ICCAUA Proceedings Journal
Proceedings of the international conference of contemporary affairs in architecture and urbanism-ICCAUA
Volume 9 (December 2026), 2610494

Journal homepage: https://journal.iccaua.com/

DOI: https://doi.org/10.38027/ICCAUA2026EN0494

Low-Carbon Lifestyles: Residential Interventions to Reduce Urban Carbon Emissions

* [1] **Deeksha Sharma** , [2] **Dipanshu Sharma**
[1] Independent Researcher, Agra, India
[2] Independent Researcher, Dubai, UAE
[1] E-mail: deeksha_s@ar.iitr.ac.in , [2] E-mail: dipanshu.sharma1911@gmail.com
[1] ORCID: https://orcid.org/0009-0007-8218-0314 , [2] ORCID: https://orcid.org/0000-0001-8740-315X

Received: 29.04.2026
Revised: 30.06.2026
Accepted: 01.07.2026
Available online: 10.07.2026

This article has been selected and peer-reviewed for publication in this journal as part of the 9th International Conference of Contemporary Affairs in Architecture and Urbanism, held on 7–8 May 2026 in Istanbul, Türkiye.

Abstract

Urbanization is a major contributor to the global carbon footprint, with the building sector alone responsible for a significant share of emissions. In developing countries like India, the residential sector ranks just behind industry in carbon emissions. This paper focuses on the role of individual households in addressing this issue by adopting simple, affordable, and practical strategies to reduce emissions. It discusses common lifestyle-based activities, such as water and electricity usage, transportation, and daily household practices, and introduces ways to modify them to lower carbon output. Techniques like grey water reuse, use of passive design, roof gardens, and the adoption of solar energy are also explored. The paper emphasizes that change at the household level, though small in scale, can collectively make a meaningful difference. These solutions aim to be cost-effective, easy to implement, and suitable for everyday homes, promoting a shift toward sustainable living from the ground up.
Keywords: Carbon Emission; Sustainable Living; Low-Carbon Strategies; Urban Heat Island (UHI) Effect; Renewable Energy.

1. Introduction

Urbanization is one of the major reasons behind the increase in global carbon emissions. Around 55% of the world's population currently lives in urban areas (United Nations, Department of Economic and Social Affairs, Population Division, 2019), and rapid urban growth has resulted in increased energy consumption, transportation demand, resource exploitation, and greenhouse gas emissions. Although urban areas occupy only a small percentage of the earth's surface, which is about 2% (Guo, Zhoa, Liu, & Zhang, 2024), they contribute a major share of global greenhouse gas emissions.
The building sector contributes significantly to global energy consumption and carbon emissions. Residential and commercial buildings together are responsible for a large portion of greenhouse gas emissions associated with heating, cooling, lighting, cooking, and electricity usage (UNEP). In India, the residential sector is one of the major contributors to greenhouse gas emissions after the industrial sector (ICLEI, 2009).
The increasing demand for housing, energy-intensive lifestyles, dependence on private transportation, excessive water consumption, and changing consumption patterns have further increased emissions from the residential sector. Therefore, there is a need to understand how household-level activities contribute to carbon emissions and identify practical solutions that can be adopted in everyday life.
This study focuses on household-scale interventions and low-carbon practices that are simple, affordable, and easy to implement. The study highlights how small behavioral and infrastructural changes at the residential level can collectively contribute toward reducing urban carbon emissions.
Aim: "To understand the impact of carbon emission due to residential sector and have a discussion over the ways to reduce the emission."
Objective:
1. To review the literature and get an overview of the residential sector's contribution in carbon emission.
2. To review and understand the low carbon emission and its impacts on household level activities.
3. To identify few techniques to minimize the carbon emission with changes in life style.

Research gap:
Existing studies mainly focus on carbon emissions at urban scale, neighborhood scale, or individual building level independently. However, there is limited research focusing on the relationship between household-level interventions and their cumulative impact on urban carbon emissions (Jamali, Taghizadeh, & Arbab, 2025).

Most studies discuss technological or policy-level approaches, while comparatively fewer studies emphasize practical lifestyle-based interventions that can be implemented by average households with limited financial investment.

Scope:
- The study focuses on residential sector emissions.
- The study emphasizes household-level interventions and lifestyle modifications.
- The paper discusses practical low-carbon strategies applicable to average households.

Limitation:
- The study is limited to the residential sector.
- Financial feasibility analysis is not included in detail.
- The activities discussed are selected based on common and major household practices.
- The study does not include detailed quantitative carbon calculations.

Methodology:

The methodology adopted for this study is primarily based on literature review and conceptual understanding of carbon emissions associated with the residential sector. Firstly, an extensive review of literature was conducted to understand the concepts of carbon footprint, greenhouse gas emissions, and low-carbon development. Secondly, global and national trends related to residential sector carbon emissions were studied to understand the growing environmental concerns associated with rapid urbanization and increasing energy consumption. Thirdly, major household-level activities contributing to carbon emissions, such as electricity consumption, water usage, transportation, and lifestyle practices, were identified and analyzed. Further, a case-based understanding using Agra city was incorporated to examine emission patterns, urban heat concerns, and the relationship between density, temperature, and green cover. Subsequently, various low-carbon household strategies and sustainable interventions were studied and discussed, including passive design techniques, water conservation methods, renewable energy adoption, and behavioral changes. Finally, the findings were analyzed to draw conclusions and recommendations regarding the role of household-level interventions in reducing urban carbon emissions and promoting sustainable living practices.

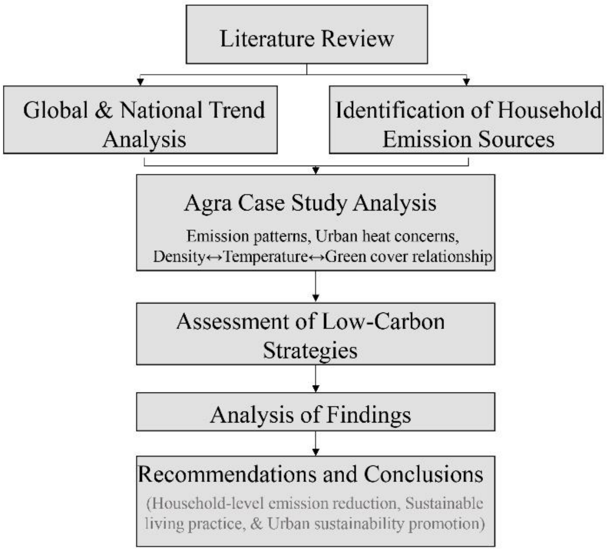

Figure 1. Structure of the Study (Developed by Authors).

2. Materials and Methods

2.1. Literature Review

2.1.1. Understanding of Carbon Footprint and Greenhouse Gases (GHGs)

Definitions:
- Carbon footprint refers to a measure used to assess the amount of greenhouse gas emissions generated by an activity, product, organization, or system, and serves as an important indicator for evaluating progress towards sustainable development (Yu, et al., 2024).
- A greenhouse gas, abbreviated GHG, is both natural and human- induced constituents of atmosphere that absorbs and emits radiation within the thermal infrared range (IPCC, 2008).

The residential sector contributes to GHGs emission through activities such as: electricity consumption, cooking and heating, water consumption, transportation, construction materials, waster generation, etc. (Yan, Zhou, Ma, & Mao, 2025).

2.1.2. Rapid Urbanization and Effects of Carbon Emission

Carbon emissions increase the concentration of greenhouse gases in the atmosphere, disturbing the natural balance and negatively affecting the environment. Urban economic activities depend heavily on infrastructure such as power supply, roads, water supply, telecommunications, transportation, sanitation, and solid waste management (IPCC, 2022). A significant share of greenhouse gas emissions is associated with these infrastructures, leading to increased pressure on natural resources. Rapid urbanization is therefore one of the major causes of increasing carbon footprint; however, its adverse impacts can be reduced through sustainable practices.

Effects of Carbon Emission on global level:
Large cities are responsible for about 75-80 per cent of the GHGs released into our atmosphere (Satterthwaite, 2008). India is the world's third largest emitter of carbon-dioxide (CO_2) in terms of absolute emissions (Alam, et al., 2023) and (Sahni & Aulakh, 2014). The UNFCCC organize different tasks and protocols to control this issue and many countries are working by making goals like zero carbon cities, eco city, Net zero goal, etc.
Effects of Carbon Emission on national level (India):
Over half of global population is living in urban areas and many researchers say that urbanization is the main cause of carbon emission (Yu, et al., 2024) because the environment gets ignored in the infrastructure development process, especially in the small-scale development process. About 34% of India's population is living in urban areas (United Nations, Department of Economic and Social Affairs, Population Division, 2019) and the Indian construction industry is growing at a rate of >8% per annum (Reddy, 2009).
In India the emission released from different building sectors are shown in the graph (refer figure 2) and it represents that there is not a very huge difference in industrial, residential and commercial sectors (ICLEI, 2009). This figure clarifies that the residential building sector is the second most emitter of the carbon in India. Further, the same situation has been analysed for the one of the Indian cities (Agra) to understand its most carbon emitting building sector (refer figure 3). Moreover, in Agra city, the residential sector is the highest emitter of carbon.

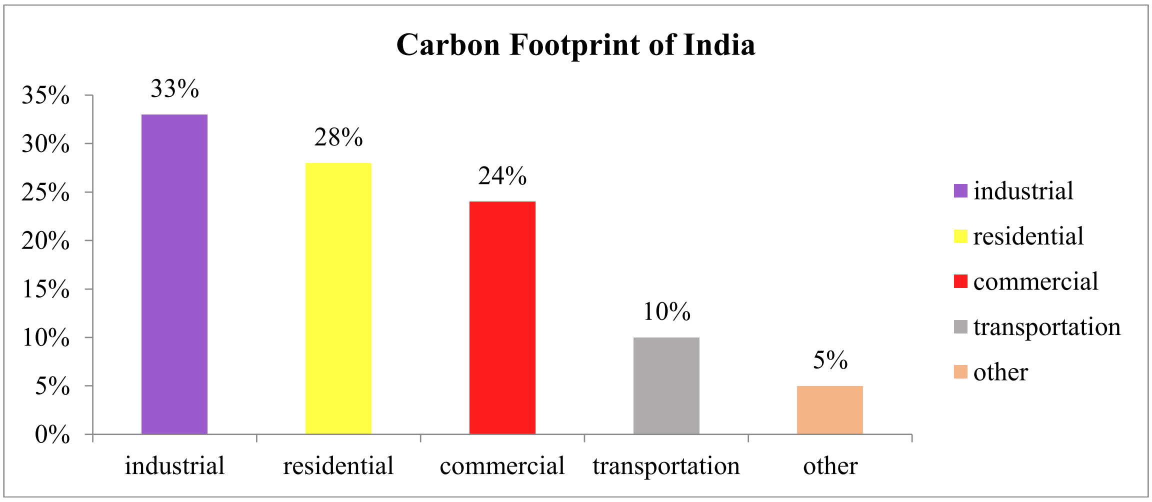

Figure 2. Carbon emission chart for different building sectors in India. (Developed by Authors- Referenced from *(ICLEI, 2009)*.

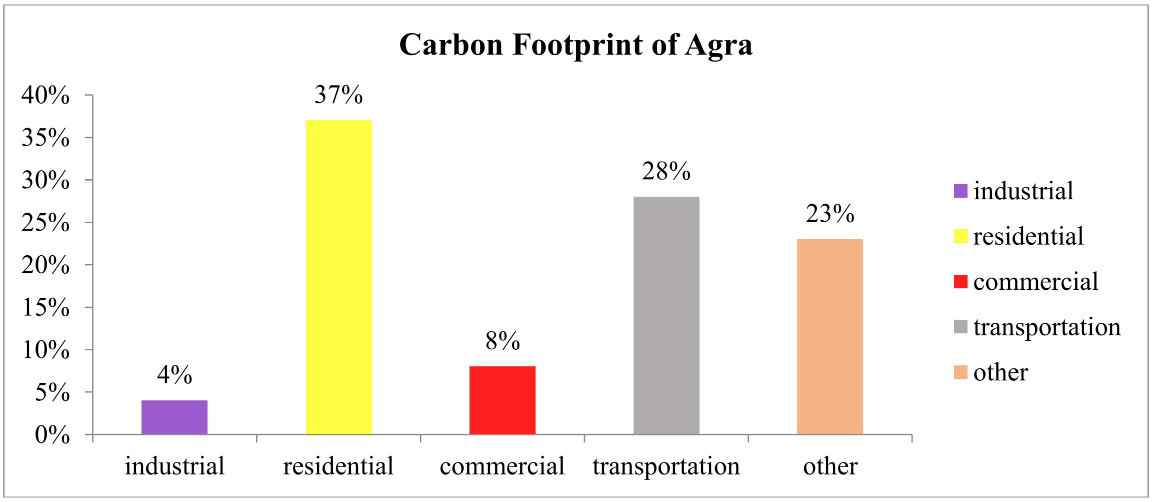

Figure 3. Carbon emission chart for different building sectors in Agra. (Developed by Authors- Referenced from *(ICLEI, 2009)*

2.1.3. Carbon Emission from Residential Sector
The residential sector contributes to carbon emissions mainly through energy used for:
- Heating and cooling
- Lighting and appliances
- Cooking
- Water pumping and treatment
- Transportation associated with household activities

Studies indicate that operational energy consumption forms a major share of residential sector emissions (Yu, et al., 2024) and (Dutt & Sil, 2014)

2.1.4. Case Study: Agra City

A case study of Agra city has been considered to understand the relationship between carbon emission patterns, population density, green cover, and temperature variations. Agra was selected as the study area because it shares characteristics similar to many Indian and global cities while also having unique qualities. The city represents a combination of historical significance, tourism activities, cultural importance, and industrial presence, making it suitable for understanding diverse urban characteristics (Sharma & Roy, 2024).

GIS-based mapping of population density, green cover, and surface temperature was carried out to examine the relationship between urban heat island (UHI) effect, climate change, and carbon emissions. The study aimed to understand whether population density, green cover, and temperature patterns are interrelated and how increasing carbon emissions influence these environmental conditions.

As observed through various literature reviews, the residential sector in India has emerged as one of the major contributors to CO_2 emissions over time (Ramachandra, Aithal, & Sreejith, 2015).

Climate Change and Urban Heat

According to Earth Data GIS, Agra experienced more than 180 extreme heat days in the year 2016. Further, population density maps, per capita green cover maps, and temperature maps were analysed (refer Figure 4) (the maps in figure 4 can be accessed through the reference mentioned and used for representation purpose in this paper) (Sharma & Roy, 2024), and the following observations were made:

- Higher density is associated with higher temperature.
- Lower green cover contributes to higher urban heat.
- Green cover helps in reducing urban temperature.

Relationship observed:

- Green Cover ∝ 1/Temperature
- Density ∝ Temperature
- Green Cover ∝ 1/Density

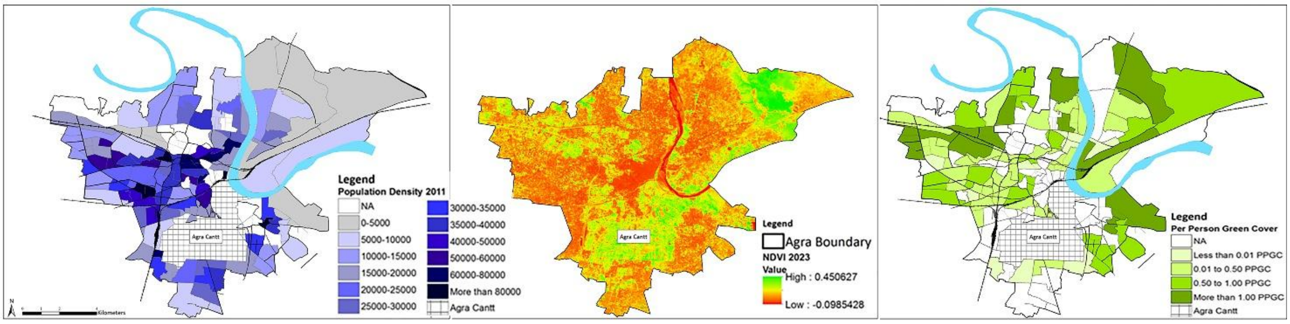

Figure 4. Comparison between population, temperature and green cover (Sharma & Roy, 2024).

Large amount of Carbon emission and greenhouse gases released, from buildings industry, during construction and in its lifetime. There are different strategies and ways introduced by government to control the emission and in addition to that this research talk about the small step that can be taken by every household on their level to contribute in reducing the emission percentage. India being a developing country is facing many issues like unemployment, poverty, improper education, lack of housing, inadequate infrastructure, etc. This research will include common activities of an average household type that can help to make a difference in amount of CO2 emission.

3. Low Carbon Emission

Low-carbon emission refers to minimizing the amount of carbon released throughout the life cycle of a product, activity, or system.

The process of reducing carbon footprint involves: 1. Knowledge: Understanding carbon emissions, 2. Effects: Understanding environmental impacts, and 3. Low-carbon consumption: Adopting sustainable and low-emission practices.

3.1.1. Ways to Reduce Carbon Emission

As discussed earlier, carbon footprint refers to the amount of carbon emitted during the entire life cycle of a product, from its production to disposal (refer figure 5). In the building and construction sector, the use of materials with qualities such as longer life span, low maintenance, and local availability can help reduce emissions associated with extraction, transportation, and maintenance activities. This research focuses on such small-scale household-level interventions that can collectively help in reducing carbon emissions. The concepts of carbon emission, its environmental impacts, and the selected research sector have been discussed in the previous sections; the following chapter focuses on practices and strategies that can help reduce emissions to some extent.

Figure 5. Life span of CO2 emission of a product. (Developed by Authors)

Low-carbon living focuses on reducing energy consumption, resource wastage, and environmentally harmful activities through efficient and sustainable alternatives.

3.1.2. Household Activities Contributing to Carbon Emission

The following household activities were identified as major contributors to carbon emissions. Based on their nature and impact, these activities were further analysed and categorized for behavioural change-based and nature-based intervention strategies (refer Table 1).

Table 1: Activities: contributing to carbon emission (Source: Developed by Author, Referred from (Dutt & Sil, 2014).

Activities	behavioural change-based strategies	Nature-based strategies
Electricity use	Energy-efficient appliance usage, conscious electricity consumption, reduced unnecessary usage	Passive ventilation, daylight utilization, roof greenery
Water consumption	Controlled water usage, water-saving practices, efficient fixtures	Greywater, rainwater harvesting, natural water recharge
Cooking practices	Efficient cooking habits, reduced fuel wastage	Natural ventilation, locally available materials/fuels
Transportation	Public transport, walking, cycling, ride sharing	Green corridors, shaded pedestrian environment
Waste generation	Waste segregation, reduced consumption, recycling practices	Composting, organic waste management
Cooling and heating	Controlled appliance use, temperature-conscious behaviour	Passive cooling, green cover, thermal insulation
Construction materials and maintenance	Use of durable materials, low-maintenance practices	Local materials, climate-responsive construction

4. Low-Carbon Strategies for Residential Sector

The residential sector contributes significantly toward urban carbon emissions through daily household activities such as electricity consumption, water usage, transportation, cooling, construction practices, and lifestyle patterns. Although these activities are generally performed at an individual household scale, their cumulative impact at neighbourhood and city level becomes substantial. Therefore, adopting low-carbon lifestyle practices and climate-responsive household interventions can play an important role in reducing urban carbon emissions. This section discusses different behavioural, passive, nature-based, and resource-efficient strategies that can help reduce the carbon footprint associated with residential sector activities while promoting sustainable urban living practices.

4.1. Lifestyle and Behavioural Interventions

Behavioural changes at the household level can significantly reduce carbon emissions without requiring major financial investment.

Sustainable Transportation: (Li, Huang, Zhang, & Yao, 2024) & (Jing, Liu, Yu, & He, 2022)

Transportation contributes significantly toward CO_2 emissions. Group travel, public transportation, walking, and cycling reduce per capita emissions and are cost-effective alternatives. As observed through various literature reviews, the use of public transportation helps in reducing CO_2 emissions while also decreasing the overall energy load on the city. Reduced dependence on private vehicles can therefore contribute toward lower fuel consumption, reduced traffic congestion, and more sustainable urban living practices.

Energy-Conscious Lifestyle: (Olatunde, Okwandu, & Akande, 2024) & (Guo, Xu, & Li, 2025)

- Switching off appliances when not in use.
- Using energy-efficient appliances.
- Reducing excessive electricity consumption.
- Optimizing natural lighting and ventilation.

An energy-conscious lifestyle is already practiced in many Indian households to some extent through daily resource-saving habits. However, the use of more effective and efficient systems can further help in reducing energy consumption. The adoption of sensor-based appliances, energy-efficient systems, and better electricity management practices can reduce unnecessary energy use and contribute toward lower carbon emissions at the household level.

4.2. Water Conservation Strategies

Water treatment and pumping consume significant energy, indirectly contributing to carbon emissions.

Greywater Reuse:

Greywater generated from household activities can be reused for gardening, flushing, and cleaning purposes. A 'Domestic grey water recycling pit' can be made as per the need and usable of the household, which will have the layer of gravels, sand and charcoal to recycle the grey water. Moreover, this home treated water can be used for different activities in the household such as gardening, washing vehicles, washing the outdoors, cleaning purposed, etc. All those activities which requires more water than usual usage of water can be performed using treated grey water.

Rainwater Harvesting:

Rainwater harvesting helps reduce dependence on external water supply systems and promotes sustainable water management.

In many Indian cities the ground water level (GWL) is decreasing, in result of which more efforts (powerful machinery) for water extraction and distribution, which means more CO2 consumption. To reduce the CO2 consumption through decreasing water level, rain water harvesting (RWH) pits are one of the best options. Ministry of Jal Shakti also introduced, Catch the Rain program under Jal Shakti Abhiyan, which is helping in promoting the use of RWH pits. A rain water harvesting pit does not need too much space, it can be built in almost all the houses as they already have the rain water pipe to drain out the excess water from roof, the scale of the pit can be adjusted based on the requirement of the household. The reference image for a typical RWH pit with the different layers and typical dimensions (refer figure 6). This pit is made attached to the rain water pipe coming from roof. It can be installed in any house hold with such simple way.

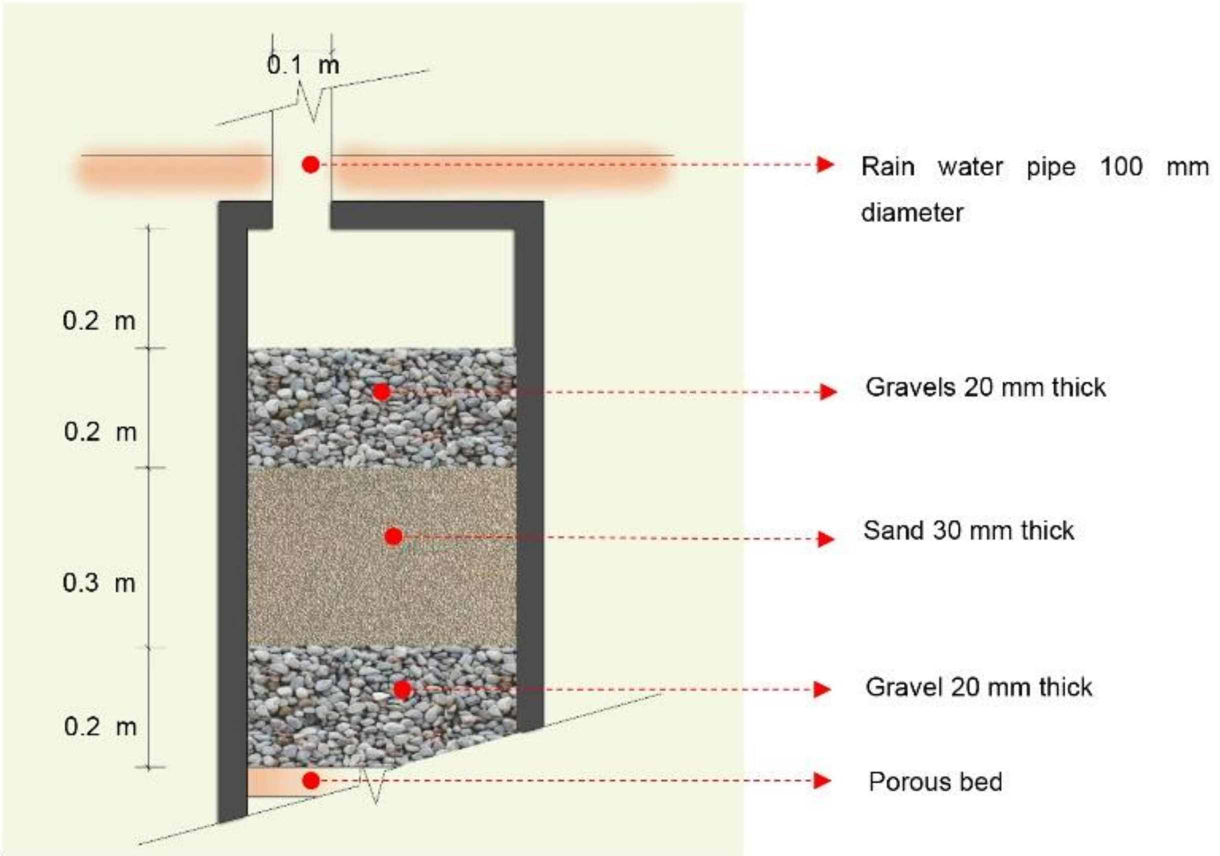

Figure 6. The rain water harvesting pit. (Developed by Authors)

4.3. Passive Design Strategies

Passive design techniques help reduce dependence on mechanical cooling and artificial lighting.

Natural Ventilation and Daylighting: (Bashir , et al., 2024)

Natural ventilation and daylighting are important passive design strategies that help reduce dependence on mechanical cooling and artificial lighting. Climate-responsive design approaches can improve indoor thermal comfort while reducing energy consumption.

A similar approach has been observed in TERI University, Delhi, where passive design techniques such as wind towers and earth tunnels have been incorporated for cooling and ventilation purposes. Wind towers help in directing natural airflow within the building, while earth tunnel systems assist in cooling the air before it enters indoor spaces. Such techniques help in maintaining indoor comfort with reduced energy demand. (refer figure 7 and 8) & (refer figure 10).

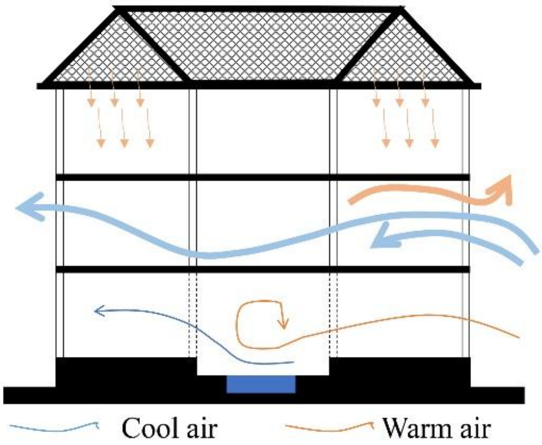

Figure 7. Illustration of natural ventilation and daylighting in typical house. (Source: Developed by Authors)

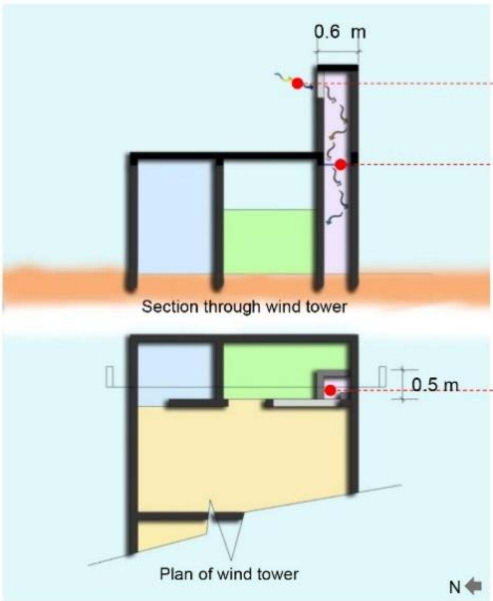

Figure 8. The wind tower to increases the cross ventilation. (Developed by Authors)

Thermal Insulation: (Violano & Cannaviello, 2023)
Thermal insulation helps in reducing heat gain and maintaining indoor thermal comfort, thereby lowering the need for mechanical cooling systems.
In TERI University, Delhi, tiles have been installed on external walls with gaps maintained through bolt connections, creating an air cavity between the wall surface and tiles (refer figure 9). This air gap acts as insulation and helps in reducing heat transfer, keeping the building comparatively cooler and improving thermal performance. Additionally, an illustration of Trombe wall, which is constructed in the cold region of Ladakh is also represented (refer figure 10). Using climate-responsive materials and shading techniques reduces indoor heat gain (refer figure 11).

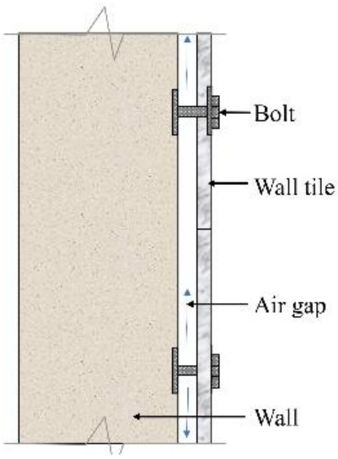

Figure 9. Illustration of air gap used for thermal insulation in TERI university. (Source: Developed by Authors)

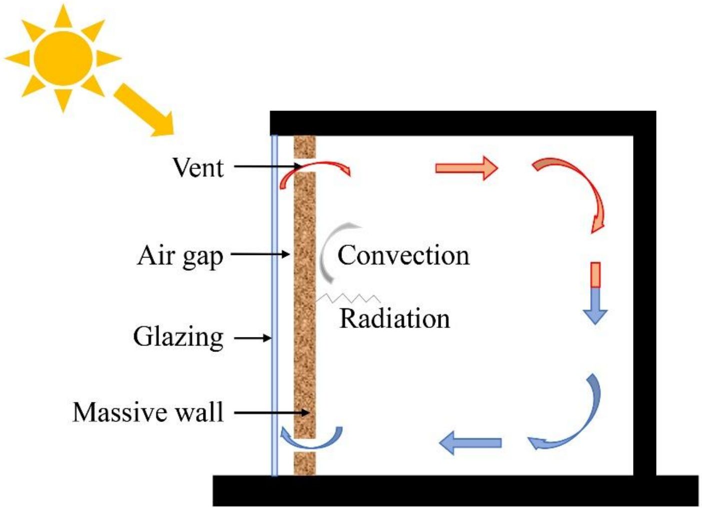

Figure 10. Illustration of thermal insulation (Trombe Wall in cold regions). (Source: Developed by Authors)

4.4. Roof Gardens and Green Cover

Roof gardens and urban greenery can also be a better and effective option of reducing the CO2 emission in heating and cooling of the building. Roof garden that will help to protect the building from heat gain or loss and having the solar panels on roof can create the cavity that protect the roof surface from direct contact of sun light, and such passive techniques for houses will help the building to use less mechanical ventilation ways. An illustration of roof garden, green cover and proper orientation of building and shades protecting the heat gain of the building (refer figure 11).

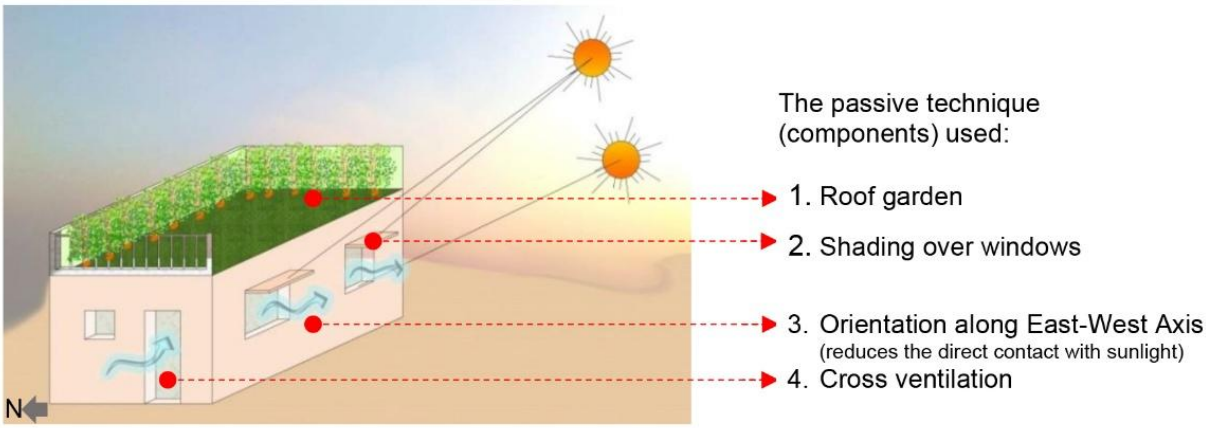

Figure 11. Passive technique to protect the building from heat gain. (Developed by Authors).

In TERI University, Delhi, extensive plantation and green cover have also been incorporated within the campus environment, helping in reducing surrounding temperatures and improving thermal comfort. Increasing green cover can contribute toward reducing carbon emissions by lowering surface temperatures and reducing energy demand for cooling purposes.

It can be observed from the map comparison and analysis in the case of Agra (refer figure 3), areas with higher green cover experience comparatively lower surface temperatures. Increased green cover helps in reducing the surrounding temperature and lowering the overall energy demand for cooling purposes. A research study on green spaces in Agra has also discussed different approaches for increasing urban green cover through techniques such as roof gardens, green walls, personal gardens, and similar strategies (Sharma & Roy, 2024).

4.5. Renewable Energy Adoption

Solar Energy:

Solar panels and solar-based systems reduce dependence on fossil-fuel-based electricity. Using solar energy for power consumption is one of the most efficient ways to reduce the CO2 emission. It is a one-time investment option and a very long-term benefit. The solar lamps and lights can be used for the outdoor lighting and for the indoor power usage solar panels can be installed. The government has also introduced the PM-Surya Ghar: Muft Bijli Yojna, according to which the government will subsidies up to 60% of the cost of installation for solar panel for households.

Renewable Energy-Based Household Practices:

- Solar water heating
- Solar lighting
- Rooftop photovoltaic systems

4.6. Vernacular and Climate-Responsive Practices

Traditional and vernacular practices often use locally available materials and climate-responsive design principles that reduce energy consumption.

These practices include:

- Courtyard planning
- Thick walls and insulation
- Use of local materials
- Climate-responsive settlement patterns

Example: In the state of Himachal Pradesh, a popular vernacular household practice is used- Thathara. In this type of housing the ground floor is kept for the cattle/ poultry/ etc. and first floor is built as per usual houses. The heat from the cattle keeps the upper floors warm, at the same time it provides shades for the cattle. This way the space is saved and energy is saved to keep the house warm, an illustration of Thathara is shown in figure 12.

Similarly, climate-responsive techniques such as water channels, high-height rooms, and pressure-based airflow movement have also been incorporated in TERI University, Delhi. Water channels help in improving the surrounding microclimate, while higher room heights improve air circulation and thermal comfort (refer figure 13). The building entrance has also been designed in a way that creates pressure-driven air movement, allowing cooler air to circulate through internal corridors and indoor spaces.

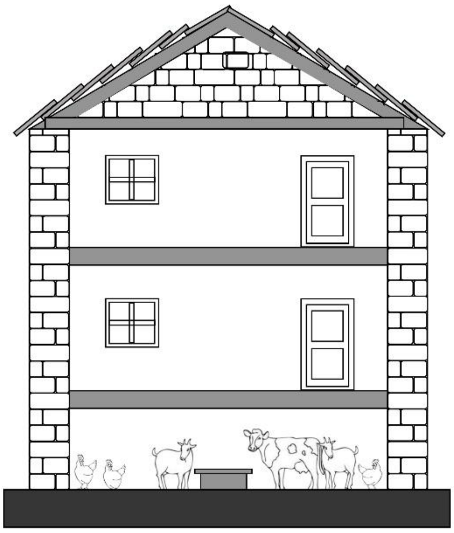

Figure 12. Thathara house. (Source: Developed by Authors).

Figure 13. Water channels across the campus of TERI university. (Source: Developed by Authors).

This section indicates that household-level low-carbon lifestyle practices can collectively contribute toward significant reduction in urban carbon emissions. Strategies such as energy-conscious behavior, water conservation, passive cooling techniques, renewable energy adoption, roof gardens, and vernacular climate-responsive practices not only reduce household energy demand but also improve urban environmental conditions. Although these interventions may appear small at an individual scale, their large-scale adoption can support sustainable urban development, reduce dependence on energy-intensive systems, and contribute toward climate-responsive urban living.

5. Relationship Between Household-Level Interventions and Urban Carbon Reduction

Small-scale residential interventions, when adopted collectively at neighborhood and city level, can significantly influence urban carbon emission patterns. Since the residential sector contributes a considerable share of urban emissions, household-level behavioral and resource-efficient changes can directly support low-carbon urban development.

The relationship between household-level interventions and urban-scale environmental benefits can be observed through various practices.

- The use of public or shared transportation helps reduce vehicular CO_2 emissions, traffic congestion, and fuel consumption.
- Water-saving fixtures, greywater reuse, and rainwater harvesting reduce freshwater demand, lower energy consumption associated with water treatment and supply systems, and improve groundwater recharge.
- Similarly, passive cooling strategies, natural ventilation, roof gardens, vegetation, and increased green cover help reduce electricity demand and mitigate Urban Heat Island (UHI) effect.
- The adoption of solar energy systems reduces dependence on fossil-fuel-based electricity, while the use of local and vernacular materials helps reduce embodied carbon associated with transportation and construction activities.

Collectively, these household-scale interventions contribute toward lowering urban carbon intensity, improving urban microclimate, reducing pressure on centralized infrastructure systems, and supporting sustainable urban planning and climate-responsive development practices.

6. Discussion

The study highlights that the residential sector plays an important role in urban carbon emissions through everyday household activities such as transportation, electricity consumption, water usage, cooling practices, construction materials, and lifestyle patterns. Rapid urbanization and increasing energy demand have further increased environmental stress and carbon emissions within cities. The findings of the study indicate that household-level interventions, although small in scale individually, can collectively contribute toward significant reduction in urban carbon emissions when adopted at a larger scale. The analysis of Agra city also demonstrated the relationship between green cover, population density, and temperature variation. Areas with higher green cover were observed to have comparatively lower surface temperatures, while densely populated areas experienced higher temperatures. This indicates that increasing green cover and adopting climate-responsive planning strategies can help reduce urban heat and lower the energy demand associated with cooling.

The study further observed that behavioral and passive design-based strategies can reduce dependence on energy-intensive systems. Practices such as public transportation usage, water conservation, passive cooling, natural ventilation, thermal insulation, roof gardens, renewable energy adoption, and vernacular climate-responsive techniques can collectively support sustainable urban living. Many of these interventions are affordable, practical, and suitable for household-scale implementation, making them accessible for wider adoption. The examples discussed in the study, including vernacular practices and climate-responsive features observed in TERI University, Delhi, demonstrate that traditional knowledge and passive design approaches can still play an effective role in reducing energy consumption and improving thermal comfort.

Similarly, household-level resource management practices such as greywater reuse, rainwater harvesting, and energy-conscious lifestyle changes can help reduce pressure on urban infrastructure systems while contributing toward environmental sustainability. The study emphasizes that achieving low-carbon urban development is not dependent only on large-scale technological or policy interventions, but also on small and practical lifestyle-based changes at the household level. The cumulative impact of such interventions can contribute toward reducing urban carbon emissions, improving environmental quality, and supporting climate-responsive urban development.

7. Conclusions

This study examined the contribution of the residential sector to carbon emissions and explored practical household-level strategies for reducing the carbon footprint. The literature review and case-based analysis confirmed that residential activities such as electricity consumption, transportation, water usage, cooling practices, construction materials, and lifestyle patterns contribute significantly to urban carbon emissions. The study therefore achieved its objectives by identifying the major sources of emissions within the residential sector and reviewing feasible low-carbon practices that can be adopted at the household level.

The findings indicate that low-carbon lifestyle practices and climate responsive interventions, including energy conscious behavior, sustainable transportation, greywater reuse, rainwater harvesting, passive design techniques, roof gardens, renewable energy adoption, and vernacular climate-responsive approaches, can collectively reduce energy demand and environmental stress. Although these interventions may appear small at the individual household scale, their cumulative implementation has the potential to contribute significantly to urban carbon reduction and sustainable development.

The case-based analysis of Agra city further demonstrated the relationship between population density, green cover, and temperature patterns. Areas with higher green cover were associated with comparatively lower temperatures, while densely populated areas experienced higher temperatures. These findings highlight the importance of integrating green infrastructure and climate responsive planning measures into residential environments to reduce urban heat.

The study supports the premise that reducing carbon emissions is not dependent solely on large scale technological advancements or government-led actions. Household-level behavioral changes and resource efficient practices can also play an important role in achieving low-carbon urban development. Furthermore, supportive policies such as incentives for renewable energy systems, rainwater harvesting, and sustainable housing practices can accelerate the adoption of these measures.

The contribution of this study lies in bringing together household-scale behavioral, passive, nature-based, and resource efficient strategies within a single framework and highlighting their collective role in reducing urban carbon emissions. While existing studies often focus on city-scale, neighborhood-scale, or building-level interventions independently, this study emphasizes the cumulative impact of everyday household actions on urban sustainability. Future research may further explore the quantitative carbon reduction potential of these interventions, regional climate-responsive adaptations, and low-cost sustainable innovations suitable for diverse urban contexts.

Acknowledgements
The authors would like to express their sincere gratitude to God for providing guidance, strength, and confidence throughout the completion of this research work. The authors are also deeply thankful to their parents for their constant support, encouragement, and motivation during the course of the study. The authors would further like to thank the officials and individuals associated with TERI University, Delhi, for providing the opportunity to visit the campus and for explaining the various climate-responsive and sustainable features incorporated within the institution, which greatly contributed to the understanding and development of this study. Special thanks are also extended to Mr. Dipanshu Sharma for his valuable support, cooperation, and contribution throughout the research work despite his professional commitments.

Funding
This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflicts of Interest
The author(s) report no conflicts of interest.

Data Availability Statement
Data could be available upon request for further research based on the requirement.

Institutional Review Board Statement
Not applicable.

CRediT Author Statement
Detailed contribution of each author is- Conceptualisation- Deeksha & Dipanshu; Methodology- Deeksha & Dipanshu; Writing – original draft- Deeksha; Writing – review & editing- Dipanshu. *All authors have read and approved the final manuscript.*

Reference List
Guo, R., Xu, A., & Li, H. (2025, July 23). Energy Conservation and Carbon Emission Reduction Potentials of Major Household Appliances in China Leveraging the LEAP Model. *MDPI, 15*(15). doi:https://doi.org/10.3390/buildings15152615

Mukherjee, A., Goswami, A., Pahil, P., Kumar, S., & Singh, P. (2025, December). Concerns of growing carbon footprint of urban groundwater extraction in India: a case study of Faridabad, Haryana. *Water-Energy Nexus, 8*, 326-340. doi:https://doi.org/10.1016/j.wen.2025.09.001

Rajan, A., Ghosh, K., & Shah, A. (2020, April 20). Carbon footprint of India's groundwater irrigation. *Carbon Management, 11*(3), 265-280. doi:https://doi.org/10.1080/17583004.2020.1750265

Ahmad, S., Baiocchi, G., & Creutzig, F. (2015, September 15). CO2 Emission frem Direct Energy Use of Urban Household in India. *Environmental Science & Technology, 49*(19), 11312-11320. doi:https://doi.org/10.1021/es505814g

Alam, M. S., Duraisamy, P., Siddik, A. B., Murshed, M., Mahmood, H., Palanisamy, M., & Kirikkaleli, D. (2023, July). The impacts of globalization, renewable energy, and agriculture on CO2 emissions in India: Contextual evidence using a novel composite carbon emission-related atmospheric quality index. *Gondwana Research, 119*, 384-401. doi:https://doi.org/10.1016/j.gr.2023.04.005

Balasbaneh, A. T., & Marsono, A. K. (2017, November 01). Strategies for reducing greenhouse gas emissions from residential sector by proposing new building structures in hot and humid climatic conditions. *Building and Environment, 124*, 357-368. doi:https://doi.org/10.1016/j.buildenv.2017.08.025

Bashir , F. M., Dodo , Y. A., Mohamed , M. A., Norwawi, N. M., Shannan , N. M., & Afghan, A. A. (2024 , February 21). Effects of natural light on improving the lighting and energy efficiency of buildings: toward low energy consumption and CO2 emission . *International Journal of Low-Carbon Technologies, 19*, 296-305. doi:https://doi.org/10.1093/ijlct/ctad130

CPWD. (2019). *Rain Water Harvesting & Conservation Manual.* New Delhi, India: Central Public Works Department: MoHUA. Retrieved 2025

Decorme, R., Crosbie, T., Vukovic, V., Ala-Juusela, M., Klepal, M., Yadack, M., . . . Costa, A. (2017, December 11). Reducing Energy Consumption and Carbon Footprint by Smart and Sustainable Use. *Proceedings, 1*(7), 1101. doi:https://doi.org/10.3390/proceedings1071101

Dutt, K. L., & Sil, P. (2014, December 06). Women's 'double day' in middle-class homes in small-town India. *22*(4), 389-405. doi:https://doi.org/10.1080/09584935.2014.979762

Ekholm, T., Krey, V., Pachauri, S., & Raihi, K. (2010, October). Determinants of household energy consumption in India. *Enger Policy, 38*(10), 5696-5707. doi:https://doi.org/10.1016/j.enpol.2010.05.017

Enshassi, A., Kochendoerfer, B., & Rizq, E. (2014, December). An evaluation of environmental impacts of construction projects. *Revista ingeniería de construcción, 29*(3), 17. doi:http://dx.doi.org/10.4067/S0718-50732014000300002

Guo, R., Zhoa, J., Liu, X., & Zhang, J. (2024, March 01). Impacts of urban scale on low-carbon development: evidence from 265 cities in China. *Front. Environ. Sci., 12*. doi:https://doi.org/10.3389/fenvs.2024.1347146

ICLEI. (2009). *Energy and Carbon Emissions Profiles of 54 South Asian Cities* (Vol. 1). ICLEI.

IEA. (2021). *India Energy Outlook: World Energy Outlook Special Report.* IEA.

IPCC. (2008). *Climate Chnage 2007: Synthesis Report.* (Core Writing Team, R. K. Pachauri, & A. Reisinger, Eds.) Geneva, Switzerland: IPCC. Retrieved 2025

IPCC. (2022). Buildings in IPCC. *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth*. doi:10.1017/9781009157926.011

Jain, S., & Pant, P. (2010, July). Environmental management systems for educational institutions: A case study of TERI University, New Delhi. *International Journal of Sustainability in Higher Education, 11*(3), 236-249. doi:https://doi.org/10.1108/14676371011058532

Jamali, N., Taghizadeh, K., & Arbab, P. (2025, June 15). Exploring the impact of the built environment form on carbon emissions in urban neighborhoods: A systematic literature review. *Sustainable Cities and Society, 128*. doi:https://doi.org/10.1016/j.scs.2025.106449

Jing, Q.-L., Liu, H.-Z., Yu, W.-Q., & He, X. (2022, May 20). The Impact of Public Transportation on Carbon Emissions—From the Perspective of Energy Consumption. *MDPI, 14*(10). doi:https://doi.org/10.3390/su14106248

Kafy, A. A., Faisal, A. A., Rakib, A. A., Fattah, M. A., Rahaman, Z. A., & Sattar, G. S. (2022, January 15). Impact of vegetation cover loss on surface temperature and carbon emission in a fastest-growing city, Cumilla, Bangladesh. *Building and Environment*. doi:https://doi.org/10.1016/j.buildenv.2021.108573

Li, J., Huang, Y., Zhang, C., & Yao, D. (2024, November 12). How does public transport development contribute to carbon emission reduction? *Transportation Research Part A*, 104-327. doi:https://doi.org/10.1016/j.tra.2024.104327

Olatunde, T., Okwandu, A., & Akande, D. O. (2024, April). Reviewing the impact of energy-efficient appliances on household consumption. *International Journal of Science and Technology Research , 6*(2), 001-011. doi:https://doi.org/10.53771/ijstra.2024.6.2.0038

Pandey, D., Agrawal, M., & Pandey, J. S. (2011, July). Carbon footprint: current methods of estimation. *Environmental Monitoring and Assessment, 178*, 135-160. doi:https://doi.org/10.1007/s10661-010-1678-y

Ramachandra, T., Aithal, B. H., & Sreejith, K. (2015, April). GHG footprint of major cities in India. *Renewable and Sustainable Energy Reviews, 44*, 473-495. doi:https://doi.org/10.1016/j.rser.2014.12.036

Reddy, B. V. (2009, September). Sustainable materials for low carbon buildings. *International Journal of Low-Carbon Technologies, 4*(3), 175-181. doi:https://doi.org/10.1093/ijlct/ctp025

Ribeiro, H. R. (2019, July 19). Effects of changing population or density on urban carbon dioxide emissions. *Nature Communication, 10*. doi:https://doi.org/10.1038/s41467-019-11184-y

Sahni, S., & Aulakh, R. S. (2014). Planning for Low Carbon Cities in India. *Envriornment and Urbanization ASIA, 5*(1), 17-34. doi:https://doi.org/10.1177/0975425314521535

Satterthwaite, D. (2008, October). Cities' contribution to global warming: Notes on the allocation of greenhouse gas emissions. *Environment and Urbanization, 20*(2), 539-550. doi:https://doi.org/10.1177/095624780809612

Sharma, D., & Roy, U. K. (2024, September 05). Economic Implications and Public Readiness for Urban Green Space Development in Agra: A Strategic Evaluation in the City of Taj. *Journal of Contemporary Urban Affairs, 8*(2), 529-545. doi:https://doi.org/10.25034/ijcua.2024.v8n2-14

Shi, W., Xiang, Y., Ying, Y., Jiao, Y., Zhao, R., & Qiu, W. (2024, April 9). Predicting Neighborhood-Level Residential Carbon Emissions from Street View Images Using Computer Vision and Machine Learning. *Remote Sensing, 16*, 1-23. doi:https://doi.org/10.3390/rs16081312

UNEP. (n.d.). *Sustainable Buildings and Climate Initiative: Promoting policies and practices for the built environment.* UNEP. Retrieved 2025, from NARSPAC Weebly.

United Nations Environment Programme. (2022). *2022 Global Status Report for Buildings and Construction: Towards a zero-emissions, efficient and resilient buildings and construction sector.* Nairobi: UNEP. Retrieved 2025

United Nations, Department of Economic and Social Affairs, Population Division. (2019). *World Urbanization Prospects: The 2018 Revision (ST/ESA/SER/.A/420)* (Vol. 2). New York: United Nations.

Violano, A., & Cannaviello, M. (2023, September 22). The Carbon Footprint of Thermal Insulation: The Added Value of Circular Models Using Recycled Textile Waste. *MDPI, 16*(19). doi:https://doi.org/10.3390/en16196768

Weisz, H., & Steinberger, J. K. (2010, August). Reducing energy and material flows in cities. *Current Opinion in Environmental Sustainability, 2*(3), 185-192. doi:https://doi.org/10.1016/j.cosust.2010.05.010

Yan, R., Zhou, N., Ma, M., & Mao, C. (2025, August 01). India's residential space cooling transition: Decarbonization ambitions since the turn of millennium. *Applied Energy, 391*, 125-929. doi:https://doi.org/10.1016/j.apenergy.2025.125929

Yang, J., & Zhang, X. (2024, December 27). A Study on Carbon-Reduction Strategies for Rural Residential Buildings Based on Economic Benefits in the Gannan Tibetan Area, China. *Sustainability, 17*(1). doi:https://doi.org/10.3390/su17010131

Yu, F., Yuan, Q., Sheng, X., Liu, M., Chen, L., Yuan, X., . . . Ma, Q. (2024, December). Understanding carbon footprint: An evaluation criterion for achieving sustainable development. *Chinese Journal of Population, Resources and Environment, 22*(4), 367-375. doi:https://doi.org/10.1016/j.cjpre.2024.11.001