THE NEW ENERGY ARCHITECTURE

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

THE NEW ENERGY ARCHITECTURE

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Architecture is a body of knowledge that has naturally evolved over time, from the existence of the world to the present, within the existential purpose of humans. Humankind has always been intricately involved with architecture to sustain life, from primitive societies to the present. The architectural knowledge requirements for survival, shelter, and heating, which originated from the first humans, continue to progress based on foundational structures and knowledge. Nowadays, due to the rapid increase in population, energy resources are becoming limited, and there has been a need for sustainable energy within architectural structures. The concept of energy architecture was born out of this need. Along with this concept, the notion of buildings that are harmonious with nature and can generate their own energy has emerged. With energy architecture, the concept of green buildings has also emerged, strengthening this new perception. These buildings generate their own electricity using renewable energy sources. The positioning of the building and the facade layout facilitates the building's use of natural heat and wind flow. Green buildings aim to reuse everything, including waste matter. This recycling ensures that the amount of energy the building releases into nature is minimized, and it is compatible with the Beyond Zero target. Worldwide agreements are oriented toward protecting against climate change. These agreements ensure that the construction materials used in energy architecture are of an appropriate standard. In this study, an explanation has been sought for energy architecture.

Keywords: Energy Architecture, Green Buildings, Sustainability, Smart Cities.

ÖZET

YENİ ENERJİ MİMARLIĞI

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Mimari; dünyanın varoluşundan beri günümüze kadar gelen insanın varoluşsal amacı içerisinde doğal olarak zamanla oluşan bir bilgi bütünüdür. İnsanoğlu yaşamını sürdürmek için ilkel toplumlardan günümüze kadar mimari ile hep içli dışlı olmuştur. Hayatta kalmak, barınmak ve ısınmak için mimari bilgi gereksinimleri ilk insanoğlundan gelmekle birlikte günümüzde de temel yapı ve bilgi taşları üzerinden ileriye doğru gitmektedir. Günümüzde ise nüfusun hızlı artışından dolayı enerji kaynakları sınırlı hale gelmeye başlamış olup mimari yapılar içerisinde de sürdülebilir enerji ihtiyacı ortaya çıkmıştır. Enerji mimarlığı kavramı da bu ihtiyaçtan doğmuştur. . Bu kavram ile beraber doğa ile uyumlu ve kendi enerjisini üretebilen bina kavramı ortaya çıkmıştır. Enerji mimarlığı ile beraber yeşil bina kavramı da ortaya çıkarak bu yeni algıyı güçlendirmiştir. Bu binalar yenilenebilir enerji kaynaklarını kullanarak kendi elektriğini üretir. Bina konumu ve cephe yerleşmesi binanın doğal ısıyı ve rüzgar akımını kullanmasını kolaylaştırır. Yeşil binalar atık maddesine kadar yeniden kullanmayı hedefler. Bu geri dönüştürme binanın doğaya saldığı enerji miktarının minumum düzeyde olmasını sağlar. Beyond zero hedefine uygundur. Dünya genelinde yapılan antlaşmalar iklim değişikliklerini korumaya yöneliktir. Bu antlaşmalarla enerji mimarlığında kullanılan yapı malzemelerinin uygun standartta olması sağlanır. Bu çalışmada enerji mimarlığına açıklama getirilmek istenmiştir.

Anahtar Kelimeler: Enerji Mimarlığı, Yeşil Binalar, Sürdürülebilirlik, Akıllı Şehirler.

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LIST OF ABBREVIATIONS

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BIM	Building Information Modelling
BP	British Petroleum
BREEAM	Building Research Establishment Environmental Assessment Method
BSI	British Standards Institution
C	Carbon
C^O	Centigrade
CI	Commercial Interiors
CS	Core and Shell
CO^2	Carbon Dioxide
COP21	The 21st Session of the United Nations Climate Change Conference
COVID-19	Corona Virus Disaster
DDT	Dirty Dozen
DR	Doctor
EB	Existing Buildings
EIA	Energy Information Administration
EIP	European Partnership for Innovation
EPA	Environmental Protection Agency
FSC	Forest Stewardship Council
GEN	Global Ecolabelling Network
GSFC	Goddard Space Flight Center Scientific Visualization Studio
H	Healthcare
H	Homes
HVAC	Heating, Ventilation, and Air Conditioning
IEA	International Energy Agency
IEU	Izmir University of Economics
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization

KM/HOUR	Kilometer/Hour
LCA	Life Cycle Assessment
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
M	Meter
M^2	Square Meters
MM	Millimeter
MIA	Missing In Action
NASA	National Aeronautics and Space Administration
NC	New Construction
ND	Neighborhood Development
PCBS	Polychlorinated Biphenyls
POPS	Pesticides
R	Retail
RMIT	Royal Melbourne Institute of Technology University
S	School
SCC	Smart Cities and Communities
SCIS	Smart Cities Information System
SDGS	Sustainable Development Goals
UN	United Nations
UNFCCC	The United Nations Framework Convention on Climate Change
UNDP	United Nations Development Program
US EPA	The United States Environmental Protection Agency
USGBC	The United States Green Building Council
W	Watt
WBCLA	Whole Buildings Life Cycle Assessment
WCED	World Commission on Environment and Development

CHAPTER 1: INTRODUCTION

1.1. Research Context

The increasing population of the world leads to many problems. The demand for energy from the rapidly increasing population cannot be met. The balance of energy demand, which began with the Industrial Revolution, is increasingly deteriorating.

The energy resources being used have begun to run out. In parallel, ongoing issues continue to increase. A new era has begun in the world with the start of the Industrial Revolution. Fossil fuels used since the beginning of the Industrial Revolution have been considered the primary energy source until the beginning of the 21st century (Ashton, 1997). According to current research, it has been determined that these primary energy sources can no longer be used. The biggest reason for this is the carbon gases released by fossil fuels. These carbon gases released into nature have caused global warming by increasing air temperatures. The other major factor is due to fossil fuels being limited. For this reason, a search for alternative energy has begun. As a result of this search, new energy sources have been found (Mohanty and Simonovic, 2021). These are energy sources known as renewable energy sources. These energy sources found in nature are, as the name suggests, an unlimited resource. The use and distribution of renewable energy sources that emerged as a result of this alternative search have become a subject of different resources. Along with this, the idea of being in 8resources, has affected every sector. The fossil fuel market is affected day by day. The use and investment areas of renewable energy resources, which are increasing day by day, have started to become more effective.

Renewable energy sources are becoming a primary energy source. It has become an important step in fulfilling the necessity of the European Union Commission. And the Paris Agreement was signed in 2015. For these reasons, the fossil fuel market began to lose its primary importance. According to the BP energy report, fossil fuels were used in 64 percent of electrical energy production on average in Europe in 2009. This rate became 40 percent in 2018. This decline continued until 2019. The use of renewable energy sources was increasing until the beginning of the Covid-19 Pandemic in 2019. However, new research conducted after the pandemic showed an increase in the use of fossil fuels. The main reason for this was due to its cheap and easily accessible nature (Sargin, 2021). As of 2022, the fossil fuel market started to meet 88 percent of electricity. The increase in this rate, which was expected to decrease, posed a new threat against global warming. Fossil fuels have been the primary energy source since the Industrial Revolution. The main cause of the problems that emerged with global warming was also the use of fossil fuels. Until 2019, the increasing demand for sustainable energy sources reduced the use of fossil fuels. With the Covid-19 pandemic, economic collapses occurred worldwide. This problem also led to an increase in the use of fossil fuels. Its cheap and accessible nature supported this.(Murgan, 2021).

In this research, energy architecture, which is the final point relating to the concept of sustainability in architecture emerging with the use of sustainable energy sources, has been investigated. Energy architecture, as a basic definition, is designs created with the right direction, right time, and right material in architecture. To understand energy architecture, we need to first understand its foundation. This foundation is sustainability. The concept of sustainability is fundamentally capable of transmitting an existing formation to future generations. The concept of sustainability has been reflected in every sector and field (Erengezgin, 2015).

Sustainability is a broad term that can have different meanings depending on the context. Generally, it refers to the ability of human society to coexist with the natural environment without depleting its resources or disrupting its balance. It can be seen that sustainability has three dimensions: environmental, economic, and social. These dimensions are interconnected and need to be considered together when achieving sustainable development goals. Sustainable architecture, an extension of energy architecture, takes into account factors such as indoor air quality, natural lighting, and the use of sustainable materials like bamboo or recycled materials. It is a way to design buildings that are not only functional and aesthetically pleasing but also sustainable, environmentally sensitive, and health-enhancing. Sustainable architecture is a building design approach that aims to minimize the negative effects of buildings on the environment while maximizing their positive effects on the people using them. This includes using sustainable materials, designing buildings to be energy efficient, and reducing carbon footprints by using renewable energy sources. This entails designing buildings to take advantage of natural light and ventilation, using recycled materials, utilizing green roofs or living walls, and using energy-saving appliances and systems. In the 1980s, the term "sustainable architecture" began to gain popularity as architects and designers started focusing on creating not just energy-efficient but also environmentally friendly buildings. During this period, many architects began experimenting with new materials and design strategies aimed at reducing the environmental impacts of buildings. In the 1990s, concerns about global warming and climate change led to an increased interest in sustainable building practices, and green architecture began to be accepted as mainstream. In 1993, the United States Green Building Council (USGBC) was established, developing the Leadership in Energy and Environmental Design (LEED) certification system for green building design and construction. In the 2000s and 2010s, green architecture continued to evolve as architects and designers focused on new technologies and strategies to create more energy-efficient and environmentally friendly buildings. This included the development of new materials and systems, such as green roofs and living walls, and increased use of renewable energy sources like solar and wind energy. Today, with many architects and designers incorporating sustainable design principles into their work, sustainable architecture has begun to be implemented. However, this trend is now giving way to new ones (Sev, 2009).

Energy architecture is a building design and construction approach that aims to maximize the positive effects on human health and well-being while minimizing the negative environmental impacts of buildings. In addition, it aims to eliminate harm to the environment. The objective of energy architecture is not just to design a sustainable space. The aim is for the designed area to feel like a part of nature. This involves using environmentally friendly materials, designing buildings to be energy efficient, using renewable energy sources, reducing waste and pollution, and considering the building's impact on the environment. The goal of energy architecture is to create healthy, comfortable, and energy-efficient buildings while minimizing their impact on the environment. In doing so, it uses all existing technology bases without harming the ecosystem. In energy architecture, when designing a living space, the energy to be used is considered according to the location of the land. The material to be used is decided according to the structure. The type of building is considered according to the topographic structure of the land. The final design is made along with all these elements. The approach progresses from part to whole, and the emerging design is made entirely with these components. As a result, the use of spaces constructed can help reduce carbon emissions, protect natural resources, and create healthier and more sustainable communities. The main goal of energy architecture is to create living spaces that appear as extensions of nature.

The concept of energy architecture is explained in this thesis by the author's expertise in two different fields. Energy architecture, which is the intersection of architecture and sustainable energy, emerges from the fusion of these two areas. The purpose of this research thesis is to shed light on this concept, which has not been adequately addressed in the literature. In the final output of the study, the selected examples will elucidate the reasons for the existence of energy architecture applications worldwide and the purposes they serve. If these objectives are pursued systematically and coherently, energy architecture implementations on a global scale can increase, leading to the preservation of a sustainable world order.

Energy architecture, which marks the current endpoint in architecture under the name of sustainability, has not been distinctly named. Even though it's discussed under many names and terms, it has not been gathered under a single title. For this reason, this research thesis aims to fill this gap. Energy architecture fundamentally alters all structural narratives on Earth. The aim of this research is to serve as a resource on energy architecture. The point touched upon in this research is the correct naming of architecture and the filling of the gaps that have emerged. In describing energy architecture, this research thesis will explain step by step how we arrived at this point and how we consolidated it here.

1.2. Research Question of the Thesis

This thesis aims to explain what energy architecture is and articulate the primary concepts, tools, and strategies used in this field. By providing information on energy architecture and related topics, it seeks to deepen the understanding of those working and interested in this area, offering a broad review and analysis of the existing literature in the field.

The research employs various sources directed toward energy architecture. These sources include scientific journals, academic articles, books, conference proceedings, and scholarly and professional resources available on the internet. Additionally, interviews and discussions conducted with experts working in energy architecture form part of the research. This study aims to compile a resource that will aid in understanding and implementing energy architecture.

1.3. Methodology

This study began with a review of literature resources, articles, theses, books, papers, and articles. The research uses various methodologies and analytical tools to determine what energy architecture is and how it's implemented. These methods and tools include comparative analysis, case study analysis, literature review, and quantitative and qualitative data analysis.

The research was conducted in the following stages:

• Investigation of the basic definition of the concept of sustainability
• Research into the definition and history of sustainable architecture
• Examination of New Carbon Architecture
• Reviewing Ecodesign and Biomimicry
• Definition and research of energy architecture
• The reflection of energy architecture in the industry worldwide
• Review of examples of energy architecture worldwide

1.4. Literature Review

Energy Architecture is a newly named architectural movement worldwide. It encompasses all buildings designed with effective and efficient energy use in architecture. However, these structures can stay upright with minimal energy consumption and minimum effort throughout their lifecycle. Turkish architect Çelik Erengezgin defines energy architecture as a design process achieved with the correct orientation, material, and guidance (Erengezgin, 2015). This research thesis has been initiated to define the next-generation energy architecture and to explain how energy architecture is implemented. It has been written to clarify the conceptual meaning of energy architecture and how this architectural current emerged today. The aim is to exist as a source in the literature and for its permanent implementation in architecture. All the elements that form energy architecture in the historical process have been considered to understand the purpose of the emergence of energy architecture. The developments that emerged during the process, from the concept of sustainability to the definition of energy architecture and how these developments contributed to energy architecture, have been investigated. Sustainability, sustainable architecture, eco-design, biomimicry, and new carbon architecture have been researched in detail. The points where these concepts have contributed to energy architecture have also been examined. Energy architecture is also the effective use of energy resources. For this reason, it is aimed to draw a roadmap about how the concept of energy is explained and how energy efficiency and energy transition are global.

The second part of this research thesis is named the green movement. This process, which started with sustainability, explains the entirety of the layers forming energy architecture. Sustainability means being able to sustain what exists. It is essential to improve what we have for healthy progress and to pass it on to the next generation (Tuyen, 2019). The concept of sustainability, which was defined at the Stockholm Conference in 1972, was accepted with the participation of 114 countries, and the first studies began. This movement, which also occurs as sustainable development, has also been reflected in architecture. With the definition of the concept of sustainability, sustainable architecture was formed. Ayşin Sev made the definition in her study called sustainable architecture as follows:

> *"Building structures that prioritize the use of renewable energy sources, are environmentally sensitive, conserve energy and water resources, material, and the area they are located inefficiently, and protect the health and comfort of people, considering future generations at every stage of its existence. In other words, it is the art of meeting people's spatial needs without endangering the existence and future of natural systems. Sustainable buildings protect and enhance the health, comfort, and productivity of users with natural light and good indoor air quality; are sensitive to the consumption of natural resources during their construction and use, do not cause environmental pollution; provide resources for other buildings after their demolition, or return to their place in nature without harming the environment." (Sev, 2009).*

This definition needs to fully explain sustainable architecture today. Sustainable architecture has transformed into a design model that uses renewable energy sources. If sustainable architecture facilitated the recycling of buildings that had completed their life cycle as defined, we would not be discussing the urban sprawl worldwide today. Energy architecture, at this point, includes both the recycling of buildings and a structure that will not disturb the ecological balance. It targets not only the use of renewable energy sources but also the recycling of excess materials in nature and the use of low-cost materials in the designed building environment.

Ecological design, another name for eco-design, emerged after sustainable architecture. It is to design our built environment and lifestyle to integrate seamlessly with the natural environment that houses all life on Earth, i.e., the biosphere. This goal should be the fundamental principle of built environment design. Ecological design is a design process to ensure the continuity of human health and natural environmental health. Each design is viewed as a system. This system is designed as if it were an extension of nature (Yeang, 2012). The principles and process of ecological design stem from the environmentally friendly building strategies of energy architecture. In addition to this, in energy architecture, any material can be used not to disrupt the environmental cycle outside of materials compatible with the ecological balance.

Biomimicry is a design approach that involves creating a system inspired by nature. It's a process of mimicking systems found in nature to apply solutions to human problems (Çelikel and Uçar, 2020).

The architectural approach that emerged under the name of new carbon architecture aims to provide carbon to nature throughout the entire life cycle of the building being designed. The priority here is to calculate carbon emissions and build a structure accordingly (King, 2017).

New carbon architecture emerged from solutions to the climate crisis determined at the United Nations climate conference. The 21st Session of the United Nations Climate Change Conference, known as COP21, was held in 2015. The Paris Climate Agreement was signed at this conference. This agreement was made to keep the temperature and CO^2 levels at a certain point. The ultimate goal was set for 2050. Research shows that if no precautions are taken, the average temperature increase will be 5 °C by 2050, and the global carbon level will reach its maximum. This research conducted by the IPCC is the modifier. It is aimed to reduce the rate of carbon released into the atmosphere with human activities to zero by 2050 (Xaver, 2019). In carbon architecture, the life cycle of all materials in the design is calculated using the Life Cycle Assessment and Whole Building Life Cycle Assessment methods. This way, the design is realized by optimizing the amount of carbon released (Duru and Koç, 2021).

New carbon architecture can be associated with energy architecture by calculating the amount of carbon released within the life cycle of the building. However, in energy architecture, plastic that cannot be decomposed in nature can be recycled and used. There is no usage form related to recycled materials in new carbon architecture. Therefore, it differs.

The subject discussed in the fourth chapter of this research thesis is why energy architecture emerged today and why effective energy use is essential. The book "The Future of Living Together in Ecology" discusses the problems that arose from disrupting the ecological balance in world history. It is a compilation of research articles written on why the climate crisis emerged and the deterioration of world health, which can cause this problem. This book discusses how to prevent climate change by protecting the ecological balance and searching for solutions for this (Bayındır and Yıldırım, 2022).

The increasing energy demand in today's world gained momentum with the invention of steam engines. With the beginning of the Industrial Revolution in the 18th century, the demand for electricity and machine energy arose. With the invention of steam machines and the use of coal, an endless energy need existed. This demand, which was questioned in the 21st century, continued to meet the increasing energy demand day by day. As a result of this research, it was determined that the resources used for energy demand are rapidly depleted and cannot be transferred to future generations. The Industrial Revolution, which started in the 18th century, led to the new discovery and use of energy resources (Ashton, 1997).

As of the 20th century, the consumption of energy resources has accelerated. This rapid consumption pushed countries to examine the continuity of existing energy resources. This picture led to the classification of fuels used for energy demand as non-renewable resources towards the end of the 21st century. The reason for classifying these resources as non-renewable was that they could only exist again for a few years after the resources were depleted (Mohanty and Simonovic, 2021). Non-renewable energy sources are quality sources that will be depleted or not renewed during our lifetime, even during many, many future generations. Most non-renewable energy are energy sources that are non-renewable or take a very long time to refill. It includes fossil fuels (coal, oil, natural gas) and nuclear fuels (uranium, plutonium). Non-renewable energy sources have been used until the 21st century because they have multiple advantages. However, there are many disadvantages as well, which is why they are not preferred for use. They are limited resources and will run out over time. The greenhouse gases that emerge during their use affect the climate. They are very costly in the long run (Holladay, Chu and Lariviere, 2017).

We are appreciate to the new technological developments, these adverse effects began to be investigated. As a result, new formations emerged along with the existing developments. Along with air pollution, the factors causing it began to be investigated. It was seen that the rapidly increasing air pollution at the beginning of the 20th century threatened the world and life in the world. As a result of this threat, it was observed that the quality of life on Earth quickly declined. The biggest reason for this was determined to be the uncontrolled and rapid use of energy resources. For sustainability, renewable energy sources have started to be used, and this transition has started to accelerate in all sectors. Energy efficiency arises from using energy as needed. Energy efficiency is an essential factor in combating climate change worldwide. Energy efficiency should follow a path from a broad-world perspective. Energy efficiency should aim to combat climate change and reduce carbon intensity. Global and national, local policies should be separated, and a path should be followed accordingly (Duman, Altan and Sağbaş, 2020). With the use of green energy, this problem will be solved, and a search for a solution will be embarked upon. Therefore, the aim of the 21st century has been to prevent the climate crisis by creating an era of energy transition (Simoes et.al., 2021). The concept of sustainability emerged during this transition to green energy. Sustainability refers to maintaining the current state and passing it on to the next generation. It is crucial to reduce ongoing air pollution in the world and ensure the continuation of a healthy world. Therefore, this process, which began with sustainability, has led to the emergence of energy architecture (Gunes, 2012).

Energy architecture is an innovative, new, and generational architectural approach. Although there are concepts such as green building, green energy, sustainability, and sustainable architecture worldwide, we cannot speak of ecological architecture. Even though examples of sustainable architecture exist in many countries, it has been observed that these structures could be more efficient and in harmony with ecological balance.

The structures built under the name of sustainable architecture are not in harmony with nature. The whole life cycle needs to be taken into account when designing the structures. This entire life cycle includes the cycle from the design process of the building to the recycling process after its use is completed. Architects worldwide need to take into account the process after the life span of a building is over when designing a building, so buildings cannot be recycled. This also explains the excess of structures in the world caused by this (Economist, 2022).

This research thesis has been written to be an explanatory literature source on energy architecture. Energy architecture ensures that the building can be recycled by taking into account the process after the life cycle of the building is over. This research aims to solve this problem by clarifying the need for more information in the literature.

CHAPTER 2: GREEN MOVEMENT

In this section, the history of green design that started with the concept of sustainability and its current state is examined. A detailed review is provided of the previous research and literature about how energy architecture emerged and the path that was followed related to it. The Green Movement section explains the concept of sustainability and its impact on architecture, the principles of ecological design, biomimicry design, and the idea of new carbon architecture. Each of these concepts constitutes the building blocks of energy architecture, and understanding these concepts will contribute to the comprehension of energy architecture.

2.1. Sustainability

The continuation of our existence is limited by the natural resources offered to us by the world we live in. Therefore, the sustainability of these life resources is essential. The rapidly increasing global population leads to a swift depletion of resources. In the picture that has emerged, it has been observed that energy resources are quickly dwindling. Sustainable development has been reflected in all sectors and projects in the 21st century. Consequently, sustainability has been the central theme in all created and implemented projects. Firstly, we need to understand what sustainable development is used for and what it means.

Sustainability introduced a feasible energy philosophy that could be applied across all fields. As a result, it started to be the main focus in all sectors. Sustainable life plans were created. These life plans were called sustainable development. This evolution, also known as the Green Movement, is fundamentally aimed at protecting the health of the world and keeping the planet viable for a more extended period. Accordingly, all work is based on this protection plan.

Sustainability is the continuity of life. The concept of sustainability begins with preserving and caring for what already exists. Its fundamental meaning is the measured use of resources (Tuyen, 2019).

2.2. History of Sustainability

Although importance was given to environmental problems after World War II, the first recorded Development was discussed at a conference held by ecological experts in Switzerland in 1971. As such, it has been recorded in history. According to the data obtained after the meeting, the primary source of environmental problems was the rapid consumption society. It is seen that industrialized countries with large populations consume their resources rapidly. Another reason is the solid thinking of developing countries for quick and effective energy production (Karbuz, 2002). The conference held in Stockholm in 1972 was about mankind and the environment. The conference, gathered under this name, aimed to extend the world's lifespan. Sustainability was discussed about this target. The conference, attended by 114 state representatives, addressed planetary and human health. In the following years, the Our Common Future report was announced at the United Nations General Assembly meeting.

The first introduction was made in this report published in 1987. Sustainable Development was first defined in the Brundtland Report prepared by the World Environment and Development Commission in 1987. With this definition, all innovative steps under sustainability have been gathered (Turkish Republic Ministry of Foreign Affairs, 2023).

The acceptance of Sustainable Development in every sense holistically was accepted with the Brundtland Report. Sustainability was the central theme at the World Summit in Rio De Janeiro in June 1992. At this conference, an integrated approach that embraces sustainable economic growth based on natural resources and the Development of human resources was discussed. The heads of state of 117 developed and developing countries attended this summit. The Rio Declaration on Environment and Development, the basis of Sustainable Development, was accepted. In this declaration, consisting of 27 principles, it was taken that the essential sustainability is human life. It has been foreseen that individuals should also comply with these sustainable development action plans. The United Nations Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, the United Nations Convention to Combat Desertification, and Agenda 21 were signed after this world summit. Although these conventions aimed at sustainable Development, they all focused on individual or social goals. They differentiated within themselves. The most important of these treaties, Agenda 21, includes supporting sustainable Development for each country (WCED, 1990).

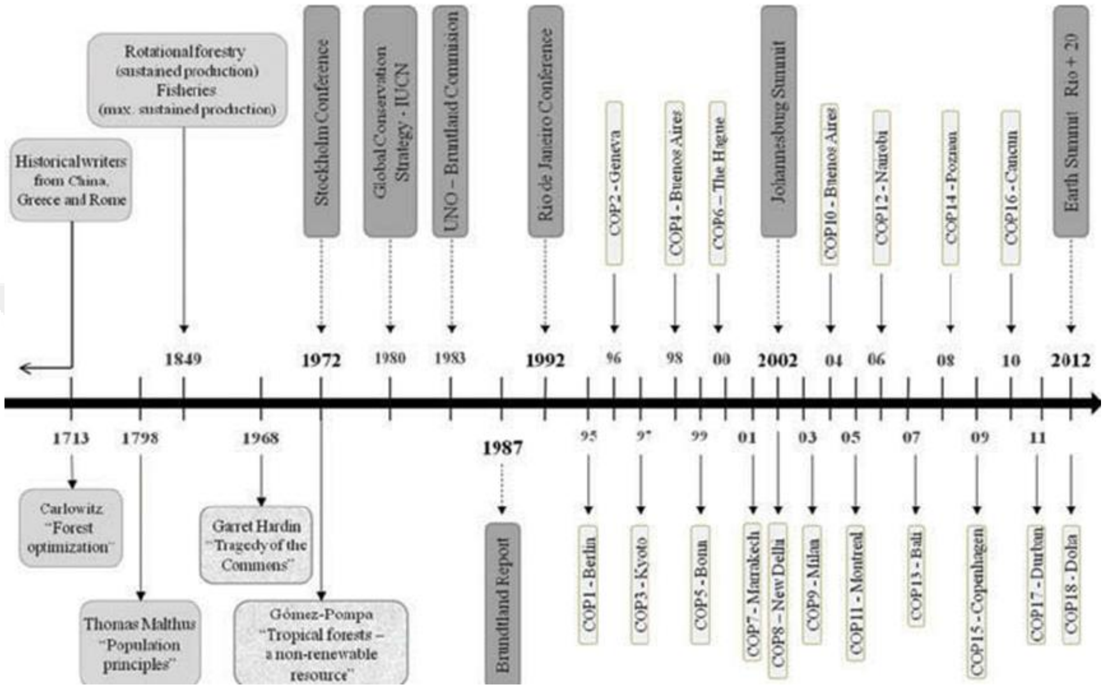


Figure 1. History of Sustainable and Sustainable Development (Source: Pedro et.al., 2015)

The United Nations Framework Convention on Climate Change (UNFCCC) is the first intergovernmental environmental treaty aimed at global warming, signed under the auspices of the United Nations. The agreement aims to reduce the ratio of greenhouse gases in the atmosphere and keep the adverse effects of these gases at a certain level by minimizing them, acknowledging that human-induced environmental pollutants have a dangerous impact on the climate. It regulates general principles, action strategies, and countries' obligations in this context. Although the treaty is significant as the first environmental agreement on climate change at the intergovernmental level, its enforcement power is weak; participating countries have supported the treaty on the level of goodwill (Changala, 2013).

The 1994 Cairo Population and Development Conference, the 1995 Copenhagen

Social Development Conference, and the 1996 Istanbul Habitat 2 Urban Summit prove this sustainability concept has become a national goal. The importance of urbanization for sustainability was emphasized at the summit held in 1996. Although the problem of irregular urbanization is generally the problem of developing countries, it is one of the most critical points. The population increases in regions where the industry is concentrated. The dense population in these regions causes the city's air quality to be low, and the greenhouse gases cannot be absorbed. Therefore, the population needs to be balanced on a global scale (Turkey Law Society Association, 2014).

The Kyoto Protocol was signed at the conference held in Kyoto in 1997. The Kyoto Protocol is the only international framework to fight global warming and climate change. It was signed within the United Nations Framework Convention on Climate Change. The countries that signed this protocol have agreed to reduce carbon dioxide and the greenhouse effect. According to the protocol, they must reduce greenhouse gases to normal levels. The protocol, signed in 1997, could enter into force in 2005. Because for the protocol to come into effect, the carbon amount released into the atmosphere by the approving countries in 1990 had to reach 55% of the total global emission, and this rate was only called at the end of 8 years with Russia's participation.

The amount of greenhouse gas released into the atmosphere will be reduced by 5%. It will ensure heat with less energy, travel a long distance with fewer energy-consuming vehicles, and install less energy-consuming technology systems in the industry; environmentalism will be the basic principle in transportation and garbage storage. Alternative energy sources will be directed to reduce the ratio of methane and carbon dioxide left in the atmosphere. Waste processes will be reorganized in high-energy-consuming enterprises such as cement, iron-steel, and lime factories. Systems and technologies emitting less carbon in thermal power plants will be implemented. The use of solar energy will come to the fore. All these articles include the basic principles of energy architecture. The production of more environmentally friendly materials has accelerated. With developing technology, recyclable architectural materials have started to be made at appropriate standards (Turkey Law Society Association, 2014).

In 1998, a convention was signed at a conference held in Aarhus. This convention signed the agreement on access to information on environmental matters, public participation in decision-making, and access to justice. The goal of this convention was to contribute to the right to life to allow current and future generations to live in a healthier environment. It passes as the first convention on obtaining information on environmental matters. This convention, which occurred in 2001, is the first step taken for developing ecological democracy. Therefore, it is imperative. The Sustainable Development Conference, signed in Rio in 2012, aims to meet to renew the convention so that sustainable Development can continue economically, socially, and environmentally. It aimed to restore the consensus under international laws based on the purposes and principles of the United Nations Treaty. The conference held in Stockholm on June 16 aimed to update the principles of the Human Environment Declaration and ensure harmony in the 21st century (Gunes, 2012).

The Paris Agreement is an agreement about the minimization of climate change and its financing within the scope of the United Nations Framework Convention on Climate Change (UNFCCC). It was signed in 2015 and came into effect in 2016. It was prepared within the scope of the UNFCCC. This agreement aims to keep the temperature increase constant. Supporting this constant minimizes climate change. According to the agreement, the parties determine how they will follow a path against the adverse effects of climate change. It accepts to make the necessary investments for low greenhouse gas emissions. Each country receives its contribution to global warming. There is no distinction between whether the countries are developed or developing. Each country follows the same protocol. Each country should present emission reduction plans (Murgan, Murtala Ganiyu A ,2021). In this historical process, these agreements have been regulated to minimize the problems caused by climate change. All emerging issues are progressing in line with sustainable development goals. This shows us how vital sustainability is in the world of the 21st century and allows us to understand its development (Caradonna, 2014)

2.3. Sustainable Architecture

The construction sector has developed new architectural methods with the rise of sustainability. Sustainable architecture can be considered the leader of the new generation architectural approach. It can be defined as the capacity of buildings to establish a connection between the environment and people. Sustainable architecture prioritizes using renewable energy sources while preserving the health and comfort of people and effectively using energy, water, materials, and space, considering future generations under all periods and conditions (Şeker, 2020). This can be regarded as the art of meeting people's spatial needs without endangering their natural systems and futures. Sustainable structures contribute to users' health, comfort, and efficiency with natural light and high-quality indoor air. These structures are sensitive to the consumption of natural resources during construction and use phases and do not cause environmental pollution. After being demolished, they either form a source of other resources or return to nature without causing harm to the environment.

Figure 2. The Museum of Tomorrow ,Rio de Janeiro Neu(Source: Zahra Najafi, 2023)

The fundamental priority of sustainable architecture is the efficient and effective use of energy. That is, it is essential for a building to derive the energy needed to sustain itself from renewable energy sources. This architectural approach aims to minimize the environmental impacts of the building and reduce the harmful effects on the ecosystem. From the perspective of sustainable architecture, the efficiency of energy use is of vital importance. Therefore, energy should be efficient and effective throughout the entire life cycle of a building. Environmental factors and natural resources are considered before constructing a structure to reduce the energy needs of buildings and increase efficiency. Realistic features like wind speed and the sun's position allow the building to save energy.

2.3.1. Sustainable Architecture Materials

In energy architecture, buildings harmonize with the environment to minimize energy consumption and waste emission. The way to achieve this is through the use of sustainable building materials. Along with advancing technology, basic building materials compatible with ecological balance have started to be used in energy architecture. These ecologically compatible building materials ensure the harmony of the structure with nature. They impact the building's sustainability by adapting to the ecological balance.

Some sustainable building materials include recycled fabric or glass wood, linoleum, sheep's wool, new technology concrete, paper panels, and kiln-fired earth. Plant cover applications on building facades prevent the building from aging. An example of this can be seen on the faculty wall of Izmir University of Economics in Izmir, Turkey. This practice ensures the compatibility of the building with the environment (IEU, 2021). In sustainable architecture, glass is also frequently used. Glass used in interiors and exteriors can be recycled and used in every area (Scheerbart, 2020).

In energy architecture, recycled materials are often used. This practice, aimed at reducing the use of new materials, facilitates the recycling of buildings. This reduces the production line and ensures energy efficiency. New construction materials that do not contain carcinogenic substances are used. Using organic and water-based paint reduces the amount of waste material released into nature. These types of substances are also referred to as green materials.

2.3.2. Sustainable Architecture Systems

Considering sustainable energy use, building heat balance is an essential factor. Heating, Ventilation, and Air Conditioning (HVAC) systems are used to manage this balance.

HVAC Systems: They are efficient and cost-effective components in a well-insulated structure. An efficient building requires less energy to produce or distribute heat but may require more ventilation to expel dirty indoor air. Energy is extracted from buildings through heat, water, air, and compost; and technologies are used to recover energy from these outputs. Such technologies can reclaim waste hot water and waste air energy and make them reusable. (Le et.al., 2023)

Solar Energy Systems: It is sourced from the likes of photovoltaic solar panels and can provide sustainable electricity. However, the electrical output of a solar panel is climate-dependent. Passive solar building design involves methods of using energy more efficiently and does not require active solar mechanisms. (Rybová , 2019)

Heat Pumps: They are also significant in energy efficiency, but their efficiency depends on external temperatures. Air-source heat pumps are generally more effective in temperate climates. Geothermal heat pumps are a more efficient alternative in other climates. (Bordbar et.al., 2023)

Wind Turbines: They can be a sustainable option for small-scale energy production. Wind turbines capable of providing power for a single building are available, but their use can be costly. To be most effective, they must be used in locations that guarantee a certain amount of wind. The average wind speed should be over 24 km/hour. (Wen et.al., 2023)

Figure 3. H&E Housing 1 (Source: Architecte, 2008)

Figure 4. H&E Housing 2 (Source: Architecte, 2008)

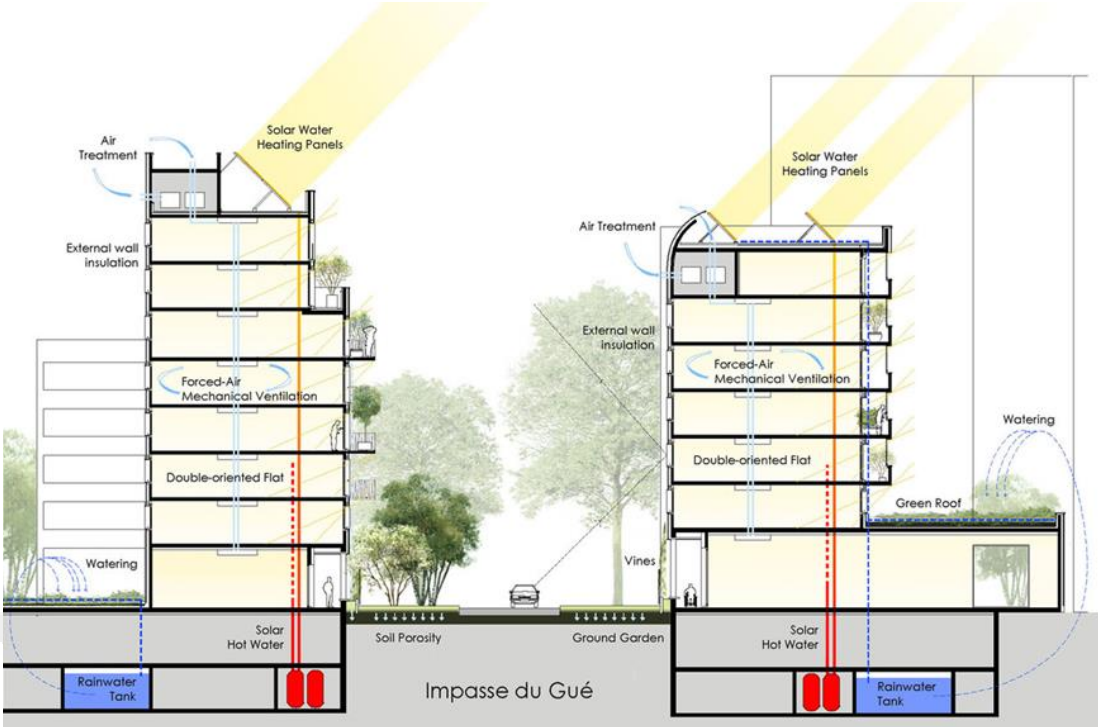


Figure 5. H&E Housing HVAC System, (Source: Architecte, 2008)

2.3.2. Sustainable Architecture Principles

As society becomes economically developed, the need for resources such as land, buildings, construction materials, and energy increases, thereby augmenting the impact of architectural activities on the global ecosystem (Sev, 2009). Sustainable design and construction aim to propose solutions for sustaining the existence of the worldwide ecosystem, comprised of living organisms and new organic elements. Sustainable architecture comes into play at this point, presenting a new design based on certain principles.

Efficient Use of Energy: Energy-efficient buildings provide comfort while minimizing energy consumption. This can be achieved through insulation, energy-efficient windows, passive solar design, and renewable energy sources.

Efficient Use of Water: Sustainable architecture encourages the conservative use of water. This is accomplished through rainwater harvesting, greywater recycling, and on-site water treatment systems.

Efficient Use of Materials: Sustainable materials can be locally available, reused, or produced without harming the environment. These materials are often durable and may not require maintenance.

Efficient Use of Building Areas: Sustainable architecture also considers how a building connects with the community and impacts the environment. This may involve being within walking distance of community services, supporting the local economy, and preserving the natural environment (Öztürk, 2022).

2.3.4. Sustainable Architecture Evaluation Criteria

After the emergence of sustainable architecture, standards have been developed worldwide to ensure sustainability and a system has been established to monitor the fulfillment of these standards. The accreditation method in this system is divided into two; the first is related to the products and components of the building and the other is related to considering the building as a whole. These standards determine the sustainability degrees and means of the products, which is necessary to ensure the same standard globally (Veziroğlu, 2010).

Standards related to building components and products:

- GreenSpec
- Energy Star
- Forest Stewardship Council (FSC)
- Global Ecolabelling Network (GEN)
- ASHRAE Standards

Whole Building Standards:

- Energy Star Label for Buildings
- Leadership Energy and Environmental Design (LEED)
- LEED New Construction (NC)
- LEED Existing Buildings (EB)
- LEED Commercial Interiors (CI)
- LEED Core and Shell (CS)
- LEED Schools (S)
- LEED Retail (R)
- LEED Healthcare/Homes (H)
- LEED Neighborhood Development (ND)
- Building Research Establishment Environmental Assessment Method (BREEAM)
- R-2000

Figure 6. Example of Sustainable Architecture, The Garage and Salt Shed (Source: Newyork, 2017)

Figure 7. The Green Mark Platinum (Source: Singapore, 2017)

2.4.Ecodesign

Ecodesign, or ecological design, utilizes its principles and strategies to harmonize our built environment and lifestyle with the natural environment, which hosts the biosphere encompassing all life on Earth. This goal should be the fundamental principle of built environment design. Ecodesign is about the sustainable use of natural resources. It's a design approach that transforms environmental impact into a positive outcome and reduces the damage inflicted upon nature. The eco-designer aims to increase energy and resource efficiency in the design of products, systems, and processes (Yeang, 2012).

Ecodesign considers sustainability principles such as recyclability, reuse, and using renewable natural resources. The ecodesign process includes sustainability and environmental impact assessments from the first step to the last. This consists of the materials used in product design, energy consumption, recycling policies, and life cycle processes. Ecodesign aims to support economic and social sustainability and environmental sustainability. In this design philosophy, the need to protect future generations is paramount. This is an innovative design approach.

Figure 8. Habitable Module IWI (Source: Zapico, 2023)

2.4.1. Principle of Ecodesign

Sustainability: Eco-design is based on sustainability, aiming to protect natural resources and minimize environmental impacts for future generations.

Life Cycle Assessment: This refers to assessing ecological consequences during every stage of a product's life cycle, which encompasses the choice of materials, manufacturing methodologies, period of utilization, and disposal strategies.

Resource Efficiency: Eco-design aims to use resources efficiently. Methods that promote material and energy savings help reduce environmental impacts while increasing efficiency.

Waste Reduction: It aims to reduce waste generation and improve waste management through methods such as reuse or recycling. This helps prevent resource depletion and reduces environmental impacts.

Minimization of Environmental Impacts: Eco-design strives to minimize the environmental impacts of products. This includes reducing harmful emissions, limiting the use of toxic substances, and minimizing impacts on natural habitats.

Innovation and Technology: Eco-design encourages using innovative technologies and design methods. Innovative solutions reduce environmental impacts while providing economic and social benefits.

User-Centric Approach: Eco-design emphasizes the compatibility of products with user needs and user experience. This promotes product longevity and repairability and encourages user behaviors that reduce environmental impacts.

These principles and concepts reflect the core values of eco-design, supporting environmental sustainability and resource efficiency goals (Hernandez-Santin et al., 2022).

2.4.2.Opportunity of Ecodesign

There are many areas where ecodesign provides benefits. Ecodesign is an approach that brings together environmental, economic, and social benefits. It is an important tool for responding to global challenges related to sustainability and resource efficiency. Some of these are listed below:

• It aims to ensure the sustainable use of natural resources by providing environmental sustainability. It contributes to the protection of the natural environment through the efficient use of resources, reduction of waste, and minimization of environmental impacts.

• It increases energy and resource efficiency. Design choices in material selection, the production process, and the use of products enable more effective use of resources and save energy.

• It offers a cost advantage to businesses and consumers as it saves on materials and energy. More efficient production processes, reduced waste costs, and energy savings can reduce costs in the long run.

• It offers an opportunity to meet increasing consumer demands related to environmental sustainability and gain a competitive advantage. Consumers tend to prefer environmentally sensitive and sustainable products, providing marketing advantages for companies.

• It encourages the development of innovative solutions. It supports innovation by using new technologies, materials, and processes for sustainability challenges.

• It provides a positive image to businesses and brands by reflecting environmental responsibility awareness.

• It aims to improve human health and well-being. Factors such as reducing harmful substances, preserving clean air and water quality, and contributing to healthier indoor environments improve people's quality of life (Pereire et al., 2018).

2.4.3.Ecomimic

Eco-imitation, or ecological imitation, applies the design principles of natural ecosystems or organisms to human-made systems. This approach aims to reduce environmental impacts and increase resource efficiency in human-made designs by imitating excellence and sustainability in nature. Eco-imitation is also associated with terms like biomimicry or bionics. This approach acknowledges that organisms and natural ecosystems have developed optimized solutions over time through evolution. These natural solutions can increase environmental sustainability and efficiency in human-made designs.

Eco-imitation can be applied in many areas. For example, in architecture, energy-efficient buildings can be designed by imitating the photosynthesis process of plant leaves. Fuel-saving airplane wings can be developed inspired by the aerodynamic structure of bird wings in aircraft design. Energy and water savings can be achieved in water treatment systems using the filtering methods of aquatic organisms.

Eco-imitation offers innovative solutions that increase environmental sustainability and resource efficiency by taking natural inspiration. Learning from millions of years of natural evolutionary processes helps human-made systems be more environmentally friendly and sustainable (Lee et al., 2023).

Figure 9. Transfer of the biological principle of shape change induced by hygroscopic and anistropic dimensional change of the spruce cone (Source: Olivier Scheffer, 2016)

Figure 10. Example of Ecomimic Design , HygroSkin, Meteorosensitive Pavilion in Stadtgarten, Stuttgart (Source: Olivier Scheffer, 2016)

2.4.4. Green Aesthetics

Architecture is an important discipline that shapes people's living spaces and determines their environmental interaction. Today, with the prominence of environmental issues and sustainability topics, the understanding of green aesthetics is gaining more and more importance in architectural designs. Green aesthetics emphasize that architectural designs should be harmonious with the environment and based on the principle of sustainability. It takes the principle of sustainability as its basis. This reduces environmental impacts by integrating energy efficiency, water saving, and natural lighting into architectural designs. Green buildings have features such as the use of recyclable materials, natural ventilation systems, and the use of renewable energy sources like solar energy.

It also takes into account human health and comfort. Using natural light and materials creates a healthier and more comfortable indoor environment. Green spaces and natural landscape designs reduce people's stress levels, facilitate more interaction with nature, and generally increase the quality of life. Green aesthetics reflect the beauty of nature and natural forms in design. Green buildings and sustainable structures are also aesthetically pleasing. Elements like green roofs, vertical gardens, and green walls allow the integration of nature into the structure and provide aesthetic harmony (Lance, 2012).

Green aesthetics can be implemented in architecture in various ways. Green buildings apply sustainability principles such as energy efficiency, water saving, natural lighting, and renewable energy sources. Elements like green roofs, solar energy panels, rainwater collection systems, and natural ventilation systems are features of green buildings. It also manifests itself in landscape architecture. The preservation of natural vegetation, using local plant species, and the preference for water-saving irrigation systems are part of green aesthetics in landscape design. Biophilic design is an approach that increases people's connection with nature and includes natural elements. Green walls, indoor plants, natural light, and using natural materials are examples of biophilic design and support green aesthetics. The front facade of the Faculty of Fine Arts at Izmir University of Economics in Izmir exemplifies biophilic design.

2.5.Biomimicry

Biomimicry is an approach that aims to solve problems by imitating the characteristics and processes of organisms in nature. Using biomimicry in architecture enriches architectural designs with nature's diversity, impressive forms, and functionality. It allows the emergence of projects compatible with the principle of sustainability.

2.5.1 What is Biomimicry?

Biomimicry is a compound of the words "bio" (life) and "mimicry" (imitation), and it's the process of designing inspired by the structures, functions, and processes of organisms in nature. Biomimicry aims to understand the fundamental principles of these systems by exploring the diversity of evolved and optimized natural systems and applying these in human-made systems. This approach aims to make human-made solutions more sustainable, efficient, and harmonious using nature's millions of years of experience. Architecture is a complex discipline that considers various factors, including environmental sustainability, energy efficiency, and aesthetics. Biomimicry provides architects with a pathway to better understand designs by observing natural solutions. Organisms in nature have evolved over the years to optimize energy conservation, material efficiency, and adaptation. By examining these features, architects and designers can design buildings that are harmonious with nature and that are sustainable (Çelikel and Uçar, 2020).

For instance, termite mounds use natural ventilation systems to regulate the internal temperature. Architects can design energy-efficient buildings using this principle. The Eastgate Center, designed by Mick Pearce, located in Harare, Zimbabwe, was inspired by termite mounds. This building also uses natural climate control (Ansari, 2022).

Furthermore, self-cleaning coatings can be developed using the feature found in lotus leaves. Biomimicry also plays a crucial role in discovering environmentally friendly and innovative materials. For instance, highly durable materials that do not harm the environment can be produced inspired by the spider's web. An important point about biomimicry is to learn from nature rather than copying natural systems. Architects can reach goals such as sustainability, energy efficiency, and functionality by interpreting and applying the principles of nature. Thanks to biomimicry, human-made systems can be more harmonious and integrated with nature.

2.5.2 An Example of Biomimicry

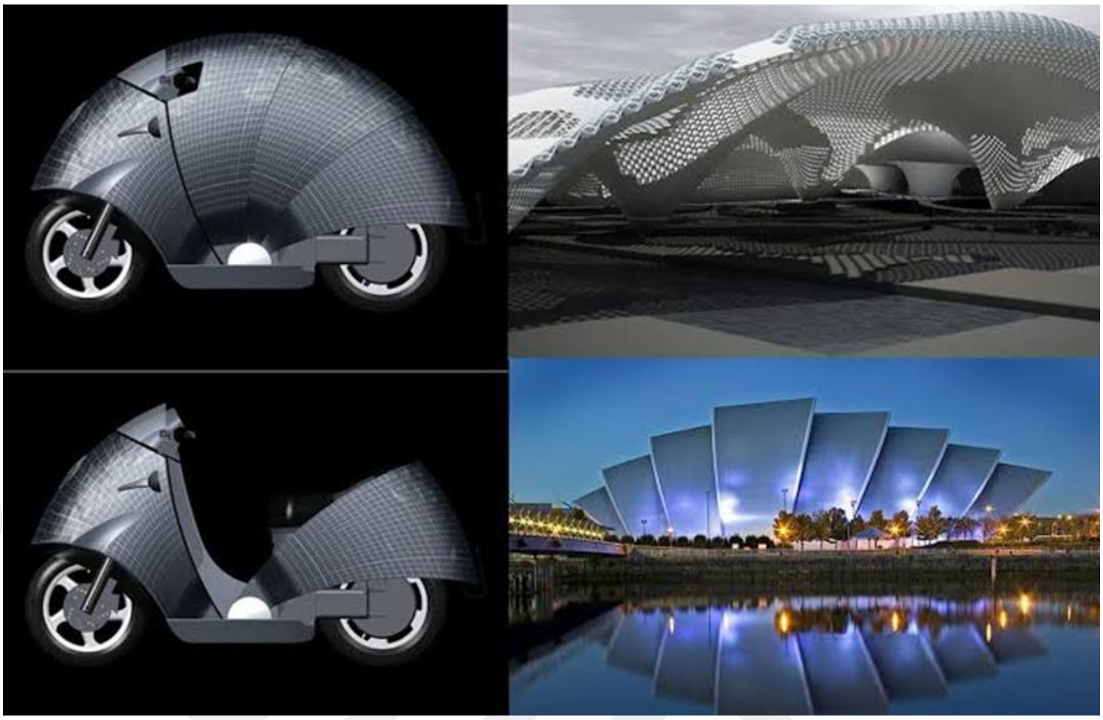


Figure 11. Biomimicry (Source: Technology and Design, 2019)

Figure 12. Example of Biomimicry , Wooden Orchids,China (Source: Vincent, 2015)

Figure 13. Example of Biomimicry , Wooden Orchids,China (Source: Vincent, 2015)

2.6. The New Carbon Architecture

When we think of the first thing that comes to mind when carbon architecture is mentioned, we can consider it an architecture made with the ratio of carbon emissions. Understanding how carbon architecture works and why it is discussed first is necessary. As its name suggests, carbon architecture is based on calculating the carbon ratio released into nature. Therefore, it aims to reduce the carbon gases emitted to nature by the designed building to zero, as in the Beyond Zero target. Carbon architecture is the final development stage of energy architecture. Understanding this architectural period can provide a broad perspective on energy architecture. Therefore, it is necessary to understand and explain this period well.

2.6.1. The Meaning of Carbon

To understand carbon architecture, we must first examine the meaning and implications of the word carbon. Carbon, in terms of its word meaning, refers to the element in the periodic table. Carbon is a non-metallic chemical that is most commonly found in nature. It is one of the most abundant elements. Carbon is a non-metallic element symbolized by C with an atomic number of 6. It forms more compounds than any other element. The carbon element forms the basis of organic compounds. It constitutes about 0.2% of the Earth's crust, making it very important. Its purest form in nature is found in diamond and graphite. It is also found in various components of coal. For these reasons, it is an element used and which exists on Earth. Carbon is found in many elements. Carbon is found in 94% of compounds. Carbon is found in a certain cycle in nature. The percentage of carbon in nature is therefore in balance and is important. To understand the balance of carbon in nature, we must clearly understand the carbon cycle.

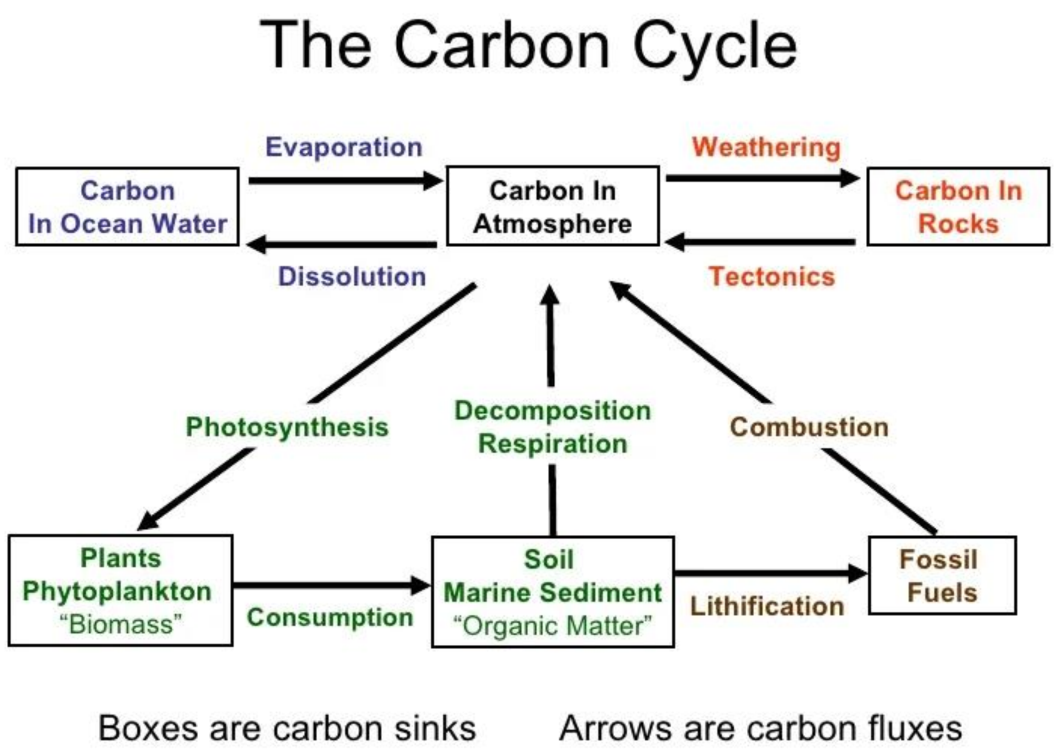


Figure 14. Carbon Cycle Diagram In Atmosphere (Source: Toppr)

The carbon cycle is the progression of carbon atoms on Earth. It can also be considered a cycle of mixing with the energy needed by living things from the atmosphere. The carbon cycle consists of 4 main stages: photosynthesis, combustion or consumption, respiration, and decomposition. Photosynthesis is the first stage. Plants, algae, and some bacteria with plant cell properties can do photosynthesis. These organisms produce their food and energy. The CO^2 gas in the atmosphere is used to break down into water and nutrients in a process called photosynthesis. Carbon turns into energy at this stage. In the combustion phase, the carbon element stored as energy in plants is transferred to their bodies. Herbivorous organisms and organisms that perform this decomposition meet their energy needs by consuming and storing it in their organisms as fat and protein. During the respiration phase, all organisms perform cellular respiration and release CO^2 gas into the atmosphere. Thus, carbon returns to the atmosphere. In the decomposition phase, when organisms die, their bodies are decomposed and broken down by other organisms in the soil. Fossilization is also seen at this stage. Some of the dead organisms become fossilized without decomposing. This process, called fossilization, involves organisms remaining underground for millions of years and forming fossil fuels such as coal, oil, and gas. When fossil fuels are burned, carbon emissions are released into the atmosphere. The salty waters found on Earth also affect the ratio of carbon in the atmosphere depending on temperature balance. (Huang et al., 2023)

Primarily, carbon is found in CO^2 (carbon dioxide) gas in the atmosphere. The CO^2 gas in the atmosphere is converted into O^2 (oxygen) and organic compounds by photosynthesis by plants. The resulting carbon is used as energy and food by all living things. It is found in nature as a mineral in the soil. It mixes with the soil as organic waste from the bodies of dead organisms. It mixes again into the atmosphere as CO^2 during respiration. The cycle is perfectly completed. The carbon cycle maintains the balance in nature and meets the basic food and energy needs of all living things. In addition, since the 20th century, the amount of carbon in nature has been increasing daily. The biggest reason for this is the increasing energy demand with the start of the Industrial Revolution. With the invention of steam machines, the demand for fossil fuels has increased. This has increased the use of fossil fuels and the release of more C (carbon) into the atmosphere. This has increased the proportion of carbon in nature and disrupted the natural order (Liu et al., 2012).

Changing the naturally occurring ratio of such an important element as carbon in our world poses a great risk. Therefore, it is necessary to adjust the ratio well. At the beginning of the 20th century, it was observed that the carbon rate in nature was rapidly increasing. To correct this imbalance, carbon-zero targets have emerged.

2.6.2. Beyond Zero

The 21st Session of the United Nations Climate Change Conference, or COP21, was held in 2015. At this conference, the Paris Climate Agreement was signed. According to this agreement, the 200 participating countries agreed to aim to keep the estimated international temperature increase between 1.5 °C and two °C. There was a significant reason for this significant agreement in 2015. The global temperature increase, slowing down over the last 30 years, saw a sudden rise in 2013. The rapid increase in the world's population, the rise in energy demand, and the gases resulting from the uncontrolled use of energy sources, namely greenhouse gases, caused this temperature increase. The rising temperatures became uncontrollable day by day, causing temperature fluctuations. In 2015, representatives from different countries made some decisions to solve this problem. Predictions of possible increases in CO^2 emissions levels by 2030 were determined. This agreement was made to maintain temperature and CO^2 levels at a certain point. The ultimate goal was set for 2050. According to the research, if no measures were taken, the average temperature increase would be 5 °C by 2050. It was observed that the global carbon level would be at its maximum. According to this research conducted by the IPCC, it was aimed to reduce the rate of carbon released into the atmosphere by human activities to zero by 2050 (Xaver Perrez, 2019).

Around the world, 80% of carbon emissions causing climate change result from using fossil fuels to meet energy demand. Energy transformation must be ensured to maintain the current order in the world and eliminate these negative effects. According to the agreed target, these carbon emissions must be reduced to zero by 2050. With the signing of this agreement, all delegates accepted this, endorsing the Net Zero, or "Beyond Zero," goal. The articles of the Paris Climate Agreement state in Article 4, Paragraph 1(d) of the Agreement that Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases, including forests. This means that all Parties are encouraged to take steps to implement and support the existing framework, including result-based payments, for policy approaches and positive incentives relating to activities reducing emissions from deforestation and forest degradation, the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries; as well as alternative policy approaches such as joint mitigation, and adaptation approaches for the integral and sustainable management of forests, as determined by the relevant principles and decisions agreed under the agreement; in this regard, the importance of encouraging non-carbon benefits of such approaches are considered (Ciobanu, 2022).

The overarching goal of the agreement is to limit global temperature increases and reduce greenhouse gas emissions to zero. According to the internationally determined temperature increase target, the aim was to limit global warming from an estimated five °C increase to a two °C increase. The 200 participating country delegates unanimously accepted this global agreement. After the Paris Climate Agreement, countries cooperated with their social institutions to prepare declarations. By publishing these, they aimed to ensure the approval and participation of all citizens. All parties are obliged to fulfill their responsibilities. Every step taken has been made to reinforce this responsibility. The concept of carbon footprint began to be heard more after the Paris Climate Agreement was signed in 2015. Countries expanded their societal goals to ensure citizens comply with the Net Zero goal. As a result, carbon emissions started a global trend. This was a harbinger of change.

The table below shows the amount of carbon released into the air while burning fossil fuels. This shows us how high this ratio is and needs to be reduced.

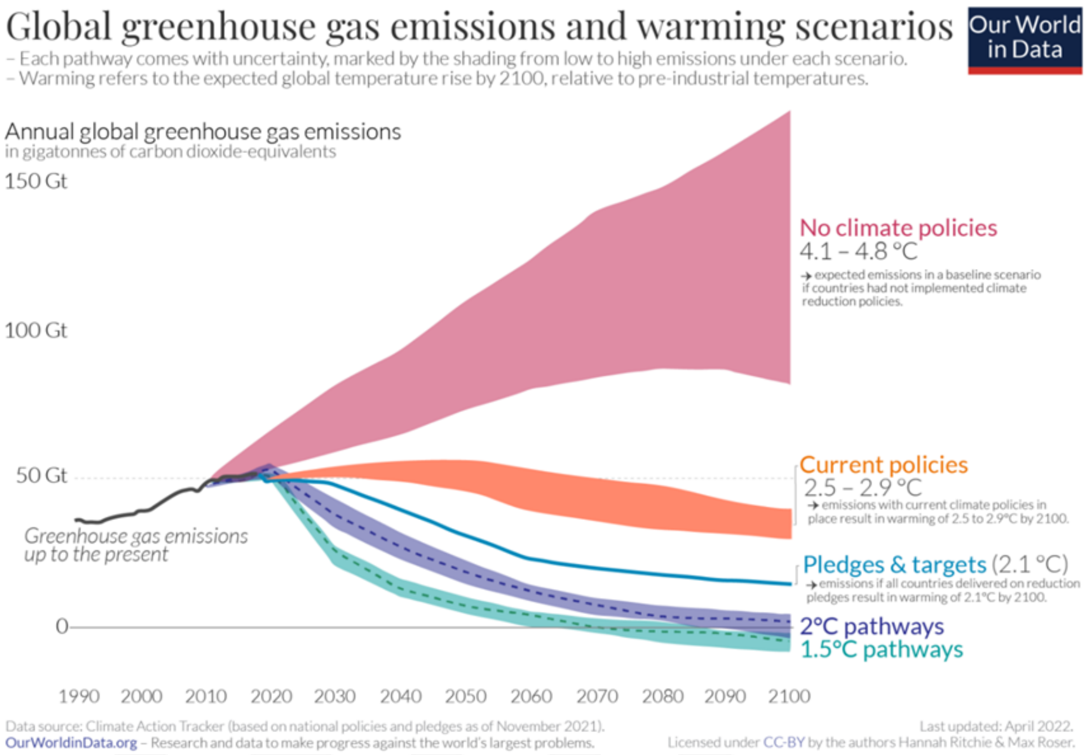


Figure 15. Global GreenHouse Gas Emissions for Beyon Zero Target (Source: Ritchie and Roser, 2022)

2.6.3. Design of Carbon

According to the research conducted by the U.S. Energy Information Administration (EIA), it has been observed that fossil fuels meet half of the energy needs of buildings. Globally, 75% of carbon emissions come from buildings during their construction. This means that the emission of CO^2 and greenhouse gases caused by the energy demand in the production and use of buildings increases temperature. The most significant factor in resolving the climate crisis comes from buildings (King, 2017).

Therefore, various studies are being conducted to reduce the amount of carbon. All of these studies in architecture have been grouped under the name of carbon architecture. Carbon architecture, fully named "the new carbon architecture," was grouped under one name in 2017 by Bruce King. This movement aims to make a design by calculating the carbon released during the use and construction of buildings. The goal is to reduce carbon emitted to nature in architecture to zero. In this regard, it is understood to be in line with the beyond-zero goal, and it is of great importance. Carbon found in its natural state is not harmful. As long as carbon found in nature is preserved, it benefits us. However, when unnatural, human-made carbon is released into nature, it causes significant harm. Non-renewable energy sources, also known as fossil fuels, used in the transportation and production sectors release much carbon into nature after use (King, 2017).

2.6.4. Calculation of Carbon in Buildings

Carbon architecture is based on the calculation of the carbon released in architecture. Keeping the carbon released into the atmosphere during the construction of buildings as close to zero as possible is the basis of this architectural approach. There are two different methods related to these calculations. The Life Cycle Assessment (LCA) method calculates the carbon emitted by the material, and the Whole Building Life Cycle Assessment (WBLCA) method for calculating the carbon emissions of the entire building.

2.6.4.1. Life Cycle Assessment Method

Life Cycle Assessment (LCA) is a research method that evaluates the environmental impacts of all stages of a product or service. When considering a product, LCA assesses the entire process, from raw material extraction and processing to recycling. The environmental impacts of the energy consumed throughout the product's life cycle are calculated in LCA studies. The goal of LCA is to demonstrate a product's or service's environmental compatibility by considering the environmental effects, such as resource use and impacts on human health during its production to recycling stages (Pålsson and Riis,2011).

Life cycle assessment is called 'cradle-to-grave' analysis, encompassing the stages from raw material extraction (cradle) to recycling (grave). The U.S. Environmental Protection Agency (US EPA) laboratories describe the LCA method in three fundamental steps:

- Calculating the environmental emissions of relevant energy and materials
- Evaluating the potential environmental impacts of the calculated results
- Interpreting and categorizing the results

The LCA technique allows for identifying the least environmentally harmful raw materials, leaving the choice to the consumer's discretion. It is an analytical study to facilitate the consumer's product selection process. Consequently, the obtained data can be utilized to develop environmentally compatible processes. It aligns with environmentally conscious approaches and policies, similar to carbon architecture. LCA corresponds to certain legal restrictions grouped under sustainable architecture (Duru and Koç, 2021).

The International Organization for Standardization (ISO) is a non-governmental organization established in 1947 to develop international standards, enhance international communication and collaboration, and promote proper growth in international trade. ISO standards constitute a set of rules and regulations to ensure the provision of international standards. LCA is evaluated within the ISO 14000 environmental management standards.

2.6.4.2. Life Cycle Assessment and International Organization for Standardization

According to the International Organization for Standardization (ISO), Life Cycle Assessment (LCA) is carried out in four fundamental stages. Firstly, the intended application is determined. Then, the reasons for conducting the product analysis are specified. A study assesses the target audience's response to the analysis. In the final stage, the decision is made whether the obtained data will be disclosed to the public. This last step is taken to maintain the credibility of the conducted studies. Since each disclosed reference value can vary according to different environmental impacts, some input data may need to be disclosed in order to maintain consistent standards.

In ISO LCA studies, the scope of the product analysis progresses through specific stages according to ISO standards. LCA seeks answers regarding how the product system operates throughout its life cycle. Questions such as how long the product will be used, what the product is, what its lifespan is, where the product will be used, and how good the product quality should be are addressed. The first step in an LCA analysis conforming to ISO standards is considering the geographical scope. The product data is examined to determine which regions are covered. The product may be processed in different geographical locations. Next, the technological scope is examined. The available technologies for producing the product are evaluated. The accuracy of the data and the repetition of the methods used during the analysis period are assessed. Analysis of the selected databases and the manufacturers supplying the product to the public are utilized (Duru and Koç, 2021).

2.6.4.3.Whole Building Life Cycle Assessment

WBLCA (Whole Building Life Cycle Assessment) analysis is a comprehensive study that examines the environmental impacts of all products and building components in a building. The carbon emissions of the entire building are measured throughout its life cycle. This analysis aims to minimize the environmental impacts of the building. WBLCA analysis can be examined in five stages, which include the lifespan of the building, the boundaries of the building, and the processes during the product, construction, and use phases (Sartori etc.al., 2022).

End of life: In WBLCA analysis, the potential environmental impacts when the lifespan of the building ends is calculated. It seeks answers to questions such as whether the building can be recycled and the amount of carbon emissions during recycling.

Use: The energy emissions of the building during its use are assessed. It involves calculating how the building meets its energy needs and in what manner.

Construction: It is the calculation of the total energy inputs during building construction.

Product: It refers to calculating the instantaneous energy consumption of the product obtained after the building is constructed.

Beyond the system boundary: This analysis stage involves calculating the building's environmental impacts' maximum and minimum value ranges.

According to the Royal Institute of British Architects (RIBA)'s new generation building work plan, building project design processes are carried out in eight stages based on WBLCA analysis. The table below shows the intersection of the design process in these eight stages and the WBLCA analysis. In the building design process, all life cycle analysis steps are applied together to calculate the environmental impacts within the most accurate range of values. This results in the creation of environmentally compatible products and structures (Sartori et al., 2022).

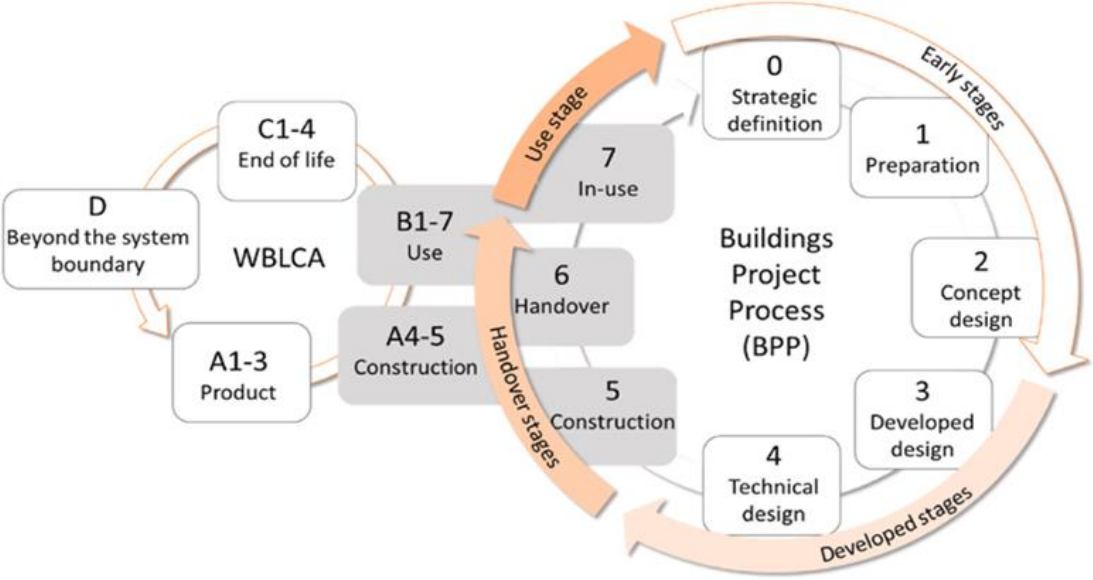


Figure 16. Intersection of Whole Building Life Cycle Assessment (WBLCA) and Building Project Process (BPP) stages. (Source: Sartori et.al., 2022)

In the New Carbon Architecture approach, a net design can be made by calculating the carbon ratios left in the atmosphere by creating life analyses of the product and the building. The Life Cycle Assessment (LCA) calculates the carbon emitted by the material, and the Whole Building Life Cycle Assessment (WBLCA) are necessary analysis method to maintain the balance of zero carbon emissions. This architectural approach aims to minimize the carbon emissions released into the atmosphere and design buildings compatible with this.

CHAPTER 3: THE NEW ENERGY ARCHITECTURE

In the 21st century, many factors are threatening global health. The rapidly increasing population, energy demand, disruption of the atmospheric balance, and global temperature increase can be classified among these problems. When looked at, it has become necessary to correct this rapidly deteriorating balance and ensure the world's future. The main reason for this transformation is the rapid temperature increases in the atmosphere. The population worldwide uses buildings to meet their housing, industrial, production, and social needs. Therefore, the first step of the transformation that will take place worldwide should be in architecture. Architecture is a body of knowledge that has naturally evolved within the purpose of human existence since the beginning of the world. Since primitive societies, humans have been intimately involved with architecture to sustain their lives. Architecture has been utilized for survival, shelter, and heating. This knowledge accumulation from the first humans is still advancing based on today's fundamental structures and information stones. For this reason, architecture is of great importance. New architectural trends have emerged to protect the rapidly deteriorating balance, and a great transformation has begun (Economist, 2022).

As the name energy architecture suggests, it can be described as the intersection of energy and architecture at a single point. Turkish architect Çelik Erengezgin first proposed the concept of energy architecture. According to Erengezgin, energy architecture is a design process that recognizes that the energy and ecology represented by the sun and the earth are an inseparable whole and reflects the existing values of life - it is the way of getting rid of all kinds of dependencies, preserving ecological balances, in short, surviving and maintaining sustainable life. The concept of energy architecture has a comprehensive perspective. First, it must be understood that energy architecture is a new architectural definition. It is a new generation sustainable approach in architecture to protect the natural ecosystem and prevent existing degradation with the emergence of sustainable energy, namely, green energy. The fundamental logic of energy architecture is to create living and production areas that can sustain themselves without causing social, economic, and ecological destruction. In this context, energy architecture can be associated with a new life philosophy.

The concept of energy architecture put forward by the architect Çelik Erengezgin is primarily defined as a common area where energy and ecology converge. Buildings resulting from architectural design should be structures that can provide heating, cooling, and lighting and produce zero waste. The natural respiration of structures and the usage of necessary energy to stay upright is essential in energy architecture. In energy architecture, the priority is functionality. In ecological thinking, using as much energy as necessary is important. Buildings use the energy they need without consuming the environment. They use what is known as green energy, which refers to sustainable or renewable energy sources (Erengezgin, 2015).

3.1.Definition of Energy Architecture

Architect Çelik Erengezgin established his definition of energy architecture based on a philosophical approach, discussing a design and formation process obtained in 9 steps. He defines the first four stages. These four items gathered under the names of Space, Air, Fire, and Wind are the components that create the environment and atmosphere of the vital space. This is a sequence of creation. Space is the first step. Existentially, there was space first. Similarly, in architecture, we have nothing when we start designing. The building is designed according to the determined plot. Air, fire, and wind are the elements that create the atmosphere. These stages called the creation sequence, consist of elements that create each other (Erengezgin, 2015).

The other four steps are described as fiction by the architect. Earth, Water, Trees, and Wood steps that make up the fiction are described as space fiction. In the architectural design process, the principal balance and the materials created are determined in these steps. The last step is the connector. In this step, which he called metal, the connector of space fiction is metal. This step has a low sustainability rate and is at the very end. Unlike classical architecture, these nine factors in this modeling are energy indicators. Each of the components created is an Eden of the low-form energy components. All steps are fundamentally subatomic structures carrying energy. In energy architecture, there is a patterned energy usage related to the buildings breathing and living. Every being produces and consumes as much energy as it needs. It uses its skin, or in other words, its shell, in return for the function of life. The approach of energy architecture based on basic philosophical logic should also be explained conceptually. This research thesis was written to explain this concept.

3.1. History of Energy Architecture

Energy architecture is fundamentally an architectural process that advocates the correct use of energy. It is a responsible planning process that starts from urban design and extends to selecting construction materials. The right direction, the right material, and the right design construct are a summary of energy architecture. Before creating a design, the purpose of use of the building, the location where the building will be constructed, and information about the materials should be determined. A design should be created based on the data obtained. In this context, the design is the final step in energy architecture, which is different from traditional architecture. Although the concept of energy architecture has recently been named, it has a long process that started with the emergence of the concept of sustainability (Erengezgin, 2015).

This concept, first introduced at the Human and Environment Conference held in Stockholm in 1972, was put forward to sustain human existence. Sustainability means to continue an action or a phenomenon. Sustainability was called sustainable development when planning how to tackle environmental and development issues. Sustainable development is a set of actions planned for the continuity of human life. The purpose of this concept, which emerged with the Climate Change Framework Agreement, is to slow down or stop the negative effects of global warming that affect human activities directly or indirectly, beyond usual climate differences.

With this goal, buildings, the most used area in the world, came to the forefront. The harmful gases and wastes that occur during the use and construction of existing buildings worldwide have also been reflected in the sustainable building approach for their classification. This trend, gathered under the name of sustainable architecture, is the first building block of energy architecture. The International Architects Association, which put forward this approach in Chicago in 1993, is based on environmental and social sustainability. This architectural approach is also known as green building design. According to the Environmental Protection Agency (EPA), a green building is defined as a building created to limit the adverse effects on human and environmental health by effectively using energy resources and reducing pollution-emitting elements.

Green buildings are a new architectural approach created by sustainable architecture. By using all resources efficiently, they inflict the least damage on nature and strive to coexist harmoniously. Issues arising from the rapid consumption of natural resources, such as climate changes and production and consumption imbalances, have accelerated these architectural processes. As a result, the search for environmentally sensitive raw materials and products increased. Evaluating products and raw materials used in buildings in terms of efficiency and defining their functionality has gained importance. Considering this entire life cycle, the ecological design movement was initiated, aiming to be environmentally harmless from the first step. This movement, known as eco-design, was started in the USA and Europe from 1990 onwards. In a study conducted in the Netherlands in 1992, Delft University of Technology published the first eco-design guide. Thus, eco-design became another necessary step for the formation of energy architecture. (Szutest, 2023)

The movement gathered under the name "New Carbon Architecture," created by Bruce King in 2017, was a step taken towards making the carbon emissions of all raw materials and energy necessary for the construction of buildings zero. This architectural approach, created in line with the "2050 Beyond Zero" goal, first aims to design with the data obtained by calculating the carbon that will be released during the construction and use of the building (King, 2017).

The idea of designing in harmony with nature emerged in the 21st century. This approach, known as biomimicry design, is reflected in all areas. Bionic design is designing products and systems based on natural organisms. It applies to many disciplines, such as architecture, engineering, product design, electronics, and urban planning. Biomimetic design is the perception of the idea of returning to nature. Eco-design aims to design compatible products that do not harm the environment by eliminating negative effects on products and systems. It is a design approach that emerged after the concept of sustainability was put forward. It supports the concept of reusability by taking a positive approach to environmental effects. In eco-design, the priority is to research the impact of the selected material and design on the environment. Ecological design is an innovative approach that protects resources and does not harm nature (Yeang, 2012).

Energy architecture is the common field where all these different approaches are collected. The new name of the building design approach, which can exist by itself without consuming natural resources in harmony with nature, which started with the concept of sustainability, is energy architecture. Energy architecture creates a new method based on all design approaches. It calculates not only the sustainability of the building and zero carbon production but also the recycling process. For this reason, all these sustainability approaches can be gathered under a single name. Energy architecture puts design last. All data are first collected; the land of the planned building, the location of the land, environmental climate conditions, and underground resources are determined. It is determined how the building should use the energy it can provide. A design is put forward following the data.

3.3.Meaning of Energy Architecture

Energy architecture encompasses sustainable buildings and their building blocks. So, the difference from sustainable architecture stems from its more inclusive structure. Energy architecture covers the building and makes all building elements sustainable. The aim is to design buildings that can withstand energy and heat without harming the environment. The building should maintain its heat balance and use renewable energy to ensure this. Architectural structures that prioritize functionality without disrupting the ecological balance form the basis of energy architecture. Energy architecture aims not to disrupt the balance in the material energy and building an ecosystem of the building and the constructed area (Green Building Journal, 2015).

In energy architecture, buildings use minimum energy and emit minimum waste in harmony with the environment. The way to achieve this is to use sustainable building materials. With advancing technology, basic building materials compatible with ecological balance have started to be used in energy architecture. These building materials compatible with the ecological balance ensure that the building is compatible with nature. It affects the sustainability of the building by adapting to the ecological balance. Sustainable building materials include recycled fabric or glass wood, linoleum, sheep wool, new technology concrete, paper panels, baked earth, and similar materials. Plant cover applications on building facades prevent the aging of the building. We can see this example on the Faculty wall of Izmir Economics University in the Izmir district of Turkey. This application ensures that the building is compatible with the environment.

In energy architecture, recycled materials are often used. This practice, done to reduce the use of new materials, enables the recycling of buildings. This reduces the production line and provides energy efficiency. New construction materials that do not contain carcinogenic substances are used (Tandoğan, 2018).

3.4. The Use of Materials in Energy Architecture

3.4.1. Wood

Wood plays a significant role in building materials. Building materials play a critical role in the construction sector and impact buildings' durability, aesthetics, and energy efficiency. Wood is a material obtained from nature. Hence, it is highly sustainable and easy to use. It has been a fundamental building material since humans first transitioned to settled life.

Wood is a material with unique physical properties. It is lightweight and flexible yet demonstrates high strength. Thanks to these characteristics, wood ensures the durability of buildings and can also be resistant to natural disasters such as earthquakes. Furthermore, wood provides excellent insulation and enhances energy efficiency. Wood is an environmentally friendly building material. Wood production requires lower energy consumption compared to other building materials and reduces carbon emissions. Besides, the recycling and recovery of wood materials are straightforward. The most crucial factor in the sustainability of wood from trees is that it absorbs CO2 in the atmosphere during its growth process, binding carbon to its natural structure. It is a natural carbon absorber. Wood can be obtained through the sustainable management of forests as a renewable resource. Wood can be long-lasting and durable when processed correctly. With proper maintenance and protection, wooden structures can stay robust for years. Enhancing the natural properties of wood and through chemical processes increases the resistance of wooden structures against factors like decay, insect attacks, and moisture. (Fengel and Wegener, 1989)

Wood is a preferred material aesthetically because it has a natural and warm appearance. The natural patterns, colors, and textures used in wooden buildings enhance the character of the structures and provide a harmonious image of the environment. Wooden structures offer many advantages. Wooden structures, which have a pleasing appearance aesthetically, create a natural and warm atmosphere. Moreover, wooden construction is quick and easy. Wooden structures are produced with less energy consumption and have fewer environmental impacts. Also, wooden structures are a sustainable option since they are suitable for recycling and can be recovered. Wood can be used for various types of structures. There are different applications, like wooden houses, wooden bridges, wooden multi-story buildings, and wooden decorative elements. Wood material offers a broad creative field to architects and designers and adapts to various design options.

The most efficiently used material in energy architecture is wood. Emerging along with sustainable architecture, wood continues to be used as a fundamental building material in energy architecture today. When combined with new technologies, wood becomes more sustainable and usable. A cubic meter of wood raw material with a total dry density of 0.50 g/cm^3 stores 250 kg of carbon and 0.935 tons of carbon dioxide. As long as we prevent the carbon stored in the woody texture from returning to nature, meaning we do not allow the wood material to burn or decay, the damage to the ecological balance will decrease. The wood needed in the construction industry is taken from trees, disrupting the ecological balance. Therefore, it conflicts with the basic philosophy of energy architecture. A solution is to plant a new sapling for each tree used. No other logging should be done until the planted sapling is restored to nature. Another solution is the recycling and reuse of wood. In this way, the goal of energy architecture continues in this building material.

3.4.1.2. Variety of Wood Materials

Strengthened Woods: Technologically processed wood materials can enhance durability and strength. Strengthened woods can be obtained by adding materials such as resins, epoxy, or polymers into the wood material. These kinds of woods can be preferred for stronger and more durable structures in the construction sector.

High-Density Wood Composites: High-density wood composites are a material formed by combining wood fibers and binding substances. These composite materials are denser and more durable than traditional wood materials. Moreover, they can be more resistant to water and decay. These properties can be used in applications such as exterior cladding, furniture, and floor coverings.

Flame-Retardant Woods: Flame-retardant woods are subjected to chemical processes to impart flame-retardant properties to the wood material. This process reduces the burning rate and fire resistance of the wood. Flame-retardant woods are used in interiors, furniture production, and for decorative purposes, which are important for building safety.

Wood-Polymer Composites: Wood-polymer composites are formed by combining wood fibers and polymer resins. These composites combine the natural beauty and warmth of wood with the durability and water resistance of polymers. Wood-polymer composites are durable and maintenance-free materials used for exterior cladding, garden furniture, pergolas, and decorative purposes.

Laminated Wood and Wood Panels: In addition to traditional wood panels, laminated wood, and wood panels have also been developed. These materials are formed by combining different layers and can be designed according to desired properties. Laminated wood and wood panels are used in many areas, such as construction, furniture, and interior decoration (Kretschmann, 2010).

Those mentioned above are some types of wood materials that have emerged due to new technological developments. These new technological woods have improved the properties of traditional wood materials, enabling them to have wider applications in energy architecture (Beldean and Pro, 2021).

3.4.2. Metal

Building materials are fundamental components used in the construction industry and significantly impact the durability, aesthetics, and functionality of structures. Metal occupies an important place among these materials. The strength, durability, and aesthetic appearance of metal allows it to find various uses in building materials.

• Metal provides excellent durability when used in building materials. Metal building materials can maintain the stability of structures with their high-strength properties and can be long-lasting. Furthermore, due to the durability of the metal, structures can be more resistant to natural disasters.
• The types of metals used in building materials are quite diverse. For example, steel, aluminum, copper, iron, and zinc are commonly used building materials. Each metal has unique properties and advantages and can be chosen according to different construction needs.
• Metal building materials also offer many advantages regarding aesthetic appearance and design flexibility. The brightness of metal provides a modern and contemporary appearance. Also, the malleability of metal gives architects and designers the freedom to create various shapes, details, and textures.
• Metal building materials are also a preferred choice regarding energy efficiency. Metals, especially aluminum and steel, can be effective in heat and sound insulation. This results in energy savings and contributes to the buildings being more sustainable.
• Metal building materials can be used in many different types of structures. For example, steel is commonly used for bridges, skyscrapers, and industrial buildings. Aluminum can be used in facade claddings, window frames, and solar panels. Copper is a preferred metal for roofing and decorative purposes (Porter et al., 2009).

3.4.2.1 Carbon Fiber

Carbon fiber is a solid and lightweight building material. It is a composite material obtained by arranging thin threads consisting of carbon atoms in a special way. These threads are formed by arranging carbon atoms in a graphite structure and exhibit extremely high strength properties. The carbon fiber material is a preferred material, especially in high-performance applications. This is because carbon fiber has a low weight, provides high strength, and exhibits high flexibility. Carbon fiber materials are lighter than steel or aluminum but have higher strength.

One of the important features of carbon fiber is that it has a high degree of tensile strength. This increases the weight-carrying capacity of carbon fiber and allows for the construction of strong and durable structures when used in structural applications. Carbon fiber also exhibits high rigidity. This makes the material resistant to changes in shape and size. Carbon fiber materials resist vibrations, impacts, and stresses and deliver high performance in long-term use.

Another advantage of carbon fiber is its chemical resistance. Carbon fiber materials resist many chemical substances and rot, oxidation, and various chemical effects. This allows carbon fiber to have a wide range of uses, especially in aviation, automotive, maritime, sports equipment, and defense industries. However, there are some limitations to carbon fiber material, such as high cost and difficulty in processing. In addition, if carbon fiber burns, it can release toxic gases, so precautions must be taken regarding fire safety (Porter et.al., 2009).

In general, carbon fiber material is a material that stands out with its high strength, lightness, and durability properties. It is widely used in sectors where there is a need to reduce weight and increase durability in advanced technology and high-performance applications.

3.4.3. Masonry

Masonry material is a key construction material used to ensure the durability of buildings and form their skeleton. This article will discuss masonry material, its properties, varieties, and areas of use.

• Masonry is a building material formed by mixing cement, sand, gravel, water, and sometimes aggregates. Masonry material is a building material used in reinforced concrete structures and wall systems. It is generally used to construct structural elements such as reinforced concrete columns, beams, and foundations. Masonry material is a durable, high-strength, and fire-resistant material.

• Masonry material can be divided into various types using different components and mixtures. The most commonly used types of masonry materials include concrete, stone, and brick. Concrete is a homogeneous building material obtained by mixing cement, sand, gravel, and water. Stone is a material extracted and processed from natural resources. Brick is a building material generally obtained by firing soil, clay, and other natural materials.

• Masonry material has many advantages. Firstly, masonry material ensures the longevity of buildings due to its durability and high strength. Also, because it is fire-resistant, it is important for the safety of buildings. Masonry material also provides sound and heat insulation, thus creating comfortable interiors. Another advantage is its environmental friendliness, especially recyclable concrete material can be preferred in this regard.

• Masonry material has a wide range of uses in the construction sector. It is especially used extensively in forming the carrier systems of buildings and in wall systems. Masonry material can be used in many structures, such as residences, commercial buildings, industrial structures, bridges, and infrastructure projects. Various types of masonry materials can be selected according to buildings' needs and design requirements.

• There are also some limitations to masonry material. Firstly, masonry material is heavy; therefore, careful planning is required in transportation and assembly processes. Also, processing and shaping masonry materials like concrete can be time-consuming and challenging. Masonry material is also sensitive to moisture; therefore, it is important to take water insulation and protective measures.

• It should not be forgotten that masonry material continuously develops and is subjected to innovations. New technologies and material additives are used to increase masonry materials' durability, energy efficiency, and sustainability. For example, special concrete mixtures can have properties that provide higher strength and reduce environmental impacts.

Masonry material is a basic building material that forms the durability and skeleton of buildings. Types of masonry materials such as concrete, stone, and brick are widely used in construction. The durability, strength, and fire resistance of masonry materials ensure the safety of buildings. Also, it creates comfortable interiors with advantages such as sound and heat insulation. Even though masonry material has limitations, it is important to remember that it is a material that is constantly being developed. With advanced technology and innovations, masonry is an important building material of energy architecture to build more durable, energy-efficient, and environmentally friendly structures (Drysdale, Hamid, and Lawrie, 2012).

3.4.4. Cement

Cement, one of the fundamental materials used in the construction industry, plays a critical role in the durability and robustness of structures. It is the main component of building materials such as concrete and mortar. Historically and in contemporary times, cement is considered an indispensable material in the construction sector. In energy architecture, cement is considered an acceptable material if it is recycled. Cement is a binder formed by grinding raw materials such as limestone, clay, silica, and aluminum oxide into a powder and mixing it with water through a specific process to harden. This hardening process, called hydration, allows the concrete or mortar to cure and strengthen. Cement production is a complex process. The basic stages involved in cement production are the extraction, grinding, calcination (baking at high temperature), cooling, and grinding steps. These processes facilitate the formation of cement clinker, and then various additives are added to produce different types of cement (Malthotra and Mehta, 2006).

There are various types of cement to meet different construction needs. Generally, Portland cement is the most commonly used type of cement used in general construction applications. In addition, there are different types, such as rapid hardening types of cement, sulfate-resistant cement, white blocks of cement, and special-purpose cement.

Cement has many advantageous features. High strength, durability, fire resistance, workability, impermeability to water, and cost-effectiveness are reasons cement is preferred in the construction sector. Moreover, customizing cement with various additives offers solutions suitable for the desired properties.

Cement production has environmental impacts such as energy consumption and carbon dioxide emissions. However, advancements are being made in terms of sustainability. For example, using alternative fuels, energy efficiency measures, and innovations to reduce the carbon footprint aims to decrease the environmental impact of cement production. Cement has an extensive range of uses in the construction sector. Concrete is a building material formed by combining cement and aggregates and is used to construct many structural elements such as foundations, walls, floors, columns, sidewalks, and bridges. Mortars are used to hold together building materials like bricks, stones, ceramics, and tiles (Nag, 2016).

3.4.4.1 The New Version of Cement

3.4.4.1.1Pollution-absorbing Bricks

Pollution-absorbing bricks, a product of collaboration between Skidmore, Owings & Merrill, and Prometheus Materials, are a type of construction material based on algae that absorb carbon and form the basis for carbon-negative buildings. A pollution-absorbing brick is a building material that neutralizes or reduces harmful atmospheric pollutants. These bricks contain special coatings or additives and aim to reduce environmental pollution. Pollution-absorbing bricks typically work through two basic mechanisms:

Adsorption: Pollution-absorbing bricks adsorb harmful gases or particles in the atmosphere onto their surfaces. Special coatings or additives on the surface are designed to trap these pollutants. In this way, air pollutants are held on the surface of the brick and prevented from spreading into the environment.

Chemical Reaction: Some pollution-absorbing bricks undergo chemical reactions with air pollutants through the special additives or coatings they contain. As a result of these reactions, harmful compounds are transformed into less harmful or harmless compounds. Photocatalytic bricks, in particular, neutralize air pollutants by oxidizing them under sunlight (LetsBuilt).

Pollution-absorbing bricks improve air quality, particularly in areas with heavy traffic or industrial zones. The use of these bricks contributes to efforts to build environmentally friendly buildings and reduce air pollution. However, the effectiveness of pollution-absorbing bricks can vary depending on air conditions, the concentration of pollutants, and the properties of the bricks.

3.4.4.1.2. Cigarette Brick

Bricks made from cigarette butts are a building material used for recycling purposes. Cigarette butts are one of the waste products that cause environmental pollution and fire risk. A team led by Dr. Abbas Mohajerani at RMIT University in Melbourne, Australia, demonstrated that bricks with as little as 1% cigarette butt content could reduce the cost of brick production and protect the environment (LetsBuilt).

> *"About 6 trillion cigarettes are produced yearly, producing 1.2 million tons of cigarette butt waste. These figures are expected to increase by more than 20% by 2050, particularly due to the increase in the world population. In Australia alone, people smoke approximately 25 to 30 billion filtered cigarettes yearly, and about 7 billion are dumped in landfills. Our research shows that if just 2.5% of annual brick production worldwide contained 1% cigarette butt content, we could completely offset the world's annual cigarette production. Mohajerani's team found that adding cigarette butts could reduce the energy needed to fire bricks by up to 58% (LetsBuilt)."*

Bricks made from cigarette butts are produced by collecting, cleaning, and appropriately processing cigarette butts. The butts are mixed and compacted with a binding agent and other materials. As a result of this process, a brick form composed of cigarette butts is obtained. Using recycled cigarette butts in brick production is important in waste management and environmental protection. This prevents the butts from being thrown into landfills or the environment.

When cigarette butts are used as a siding material in brick production, more sustainable and efficient material use is achieved. This can contribute to the conservation of natural resources and energy saving. However, bricks made from cigarette butts have some limitations and potential problems. Cigarette butts contain various chemicals, and the potential release of these substances in brick production is concerning. Therefore, using cigarette butts in brick production requires appropriate monitoring and evaluation processes. Detailed studies and tests should be conducted on the durability and performance of bricks made from cigarette butts. Factors such as the mechanical properties of these bricks, insulation, and water resistance should be considered.

More research and development on real-world applications and usage areas of bricks made from cigarette butts are essential. This way, more effective solutions can be found in waste management and sustainable building materials.

3.4.4.1.3. Light Emitting Brick: A Creative Building Material

Building materials are constantly evolving with innovation and technology. A light-emitting brick is one of these innovative materials. Combining traditional bricks' functionality and aesthetic appearance, light-emitting bricks bring the lighting and decorative purposes of buildings to a different dimension. Light-emitting bricks emit light through LED (Light et al.) or optical fiber systems embedded within them. LEDs or optical fibers generate light within the brick using electric energy, which passes through the brick's surface to provide illumination (LetsBuilt).

• Light-emitting bricks can be used creatively in the interior and exterior of buildings. These bricks offer the opportunity to create various decorative effects with different color options and adjustable brightness levels. They provide impressive visual effects when used in night lighting or special designs.

• Light-emitting bricks can be used to meet lighting needs indoors or outdoors. For example, light-emitting bricks used in corridors, stair treads, garden paths, and pool edges provide an aesthetic appearance and a safe lighting solution.

• Light-emitting bricks offer an energy-efficient lighting option using LED technology. LEDs consume less energy than traditional lighting sources and have a long lifespan. This saves energy and offers a sustainable lighting solution.

• Light-emitting bricks can become even more innovative with continuously evolving technology. For instance, integration with more advanced LED technologies or smart lighting systems could enhance the potential of light-emitting bricks. These materials are expected to offer broader application areas and more functional features in the future.

• Light-emitting bricks offer a creative option for lighting and decoration of buildings. Attracting attention with their aesthetic appearance, energy efficiency, and various application areas, these materials will likely become more popular in the construction industry. While increasing the visual appeal of buildings, light-emitting bricks also provide important advantages such as energy savings and sustainability.

2.4.5. Natural Stone

Natural stone materials are durable and aesthetic building materials derived from natural resources and used in energy architecture. Natural stones have various physical and chemical properties and have a wide range of uses. There are many types:

Granite: Granite is a natural stone known for its density and durability. It can be found in various colors and is used in many structural elements such as granite slabs, countertops, floor tiles, wall coverings, and exterior cladding. Its aesthetic appearance, brightness, and resilience make granite a popular choice.

Marble: Marble is a natural stone with an elegant and luxurious appearance. It can have different colors and patterns. Marble is used in many decorative applications in interiors, such as floor tiling, wall coverings, stairs, countertops, and sculptures. In addition, it is a durable material used in exterior cladding.

Travertine: Travertine is a natural stone material used particularly since the ancient Roman period. It has a porous structure and is generally white or beige. Travertine is used in many areas, both indoors and outdoors, such as floor tiling, wall coverings, bathroom countertops, and decorative ornaments.

Limestone: Limestone is a soft and porous natural stone material. It can be found in white, beige, yellow, and brown tones. Limestone is used in many structural elements indoors, such as floor tiling, wall coverings, stairs, and exterior cladding.

Slate: Slate is a natural stone with a layered structure, generally grey or black. Slate is used in various applications indoors, such as floor tiling, wall coverings, fireplaces, and exterior cladding.

Conglomerate: Conglomerate is a material with a compound structure where natural stones are bound to cement. This stone has various color and texture options and is used indoors and in exterior cladding (MIA and BSI, 2014).

Natural stones play an important role in energy architecture.

• Natural stones are materials derived from limited resources found in nature. Therefore, the sustainable use of natural stones requires the effective and careful management of these resources. Quarries and extraction processes should involve good practices and monitoring to minimize environmental impacts.

• Natural stones ensure the longevity of structures. These materials are strong and durable, resisting various weather conditions and environmental impacts. Thanks to these features, natural stones reduce the maintenance needs of structures and can be used for a longer period.

• Natural stones also provide an advantage in terms of energy efficiency. Natural stone materials have good insulating properties against heat and cold. This reduces buildings' heating and cooling needs, leading to energy savings.

• Natural stone materials have the potential for recycling and reuse. Natural stone materials from demolished old buildings can be reprocessed and used in new projects. This supports the efficient use of resources and the reduction of waste.

• Natural stones offer a rich choice in terms of aesthetics. With different colors, patterns, and textures, natural stone materials provide a wide field of creativity for architects and designers. This supports aesthetic diversity, which is an important element of energy architecture.

• The local extraction and processing of natural stones contribute to local economies. Also, the use of natural stones helps preserve local cultural values. Especially in restoring historical buildings, using local stone materials contributes to preserving the region's cultural heritage.

In conclusion, natural stones play an important role in energy architecture. Effective use of natural resources, durability, energy efficiency, recycling potential, aesthetic diversity, and contribution to the local economy are the basic principles of the sustainable use of natural stones. While minimizing environmental impacts, these materials are considered an important element of energy architecture due to their advantages, such as aesthetics, durability, and longevity. (Demirtas, 2022)

3.4.6. Nanotechnological Materials

Energy architecture is a discipline that continually adapts to technology, constructing buildings and generating innovative and sustainable solutions. In recent years, nanotechnology materials have created a significant revolution in energy architecture. Nanotechnology is a discipline that involves operating a materials at the atomic and molecular levels. This technology is moving architects into a new era of designing more efficient, sustainable, and aesthetically appealing structures.

Nanotechnology materials offer huge benefits for architects due to their unique properties. These materials nanoscale size, high surface-area-to-volume ratio, and special features present an incredible variety of design options. One can create desired shapes, generate different textures and surfaces, and build aesthetically striking structures. Nanotechnology materials allow the realization of designs that could otherwise have not been imagined before, enabling creativity in architectural projects without limitation (Çüçen and Altunci, 2022).

Nanotechnology materials assist architects in achieving their sustainability goals. These materials possess properties that provide energy efficiency. For example, high-performance insulation systems using nanomaterials reduce the energy consumption of buildings and control heat transfer. Also, nanocoatings offer advanced systems for solar energy collection and storage. Nanotechnology materials help architects achieve energy efficiency and sustainability goals while designing eco-friendly buildings. Nanotechnology materials play a crucial role in enhancing the durability and performance of structures. Nanomaterials combined with high strength and lightness, nanocomposite materials can be used in structural applications. Self-cleaning coatings reduce the maintenance of buildings and ensure longevity. Nanotechnology materials help architects design durable, long-lasting structures, reducing costs and maintenance requirements.

Nanotechnology materials have a significant role in improving buildings aesthetically and functionally. Nanoscale pigments and coatings can control color changes and reflections by manipulating light. Also, nanotechnology materials increase the functionality of structures with features like smart windows and transparency control. These materials allow architects to create structures that are impressive both aesthetically and functionally.

In conclusion, nanotechnology materials have revolutionized energy architecture. These materials enable architects to meet sustainability goals, energy efficiency, durability, and aesthetics. Nanotechnology materials enhance the performance of buildings while encouraging architects to create more innovative and creative designs. In the future, the use of nanotechnology materials in architecture is expected to become even more widespread, contributing to the emergence of more sustainable, efficient, and aesthetically appealing buildings.

3.4.7. Waste Of Materials Management

Waste material is characterized as excess arising in production, life, and consumption processes in the industry. All societies, indeed, produce waste. At the most basic level, these are domestic wastes consisting of food peels, animal manure, ash, broken tools, kitchen utensils, and old clothes. This waste in an agricultural society can be easily consumed within the natural cycle. However, in the 21st century, half of the world's population lives in large cities, that is, metropolises, where non-agricultural activities occur. According to data in the World Urbanization Prospects report published by the United Nations in 2014, while 30% of the world population lived in cities in 1950, this percentage has increased to 54% as of 2014, and this situation is increasing daily. According to studies conducted depending on these conditions, 60% of the world's population will live in cities by 2050 (Tandoğan, 2018).

With the advancement of technology, production has become easier, and the content of natural waste generated during production in agriculture has also changed. Chemical foods produced to facilitate production have deteriorated waste quality and started to leave more non-recyclable waste material in nature. Today, domestic and industrial waste, classified as hazardous or non-hazardous, and medical and construction waste have diversified. The demand for consumption due to the rapid increase in population is rapidly increasing, and therefore the amount of waste is uncontrollably increasing. The fact that wastes, which cannot decompose naturally in nature and have chemical content, cannot be taken back from nature and the use of resources overcapacity has caused these wastes to become an environmental problem (Tandoğan, 2018).

When waste materials cannot be recycled properly, when they cannot be taken from nature for reuse, they cause environmental impacts. Environmental impacts are a factor that prevents the efficient use of natural resources. Therefore, collecting and recycling waste materials back to nature is very important. Using waste materials as a new resource facilitates environmental sustainability (Özarısoy and Altan, 2021).

The amount of waste produced each year is 212 billion tons. A large part of this waste, buried in regular landfill sites worldwide, contains energy equivalent to 4.5 billion barrels of oil and can meet 10% of global electricity consumption. When we look at the full definition of the waste concept, it refers to any matter and material that is not used, is not intended to be used, has no value, and is thrown out. Wastes can generally be found in solid, liquid, and gas forms. Any material that cannot be recovered from nature falls into the waste group. Today's most significant waste problem can be described as construction waste.

Architecture is a multi-layered mirror of life: a field where economy, technology, environment, social, and cultural elements are carefully processed. Recently, in this complex equation, waste materials in energy architecture have played a serious role. This role aims to efficiently use material resources and minimize our environmental harm in an age when sustainability concerns are increasing. Waste material is considered trash left over after consumption and is usually thrown away. These are typically classified as industrial wastes, construction wastes, domestic wastes, and electronic wastes. Using such waste in architecture allows for reducing the amount of waste and creating new and innovative designs.

3.5. Position of Building

Thermal balance refers to the equilibrium reached in heat transfer between a structure's interior and exterior temperatures. This balance makes the interior comfortable while protecting the structure from hot or cold weather conditions. Factors such as heat sources, insulation, ventilation, and air conditioning must be considered to maintain a good thermal balance. In energy architecture, the natural ventilation method is employed, facilitated by correct window and door openings.

The first step is designing an energy-efficient structure. By using an effective insulation material, we can protect the interior from external temperature fluctuations. At the same time, we should also consider elements like correctly positioned windows and doors to safeguard the structure from overheating or overcooling. Features such as high-performance glazing and sun breakers can enhance natural lighting while protecting the interior from the adverse effects of solar radiation (Yilmaz, 2005).

Ventilation and air conditioning systems are also vital to the thermal balance. A well-designed system ensures the freshness of indoor air and maintains the desired temperature and humidity levels. However, ventilation systems need to operate efficiently for energy conservation. Heat recovery systems provide energy savings by reclaiming heat from the exhausted air. Additionally, passive design strategies can be effective for thermal balance. Properly positioned large windows allow the utilization of natural solar energy and reduce the need for heating and cooling. The use of thermal mass also helps to balance indoor temperature. Materials with high heat storage capacity release the heat they accumulate during the day and during the night, ensuring a more stable temperature in the space.

3.5.1. Bioclimatic Design

Bioclimatic design is a planning and design strategy used to increase harmony between natural environments and structures. During the design process, it is possible to achieve energy conservation, sustainability, and comfort by considering local climate and environmental conditions. This design approach prioritizes protecting nature and reducing environmental pollution while enhancing the possibility of using natural resources and energy more efficiently (Al Jada'an, 2018).

Bioclimatic design carefully examines and considers the natural environment and climate conditions to reduce the environmental impact of buildings, save energy, and improve the quality of life for occupants. This design approach uses a combination of traditional construction methods and modern technologies to make buildings more effective and efficient. The implementation of this approach plays a significant role in creating significant differences in spatial comfort and energy consumption.

Local Climate: The first step is to carefully understand the region's climate where the building is located. This location includes factors such as wind direction and speed, sun exposure duration, annual thermal fluctuations, and the amount of precipitation.

Using Natural Energy Sources: Bioclimatic design uses natural sources such as solar, wind, and geothermal energy. These energy sources are used for heating, cooling, and lighting buildings.

Energy Efficiency: Bioclimatic design aims to optimize energy efficiency. The design includes insulation of buildings, positioning and sizing of windows, and the choice of construction materials.

Comfort: Bioclimatic design ensures that people feel comfortable in indoor environments. The comfortable area includes providing the right temperature, humidity, and lighting.

Sustainability: Bioclimatic design aims to minimize the environmental footprint of buildings. This involves using local materials, reducing energy consumption, and conserving water (Esfehankalateh et.al., 2021).

The bioclimatic design aims to increase energy efficiency and comfort while reducing the environmental impact of buildings and other structures. Thus, it provides advantages both economically and environmentally. In energy architecture, bioclimatic design plays an important role also in facade applications, increasing building efficiency and reducing energy consumption (Rahim, 2020).

3.6. Energy Generation

Energy architecture is an approach that aims to increase the energy efficiency of buildings and promote the transition to sustainable energy sources. However, energy efficiency is not limited to reducing consumption; it also needs to consider energy production. Here, the role of the energy architect gains importance. Energy architects play a significant role in constructing a sustainable future by using renewable energy sources that allow buildings to generate energy.

Solar Energy Systems: Solar energy is the most common and potentially the largest energy source. Energy architects specialize in the design of systems that convert solar energy into electricity using photovoltaic (PV) panels. Roofs, facade surfaces, and other structural elements can be used to integrate solar panels. As a result, buildings can meet their own electricity needs and even sell excess energy to the grid.

Wind Energy Systems: Wind energy has significant potential in energy production. Energy architects specialize in structural design and planning for the placement and integration of wind turbines. Roofs of buildings or nearby open spaces can be ideal locations for wind turbines to be used for energy production.

Hydroelectric Energy Systems: Hydroelectric energy enables electricity production from water power. Energy architects specialize in the design of hydroelectric systems based on water resources and principles of fluid mechanics. Various hydroelectric energy systems, such as artificial ponds, river turbines, or tidal energy, can be used.

Other Renewable Energy Sources: Energy architects can also use other renewable energy sources to generate a building's energy. Resources such as biomass energy, geothermal energy, and tidal energy can be used in different regions and different types of buildings (Mousavi et.al., 2023).

Energy architecture plays an important role in sustainable energy production. By using solar, wind, hydroelectric, and other renewable energy sources, buildings can generate and meet their energy needs. The expertise of the energy architect is a significant factor in the design and integration processes for energy production and contributes to the construction of a sustainable future.

3.7. Building Information Modelling (BIM)

In the architecture and construction sectors, technology has always played a role as a catalyst. In recent years, a new technology called BIM (Building et al.) has been altering and coordinating the implementation of all processes from design to construction, maintenance, and management stages. This development in engineering is also defined as BIM Energy Architecture. The new energy architecture, the subject of this research thesis, encompasses this BIM model (Asım et.al., 2021).

BIM (Building Information Modeling) is a process used throughout the entire life cycle of a construction project. This technology digitally designs and manages a structure's physical and functional characteristics. A BIM tool presents all elements and features of a building as a digital 3D model, and this model provides detailed information throughout the project. Today's drawing programs used by building designers, such as Autocad, 3Dmax, and Sketchup, are based on this BIM modeling.

BIM is not merely a 3D modeling tool. It has a broad application range, including project management, scheduling, cost estimation, energy analysis, and maintenance planning. The essence of BIM is the ability to consolidate all information of a building project in a central model. The application of BIM offers a range of benefits for all parties involved in the project.

• BIM allows the project team to work simultaneously on the same model. This model leads to more effective collaboration and faster decision-making processes. Moreover, every change made to the model automatically reflects on all documents, reducing the likelihood of errors and conflicts.

• BIM provides more accurate cost estimates for the structure's design, construction, and maintenance. A modeling system aids in better budget management and helps to prevent unexpected cost increases.

• BIM enables detailed analyses regarding energy efficiency and sustainability. This assists in reducing the environmental impact of the structure.

BIM technology is creating a revolution in integrating and optimizing design and construction processes. Architects, engineers, contractors, and all other parties can provide more collaboration and coordination through BIM. This enables the completion of faster and more efficient projects. In addition, the data richness offered by BIM allows for better decision-making processes and more informed design decisions. This decision equates to better building performance, lower construction costs, and more sustainable structures (Wan et al., 2022).

3.8. Sustainable Urbanism

Sustainable urbanism is a holistic approach that integrates urban planning, architecture, and environmental sustainability practices. It promotes the creation of dense, walkable neighborhoods that facilitate a reduction in greenhouse gas emissions and resource consumption. It also fosters community interaction and promotes a healthier lifestyle (Farr et.al., 2008).

In essence, sustainable urbanism is about creating cities that are not only sustainable in environmental terms but also economically viable and socially equitable. The goal is to create urban environments that introduce the future without compromising the capability of generations to meet their own needs (WCED, 1990).

3.8.1. Principles of Sustainable Urbanism

Density and Mixed-Use Development: By promoting compact, mixed-use development, sustainable urbanism reduces the need for private transportation, reduces energy consumption, and facilitates social interaction.

Walkability: Sustainable urbanism emphasizes walkable neighborhoods, reducing car dependency and promoting healthier lifestyles (Speck, 2012).

Public Transport and Connectivity: Efficient public transport systems and connectivity reduce greenhouse gas emissions and create a more equitable society by providing all community members access to essential services.

Green Spaces and Biodiversity: Incorporating green spaces enhances biodiversity, provides natural cooling effects, and improves the psychological well-being of residents.

Energy Efficiency: Sustainable urban design encourages the use of energy-efficient buildings and renewable energy sources, reducing the carbon footprint of urban areas.

Social Equity: This approach ensures access to essential services and resources for all residents, regardless of socio-economic status.

3.8.2. The Future of Sustainable Urbanism

With increasing urbanization and the escalating impacts of climate change, the importance of sustainable urbanism will continue to grow. By creating environmentally sustainable, economically viable, and socially equitable cities, we can ensure a resilient and prosperous future for all. Understanding and implementing sustainable urbanism is critical for architects, urban planners, and policy-makers alike. As we move forward, it is essential to learn from successful sustainable urbanism examples, continuously innovate, and adapt to the unique challenges and opportunities each urban context presents (Azzali and Law, 2020).

3.9. Smart Cities

A smart city is where traditional networks and services got more efficient using digital solutions to benefit its residents and the business world. A smart city goes beyond digital technologies for better use of resources and less emissions. It means smarter urban transport networks, improved water supply, and waste disposal facilities, and efficient ways to light and heat buildings. It also means more interactive and responsive city management, safe public areas, and meeting the needs of the aging population. A smart city is an urban area that creates a modern living space by collecting data from living spaces. Different types of electronic devices and methods are used. These collected data are used to raise life comfort in an urban area. Data collected from people living in urban areas are also included in this. It collects the information flow of the working capacity of power plants, data storage of transportation systems, and the water supply networks. It presents an analysis of these data. These data formed in the concept of smart cities are used and planned. A new definition is made. Smart cities are defined as smart according to technology and data analysis capacity. 6 different points are developed in smart cities. A smart city can be designed by developing these six goals (Kozłowski and Suwar, 2021).

Smart Economy: Smart economy refers to the competitiveness of the city. It is the capacity for innovation, entrepreneurship, trademarks, productivity, and flexibility. It is also defined as integrating the labor market and the internal environment. On this point, information and communication technologies (ICT) are used to increase e-business and e-trading and the opportunities related to production and service. Delivery and innovation, as well as new products, services, or business models, are developed.

Smart People: It is about the qualification and education of residents, as well as social interactions about integration and public life. Essentially, it is about the city's openness to the world. ICT serves to increase the creativity of people. Moreover, it is used to improve innovation and the availability of education and training.

Smart Governance: Defined by effective and efficient public government. Its management is the quality of public services. Communication technologies are used for information and development in e-management. According to these data, public authorities make support decisions related to democratization and service delivery.

Smart Mobility: Mobility means the services and information of availability and accessibility. As well as communication technology, sustainable transportation is also in this context. Electric public buses are just one example.

Smart Environment: It refers to the natural living conditions in the city. It is managing the pollution and resource in green areas and protecting the environment. For example, effective waste management, the use of renewable energy resources, and green urban planning. Informational and communication technologies are used to improve the ecological condition of the city.

Smart Living: It covers different aspects of life quality. City authorities
should pay special attention to health, safety, culture, and living conditions. An important aspect is also the revitalization of tourism. There should be information data on entertainment activities, leisure time, and nightlife. It is re-creating social initiatives that support information and communication technologies.

3.9.1. Smart City Aims

The concept of a smart city adapts to the concept of sustainability of the 21st century. When combined with this concept, it shows that making cities become smart cities is a way. The transformation of cities is achieved by developing six key smart city focal points. For this reason, the European Commission aims to increase application data in countries by making it a market. The Smart Cities marketing was created by combining two legacy platforms, the "Marketplace of the European Partnership for Innovation in Smart Cities and Communities (EIP-SCC Marketplace)" and the "Smart Cities Information System (SCIS). "It's a big European Commission initiative changing the market, aiming to bring together cities, industries, Small and Medium-Sized Enterprises, investors, banks, researchers, and many other smart city actors. The common goal of this market is to improve the life quality of the citizens, increase the competitiveness of European cities and industries, and achieve the European energy and climate goals. These marketing targets developed by the European Commission also include smart city targets.

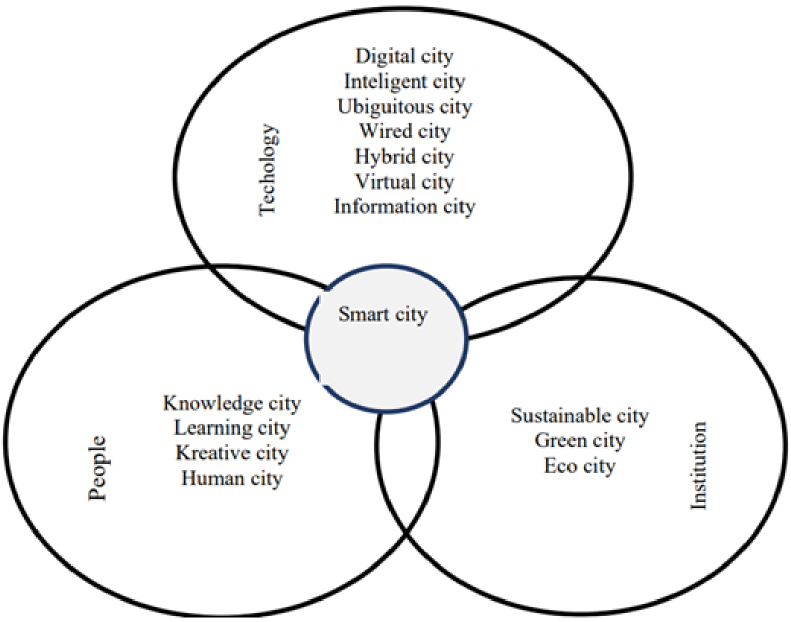


Figure 17. Smart Cities Aims,The attributes of technology, human, and institution of smart cities(Source: Kozłowski and Suwar, 2021)

These common goals are,

* Sustainable urban mobility

* Sustainable regions and the built environment

* Integrated infrastructures and processes in energy, information, and communication technologies, and transportation

* Citizen-oriented

* Policy and regulation
* Integrated planning and management
* Information sharing
* Basic lines, performance indicators, and metrics
* Open data management
* Standards
* Business models, purchasing, and financing.

In the basic logic, The Smart Cities Marketplace has been primarily developed for the European Union countries to complete the smart city transformation. However, providing achievement to all parts of the world has enabled the implementation of this concept for many countries. According to the Navigant research report, 250 smart city projects are worldwide. A majority of more than 178 cities have been identified worldwide (Alshahadeh, 2018).

3.9.2 Smart Energy Systems

The rate of urbanization, which is increasing daily, has reached 66% of the world's population. In order to solve this problem of rapid urbanization, the smart city concept has become important. A low carbon economy became the adopted way of the 21st century. For this reason, it has started implementing the smart city concept to reach the zero-carbon target by 2050. A reliable, efficient, and low-carbonaceous energy supply is one of the most important elements of the smart city concept. Following this concept, the use of smart energy systems have been increased and energy production at maximum efficiency has been achieved thanks to the smart energy systems provided. Smart energy systems aim to make minimum carbon emissions. There are two different viewpoints on these systems. The first viewpoint defines smart energy systems as smart applications for operating and controlling. It includes components of the energy system. The components of such systems include artificial intelligence and automated algorithms that use demand information to optimize energy. The second viewpoint defines smart energy systems as technologies and accompanying infrastructure that integrate the components of the energy system (Biresselioğlu M., Demir M. and Altıncı S., 2022).

Smart energy systems help to ensure sustainability by providing the best use of resources, efficiency, and cost-effectiveness of energy needs. Smart energy systems should ensure good optimization to ensure sustainability. For this reason, these systems should provide the basic determinants.

3.9.3.Expectation For Smart Energy Systems

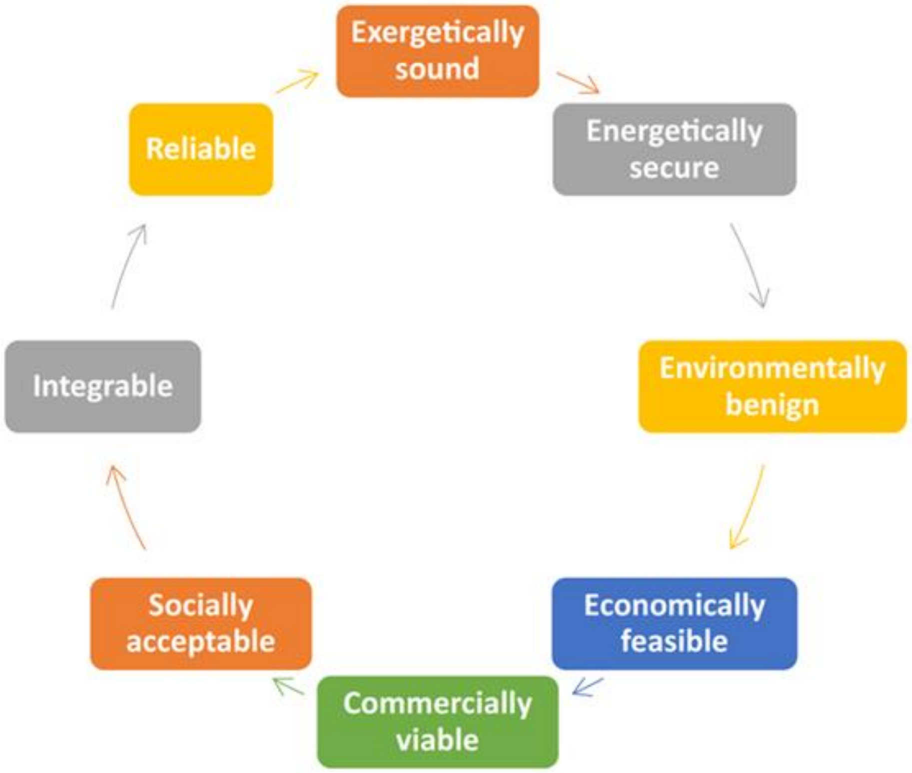


Figure 18. Major Expectation From Smart Energy Systems(Source: Dincer and Acar, 2017)

This expectation creates good quality for smart energy systems. Smart energy systems have eight different major expectations. These expectations are exegetically sound, energetically secure, environmentally benign, economically feasible, commercially viable, socially acceptable, integrable, and reliable.

Energetically Sound: Exergy is a mean critical chart for energy quality. If we accept a system that's common name is a smart energy system, this system uses minimum exergy destruction, and it uses maximum exergy efficiency.

Energetically Secure: This title gives details about energy security. Smart energy systems can design from an economically predictable and renewable source. These systems can use with these. The latest user reaches practical and safe energy, creating energy security (Dincer and Acar, 2017).

Environmentally Benign: Smart energy systems use fewer carbon emissions, and they use source efficiency. This creates clean use of energy. Smart energy systems use the waste of recycling systems. That means a better environment for the future.

Economically Feasible: Proper and predictable energy use in smart energy systems. On the other hand, smart energy systems have economic benefits at a low cost.

Commercially Viable: Smart energy systems use easily accessible energy sources. This factor affects economic issues.

Socially Acceptable: Smart energy systems can provide social requirements. If one of the smart energy systems can be successful, society will be able to accept that.

Integrable: Integrable design is important for smart energy systems. The better way is to use available energy infrastructure that transforms into smart energy systems. If energy systems do not change too much, society will probably accept this proposal (O'Dwyera et.al., 2019).

Reliable: The terminology of energy systems includes energy generation, use of a long time, and process. Smart energy systems are reliable for every step. Reliable expectations increase acceptability (Borruso and Balletto, 2022).

3.9.4. Smart Energy System Technologies

Smart energy systems use different technology. Because of that, smart energy systems use two different energies for efficiency. Smart gas grids, smart thermal grids, and smart electricity grids. These systems combine different technology for maximum energy.

Smart Electricity Grids: They connect heat pumps and electric cars to renewable sources like wind and solar. Also, smart electricity grids efficiently take sustainable, economical, and reliable energy sources to users. They integrate different energy sources.

Smart Thermal Grids: Smart thermal grid technology connects with the electrical and heating sector. This is the use of storage to provide additional heat and create energy to be recycled. On the other hand, smart thermal grids are like a piping system in a city of buildings.

Smart Gas Grids: Smart gas grid technologies connect with electrical, heating, and transportation systems. Smart Gas Grids are gas infrastructures that can intelligently integrate the actions of all their users (suppliers, consumers, and both) to efficiently provide sustainable, economic, and safe gas supply and storage (Csukas and Roland, 2021).

Smart energy systems can produce green energy by using renewable energy resources and fossil fuels together. For example, one of the most widely used natural gas and renewable energy resources produces zero-carbon energy by using them together. Smart energy systems produce more efficient energy by using two different energy resources. These systems are more efficient than the old ones. When we examine smart energy systems, we can observe a lower energy production cost.

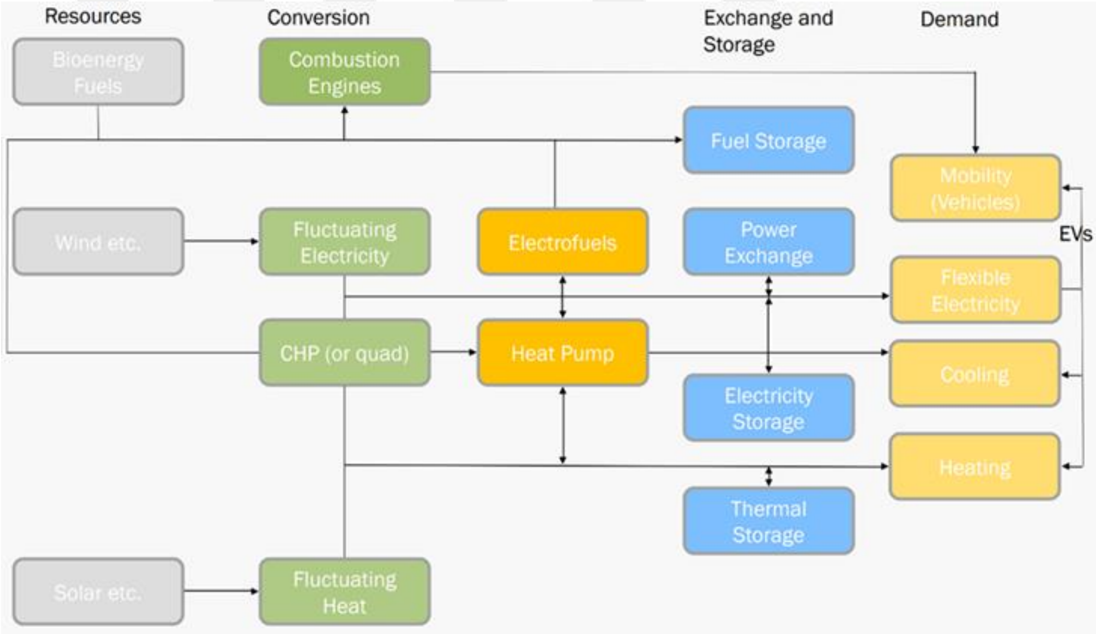


Figure 19. European Comission Energy Plan(Source: Smart Energy System, 2015)

Smart cities represent the latest stage in energy architecture, where sustainability and energy flow intersect. Due to their highly technical nature, brilliant cities are difficult to recycle. Globally speaking, heating, cooling, and operating existing buildings constitute 27% of global energy-sourced carbon dioxide emissions. Constructing new ones requires mountains of steel and massive amounts of cement, which, combined with demolition, account for 10% of the global CO2 emitted annually. Building rubble makes up one-third of the European Union's annual waste weight. Without achieving the recycling of buildings, it would be impossible to speak of a truly efficient Energy Architecture. Hence, the biggest problem is building recycling, and energy architects must focus on solving this problem first and foremost (Economist, 2022).

CHAPTER 4: ENERGY PERSPECTIVE

This section provides an explanation based on fundamental concepts about how Energy Architecture is influenced sectoral. What is ecological balance, and what benefits does it provide? How do sustainability and the economy establish a relationship? What types of energy are used worldwide, and what is the transition of these energy types? By examining the main influences leading to energy architecture, it how this has made a global impact, and, relatedly, the various ways of its implementation is explored. The effect and benefit of Energy Architecture globally will be discussed.

4.1.Ecology

Energy Architecture is a discipline that considers energy efficiency and environmental impacts by analyzing the energy confections between buildings and their environments. Energy architects utilize renewable energy sources and passive design strategies to reduce energy consumption and its environmental impact. Therefore, the relationship between energy architecture and ecological balance implies harmony and mutual interaction between human-made structures and the natural environment.

4.1.1.Ecological Balance

Ecological balance refers to a state of equilibrium that emerges from the interactions of all living organisms within an ecosystem. Each species within an ecosystem is interrelated, with factors such as resource usage, predation, and feeding habits. These interactions lead to the formation of food chains and networks among species. Changes in a species' population can directly or indirectly affect other species within the ecosystem (Bayındır and Yıldırım, 2022).

Ecological balance is critically important for biodiversity and the functionality of ecosystems in the natural world. Each species within an ecosystem contributes to the functioning of the ecosystem, ensuring a certain order and harmony among all organisms. Ecological balance is also associated with using natural resources and energy flow. Interactions among species within an ecosystem are based on energy transfer. Plants produce their food using solar energy through photosynthesis. Herbivores derive their energy by consuming plants, and carnivorous species acquire energy by preying on herbivores. This energy flow maintains the ecosystem's energy balance and forms a food web among species. Excessive increases or decreases in the population of any species can lead to energy imbalances in the ecosystem and disrupt the ecological balance.

Human activities can have significant impacts on ecological balance. Runaway production in the construction sector can lead to imbalances in natural ecosystems.

4.1.2. Ecological Balance and Architecture

Ecological balance refers to a stable equilibrium among species and ecosystems in the natural world. Human intervention often disrupts this balance, leading to environmental issues. The construction sector, in particular, has significant impacts due to its energy consumption, greenhouse gas emissions, and depletion of natural resources.

The goal of energy architects is to design buildings and other structures in ways that assist in maintaining ecological balance. This activity involves strategies such as energy efficiency, using renewable energy, applying sustainable materials, and green infrastructure. Sustainable materials reduce environmental impacts and limit the consumption of natural resources. This includes using recycled and locally produced materials. Green infrastructure aids environmental goals such as water management and biodiversity conservation. This involves using green roofs, rain gardens, and areas suitable for biodiversity. Energy architecture contributes to the ecological balance by bringing a green equilibrium to the construction sector.

4.1. Sustainability and Economy

The relationship between sustainability and the economy is increasingly gaining importance today. The connection between sustainability and the economy has become even more impactful with the emergence of Energy Architecture. There is a growing awareness of environmental issues in carrying out economic activities. Below is an explanation of how sustainability contributes to the economy.

• In the traditional economic model, the focus on resource consumption and growth can overlook environmental issues and the sustainability of resources. However, sustainability offers solutions for a more sustainable future by considering the environmental, social, and economic impacts of economic activities.

• The concept of a green economy is an approach that adopts sustainability principles and supports economic growth while combating environmental problems. A green economy creates innovative business opportunities for renewable energy, energy efficiency, recycling, and sustainable transportation. This stimulates the growth of the green job sector and contributes to resolving environmental problems while creating employment.

• Sustainable businesses lead in reducing environmental impacts and fulfilling social responsibilities. Sustainability strategies can reduce businesses' costs and increase their efficiency in areas such as energy and resource efficiency, waste reduction, use of renewable energy, and social sustainability.

• Governments implement policies and regulations that support sustainability and economic growth. These policies can focus on promoting sustainable energy sources, environmental taxes and incentives, and supporting green businesses. Also, standards and certifications related to sustainability help companies monitor and report their sustainability performance (Holdren, 2007).

Along with energy architecture, the concept of green investment has emerged. Green investments are projects carried out considering sustainability principles. Such investments carry features like environmental sensitivity, energy efficiency, and the use of renewable energy. Green buildings offer economic returns in the long run, thanks to the energy savings they provide and their low operating costs while minimizing environmental impacts.

4.2.1. Sustainable Development Target

The advancement of sustainability along with Energy Architecture has certain economic impacts. This transformation, which started with Sustainable Development, has been defined today under Energy Architecture. Sustainable development is an approach that aims to meet people's needs while considering the needs of future generations. The Sustainable Development Goals (SDGs), set by the United Nations (UN), provide a globally adopted framework. This section explains the sustainable development goals to explain the change in the sector (Üstük and Gönülal, 2021).

- *Ending poverty:* Poverty is one of the biggest obstacles to sustainable development. This goal aims to reduce income inequality and contribute to everyone's prosperity fairly and sustainably.
- *Ending hunger, ensuring food security, and supporting sustainable agriculture:* All people should have access to sufficient and nutritious food. At the same time, promoting sustainable agricultural practices should ensure the more effective use of resources by increasing productivity.
- *Promoting good health and well-being:* Good health and well-being are key components in the sustainable development process of societies. This goal aims to increase access to health services, prevent diseases, and support the sustainability of health services.
- *Providing quality education opportunities:* This goal aims to increase literacy rates, reduce inequalities, and encourage lifelong learning.
- *Achieving gender equality:* aims to promote gender equality and empower women and girls socially, economically, and politically. It also aims to end violence against women and support women to take active leadership positions.
- *Providing clean water and sanitation:* Access to clean water sources is important for health, hygiene, and sustainability. This goal is set in line with this purpose.
- *Ensure access to affordable and sustainable energy:* Aims to increase energy access, improve energy efficiency, and promote clean and sustainable energy sources.
- *Promoting economic growth, employment, and decent work*: Economic growth, increasing employment, and reducing income inequalities are targeted.
- *Promoting resilient infrastructure, industrial innovation, and sustainable industries:* Sustainable infrastructure and industries minimize environmental impacts by supporting economic growth.
- *Reducing inequalities:* This goal aims for sustainable development to be fair and inclusive for everyone (Çelebi, 2019).

The Sustainable Development Goals provide a roadmap for improving people's quality of life, ensuring environmental sustainability, and reducing social inequalities. International cooperation, political commitments, and community participation are important for achieving these goals. The Sustainable Development Goals provide a guiding vision to protect people's well-being and the planet's sustainability (Du Pisani, 2006).

4.3. International Energy Usage

The use of natural resources in Energy Architecture is anticipated in building structures. Using renewable energy sources in nature reduces carbon emissions, facilitating this balance. This section explains what these energy sources are (He, 2022).

Globally, energy sources vary. Fossil fuels (coal, oil, natural gas), renewable energy sources (solar, wind, hydropower, biomass), and nuclear energy constitute the basis of the energy supply. Energy use is a fundamental factor supporting economic growth.
From an environmental sustainability perspective, using fossil fuels leads to climate change and air pollution. Using renewable energy sources eliminates these adverse effects, creating a healthier environment.

4.3.1. Fossil Fuels

Fossil fuels are energy sources from the decay and fossilization of organic matter over millions of years of natural processes. The most common fossil fuels are coal, oil, and natural gas.

Coal: Coal is a fossil fuel formed by plant debris transforming over time under high pressure and temperature. Coal is widely used globally for electricity generation and industrial processes.

Oil: Oil is a fossil fuel formed under high pressure from organic materials located at the seabed or underground in rocks. Oil is used in transportation, energy production, and the chemical industry.

Natural Gas: Natural Gas is a fossil fuel formed from the decay of organic matter in the earth's crust. Natural gas is used in heating, electricity generation, and industrial applications.

Fossil fuels provide energy in various areas, such as electricity generation, heating, and industrial processes. Coal is usually used for electricity production. Coal is burned to produce steam, and this steam rotates turbines to generate electrical energy. Oil and natural gas are used in heating, electricity production, and industrial processes.

Fossil fuels meet a significant portion of global energy demand. According to reports from the International Energy Agency (IEA) and other energy organizations, fossil fuels still constitute a large portion of the global energy supply (Holladay, Chu and Lariviere, 2017).
However, fossil fuel use has consequences such as climate change, air pollution, and environmental impacts.

- Greenhouse gases, particularly carbon dioxide (CO2), are emitted during the combustion of fossil fuels. These greenhouse gases accumulate in the atmosphere, creating a greenhouse effect and leading to climate change.
- Air pollution occurs as a result of fossil fuel combustion. Polluted air can cause respiratory diseases, respiratory problems like asthma, and decreased air quality.
- Water pollution can occur during the production and use of fossil fuels. Oil spills can cause major environmental disasters in the seas and oceans.

The environmental impacts of fossil fuels and their limited resources have increased the shift toward sustainable energy sources. Considering the limited resources of fossil fuels and their environmental impacts, sustainability is a significant issue. The use of fossil fuels contradicts sustainability. Therefore, the usage of fossil fuels needs to transition and change. The limited reserves of fossil fuels and their environmental impacts highlight the need for an energy transition and sustainable energy sources.

Sustainability is essential for reducing fossil fuel use and transitioning to clean energy sources. Policymakers must make informed decisions on energy transition, renewable energy policies, and sustainable development goals (IEA, 2023).

4.3.2. Renewable Energies

Renewable energy sources are resources found in unlimited quantities in nature and can be constantly renewed. These resources form through natural processes or human interaction and can be used for energy production. Today, renewable energy sources hold an important place in the energy sector. When used in conjunction with sustainability, these renewable resources allow for energy production without disturbing the ecological balance, which is why they are preferred in Energy Architecture. Sources such as solar, wind, hydroelectric, biomass, and geothermal have the potential to produce unlimited and green energy (Yılmaz, 2005).

Solar Energy: Solar energy utilizes light and heat energy from the sun. Solar energy can be used for electricity generation with photovoltaic (PV) panels or heating and hot water production with thermal solar energy systems.

Wind Energy: Wind energy converts the kinetic energy of wind into electrical energy through turbines. Wind farms are typically used for wind energy production in windy regions.

Hydroelectric Energy: Hydroelectric energy generates electricity using the potential energy of water. Dams or river turbines convert the kinetic energy of water into electrical energy.

Biomass Energy: Biomass energy is the energy obtained from biological resources. Plant waste, wood, biomass plants, or biogas systems can be used for heating and electricity production.

Geothermal Energy: Geothermal energy is the energy obtained from hot sources underground. These sources are used for electricity and heat production through geothermal power plants (BP, 2021).

Renewable energy is of critical importance for a sustainable energy future. These energy sources have many advantages:

- The costs of renewable energy technologies such as solar and wind have significantly decreased in recent years. Reducing investment, production, and installation costs has made renewable energy sources more competitive. The renewable energy sector has the potential to create job opportunities.
- Renewable energy projects employ various sectors such as construction, maintenance, operations, and management.

- Renewable energy sources have the potential to use natural resources sustainably. Resources like solar, wind, and hydroelectric are constantly renewable and inexhaustible.
- Renewable energy reduces carbon emissions, unlike fossil fuels. This helps decrease environmental problems such as climate change, air pollution, and water pollution.
- Renewable energy projects can encourage local economic development. The resources used for energy production can be found in local areas and contribute to local economies (Sev, 2009).

The falling costs, employment opportunities, and energy security advantages support the growth of the renewable energy sector. Additionally, the reduction of environmental impacts and the importance of using renewable energy sources for a sustainable energy future are paramount. With advanced technology and policy support, adopting renewable energy can be widely accepted, and the energy transition can be accelerated (Simoes et.al., 2021).

4.4. Energy Transition

The energy transition is a transformation process from fossil fuels to clean and sustainable energy sources. During this process, energy production and usage are based on environmentally friendly and low-carbon sources. The energy transition is critical for combating climate change, ensuring energy security and environmental sustainability. The energy transition encompasses a broad transformation process:
Use of Renewable Energy Sources: Energy production based on renewable energy sources such as solar, wind, hydroelectric, geothermal, and biomass is preferred instead of fossil fuels. Renewable energy provides energy in an unlimited and environmentally friendly way.
Energy Efficiency and Savings: The energy transition encourages the adoption of energy efficiency and saving measures. Energy consumption is reduced with more efficient energy production and usage technologies.
Electrification: In the energy transition process, electrical energy is widely used. Electrification encourages using electricity instead of fossil fuels in transportation, heating, and industrial processes.

Energy Storage and Distribution: The energy transition involves developing new technologies for more effective storage and distribution of renewable energy. Energy storage solutions balance the supply and demand for renewable energy sources.

Transformation and Adaptation: The energy transition requires transforming infrastructure, policies, and economic structures in the energy sector. In this process, energy policies, incentives, regulations, and international cooperation play a crucial role.

The energy transition has become a global goal embraced by many countries, companies, and communities. This transformation process is critical in combating climate change and building a clean and sustainable energy future. (Cao et.al.2022)

4.5. Energy Efficiency

Energy efficiency is a strategy that reduces energy consumption and uses energy more effectively. Energy efficiency enables more efficient use of natural resources by reducing energy consumption. This enhances the sustainability of energy sources and ensures their availability for future generations. Energy efficiency reduces greenhouse gas emissions along with the decrease in energy consumption. This contributes to combating climate change and reduces environmental impacts. It leads to a reduction in energy costs. Both individuals and businesses achieve economic gains by saving on energy bills. It enhances energy security by using energy resources more effectively. The aim is to maintain a stable energy supply and reduce dependency on energy imports (Shu et.al., 2020). Various energy efficiency practices are available. Buildings: Buildings constitute a large portion of energy consumption. Well-insulated buildings ensure more effective use of energy resources. Technologies such as LED lighting, energy-efficient heating and cooling systems, and smart home automation provide energy efficiency.

Industry: Methods such as process improvements for energy efficiency, energy recovery, and optimization of energy-intensive production processes are used. *Transportation:* Measures such as more fuel-efficient vehicles, electric and hybrid cars, incentives for public transport, and bicycle lanes increase energy efficiency.

Industrial Processes: In industrial processes, energy audits, energy management systems, and energy-efficient equipment are important for energy efficiency. Energy efficiency is a way of reducing energy consumption while providing the same level of service. Energy architects use various design strategies aimed at using energy more efficiently.

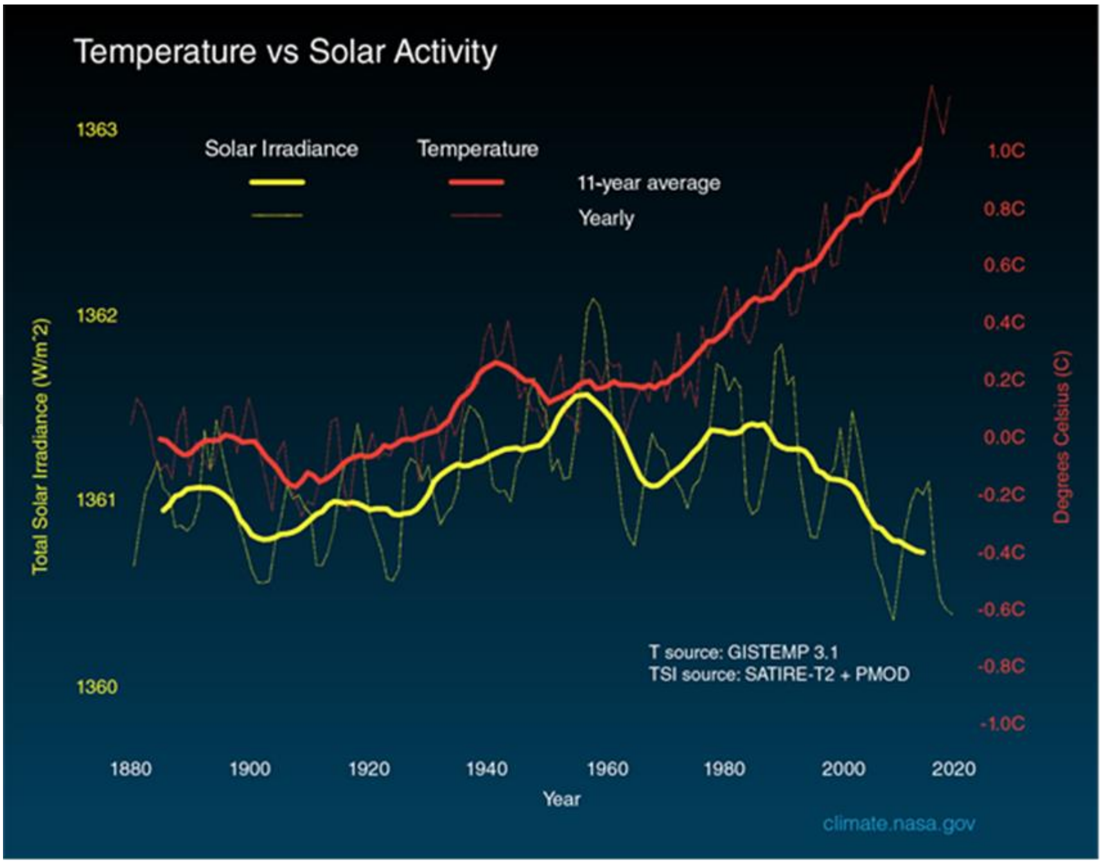
> *"Energy efficiency should follow a path that considers a broad global perspective. Energy efficiency should aim at combating climate change and reducing carbon intensity. Global, national, and local policies should be differentiated, and a pathway should be pursued accordingly" (Duman Altan and Sağbaş, 2020).*

4.6. Climate Change

Climate changes have occurred since the creation of the world. However, these changes occurred spontaneously and without disturbing the life cycle. The biggest problem of today, global warming, does not belong to this natural cycle. The atmosphere contains naturally occurring carbon dioxide and its derivatives containing carbon. These gases stabilize the air temperature by keeping the heat in the atmosphere. It ensures that the earth is at a comfortable temperature for living beings. These gases, also known as greenhouse gases, create the natural greenhouse effect in the atmosphere. With the Industrial Revolution that started in the 19th century, the use of fossil fuels increased. With the increasing population, the destruction of natural areas has been triggered. Cutting and not renewing the trees used for industrial activities caused the destruction of forest areas and the inability to convert the carbon dioxide gases released into oxygen by natural means. The rate of greenhouse gases in the atmosphere has started to increase. With the increase of greenhouse gases, more heat has started to be kept in the atmosphere. As a result of this increase in temperature, global warming has occurred. The biggest consequence of global warming is climate change (Sahin, 2022).

Table 2. Global Temperature and Solar Activity (Source:NASA, 2021)
Compares global surface temperature changes (red line) and the amount of solar energy Earth has received since 1880 (yellow line) in watts (units of energy), according to 2021 Nasa data. Lighter/thinner lines show annual levels, while heavier/thicker lines show 11-year average trends. Eleven-year averages reduce natural noise year-over-year in the data, making the underlying trends more obvious. The amount of solar

energy Earth receives has followed the Sun's 11-year natural cycle of minor ups and downs with no net increase since the 1950s. During the same period, global temperature increased significantly. Therefore, it is doubtful that the Sun is causing the global temperature warming trend observed in the last half-century.

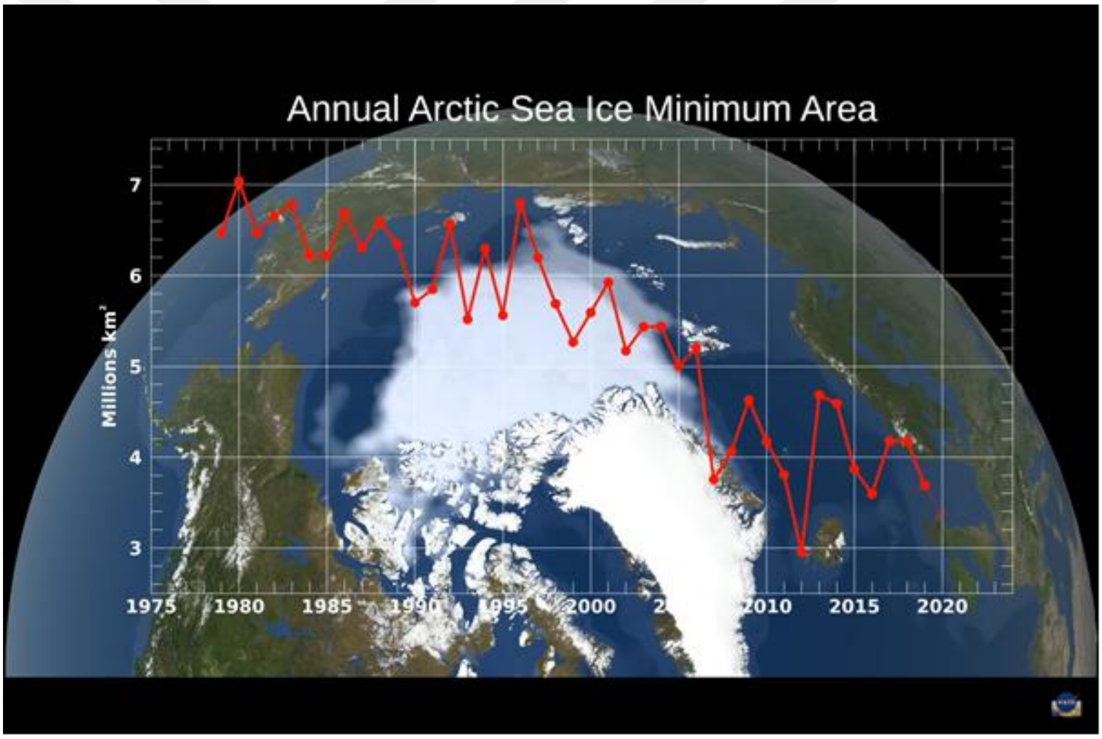


As a result of climate changes, certain changes have occurred on Earth. The first of these is global temperature rise. The average surface temperature has increased by 0.8 degrees in the last century. This means the warmest century of the last millennium. According to the fourth evaluation report of the Intergovernmental Panel on Climate Change (IPCC), it is predicted that the average temperature values in the world will increase between 1.8 – 4.0 C^0 by 2100 (NASA, 2021).

The result of the greatest temperature change is the rapid melting of glaciers. Although the world has experienced sudden temperature changes, this has happened within its natural life cycle. This increase does not belong to the natural life cycle. After the increase in temperature in the last century, land and sea ice in the poles and mountain glaciers in the middle latitudes have decreased in volume and area. Melting glaciers rapidly increased the volume of water in the seas and oceans.

This ratio is 2mm in all water areas. This increase in the volume of all brine per century also causes an increase in water temperature. As a result of this increase in the amount of water, soil losses have occurred in the coastal areas.

Table 3. Annual Arctic Sea Ice Minimum Area (Source:NASA,2021)
* NASA/Goddard Space Flight Center Scientific Visualization Studio /
The Blue Marble data is courtesy of Reto Stockli (NASA/GSFC). (4)
Satellites have been continuously monitoring changes in Arctic ice since 1979. Thanks to these satellite images, the loss of volume in the north pole glaciers can be seen. With a graph overlay, this visualization shows the annual minimum width of Arctic sea ice each year from 1979 to 2020.



The effect of this temperature increase on living things and on nature is great and controversial. With the melting of the glaciers, the glacial ecosystem and the living ecosystem will be adversely affected. Creatures that cannot survive above this temperature will become extinct and leave the ecosystem. The increase in water level causes floods and puts habitats in danger. All these prompt the danger of destroying the ecosystem by shortening the earth's life span. The effect of all these climate changes shows that the natural life cycle is irreversibly deteriorating. In order to prevent this and extend the life span of the world, renewable resources should be used in many different areas, and these resources should be evaluated well.

Climate changes have enabled the world to act with the logic of renewable in all production areas. One of the steps taken to keep the natural ecosystem alive with sustainable energy and to minimize the consequences of climate change is in the field of architecture. This architectural formation, called sustainable architecture, seeks answers to the questions of how efficient the building is and whether its use does not harm the environment. The Environmental Protection Agency (EPA) defines a green building as a building created to limit the negative effects on human and environmental health by effectively using energy resources and reducing the elements that emit pollution. Green buildings are a new architectural approach created by sustainable architecture. Green buildings use all resources efficiently and cause the least damage to nature. It tries to exist harmoniously in nature.

Energy architecture is a new concept that has emerged in recent years. According to master architect Çelik Erengezgin,

> *"Energy Architecture; To get rid of all kinds of addiction, to protect the ecological balance, in short; It is the only way to "survive and survive," that is, "sustainable life." "Energy architecture includes sustainable building and its building blocks. In other words, its difference from sustainable architecture is that it has a more inclusive structure. Energy architecture encompasses the building and the sustainability of all building elements. The aim is to design buildings that can stand with their energy and heat without harming the environment. The building must maintain its heat balance and use renewable energy to achieve this. Architectural structures, whose functionality is at the forefront without disturbing the ecological balance, form the basis of energy architecture. Energy architecture aims not to disturb the balance of the building and the constructed area in the material, energy, and building ecosystem (Erengezgin, 2015).”*

4.7. International Agreements for Energy Architecture

International agreements facilitate the energy transition in Energy Architecture by increasing the use of green energy. While many conventions are worldwide, the most important ones are the Brundtland Report, the Stockholm Convention, and the Paris Climate Agreement. These agreements have changed energy consumption globally by facilitating the energy transition on a global scale.

4.7.1. Brutland Report

The Brundtland Report, officially known as "Our Common Future," was published in 1987 by the World Commission. This report is considered one of the main documents that propagate the idea of global sustainable development. The World Commission, led by Gro Harlem Brundtland, former Prime Minister of Norway, was established by the United Nations in 1983. The purpose of the Commission was to develop an understanding of environmental and development issues. The report prepared by the Commission later became known as the Brundtland Report (WCED, 1990).

The Brundtland Report defines sustainable development as "meeting the needs of today without compromising the ability of future generations to meet their own needs." This definition advocates that economic development, environmental protection, and social equality can coexist, and it argues for the preservation of the Earth for generations to come.

This report was one of the first large-scale initiatives to emphasize the connection between environmental protection and economic development, and these concepts have become significant in many policy and strategy formulations worldwide (WCED, 1990).

4.7.2 United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is the first intergovernmental environmental agreement signed under the auspices of the United Nations to address global warming. The Convention acknowledges the dangerous impacts of anthropogenic environmental pollution on the climate, aiming to reduce the proportions of greenhouse gases in the atmosphere and minimize their adverse effects to maintain them at a certain level. In line with these aims, it establishes general principles, action strategies, and responsibilities of countries. Although the Convention is significant as the first intergovernmental environmental consensus on climate change, its enforcement power needs to be stronger, with signatory countries supporting the Convention on a good faith basis. The Kyoto Protocol, signed in 1997 under this Convention, contains more concrete objectives. (United Nations Climate Change, 2023)

4.7.3. The Kyoto Protocol

The Kyoto Protocol is the sole international framework to combat global warming and climate change. It was signed by the United Nations Framework Convention on Climate Change (UNFCCC). Countries that have signed this protocol have committed to reducing carbon dioxide and greenhouse gas emissions. According to the protocol, countries must reduce greenhouse gas levels to normal. The protocol was signed in 1997 but did not come into effect until 2005. This is because, for the protocol to be enacted, the carbon emitted into the atmosphere by the ratifying countries in 1990 needed to reach 55% of the total global emissions, a threshold that was only reached eight years later with the inclusion of Russia. The protocol stipulates that the amount of greenhouse gases released into the atmosphere will be cut by 5%.

A range of initiatives will be implemented, including heating with less energy, traveling long distances with less energy-consuming vehicles, and integrating less energy-consuming technology systems into the industry. Environmentalism will become a fundamental principle in transportation and waste disposal. Alternative energy sources will be pursued to reduce the amount of methane and carbon dioxide released into the atmosphere. Waste processes in high-energy-consuming businesses such as cement, iron-steel, and lime factories will be restructured. Thermal power plants will introduce systems and technologies that emit less carbon. The use of solar energy will be prioritized. All these items encompass the fundamental principles of energy architecture. The production of more environmentally friendly materials has accelerated. With the advancement of technology, the production of recyclable architectural materials at appropriate standards has begun (Najarzadeh et.al., 2021).

4.7.4. The Stockholm Convention

The Stockholm Convention, officially titled "The Stockholm Convention on Persistent Organic Pollutants," is an international environmental agreement regulating the production, use, and release of specific persistent organic pollutants (POPs) that can harm the environment and human health. The Convention was opened at the United Nations Conference held in Stockholm, the capital of Sweden, on 22 May 2001 and entered into force in 2004 (Turkish Republic Ministry of Foreign Affairs, 2023).

POPs are chemical substances that can harm human health and the environment, are slow to degrade, can be transported over long distances, and can accumulate in ecosystems. The Stockholm Convention provides an international framework for minimizing or eliminating the adverse effects of these substances. The Convention initially targeted 12 POPs, also known as the "Dirty Dozen." These substances include pesticides (like DDT), industrial chemicals (like polychlorinated biphenyls or PCBs), and by-products (like dioxins and furans). However, the Convention can include more pollutants in light of new scientific data. The Stockholm Convention encourages tools such as information sharing, technology transfer, and capacity building to help states effectively manage these pollutants. The agreement also supports the alternatives to these pollutants and their safe use and disposal.

The Stockholm Convention is a significant international effort to protect human health and the environment from the adverse effects of persistent organic pollutants. The Convention forms part of a series of environmental agreements constituting the bridge between science and policy and facilitating progress toward global sustainability goals (Turkish Republic Ministry of Foreign Affairs, 2023).

4.7.5. The Paris Climate Agreement

The Paris Climate Agreement is an international accord adopted by countries party to the United Nations Framework Convention on Climate Change (UNFCCC) and accepted during the 21st Conference of the Parties (COP21) held in 2015. COP21 took place in Paris, the capital of France, from November 30 to December 12, 2015. The Paris Agreement provided a framework for countries to coordinate their efforts to combat climate change.

The Agreement's main objective is to keep the global average temperature increase well below two °C compared to pre-industrial levels and to strive towards limiting the temperature increase to 1.5°C. These targets guide efforts to minimize the risks and impacts associated with climate change. Other significant aspects of the Paris Agreement include a financing mechanism to support developing countries in addressing the effects of climate change and enhancing climate resilience. The Agreement stipulates that developed countries should support developing countries in their fight against climate change and transition to a low-carbon economy.

The Paris Climate Agreement forms the global framework for the fight against climate change. Climate change is a global issue with profound effects on environmental, economic, social, and political systems. Therefore, the Paris Agreement acknowledges that actions related to climate change require a comprehensive and multilayered approach (Knez, Štrbac and Podbregar, 2022).

The Paris Climate Agreement recognizes the role of governments, the private sector, civil society, and individuals in combating climate change. The Agreement emphasizes that all these actors must play active and significant roles in the fight against climate change.

4.7.6. In Turkey

Turkey has signed various climate agreements and has adopted the legal regulations stipulated by these agreements. Globally, Turkey has signed the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Climate Agreement. Turkey became a party to the United Nations Framework Convention on Climate Change on May 24, 2004. With this, the opportunity for work on financing needs, capacity building, financing, and technology transfer in Turkey's fight against climate change was established. Turkey joined the Kyoto Protocol according to Law No. 5836, published in the Official Gazette No. 27144, on February

17, 2009. The most recent Paris Climate Agreement was ratified with a decision dated October 6, 2021 (Grand National Assembly of Turkey Law, 2009).

All these agreements have resulted in using recycled materials in energy architecture. It has become a requirement for the carbon emissions of buildings to be zero. Buildings' heating and insulation systems have begun to be made with renewable energy sources. Although these regulations are not implemented throughout Turkey, they have been established as new objectives (Özışık, 2019).

4.8. Green Jobs

The advent of the Industrial Revolution initiated a new era worldwide, along with the creation of new employment opportunities. Since the dawn of the Industrial Revolution, fossil fuels have been considered the primary energy source until the early 21st century. According to recent research, it has been determined that these primary energy sources can no longer be used extensively. The main reason for this is the carbon gases emitted by fossil fuels. These carbon gases, released into the environment, have caused global warming by increasing air temperature. Another significant factor is that fossil fuels are finite. Hence, the search for alternative energy sources has begun. The outcome of this search has been the discovery of new energy sources, known as renewable energy sources. As their name suggests, these energy sources found in nature are unlimited. Due to this alternative search, the emergence and distribution of renewable energy sources have become subjects of different sources. One of these is green jobs. Renewable energy sources have affected all sectors, creating new job opportunities. As the name suggests, green jobs prioritize sustainability, like the green economy and renewable energy sources (Dell'Anna, 2021).

The fossil fuel market is impacted day by day. Renewable energy sources, whose usage and investment areas increase daily, have become more effective. Renewable energy sources are becoming the primary energy source. Along with using renewable energy sources, emerging green jobs gave a new reason for these investments. With the world's increasing population, finding a job is becoming more challenging daily. Green jobs attract investors' attention with the new employment opportunities they provide.

It has become an essential step to ensure the requirements of the European Union Commission and the Paris Agreement signed in 2015. Due to these reasons, the fossil fuel market has started to lose its primary importance. This research was conducted to examine its impacts and discuss the results. Although we observe the effects on the fossil fuel market, we have yet to have a clear result (Knez, Štrbac and Podbregar, 2022).

The concept of green jobs emerged alongside the sustainable energy market. The concept of green jobs is directly related to the green economy. The use of sustainable energy sources is classified within the green economy. The United Nations Environment Program (UNEP) defines the green economy as economic activities that significantly reduce environmental risks and ecological scarcity while ensuring humanity's well-being and social equality. Green jobs and the green economy are inclusive approaches prioritizing ecological sensitivity, social welfare, and social equality. Increasing energy efficiency with green job opportunities in various sectors, reducing greenhouse gas emissions, and minimizing pollution are primary goals. The employment created by the green economy aims to reduce environmental risks in all job fields. It protects against the factors of potential climate change. These economic activities' common points are low carbon, resource efficiency, and socially inclusive activities. The increase in income and employment provided by the green economy primarily depends on being supported by public expenditures, political reforms, and regulations. Within this scope, the public and private sectors must invest together in activities to prevent the loss of ecosystem services and biodiversity, increase resource and energy efficiency, and reduce carbon emissions and pollution (Gunaydın, 2015).

With the emergence of the concept of green jobs, it was observed that investments in the sustainable energy market also started to increase. The use of fossil fuels, linked to climate change, decreased with the advent of green jobs. Green jobs, seen in countries' economic development packages, reduced the orientation towards fossil fuels (Yılmaz, 2014). They imparted momentum to the sustainable energy market. Therefore, green jobs increase demand for the sustainable energy market. They also revitalized the green economy with the new job opportunities they provided. The Paris Agreement, signed in 2015, prioritized the goal of zero carbon by 2050. Accordingly, sustainable energy sources should become the primary source of consumption. Green jobs are contributing to this (Valujeva et.al., 2021).

The fossil fuel market has been one of the most affected sectors by green jobs. Although the impacts are not apparent with current data, we will see these effects worldwide by 2050. This research paper illuminates this question. According to the BP energy report, fossil fuels were used at an average rate of 64% in electricity production in Europe in 2009. By 2018, this rate had dropped to 40%. This decline continued until 2019. Until the beginning of the Covid-19 Pandemic in 2019, the use of renewable energy sources was increasing. However, new research after the pandemic showed a rise in fossil fuel use. The primary reason for this was its cheap and easily accessible nature. The fossil fuel market began to cover 88% of electricity as of 2022. The increase of this ratio, expected to decrease, poses a new threat against global warming. Therefore, reducing fossil fuel use became a priority. The concept of green jobs, emerging at this point, aims to reduce demand for fossil fuels with the new job opportunities it provides.

Fossil fuels have been the primary energy source since the Industrial Revolution. The most significant cause of problems arising from global warming is the use of fossil fuels. Until 2019, the increasing demand for sustainable energy sources reduced the use of fossil fuels. With the Covid-19 pandemic, economies worldwide experienced collapses. This issue led to an increase in fossil fuel use. Its cheap and accessible nature supported this. Green jobs, emerging with the development of the green economy, provide new job opportunities, and this increased demand and investment in the renewable energy market. With the concept of green jobs, the demand for the fossil fuel market began to decrease. In the next 20 years, it will be seen how green jobs negatively affect the fossil fuel market. In this way, sustainable energy sources will become the primary energy source. The contributions and benefits of green jobs to the zero-carbon action plan will become more clearly understood.

CHAPTER 5: CONCLUSION

In this section, we will be observing examples of New Energy architecture. It will discuss how buildings that can serve as examples in the 21st century are constructed, at which stages they provide examples, and under which conditions they are unsuitable. At the end of this research thesis, the reasons and the relationships of why and how will be determined.

5.1 Examples of Energy Architecture

5.1.1. Sun Houses

The "Sun Houses," designed by Architect Çelik Erengezgin, exemplify the principles of Energy Architecture. The first example, located in Diyarbakır, appears to resemble a traditional home design in its form, but in reality, it is a design that generates its own energy. Energy Architecture aims for buildings to generate the energy necessary for their own life cycles. "Energy architecture anticipates buildings using energy at the natural and modest scale of breathing" (Erengezgin, 2007).

Figure 20. Sun Houses, Diyarbakir (Source: Bianet, 2007)

Technical Specifications: The house has a 66m2 closed ground floor area. It includes a 16m2 greenhouse, 21m2 mezzanine floor, and a 9m2 attic storage area. It is designed as a small house without a bathroom. This basic design, which can grow modularly up to 150m2, is a prime example of Energy Architecture. The lower ground floor has been designed as a meeting room. The kitchen has an energy design that generates its energy. The mezzanine floor has been planned as a working office. The Sun House also falls into a laboratory category because it continuously shares its energy production methods with the world. A greenhouse on the south-facing side, receiving sunlight, can grow all the necessary food supplies.

Materials: The building is constructed from wood, which causes minimal environmental harm, thus enhancing sustainability. The walls use insulation materials made from a pulp of cellulose and boron compounds. The interior of the house uses a plasterboard and a special plaster. This plaster is produced by combining perlite with an organic binder on fibrous chipboard. This plaster is one of the world's first and most pioneering solutions with its water and heat-insulating yet vapor-permeable structure. All these materials are derived from the earth. The kitchen materials are sourced locally to suit the region and minimize transportation costs. Wet surfaces include locally sourced basalt and marble. The necessary electronic appliances are chosen from the most energy-efficient options. The electronic equipment is grounded to prevent electrical leaks into the environment, effectively neutralizing any adverse environmental impact.

Lighting: Energy-saving bulbs that provide daylight and LED lighting are used in the house. The window openings in the house's facades ensure natural daylight throughout the day.

Water Consumption: Special water heads prevent excessive water consumption from the taps. This increases the air volume without reducing pressure, thereby achieving water conservation. The hot water heated in the solar collectors on the roof is used both as domestic water and for indoor floor heating. Although the water sources around the house are adequate, the house stores excess water for garden irrigation, ensuring a continuous water cycle.

Energy Production: The kitchen contains a solar stove that uses solar and hydrogen energy. There are 16 80-watt solar panels and four solar collectors on the 40-degree sloping south roof of the house. The electricity generated during sunny hours is converted into hydrogen via an electrolyzer and stored under compression. During the night, the hydrogen stored during the day is converted back into electricity or heat through fuel cells or a hydrogen-burning boiler.

Heating-Cooling: The greenhouse area remains warm throughout both winter and summer. Sunlight from here enters the house through a vent created in the indoor area, immediately heating the house. When the vent in the upper floor is opened, cool air from the north cools the house. The vines in this area are leafy in the summer, ensuring the wind from the facade is cool. If the air is cold in the summer, the external vent is closed to warm the space. The glass walls used on the east, south, and west facades also generate energy with the same design. The cast body fireplace heats the air from the underground, which is an average of 15 degrees, fluctuates by +- (5) degrees, and distributes it throughout the space (Erengezgin, 2007).

5.1.2. Makoko School

The Makoko Floating School is a dynamic architectural system situated in Makoko, a community in Lagos – the second most populous city in Africa, intimately interwoven with the lagoon. This floating structure school can adapt to tidal changes and different water levels, thus presenting an exemplary case of energy architecture. The modular system of the Makoko Floating School can be implemented in varying sizes and forms. Sponsored by the United Nations Development Program (UNDP) and the Heinrich Boell Foundation in Germany, this project by NLE Architects represents the first phase of a three-stage development that would evolve into a floating community of interconnected residential units. The second phase involves applying this module to individual homes, while the third phase anticipates forming an architectural floating community.

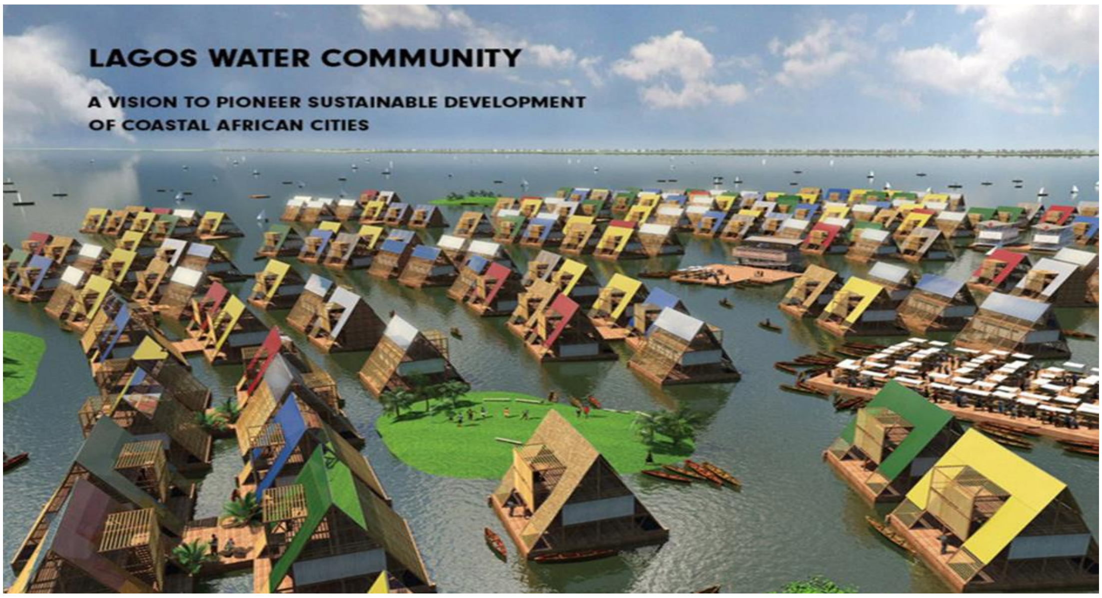


Figure 21. Lagos Water Community ,2013 (Source: Archdaily, 2013)

However, necessary steps to ensure sustainability are still under discussion. Due to safety concerns, the school was abandoned in March 2016 and collapsed in a storm in June 2016. Subsequent iterations have been proposed. Because it diverges from traditional architecture, sufficient funding must be secured, which signifies a challenge to be addressed within energy architecture. Even though the structure complies with the principles of energy architecture, it was not continued due to a lack of sustained sustainability (Riise and Adeyemi,2015).

In 2016, the second iteration of the Makoko Floating School, named Makoko Floating School II (MFS II), was showcased at the Venice Architecture Biennale. The third iteration, MFS III, was exhibited in 2018. Located in Bruges, Belgium, MFS III aims to redesign the floating school to be structurally stronger, claiming a lifespan of 25 years (NLEworks, 2018).

Figure 22. Mokoko Flooting School (Source: Archdaily, 2013)

Technical Specifications: The building comprises of three levels. The first level provides an open playground for recess, functioning as a gathering area for the community after school hours. The second level is an enclosed space housing classrooms that serve 60 to 100 students. A continuous stairway along the edge connects the third level's open playground, classrooms, and semi-enclosed workshops. The constructed pyramid has a height of 10 meters, with a base dimension of 10m x 10m.

Given the proximity of the center of gravity to the base, which enhances stability and wind resistance, the frame possesses an ideal form for a floating object. The structure is capable of carrying 100 adults even under challenging weather conditions.

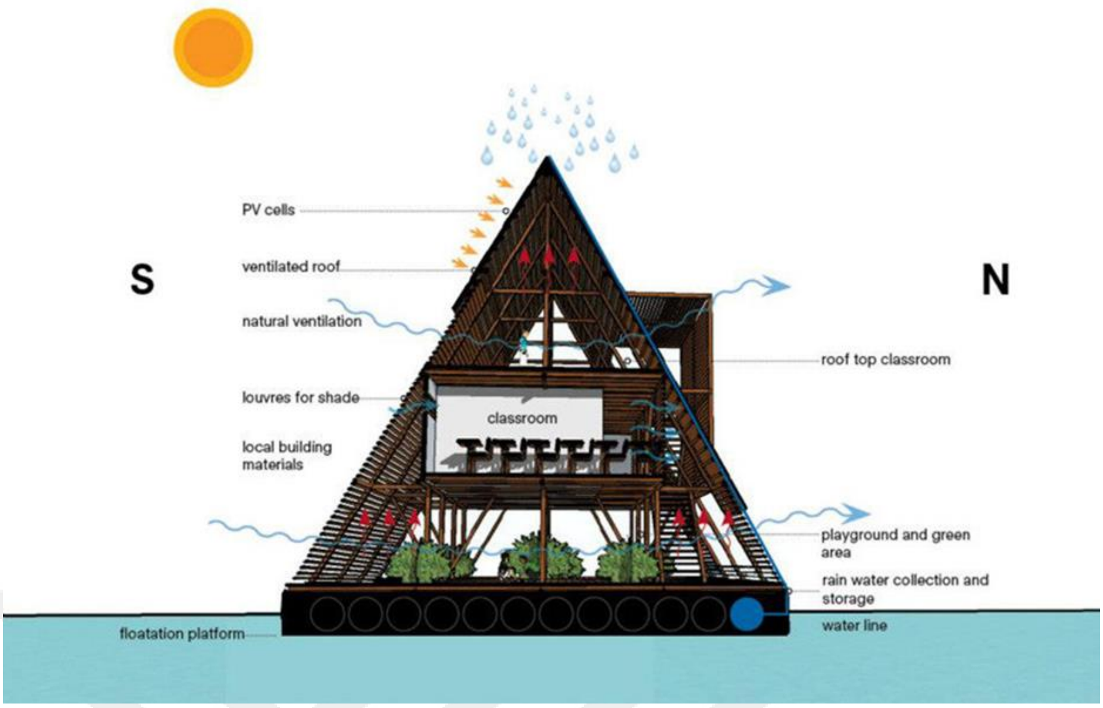


Figure 23. MFI Technical Isuues (Source:Archdaily, 2013)

Materials: Local wood is used as the primary material. Predetermined as the main material, wood is used inside the school for support and finishing. The overall composition of the design follows a triangular A-Frame section. Classrooms are located on the second floor, surrounded by public green spaces. The structure rests on conventional plastic barrels.

This simple solution reflects a reuse of readily available materials capable of providing multiple uses. Non-biodegradable plastic is recycled and used in construction.

Lighting: Natural sunlight is utilized for illumination. Electricity generated from solar panels on the roof provides night-time lighting.

Water Consumption: A rainwater storage system on the roof facilitates water supply barrels on which the building floats, especially those at the edges, are used for water storage.

Energy Production: Solar panels applied to the roof enable electricity production.

Heating-Cooling: The building's climatization is naturally achieved. Through the openings of windows and doors, heating and cooling are provided. The regional climate facilitates such passive climate control.

Figure 24. MFI Materials (Source: Archdaily, 2013)

Figure 25. MFI Light Direction(Source: Archdaily, 2013)

Figure 26. MFI Energy Generation (Source: Archdaily, 2013)

5.1.3. Shigeru Ban Disaster House

Following the 2011 earthquake in Japan, Shigeru Ban installed a system of 1,800 paper partition units in gathering areas to maintain privacy among families. Renowned as a master of temporary architecture and often referred to as the "First Responder of Architecture," Ban has been designing simple structures built from inexpensive, locally sourced materials for over 20 years to aid natural and artificial mass displacement and disaster victims. These systems have been used to construct temporary housing units. These emergency shelters, being modular, can be set up immediately. These temporary residences serve as examples of Energy Architecture (Bulut and Gurani, 2018).

Figure 27. Shigeru Ban Disaster Houses Outside View 1 (Source: Ro, 2017)

Figure 28. Shigeru Ban Disaster Houses Outside View 2 (Source: Ro, 2017)

Materials: The use of paper tubes is seen in this design. Utilizing paper tube technology, he designed his projects to be easily dismantled and transportable. The building materials used in these structures can be reused, thus becoming building materials again. In this project, paper tubes form all the structural and interior elements. These houses can be entirely reconstructed. The same materials are used for reconstruction.

Lighting: Natural daylight performs the function of illumination.

Water Consumption: Natural resources found in the vicinity are used.

Figure 29. Shigeru Ban Disaster Houses Inside View (Source: Ro, 2017)

Environmental Management: Environmental factors are the most important factors in these designs. This ensures that the design is renewable and transferable to future generations. Design applications with accessible and economical materials fall into the green building category. Some of Ban's designs, such as the refugee camp in Turkey, have also been transformed into permanent structures (DacIstanbul, 2015).

5.1.4. Eastgate Centre

The East Gate Center in Zimbabwe is an office building designed by architect Mike Pearce in Harare. Harare has a temperate climate, with temperatures between 10 and 14 °C. As such, the region is suitable for passive climate control systems. The building was opened in 1996 and is the first unregistered example of Energy Architecture. With its natural climate control, energy usage is kept at a minimum. The building represents the first step in contemporary Zimbabwean architecture, combining traditional Zimbabwean stone construction with modern brick and glass elements.

Figure 30. View of Eastgate Center, Zimbabwe (Source: Living Spaces, 2018)

Technical specifications: The building serves as an office and a shopping center. It contains 5,600 m² of retail space, 26,000 m² of office space, and a parking lot for 450 cars. It utilizes 19th-century modernist cage steel craftsmanship technology. The building structure comprises a glass suspension bridge, a glass roof, and local stone walls. An atrium on the intermediate floor ensures easy transportation between office floors via an elevator. The elevators are connected to a glass walkway covering the atrium on the second level. The center of the air path connects to the street level via escalators where the street exits to the city.

Materials: The building has a cradle roof with 48 brick chimneys to vent exhaust air from the offices. Under the office floors, there is a hanging floor plant room behind a cross-striped screen, along with 32 low and high-volume fans that draw air from the atrium through filters.

Energy production: Zimbabwe is a hot country, and artificial climate control can be costly. Termites in Africa ventilate their nests by creating passive cooling.

"High mounds contain conductors that release air from the top and sides while the

mound is designed to capture the breeze. With the help of termites that modulate the tunnels to control airflow when the wind blows, the hot air from the dominant rooms underground is drawn out of the structure" (Tekin and Kurugöl,2011).

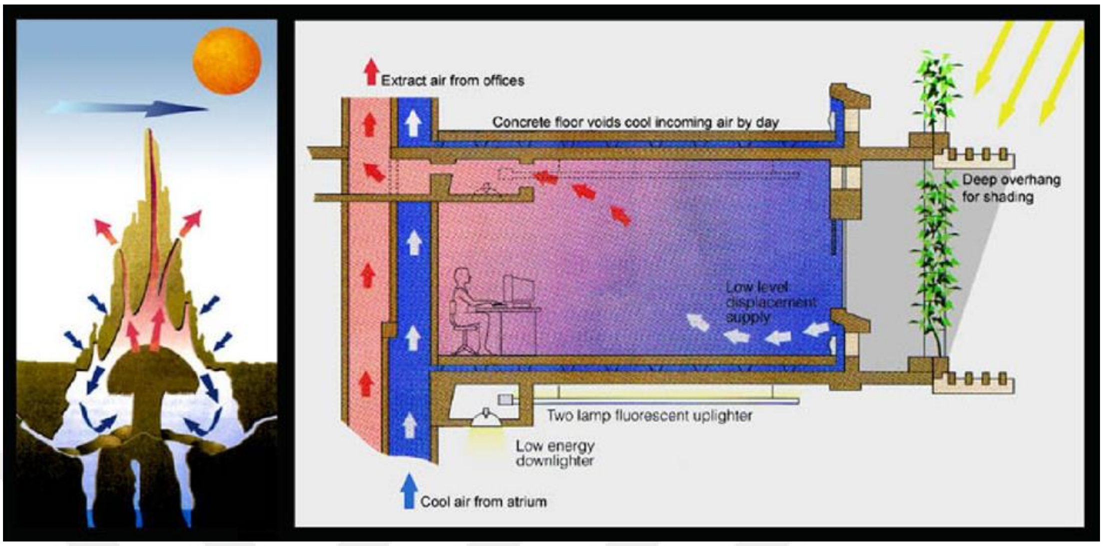


Figure 31. Similarity of Eastgate and Termite (Source: Living Spaces, 2018)

In architecture, the passive cooling system, inspired by the 'self-cooling termite mounds' on the continent, is an excellent example of biomimicry. "Passive cooling works by storing heat during the day and releasing it throughout the night" (Living Spaces, 2018).

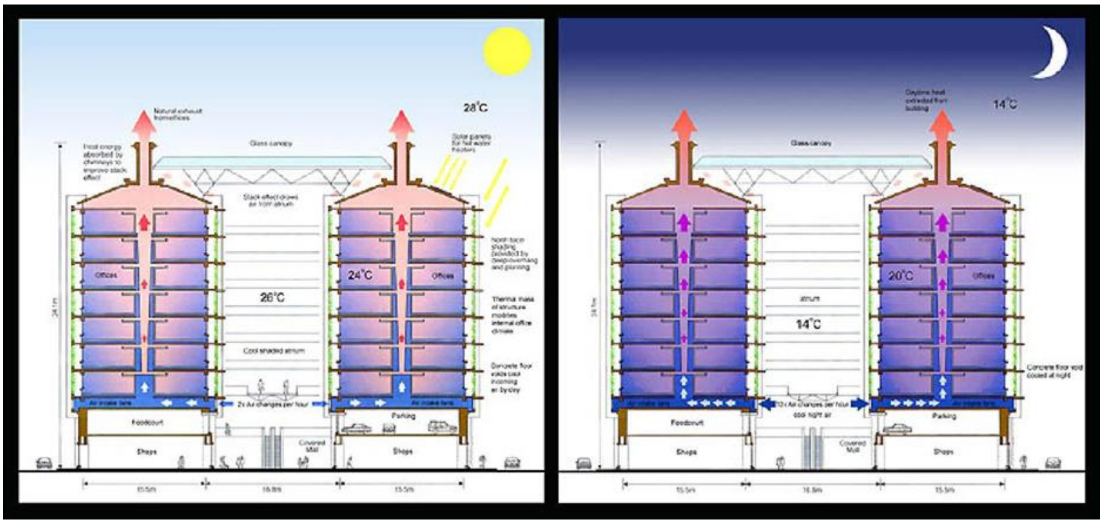


Figure 32. Ventilation of Eastgate (Source: Living Spaces, 2018)

The temperature of the building is cold at the beginning of the day. As the day goes on, heat from the sun, machines, and people is absorbed by the fabric of the building. Since the heat capacity of the materials is high, the temperature inside does not rise significantly. When the outside temperature starts to fall, the warm indoor air rises and is expelled through the chimneys on the roof using fans. As a result, cold air is brought in from below the building. This activity continues throughout the night until an ideal temperature is reached (Livin Spaces, 2018).

Climate control; deep eaves are used for shading from the high summer sun while allowing low winter sun rays to soften the interiors. Adjustable overlapping and deep precast concrete protruding windows regulate sunlight inside. Protruding stone elements (protrusions) also increase the outer surface area for increased heat loss at night and minimize heat gain during the day. Precast concrete, brushed to reveal the underlying granite aggregate, matches the lichen-covered rocks of the region's wild landscape.Horizontal protruding overhangs are interrupted by steel columns supporting green ivy.

Figure 33. Interior View of Eastgate Center (Source: Ansari, 2022)

The Eastergate Center uses 50% less energy than buildings that use artificial climate control systems, thanks to its passive cooling system. As a result, the offices are less costly, which translates into a much more affordable rental fee.

5.1.5 Robinson Tower

In 2014, due to Singapore's landscape replacement policy, the appearance of buildings changed, with the Robinson Tower being one of the first examples. If a building destroys green space during construction, it must incorporate an equivalent amount of green space. Although these towers are associated with sustainable architecture, the landscape design they utilize to minimize environmental damage can be interpreted within the scope of energy architecture.

Figure 34. Robinson Tower Outside View (Source: Abdel, 2018)

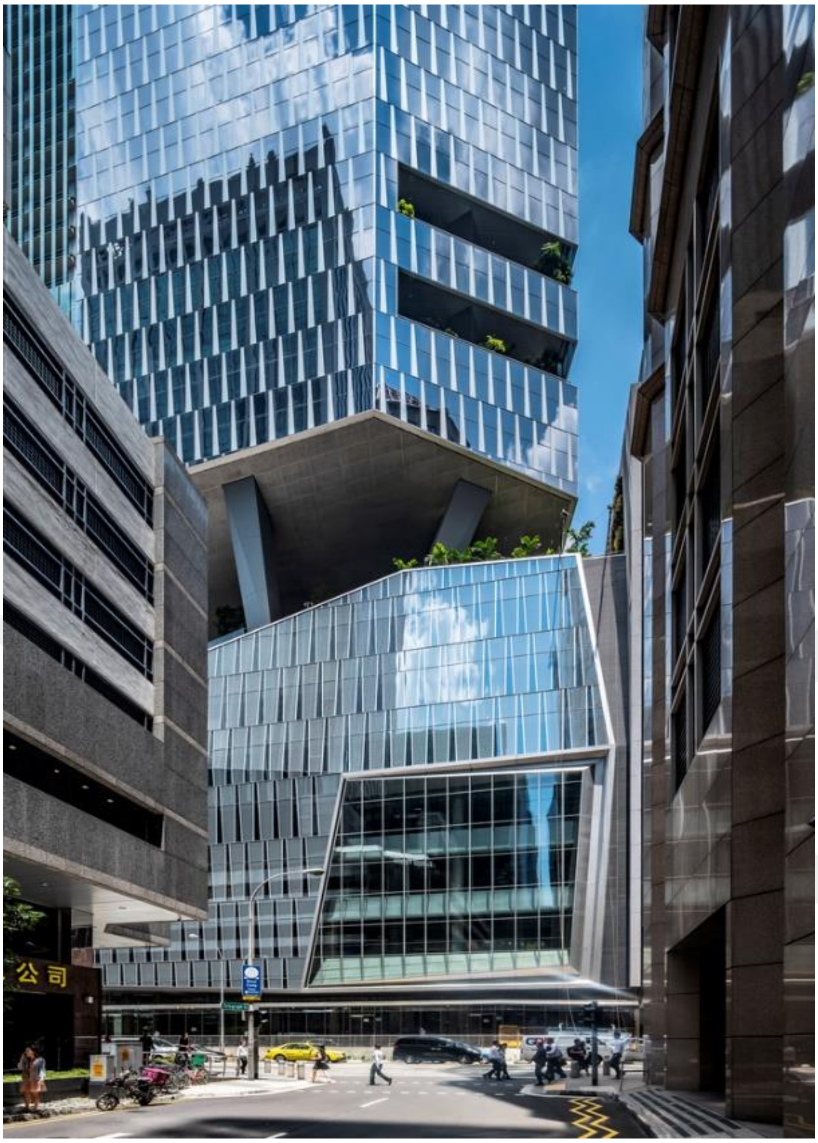


Figure 35. Robinson Tower V Shape (Source: Abdel, 2018)

Technical Specifications: The Robinson Tower is a boutique retail and office tower spanning 24,000 m². The structure alters the city's skyline and is defined by the constraints of a V-shaped system, thus splitting the building into two different structures. A marina is formed with a platform located on the roof of the terrace area at ground level, which allows for the utilization of natural lighting. It is a 20-story office building.

Materials: The building uses traditional architectural building materials like iron and steel.

Lighting: Due to its long and vertical structure, it directly receives sunlight across all floors. However, it uses energy-efficient LED lights in the evening.

Energy Production: It uses modern air-conditioning systems, suggesting an environmental approach to energy production.

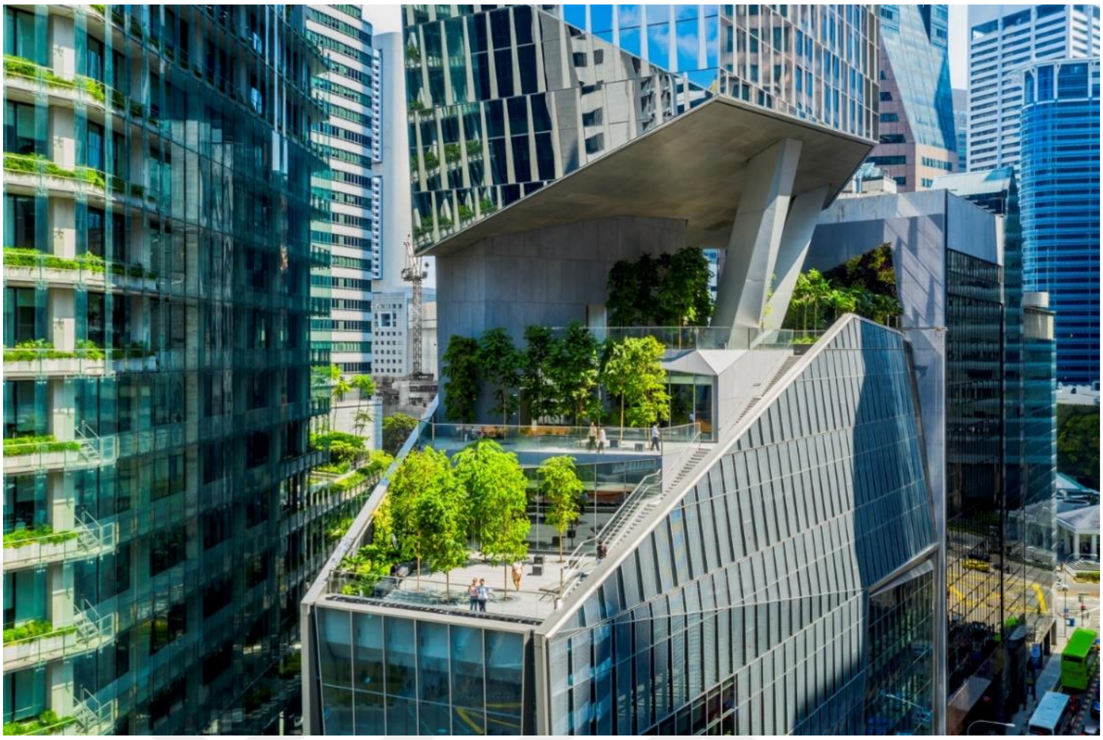


Figure 36. Robinson Garden View (Source: Abdel, 2018)

Figure 37. Robinson Tower Interior Garden (Source: Abdel, 2018)

The Robinson Tower has been examined within the context of energy architecture. It can be considered an example of energy architecture because it recovers the green spaces it destroys within its structure. However, it is not an optimal example as it needs to consider sustainability regarding energy production, air conditioning, and lighting (Harrouk, 2019).

5.2 Analysis

This academic thesis explain about energy architecture also five different examples collects in world data and this examples shows energy architecture. Energy architecture applications in different parts of the world are examined in the table below.

Table 4. Analysis of Energy Architecture Samples

	Culture	**Limeted Space**	**Law**	**Economy**	**Poverty**	**Natural Disaster**	**Climate**
1				+			+
2	+				+		
3	+					+	
4							+
5		+	+				

Example 1 : Sun House

Example 2 : Makoko School

Example 3 : Shingeru Ban Disaster House

Example 4 : Eastgate Center

Example 5 : Robinson Tower

According to this table, the purpose of the selected examples varies in each region. The first example is the Sun House, an award-winning design by architect Celik Erengezgin, which brought forth the concept of energy architecture. The Sun House was initially constructed in Diyarbakır, Turkey. The application purposes of this solar house fall under the categories of economy and climate. Diyarbakır, Turkey, receives the highest amount of sunlight, making it suitable for efficient solar energy utilization. The solar panels on the roof of the Sun House convert this solar energy into electricity. Since the region's climate is favorable, renewable solar energy is utilized as a sustainable energy source. The building stores solar energy and generates its electricity, thus consuming less energy and proving to be economically efficient.

The second example is the Makoko Schools, chosen as an energy architecture application. The purpose of this application is categorized under poverty and culture. It refers to the school system for the population living in the Makoko area of Lagos, Nigeria, which resides in a community of interconnected buildings on water, resembling a movable building system akin to a boat. Living near water is a cultural element in this region. Additionally, the economic income level of the population is not very high, which has facilitated energy architecture applications in the area.

The third example is the Shigeru Ban Disaster House, designed by Shingo Ban in Japan after the earthquake in 2011. This structure was made from recycled paper. The building consists entirely of paper tubes and represents Japan's traditional housing style, making it culturally significant. Furthermore, the design aimed for ease and practicality in construction after a natural disaster. Thus, the structure was designed with cultural and natural disaster-related factors in mind.

The Easgate Center, a Zimbabwean office building, is the fourth example. The design of this building was inspired by termite mounds. Warm air rises and is released from the top of the building into the external atmosphere, maintaining a constant internal temperature. The openings at the top help regulate the temperature inside the building. This structure is closely connected to the external atmosphere. The region experiences variable temperatures between 10 and 14 degrees Celsius, which indicates the application of energy architecture for climatic reasons.

The fifth and final example is the Robinson Tower, one of the numerous architectural examples in Singapore. Due to the increasing population in Singapore, available land for constructing buildings is limited. As a result, the government has allowed converting green areas into developed land, but for each green area cut down, developers are required to create green spaces within their projects. This mandatory rule, as governed by laws, has driven the implementation of energy architecture in Singapore.

Considering all the examples provided, there is a driving force behind the application of energy architecture in each region. These driving forces have contributed to the emergence of such applications. One of the most significant global issues we face is the uncontrolled construction of buildings. Production, life, and shelter, among other activities, take place within these structures. Hence, the sustainability of buildings holds paramount importance. By investigating the reasons behind the regional implementation of energy architecture and developing projects accordingly, buildings worldwide will be constructed in line with the design philosophy of energy architecture. This is a crucial step in sustaining the construction industry.

5.3 Conclusion

The concept of sustainability entered our lives in the 21st century. It has permeated our everyday life and has found a place in all fields. Accompanying this concept, the ideas of green energy and green buildings have come together under energy architecture. The first part of this research thesis summarizes the energy architecture process from its inception to the present day. In order to understand this concept better, the Green Movement, which begins with the concept of sustainability, is explained in the first section.

Sustainability means ensuring production and productivity and preserving diversity. When sustainability is mentioned, it brings to mind the transfer of all existing resources to the next generation. Each resource is passed on to the next generation in a continuous manner. The emergence of the concept of sustainability is due to the rapid consumption of resources. Sustainability has brought about an approach that can be applied in all fields. It has begun to be adopted in all sectors. This implementation of sustainability across all sectors has been called the sustainable development plan. Sustainable development is fundamentally about protecting the world's health and prolonging the planet's life. The concept of sustainability, first proposed at the Stockholm Conference in 1971, is the first step in energy architecture. Following the emergence of sustainability, sustainable architecture began to be practiced as it was applied in architecture. Sustainable architecture is a design approach that is harmonious with nature and oriented towards the comfort needs of people. The most important feature of sustainable architecture is its priority on renewable energy sources and its use of energy in its location.

Following sustainable architecture, eco-design or ecological design is an approach aimed at harmoniously designing existing products and services with all life forms on earth. Eco-design includes sustainability principles such as reusing and using renewable natural resources. The ecological design prioritizes environmental and economic sustainability. This design approach focuses on preserving the living space of future generations. Following the approach of ecological design, the concept of biomimicry emerged. Biomimicry is a combination of the words "life" and "imitation," it refers to the process of designing by drawing inspiration from the structures and functions of organisms in nature. It involves exploring evolved natural systems and creating new products following their fundamental principles.

Biomimetic architecture aims to create new structures using environmental sustainability and energy efficiency. Buildings designed in this way are sustainable buildings. The final approach before energy architecture is new carbon architecture. The basic logic of the new carbon architecture is centered on zeroing carbon emissions. For all constructed or created buildings, the primary goal is to neutralize the amount of carbon released to nature from the beginning to the recycling process. The design is based on calculating and absorbing carbon released into the air. It aims to design by calculating the amount of carbon emitted throughout the life cycle of the building using methods like Life Cycle Assessment and Whole Building Life Cycle Assessment.

All these design approaches that began towards the end of the 20th century have been gathered under energy architecture in the 21st century. The goal in energy architecture is for the designed structures, or the buildings created, to appear as part of nature. The Turkish architect Çelik Eren Gezgin first proposed the concept of energy architecture under this name. It is argued that the energy and ecology represented by the sun and earth are an inseparable whole. It aims to design a new structure by combining energy and ecology. Energy architecture is a collection of structures resulting from the use of the right direction, the right materials, and the right energy. Unlike classical architecture, the modeling of energy architecture is based on a more philosophical approach.

In classical architecture, a building is designed according to the land where the building will be established and the method of use. However, in energy architecture, the priority is to determine the land and list the energy resources in the environment. Upon determining the natural resources found in the environment, a data table is created. According to this data table, a building is designed to best align with the ecological balance. Natural energy sources are used on the land where the building will be built. In material selection, natural stones found in the environment of the building are primarily used. Therefore, unlike classical architecture, material and energy usage is not unlimited. The design of the building is not the primary stage. The priority is for the building to stand without disrupting the ecological balance. Materials in energy architecture do not necessarily include sustainable or natural materials. As long as it does not disturb the ecological balance, plastic that does not degrade in nature for thousands of years can be recycled and used within this architectural approach. The aim is to produce a structure without disturbing the ecological balance. Therefore, waste materials that do not disappear naturally in nature are also recycled and reclaimed. Even if sustainable materials are used, these materials are combined with new technology to increase efficiency. With the development of nanotechnology, it can be used in wood, cement, concrete, and metal.

Energy architecture ensures the heat balance according to the natural temperature of the building, i.e., the angle at which it receives the sun. It creates natural ventilation and climate control systems using the window and door openings of the building. A properly designed building system maintains indoor ventilation and heat balance. Thus, using energy efficiency would require less external energy to continue the building's lifecycle. It is also possible to see the bioclimatic design in energy architecture. This approach, which emerges with sustainability, aims to design the facade of the building according to the climate conditions in which it is located, to reduce the building's environmental impact and ensure better balance with the environment.

With the combination of all these concepts, energy architecture has given rise to smart cities today. Smart cities refer to collective living spaces formed by buildings designed according to the principles of energy architecture without disturbing the natural balance. In smart cities, energy production is kept to a minimum, and energy efficiency is paramount.

Energy architecture creates an ecological balance by analyzing energy activities between the building and its environment without disturbing the natural balance. Structures use sustainable energy sources to continue their lifecycle without disturbing the ecological balance. The fourth section of this research thesis looks at the main concepts and sectors influenced by energy architecture and the scope of energy architecture's energy impact. Energy architecture can be considered a distinct movement on an international scale within a sustainable environment. The areas most used by people in the world are structures.

For this reason, architecture is the area that needs the most attention and should be given the most importance in terms of environmental impact. For this reason, energy architecture has been made binding worldwide through legal agreements. The Paris Peace Treaty, one of the international agreements aiming to reduce the use of fossil fuels to accelerate the transition to green energy, is the most important. Countries aim to protect the ecological balance with these agreements for sustainability and the protection of green energy.

Energy architecture affects not only architecture but all sectors. It is the most crucial sector approach to minimize the effects of global climate change. It aims to design all life cycles related to the recycling of buildings without disturbing the balance. This research thesis is written to explain the latest design approach in architecture, namely energy architecture, to protect world health and create a more livable environment with the emergence of sustainability. Although energy architecture is defined descriptively, it aims to provide a new contribution to the literature on this subject.

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