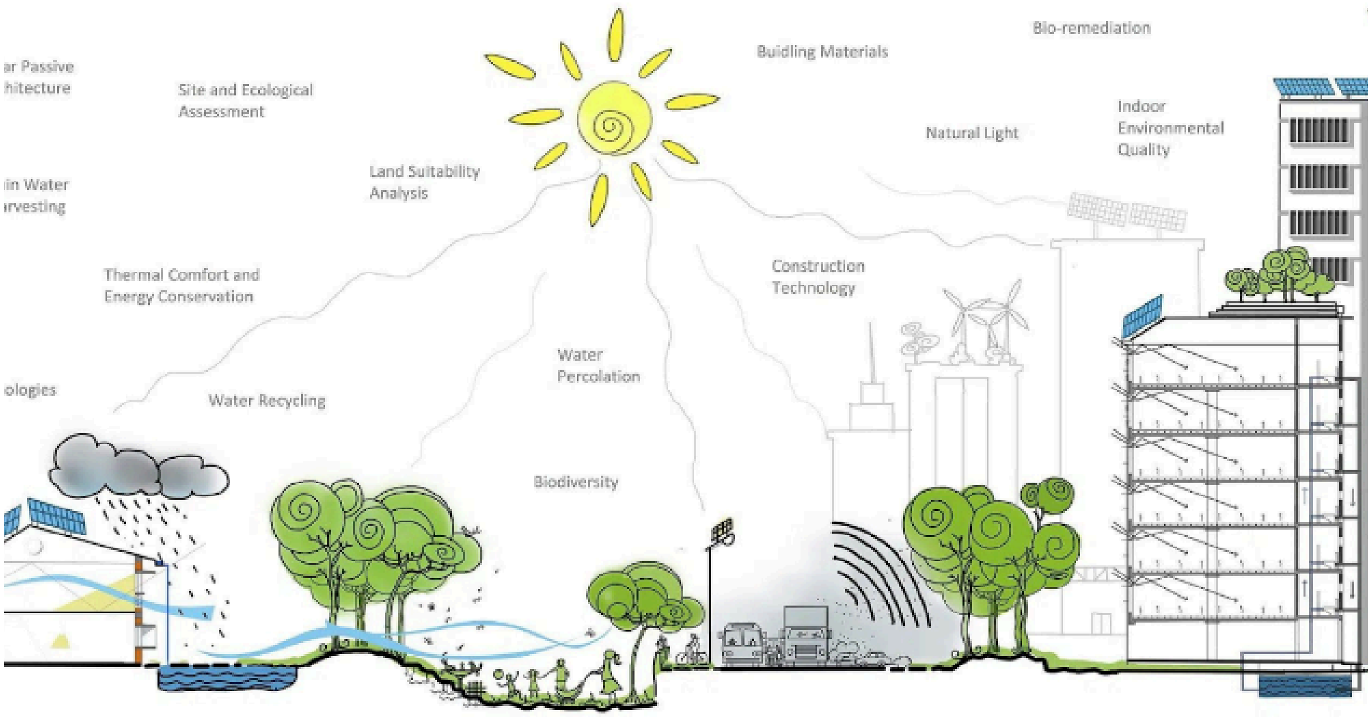


Image 5. Elements affect construction (Resource:https://www.linkedin.com/pulse/embracing-nature-transformative-power-biophilic-design-wairimu-hriaf/)

3.6. Renewable energy

The utilization of renewable energy in construction aligns with the goals of sustainability and reducing environmental impact. While offering numerous benefits, it also presents challenges for users:

- Benefits:

- Reduce carbon dioxide
- Energy efficiency: more sustainable and less dependent on fossil fuel.
- Save the long-term costs
- Enhance the building productivity: Integrate the renewable system in designing

- Challenges:

- High prime cost.
- Unconstant
- Require new technologies and specialties, including worker training, adjust design activities, and assure compatibility with traditional building methods.

3.7. Use water effectively

Bring various advantages for construction like:
- Save natural resources: Using water effectively protects the important and usually being limited natural resources. It is more important in the areas that face the lack of water caused by climate change, overpopulation, or other contributors.
- Save the cost: Managing water reasonably can save significant costs. It includes limiting the cost related to water lacking or broken, ...
- Preserve the environment: Using water effectively lowers the stress on the water resources and local ecosystem, and prevents water overusing, ...

3.8. Certificate

Applying scope: LOTUS NC can be used for different types of buildings, including:
- Housing building like flat with several separate apartments;
- Cultural building (library, movie theater, museum, theater, club, radio station, television station, exhibition center, cultural house);
- Educational building (kindergarten, nursery school, primary school, secondary and high school, university, vocational school, college);
- Healthcare building (health station, general hospital, specialty hospital from central to local, sanatorium, and temporary health center);
- Commercial building (market, store, shopping center, supermarket, restaurant, counter);
- Office building;
- Hotel and motel building;
- Traffic Services building (gas station, bus station, bus stop, information services center, post office);
- Stadium and sports center;
- Factory

Conditions to apply:
- Entireness and independence.
- Renovation project to a huge extent
- Project Core & Shell (the structural project has some categories belonging to the construction spiral part which is left by the investors for the rent area unit design and construct) is also evaluated with LOTUS NC when adapting some minimum requirements.

Image 6. Certificate systems of LOTUS
(Resource: Tiêu chuẩn công trình xanh Lotus)

4. Specific research

4.1. The River (Grace Farms by SANAA)

Constructal extent and location:
Location: 365 Lukes Wood Street, New Canaan, New York City, USA
Traffic: The Tower is inside the preserve area, far away from the main crossroad, with a sparse traffic density, there is a definite space between the parking area and the building.
Climate: Belong to mild climate with evidently seasons area.
Scenery: South-East (main entrance) which nearby spare area in the whole building concurrently connects the way to parking, the surrounding area is used to plant trees, and tiny farms in the West.

Area: The area of the building is approximately 8000 m2
Design: SANAA (Sejima Kazuyo and Nishizawa Ryue)
Construction:
Construction unit: Handel Architects
Scenery designer: OLIN
Engineer of MEP and light: Buro Happola
Structural Engineer: Robert Sliman Associates Civil Engineer.
...
Formation history: The River Tower was built in August 2013, completed in August 2015, and has been operated until now.
Main function: The River Tower is a cultural and humane center that is considered a public complex, so the building is almost full of functions that can adapt to residents and living activities. The River Tower has 6 main functions in Grace Farms, including:
(1) Grandstand;
(2) Library;
(3) Office;
(4) Canteen;
(5) Pavilion;
(6) Stadium;

Image 7. The River Tower
(Resource: https://gracefarms.org/event/grace-farms-tour-2024/2024-04-27)

Hình 8. Mặt bằng tổng thể khu bảo tồn
(Nguồn: River building at Grace Farms in Connecticut, USA, by SANAA - The Architectural Review)

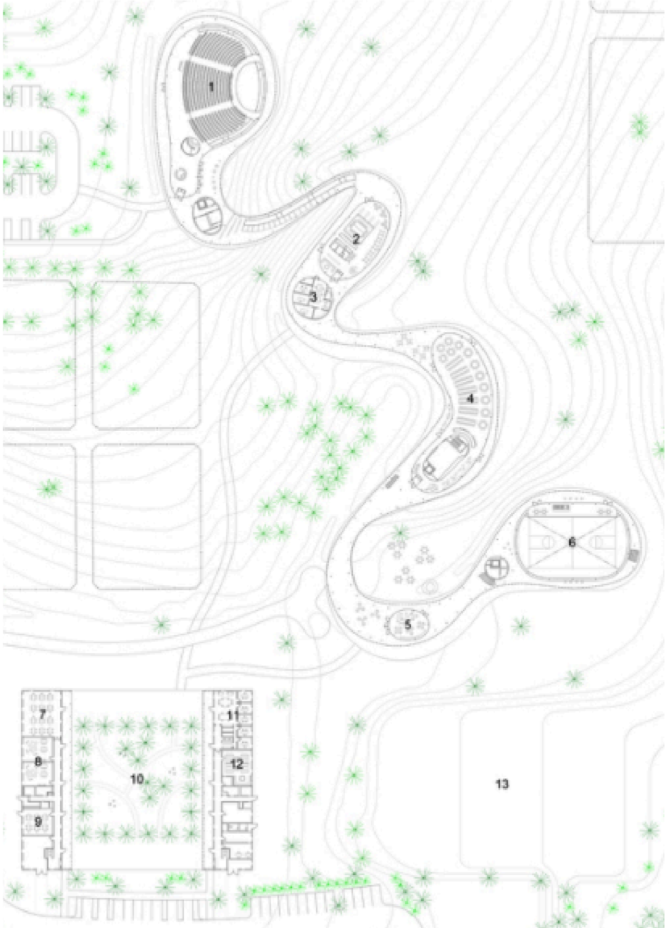


Image 8. The master plan of the preserve area
(Resource: River building at Grace Farms in Connecticut, USA, by SANAA - The Architectural Review)

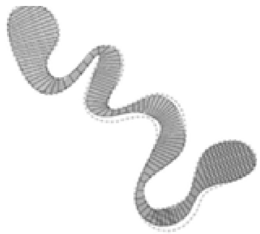
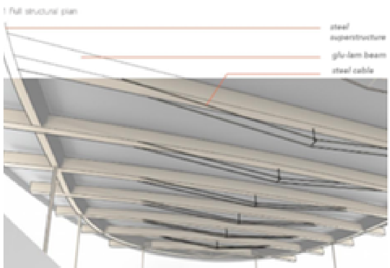
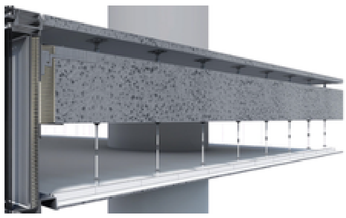
4.2. Headquarters of Viettel Corporation

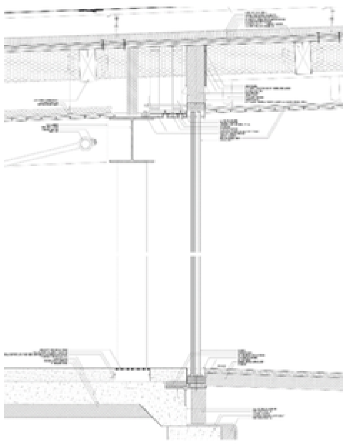
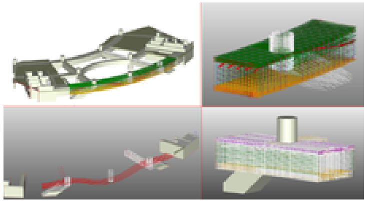
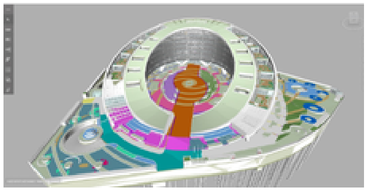
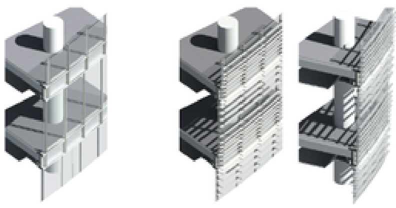
Image 10. Headquarters of Viettel Corporation
(Resource: https://maisonoffice.vn/tin-tuc/tru-so-viettel/)

Location: Block D26, new urban area Cau Giay, Yen Hoa ward, Cau Giay district, Ha Noi City.
Traffic: Lane 7, Ton That Thuyet ward with a high traffic density.
Structural area: 23710 m2
Construction designer: Design Consulting Company Gensler (USA)
Furniture designer: PTW Architects
Formation history:
1st quarter of 2018: The Tower was ground broken
Start operation in June 2019
Main function: each floor is designed suitably based on the specific functions:
Basement: organize events like conferences and meetings.
Floor 1: customer reception place, exhibit and provide canteen services to officers.
Floor 2: meeting rooms.
Floor 3 to floor 8: working offices.

4.3. Analysis and comparison of the overview of construction

Both of the buildings have a variety of functions, however, their main function is different. If The River (Grace Farms) focuses on public living activities, the headquarters of Viettel Corporation is a business environment, where people work together, and harmonize with nature. The special intersect point is not only the function but also adapts to the requirements of energy efficiency construction which are proposed according to the elements below:

	The River Project (Grace Farms by SANAA)	Viettel Group Headquarters
Natural light	Using glass materials for most functional areas, creates good natural light absorption, reduces the need to use artificial light, and creates a bright environment. Use solar energy passively.	Use diverse, suitable, advanced, and insulated window systems Building front: reduces the need for artificial lighting and mechanical ventilation, helping to reduce overall energy consumption.
Use sustainable materials (all recyclable)	- Glulam wood: low load, is a solution that helps minimize negative impacts on the environment, is environmentally friendly to help reduce carbon emissions and optimize the use of natural resources.)  	- Composite floors: good durability, combined with concrete, are used to achieve effective load distribution and support.-> improve the building's load-bearing capacity while reducing the overall weight of the structure.  - Steel: low load, high durability, and stability help parts withstand high pressure and load without causing excessive deformation, high flexibility.

	- Aluminum: highly durable, lightweight, it can reduce the load on the building structure and is easier to handle during installation. Can absorb sunlight, reduce heat absorption, and potentially reduce cooling costs in hot seasons. This reflective property also helps reduce the urban heat island effect.  - -Glass: prevents heat from outside to inside, minimizing heat transfer to the outside. Glass also has the ability to actively collect energy and convert it into energy to serve the building's daily needs. 	 -Concrete: good durability, regulates indoor temperature by absorbing and releasing heat slowly. This can contribute to energy savings by reducing heating and cooling needs.  - Glass: modern Low-E glass technology, can help control heat absorption and loss, improving the overall energy efficiency of the building. 

Other energy systems	- HVAC system: uses a geothermal heating system to regulate temperature (cool in summer, warm in winter); In addition to natural ventilation, the energy recovery ventilation system (ERV - Energy Recovery Ventilator) is also used. - Lighting system: using LED lights and ceiling lights managed by BMS.	- HVAC system: use energy-saving HVAC equipment (air conditioners with high SEER, heaters with high E,...); Additionally, VAV systems are used to reduce energy consumption by minimizing unnecessary heating or cooling. - Chilled Beam cooling system is used for cooling: helps reduce the energy needed for cooling. Also use EVR. - BMS system: manages the operation of pre-programmed or remotely controlled HVAC systems.
Surrounding landscape	- Trees and other vegetation around buildings provide shade (reducing the amount of solar heat absorbed through windows and walls) and act as windbreaks (reducing cold winds), helping to reduce cooling loads and heating of the building-> more stable indoor temperature. - Water management system (biological	- Surrounding trees and green roofs: create shade and cooling -> reduce heat absorption and reduce energy needs for cooling. - Green space and reflective materials (glass): reduce the heat island effect, helping to reduce the building's cooling load. - Integrating photovoltaic panels on green roofs or shady areas can generate

	drainage ditch,...): has the effect of reducing flow and minimizing the urban heat island effect,... - Water pool: cooling around the building.	renewable energy, helping to reduce both heating and cooling energy needs.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclude

Energy efficiency standards are an essential requirement: They help establish a baseline for performance and encourage the adoption of energy-saving technologies and practices.
Economic benefits: Energy efficient buildings, although initial construction costs may be higher than normal, have lower operating costs, higher property values and bring better return on investment.
Human health: Energy-efficient buildings that incorporate ventilation, HVAC, etc. systems often provide better building microclimate quality as well as reduced noise levels, contributing to the overall health of building users.
Technological advances: Advances in technology and materials continue to improve the energy efficiency of buildings.
Regulatory frameworks: These frameworks are not completely mature and need to be regularly updated to reflect technological advances and changing environmental standards.

5.2. Recommended

Promote energy-saving technology: Encourage the use of advanced technology and materials that increase the energy efficiency of buildings. Governments and organizations should offer incentives, discounts and subsidies that can help offset initial costs and promote adoption in construction projects.
Encourage renovation of existing buildings to meet modern energy efficiency standards.
Raise public awareness of the benefits of energy-efficient buildings through educational campaigns and outreach programs.

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PART 4

HOW TO REDUCE AND SUBSTITUTE TRADITIONAL CONCRETE

1. General Introduction

Concrete is a popular material in construction projects because of its solidity and stability. However, the abuse of this item leaves many long-term consequences for the environment and climate change.

This article will clarify those consequences, provide statistics on the amount of unnecessary concrete used in construction, and analyze measures to reduce concrete use in construction that have been researched and used. Practical application, thereby making recommendations for the Vietnamese market.

2. Harmful effects of overusing concrete

Overuse of concrete will leave negative and long-term impacts on the environment. This is because throughout their life cycle, concrete materials have weaknesses that affect the environment, especially during the production process.

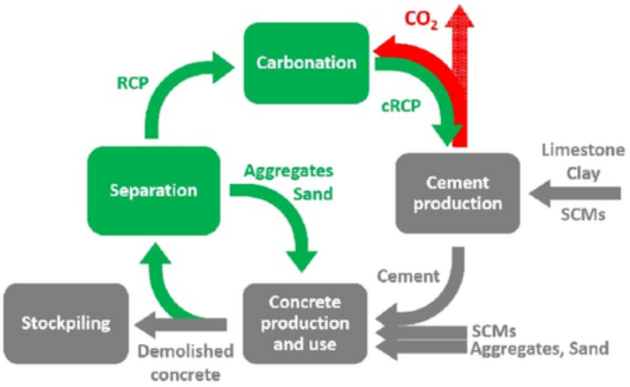


Image 1. The life cycle of concrete emits CO2 [1]

2.1. Concrete production process

Concrete is made by mixing a binder, which can be cement or lime, with fine or coarse granular materials (such as stone, gravel or sand) and water.

Figure 2. Mixing concrete
(Source: account book)

2.2. The cement production process emits a lot of CO2

Cement is produced in large, capital-intensive factories, often located near limestone mines or other sources of raw carbonate minerals, as this is the main raw material in the cement production process. Because manufacturing plants are expensive, the number of plants in a country is often limited (less than 100) [2]. Therefore, transporting cement also leaves a large amount of carbon emissions.

Image 3. Cement factory
(Source: HANCORP)

Carbon dioxide is emitted as a by-product during the production of clinker, an intermediate product in cement production, in which calcium carbonate ($CaCO_3$) is calcined and converted to lime (CaO), the main component of cement [2]. This process emits up to 57% of CO_2 in cement production and cannot be changed [3].

Specifically, CO_2 is released as a by-product during the calcification process, which takes place at the upper, cooler top of the furnace, or in a precalciner, with temperatures ranging from 600-900°C, leading to the conversion of carbonates into oxides [2].

Image 4. Clinker
(Source: Ximang.vn)

The high temperatures required for production are often achieved by burning fossil fuels, such as coal or oil, along with the process of transporting cement to construction sites which also results in CO2 emissions.

As a result, cement production contributes about 8-10% of total global CO2 emissions [4].

2.3. Exploitation of concrete production resources affects the environment

Mining materials to produce concrete can lead to the depletion of natural resources and habitat destruction.

Sand and gravel are the main ingredients in concrete. Mining sand from rivers, beaches or mines can deplete resources, cause soil erosion and affect aquatic ecosystems. Simultaneous sand and gravel mining can affect groundwater and cause water shortages for residential and agricultural areas. Limestone is the main raw material for cement production; Limestone mining often takes place in quarries, which can cause landscape destruction and loss of plant and animal habitats.

After mining, restoring the environment to its original state is very difficult, expensive and time-consuming.

Figure 5. Excessive sand and gravel mining causes river bank erosion
(Source: VietnamPlus)

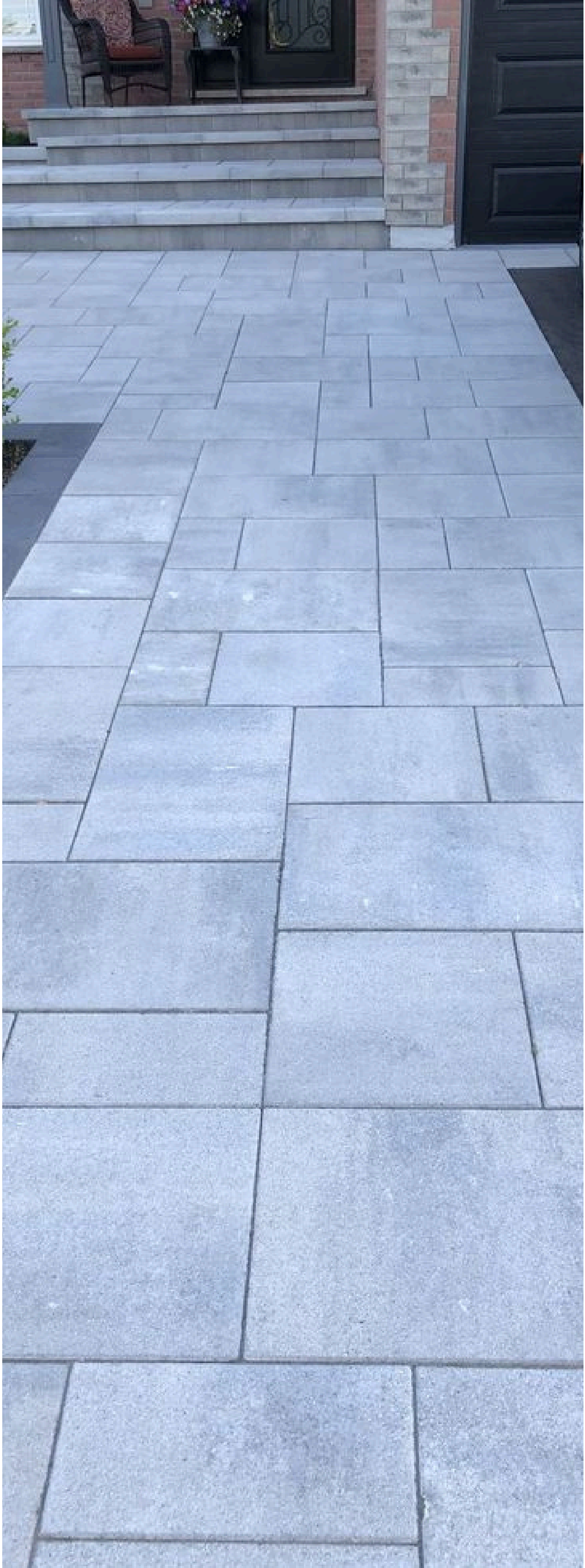
2.4. The process of using concrete

Concrete can contribute to the "Urban Heat Island effect" phenomenon. With its dense structure, concrete retains heat well, has the ability to absorb heat from the sun during the day and retain heat at night, causing urban temperatures to rise. Other large concrete surfaces, such as roads, parking lots and sidewalks, prevent water from seeping into the ground, reducing urban cooling and increasing surface temperatures.

Concrete takes up agricultural and natural land, causing animals, plants and fungi to be buried under tons of concrete, reducing biodiversity. Up to 80% of urban areas are covered by sidewalks or buildings, leaving little land for green spaces [5].

Image 6. Nha Trang city lacks green space (Source: Thanh Nien Newspaper)

Concrete does not allow water to penetrate the soil, causing waterlogging and groundwater depletion. "Previously, local flooding rarely happened, but recently, urbanization and concreting have made the sidewalks covered with bricks and stones, causing the rainwater to not have time to absorb, and there is no drainage



area, so the water flows down, causing damage. Therefore, it is necessary to calculate the flow of rainwater to ensure both urban development and drainage, ensuring infiltration" - Vice Chairman of the City People's Committee analyzed at the Supervision session on the Implementation of Regulations. of Environmental Protection Law in the Management of Drainage and Wastewater Treatment Activities in the City [6].

Image 7. Flooding due to the effects of climate change and concretization.
(Source: Ministry of Natural Resources and Environment)

2.5. Demolition process of concrete structures

During demolition, pieces of concrete, aggregates and other materials can release dust into the air, causing air pollution and affecting people's health.

Disposing of old concrete waste is not easy and is often not thoroughly recycled, leading to an increasing amount of waste.

3. Current situation of concrete abuse

3.1. Construction level

Concrete is a high-strength material that creates stability for the structure, which leads to its overuse to make the structure more solid.

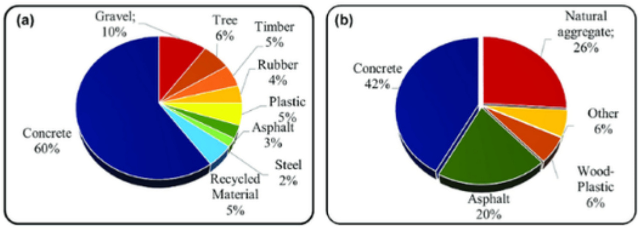


Image 8. Percentage of materials used for the construction of a building (a) and percentage of waste (b) [7]

It can be seen that concrete is the material that accounts for the largest part of both the construction process and the amount of construction waste in a building. However, the management of the amount of cement, the main ingredient that causes CO_2 emissions in concrete, has not been thoroughly optimized.

The use of concrete to achieve the required structural strength is often not specifically calculated, leading to excess use of concrete. Research results show that up to 35% concrete savings can be achieved without increasing structural depth, where, in most cases, a slight increase in construction complexity is sufficient to achieve Significant concrete savings. [8]

At the same time, the actual excess of cement in concrete mixtures was 7 to 21% higher than required. The content of cementitious materials should be reduced from 6 to 17% so that concrete can achieve better compressive strength without wasting cement. [9]

3.2. *Urban level*

The urbanization process along with the acceleration of concrete is creating many dangerous formulas for the living environment and people's quality of life. Construction of high-rise buildings based on limited interfaces, lack of adequate infrastructure and planning, leads to a series of problems such as traffic congestion, air pollution, overflow and overcrowding. health and education systems. This situation reflects an unsustainable urban planning process in which economic interests often take precedence over environmental factors and welfare interests.

4. Measures to reduce concrete usage

4.1. *Use alternative materials*

4.1.1. *Biological materials*

4.1.1.1. *Materials from soil*

One of the distinguishing features of rammed earth construction is its minimal carbon footprint. Concrete production is notorious for its high energy consumption and greenhouse gas emissions. In contrast, rammed earth requires much less energy and produces less waste during construction. Rammed earth walls have high thermal mass properties, which contribute to more stable indoor temperatures. This natural temperature regulation can reduce the need for heating and cooling systems, thereby reducing energy consumption.[10]

Rammed earth walls gain strength through compression and compaction during construction. Although concrete is known for its tensile strength, the compressive strength of rammed earth can be comparable or even superior, depending on factors such as mix design, compaction techniques and soil properties. use. The bonding properties of rammed earth and the bond of its particles contribute to its durability, allowing it to withstand significant loads and pressures.[10]

Image 9. Telenor Headquarters, Islamabad (The tallest building using rammed earth materials)
(Source: Sirewall)

When properly designed and constructed, rammed earth walls can last for centuries. Historical examples, such as the Great Wall and many other ancient structures, testify to the outstanding durability of rammed earth. Modern engineering methods, including proper foundation design, proper soil selection and proper maintenance, can further extend the life of rammed earth walls.

Image 10. Great Wall, China
(Source: iViVu.com)

Scientists at Texas A&M University propose using soil in construction to replace concrete. According to the research team, if treated properly, these soils with high clay content can have properties similar to concrete. They plan to produce them using high-capacity 3D printers, using local soil.[11]

4.1.1.2. Self-healing concrete

Hendrik Jonkers, a microbiologist at Delft University in the Netherlands, tested thermophilic bacteria such as Sporosarcina pasteurii and Bacillus pseudofirmus, live in lakes near volcanoes and is able to withstand temperatures up to 200°C, with the goal of developing self-healing concrete.[11]

Biotechnology company Green Basilisk (Netherlands) has introduced to the market a supplement containing bacterial spores for traditional concrete, named Basilisk. When exposed to water, bacteria in Basilisk will grow and produce limestone, helping concrete to resist water, crack and achieve a stable structure.[11]

4.1.2. Industrial by-products that replace cement [12]

4.1.2.1. Fly ash:

Large volumes of fly ash are produced and widely available at coal-fired power plants as a surplus material and often end up in landfills. Fly ash requires less water, improving slurry properties and workability. It can reduce cement demand by 20% and water demand by 10%. The main benefits of using fly ash include its ability to replace a large percentage of cement, making it cheaper than Portland cement, reducing run-off, increasing the strength of concrete and reducing shrinkage. compared to traditional concrete. The performance of fly ash also depends on different grades from different sources.

Image 11. Dry fly ash collection point (Source: South East Coal Ash)

4.1.2.2 Silica ash:

Also known as micro silica, silica ash is an ultra-fine powder. This is a surplus material from the silicon production process, untreated, which can replace about 7% - 12% of cement in concrete. It is the third most used cement replacement material in the concrete industry. The use of micro silicamicrosilica or silica ash has demonstrated greater durability, low permeability and increased compressive strength compared to traditional concrete.

4.1.2.3. Blast furnace grain ash and slag:

As one of the common industrial byproducts, blast furnaces can be recycled to create an environmentally friendly alternative to concrete. This is a waste product of the steel industry and comes in the form of glass granular material. In theory, blast furnace cement can replace 100% of Portland cement, but usually only about 70% is used.

4.1.2.4. Rice husk ash:

As the hard protective shell of rice grains, rice husk ash is separated during the rice production process. This is a common waste material in rice-producing countries. Current global rice production is estimated at 700 million tons, and rice husk ash accounts for about 20% of the weight of rice. Replacing 15% of cement with rice husk ash can increase the compressive strength of concrete by about 20%. However, when replaced beyond 20%, there will be a slight decrease in durability parameters of about 4.5%. Due to its high permeability, it is necessary to maintain a perfect water-cement ratio.

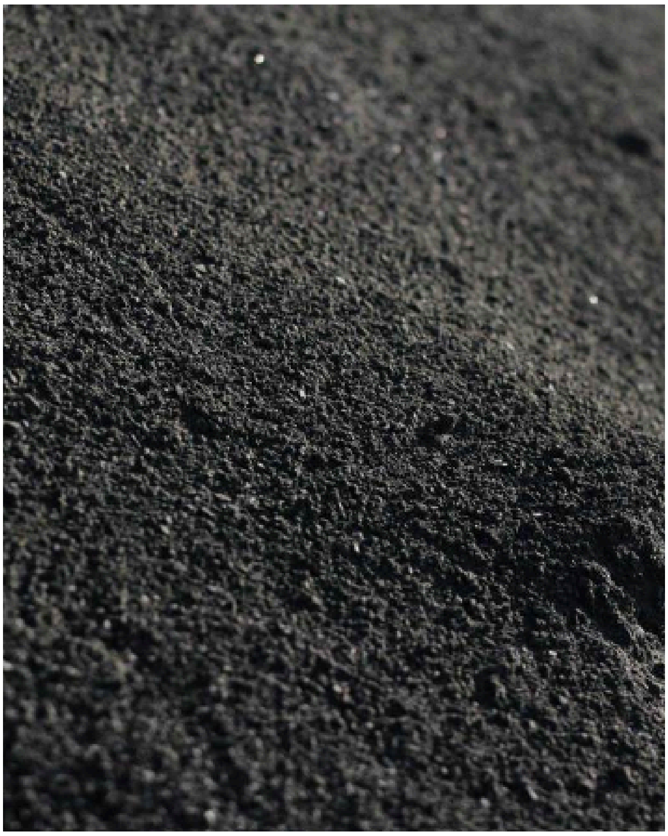


Image 12. Rice husk ash
(Source: Biruni Consulting)

1.2.5 Tires:

As a non-degradable material with a very short lifespan of only about 4 years, waste tires are one of the most difficult types of waste to handle, causing many health and environmental concerns. However, replacing 20% of cement with tire rubber may affect the compaction of concrete; Therefore, it is often used in places where low durability is required, such as low-rise buildings, parks, slabs and farms, to prevent slipping.

4.1.3. Recycled concrete

Recycled concrete is a construction material produced by reusing used or demolished concrete structures. This recycling process involves crushing old concrete blocks to form new aggregates, which can be used for many different purposes in construction, such as making foundations, roads, or civil works. other uses.

Recycled concrete aggregate (RCA) is a multi-purpose material, effectively applied by many developed countries such as the US, Singapore, France and Germany. RCA is environmentally friendly, which is one of the outstanding advantages of this green material. The process of quarrying and crushing to produce new aggregate often consumes a lot of natural resources and mechanical technology. However, recycling concrete creates a new life for the aggregate with minimal processing required, helping to minimize the impact on natural resources. Additionally, RCA treatment requires less space than leaving concrete to decompose in landfills.

4.2. Reduce building size and Optimize structural design

Reducing building size and optimal structural design are effective methods to minimize the amount of concrete used in construction. These methods require:
- Use building information modeling (BIM) engineering software to optimize structures and construction processes, thereby reducing project size while still ensuring sustainability.
- Creating open spaces and actively exploiting natural light, helps reduce the need for materials and construction areas.
- Designing structures with optimal load-bearing elements helps reduce the amount of concrete needed while still maintaining stability.
- Use multi-purpose construction solutions to save space and reduce the amount of concrete needed.

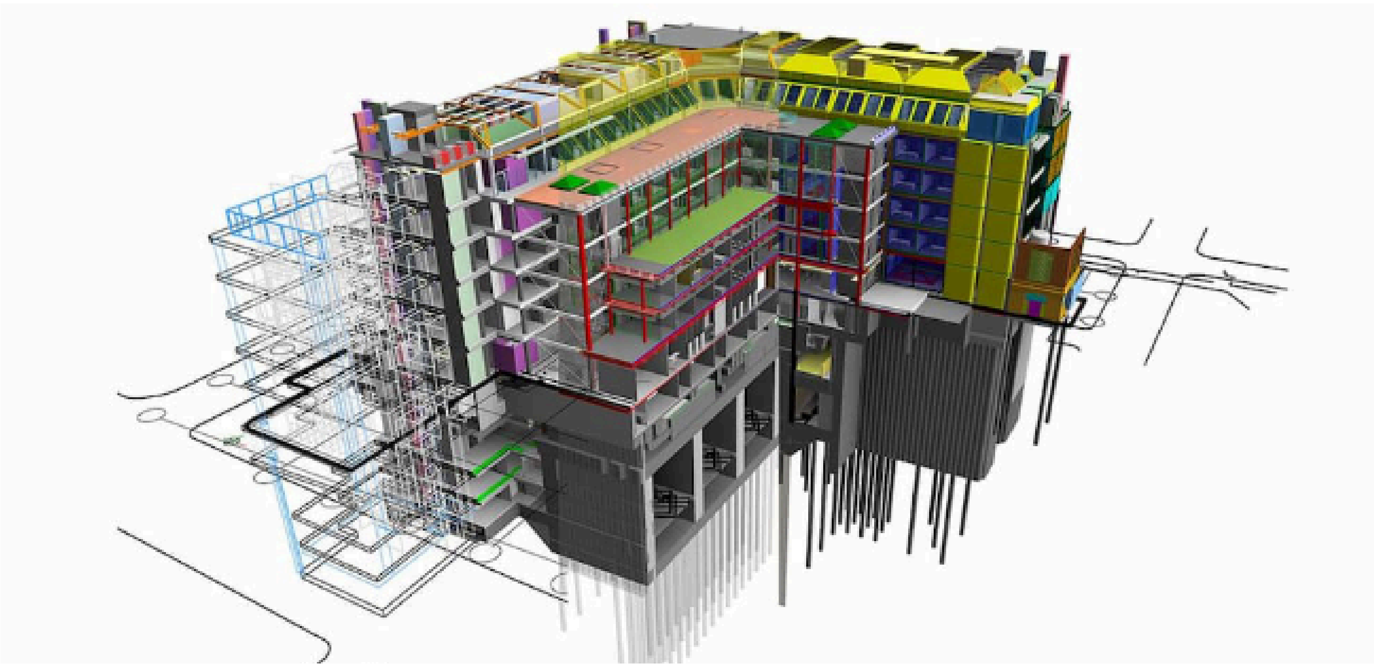


Image 13. Using BIM engineering software to design structures
(Source: Point Group)

5. Improve construction process

5.1. 3D printing technology

3D printing concrete is a major change in the way we build. Instead of using traditional methods, we use computer-controlled robotic arms to precisely place layers of concrete, allowing for complex and customized structures. This method helps reduce concrete volume while still ensuring durability with minimal concrete waste. Furthermore, it also saves time and costs.

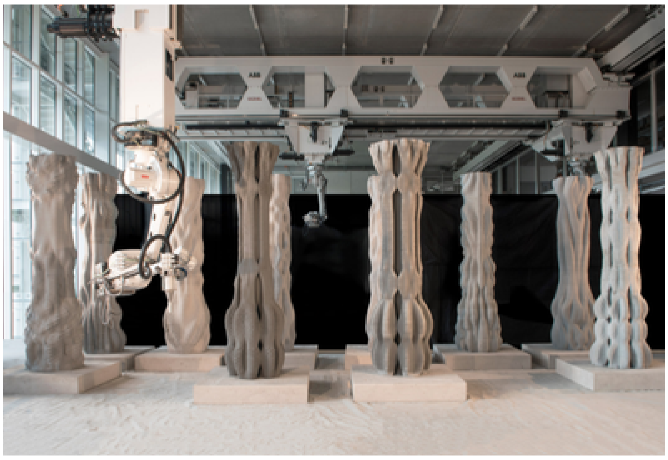


Image 14. 3D printed complex concrete structures (Source: de zeen)

5.2. Construction by assembly method

Prefabricated construction significantly reduces waste generation thanks to the precision and controlled environment in which the modules are built. According to a report by the Waste and Resources Action Program (WRAP), prefabricated construction can reduce waste such as wood, cardboard, plastic, and concrete by up to 90% compared to traditional construction methods. system [13].

Precision in the factory environment helps minimize overcutting and overuse of material.
Additionally, any waste generated can be sorted and recycled more effectively in a factory environment, as opposed to on a construction site, where waste sorting and recycling can be more difficult.

Image 15. Construction by assembly method (Source: ArchDaily)

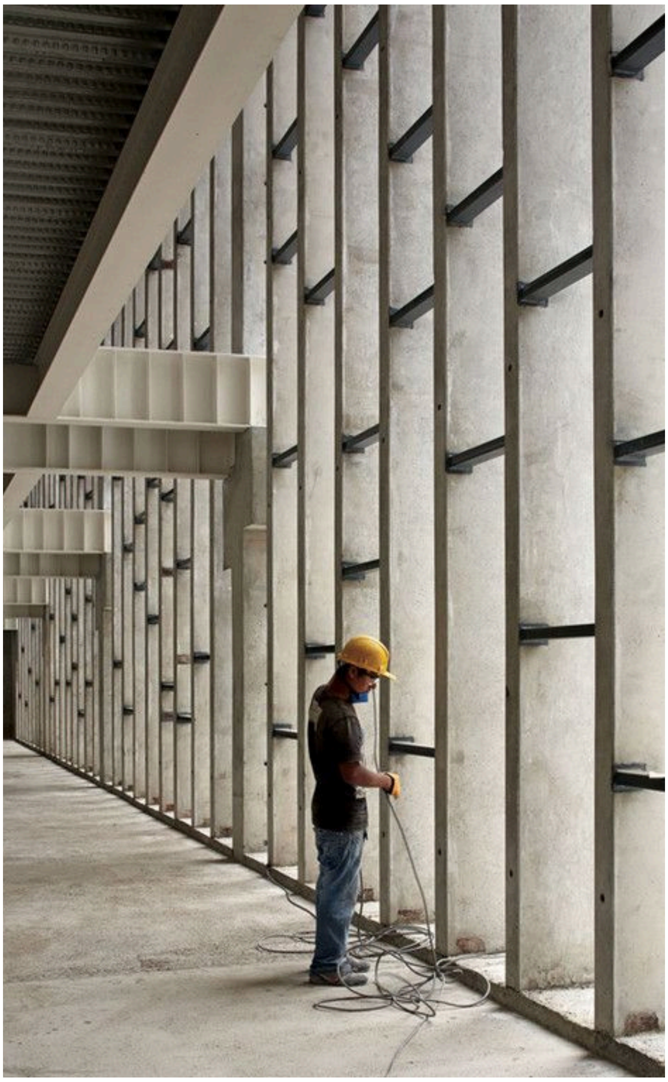
6. Recommendations for the Vietnamese market

Promote measures to improve energy efficiency in production processes, and exploit renewable and low-cost fuel sources from other industries to reduce costs. For products producing construction materials, especially clinker and cement, it is necessary to apply solutions to simultaneously treat industrial and domestic waste to protect the environment.
Quickly improve the distribution system, cut unnecessary parts and intermediaries from factory to consumer to reduce sales costs. Seeking opportunities to expand markets and provide construction materials export products to many

countries around the world. Businesses in the industry, especially the cement industry, need to maintain healthy competition through flexible and reasonable pricing strategies.

7. Conclusion

The work of developing construction materials, especially in the cement production industry, must go hand in hand with the responsibility to protect the environment. Businesses need to apply solutions to reduce greenhouse gas emissions, use recycled materials and



effectively treat industrial and domestic waste. By transitioning to advanced production methods and optimizing resources, the cement industry not only minimizes its negative impact on the environment but also contributes to building a green and sustainable economy for the future. hybrid. Technological innovation and raising awareness about environmental protection are not only requirements but also opportunities for businesses to develop long-term and be socially responsible.

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