ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

Net Zero Energy Residential Homes, the Future of Sustainable Living: A Mixed Method Approach to Examine the Social, Economic and Environmental Impact

[1]Diangha Roderick Ngong; [2]Bwemba Charles; [3]Jacques Lionel Ntamag
[1,2]Department of Architecture, National Advanced School of Public Works
[3]Local Material Promotion Authority
[1,2,3]Yaoundé, Cameroon

Abstract:- The aim of this article is to provide an understanding literature review on net zero energy residential homes, examining their potential to shape a sustainable future. The article will explore the evolution of residential homes, technological advancements driving the adoption of net zero residential homes and the societal benefits and challenges associated with this homes.by synthesizing existing research this study seeks to add to a deeper understanding of net zero residential homes as a promising solution for sustainable living and info future policy and research direction.

Keywords:- *Net-Zero Energy, Sustainable Living, Residential Homes, Climate Change, Energy Efficiency.*

I. INTRODUCTION

In the face of mounting climate concerns and the urgent need for sustainable solutions, the idea of net zero energy residential homes emerges as a beacon of hope. These homes aspire to achieve a delicate balance between the production of energy and its consumption, ultimately striving to meet its own energy needs. This literature review embarks on an in-depth exploration of zero energy residential homes, unveiling their profound economic, social, and environmental implications but first we will see the evolution of residential housing. The findings will have important implications for sustainable living and future research directions. Ultimately, this review will present a compelling vision for the future of zero energy homes as a key component of a sustainable society. By embracing this innovative approach to housing, we can have a more just, equitable, and environmentally responsible world for the next generations to come.

II. THE EVOLUTION OF HOUSING: FROM NOMADIC SHELTER TO SMART HOMES

The journey of human habitation has spanned millennia, reflecting our evolving needs, technologies, and understanding of the world around us. This journey can be broadly categorized into five key eras:

A. The Dawn of Shelter: Nomadic Beginnings (Prehistoric Era)

- The First Homes: Our ancestors, nomadic hunter-gatherers, relied on natural shelters for protection. Caves, rock overhangs, and even large trees offered rudimentary protection from the elements.
- Early Structures*:* As early humans transitioned to more settled lifestyles, they started constructing temporary shelters from materials found in their environment. These included:

✓ Lean-tos: Simple structures made from branches and animal hides.
✓ Tents: Crafted from animal skins stretched over poles, providing greater mobility.
✓ Wigwams: Circular structures made from woven branches and covered with animal skins or plant material.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

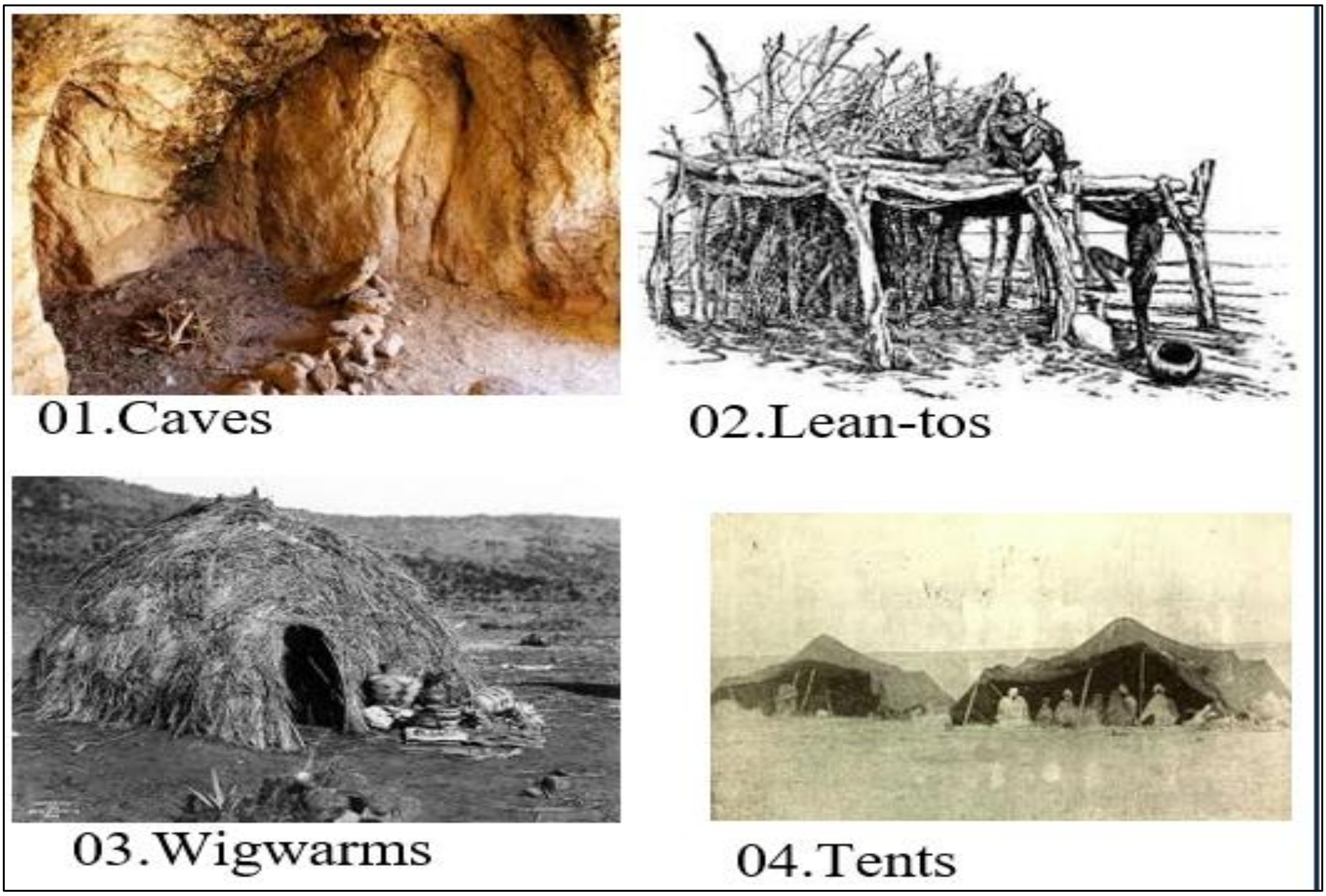

Fig 1: Some Early Nomadic Homes (Shelter)

B. Early Settlements and Vernacular Architecture (8000 BCE - 4000 BCE)

➢ *Rise of Permanent Dwellings*

The development of agriculture, animal domestication and formation of communities gave rise to this transition. And with the entablement of permanent settlements the need for a more durable and secure dwelling arose. This era saw the emergence of vernacular architecture, a style of building that used locally available materials and construction techniques adapted to specific climates and resources of the region. Mudbrick houses from sundried earth mixed with straw or reeds were common in regions with arid climates, Timber framed houses were constructed in regions of temperate climate and stone houses in cold climates.

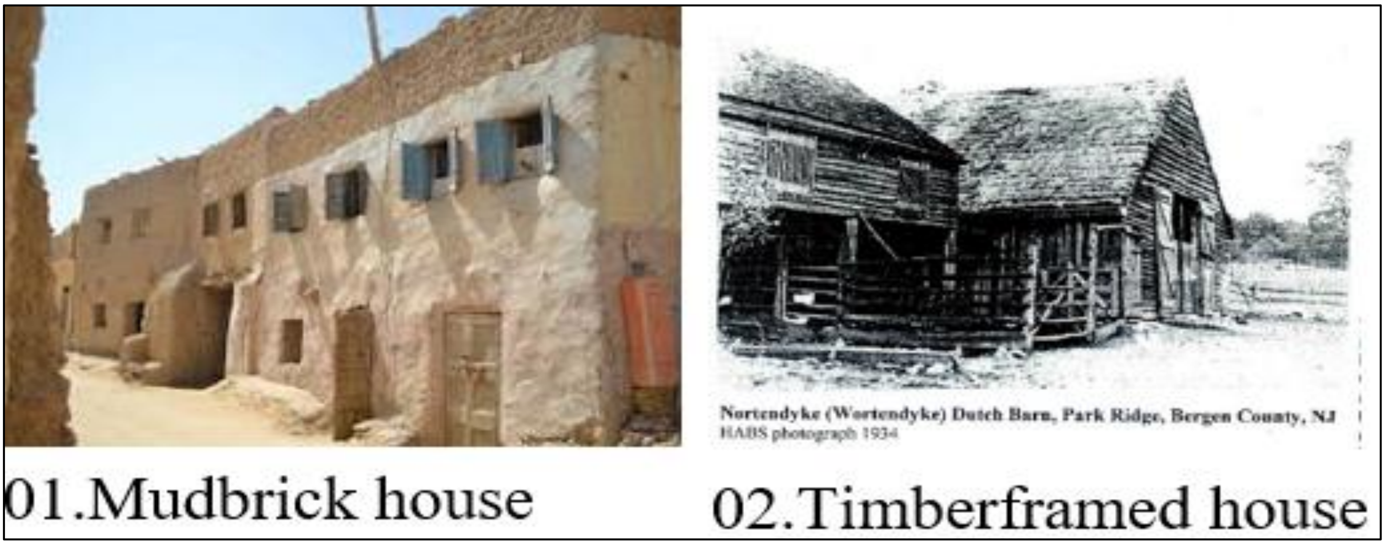

Fig 2: Some Early Settlements and Vernacular Architecture

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

C. Urbanization and Monumental Architecture (4000 BCE - 1450 CE) Rise of Cities.

The increase in agricultural production, development of trade and technological advancements lead to the rise of cities and housing styles and living conditions were significantly affected with the introduction of denser houses, social segregation and public infrastructures. Alongside this development of urban housing this period saw a rise in monumental architecture.

Some of the monumental architecture and residentials housings during this era include:

➤ *Mesopotamian Architecture*

- Ziggurats: Tiered pyramids serving as temples for the gods.
- Residential housing: They are usually grouped around a central temple or in narrow streets. The Mesopotamians lived mostly in mud-brick houses. The mud is held together with a braid of reeds. It is made from molds, dried in the sun, and baked in ovens. One or two rooms in the mud-brick houses have flat roofs.

Fig 3: Mesopotamian Architecture

➤ *Egyptian Architecture*

- *Pyramids:*

Massive tombs built for pharaohs as expressions of power and belief in the afterlife.

- *Residential Housing.*
- *Reed Huts:*

The first type of house that the ancient Egyptians lived in was tents made of papyrus reeds, a grass-like plant found in Egypt and also used to make paper. Mud and wood were used in buildings and structures during the dynastic period; in ancient times, Egyptians lived in houses made of mud. Annual floods brought a lot of mud, which made it easier to build. Brick makers used wooden molds to shape the soil into rectangular shapes, which were then dried and hardened in the sun.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

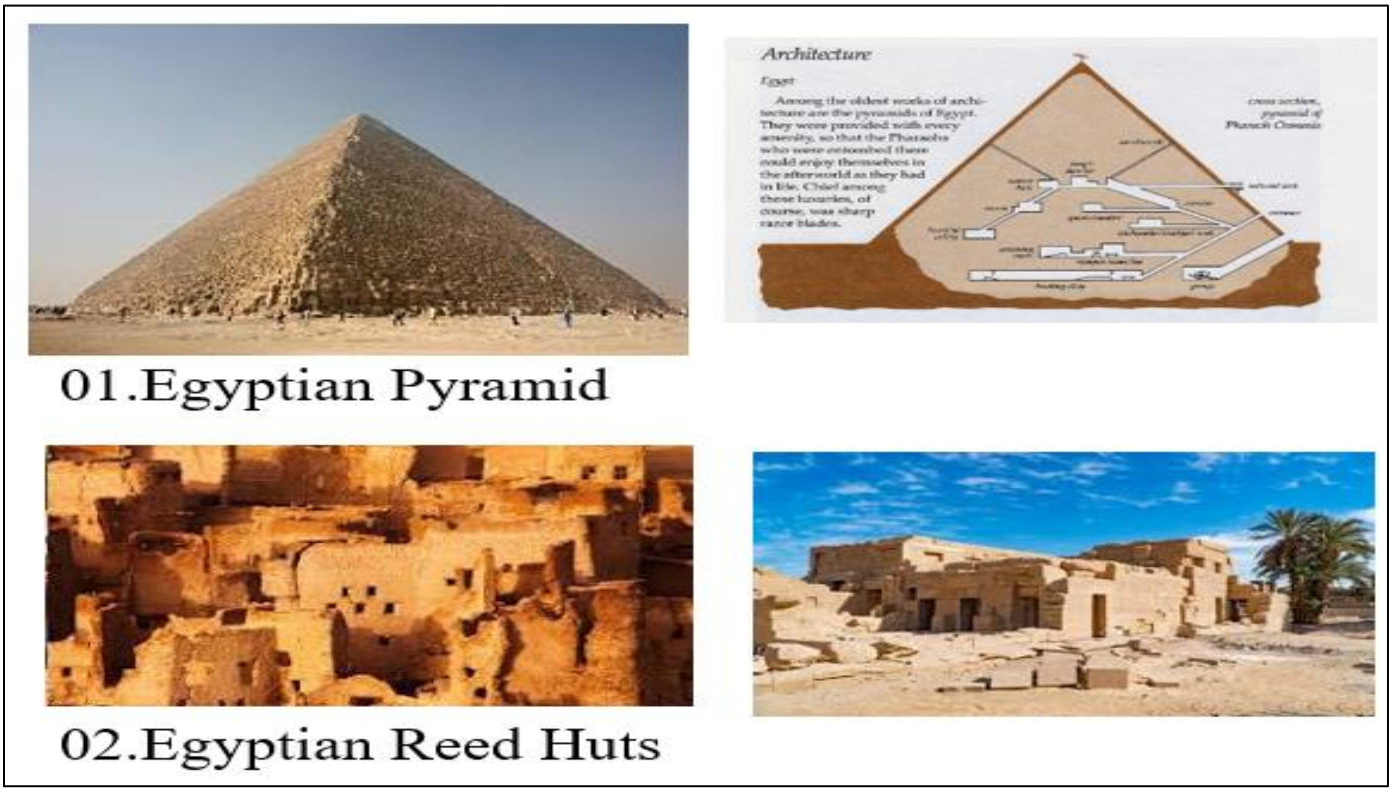

Fig 4: Egyptian Architecture

➢ *Greek Architecture*

- *Acropolis:*

The castle on the hill contains temples to gods such as Athena and the Parthenon. The superstructure of the temple is mostly made of adobe and wood, while the building platfo rm is made of cut stone. The columns are carved from local stones, usually limestone or tuff. In earlier temples, the colu mns were made of wood.

- *Housing:*

The ancient Greeks lived in houses made of solar clay called "oikos". Unfortunately, the walls are weak. It is common for buildings to collapse and have to be rebuilt frequently. The roof of the house is made of tiles and the windows are small and covered with wooden shutters. The room opens onto the courtyard.

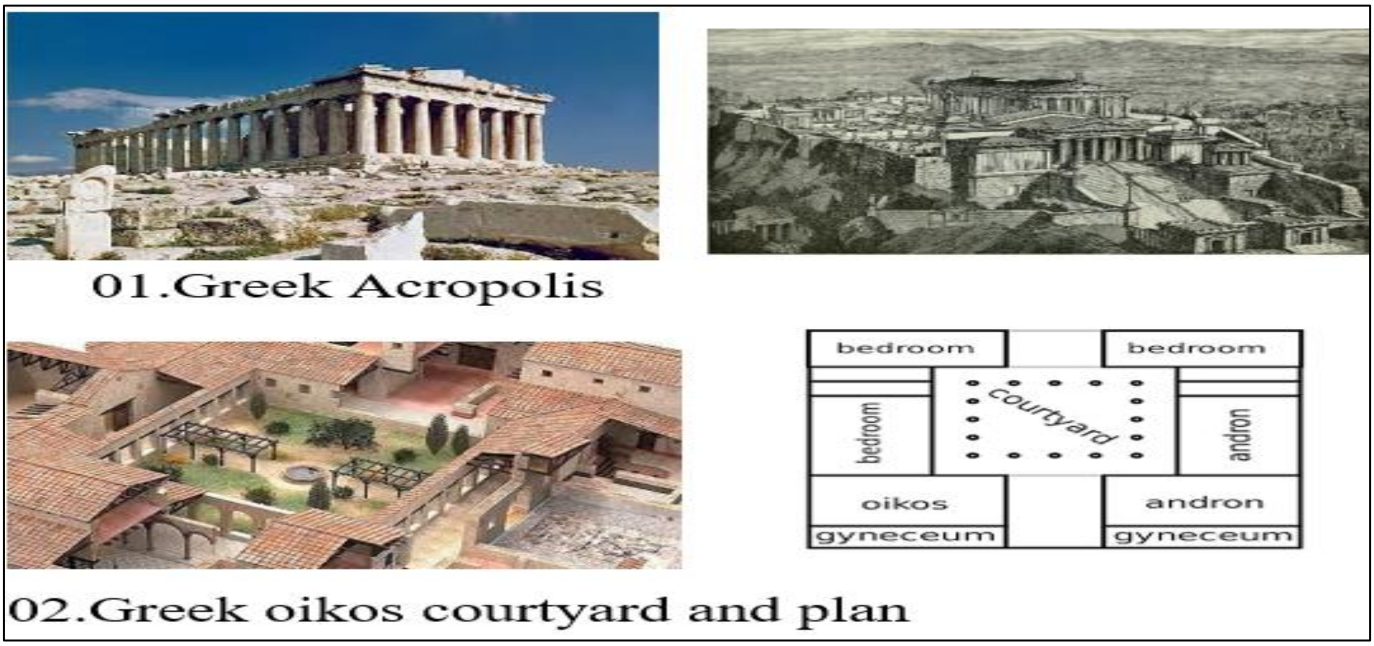

Fig 5: Greek Architecture

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

➢ *Roman Architecture*

- *Colosseum:*

An elliptical amphitheater used for gladiatorial contests and public spectacles.

- *Housing*

✓ Insulae: Most of the population in Rome and other cities live in small shops and offices where the owners live above and behind their work areas. Many islands will surround an open courtyard and together form a city block. The islands are generally poor and have little, if any, clean water or heat. They are made of wood and brick and are very simple.

✓ Domus: This the residence of the wealthy roman elite. Constructed with stone, bricks concrete and wood and decorated with marble, mosaic (elaborate patterns and scenes crafted using small pieces of colored stones, glass or ceramic tiles to decorate floors, walls and even ceilings) frescoes (wall paintings created using pigments and a wet plaster technique), stucco (a plaster like material used to smooth walls and create decorative moldings and patterns).

Other materials like terracotta were used for roof tiles and decorative elements, lead used for pipes and water channels, glass used for windows though it was rare and expensive.

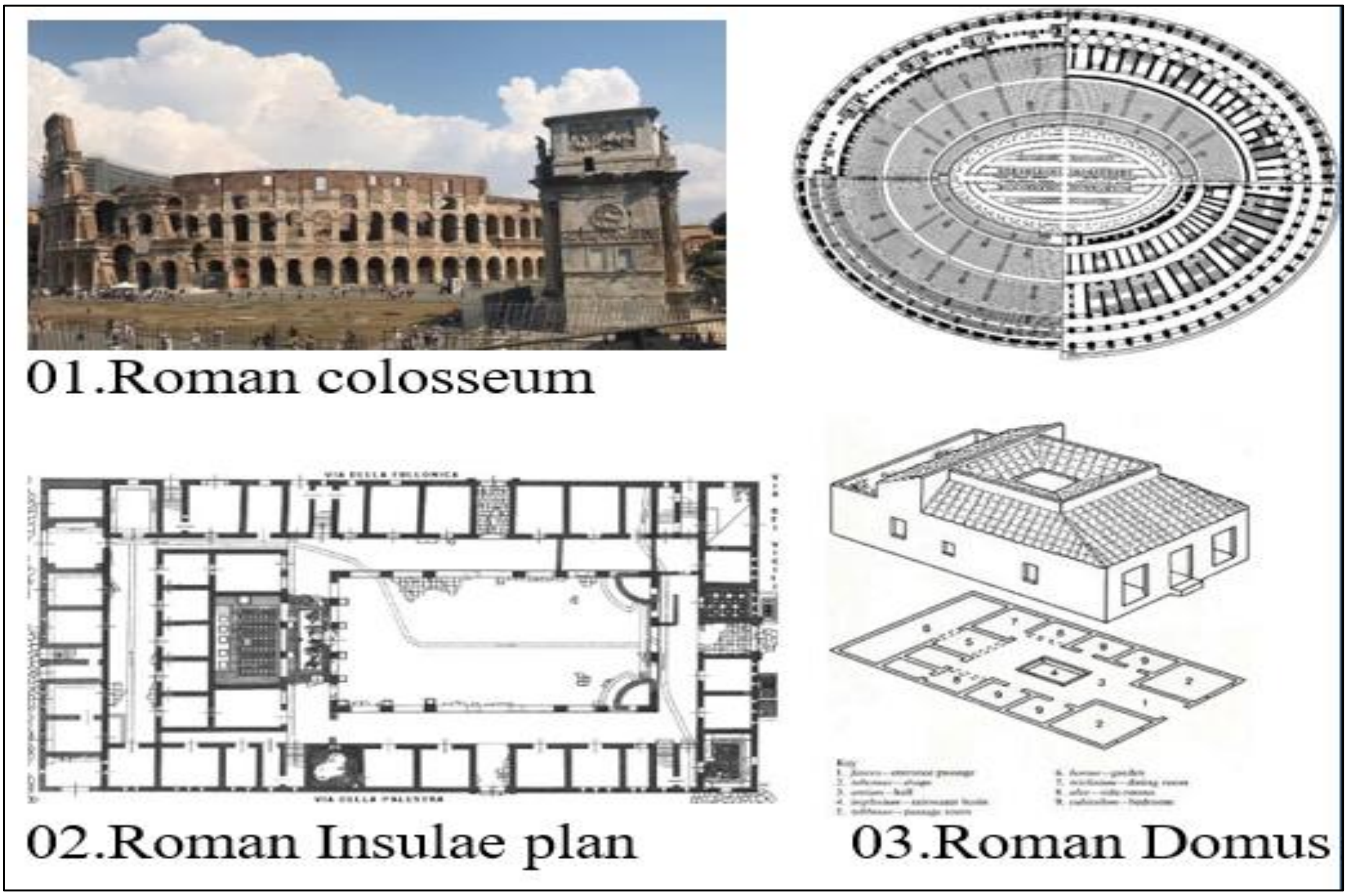

Fig 6: Roman Architecture

D. Industrial Revolution and Standardized Housing (1450 CE - 1945 CE)

The Industrial Revolution (18th-19th centuries) ushered in a period of profound transformation that significantly impacted housing, from mass production due to the developments of new materials like steel and concrete and urban expansion as industrialization attracted large number of workers to cities leading to rapid urban expansion. The demand for housing outpaced traditional construction methods necessitating quicker and more economical solutions.

➢ *Housing Developed During this Period Included*

- *Terraced Houses:*

Townhouses emerged as a response to the Industrial Revolution as people flocked to cities and towns in search of work. Townhouses provide good services away from slums. Rows of identical or near-identical houses-built side-by-side, common in working-class neighborhoods. These houses were often cramped and lacked basic amenities like private bathrooms.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

- *Tenements:*

Multi-story apartment buildings with shared amenities like kitchens and bathrooms. Tenements were notorious for overcrowding, poor ventilation, and fire hazards. The low-rise buildings common in the city's Lower East Side neighborhoods are often cramped, poorly lit, and lack proper plumbing and ventilation. Many homes were built for working families, and many people moved to the city to work in manufacturing. Other buildings, such as warehouses or storage facilities, were converted into apartments.

➢ *This Period also Saw the Rise of Suburbs and Modern Architecture:*

- *The 20th Century Witnessed a Shift in Housing Trends:*

✓ Suburbanization: The rise of the automobile and growing economic prosperity led to the development of suburbs. Suburbs offered detached single-family homes, considered more desirable compared to densely populated urban areas.
✓ Modern Architecture: Pioneering architects like Le Corbusier and Frank Lloyd Wright challenged embraced new materials like steel and glass challenging traditional methods. These architects emphasized functionality, open floor plans, and connection with the natural environment.

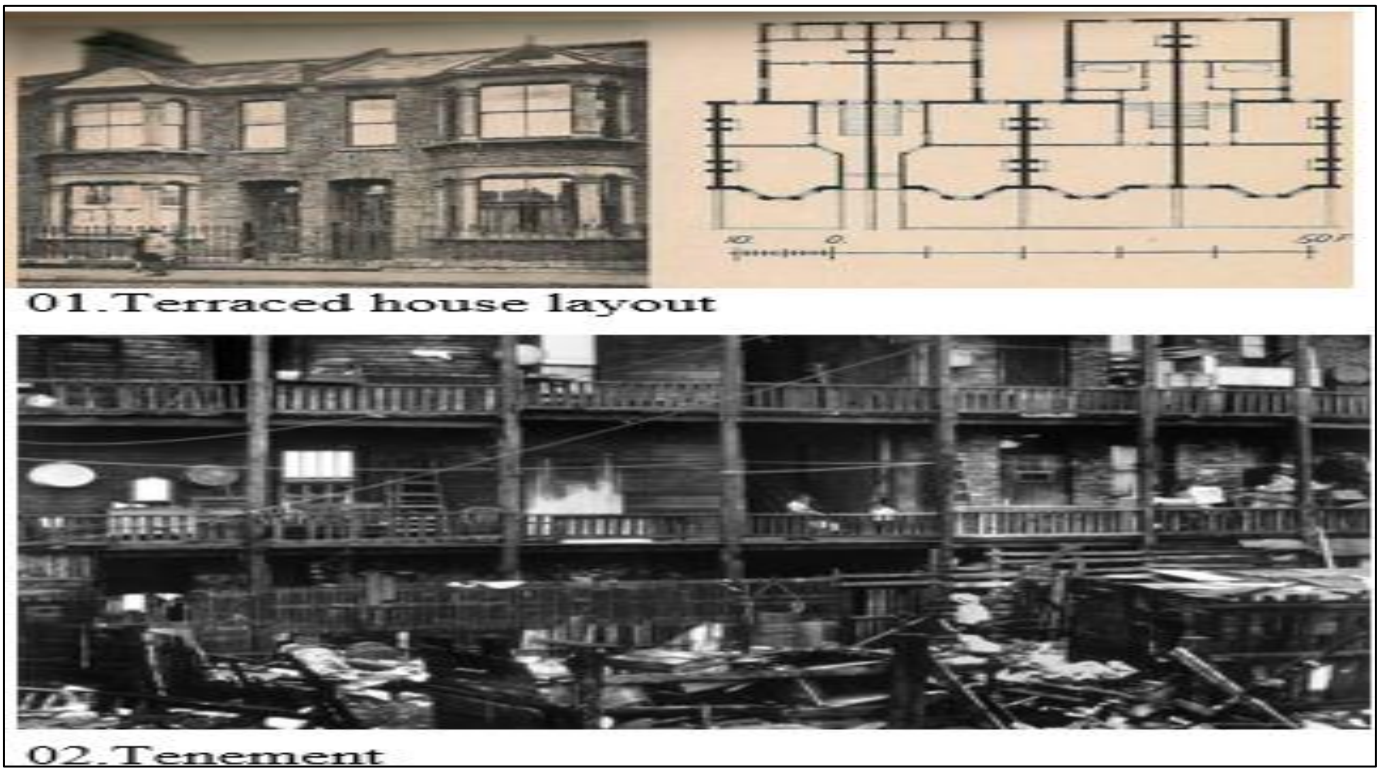

Fig 7: Industrial Revolution Standardized Houses

E. The Rise of Smart Homes and Sustainability (1945 CE - Present)

The post-World War II era saw a significant shift in housing trends, driven by technological advancements, environmental concerns, and evolving social needs.

➢ *Technological Advancements and Smart Homes:*

- *Automation and Connectivity:*

The rise of personal computers, the internet, and advancements in electronics gave room for the development of smart homes. These homes integrate technology to automate various functions, enhance comfort, and offer remote control capabilities.

- *Examples of Smart Home Features:*

✓ Energy-efficient climate control using smart thermostats.
✓ Mood control and security with lighting systems that are smart.
✓ Appliances controlled remotely via smartphones or voice assistants.
✓ Home security systems with remote monitoring and automated alerts.

- *Benefits of Smart Homes:*

✓ Increased convenience and comfort.
✓ Potential for improved energy efficiency.
✓ Enhanced security features.
✓ Remote monitoring capabilities for increased peace of mind.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

➢ *Sustainability and Energy Efficiency:*

- *Increasing Environmental Concerns:*

Change in climate and natural resources depletion have led to an increasing focus on sustainable housing practices. This includes designing and constructing homes with minimal environmental impact.

- *Key Features of Sustainable Homes:*

✓ Energy-efficient tools and building materials.
✓ Renewable energy sources like solar panels.
✓ Water conservation features like low-flow plumbing fixtures.
✓ Use of recycled or sustainable construction materials like bamboo or reclaimed wood.
✓ Designs that optimize natural light and ventilation.

- *Benefits of Sustainable Housing:*

✓ Reduced energy consumption and carbon footprint.
✓ Lower utility bills for homeowners.
✓ More environmentally responsible construction practices.

➢ *Social Issues and the Future of Housing:*

- *Affordability Crisis:*

The rising cost of housing in most parts of the world presents a considerable challenge. Innovative solutions and policy changes are needed to ensure access to affordable housing for all.

- *Aging Populations:*

As populations age, there's a growing need for housing that meets the specific needs of older adults, such as accessibility features and universal design principles.

- *Urbanization and Density:*

The trend of urbanization continues, necessitating the development of dense yet sustainable housing solutions that promote social interaction and community living.

III. BACKGROUND

A. Net Zero Energy Housing Terminologies and Definition

The field of net-zero energy construction boasts a unique vocabulary, merging traditional building concepts with cutting-edge energy technologies. Understanding these terms is crucial for comprehending the intricacies of this sustainable approach to building design.

➢ *Zero Energy Building (ZEB), Net Zero Energy Building (NZEB), and Zero Net Energy Building (ZNEB):*

These terms are often used interchangeably with the same term, namely that a connected building has less energy than its energy plate. As stated by the U.S. Department of Energy (DOE), ZEB is equal to the annual electricity distribution and electricity exports from the energy base. A net zero energy building is a building that has been designed and constructed to minimize its energy demand through efficiency measures. Additional energy needs are then offset by on-site or off-site renewable energy to achieve zero energy consumption, usually for a period of one year. NZEB is an important step toward a sustainable and energy-independent future for the built environment. A building reaches NZE when its annual electricity production equals that of the renewable energy source. Simply put, a building uses less energy than it produces over a given period of time (usually a year).

➢ *Zero Energy Building (nZEB) or Zero Energy Building (nZEB):*

Used together with "Rising Zero Energy Building" and "Zero Energy Ready" to describe buildings with the potential to reach zero energy consumption - Vitality. nZEB and nNZEB are energy buildings designed to reduce energy consumption and include renewable energy systems for areas that cannot produce enough energy each year to reach zero carbon emissions. According to research, at least 30% of the energy needs of nZEB are generated on-site from renewable energy sources.

➢ *Off-Grid Zero Energy Buildings (OFF-Grid Zero Energy Buildings):*

These buildings are highly energy efficient buildings that produce energy suitable for domestic use using renewable energy, not connected to an external energy source (such as a generator). machinery. In such buildings, the balance between energy consumption and production is achieved in an hour (or short period). To do this, these buildings need to have a lot of energy production (5,000 to 15,000 square meters of living space) and the ability to store energy to act as a backup power when energy is produced (at night or under the cloud) or for months. The estimated cost of renewable energy in OZEB is 10 times that of NZEB.

➢ *Source Energy:*

This refers to the total energy used in generating the energy delivered to the building. This includes the energy lost during production, transmission, and distribution. Imagine a power plant generating electricity for a city. The source energy would encompass the fuel used by the power plant, the energy lost during electricity transmission through power lines, and finally, the electricity delivered to the building.

➢ *Embodied Energy:*

Embodied energy is the total energy consumed throughout a building's entire life cycle. This includes the energy used for material extraction, transportation, construction, operation, maintenance, and eventually, demolition. It's a broader concept than just operational energy use and considers the environmental impact of the building from cradle to grave.

➢ *Renewable Energy Sources:*

This refers to energy sources that can be replenish naturally and can be used repeatedly. Examples include solar, wind, geothermal, and hydropower. Solar panels which convert sunlight into electricity, wind turbines which harness the power of wind, geothermal power plants utilize heat from

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

the Earth's core, and hydroelectric dams generate electricity from the flow of water.

B. Net Zero Energy Residential Homes Examples

➢ *Case Study 1. Lahagu Housing*

The Lahagu Housing project is an affordable housing design in Tamale, Ghana. Developed by leading international appliance developer Reall, the project highlights that a secure, smart home can alsobe affordable. It offers lowincome people the opportunity to get on Ghana's housing ladder and encourages developers to see the value of green housing.

Consisting of 100 twobedroom green affordable homes built by Afreh Group, the project is 34% more energy efficient, 31% more water efficient and has 56% more energy in its materials than traditional local housing. The contractor has enhanced green performance with measures such as low water flow, earthen walls and windy areas. The Lahagu housing project is the first housing project in northern Ghana to receive EDGE certification. Reall and Afreh Group are drawing on best practices from the Ghanaian and UK construction industry to deliver affordable, climate friendly and attractive products to Ghanaian customers. The project was delivered for the benefit of the Tamale Community Cooperative Credit Union and is a showcase of what is available in the Ghanaian market. Local lenders such as First National Bank, Stanbic and Absa have all expressed interest in this type of product and the opportunity to enter the newmarket segment upon delivery of the air contract. Lahagu housing scheme received final EDGE certification from Sintali-SGS on December 1, 2021Measures used

- *Energy:*

Reduce window/wall ratio, operable window to natural air, no air conditioning, energysaving bulbs - indoor Locati on, energy-saving light - outdoor location.

- *Water:*

Lowflow shower heads, low flow kitchen sinks, low flow laundry, bathroom with two toilets

- *Materials:*

Floor slabs - cast - Reinforced concrete, Roof structure - steel beams Aluminum panels for external wall - pressurest abilized earth blocks, internal wall - pressurestabilized earth blocks, floor - finished stone floor

- *Total CO_2 Savings (Annually)* 22

Fig 8: Lahagu Housing Project

➢ *Casestudy 2: Rehoboth Knightsbridge*

Rehoboth Knightsbridge in Kwabenya is a beautiful place to live with 1,700 apartments. The complex includes leisure facilities, saunas and business areas. Knightsbridge is located in the Greater Accra area with easy access to major roads leading to the Central Business District. This is Africa's first affordable housing community in Accra, Ghana, currently under development by Ghana's leading property developer Rehoboth Properties Ltd. Be brave and work hard. With this development, Rehoboth Properties is taking affordable housing in Ghana to a new level. Housing prices across the country continue to remain high. A property in Knightsbridge is not just a home, it is a place where the good life goes beyond borders with amenities such as sauna and bathroom, pool, swimming pool, gym, lawn tennis, basketball court, laundry, rooftop restaurant, Pharmacy. As a leader in the Ghanaian real estate sector, there is no doubt that Rehoboth Properties Ltd cares about the environment and should contribute to reducing Ghana's carbon footprint.

This is evidenced by the construction process of our buildings and the features of their products. Rehoboth Properties Ltd believes in the sustainability of the built environment. Sustainability in the built environment has been overlooked for many years and it is time for many developers to start thinking about this issue. In addition to the environmental benefits of green buildings, there are also many economic benefits for consumers. The Knightsbridge development achieved great results in areas such as: 31% energy savings, 31% water savings and a 68% reduction in energy consumption. Rehoboth Knightsbridge has received a Preliminary EDGE Certificate from Sintali-SGS on April 1, 2021 Measures used

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

- *Energy:*

✓ Reduction in the window to wall ratio
✓ Natural ventilation with operable windows and no A/C
✓ Ceiling fans in all habitable rooms
✓ Energy-saving light bulbs in internal and external spaces.

- *Water:*

Low-flow showerheads and faucets for kitchen sinks and washbasins, dual flush for water closets.

- *Materials:*

✓ In-situ reinforced concrete slabs in floors and roof construction.
✓ Aluminum sheets on timber rafters in roof construction
✓ Medium weight hollow concrete blocks in internal and external walls.

- *Total CO2 Savings (annually)* 27.36

Fig 9: Rehoboth Knightsbridge Housing Project

C. Influence of Weather on the Performance of Net Zero Energy Buildings

Weather plays a significant role in the performance of Net Zero Energy Buildings (NZEBs). Let's delve deeper into how various weather elements impact NZEB efficiency:

➢ *Temperature Extremes:*

Extremely hot or cold weather can increase energy demand for heating and cooling, affecting a building's ability to achieve zero energy use. Areas with moderate annual temperatures are generally suitable for NZEB.

➢ *Precipitation:*

Rainfall patterns can affect rainwater harvesting systems and rooftop solar panel efficiency. Areas with consistent rainfall can benefit from rainwater harvesting for toilet flushing or irrigation, reducing reliance on municipal water supplies. However, excessive snowfall in some regions might require additional measures to ensure solar panel functionality during winter months.

➢ *Sunshine Hours:*

The amount of solar radiation available determines the effectiveness of solar energy generation. Locations with high sunshine hours are ideal for NZEBs that rely heavily on photovoltaic systems to meet their energy needs.

➢ *Solar Radiation:*

The amount of solar radiation available determines the effectiveness of solar energy generation. Locations with high sunshine hours are better suited for photovoltaic systems.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

➢ *Climate:*

Microclimates within a site can be utilized to optimize passive design strategies. For example, strategically planting trees can provide shade in summers and minimize cooling needs. Understanding wind patterns can inform natural ventilation strategies, reducing reliance on mechanical systems.

➢ *Strategies for Mitigating Weather Impacts:*

- *Climate-Specific Design:*

NZEBs should be designed considering the local climate for optimal energy performance. In hot and humid climates, building orientation, window placement, and proper insulation can minimize heat gain. In cold climates, maximizing solar gain and utilizing passive solar heating strategies become crucial.

- *Weather Monitoring and Control Systems*

Smart building automation systems can monitor weather conditions in real-time and adjust energy use accordingly. For instance, the system might automatically adjust thermostat settings or activate ventilation systems based on outdoor temperature and humidity.

- *Building Envelope Optimization:*

A well-insulated building envelope with high thermal resistance minimizes heat transfer, reducing the energy consumed for both heating and cooling processes regardless of the climate.

By understanding these weather influences and implementing appropriate strategies, designers and building owners can ensure that NZEBs function efficiently across various climatic conditions.

D. User Behavior and its Impact on the Performance of Net Zero Energy Building.

While Net Zero Energy Buildings (NZEBs) are designed to meet high energy-efficiency, occupant behavior plays a significant role in their ability to achieve true net zero energy consumption.

➢ *Energy Consumption Habits:*

- *Lighting:*

Leaving lights on in unoccupied spaces or using high-intensity lighting unnecessarily can significantly increase energy consumption. Utilizing natural daylight and energy-efficient LED bulbs can make a big difference.

- *Appliance Usage:*

The type and frequency of appliance use can affect energy consumption. Simple actions like switching off electronics when not in use and utilizing energy-efficient appliances can contribute to energy savings.

- *HVAC (Heating, Ventilation and Air Conditioning) Controls:*

Maintaining comfortable indoor temperatures is important, but adjusting thermostats to more moderate settings and utilizing fans whenever possible can reduce reliance on HVAC systems.

➢ *Water Usage Habits:*

- *Water Conservation Practices:*

Shorter showers, fixing leaky faucets, and using water-efficient appliances can minimize water consumption in NZEBs that utilize rainwater harvesting or other water conservation strategies.

➢ *Operational Practices:*

- *Shading Management:*

Optimizing the use of blinds or shades during different seasons can help regulate indoor temperatures. During summers, strategically lowering shades can block sunlight and reduce cooling needs. In winters, allowing sunlight to penetrate can contribute to passive solar heating.

- *Ventilation Habits:*

Opening windows during appropriate seasons can promote natural ventilation and reduce reliance on mechanical ventilation systems.

- *Strategies for Encouraging Positive User Behavior:*

✓ *User Education and Training:*

Educating occupants about the NZEB features and how their behavior can impact energy use is crucial. Providing training on efficient appliance use, lighting control strategies, and responsible water consumption habits empowers occupants to add to the building's net zero energy goals.

➢ *Real-Time Feedback Systems:*

Implementing real-time energy consumption displays within the building can raise occupant awareness about their energy use patterns. This feedback loop can encourage them to make adjustments and adopt more sustainable practices.

- Gamification and Incentives: Introducing gamified elements or incentive programs can motivate occupants to compete and achieve energy-saving goals. This can foster a sense of community and encourage positive behavioral changes.
- User-Friendly Controls: Easy-to-use controls for lighting, temperature, and ventilation systems promote user engagement in energy management.

Understanding the impact of user behavior and implementing strategies to encourage positive changes, occupants can become active participants in achieving the net zero energy goals of these sustainable buildings.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

IV. TECHNICAL ASPECTS OF NZE DESIGN AND CONSTRUCTION

A. Passive Design.

These strategies aim to minimize energy consumption by optimizing the building's orientation, daylighting, its natural ventilation, and thermal mass.

➢ *Building Orientation:*

The home is oriented to maximize sunlight in the winte r and minimize sunlight in the summer. This can be done by orienting the length of the home eastwest and creating a sout hfacing window to capture sunlight. This can reduce the nee d for lighting, especially during the day.

➢ *Daylighting:*

Windows and skylights are strategically placed to maximize natural daylighting. This can reduce the need for lighting bulbs, especially during the day.

➢ *Natural Ventilation:*

Operable windows and doors allow for natural ventilation, which helps to cool the building in summer and reduce or completely remove the need for air conditioning.

➢ *Thermal Mass:*

Thermal materials, such as rocks and stones, absorb an d store heat during the day and release it at night. This helps control temperature fluctuations in the home and reduces the need for heating and cooling.

B. Building Envelope

This is the physical barrier between the interior and exterior of the building which plays a crucial role in reducing heat transfer, which then helps to maintain a comfortable indoor environment.

➢ *Insulation:*

Insulation materials are used to minimize heat transfer through the walls, roof, and floor. Common insulation materials include cellulose, fiberglass, and spray foam.

➢ *Airtightness:*

Air leakage is a major source of energy loss in buildings. Airtight construction methods, such as weatherstripping, caulking, and gaskets, are used to seal gaps and prevent air leakage.

➢ *Windows:*

Energy-efficient windows have low U-values, which measure solar heat gain coefficients, the rate of heat transfer through the window and, the amount of solar heat that is transmitted through the window.

C. Energy Efficient Appliances ANS Systems

This uses less energy to perform the same tasks as conventional appliances and systems.

➢ *Lighting:*

LED lighting is one of the most energy-efficient lighting technology available. LED bulbs use up to 80% less energy than traditional incandescent bulbs and last much longer.

➢ *Appliances:*

Energy Star-rated appliances meet strict energy efficiency standards set by the U.S. Environmental Protection Agency. These appliances can save significant amounts of energy over their lifetime.

➢ *Heating, Cooling, and Ventilation Systems:*

High-efficiency heating, cooling, and ventilation systems use less energy to maintain a comfortable indoor environment. Common high-efficiency systems include heat pumps, geothermal systems, and energy recovery ventilators.

D. Renewable Energy Integration

Renewable energy systems generate electricity or heat from renewable sources, such as sunlight, wind, and geothermal heat. These systems can significantly reduce the reliance on fossil fuels and help to achieve net zero energy.

➢ *Solar Panels:*

They convert sunlight into electricity. They can be installed on the roof or ground-mounted.

➢ *Wind Turbines:*

They convert the kinetic energy of the wind into electricity. They are typically used in areas with ample wind resources.

➢ *Geothermal Energy Systems:*

It uses the heat from the earth to heat and cool buildings. They can be installed in areas with geothermal resources.

➢ *Micro-Hydro Systems:*

Micro-hydro systems generate electricity from flowing water. They can be installed in areas with a suitable water source, such as a river or stream.

V. SOCIAL IMPACTS OF NZE HOUSING

A. Health and Wellbeing

NZE homes can have a good impact on the health and well-being of their occupants.

➢ *Improved Indoor Air Quality:*

NZE homes are typically more airtight than conventional homes, which reduces the infiltration of outdoor pollutants.

➢ *Enhanced Thermal Comfort:*

NZE homes are designed to maintain a comfortable indoor temperature throughout the year. Which reduces the risk of heat-related illnesses in summer and in winter cold-related illnesses.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

- *Access to Natural Daylight:*

NZE homes often have large windows and skylights to maximize natural daylighting. This can improve mood, cognitive function, and sleep quality.

B. Community Resilience

NZE homes can contribute to more resilient communities.

- *Reduced Reliance on External Energy Sources:*

NZE homes rely less on external energy sources, such as the electrical grid and natural gas network. This can make communities more resilient to energy price fluctuations and shortages.

- *Potential for Microgrids:*

NZE homes can be integrated into microgrids, which are small, self-contained electrical grids providing power to a community during outages.

- *Shared Renewable Energy Systems:*

NZE homes can share renewable energy systems, such as solar PV panels. This can foster community cohesion and reduce the overall cost of renewable energy.

C. Social Equity and Affordability

NZE housing can promote social equity and affordability.

- *Reduced Energy Poverty:*

NZE homes can help to reduce energy poverty by lowering utility bills. This saves up more money for other important expenses, such as food, transportation, and healthcare.

- *Government Incentives and Policies:*

Governments can implement incentives and policies to make NZE housing more affordable for low-income households. This can include tax credits, rebates and loans.

However, there are also some potential challenges to ensuring social equity and affordability in NZE housing.

- *Gentrification and Displacement:*

Rising property values in NZE housing areas can lead to gentrification and displacement of low-income earners.

- *Lack of Affordable NZE Housing:*

There is a shortage of affordable NZE housing in many communities. This can make it difficult for low-income households to access the benefits of NZE housing.

- *Limited Access to Financing:*

Low-income households may have difficulty obtaining financing for NZE housing, which can be more expensive to build than conventional housing.

VI. ENVIRONMENTAL IMPACTS OF NZE HOUSING

NZE homes can have proven to have a positive impact on the environment. The core objective of energy-zero housing lies in its potential to significantly reduce our environmental footprint.

A. Greenhouse Gas Emissions Reduction

Compared to conventional homes, NZE homes can reduce greenhouse gas emissions. This is because NZE homes rely on renewable energy sources and reduce energy consumption.

- *Renewable Energy:*

NZE homes generate their own renewable energy, typically through solar PV panels or geothermal systems, reducing the reliance on fossil fuels, which are a major factor of greenhouse gas emissions.

- *Reduction in Energy Consumption:*

The design of this homes makes them energy-efficient, meaning that they use less energy to heat, cool, and light the home. This reduction in energy consumption also reduces greenhouse gas emissions.

B. Resource Conservation

NZE homes can also conserve natural resources.

- *Water Conservation:*

NZE homes often have water-efficient appliances and fixtures. They may also collect rainwater for use in irrigation and other non-potable purposes.

- *Reduced Material Consumption:*

NZE homes are typically built with sustainable materials, like recycled and low-carbon materials. This reduces the demand for virgin materials and helps to conserve natural resources.

C. Air and Water Quality Improvement

NZE homes can also improve air and water quality.

- *Reduced Air Pollution:*

NZE homes rely less on fossil fuels, which are a major source of air pollution. This can improve air quality and reduce the risk of respiratory problems.

- *Improved Water Quality:*

NZE homes may collect rainwater for use in irrigation and other non-potable purposes. This can reduce the demand for potable water and help to protect water quality.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1132

VII. ECONOMIC IMPACTS OF NZE HOUSING

NZE housing has a positive impact on the economy.

A. Job Creation

The construction and operation of NZE homes can create new jobs in a variety of sectors.

- *Renewable Energy Sector:*

NZE homes often rely on renewable energy systems, this will create jobs in the renewable energy sector, including jobs in manufacturing, installation, and maintenance.

- *Energy Efficiency Sector:*

NZE homes require energy-efficient appliances, systems, and building materials. This can create jobs in the energy efficiency sector, including jobs in manufacturing, installation, and consulting.

- *Construction Sector:*

The construction of NZE homes can create jobs in the construction sector, including jobs for architects, engineers, contractors, and skilled tradespeople.

B. Increased Property Values

NZE homes tend to have higher property values than conventional homes. This is because NZE homes are energy-efficient and have lower operating costs. This can lead to increased tax revenue for local governments.

C. Long-Term Cost Savings

NZE homes save homeowners money on energy bills over the long period. This is because NZE homes use less energy to heat, cool, and light the home. This can save more money for other important expenses, such as food, transportation, and healthcare.

However, there are also some potential challenges to ensuring the economic benefits of NZE housing.

- *Higher Upfront Costs:*

NZE homes can be more expensive to build than conventional homes. This can make it difficult for some homeowners to afford NZE housing.

- *Lack of Skilled Labor:*

There is a shortage of skilled labor in the renewable energy and energy efficiency sectors. This makes it difficult to find qualified contractors to build and maintain NZE homes.

- *Limited Access to Financing:*

Homeowners may have difficulty obtaining financing for NZE homes, which can be more expensive to build than conventional homes.

Overall, NZE housing has a positive impact on the economy by creating jobs, increasing property values, and saving homeowners money on energy bills. However, there are some challenges to ensuring the economic benefits of NZE housing, such as higher upfront costs, lack of skilled labor, and limited access to financing.

VIII. CONCLUSION

In summary this works has provided us with the history of residential homes from when man first walked the earth, a background on net zero residential homes and some case studies and the potentials benefits of moving towards a net zero energy residential construction.

This will help us better transition to a sustainable approach in construction ensuring economic social and environmental benefits resulting in a sustainable future.

REFERENCES

[1]. Aashiyana (n.d.). Aashiyana.tatasteel.com.
[2]. Britannica (n.d.). History of Modern Architecture.
[3]. Department of Energy (DOE). (n.d.). Zero Energy Homes. Energy.gov. https://www.energy.gov/eere/buildings/zero-energy-ready-home-program.
[4]. Dillon, P. (2014). The Story of Architecture: From the Pyramids to the Present Day. London: Dorling Kindersley. (pp. 20-35).
[5]. Early Human Settlements. By Marvin Harris. Britannica. https://www.britannica.com/biography/Marvin-Harris.
[6]. EDGE Buildings. (n.d.). Lahagu Housing Project. Edgebuildings.com. https://edgebuildings.com/project-studies/lahagu-housing-project/
[7]. Hall, P., & McNeil, G. (2000). The History of Human Settlements. London: Routledge. (pp. 80-105).
[8]. Norwich, J. J. (1997). A World History of Architecture. New York: Viking. (pp. 5-18).
[9]. Pawley, M. (2010). Sustainable Housing Design: Principles, Practices, and Choices. London: Thames & Hudson. (pp. 250-275).
[10]. History of Modern Architecture." Britannica*. https://www.britannica.com/art/Western-architecture/20th-century-architecture.
[11]. MoMA (n.d.). What is Monumental Architecture? https://www.moma.org/interactives/moma_through_time/1930/a-modern-building-for-a-modern-museum/
[12]. EDGE Buildings. (n.d.). Lahagu Housing Project. Edgebuildings.com. https://edgebuildings.com/project-studies/lahagu-housing-project/
[13]. Rehoboth Properties Limited. (n.d.). Rehoboth Knightsbridge Project. Rehobothpropertiesgh.com. https://www.rehobothpropertiesgh.com/floor-plans.