International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 3, May-Jun-2026, ISSN (Online): 2395-566X

Energy Conservation in Residential Unitsa Climate-Responsive Design Approacha Climate-Responsive Design Approach

Ar. Yashika Garg, Tasneem Patanwala
Department of Architecture
SOA. IPS ACADEMY, INDORE

Abstract: **Energy conservation is now considered an essential consideration in residential architecture owing to urbanization and changes in lifestyle patterns. Contemporary residences require high levels of energy, especially when it comes to air-conditioning, lighting, and other home appliances. Consequently, energy use poses many environmental problems. In addition, the economic aspect of the issue cannot be ignored either. This paper will analyze how residential architecture could become an efficient instrument to decrease the level of energy consumption. Apart from energy-saving mechanical systems, architects should focus on passive energy-saving techniques which include proper orientation, natural ventilation, use of appropriate shading structures, and locally produced materials. All these techniques make it possible to cut down the need for energy consumption, providing residents with thermal comfort at the same time. Qualitative research will be applied in the study with the support of a case study approach. The example under discussion includes the Aranya Low-Cost Housing project designed by Balkrishna Vithaldas Doshi.**

Keywords: Energy conservation, Passive design, Residential architecture, Climate-responsive design, Natural ventilation, Sustainable housing, Thermal comfort

I. INTRODUCTION

The energy demands of households have greatly increased in recent times due to the rise in urbanization and changes in lifestyle patterns. The present-day home is not just a simple structure but a technologically equipped one where various appliance depend on artificial systems for their functioning. Artificial systems like air conditioning, fans, artificial lights, and a lot of other electronic devices have found common usage. These devices are great additions for improving convenience and comfort but at the same time, they increase energy consumption and strain natural resources.

The situation in countries like India is quite different because the demand for cooling is very high. This is due to rising temperatures and rapid urban growth. In many cases, residential buildings use up to 80% of the total energy consumed in an area. This raises concerns about sustainability, rising electricity costs, and energy availability.

It is important to mention that older buildings used passive design strategies to improve energy efficiency. They did this by incorporating features like courtyards, thick walls, shading devices, and ventilation methods. However, today, many architects tend to overlook these strategies, even though they offer significant benefits.

This paper will discuss how architectural design can help save energy.

II. OBJECTIVES

The research paper's objectives are as follows:

1. To stress the importance of conserving energy in the domestic sphere

• To investigate passive designs that reduce energy consumption

• To examine examples of residential buildings

• Comparing traditional houses with energy-saving concepts

2. To show the significance of architectural design in sustainable development

III. METHODOLOGY

The methodology adopted in this research is qualitative. Unlike quantitative methodology,

which uses mathematics, simulation, and modeling, this research tries to understand the design

process by observing and analyzing it. The following are some of the tasks involved:

Analysis of literature on effective architecture designs

Analysis of passive design ideas

Observation of residential buildings in Indore

Comparison between traditional and modern methods

Use of information from books, journals, and architectural magazines

IV. LITERATURE REVIEW

The subject of energy-efficient design has drawn significant scholarly interest since ancient times. According to Givoni (1998), buildings can attain thermal comfort by aligning their design with local climatic conditions, which helps reduce their energy needs.

Koenigsberg et al. (In 2015, recall how tropical architecture from earlier times was crafted to manage temperature, solar radiation, and airflow using fundamental methods such as shading, ventilation, and the careful selection of materials to maintain comfort for those inside. Szokolay (2014) has repeatedly emphasized that passive design is a crucial method for lowering energy consumption, with orientation, ventilation, and thermal mass playing key roles in this process.

Some of the most current literature on the subject suggests that passive techniques can help reduce domestic energy use by approximately 20% – 40%.

V. ENERGY CONSUMPTION IN RESIDENTIAL BUILDINGS

Residential buildings consume energy mainly for:

• Cooling and heating

• Lighting

• Household appliances

In hot climates like Indore, cooling accounts for the largest share of energy consumption. Poorly designed buildings absorb excessive heat, which increases the need for air conditioning.

Several factors influence energy consumption in residential buildings:

• Building orientation

• Window size and placement

• Material properties

• Ventilation

• User behavior

If these factors are not considered during design, energy consumption increases significantly. Therefore, it is important to integrate energy-efficient strategies at the early stages of design.

VI. PASSIVE DESIGN STRATEGIES

Passive design refers to techniques that reduce energy consumption by using natural elements such as sunlight, wind, and materials.

A. Orientation

Building orientation plays a major role in controlling heat gain and daylight. In India, the west direction receives strong afternoon sunlight, which increases indoor temperature. By minimizing openings on the west side and maximizing openings on the north and south sides, heat gain can be reduced.

Correct orientation also enhances natural light, decreasing reliance on artificial lighting during daylight hours.

B. Natural Ventilation

Natural ventilation lets air move through the building, helping to dissipate heat and enhance comfort.

Cross ventilation is created by positioning openings on opposite sides of a room. Air circulation aids in keeping indoor temperatures stable and lessens reliance on air conditioning.

In hot climates, ventilation ranks as one of the most effective ways to cool down.

C. Daylighting

Daylighting involves utilizing natural light within buildings. It lowers electricity use and enhances indoor air quality. Nevertheless, too much sunlight can lead to higher heat accumulation. Thus, daylight needs to be managed through shading devices.

D. Shading Devices

Devices like louvers, overhangs, and jaalis help minimize direct sunlight exposure. They permit only diffused light to enter the interior while managing excessive heat gain. These features are found in traditional architecture and continue to hold significance in modern designs as well.

E. Thermal Mass And Materials

Bricks, stone, and concrete naturally possess high thermal mass. They absorb heat during the day and release it at night, helping to maintain stable indoor temperatures. Using locally sourced building materials cuts down on construction costs and lowers environmental impact.

VII. CASE STUDY 1:

Modern House In Indore

This contemporary residence in Indore illustrates how passive design principles can be integrated into modern architectural projects.

Features include

Shading elements to manage sunlight

Wide openings to enhance natural lighting

An open-concept layout to promote better airflow

Locally available building materials

Effects on energy consumption:

Minimal dependence on artificial lighting

Decreased heating demand

Comfortable interior climate conditions

The above example proves that energy efficiency can go together with stylishness in modern homes.

VIII. CASE STUDY 2:

Aranya Housing, Indore

A. The Project

The Aranya Low-Cost Housing Project is an iconic example of architecture in harmony with the climatic conditions designed by Balkrishna Vithaldas Doshi. Constructed in 1989, the project provides accommodation to thousands of people using the approach of affordable and incremental housing development. Instead of using the conventional approach, Aranya focuses on efficiency in space utilization, use of locally sourced materials, and passive measures to ensure minimal energy consumption.

B. Climatic Conditions Of Indore

Indore experiences a combination of climatic conditions. The area witnesses hot summers, which lead to higher solar heat gain; cool winter months; and changing wind directions. Such climatic conditions expose buildings to higher temperatures, particularly during summer afternoons, leading to higher temperatures.

C. Energy Efficiency In Urban Planning

Building Density And Compact Design

High building density and compact design of Aranya ensures homes are packed closely.

Energy Efficiency Impact:

Fewer surfaces exposed to the sun

Reduced heat absorption

Minimal cooling requirements

This design minimizes exposure to heat within buildings.

Narrow Streets And Shadow Effect

Narrow streets and paths run across the project.

Energy Efficiency Impact:

Building shadow, each other

Cooler streets compared to open areas

Lower reflection of heat inside buildings

Such a design creates a self-shadow effect within buildings.

International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 3, May-Jun-2026, ISSN (Online): 2395-566X

D. Building-Level Energy Conservation Measures

Courtyard Design

Most buildings have private courtyards.

Energy impact:

Increases natural ventilation

1. Promotes the creation of a stack effect where warm air rises and escapes

• Enhances natural lighting

The courtyard serves as an inherent cooling agent, reducing the need for mechanical cooling.

E. Natural Ventilation

Windows and doors are positioned to facilitate cross-ventilation.

Energy impact:

Air flow helps remove heat from interiors

Decreases temperatures indoors

Reduces dependence on artificial cooling systems

Ventilation is regarded as one of the most powerful energy conservation techniques in tropical regions.

Local Material Use

Building construction relies heavily on bricks, stones, and lime.

Energy impact:

The high thermal mass moderates' indoor temperatures

1. Heat absorption during the day followed by slow release of heat reduces the need for artificial cooling

2. Utilization of locally available materials also reduces embodied energy.

Incremental Housing Approach

Aranya follows the principle of incremental housing, whereby houses are extended progressively.

Energy impact:

1. Starting off with small house sizes reduces initial energy needs

• Progressive addition of space minimizes resource utilization

• Space optimization results in reduced energy consumption

F. Passive Cooling Techniques

The project incorporates a few techniques of passive cooling, including:

In-built shading

Design encouraging air flow

Use of high thermal mass material

Cooler courtyard spaces

From all these, we get:

Lower indoor temperatures than outdoor temperatures

Reduced dependence on mechanical cooling

G. Sociobehavioral Impact Of Energy Consumption

How do people use energy in the Aranya community?

1. Outdoor shaded areas reduce the requirement for energy inside the building

• Common areas increase social interaction, thus eliminating loneliness

• Smaller rooms result in less energy consumption

All these prove that energy efficiency can be achieved through behavioral changes.

H. Key Learning Points

1. Urban planning plays an important role in energy consumption

• Passive strategies surpass mechanical cooling in hotter areas

• Incorporating local materials enhances thermal efficiency

2. It's crucial to integrate courtyards and ventilation systems

3. Buildings with optimal density consume less energy.

I. Conclusion To Case Study

Study The Aranya Low-Cost Housing Project demonstrates that energy efficiency can be achieved without relying on complex technology hinges on intelligent design. By employing passive cooling methods, thoughtful design layouts, and locally sourced materials, energy usage can be lowered considerably.

International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 3, May-Jun-2026, ISSN (Online): 2395-566X

IX. IMPLICATIONS OF THE FINDINGS FOR FUTURE HOUSING

• Treating climate as a crucial factor in design

• Focus on passive techniques

• Carefully consider orientation

• Use local materials

Strive to reduce the building's energy demand; these concepts help in developing sustainable housing.

X. LIMITATIONS OF THE STUDY

• Employed a qualitative research approach

• Lack of numerical data

Outcomes may differ according to climatic conditions and human behavior in space.

XI. CONCLUSION

Energy conservation in domestic structures is essential for sustainable development. The present

study demonstrates the critical role of architectural design in reducing energy consumption.

Using passive design principles, comfortable living spaces can be created with minimal

dependency on artificial heating or cooling systems. The examples provided demonstrate that

energy efficiency can be achieved through efficient design. In future, architectural designs for

residences should focus on climatic sensitivity to reduce their environmental footprint and

improve the quality of life.

REFERENCES

BIBLIOGRAPHY

1. Givoni, B. (1998). Climate Considerations in Building and Urban Design. John Wiley & Sons.
2. Koenigsberger, O. H., Ingersoll, T. G., Mayhew, A., & Szokolay, S. V. (2015). Manual of Tropical Housing and Building. Orient Blackswan.
3. Szokolay, S. V. (2014). Introduction to Architectural Science: The Basis of Sustainable Design. Routledge.
4. Doshi, B. V. (1989). Aranya Low-Cost Housing Project, Indore.
5. Olgyay, V. (2015). Design with Climate: Bioclimatic Approach to Architectural Regionalism. Princeton University Press.

WEBLIOGRAPHY

1. International Energy Agency
   Energy Efficiency in Buildings Report
   https://www.iea.org
2. Bureau of Energy Efficiency
   Energy Conservation Building Guidelines
   https://beeindia.gov.in
3. Ministry of New and Renewable Energy
   Sustainable Energy Resources
   https://mnre.gov.in
4. ResearchGate
   Passive Design Strategies for Energy Efficiency
   https://www.researchgate.net
5. ScienceDirect
   Energy Conservation in Buildings Research Papers
   https://www.sciencedirect.com
6. The Architects Diary
   Case Study: Residential Design in Indore
   https://thearchitectsdiary.com