

**Case Study Title:**

**Mahindra Zen - India's 2<sup>nd</sup> (and Bengaluru's first) Net Zero Energy+Waste High rise residential development using passive first approach**



Mahindra Zen – India's 1<sup>st</sup> (and Bengaluru's 1<sup>st</sup>) Net Zero Energy+Waste High Rise Residential development, Bengaluru

Project Name	Mahindra Zen
Location	Bengaluru, Karnataka, India
Climate Zone	Temperate
Latitude/Longitude	12.97°N; 77.58°E
Building Type	High rise Residential development
Floor Area [sqm]	Plot Area – 4.25 acres (17,199 m <sup>2</sup> ) Built-Up Area (BUA) – 54,507.60 m <sup>2</sup>
Building Height [m]	83.5 m
Number of Storeys	1B+ G + 25 Residential floors
Completion Year	2026
Project Team	<ul style="list-style-type: none"> <li>• <b>Developer</b> - Mahindra Lifespace Developers Limited (Project Name: Mahindra Zen)</li> <li>• <b>Concept Design</b> - M/s Urban Frame</li> <li>• <b>Architect</b> - M/s Urban Frame</li> <li>• <b>Structural Consultant</b> - M/s Smart Minds Engineering Pvt. Ltd.,</li> <li>• <b>MEP Consultant</b> - M/s QDC India Consulting Pvt. Ltd.,</li> <li>• <b>Landscape Consultant</b> - M/s Dhruva Associates</li> <li>• <b>IGBC Certification</b> - M/s Ecofirst Services Limited</li> </ul>

## 1. Project Description

### Project Overview

Established in 1994, Mahindra Lifespace Developers Ltd. (Mahindra Lifespaces®) brings the Mahindra Group's philosophy of 'Rise' to India's real estate and infrastructure industry through thriving residential communities and enabling business ecosystems. The Company's development footprint spans 47.56 million sq. ft. (as on 31<sup>st</sup> Mar 2025) of completed, ongoing and forthcoming residential projects across seven Indian cities; and over 5000 acres of ongoing and forthcoming projects under development / management at its integrated developments / industrial clusters across four locations. Mahindra Lifespaces' development portfolio comprises premium residential projects; value homes under the 'Mahindra Happinest®' brand; and integrated cities and industrial clusters under the 'Mahindra World City' and 'Origins by Mahindra' brands, respectively. The Company leverages innovation, thoughtful design, and a deep commitment to sustainability to craft quality life and business growth.

As a pioneer in Net Zero homes in India, Mahindra Lifespaces® is committed to building only Net Zero homes from 2030 onwards. The company has already launched India's first three Net Zero residential developments: **One Net Zero Energy - Mahindra Eden (Bengaluru) and two Net Zero Energy+ Waste - Mahindra Vista (Mumbai) and Mahindra Zen (Bengaluru)**, showcasing its dedication to environmental responsibility and innovation. With a 100% Green portfolio since 2014, the Company is working towards carbon neutrality by 2040 with approved Science Based Targets (SBT) in line with 1.5°C low carbon pathway as an enabler and actively supports research on green buildings tailored to climatic conditions in India through the Mahindra TERI Centre of Excellence (MTCoE). Mahindra Lifespaces® is the recipient of over 90 awards for its projects and ESG initiatives.

Mahindra Lifespaces® is the first Indian real estate company to publicly disclose its sustainability strategy and performance through a standalone sustainability report in 2011 in line with GRI standards; the company completed 13th year of sustainability reporting in 2023-24. MLDL's residential business and Integrated Cities - Mahindra World City (Chennai and Jaipur) are the first Indian real estate companies with approved Science Based Targets (SBT) in line with the 1.5°C low carbon pathway, having paved a unique path as a real estate developer with a 100% green certified portfolio since 2014. These SBTs enable the company to achieve its 2040 carbon neutrality goal through its carbon neutrality action plan. With a futuristic approach across its operations, Mahindra Lifespaces became a TCFD (Task Force on Climate-Related Financial Disclosures) supporter in February 2021, making it the first real estate sector brand from the real estate management and development industry in India to do so.

### MLDL Sustainability Focus Areas

Ambition: Global ESG Leader		Vision: Together we Rise for Planet Positive	
<p style="text-align: center; color: white; font-weight: bold;">Greening Ourselves (Construction Phase<sup>1</sup>)</p> <p style="text-align: center; color: white; font-weight: bold;">Net Zero on scope 1+2 emissions</p> <p style="color: red; font-weight: bold;">Commitments:</p> <p style="color: red; font-weight: bold;">A. Carbon Neutral on Scope 1+2 by 2040</p> <hr/> <p style="text-align: center; color: white; font-weight: bold;">Net Zero on water and waste</p> <p style="color: red; font-weight: bold;">Commitments:</p> <p style="color: red; font-weight: bold;">A. Water Positive developments by 2030</p> <p style="color: red; font-weight: bold;">B. Zero Waste to Landfill by 2030</p> <hr/> <p style="text-align: center; color: white; font-weight: bold;">Material circularity (e.g., GGBS/fly ash replaces cement in concrete, use of secondary steel, aluminium formwork with multiple reuse)</p>	<p style="text-align: center; color: white; font-weight: bold;">Decarbonizing Our Industries (Use Phase<sup>2</sup>)</p> <p style="text-align: center; color: white; font-weight: bold;">Green portfolio transition</p> <p style="color: red; font-weight: bold;">Commitments:</p> <p style="color: red; font-weight: bold;">A. Net Zero Energy by 2030</p> <p style="color: red; font-weight: bold;">B. Net Zero Water by 2030</p> <p style="color: red; font-weight: bold;">C. Net Zero Waste by 2030</p> <hr/> <p style="text-align: center; color: white; font-weight: bold;">Net Zero transition - suppliers support (Micro-solutions for suppliers via DBC<sup>2</sup>, &amp; MTCoE<sup>2</sup>; for Contractors – energy efficiency e.g., use of electric concrete pumps replacing diesel, etc.)</p> <hr/> <p style="text-align: center; color: white; font-weight: bold;">Industry circularity (e.g. - waste recycling)</p>	<p style="text-align: center; color: white; font-weight: bold;">Rejuvenating Nature</p> <p style="color: gray; font-weight: bold;">7. Promoting regenerative agriculture (via improved farming techniques)</p> <hr/> <p style="color: gray; font-weight: bold;">8. Afforestation (Landscaping &amp; planting for green community)</p> <hr/> <p style="color: gray; font-weight: bold;">9. Biodiversity Conservation (Site flora and fauna preservation &amp; restoration)</p>	

Notes: (1) Construction Phase: Site offices and Sales Gallery (2) Use Phase: Buildings

Sustainability Commitments at Mahindra Lifespaces® (Source: MLDL, 2022)

With the launch of 'Mahindra Eden', India's first Net Zero energy residential project, the company also set a new standard in sustainable development. Subsequently, we launched Mahindra Vista and Mahindra Zen as India's 1st and 2nd Net Zero Energy+Waste high rise residential developments and many more in progress.







Mahindra Lifespace Developers Limited's (MLDL) Zen in Bengaluru exemplifies a green building commitment to sustainability through innovative design and operational practices. The project integrates green building principles to minimize environmental impact while enhancing the quality of life for its occupants. This has been achieved through a combination of energy efficiency, water conservation, use of eco-friendly materials, and comprehensive waste management system.

The building is designed to meet globally recognized green certification standards such as IGBC, ensuring that sustainability is embedded in its lifecycle. By incorporating sustainability features, Mahindra Zen not only reduces its environmental footprint but also lowers operational costs and enhances the well-being of its residents and users. It stands as a model of sustainable urban development in Bengaluru, addressing both local environmental challenges and global climate goals.

This case study reflects the ***use passive first approach incorporating climate responsive design followed by active measures with integration of renewables to make a high-rise residential development Net Zero.*** Apart from energy, the project exemplifies a model development involving deconstruction (during demolition phase) to recover and reuse >10% of the demolished materials within the new product developed.

'Mahindra Zen' is estimated to save over 0.5 million kWh of electricity annually – enough for powering over 52 homes, and diverting >90% of C&D (Construction and Demolition) waste away from landfill. Mahindra Zen in Bengaluru is a Net-Zero energy+waste high rise residential project, certified by IGBC (Indian Green Building Council).

The intent of the project is to address issues across multiple areas, from energy demand management to biodiversity conservation.

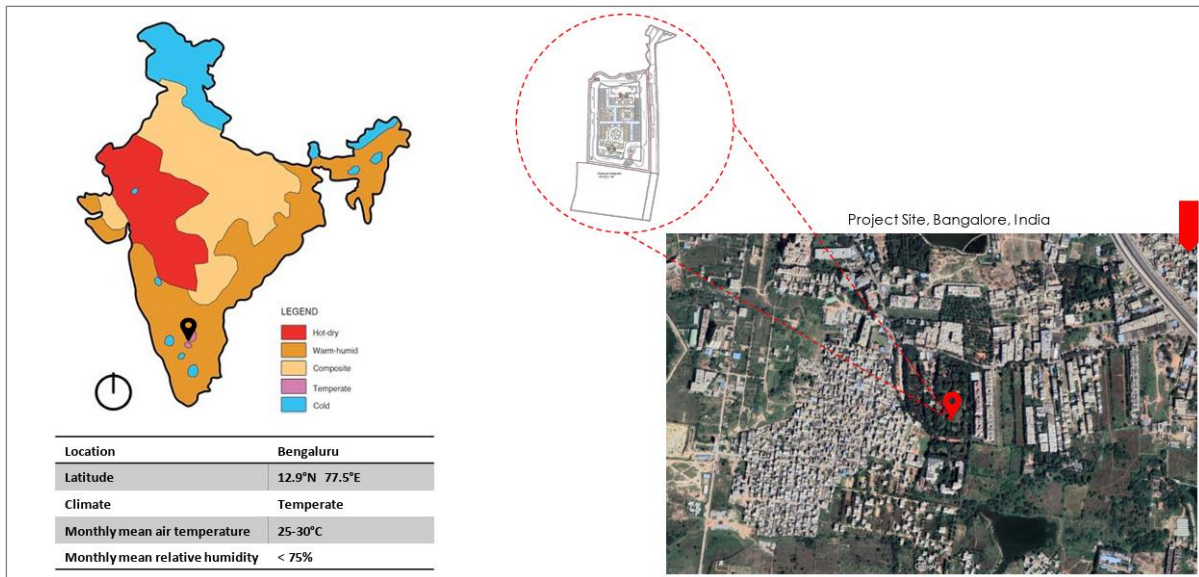
<p><b>New construction</b></p>  <p><b>70%</b> of building requirement until 2050 is yet to be constructed (230 billion sq. m. of new construction)</p>	<p><b>Energy consumption</b></p>  <p>Buildings and construction sectors combined are responsible for <b>34%</b> of global energy consumption</p>	<p><b>CO<sub>2</sub> emissions</b></p>  <p>~<b>36%</b> of total direct &amp; indirect CO<sub>2</sub> emissions generated by building &amp; construction sector</p>
<p><b>Bengaluru population growth</b></p>  <p><b>1028%</b> population rise in urban areas of Bengaluru between 1973 and 2017</p>	<p><b>Soaring Bengaluru temperatures</b></p>  <p><b>2-2.5</b> Degree Celsius temperature rise in Bengaluru over last decade</p>	<p><b>Declining vegetation cover &amp; water bodies</b></p>  <p><b>88%</b> decline in vegetation cover and <b>79%</b> decline in water bodies in Bengaluru between 1973 and 2017</p>



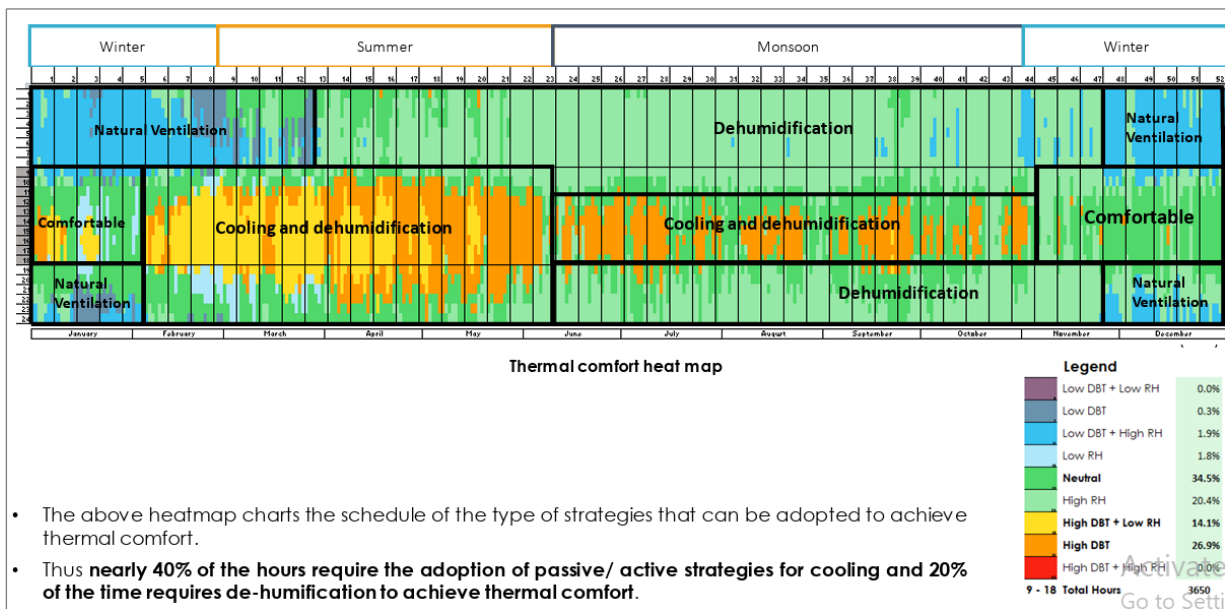
## 2. Climate & Site Context

Basic Climate Conditions		
Temperature	Annual Average	24°C
	Annual Range	21.4°C (December) - 28°C (April)
Relative Humidity	Annual Average	67%
	Annual Range	45% (March) - 82% (August)
Annual Degree-Days (ASHRAE Standard 169-2020)		HDD 18°C: 0 CDD 10°C: 5163
Climate Analysis		

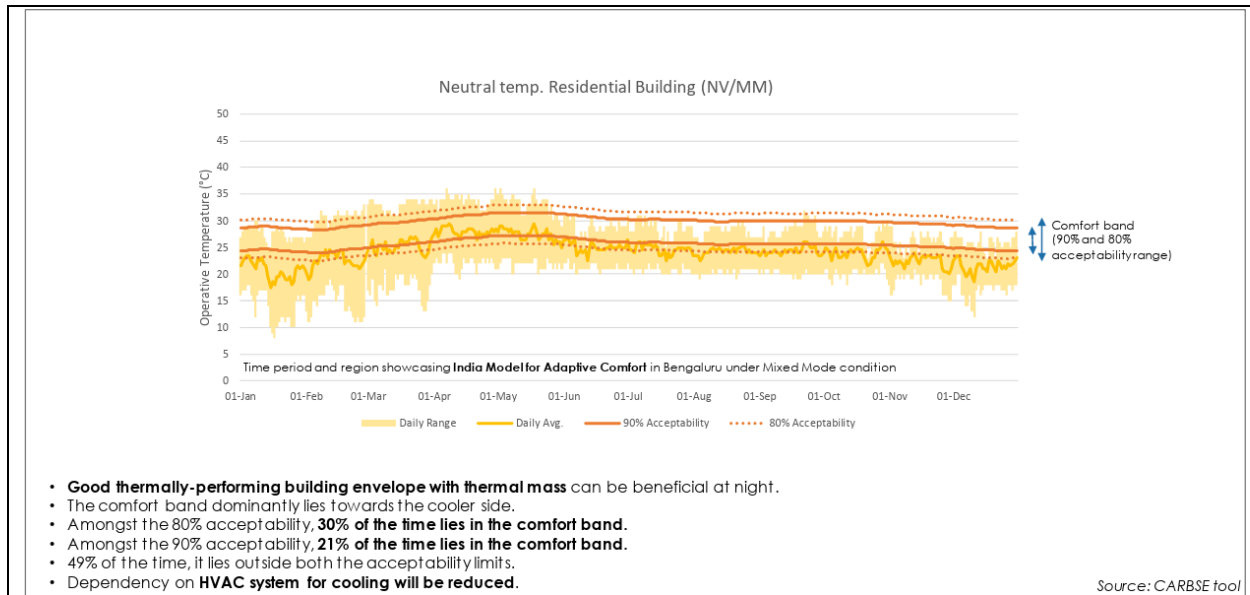
Mahindra Zen is in Bengaluru, Karnataka, India which is in the 'Temperate' climatic zone.



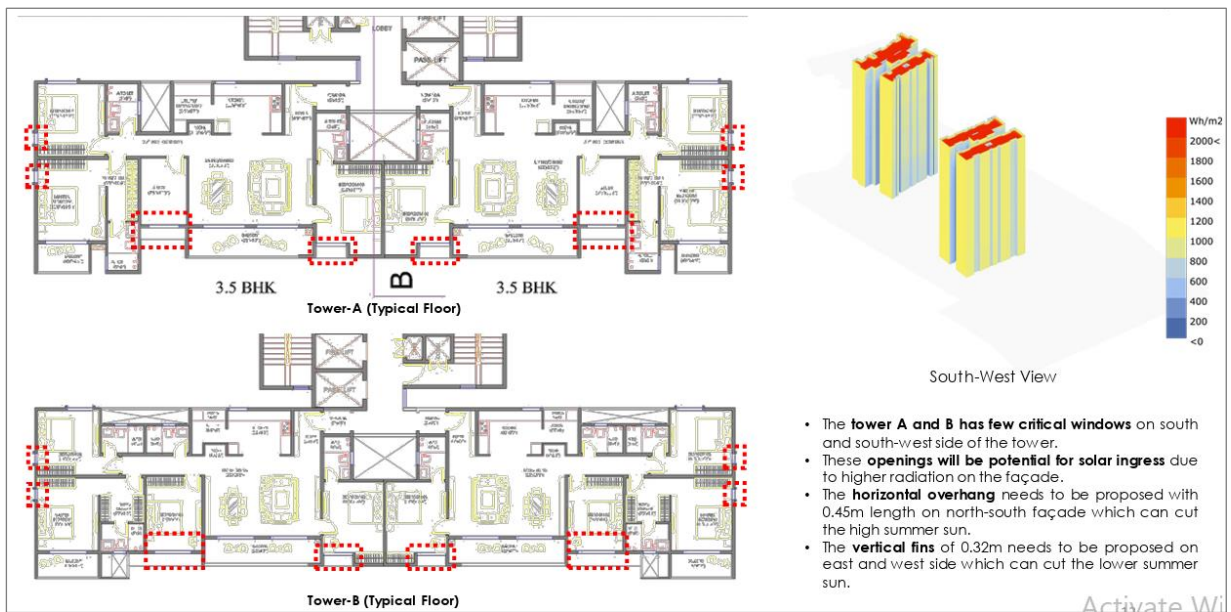
### Comfort Study



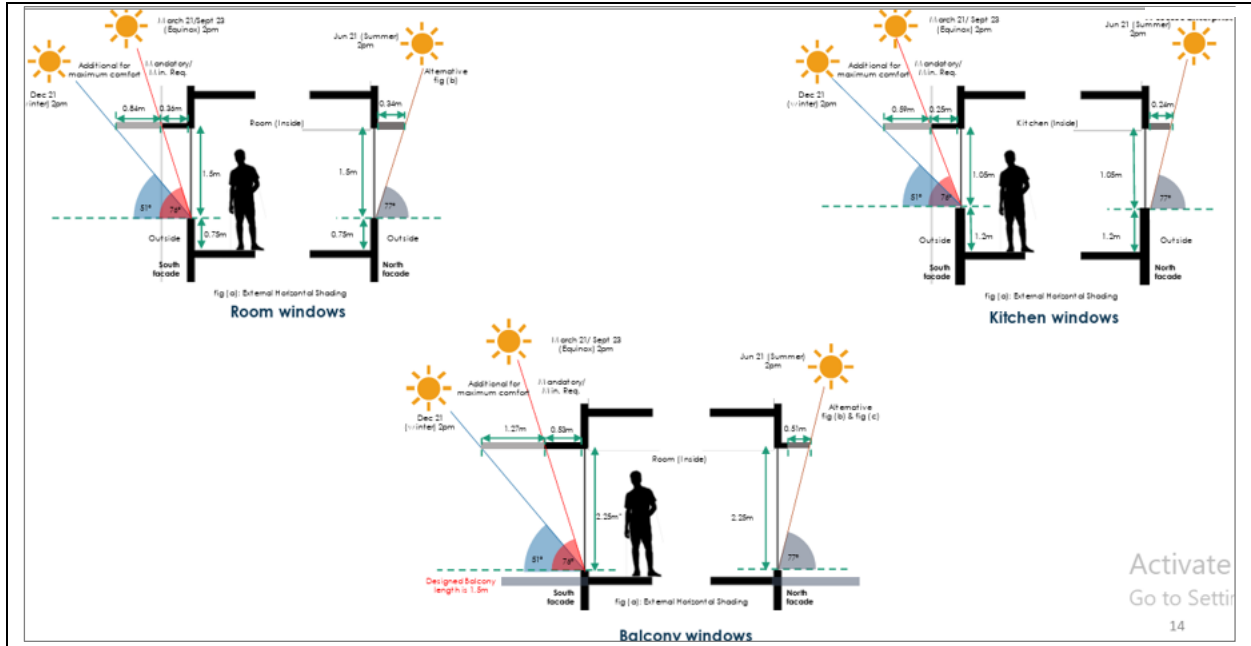
### Adaptive Comfort Study



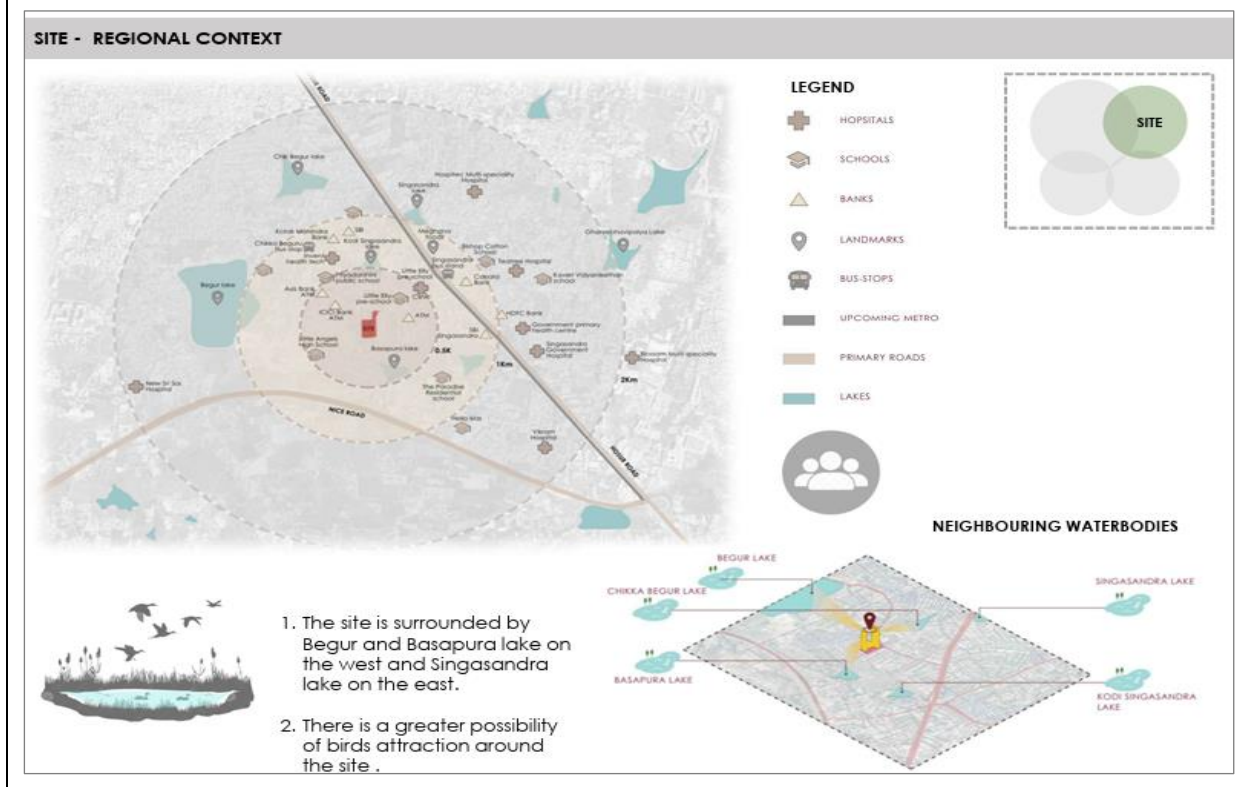
## Solar Exposure



## Shadow Analysis



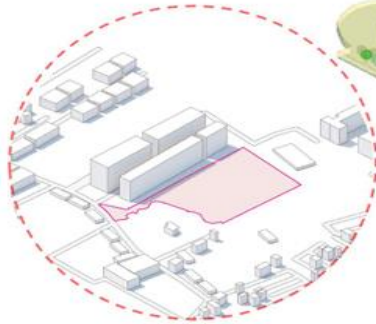
## Site Analysis



**SITE DETAILS - EXISTING BUILT AND OPEN SPACE**

**EXISTING BUILDING MAPPING**

1. Security Cabin
2. Temple
3. Kadira Room
4. Snooker
5. Nirvana Bar
6. Shed
7. Kitchen
8. Sales Office
9. Gas Shed
10. Shed
11. Rest Room
12. Toilet



**SITE IMMEDIATE SURROUNDS**



**EAST ROAD**

- HUGE ADVANTAGE OF **MINIMUM TRAFFIC**
- VISITORS PARKING CAN BE PROVIDED
- WAITING BAY FOR SCHOOL BUSES
- PROVISION OF **CYCLE STAND AND KIDS CYCLING ZONE**



- **VISUAL CONNECT** THE EXISTING DENSE PLANTING WITH BOULDER RETAINING WALL CAN BE RETAINED AND A TRANSPARENT FENCE CAN BE INTRODUCED



- **DENSE PLANTATION** CAN BE PROPOSED ALONG THE NORTH, SOUTH AND WEST EDGE FOR SCREENING
- THE EXISTING NEIGHBORING GREEN SPACES CAN BE INTEGRATED IN THE SCHEME AS **BORROWED VIEWS**

### SITE

APPROACH ROAD



EXISTING STONE SCULPTURE USED AS SIGNAGE BY THE PREVIOUS OCCUPANT





MEDIAN ALONG THE ROAD



EXISTING BUILDINGS



EXISTING VEGETATION



EASTERN EDGE - MALIBU ENCLAVE (APARTMENT) AND TVS PROPERTY



SOUTHERN EDGE NEIGHBOURING PROPERTY



### EXISTING RESOURCES - BIODIVERSITY

FLORA AND FAUNA

The site cradles maximum number of flora and fauna .



Indian Almond (*Terminalia catappa*)



Western Koel (*Eudynamis scolopaceus*)




Indian Shot  
*(Canna indica)*

Chocolate Pansy  
*(Humonia inbita)*

FLORA			
SR. NO.	FLORAL ELEMENTS	NO. OF SPECIES	NO. OF FAMILIES
1	TREES	42	20
2	SHRUBS	20	16
3	CLIMBERS	14	9
4	HERBS	31	13
5	GRASSES	11	1

FAUNA			
SR. NO.	FAUNAL ELEMENTS	NO. OF SPECIES	NO. OF FAMILIES
1	BIRDS	27	17
2	BUTTERFLIES	23	5
3	MAMMALS	1	1
4	REPTILES	4	4
5	SPIDERS	1	1

DETAILS OF EXISTING TREES	
Native Tree Species	22
Exotic Tree Species	22
<b>TOTAL SPECIES OF TREES</b>	<b>44</b>





Passive Cooling Case Studies

Produced by the Passive Cooling Working Group hosted by the UNEP-led Cool Coalition and GlobalABC



**Passive Cooling Strategies** (please tick implemented passive cooling strategies)

- Building Orientation & Form (site orientation, building shape, etc.)
- Envelope Design (insulation, air-tightness, shading, window system, thermal mass, etc.)
- Natural Ventilation (cross ventilation, stack ventilation, night ventilation, etc.)
- Evaporative Cooling (direct/indirect evaporative cooling, etc.)
- Ground Cooling (geothermal, ground-coupled systems, basement/underground space, etc.)
- Radiative Cooling (cool roof, night sky radiation, radiant barriers, reflective surfaces, etc.)
- Nature-based Solutions (green roof/wall, tree shading, etc.)
- Others (human behavior, clothing, semi-passive (fans, etc.))

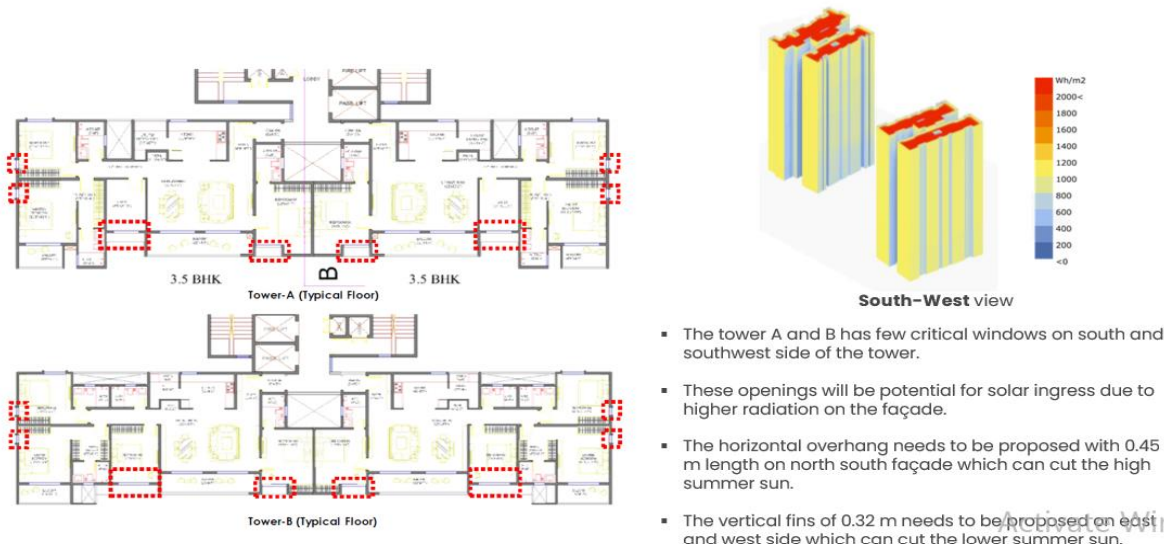
**Description** (please describe one strategy per box – you can add more boxes below if needed)

**3. Passive Cooling Design Details**

**Orientation:** The buildings are strategically oriented so that the longer façades face the north-south direction, while the shorter façades face the east-west direction. This thoughtful orientation is designed to minimise heat gain through the east and west façades, which are typically more exposed to direct sunlight.



From the analysis, it was observed that **63% of the spaces are uncomfortable** in a year in Natural Ventilation mode.



**Placement of Towers:** The two towers are deliberately located 60 metres apart to ensure privacy for the residents and to avoid interfering with the natural wind flow pattern. This spacing is crucial as it allows for unobstructed airflow around and between the buildings, ensuring that natural ventilation is not hampered. By maintaining this distance, the design promotes better air circulation within the residential units, contributing to a more comfortable and healthier living environment.



**Placement of Windows:** Larger windows are strategically placed on the north-south façades to maximise the entry of natural daylight into the building. This placement ensures that the interiors are well-lit throughout the day, reducing the need for artificial lighting and creating a pleasant living environment. Conversely, smaller windows are positioned on the east-west façades to minimise exposure to harsh solar radiation, which can lead to excessive heat gain and glare. This thoughtful arrangement helps maintain a comfortable indoor temperature.

**Natural Daylighting:** The design ensures that up to 75% of the regularly occupied spaces receive ample natural daylight. Natural daylighting has been shown to improve mood, productivity, and overall well-being, making it a key feature of the project's design.

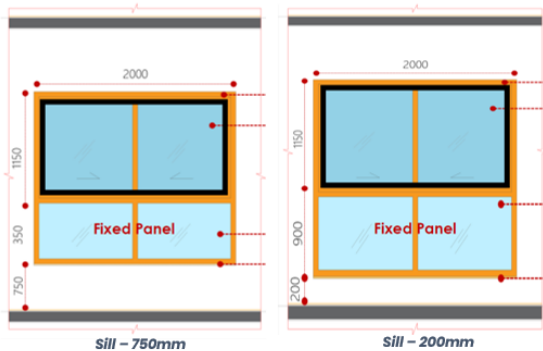
**Cross-Ventilation:** Additional slit windows have been incorporated into the design to introduce cross ventilation in the regularly occupied spaces. This feature allows for the continuous flow of fresh air throughout the interiors, enhancing occupant comfort and indoor air quality.

**Window sill Level:** The windows are designed with higher sill levels of 750 mm, in contrast to contemporary full-height windows. This design choice helps to keep the indoors cool and comfortable by reducing the amount of direct sunlight and heat entering the space. Higher sill levels also provide additional privacy and security while still allowing for adequate natural light and ventilation.



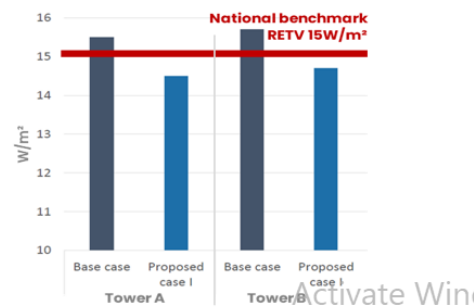
Inside view of window sill

### Window Design



Towers	Cases	Sill level (on all the sides)	WWR	U-value wall (W/sqm)	U-value glass (W/sqm)	SHGC
Tower A	Base case	200mm	19%	2.52	5.7	0.5
	Proposed case I	750mm	18%	2.52	5.7 North 4.5 other sides	0.5 North 0.47 other sides
Tower B	Base case	200mm	20%	2.52	5.7	0.5
	Proposed case I	750mm	19%	2.52	5.7 North 4.5 other sides	0.5 North 0.47 other sides

RETV is a measure of heat gain into the building which considers the two basic components of heat gain i.e., the external walls and windows of a building.



**Window Shading:** Appropriate shading design for the windows helps block harsh solar radiation for most of the day. These shading elements are strategically placed to reduce glare and prevent excessive heat from entering the residential spaces. By minimising direct sunlight exposure, the shading helps maintain a cooler indoor environment and enhances visual comfort.

### Shading Design

- The dimension of the windows can change w.r.t the special requirements, but the corresponding shading dimension needs to be proportion to the dimensions as represented in the image.
- For Tower A & Tower B, the vertical fins of 0.32m depth are required for 0.6m width windows in east and west facing side.

Activate W

### Shading Design

Projection Factor is a ratio of the length of overhang projection divided by height from window sill to the bottom end of the overhang (must be permanent).

Act

**Maximum Window Opening:** The windows are designed to maximise the effective opening area, allowing for optimal natural ventilation and cross-ventilation. This design feature ensures that fresh air can flow freely into the living spaces. By doing so, the windows help

regulate indoor temperatures naturally, reduce humidity levels, and improve indoor air quality, making the living space more pleasant and comfortable.

**Green Area:** The project retains up to 15% of the ground as green space, which plays a crucial role in reducing the urban heat island effect. This green area includes landscaped gardens, lawns, and other vegetated spaces that help cool the surrounding environment by providing shade and releasing moisture through evapotranspiration. Additionally, the building design has been thoughtfully modified to retain three existing trees on-site, preserving the natural ecosystem and enhancing the aesthetic appeal of the development.

The thoughtful integration of these passive design measures has significantly enhanced the project’s sustainability and energy efficiency. By focusing on natural daylighting, ventilation, and strategic orientation, the development not only reduces operational energy consumption by up to 15% but also ensures a comfortable living environment for its residents. The commitment to green building standards and the preservation of natural elements on-site further underscores the project’s dedication to environmental stewardship. This holistic approach not only benefits the occupants, but also contributes positively to the broader community and ecosystem.

#### 4. Active Components

##### Active (Hybrid) Cooling Strategies

(please describe one strategy per box – you can add more boxes below if needed)

Through integration of active design measures – use of energy efficient equipments and appliances. This included use of energy efficient lighting and equipments in common areas; use of Variable Voltage Variable Frequency, (VVVF) lift drives; use of energy efficient and star rated pumps and motors; use of low flow fixtures in taps reducing the water demand and hence the pumping energy requirement; behavioural interventions including influencing the customers through varied touchpoints such as resident assist (operational guidebook on sustainability measures and their method of usage) to adopt and use star rated appliances in their homes, and maintaining AC set point at 24oC which would help reduce the energy consumption further.

#### 5. Performance Data

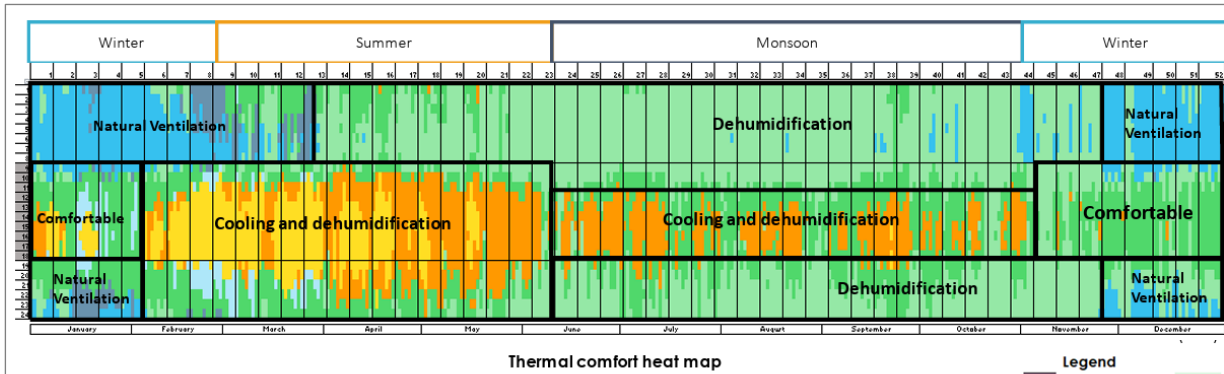
##### Cooling Energy Use

A significant outcome of the project’s design strategy is its climate-responsive architecture, aimed at reducing the building’s energy demand while improving occupant comfort. By using sun path and solar radiation analysis, the design achieved an optimal orientation, minimizing solar radiation on building surfaces and reducing heat gains through windows. The orientation ensures that 95% of habitable areas receive adequate daylight and ventilation, reducing the need for artificial lighting and mechanical ventilation (Sharma et al. 2023). Applying learnings from the work under Indo-Swiss Building Energy Efficiency Project (BEEP) for MLDL, Mahindra Zen implemented CRD, and passive design measures that limit heat gains, including appropriate shading, right window sizing, and high-performance glazing. Climate-responsive design (CRD) along with passive and active design measures has led to a remarkable **19%** reduction in energy demand saving **4,78,143 kWh** of electricity. By optimizing building and window orientation based on sun path and solar radiation analysis, the project ensures that

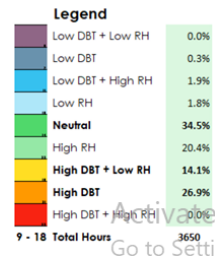
95% of habitable areas receive adequate daylight and ventilation, reducing reliance on artificial lighting and air conditioning. The use of solar reflective paint, high-performance glass, and appropriate window-to-wall ratio further minimizes heat loads, contributing to lower energy consumption.

## Indoor Thermal Comfort

### Comfort Study

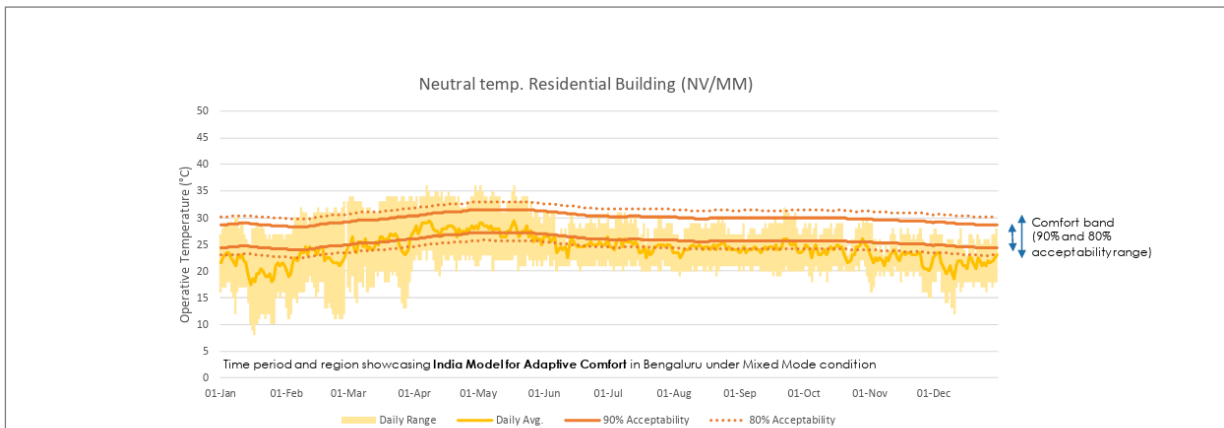


Thermal comfort heat map



- The above heatmap charts the schedule of the type of strategies that can be adopted to achieve thermal comfort.
- Thus **nearly 40% of the hours require the adoption of passive/ active strategies for cooling and 20% of the time requires de-humidification to achieve thermal comfort.**

### Adaptive Comfort Study



- **Good thermally-performing building envelope with thermal mass** can be beneficial at night.
- The comfort band dominantly lies towards the cooler side.
- Amongst the 80% acceptability, **30% of the time lies in the comfort band.**
- Amongst the 90% acceptability, **21% of the time lies in the comfort band.**
- 49% of the time, it lies outside both the acceptability limits.
- Dependency on **HVAC system for cooling will be reduced.**

Source: CARBSE tool

## 6. Financial Data

### Cost Benefits

Climate-responsive design (CRD) along with passive and active design measures has led to a remarkable **19%** reduction in energy demand with potential saving **4,78,143 kWh** of electricity. In addition, Mahindra Zen exemplifies the principles of water conservation and waste management. With a **51%** savings in water through reduced freshwater demand using water savings fixtures, rainwater harvesting tanks to capture, store, and reuse on site for multiple purposes; a sewage treatment plant for treating sewage water, and reusing for flushing in individual homes, and for landscaping; the development works towards conserving the most critical resource i.e., water in the city of Bengaluru. During construction phase too, the development is using recycled sewage water from the municipality and nearby STP thereby reducing the burden on freshwater sources.

Its approach to waste management is equally robust, with **>90%** of construction and demolition waste being diverted away from landfill during construction and demolition phase and even in the use phase. This is facilitated through deconstruction of existing structure onsite to recover the materials for reuse during construction, and sending the recyclables to authorized recyclers, and an on-site organic waste composting, segregation of dry waste onsite and partnership with authorized dry waste recycling partners, contributing to circular economy. By implementing these measures, Mahindra Zen promotes a closed-loop, circular economy approach (Mahindra Lifespaces®, 2024). The project's Net Zero certification by the Indian Green Building Council (IGBC) is a testament to its commitment to sustainable building practices.

At the apartment/unit level, each resident potentially saves around **INR (Indian Rupee) 8 per sq. ft.** with **INR 7 per sq. ft.** through passive and active design measures, and at the common area level, they would save around INR (Indian Rupee) 13 per sq. ft. making a potential saving of **INR 21 per sq. ft on maintenance cost.**

### Climate-responsive design (CRD)

Gartner's 'Climate-Centered Innovation framework'

#### Energy

**19%** Annual Energy Savings (4,78,143 kWh)

**81%** 5% | Onsite RE, 95% | Grid RE

**52 Homes**

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#### Waste

**3%** Reject Waste

**97%** Waste diversion away from landfill (243 tonnes)

**243 Waste Trucks**

#### Water

**49%** External Freshwater dependency

**51%** Annual Freshwater Savings (37,006 kilolitres)

**3701 Water Tankers**

Net Zero Waste @Mahindra Zen

#### Reuse of demolition waste

Reuse of demolition waste

Reuse of old furniture from Eden

## 7. Passive Cooling Operation

### Maintenance Requirement

At the apartment/unit level, each resident potentially saves around **INR (Indian Rupee) 8 per sq. ft.** with **INR 7 per sq. ft.** through passive and active design measures, and at the common area level, they would save around INR (Indian Rupee) 13 per sq. ft. making a potential saving of **INR 21 per sq. ft on maintenance cost.**

## 8. Lesson Learnt / Recommendations

### Technical Challenges, Solutions and Achievement

#### 1. High energy demand for high rise residential homes

One of the most significant aspects when it comes to a high-rise residential building is addressing its high energy demand. High-rise buildings, when not designed and built considering the local climatic conditions inherently consume a substantial amount of energy, especially for artificial cooling and lighting. Also, energy inefficient walls made from concrete without any insulation owing to faster construction practices inadvertently traps heat within the homes, increasing the reliance on artificial cooling systems like air conditioners, and making it thermally uncomfortable for the occupants impacting their health and well-being. Design and use of large inefficient glass windows for better view and the use of non-insulated roofs further exacerbates the problem, leading to thermal and visual discomfort for residents and a spike in energy usage. Furthermore, the building's common areas are equipped with energy-intensive electrical equipments such as lifts, pumps, and motors, which further strains the energy demand.

##### **Solution and achievement**

Energy demand was reduced within the development through integration of climate responsive design (CRD), and passive design measures and energy efficiency attained through active design measures. CRD for us is designing for “least possible air-conditioning; and no artificial lights during the day”. Climate-responsive design (CRD) along with passive and active design measures has led to a remarkable **19%** reduction in energy demand with potential saving **4,78,143** kWh of electricity.

#### 2. Limited technical expertise on CRD and passive design

Another challenge is limitation in technical expertise in understanding and applying passive and active design measures to enhance thermal and visual comfort without increasing energy demand. Lack of both in-house and external knowledge on passive design first principle meant that energy efficiency solutions were largely mechanical, further driving up energy consumption.

##### **Solution and achievement**

MLDL's CRD and other design measures were standardized basis the earlier work under BEEP (Building Energy Efficiency Project) by SDC (Swiss Agency for Development and Cooperation).

#### 3. Onsite renewable energy generation and sourcing from grid

Next step after energy demand reduction and energy efficiency was meeting the residual energy demand through onsite and offsite renewable energy to achieve Net Zero Energy. The challenge of renewable energy generation within the premises thereby helping meet a major portion of its energy demand required exploring renewable sources such as onsite Solar PV, but the space limitation and capital-intensive nature of the solution made large-scale implementation difficult. Apart from this, tackling the issue of renewable energy sourcing was equally challenging. Initially, Bangalore Electricity Supply Company Limited (BESCOM) did not have regulatory provisions to offer renewable energy to residential customers, only extending this benefit to commercial and high-tension (HT) users (Sundaram et al. 2022).

##### **Solution and achievement**

We were able to install 80 kWp of onsite solar PV catering to 5% of total energy demand, and remaining was procured from grid. For sourcing grid-based renewable energy from BESCOM, Mahindra Lifespaces®, along with other developers and internal and external partners advocated for the amendment in the green tariff order to include low-tension (LT) or residential customers, a policy change that was eventually implemented by the Karnataka

Electricity Regulatory Commission (KERC) in September 2023. This amendment allowed residential buildings like Mahindra Zen to access grid-based renewable energy.

#### 4. Net Zero Waste

Designing for 100% waste diversion away from landfill and reducing maximum dependency on freshwater sources for designing efficient water systems posed additional challenges. The treatment of non-biodegradable waste remained an operational challenge, requiring careful vendor selection and long-term planning. Similarly, the demand-side water management system struggled to meet the excess water requirements of residents, which in turn increased energy consumption for water pumping systems. Balancing water conservation with the high demands of urban living proved complex, despite adhering to the National Building Code standards makes Mahindra Zen distinct.

##### **Solution and achievement**

Mahindra Zen achieved >90% construction and demolition waste diversion away from landfill with recovery and reuse of 100% of deconstructed waste and 100% of organic waste management during use phase, recyclables were sent to authorized recyclers.

#### 5. Biodiversity Conservation

Lastly, biodiversity conservation during construction process was a major concern. The construction activities posed a challenge to the site's rich biodiversity, providing an opportunity to the team to undertake structured and planned approach through zonal bifurcation of the areas rich in biodiversity, preserving, and enhancing the biodiversity throughout the project development lifecycle making it a nature positive development.

##### **Solution and achievement**

Sustainable construction management at Mahindra Zen has been carefully planned to protect the biodiversity of the project site. The development is being executed in phases, allowing careful monitoring and minimizing the disturbance to existing flora and fauna. To further safeguard the environment, specific zones have been demarcated where no construction activity will take place, ensuring that sensitive areas remain untouched throughout the building process. Green areas within the project are also fenced off from the construction zones, reducing direct human and machinery impact on the surrounding ecosystem. In addition to this, the construction team has implemented MLDL's internal standard operating procedures to mitigate air, noise, and light pollution during construction. These measures include limiting work hours, using noise-dampening equipment, and installing shields to minimize artificial lighting at night, which can interfere with local wildlife. These strategies align with the 10-point Nature Resolution established by Mahindra Lifespaces®, aimed at protecting biodiversity while ensuring the project meets sustainable development goals.



## Tree protection during construction phase @Mahindra Zen



Tree protection during construction phase @Mahindra Zen

### 6. Pollution Prevention

Construction, by itself, is a polluting sector – leaving a large carbon footprint. Construction activities use natural resources, disrupt natural ecosystems, and cause air, water, noise, land pollution and contribute to greenhouse gas emissions. Urban living also has its share of resource use and pollution.

#### Solution and Achievement

To ensure sustainability across MLDL's real estate development lifecycle, we focus on providing equitable prices and finding suitable locations for our projects with mitigation of any risk to the environment and occupants. During construction, we follow our internal standard operating procedure (SOP) and aspect impact register (containing control measures for all identified risks pertaining to each activity) to mitigate any environmental risk. This includes barricading the site on all sides to avoid disturbance to external population, and avoid dust from moving out of the site; internal barricading of biodiverse sensitive zones to preserve the

natural water bodies and biodiversity within the site; washing of truck wheels which load and unload materials and other resources while entering the site and channelizing and reusing this water for dust suppression on site; regular water sprinkling to suppress the dust generated during construction; monthly monitoring of air, water, noise quality within the site by 3<sup>rd</sup> party NABL accredited lab partners; PUC check of all vehicles entering the site; covering all vehicles loaded with materials moving into and out from the site. We have also deployed real time air quality monitoring unit which provides level of pollutants and hence the air quality index of the site, which is then displayed on a centralized dashboard vis-à-vis the air quality index of the vicinity there helping Mahindra Zen to take the necessary action upfront and reviewed regularly by the senior management.

**7. Sourcing of renewable energy from grid**

While 5% onsite renewable energy generation was achieved using solar system, remaining 'green power' was required to be procured from the grid, which was a significant portion of renewable energy for the project. And green power from local discom was typically offered only to Industrial customers.

**Solution and Achievement**

For this purpose, special approval was sought from the government body (local grid) in Karnataka to supply green power to residential building. They ended up paying 10% more per KWH but design choices reduced overall consumption significantly.

**Financial Challenges, Solutions and Achievement**

NA

**Other Challenges, Solutions and Achievement**

NA

**9. Free Description**

**Free Description**

Mahindra Zen's climate action or Net Zero strategy follows a 3-pronged approach -  
**1. Demand Reduction:** Through climate responsive design (CRD) and passive design measures (efficient wall, roof, and glass). Included orienting the buildings with long façade in north-south direction; use of efficient walling assembly; use of high Solar Reflective Index (SRI) paints on roof, and wall; use of lower solar heat gain co-efficient (SHGC) or efficient glass, helping minimize heat gain, contributing to a thermally comfortable indoor environment and thereby lowering the energy demand.

**2. Energy efficiency:** Through integration of active design measures – use of energy efficient equipments and appliances. This included use of energy efficient lighting and equipments in common areas; use of Variable Voltage Variable Frequency, (VVVF) lift drives; use of energy efficient and star rated pumps and motors; use of low flow fixtures in taps reducing the water demand and hence the pumping energy requirement; behavioural interventions including influencing the customers through varied touchpoints such as resident assist (operational guidebook on sustainability measures and their method of usage) to adopt and use star rated appliances in their homes, and maintaining AC set point at 24°C which would help reduce the energy consumption further.

CRD, passive and active design measures helped reduce the energy demand of the development by 19% as compared to a conventional building without integration of any of the

mentioned sustainability measures. While CRD, passive and active design measures do help improve the thermal comfort inside the individual homes; rich biodiversity at Mahindra Zen preserved on the site help reduce the urban heat island effect i.e., improves the microclimate of the region with direct benefits on health and well-being of the residents. Trees block the sun's rays, reducing amount of solar radiation reaching the ground surface, whereas water bodies evaporate the surface water helping cool the air.

**3. Integration of renewables:** The integration of renewable energy is another hallmark of Mahindra Zen's sustainability. The development features 5% of total energy demand requirement being met through onsite renewable energy which includes 80 KW of rooftop solar panels and remaining 95% residual energy demand is being met through renewable energy procured from the grid through BESCO.

### Health, and Well-being

In alignment with health and well-being principles, Mahindra Zen enhances the quality of life for its residents by fostering a strong connection to nature. Green spaces, landscaping, and preserved natural features contribute to physical and mental health benefits, offering residents spaces for relaxation and outdoor activities (Mahindra Lifespaces®, 2024). The development promotes indoor air quality through ample ventilation, the use of non-toxic materials, and high-efficiency filtration systems, all of which are essential for maintaining a healthy living environment.

Fitness and wellness amenities like gyms, jogging tracks, meditation zones, and community spaces further support residents' holistic well-being. The project also encourages social engagement through common areas and event spaces, which contribute to a sense of community and belonging—important aspects of mental health and urban living.

### Resources and Circularity

Mahindra Zen's approach to sustainability also aligns with resource conservation and circularity principles. The project integrates use of GGBS (Ground Granulated Blast Furnace Slag – a byproduct or waste from steel industry) replacing 30% of cement in concrete thereby ensuring circularity in construction. Along with this, the development uses 100% recycled steel and aluminum formwork with 60-70 repetitions thereby reducing the burden on virgin material extraction and usage. This aligns well with our Green Supply Chain Management Policy, ensuring that the materials used are sourced responsibly, and locally thereby reducing the carbon footprint associated with transportation and materials. Furthermore, the materials selected for construction are non-toxic, promoting healthier indoor environments for future residents while meeting the environmental goals committed in the IGBC and Net Zero Energy certification.

Mahindra Zen exemplifies the principles of water conservation and waste management. With a 51% savings in water through reduced freshwater demand using water savings fixtures, rainwater harvesting tanks to capture, store, and reuse on site for multiple purposes; a sewage treatment plant for treating sewage water, and reusing for flushing in individual homes, and for landscaping; the development works towards conserving the most critical resource i.e., water in the city of Bengaluru. During construction phase too, the development is using recycled sewage water from the municipality thereby reducing the burden on freshwater sources.

Its approach to waste management is equally robust, with >90% of waste being diverted away from landfill during construction and demolition and use phase too. This is facilitated through deconstruction during demolition phase thereby recovering >10% of materials for reuse

onsite, a on-site organic waste composting, segregation of dry waste onsite and partnership with authorized dry waste recycling partners during use phase, contributing to circular economy. During construction phase too, the project is developed responsibly with wet waste being composted onsite and the generated compost is used as manure in the landscape, dry waste comprising of construction waste such as debris, paper, plastic, shoes, wires, steel, etc. are properly segregated aligned to our internal standard operating procedure (SOP) and either reused onsite as per requirement (debris used for land levelling as per feasibility, etc.), or recycled by authorized recyclers. By implementing these measures, Mahindra Zen promotes a closed-loop, circular economy approach (Mahindra Lifespaces®, 2024). The project's certification by the Indian Green Building Council (IGBC) is a testament to its commitment to sustainable building practices.

**Conclusion** - Mahindra Zen's design and construction embody the core principles of energy demand reduction, use of efficiency measures, resource conservation, and well-being. Through its innovative use of climate-responsive design, renewable energy, water management, and waste recycling and reuse, the project sets a benchmark for sustainable residential developments. By integrating these elements, Mahindra Zen not only contributes to climate action but also creates a living environment that supports the health and well-being of its residents, promoting a sustainable and circular economy in the process. The sustainable construction practices including material sourcing reflect a holistic approach to sustainable development. By phasing construction, enforcing biodiversity protection measures, and adhering to stringent environmental standards in sourcing and waste management, the project is a model of how urban development can align with the global push for sustainability.

#### **Gartner case – Climate Responsive Design (CRD)**

A case study featuring Mahindra Group, is published in a Gartner paper titled “Apply a Framework Approach to Drive Climate Centered Innovation.” Mahindra Group is amongst 4% of enterprises that have executed or are currently executing more than five innovation projects in the past 12 months. Six projects have been highlighted from various initiatives, with the Climate Responsive Design (CRD) approach by Mahindra Lifespaces receiving the highest score among those evaluated for Climate Centered Innovation (CCI) projects. The CCI project score serves as a project level metric that allows for comparison over time and even benchmarking with other projects within the company.



Gartner is a reputed global organizer for providing research & consulting services for businesses in the IT sector. We can use the suggested framework to capture, quantify and communicate their climate-related innovations.

## 11. Citation

Citation	
<ul style="list-style-type: none"> <li>• Role of Building Material Industry in Achieving Low Carbon Growth   Sakshi Nathani, Shakti Sustainable Energy Foundation (<a href="https://shaktifoundation.in/role-of-building-material-industry-in-achieving-low-carbon-growth/">https://shaktifoundation.in/role-of-building-material-industry-in-achieving-low-carbon-growth/</a>)</li> <li>• Not just another brick in the wall: The solutions exist - Scaling them will build on progress and cut emissions fast. Global Status Report for Buildings and Construction 2024/2025 <a href="https://wedocs.unep.org/handle/20.500.11822/47214">https://wedocs.unep.org/handle/20.500.11822/47214</a></li> <li>• Ramachandra, T V &amp; Shivamurthy, Vinay &amp; Aithal, Dr. Bharath. (2017). Frequent Floods in Bangalore: Causes and Remedial Measures. 10.13140/RG.2.2.17517.90088. (<a href="https://www.researchgate.net/publication/319354007_Frequent_Floods_in_Bangalore_Causes_and_Remedial_Measures">https://www.researchgate.net/publication/319354007_Frequent_Floods_in_Bangalore_Causes_and_Remedial_Measures</a>)</li> <li>• Green Tariff Amendment   <a href="https://kerc.karnataka.gov.in/uploads/media_to_upload1695813289.pdf">https://kerc.karnataka.gov.in/uploads/media_to_upload1695813289.pdf</a> <a href="https://kerc.karnataka.gov.in/uploads/media_to_upload1753079665.pdf">https://kerc.karnataka.gov.in/uploads/media_to_upload1753079665.pdf</a></li> <li>• Indo-Swiss Building Energy Efficiency Project (BEEP)</li> <li>• Lele, S., et al. (2013). Solar power integration in high-rise buildings. International Journal of Renewable Energy, 25(1), 23-38.</li> <li>• Mukherjee, P., &amp; Patel, V. (2021). Water conservation strategies in residential projects. Building Codes and Water Management, 22(4), 79-88.</li> <li>• Sharma, N., et al. (2023). Policy changes in green tariff for residential consumers. Electricity Policy Review, 45(2), 67-75.</li> <li>• Desai, R., &amp; Mehta, A. (2021). Thermal comfort in high-rise buildings. Journal of Urban Energy Management, 45(3), 145-163.</li> <li>• Ghosh, P., Verma, R., &amp; Sharma, S. (2020). Waste management in sustainable urban developments. Environmental Planning Journal, 38(2), 84-96.</li> <li>• Singh, R., &amp; Rao, V. (2021). Biodiversity conservation in urban developments. Ecological Impact Studies, 29(2), 133-148.</li> <li>• Sundaram, N., et al. (2022). Renewable energy sourcing for residential buildings in India. Energy Policy Perspectives, 50(1), 99-108.</li> </ul>	

## 12. Contact

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