30 STORIES | BEYOND BUILDINGS

GRIHA

30 Stories | Beyond Buildings

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FOREWORD

Dear Friends,

It is heartening to note that government and private agencies alike are committing themselves to align with GRIHA and many have pledged their upcoming projects for GRIHA ratings. One such example was the signing of the agreement between the GRIHA Council and Public Works Department (PWD), Government of Maharashtra.

A significant outcome of this agreement is that PWD Maharashtra in 2019 not only upgraded 301 of their existing buildings to green buildings but also undertook steps to ensure that all upcoming construction met green building norms. The collaborative venture between GRIHA Council and PWD Maharashtra has been a significant contributor to the sustainable development in the country and I am proud to announce the release of the book ***30 Stories | Beyond Buildings***, which commemorates the achievements of this journey.

GRIHA has been a catalyst for promoting green development movement in India and is seen as an effective agent of change for addressing issues related to air-quality, protecting biodiversity, and reducing greenhouse gas emissions. While new construction places increasingly exorbitant demands on our energy and water, the impact of existing buildings and their notorious nature of being resource guzzlers cannot be side-lined. By encouraging retrofit technologies in existing buildings, we can take decisive steps towards improving their resource efficiency and environmental performance.

30 Stories | Beyond Buildings tells the story of 30 such government buildings that took precise measures to ensure that their development confirms with the country's sustainability norms and displays exemplary environmental performance. By promoting ideas of green building, this story aims to encourage the nation to accelerate the greening of all existing development and increase our green building footprint, thereby aiding the mitigation of global warming and climate change.

I gratefully acknowledge the support of PWD Maharashtra for embarking with us on this journey towards a greener India and compliment the efforts of our team at GRIHA Council in putting together the awaited publication.

Ajay Mathur
President
GRIHA Council

PREFACE

Nowadays, as environmental awareness attains momentum, the percentage of new development opting to adhere to sustainability norms is also on the rise. But, what about the existing buildings?

Do these buildings have a considerable environmental impact? Are low cost interventions available to reduce their collective operative carbon footprint? And, primarily, can the resources costs and efforts inputted to retrofit these buildings provide a substantial outcome? The answer is 'Yes'.

It is equally pertinent for a successful sustainable development that one calls for attention to the environmental performance of the nation's existing building stock. Existing buildings contain immense potential for minimizing operative carbon, which can be realised through strategizing for reduced consumption of resources, enhanced efficiencies, optimized operation and maintenance protocols, and augmented indoor comfort of the occupants. Responding to the same, in 2017, the GRIHA Council introduced the 'GRIHA for Existing Buildings (EB)' rating as an integrated tool to evaluate performance and provide solutions for improved sustainability in existing buildings.

In 2019, upon recognizing the need for sustainable interventions and upgradations, Maharashtra's Public Works Department joined hands with GRIHA Council to convert 301 government buildings into green developments in accordance with the GRIHA EB rating system. It is the details of successful collaborative venture that, on behalf of the GRIHA Council and its partners, I am pleased to present to you, in the form of a book ***30 Stories | Beyond Buildings***.

30 Stories | Beyond Buildings is an illustrated account of the processes, contributions, results, and successful completion of this ambitious undertaking. It introduces the formation of the effective partnerships between the government, the private sector and civil societies, which is the key to sustainable development. The chapters in the book comprise an overview of the Existing Buildings rating system, followed by an insight in to the stages of this collaborative exercise. The book goes on to display the reduction in resource use and subsequent carbon impact achieved in totality by the 301 retrofitted projects, while delving into greater depths of the strategies that contributed to the improved performance of 30 select buildings. Going beyond architecture, the narrative speaks of all interrelated aspects of a green development including, perceptive and measured indoor comfort level, benefits to society and financial implications of such projects.

Stabilizing and reducing carbon emissions is the key to living within environmental limits. While, 301 buildings are a mere drop in the ocean of India's vast built up, nonetheless, they approximately make for a total carbon dioxide offset of over 7.5 million tonne annually. Thus, this pilot project was a decisive step towards limiting the rise in the average global temperature and by displaying the viability of such a venture, it intends to galvanize a trend in the same direction.

Lastly, the publication aims to display the large positive impact existing buildings can make to the environment through the implementation of simple and economically viable advanced technologies and operational practices. With over 45,000 persons influenced directly, and many more continuing to engage with these buildings daily, this exercise sets an example of how an efficient model can create in the masses, a deep environmental awareness. The results of this successful venture have also incentivized the PWD to adopt green building norms for the construction of all new government buildings. On the same note, we hope that 30 Stories Beyond Buildings will inspire every building owner to incorporate similar changes in order to attain higher levels of sustainability in existing buildings.

I gratefully acknowledge the support of all those associated with this collaborative activity and the development of this publication. We aim to continue such public–private partnerships towards our common goal of environmental sustainability.

Sanjay Seth
Chief Executive Officer
GRIHA Council

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MESSAGE

It gives me immense pleasure to learn that GRIHA Council is launching their awaited publication ***30 Stories | Beyond Buildings*** in December 2020. PWD is proud to have participated in this expansive GRIHA for Existing Buildings rating project which was significant milestone toward sustainable development in the country.

PWD, Maharashtra has been at the forefront of adopting green parameters for public work development. In our pursuance towards sustainability, the Government of Maharashtra issued the GR No. BDG2016/P.K. 133/Buildings-2, dated 8th July 2016 for implementation of Green Building Concept for all government building projects. It also mandated the use of environment friendly resources in construction of New Government/ Semi-Government buildings.

As part of an earlier initiative, PWD buildings had transitioned to energy efficient electrical fittings. However, this combined venture to achieve the GRIHA for Existing Buildings rating for 301 government buildings in the state, by incorporating suggestions and guidelines outlined by GRIHA Council on solid waste management, indoor visual-thermal-acoustic comfort, maintenance, metering, monitoring and energy/water management ensured that we achieved holistic sustainability. This project was the key to harnessing the complete potential of green development in existing buildings and it created an opportunity for the state of Maharashtra to set an example and instil pride in every PWD officer.

I look forward to the publication of this exemplar project and wish GRIHA success in their future endeavours.

Manoj Saunik
Additional Chief Secretary
Public Works Department

MESSAGE

A. A. Sagane

Ex-Secretary (Works)
Public Works Department
Government of Maharashtra

I am delighted to learn about the upcoming launch of the GRIHA publication ***30 Stories | Beyond Buildings***. The collaborative venture between GRIHA Council and PWD Maharashtra towards green development was an extraordinary step and I congratulate the GRIHA team for translating this initiative into a commendable publication.

The Public Works Department (PWD) of the Government of Maharashtra primarily executes the construction and maintenance of roads, bridges and government buildings. In consequence to the aim of the GRIHA Council, PWD Maharashtra too strives for integrated development through diverse partnerships. We aim to incorporate innovative measures for the benefit of the states' citizens and lay equal emphasis on the need for environment-friendly construction practices to optimize use of natural resources.

The collaboration with GRIHA Council for upcoming and existing buildings was a pivotal step towards our sustainability goals. In a span of less than a year, this collaboration enabled us to successfully convert 301 non-residential existing buildings into green developments under the 'GRIHA for Existing Buildings' (GRIHA EB) rating system and fetching in excess of Rs. 10 crore on perpetual yearly savings in energy and water bills in addition to an equivalent growth of 1000 trees. We are proud to have set an exceptional example of how government buildings can reduce the consumption of energy, water and improve indoor comfort, ultimately resulting in the increased work efficiency of government servants who are the occupants of these non-residential building. The key achievement of the activity lay in its widespread sphere of influence with representation of buildings from rural and urban sectors across the seven regions of Maharashtra—Aurangabad, Nagpur, Nashik, Konkan, Pune, Amravati and Mumbai- thereby introducing over 5 lakh people to green building concepts.

I applaud the efforts taken by both teams in making this project a grand success and convey my best wishes to GRIHA Council for the publication.

A. A. Sagane
Ex-Secretary (Works)
Public Works Department, Government of Maharashtra

Acknowledgements

The GRIHA Council would like to thank the Public Works Department of Maharashtra for participating in this massive green building drive and leading by example in fulfilling our joint vision for a greener state. We are grateful to the regional Chief Engineers (CE) of each division who spearheaded this activity, namely Shri P.D. Naoghre, CE, Amravati; Shri P.K. Ingole, CE, Konkan; Shri K.T. Patil, CE, Mumbai; Shri P.B. Bhosale, CE, Nashik; Shri U.P. Debadwar, Secretary (Roads), ex. CE, Nagpur; and Shri S.S. Salunkhe, CE, Pune. We also thank all the regional Superintending Engineers, the Executive Engineers, and the entire on-ground team of the PWD, whose promptness, dedication, and enthusiasm to learn and contribute for a sustainable built environment, tremendously eased this process.

We express our gratitude towards Shri Sandeep A. Patil, Chief Engineer (Electrical) and Shri Sanjay Waman Gedam, Chief Architect of PWD Maharashtra for their encouragement and able assistance which resulted in the successful completion of this activity.

We would like to express our sincere gratitude to Shri Ajit. A. Sagane, ex. Secretary (Works) and Shri Manoj Saunik, Additional Chief Secretary PWD for being a pillar of support throughout the process. Finally, our heartfelt gratitude to Shri Ashok Shankarrao Chavan, Minister of Public Works for supporting GRIHA Council in all our endeavours.

We would like to convey our sincere gratitude to the team of third-party evaluators Mr Akash Jain, Mr Hrushikesh Kolatkar, Mr Gaurang Lele, Mr Mihir Save, Mr Jayesh Vira, and Mr Shirish Deshpande who were instrumental in facilitating the entire rating process on behalf of the clients and also provided handholding for the onground staff of the PWD.

Lastly, the GRIHA Council extends its gratitude to Dr Ajay Mathur, President of GRIHA Council for always providing his strong leadership and counsel.

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1. The GRIHA - PWD Venture for Sustainability

1.1 An Overview

Buildings account for a substantial part of energy consumption and greenhouse gas emissions. Green buildings result in longevity, improve productivity and enhance the overall quality of life. I would like to congratulate the GRIHA Council for undertaking this noble initiative which can prove to be a game changer in our efforts towards a greener future.

-Mr. Nitin Gadkari (Hon'ble Minister for Road Transport & Highways, and Minister of Micro, Small and Medium Enterprises)

PHOTO 1.1 Memorandum of understanding signed on 10th December 2018 by Shri Ajit Sagane (Secretary, PWD Maharashtra) and Mr. Sanjay Seth (CEO, GRIHA Council)

Public buildings managed and operated by state governments span across a substantial square footage across the length and breadth of the country. These buildings – administrative offices, courts, hospitals, rest houses, hostels, and educational institutions – are occupied by thousands of public servants and visited by innumerable citizens every day. Many of these structures were built at a time when terms such as 'sick building syndrome' were not the by-words that they are today, and expectations in terms of comfort and safety were a far cry from that of modern occupants. The majority of these buildings today also employ inefficient technologies for meeting indoor comfort requirements and barely monitor resource use. As a consequence, they contribute significantly towards excessive and inefficient consumption-induced carbon emissions resulting in negative impact on the local microclimate. When all the functioning public buildings in a state are accounted for together, the cost of inefficiency on such a scale not only adds up to a significant environmental footprint but also comes at huge direct and indirect cost to the exchequer.

Recognizing the importance of sustainable development and leading the change from the front, the Government of Maharashtra had made a policy decision to construct all new buildings in line with the requirements of the GRIHA rating system. The Public Works Department (PWD) issued a notification to that effect on August 29, 2017, and additionally proposed retrofits to existing public buildings across the state such that they may comply with GRIHA's rating variant for existing buildings – the GRIHA for Existing Buildings. In order to solidify the commitment, in January of 2018 GRIHA Council signed a Memorandum of Understanding (MoU) with the PWD-GoM for the promotion and implementation of GRIHA in the state. The MoU was signed by Shri Ajit Sagane, Secretary (Works), PWD, GoM and Shri Sanjay Seth, Chief Executive Officer, GRIHA Council (Photo 1.1), in the presence of the then Hon'ble Minister, Public Works, Shri Chandrakant Patil, and other senior officials of PWD and GRIHA Council. The underlying intent was to implement compliance with the ECBC (Energy Conservation Building Code) and promote green building concepts through the GRIHA rating system.

A dedicated PWD–GRIHA Green Building Cell was also established at PWD headquarters in Mumbai, a first-of-its-kind initiative by a state government and a nodal agency. Under the ambit of this collaboration, PWD would be committed to obtaining GRIHA ratings for all upcoming projects, while GRIHA Council, as a first step, would be responsible for conducting extensive customized training programmes across Maharashtra in order to build internal capacity within the PWD on the subject of sustainable buildings.

Also, a key part of this collaborative effort was the PWD GoM's decision to get their existing buildings evaluated, retrofitted, and rated under the GRIHA for Existing Buildings rating system. After intense deliberations between the two organizations, a target was set to transform 301 of these buildings into green buildings within a relatively short time frame, thus reducing resource consumption, implementing rainwater harvesting, and improving solid waste management and indoor visual–thermal–acoustic comfort amongst other strategies. The buildings selected were those that already had their electrical fittings replaced by the Energy Efficiency Services Ltd (EESL), as part of an earlier initiative by PWD GoM.

A pioneering exercise of this nature and magnitude, scheduled for completion within a clearly outlined time frame, this PWD-GRIHA for Existing Buildings exercise required unprecedented levels of co-operation and communication between PWD officials, GRIHA experts, and third-party assessors for its success.

1.2 GRIHA for Existing Buildings

In the last few decades, green buildings and retrofit technologies have evolved and matured in India. Taking inputs from technological advancements, the GRIHA Existing Building rating has been prudently designed to stimulate resource efficiency in our built environment. India's "Intended Nationally Determined Contributions" (INDCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) highlights GRIHA as the country's own green building rating for combating global warming and climate change and identifies it as a key instrument to facilitate the mitigation of greenhouse gas emissions. It is our endeavour to facilitate modern, innovative, and green technologies, and the rating for Existing Buildings would help accelerate the greening of the existing stock of buildings in our country.

-Dr. Ajay Mathur (President, GRIHA Council)

'GRIHA for Existing Buildings' is a performance-oriented rating system where points are earned for meeting the intent (appraisals) of the criteria. Each criterion has a number of points assigned to it and documents demonstrating compliance, as specified under the relevant section of the Existing Buildings manual, have to be submitted in the prescribed format. While the intent of some of the criteria are self-validating in nature, there are others such as energy consumption, thermal and visual comfort, noise control, and indoor air quality that need to be validated on-site through measurements and monitoring. The points related to these criteria (specified under the relevant sections) are only awarded after verification by GRIHA Council.

GRIHA for Existing Buildings is a 100-point system consisting of 12 criteria categorized under seven sections - ***Site Parameters, Maintenance and Housekeeping, Energy, Water, Human Health and Comfort, Social Aspects,*** and ***Bonus Points***. 6 of these 12 criteria are mandatory, while the remaining are optional. Each criterion, apart from the 6 that are mandatory, has a specific number of points assigned to it; a project that meets the requirements of the criterion would qualify for the associated points. Different levels of certification (one star to five stars) is awarded based on the number of points earned. The minimum points required for certification is 25. The twelve criteria of the GRIHA for Existing Buildings rating are:

Criterion 1 aims to reduce the use of private vehicles and promote walking, cycling, and the use of public transport. Points are earned by establishing proximity of basic amenities (such as banks, pharmacies, public transport) to the project site, or by providing collective transport service to the nearest public transportation node. Projects might provide preferred parking for electric vehicles/ pooled vehicles, bicycle rental/parking, or shuttle services.

Criterion 2 aims to encourage the plantation of trees and the implementation of adequate measures on-site to reduce contribution to the urban heat island effect. Points are earned by establishing the presence of 1 tree per 80 m^2 of total site/plot area and demonstrating that a percentage of the site surface visible to the sky (including building rooftops) is either soft paved, covered with high Solar Reflective Index (SRI) coating, or shaded by trees, pergolas, solar panels, or any combination thereof.

Criterion 3 aims to ensure that good practices are followed in the operation and maintenance of building systems, eco-friendly and biodegradable products are used for housekeeping, energy-efficient appliances are used in operations, and solid waste is managed responsibly within the project boundary. Points are earned by providing infrastructure and establishing protocols for environment friendly procurement and waste management.

Criterion 4 aims to promote reliable metering of energy and water consumption of the building to monitor and analyse performance.

Criterion 5 aims to promote energy efficiency. Points are earned either by having an audit conducted or by demonstrating a reduction in energy consumption through comparisons between historical and post-retrofit consumption data (electricity bills).

Criterion 6 aims to promote the use of renewable energy technologies. Points are earned through the installation of renewable energy-generation technology on-site.

Criterion 7 aims to estimate water consumption for different applications and identify potential areas to optimize water consumption within the project boundary. Points are earned either by having an audit conducted or through the installation of water-efficient fixtures and/or undertaking water-saving measures such as replacing irrigation-intensive landscape elements with native species and installing infrastructure for harvesting rainwater.

Criterion 8 aims to promote water reuse and recycling in order to meet the

PHOTO 1.2 Orientation workshop conducted on GRIHA for Existing Buildings rating system for PWD officials

requirement for non-potable water and to reduce the overall water demand from the local municipal supply/ground water.

Criterion 9 aims to ensure that interior spaces of the building meet the thermal, visual, and acoustic comfort requirements of building occupants, as per nationally accepted standards.

Criterion 10 aims to ensure good indoor air quality and quantity for building occupants.

Criterion 11 aims to ensure that the project is accessible for persons who are elderly and differently abled, and to encourage environmental awareness among building occupants and visitors. Points are earned by providing ramps at the entrance, preferred parking for the differently abled, toilet facilities for persons with special needs, and introduction of innovative displays, short tours or awareness programmes.

Criterion 12, the last of this rating, aims to reward additional measures adopted by the project that have not been covered in previous sections but can significantly improve the sustainability quotient of the project.

1.3 The Exercise

The intent of the PWD (GoM) - GRIHA Council joint exercise was to successfully complete the evaluation, retrofitting, appraisal, and documentation of 301 public buildings across Maharashtra in a span of six months, such that they could be made compliant with the rating variant at the end of the stipulated time period.

Once the projects were registered on the GRIHA portal by the respective PWD teams, the first stage involving extensive workshops was conducted by GRIHA officials across the seven administrative regions of Maharashtra (Photo 1.2). A total of 587 PWD officials were trained by GRIHA at this stage. General recommendations were shared, and forms customized specifically for the exercise were distributed to ensure consistent data collection and an accurate evaluation of the current state of each building. This data would prove invaluable in identifying the retrofits that would be required in both general and specific to each project. The intent of this stage was to acquaint PWD officials with the core tenets of the rating system and provide them with insight into the scope of interventions that might be required. At this stage, with a clearer picture of both the task at hand and the benefits of a green rating, the PWD teams were able to switch the buildings they would like to pursue a rating for; without initial clarity regarding the nature of the activity, they had in several instances nominated buildings that were either recently constructed, scheduled to be demolished in the near future, or that were not regularly occupied.

Following a detailed analysis of the dataset collected, GRIHA Council issued each team a list of measures to be implemented, so as to be able to both qualify for and perform better in the rating. After a period of time allocated to the individual project teams to implement retrofits on their respective projects, the second stage involved a site visit to each individual project by teams of third-party evaluators (Photos 1.3 and 1.4). These highly experienced professionals, without an affiliation to either organization, were responsible for independent evaluation and documentation of every project, and they advised project teams on how best to balance costs and impact in order to achieve a desired rating for their projects. They collected detailed measurements on parameters, such as illuminance, noise levels, and resource consumption, and submitted a detailed report of each project for evaluation to GRIHA Council (Photo 1.5).

In the third stage, each project was physically audited in turn by a GRIHA Council official, with the intent to corroborate the documentation compiled by the evaluators and ensure that post-retrofitting, each building was indeed performing as intended (Photo 1.6). These officials made their own visits and compiled their sets of documentation.

The final stage involved the compilation and evaluation of each project by GRIHA Council and the subsequent announcement of ratings at the 10th Regional GRIHA Summit at Nagpur (Photo 1.7). At the event, an interactive session was organized between the leadership of GRIHA Council and the PWD-GoM in order to brainstorm on the lessons learnt and experience gained during the execution of the PWD-GRIHA EB initiative. The meeting was presided over by Mr Ajit Sagane and Mr Sanjay Seth and included the seven Chief Engineers, senior officials from PWD and GRIHA Council, and the evaluators (Photo 1.8). GRIHA Council also felicitated enterprising officials from the ranks of the PWD who demonstrated remarkable enthusiasm, ability, and interest in the adoption of sustainable initiatives.

At the behest of the PWD (GoM) Secretary, projects that had received a rating below three stars were afforded additional time to incorporate further improvements.

PHOTO 1.3 Site visits and first audit by Ar. Gaurang Lele (Director, Shashwat)

PHOTO 1.5 Temperature, relative humidity, and decibel levels being monitored on-site

PHOTO 1.4 Site visits and first audit by Mr. Sanket Awasare (Environmental Executive, BEIPL)

PHOTO 1.6 Final site inspection being conducted by Ar. Sanchit Malik (Project Officer, GRIHA Council) at Rest House, Kagal

PHOTO 1.7 Inauguration of the 10th Regional GRIHA Summit at Nagpur

PHOTO 1.8 Regional Chief Engineers Meet at the 10th Regional GRIHA Summit

GRIHA Council handheld these project teams and helped re-evaluate each individual project so that they could balance costs, time, and practicality in the implementation of additional interventions. By the end of the exercise, over 80% of the registered buildings had been able to achieve a rating of three stars or higher, with several being rated five stars and only a handful were unable to meet the mandatory requirements for a rating due to unavoidable circumstances.

1.4 The Outcome

Upon completion of the exercise, the vast majority of projects were found to have achieved at least a three-star rating, and a handful having been awarded the coveted five stars. The majority of the buildings saw significant improvement in accessibility, liveability and resource optimization, and monitoring. As part of the endeavour, rooftop solar photovoltaics (PV) were incorporated into a large number of projects that previously did not have them, and measures were implemented to ensure barrier free access for the differently abled. Meters were installed to monitor energy and water usage and identify potential wastage, solid waste management practices and infrastructure were developed, firefighting equipment were installed or upgraded, and rooftop surfaces were covered with high SRI material to reduce each building's contribution to the urban heat island effect. Additionally, maintenance and housekeeping protocols were put in place for systems, policies were enacted for the purchase of efficient, environment friendly equipment, rainwater harvesting infrastructure was developed, and vast areas of landscape were altered to include native species and reduce the demand for irrigation. The greatest impact of all, perhaps, may have been made through the awareness initiatives undertaken by each project team as part of the rating process; training programmes were conducted and posters were displayed at

PHOTO 1.9 Launch of the policy brief, Future Shift: Integrating Sustainable Initiatives in Functional Buildings

prominent locations in each project to ensure that the countless individuals who visit these buildings are made aware of the need for sustainable development, and of what steps might be taken at an individual level in order to collectively move towards a 'greener' future.

The magnitude of the project and the involvement of multiple teams working on 301 buildings resulted in a vast repository of data and documentation that offered significant insight into the general condition of public buildings in India, and the scale and cost of interventions required in order to incorporate elements of sustainability. Moving forward, both the PWD and GRIHA Council gained immense experience from the exercise, and the new learnings took the form of the policy brief '***Future Shift: Integrating Sustainable Initiatives in Functional Buildings'***, launched in June 2019 (Photo 1.9).

The policy brief outlines protocols for maintenance and waste management and establishes standards for the procurement of efficient equipment and environment friendly housekeeping products. It is hoped that through the implementation of policies such as this, public buildings across the country might make a gradual transition towards a greener tomorrow, and generate an impact far beyond that achieved through the buildings which were rated under the PWD-GRIHA for Existing Buildings programme in Maharashtra.

We are honoured to partner with the Government of Maharashtra in this initiative. It is heartening to see that the state is committed to large scale transformations in the urban built environment. The leadership shown by the state and the Public Works Department for implementing sustainable strategies in new and existing buildings is commendable and needs to be applauded.

-Mr. Sanjay Seth (CEO, GRIHA Council)

2. 1 Year - 301 Buildings | A Success Story

2.1 Introduction

Maharashtra, the third largest state of India by area, is divided into seven administrative regions by the PWD, for ease of work. They are Amravati, Aurangabad, Konkan, Mumbai, Nagpur, Nashik, and Pune. For the mission of retrofitting the existing buildings to be green buildings, 300 projects located across these seven regions and 1 located in New Delhi were registered with the GRIHA Council. Figure 2.1 shows the concentration of the EB rated buildings in each of these regions which contributes to the growth of the overall green building footprint in Maharashtra.

This chapter summarizes the performance of these buildings, based on three environmental parameters. It computes for the resultant positive impact on the environment and displays it in terms of achievable resource optimization. .

Out of these 301 projects, the performance of 100 projects has been assessed for the positive impact made by them in terms of energy savings, water savings, and subsequent CO_2 reductions.

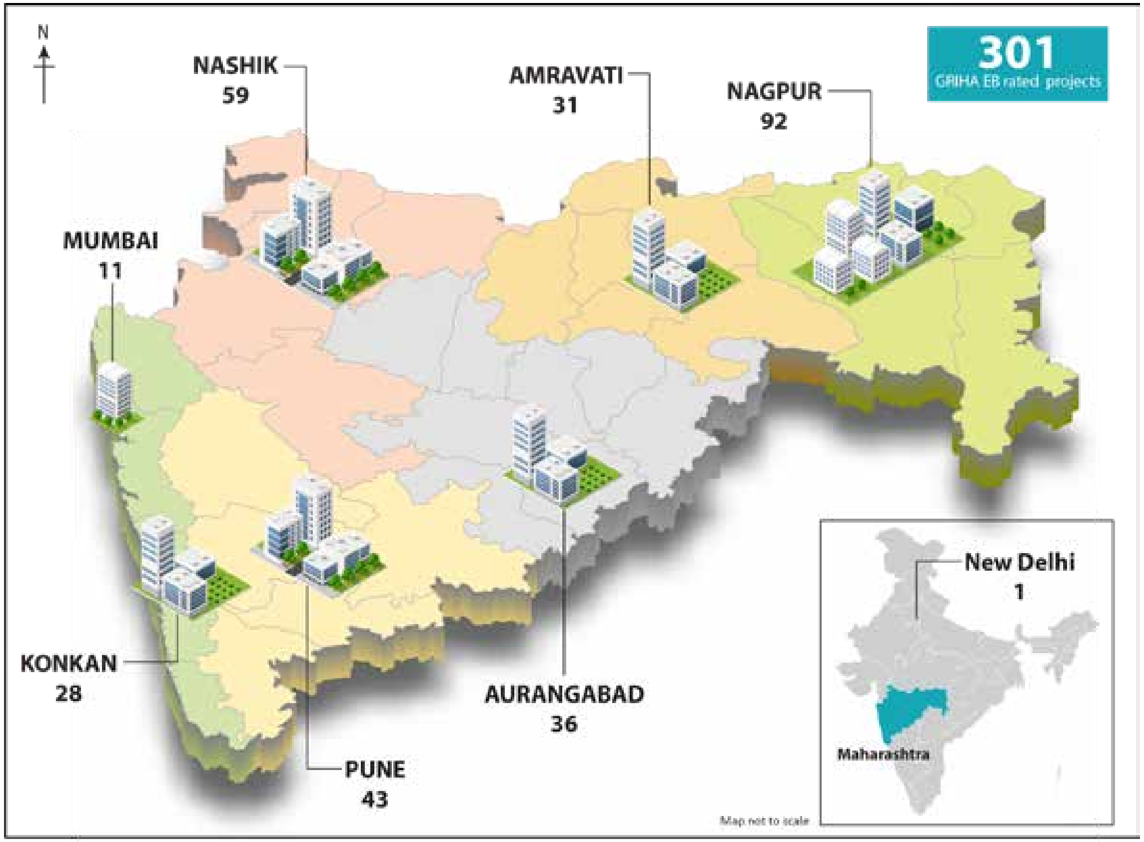


FIGURE 2.1 Concentration of projects in each region of Maharashtra

2.2 Total Energy Savings

This section demonstrates the average reduction seen in the energy consumption in the existing buildings which was achieved by adopting a few simple strategies such as:

- Replacing the conventional high wattage fixtures and appliances with energy-efficient fixtures, such as LEDs, and rated equipment, such as the BEE star-rated fans and air conditioners.
- Applying high Solar Reflective Index (SRI) paints on the rooftop for reduction in the indoor temperature during the hot months and subsequent reduction in the load on the artificial cooling systems.
- Creating awareness among the users by use of creative posters, conducting programmes, and circulation of information brochures, resulting in conservative usage patterns.

As seen in Figure 2.2, the energy consumption before retrofitting the building was about 13,535,519 kWh/year whereas the energy consumption after retrofitting came down to about 10,828,729 kWh/year, i.e. displaying an average annual energy saving of 20% as a result of the measures taken for GRIHA for Existing Buildings rating system.

Figure 2.3 depicts how, in the presence of sustainable measures, these buildings can, on average, extend their energy allocation of 48 years to 60 years. Thus, by implementing the energy-efficiency measures, the same amount of energy can now meet demands for an additional 12 years, compared to what it would have in a non-efficient model.

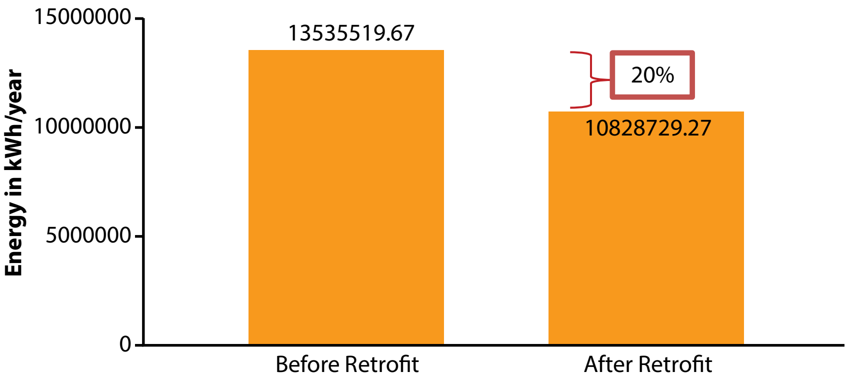


FIGURE 2.2 Energy demand before and after retrofitting

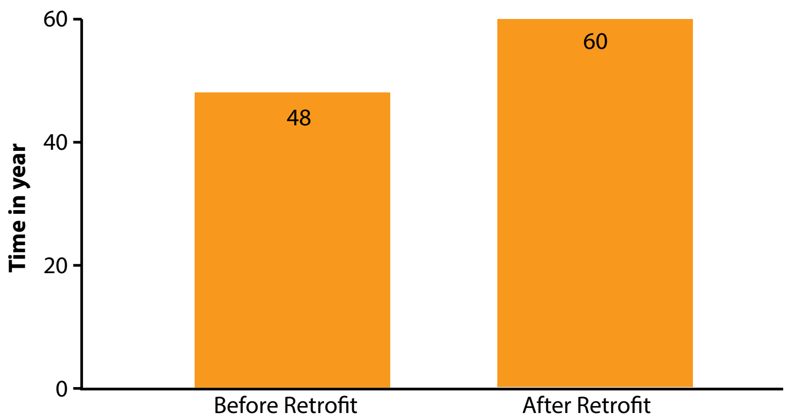


FIGURE 2.3 An additional supply of energy gained as a result of implementing the GRIHA for Existing Buildings rating system

A further reduction in the conventional energy demand from the grid can be made by offsetting it with renewable energy (RE) source. The RE system installed in the projects included either solar PV or solar hot water systems or both. Renewable energy also called as green energy or clean energy helps to reduce the dependency on the conventional energy generated from the thermal power plants thereby reducing the carbon emissions in the environment.

Figure 2.2 displays the reduction in conventional energy consumption attained by the projects before and after retrofitting. Figure 2.4 illustrates the reduced demand due to the installation of the RE systems, which is 44.8%. Thus, the interventions result in a 55.9% cumulative reduction of conventional energy demand at source.

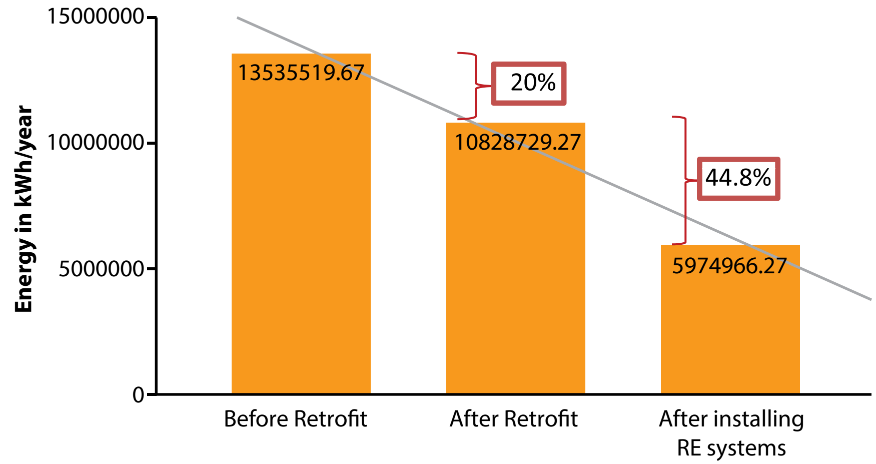


FIGURE 2.4 Stages of reducing demand of conventional energy

2.3 Total Water Savings

Water is the most important resource for survival and its increasing scarcity is leading to water stress in the country. For a reduced and efficient water consumption pattern, various strategies such as the use of efficient low flow fixtures instead of conventional ones, use of efficient irrigation methods for landscaping, planting of low maintenance native vegetation, minimizing lawn area, etc. were adopted during the retrofitting of these projects.

As we see in Figure 2.5, the annual water demand for the projects before retrofitting was about 668,488 kl/year whereas the annual water demand after retrofitting came down to 459,439 kl/year which resulted in water savings of about 31.3% each year.

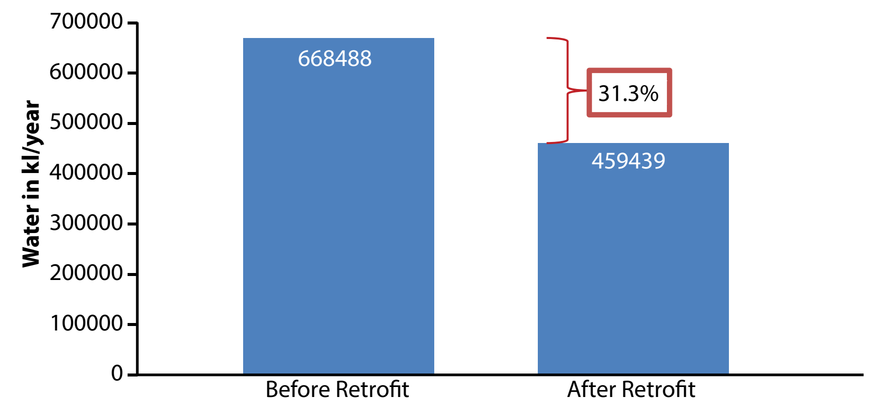


FIGURE 2.5 Water demand before and after retrofitting

From Figure 2.6, we see that due to sustainable measures, these buildings can, on average, extend their water allocation of 41 years to 60 years, i.e. by almost 19 years. The water saved due to the initiative undertaken by PWD Government of Maharashtra by adopting the GRIHA for Existing Buildings rating variant and undergoing various strategies can help to provide an extra water requirement of 4242 people each year.

2.4 CO_2 Reduction

Carbon dioxide, a key greenhouse gas, is a primary driver of global climate change. With the increased production of materials, extraction of oil and gas, and increased human activity, the percentage of CO_2 emissions is on the rise and has disturbed the environmental equilibrium, in turn contributing to the phenomenon of global warming. Buildings and construction together account for 36% of global final energy use and 39% of energy-related carbon dioxide (CO_2) emissions. (IUnited Nations Environment Programme , 2019)*

Under this pilot initiative, three aspects - energy, water, and landscape - were focused upon that directly or indirectly contribute towards reduction in CO_2 emissions into the atmosphere.

Ensuring protection and preservation of existing trees and densifying of landscape by planting of native trees has resulted in carbon sequestration of about 333 tonne of CO_2 annually. Water saved in these projects results in less energy required for extraction, pumping, distribution systems, etc. leading to about 1205 tonne of annual CO_2 reduction.

United Nations Environment Programme, 2019. 2019 Global Status Report for Buildings and Construction, s.l.: International Energy Agency.

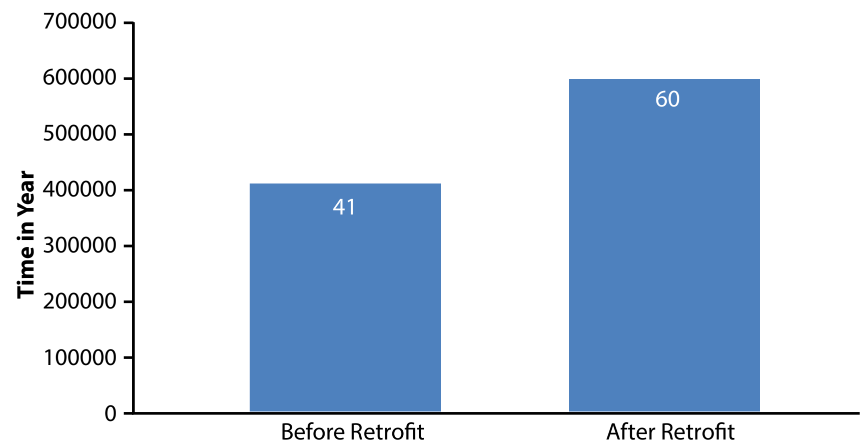


FIGURE 2.6 An additional supply of water gained as a result of implementing the GRIHA for Existing Buildings rating system

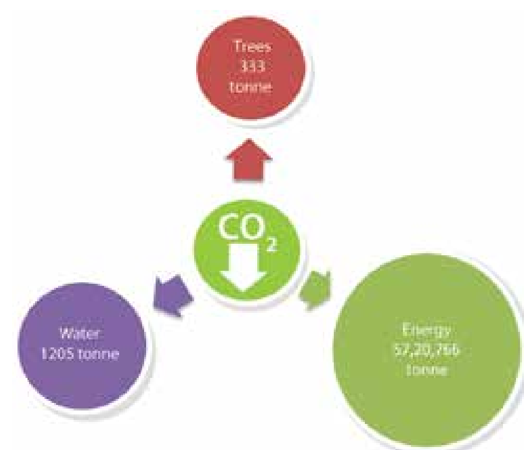


FIGURE 2.7 Resultant carbon impact

Furthermore, a reduction in energy demand and subsequent offset with clean sources was most impactful with a reduction of about 5,720,766 tonne (Figure 2.7).

Thus, if we draw a parallel between the cumulative carbon reduction due to trees, water, and energy against a car that emits 4.6 tonne of CO_2 annually, the carbon impact achieved is equivalent to withdrawing of 12,43,978 cars from the road each year. This significant reduction is, however, attributed to only a small fraction of the total number of buildings in the state. To meet national climate targets, one needs to ensure that more and more existing buildings follow the example set by this pilot project and undergo retrofitting for a better environmental performance.

3. 30 stories | Beyond Buildings

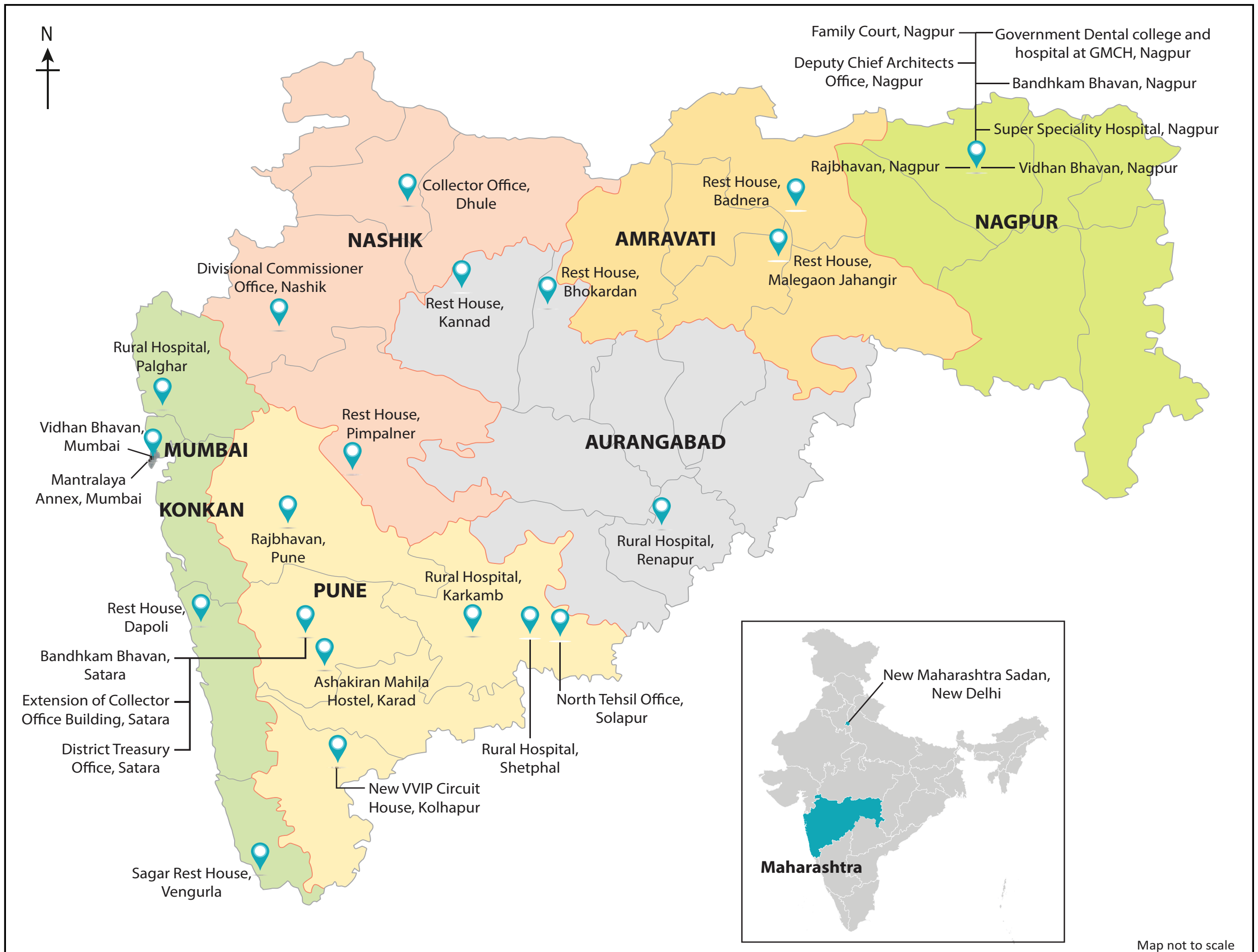


FIGURE 3.1 29 buildings spanning across the 7 regions of Maharashtra, and 1 in New Delhi

3.1 Introduction

Of the 301 PWD buildings that underwent a sustainable transformation, this chapter illustrates the detailed performance of 30 exemplar buildings. Spanning across the seven regions of Maharashtra - Amravati, Aurangabad, Konkan, Mumbai, Nagpur, Nashik and Pune - and 1 located in New Delhi; representing the various building typologies - residential, healthcare, institutional, hospitality, and commercial - and with a range of built up areas from about 220 m^2 to 37,000 m^2, this chapter tells a story that goes beyond buildings. It is a story of varied scales, locations, building ages, typologies, and even architectural characteristics, a collection held together by one commonality - their robust environmental performance.

Existing buildings can and should be made sustainable. A building's sustainability directly correlates to the carbon footprint it has in the environment. In the case of an existing building, its carbon footprint is defined as the amount of CO_2 it produces during its operations and activities, i.e. its operational carbon impact. In order to reduce an existing building's carbon footprint, one must optimize the use of resources such as energy and water, lessen and manage the waste generated, and switch to environment friendly products, amongst other strategies.

Each project in this chapter highlights the results of sustainable and low-cost interventions made by the project teams to meet the compliances of the GRIHA for Existing Buildings rating. These results are as follows:

Total reduction in the Urban Heat Island Effect (UHIE) achieved: It is the percentage reduction in the urban heat island effect of the project as compared to the same project without the implementation of sustainable strategies. This is determined by the amount of site surface visible to sky (including building roofs) that is either **soft paved / covered with high SRI coating / shaded by trees / shaded by vegetated pergolas /shaded by solar panels or any combination** of these strategies.

Total energy offset by renewables: It is the percentage of the post-retrofit energy demand that is offset by the energy generated on-site using renewable sources. This includes the use of **solar hot water systems and/ or photovoltaic panels.**

Total water reduction achieved: It is the percentage of reduction achieved in building and landscape water requirement as compared to the pre-retrofit demand.

As you will see in the infographic of each case sudy, it is eminent that the three dominant aspects, which account for the maximum carbon offset of an existing project, are as follows:

Site: It includes the planting and preservation of trees at site. Vegetation, both preserved and newly planted, sequester carbon by capturing carbon dioxide from the atmosphere. Native vegetation is preferred as they require the least resources for their maintenance. Thus, by **increasing the number of trees on-site**, a development can, through natural means, reduce their carbon impact on the environment.

Energy: It includes the lowering of conventional energy demand annually, by the use of energy-efficient fixtures and other passive design strategies. Moreover, a shift to renewable energy sources will also reduce dependency on coal-based energy generation. **Thus, the reduction in conventional energy demand at source** by the project is the total conventional energy saved at its source which included the losses of distribution and transmittance.

Water: It includes the **reduction of building water demand** made in the project by installation of low-flow fittings. It also accounts for the **reduction in landscape water demand** achieved by switching to native landscapes. The summation of this reduction is translated into the carbon reduction achieved due to the lowered energy required by the project for freshwater extraction and distribution.

Thus, the total carbon offset of each project in tonnes of CO_2 equivalent is presented as a summation of these three aspects whose percentage contribution has been depicted in the form of info-graphics in each case study.

3.2 Divisions: Amravati, Aurangabad, Konkan and Mumbai

1. Rest House, Malegaon Jahangir

Vishram Gruha at Malegaon (Credits: Gaurang Lele)

★★★★★

Aerial view of the rest house (Credits: after Google Earth Pro)

About

Location: Malegaon Jahangir, District Washim

Typology: Hospitality

Purpose: Rest House

Site area: 9235 m^2

Built up area: 319 m^2

Ground coverage: 319 m^2

Typical of PWD rest houses across Maharashtra, the building has a miniscule built up area relative to the expansive site area it stands upon. Predictably, this gives the project an advantage when evaluated for GRIHA criteria that reward minimal impact on surrounding landscape and the presence of native vegetation on-site. The project features traditional climate responsive elements such as a shaded walkway along the outer walls that block solar radiation from heating the envelope, and clerestory windows that allow the ingress of daylight.

GRIHA for Existing Buildings :
Awarded = 86.4% (*5 Star Rating: 86–100%)

SITE PARAMETERS

- Number of trees at site = 124
- Soft landscape area = 8500 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 319 m^2
- Hard paved area with other strategies = 0 m^2

Total reduction in UHIE achieved= 95.5%

ENERGY PERFORMANCE

- Energy consumption before retrofit = 4627 kWh/y
- Energy consumption after retrofit = 3354 kWh/y
- Proposed PV panel system = 2 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 5315.53 kWh/y.

Total energy offset by renewables = 93%

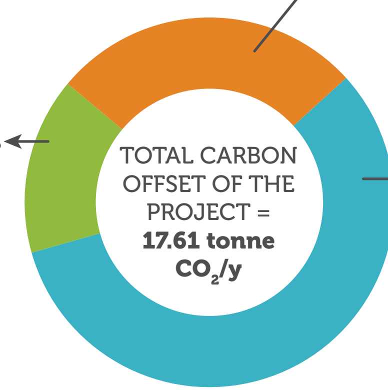
WATER PERFORMANCE

- Water consumption before retrofit = 37659332 L/y
- Water consumption after retrofit = 205533 L/y
- Reduction in building water demand = 30.8%
- Reduction in landscape water demand = 100%

Total water reduction achieved = 99.5%

Offset due to **energy conservation: 27.17%**

Offset due to **sequestration by trees: 15.49%**



Offset due to **water conservation: 57.34%**

Front elevation of Vishram Gruha, Malegaon (Credits: Gaurang Lele)

At the same time that it was chosen as a part of the 301 pilot projects for GRIHA assessment, the building which was in a poor condition had been taken up for renovation by the PWD. During the first visit, we explained the GRIHA EB guidelines to the project team and they promptly included the same within their renovation plans. The commendable implementation of these guidelines was witnessed during the final assessment, along with their completed renovation. The enthusiastic team ensured that they incorporated all the possible steps and went on to achieve the highest rating of a 5 star.

Ar. Anagha Shinde Rajurkar, Director, Shashwat

2. Rest House, Badnera

Front elevation of the rest house at Badnera (Credits: Author)

★★★★

Aerial view of the rest house (Credits: after Google Earth Pro)

About

Location: Badnera, District Amravati

Typology: Hospitality

Purpose: Rest House

Site area: 5148.6 m^2

Built up area: 299 m^2

Ground coverage: 149.5 m^2

With a simple rectangular floor plan and a north–south faced sloping roof, this small building is situated in the middle of a site which spans an area larger than 15 times its built up area. This large built up area to landscape ratio coupled with a dense tree cover proved beneficial for the project as did its east–west orientation. Despite its geographic disposition of high temperatures, this rest house maintains a comfortable range of 28°C–32°C indoors. Protected by the overhang of the roof, the windows provide daylight ranging between 320 and 475 lux, suitably meeting the indoor visual comfort requirements. As illustrated, it was one of the few projects on-site that ensured a comparable reduction in carbon impact by implementing equitable strategies for each of the criteria of energy, water, and site performance.

GRIHA for Existing Buildings:
Awarded = 71.4% (*4 Star Rating: 71-85%)

SITE PARAMETERS

- Number of trees at site = 136
- Soft landscape area = 4035.9 m^2
- Percentage of lawn area = 4.95%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 162.5 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 11678 kWh/y
- Energy consumption after retrofit = 10492 kWh/y
- Proposed PV panel system = 2 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 5085.63 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 50202069 L/y
- Water consumption after retrofit = 898000 L/y
- Reduction in building water demand = 33.8%
- Reduction in landscape water demand = 98.8%

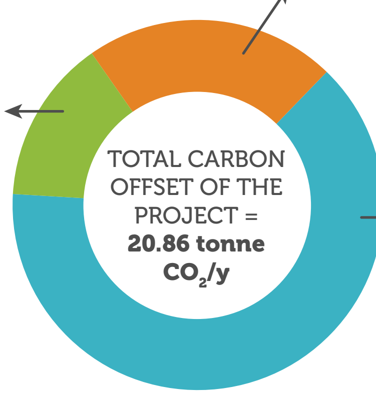
Total reduction in UHIE achieved = 81.5%

Total energy offset by renewables = 28.8%

Total water reduction achieved = 98.2%

Offset due to **energy conservation: 21.94%**

Offset due to **sequestration by trees: 14.34%**



Offset due to **water conservation: 63.72%**

Electric vehicle charging station at Badnera (Credits: Author)

Sustainable transportation is the capacity to provide for the mobility needs of a society so as to least damage the environment and ensure the provision is not at the cost of future mobility needs. It encompasses not only the use of alternative non-motorized vehicles but also the reduction in the use of conventional private transportation systems and shift to pooled systems. This project encourages sustainable transport mechanisms with the simple provision of an electric vehicle charging station. It is important to note that the campus has installed a PV system to offset in part, their conventional energy demand, thereby making the electric vehicles a truly greener choice. Apart from that, parking preference is given to electric vehicles, pooled vehicles and bicycles with separate shaded spaces designated on-site for it.

We were quite interested in maximizing our green footprint – in addition to the mandatory requirements for an EB rating such as rainwater harvesting infrastructure and charging points for electric vehicles, we decided to go the extra mile and set up an organic garden within the premises and attempt for additional points under GRIHA's innovation criteria. It turned out to be quite a success!

Shri. P. D. Naoghre, Chief Engineer, Public Works Region, Amravati

3. Rest House, Kannad

Rest house at Kannad (Credits: Author)

★★★★

Aerial view of the rest house (Credits: after Google Earth Pro)

About

Location: Kannad, District Aurangabad

Typology: Hospitality

Purpose: Rest House

Site area: 589 m^2

Built up area: 322 m^2

Ground coverage: 322 m^2

Located in the dry Marathwada region, this rest house is a ground floor structure with a semi-enclosed veranda along the front entrance. The project team's most significant contribution towards making their building GRIHA compliant was implementing measures to reduce the urban heat island effect over an area of 547.6 m^2 out of the 589 m^2 of site area. This included meeting the GRIHA requirement of having 1 tree per 80 m^2 of site area by planting new native trees and protective measures for the existing. Also, key to the building's performance was the team's success in not only switching their electric demand completely to solar energy but moreover generating three times the building's demand enabling it to give back to the grid.

GRIHA for Existing Buildings:
Awarded = 80% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 10
- Soft landscape area = 225.63 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 322 m^2
- Hard paved area with other strategies = 0 m^2

Total reduction in UHIE achieved = 92.98%

ENERGY PERFORMANCE

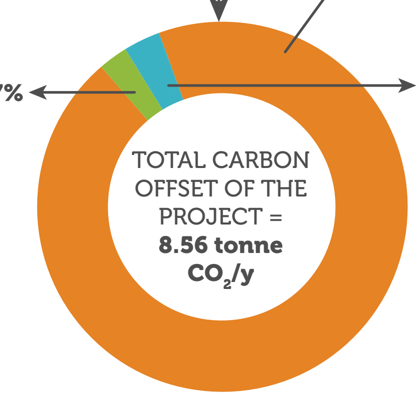
- Energy consumption before retrofit = 5244 kWh/y
- Energy consumption after retrofit = 966 kWh/y
- Proposed PV panel system = 2 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 8958.84 kWh/y

Total energy offset by renewables = 323.6%

WATER PERFORMANCE

- Water consumption before retrofit = 1038915 L/y
- Water consumption after retrofit = 16077 L/y
- Reduction in building water demand = 84.3%
- Reduction in landscape water demand = 100%

Total water reduction achieved = 98.5%



Cool roof paint being applied at Kannad (Credits: Author)

Cool roofs are those that employ strategies to increase their reflectivity, ensuring that heat gains through the roof get minimized. Strategies include the use of high Solar Reflective Index (SRI) paints, reflective roof panels and tiles, coating of limewash, or the use of green cover and other shading. The rest house at Kannad opted for the use of high SRI paint, which has the least cost among the strategies, and is low maintenance. As a result, the building could demonstrate compliance with the Indian Model for Adaptive Comfort (IMAC) standards. Temperature and relative humidity were measured by GRIHA Council officials during the due diligence visit in the month of March and were found to be within the range of 27°C–28°C and 38%–39%, respectively.

The building wasn't in good shape before this exercise and we wanted to make significant improvements. We ended up making several key changes like painting the rooftops with white paint to reflect heat and providing ramps at the building entrance. We also displayed multiple posters for environmental awareness around the entire building so that visitors can learn about the measures we have taken to transform this into a green building.

Shri K.T. Patil, Chief Engineer, P.W. Region, Mumbai

4. Rest House, Bhokardan

Rest house at Bhokardan (Credits: Author)

Aerial view of the rest house (Credits: after Google Earth Pro)

About

Location: Bhokardan, District Jalna

Typology: Hospitality

Purpose: Rest House

Site area: 10180 m^2

Built up area: 224 m^2

Ground coverage: 224 m^2

Built on an expansive site in water stressed Marathwada region of central Maharashtra, the rest house at Bhokardan boasts passive design features that enhance indoor comfort, even without electricity. With the building occupying barely 2% of the site area and with no other hard paving present, the site preserves a large area of much needed natural groundcover that allows rainwater to seep into the soil and recharge shallow aquifers. Given the basic energy demands of such a small structure, the installation of solar PV has allowed the building to have a net positive energy footprint, generating five times more energy than it consumes.

GRIHA for Existing Buildings:
Awarded = 74% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 187
- Soft landscape area = 7970 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 224 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 3942 kWh/y
- Energy consumption after retrofit = 783 kWh/y
- Installed PV panel system = 3 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 9114.93 kWh/y

WATER PERFORMANCE

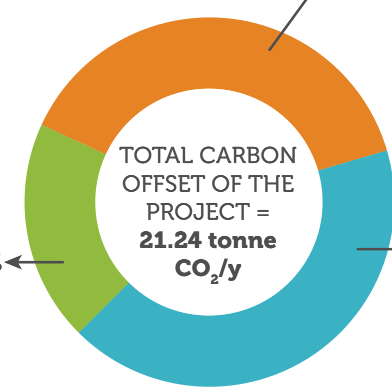
- Water consumption before retrofit = 33345007 L/y
- Water consumption after retrofit = 234294 L/y
- Reduction in building water demand = 6.3%
- Reduction in landscape water demand = 100%

Total reduction in UHIE achieved = 80.5%

Total energy offset by renewables = 558.6%

Total water reduction achieved = 99.3%

Offset due to **energy conservation: 38.61%**



Offset due to **sequestration by trees: 19.37%**

Offset due to **water conservation: 42.02%**

Entrance porch of the rest house at Bhokardan (Credits: Author)

I would like to thank the GRIHA Council as well as the PWD on-site team for the work done during the audit. Everything was completed on time and in accordance with the agreed procedures and methods. We know from our own experience that it must have required a considerable amount of planning and organization. I would like to mention the support and cooperation provided by Mr. S. S. Dube which ensured a successful outcome.

Mr Hrushikesh Kolatkar, Managing Director, Built Environment (India) Pvt. Ltd

5. Rural Hospital, Renapur

Gramin Rungnalaya at Renapur (Credits: Author)

Aerial view of the hospital (Credits: after Google Earth Pro)

About

Location: Renapur, District Latur

Typology: Healthcare

Purpose: Hospital

Site area: 9375.4 m^2

Built up area: 836 m^2

Ground coverage: 836 m^2

The only source of medical care for miles around, the rural hospital at Renapur scores high on ingenuity and maximum impact with minimal infrastructure. High SRI paint on the roof surface provides a cost-effective method of reducing heat gain through the roof and offsetting contribution to the heat island effect. With deep window shades to block the sun in summer months and native trees surrounding the rear end of the building and tended to by the hospital employees, this remote hospital stands as a testament to the fact that any building anywhere can be built green, and that not all green buildings are expensive.

GRIHA for Existing Buildings:
Awarded = 58% (*3 Star Rating: 56–70%)

SITE PARAMETERS

- Number of trees at site = 50
- Soft landscape area = 6477 m^2
- Percentage of lawn area = 56.01%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 1764 m^2

Total reduction in UHIE achieved = 87.9%

ENERGY PERFORMANCE

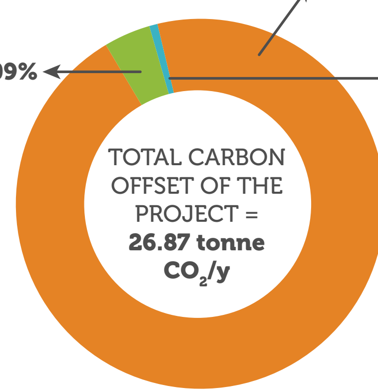
- Energy consumption before retrofit = 17256 kWh/y
- Energy consumption after retrofit = 18770 kWh/y
- Installed PV panel system = 0 kWp
- Installed solar hot water system = 2000 L
- Reduction in conventional energy demand at source = 28418.06 kWh/y

Total energy offset by renewables = 133.19%

WATER PERFORMANCE

- Water consumption before retrofit = 1570571 L/y
- Water consumption after retrofit = 840021 L/y
- Reduction in building water demand = 37.77%
- Reduction in landscape water demand = 49.45%

Total Water reduction achieved = 46.51%



Water meters installed at the Renapur hospital (Credits: Author)

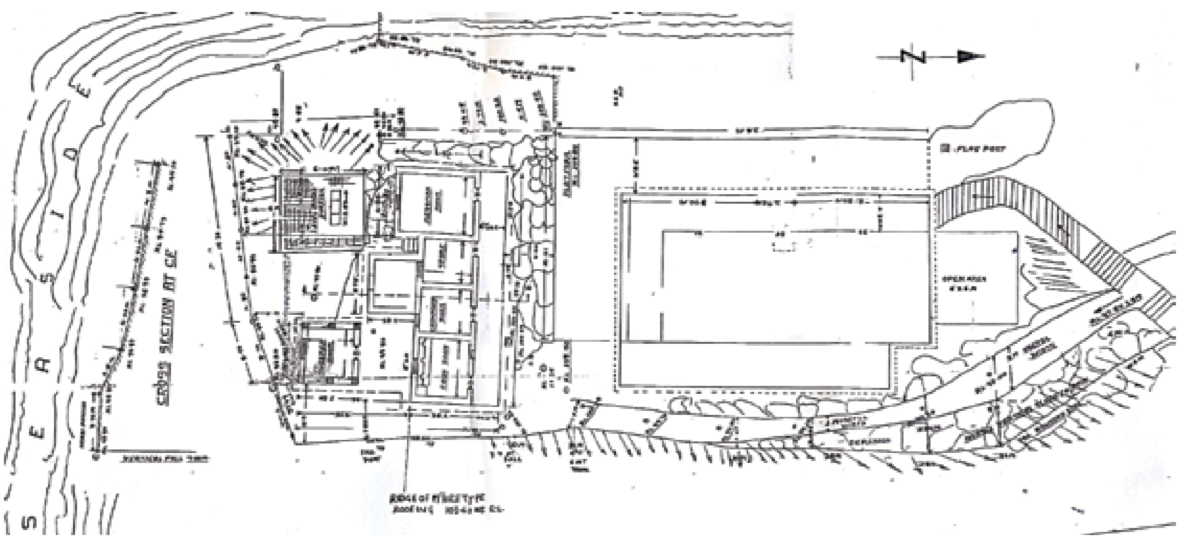
Working toward a GRIHA EB Rating for our rural hospital was an experience quite different from my usual responsibilities, but in the end, it was quite rewarding as it completely changed how our building functioned. Initially, we were pleased to find out that there were several sustainable features already incorporated into the building, such as white paint on the roof and a solar hot water system. However, we got to learn about several other things that we could add, in order to make our building more environment and people friendly – choosing environment-friendly alternatives to housekeeping products, metering our water consumption, segregating waste efficiently and educating visitors about the importance of going green. In the end, we were quite pleased with what we could achieve and honored that we were chosen to be part of this pilot project.

Mr. Maheboob Shaikh, Sectional Engineer, PWD Maharashtra

6. Sagar Rest House, Vengurla

Sagar rest house at Vengurla (Credits: Author)

Aerial view of the rest house (Credits: after Google Earth Pro)



Plan of the rest house at Vengurla (Credits: after PWD Maharashtra)

About

Location: Vengurla, District Sindhudurg

Typology: Hospitality

Purpose: Rest House

Site area: 1273 m^2

Built up area: 423.75 m^2

Ground coverage: 423.75 m^2

Set against the backdrop of the Arabian Sea, the rest house at Vengurla leverages the climate responsiveness of traditional Konkan architecture – a pitched roof laid with Mangalore tiles helps manage the torrential monsoon rain while the verandah covered by an overhang creates a transition space between the indoor and the outdoor environments. Offering a resting and gathering space in the hot and humid coastal climate, the semi-covered verandah also serves to prevent the incidence of solar radiation on the exterior walls, effectively preventing the interior spaces from heating up during the hot summer months.

GRIHA for Existing Buildings:
Awarded = 66.3% (*3 Star Rating: 56–70%)

SITE PARAMETERS

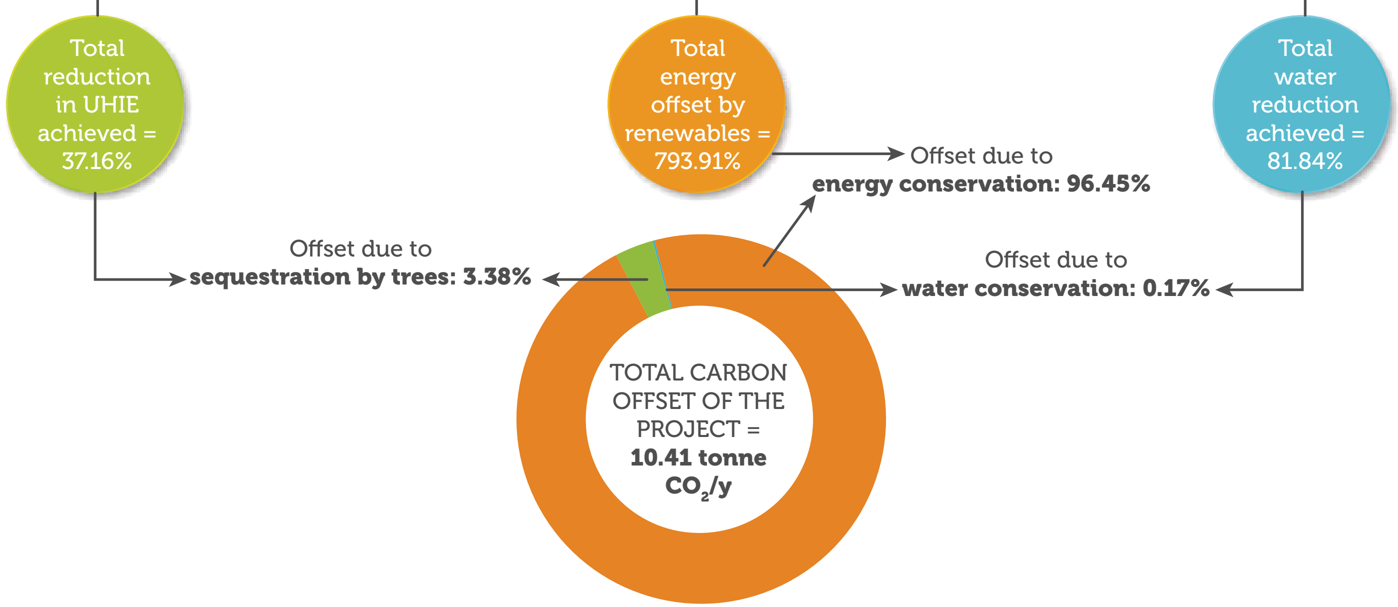
- Number of trees at site = 16
- Soft landscape area = 473 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 7852 kWh/y
- Energy consumption after retrofit = 197 kWh/y
- Proposed PV panel system = 1 kWp
- Installed Solar hot water system = 0 L
- Reduction in conventional energy demand at source = 11155 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 81423 L/y
- Water consumption after retrofit = 14784 L/y
- Reduction in building water demand = 0%
- Reduction in landscape water demand = 100%



Verandas of the rest house at Vengurla (Credits: Author)

Set in a picturesque location, this building always attracted a lot of attention and we are now pleased to announce that it is green as well. While we could not attempt several criteria under GRIHA such as rainwater recharge due to natural conditions around the site, we tried to make up for it by going net zero energy and meeting all our building's energy demands through rooftop photovoltaics. We also benefitted from the building's traditional architecture and materials used in its construction.

Mr Rajan V. Chavan, Sectional Engineer, PWD Maharashtra

7. Rest House, Dapoli

Rest house at Dapoli (Credits: Author)

Aerial view of the rest house (Credits: after Google Earth Pro)

About

Location: Dapoli, District Ratnagiri

Typology: Hospitality

Purpose: Rest House

Site area: 5033 m^2

Built up area: 240.9 m^2

Ground coverage: 240.9 m^2

Originally constructed long before India attained Independence, the appearance of this building belies its age owing to careful management and diligent upkeep by the PWD. However, the ingenuity incorporated into the design - arched walkways, a high plinth, and thick insulating walls have resulted in a structure that is well suited to the Konkan coast and could provide comfort to occupants in an unforgiving climate long before fans and air conditioners powered by electricity were in common use.

GRIHA for Existing Buildings:
Awarded = 73.8% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 68
- Soft landscape area = 3266 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 1220 kWh/y
- Energy consumption after retrofit = 600 kWh/y
- Installed PV panel system = 0 kWp
- Installed Solar hot water system = 100 L
- Reduction in conventional energy demand at source = 2262.7 kWh/y

WATER PERFORMANCE

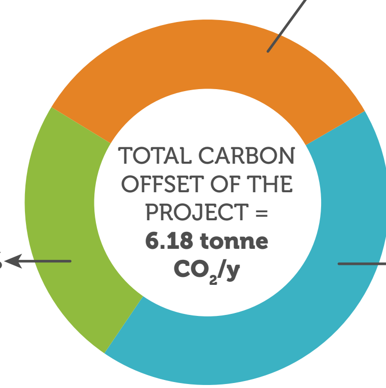
- Water consumption before retrofit = 9851913 L/y
- Water consumption after retrofit = 29264 L/y
- Reduction in building water demand = 0%
- Reduction in landscape water demand = 100%

Total reduction in UHIE achieved = 64.89%

Total energy offset by renewables = 208.34%

Total water reduction achieved = 99.70%

Offset due to **energy conservation: 32.95%**



Offset due to **sequestration by trees: 24.20%**

Offset due to **water conservation: 42.85%**

No smoking signage on the premises (Credits: Mr Hrushikesh Kolatkar)

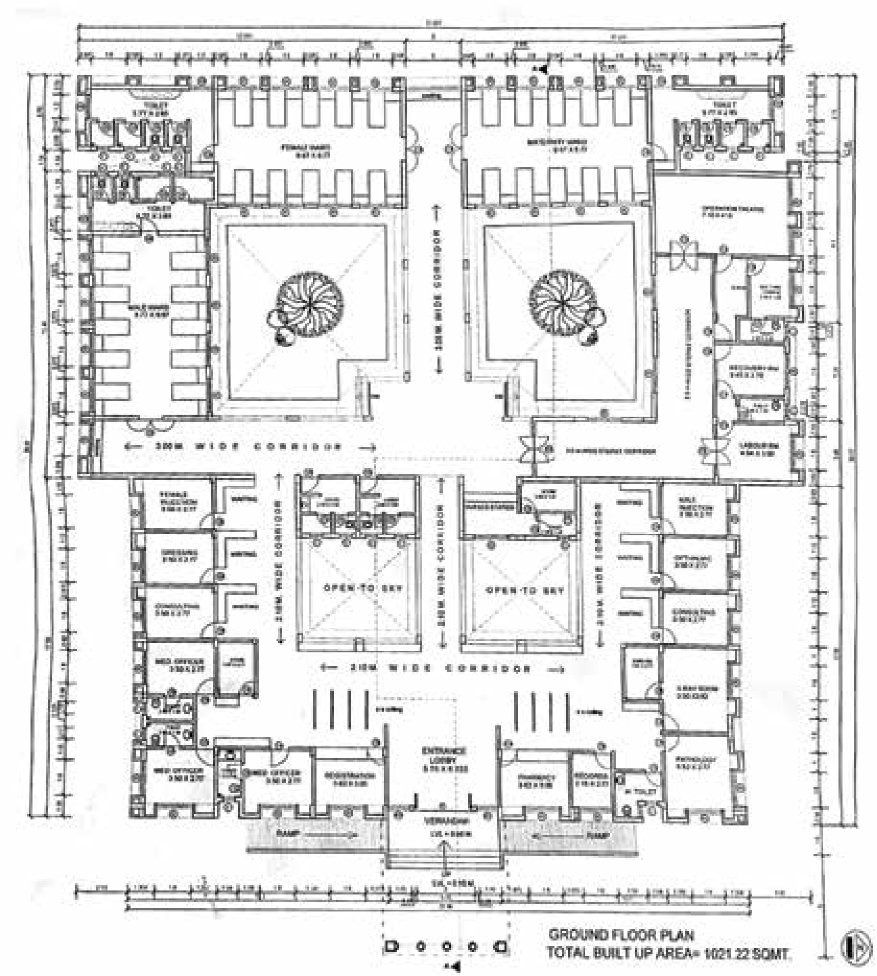
Indoor air quality (IAQ) is one of the prime threats to public health, viz a viz environmental risk. Use of pesticides, carbon monoxide and carbon dioxide levels, presence of volatile organic compounds, insufficient outdoor air, and limited access to sunlight are some of the factors affecting the IAQ. Environmental tobacco smoke that contains a wide range of toxic and carcinogenic substances not only deteriorates the IAQ but also causes serious health problems among those exposed to it. It is, therefore, imperative to design buildings so as to provide all occupants with a desirable level of IAQ as specified by the National Ambient Air Quality Standards or the NBC 2005 or equivalent.

I take this opportunity to express my sincere gratitude for participating in this audit and verifying the complete implementation of all the changes asked of by EB to make the project sustainable and green. I am especially grateful to Mr J.M. Patel for his coordination with the other team members, which was highly beneficial to the successful conclusion of this project. I hope that we will have the opportunity to work together on other exciting projects in the future. In conclusion, please forward my thanks to the entire team for their contribution to making this project the success it is.

Ms Rashmi Kolatkar, Managing Director, Built Environment (India) Pvt. Ltd

8. Rural Hospital, Palghar

Entrance to the rural hospital at Palghar (Credits: Manasi Kulkarni)



Plan of the hospital (Credits: after PWD Maharashtra)

About

Location: Palghar

Typology: Healthcare

Purpose: Hospital

Site area: 3160 m^2

Built up area: 1090 m^2

Ground coverage: 1090 m^2

The hospital building is a ground floor structure with a symmetric plan. It is punctured with four open to sky courtyards along the main corridors, such that they bring in daylight and induce natural ventilation in the building. The benefits of the courtyard were evident at the time of the due diligence visit, with indoor temperatures ranging between 28°C and 29°C and indoor daylight levels between 211 and 298 lux in the occupied spaces.

GRIHA for Existing Buildings:
Awarded = 71.4% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 40
- Soft landscape area = 890 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 48724 kWh/y
- Energy consumption after retrofit = 40975 kWh/y
- Installed PV panel system = 0 kWp
- Installed Solar hot water system = 1000 L
- Reduction in conventional energy demand at source = 24501.29 kWh/y

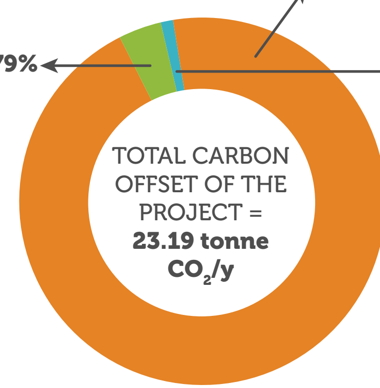
WATER PERFORMANCE

- Water consumption before retrofit = 2878211 L/y
- Water consumption after retrofit = 1932345 L/y
- Reduction in building water demand = 30.7%
- Reduction in landscape water demand = 94.69%

Total reduction in UHIE achieved = 28.16%

Total energy offset by renewables = 30.51%

Total water reduction achieved = 32.86%



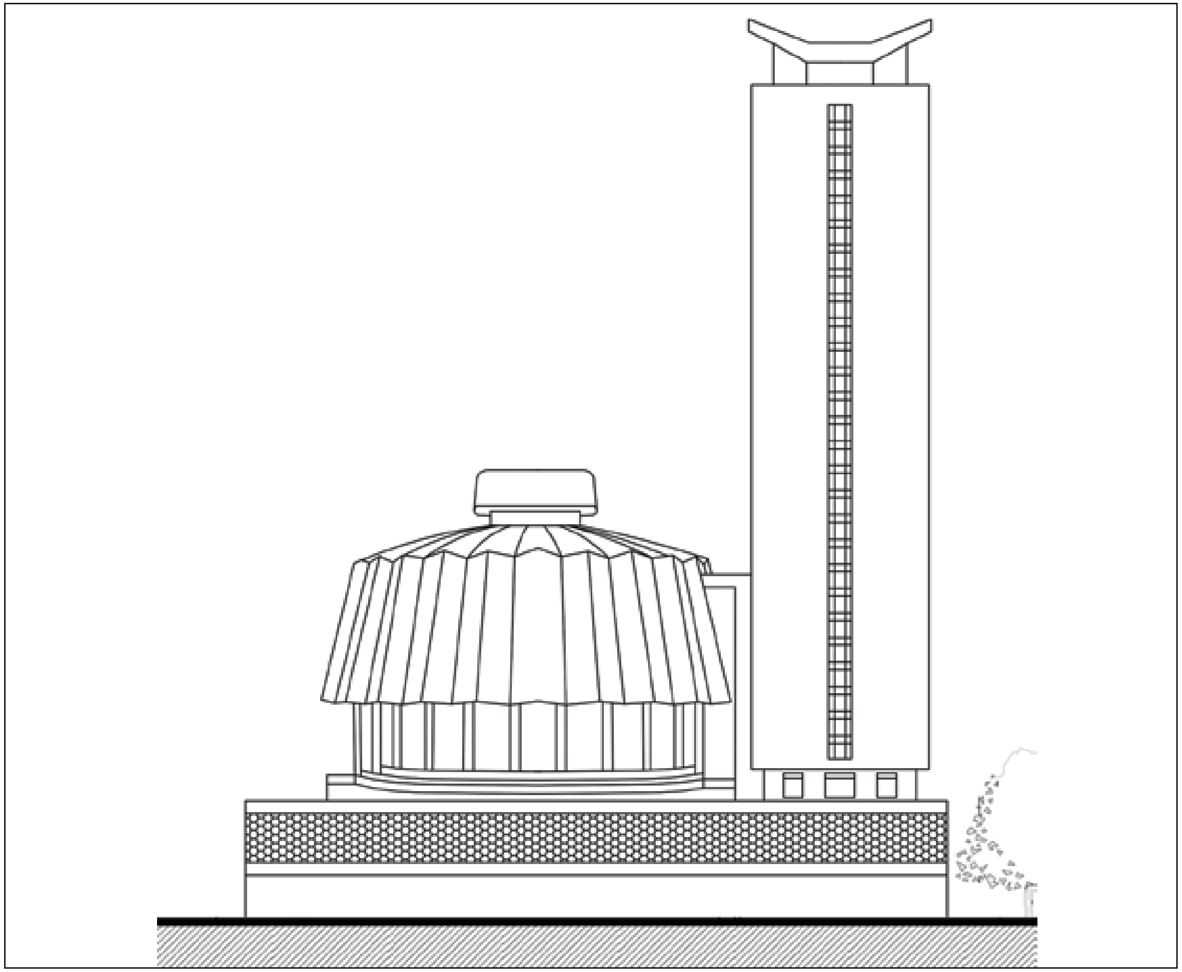
Waste segregation for safe disposal (Credits: Manasi Kulkarni)

Being a hospital building, the appraisals pertaining to being inclusive were already present such as the two ramps leading up to the building entrance or the presence of sturdy railings everywhere. However, during the audit we realised that the railing did not comply with the norms for the disabled. What is commendable is that, upon our suggestions, the team took prompt action to upgrade their existing systems, label and create awareness about it, and incorporate new strategies such as the addition of charging points for E-vehicles and the use of high SRI paint.

Ms Manasi Kulkarni, Manager, Beratung Consultants Pvt. Ltd.

9. Vidhan Bhavan, Mumbai

Vidhan Bhavan at Mumbai (Credits: Gaurang Lele)



Elevation of the Vidhan Bhavan (Credits: Author)

About

Location: Mumbai

Typology: Commercial

Purpose: Office

Site area: 15670 m^2

Built up area: 36985 m^2

Ground coverage: 6000 m^2

This building was one of the few high-rise projects assessed in this venture and stands at a height of 71.3 m. Completed in 1981, the Vidhan Bhavan was designed in a modernist architectural style. Its distinctive form and perforated fenestrations, as well as its political significance have made it an easily recognized and well-known structure. Apart from being characteristic of the architecture, thefenestration is in line with the 'form follows function' approach of modernist architecture and ensures that the halls and other indoor spaces are shaded with uniform daylight distribution. Another notable point for this project was the use of treated water to maintain the expansive landscape on-site.

GRIHA for Existing Buildings:
Awarded = 56.3% (*3 Star Rating: 56–70%)

SITE PARAMETERS

- Number of trees at site = 28
- Soft landscape area = 4884 m^2
- Percentage of lawn area = 41.79%
- Hard paved area with SRI>50% = 908 m^2
- Hard paved area with other strategies = 1795 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 1568510 kWh/y
- Energy consumption after retrofit = 1546270 kWh/y
- Proposed PV panel system= 152 kWp
- Installed Solar hot water system= 0 L
- Reduction in conventional energy demand at source = 313863.11 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 5370175 L/y
- Water consumption after retrofit = 3044322 L/y
- Reduction in building water demand = 40.45%
- Reduction in landscape water demand = 67.45%

Total reduction in UHIE achieved = 48.42%

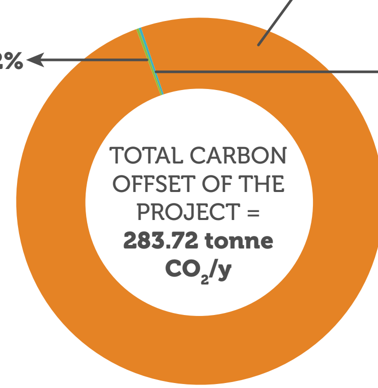
Total energy offset by renewables = 15.34%

Total water reduction achieved = 43.31%

Offset due to **sequestration by trees: 0.22%**

Offset due to **energy conservation: 99.56%**

Offset due to **water conservation: 0.22%**



Meters installed at the Vidhan Bhavan (Credits: Gaurang Lele)

Metering technologies play a significant role in collecting and providing information needed to meet energy and water consumption goals, save money, and improve building operation. Monitoring and verification of building performance is essential to track benefits accrued from systematic improvements and to identify potential threats and scopes. Metering and monitoring are thus supporting systems in a sustainable development that lead to better management of resources. Therefore, the intent of the GRIHA criterion for metering and monitoring is to promote reliable metering of energy and water consumption of a building in order to monitor and analyse the performance of the project.

The primary concern identified during the assessment was that the older air-conditioning systems in the three main halls, used R-22 as the refrigerant, which is an HCFC (hydrochlorofluorocarbon). This was a critical issue as HCFCs when released into the atmosphere deplete the ozone layer thereby permitting increased amounts of harmful ultraviolet radiation to reach the earth's surface. They also contribute to global warming by trapping excess heat in the earth's lower atmosphere. As a result of the EB assessment, the project team of Vidhan Bhavan passed a decision to replace R-22 systems with R-410 almost immediately, by 1.1.2020, which was a significant achievement.

Ar. Anagha Shinde Rajurkar, Director, Shashwat

10. Mantralaya Annex, Mumbai

View of the Mantralaya Annex building (Credits: Author)

Aerial view of the annex building (Credits: after Google Earth Pro)

About

Location: Mumbai

Typology: Commercial

Purpose: Office

Site area: 7928 m^2

Built up area: 16924 m^2

Ground coverage: 3019 m^2

The Mantralaya located in South Mumbai was built in 1955 and is used as the administrative headquarters of the Maharashtra state government. The Annexe building is a part of this complex, built to accommodate the growing number of staff and departments. At the time of assessment, this building was undergoing renovation during which several sustainable strategies were implemented in the structure and the premises, such as water-saving fixtures, posters and training for disciplined use, and acoustic treatment in corridors to control noise levels in the offices. Another measure taken by them was in line with the government's policy to encourage e-vehicles, due to which the project made tie-ups for leasing of electric vehicles and built charging stations.

GRIHA for Existing Buildings:
Awarded = 57.6% (*3 Star Rating: 56–70%)

SITE PARAMETERS

- Number of trees at site = 20
- Soft landscape area = 360 m²
- Percentage of lawn area = 16.67%
- Hard paved area with SRI>50% = 2819 m²
- Hard paved area with other strategies = 0 m²

ENERGY PERFORMANCE

- Energy consumption before retrofit = 1947930 kWh/y
- Energy consumption after retrofit = 1786284 kWh/y
- Proposed PV panel system = 75 kWp
- Installed Solar hot water system = 0 L
- Reduction in conventional energy demand at source = 337179.81 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 8732750 L/y
- Water consumption after retrofit = 4902068 L/y
- Reduction in building water demand = 35.61%
- Reduction in landscape water demand = 91.18%

Total reduction in UHIE achieved = 52.65%

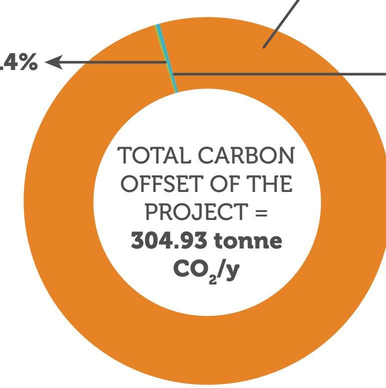
Total energy offset by renewables = 6.55%

Total water reduction achieved = 43.87%

Offset due to **energy conservation: 99.52%**

Offset due to **sequestration by trees: 0.14%**

Offset due to **water conservation: 0.34%**



Use of organic cleaning solutions (Credits: Author)

The criterion on **green procurement** includes maintaining a policy on the purchase and use of environment friendly products for housekeeping, which includes all cleaning material and pest control. The products may be classified as environmentally friendly if they are non-toxic, contain low volatile organic compounds (VOCs), are made from organic/ natural ingredients, and/or are biodegradable. They may also be green certified which accounts for its environmental sustainability throughout the stages of its life cycles from raw material sourcing, manufacture, to use, disposal, and recycling. This policy helps maintain indoor air quality levels within desirable limits. It also promotes the conscious use of products that have a low impact on the environment, and do not release harmful emissions into the habitable/ regularly occupied spaces. An existing building has more stakeholders than a new construction, and with this policy, the housekeeping and maintenance staff can ensure that the building moves a step closer to being a green development.

3.3 Divisions: Nagpur and Nashik

1. Family Court, Nagpur

Family court at Nagpur (Credits: Author)

Aerial view of the court (Credits: after Google Earth Pro)

About

Location: Nagpur

Typology: Instituitional

Purpose: Court

Site area: 12103 m^2

Built up area: 5844 m^2

Ground coverage: 1461 m^2

Constructed in the early days of Independent India, this imposing structure displays influences from the Colonial style of architecture as well as elements that are traditional to Central India. A portico shades the entrance, while colonnaded walkways around the edges of the floorplate protect interior spaces from unwanted heat gain. Large windows with hinged frames ensure that the building can be operated in mixed-mode, taking advantage of natural ventilation whenever possible in order to optimize energy consumption while proposed rooftop solar PV can generate over a third of the operational electricity required by the building annually.

GRIHA for Existing Buildings:
Awarded = 71.3% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 56
- Soft landscape area = 2585 m^2
- Percentage of lawn area = 40.31%
- Hard paved area with SRI>50% = 1461 m^2
- Hard paved area with other strategies = 0 m^2

Total reduction in UHIE achieved = 33.43%

ENERGY PERFORMANCE

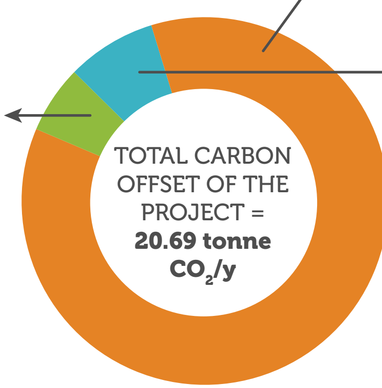
- Energy consumption before retrofit = 38561 kWh/y
- Energy consumption after retrofit = 34268 kWh/y
- Proposed PV panel system = 8 kWp
- Installed Solar hot water system = 0 L
- Reduction in conventional energy demand at source = 19796.81 kWh/y

Total energy offset by renewables = 35.22%

WATER PERFORMANCE

- Water consumption before retrofit= 10016216 L/yr
- Water consumption after retrofit= 3946480 L/yr
- Reduction in building water demand= 33.71%
- Reduction in landscape water demand= 63.72%

Total water reduction achieved = 60.59%



Offset due to **energy conservation: 86.13%**

Offset due to **water conservation: 7.91%**

Offset due to **sequestration by trees: 5.96%**

Verandas of the Family court (Credits: Mr Jayesh Vira)

Amongst the buildings that I worked with in this venture, this one stood out for me not only due to its performance but also because of the enthusiasm of the on-site team. They were happy to implement any suggestions made for the project and also ensured that they understood why each strategy was implemented and how it would benefit the building. I would especially like to mention Mr. Barai from PWD Maharashtra, who was very supportive throughout the process. He was speedy and prompt in asking for clarifications and providing documentations. He was also present and proactive during every visit. I will conclude by thanking the team and congratulate them for receiving a 4-star rating.

Mr Jayesh Vira, Managing Director, Gadin Consultancy & Co.

2. Government Dental College and Hospital at GMCH, Nagpur

Verandas of the Family court (Credits: Mr Jayesh Vira)

Aerial view of the dental college and hospital (Credits: after Google Earth Pro)

About

Location: Nagpur

Typology: Healthcare

Purpose: College and Hospital

Site area: 6494 m^2

Built up area: 11170 m^2

Ground coverage: 4607.5 m^2

Windows with deep shades allows the dental college and hospital building, at the Government Medical College and Hospital (GMCH), Nagpur to make the most of daylight while minimizing unwanted heat gain, and the presence of a central courtyard ensures effective natural ventilation – incident solar radiation causes the air inside the open courtyard to heat up and rise, creating an area of low pressure that draws in cooler air through the interior spaces. Studies indicate that courtyards designed with an appropriate width to height ratio significantly improve natural ventilation through this passive cooling effect during hot summers. Planted with native vegetation, the ecological buffer spaces in the courtyard also positively influence the cooling load in summer and heating load in winter.

GRIHA for Existing Buildings:
Awarded = 72.5% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 28
- Soft landscape area = 1887 m^2
- Percentage of lawn area = 54.85%
- Hard paved area with SRI>50% = 2307 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 287969 kWh/y
- Energy consumption after retrofit = 78545 kWh/y
- Installed PV panel system = 4 kWp
- Proposed PV panel system = 11 kWp
- Reduction in conventional energy demand at source = 280791.39 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 13172655 L/y
- Water consumption after retrofit = 6322269 L/y
- Reduction in building water demand = 39.41%
- Reduction in landscape water demand = 64.74%

Total reduction in UHIE achieved = 64.58%

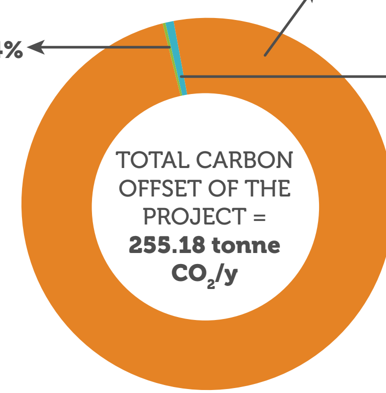
Total energy offset by renewables = 28.82%

Total water reduction achieved = 52%

Offset due to **energy conservation: 99.03%**

Offset due to **sequestration by trees: 0.24%**

Offset due to **water conservation: 0.72%**



A courtyard in the building (Credits: Author)

Landscapes, such as this courtyard, are a key aspect of a built environment. However, given the increasing water crisis, there is a need to reduce landscape water consumption while maintaining its aesthetic and other benefits. Appropriate planting and efficient irrigation systems can reduce landscape water demand by up to 70% and reduce the load on direct and municipal supplies. Of the common types of irrigation systems, drip irrigation should be preferred as it offers increased watering efficiency and plant performance. The second most-efficient typology is a permanent sprinkler system which can be used for delivering a large quantum of water over a large area and in a short period of time.

Even though we already had toilets for the differently abled in the building, the EB exercise brought to our notice that they needed repairing. Displaying posters for environmental awareness and using high SRI paint on the roof were also great suggestions made by GRIHA Council for further improvement. With respect to the architecture of the building, the courtyard planning worked favorably for us and helped maintain indoor daylighting and thermal comfort levels within prescribed limits.

Shri B.D. Ramteke, Deputy Engineer, P. W. Sub Dn. No. 5, Nagpur

3. Bandhkam Bhavan, Nagpur

Bandhkam Bhavan within the PWD premises at Nagpur (Credits: Author)

★★★★

Aerial view of the Bandkam Bhavan (Credits: after Google Earth Pro)

About

Location: Nagpur

Typology: Commercial

Purpose: Office

Site area: 3097 m^2

Built up area: 1105 m^2

Ground coverage: 552.5 m^2

The office of the Public Works Department in Nagpur is a fairly recent construction with the compact and efficient layout typical of modern office buildings. With a vast array of rooftop solar PV the site generates three times the energy it consumes while efficient plumbing fixtures and native landscape elements ensure that the building water demand is kept at a fraction of what could be expected from a conventional building of this scale. Through the adoption of sustainable initiatives in their own office spaces, the PWD Maharashtra effectively walks the talk and demonstrates the positive impact possible through green building techniques and technologies.

GRIHA for Existing Buildings:
Awarded = 81.25% (*4 Star Rating: 71-85%)

SITE PARAMETERS

- Number of trees at site = 20
- Soft landscape area = 1177.04 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 1105 m^2
- Hard paved area with other strategies = 0 m^2

Total reduction in UHIE achieved = 73.7%

ENERGY PERFORMANCE

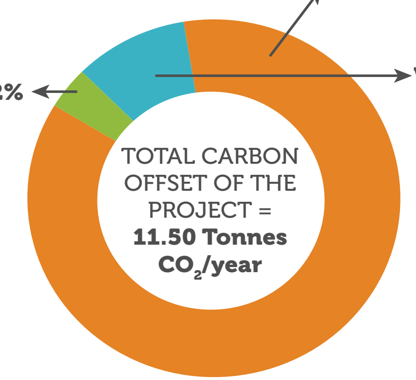
- Energy consumption before retrofit = 3549 kWh/y
- Energy consumption after retrofit = 1977 kWh/y
- Installed PV panel system = 5 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 11027.94 kWh/y

Total energy offset by renewables = 381.48%

WATER PERFORMANCE

- Water consumption before retrofit = 4604887 L/y
- Water consumption after retrofit = 379612 L/y
- Reduction in building water demand = 31.49%
- Reduction in landscape water demand = 100%

Total water reduction achieved = 91.76%



Maintaining the microclimate at Bandhkam Bhavan (Credits: Author)

A significant challenge of fast-paced urbanization is the increasing Urban Heat Island Effect (UHIE). Increasing heating, ventilation, and air conditioning (HVAC) usage as well as dearth of solar protective measures and vegetation has compounded this phenomenon. In order to maintain the **microclimate** of the site and reduce its contribution to the UHIE, this project has not only preserved and densified its on-site vegetation but has also declared to provide rainwater harvesting system to cater to the maintenance of the same. Moreover, they have increased the albedo of 35.6% of their hard-paved area in order to reduce the UHIE. Another strategy that may be implemented is the introduction of water bodies on-site, which through evaporative cooling, helps maintain a site's microclimate.

4. Deputy Chief Architects Office, Nagpur

Front elevation of the office at Nagpur (Credits: Author)

Aerial view of the office (Credits: after Google Earth Pro)

About

Location: Nagpur

Typology: Commercial

Purpose: Office

Site area: 1384.59 m^2

Built up area: 973 m^2

Ground coverage: 486.5 m^2

On the site of the PWD office in Nagpur, along with the Bandhkam Bhavan, is located the Deputy Chief Architect's office. A ground+1 rectangular planned building, it is oriented along the north–south axis. Deep vertical and horizontal fenestrations shade the windows on the longer facades, reducing direct solar gains in the building. However, while indoor thermal comfort levels are met, daylight levels ranged between 100 and 170 lux, lower than the desired limits. Nonetheless, the project performs well in most of the other criteria, with an environmental highlight of the entire PWD premises being its renewable energy capacity. In case of this building, the PV system installed generates over 200% of what the building consumes.

GRIHA for Existing Buildings:
Awarded = 76.3% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 6
- Soft landscape area = 643.34 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 324.4 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 6015 kWh/y
- Energy consumption after retrofit = 3695 kWh/y
- Installed PV panel system = 5 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 11934.23 kWh/y

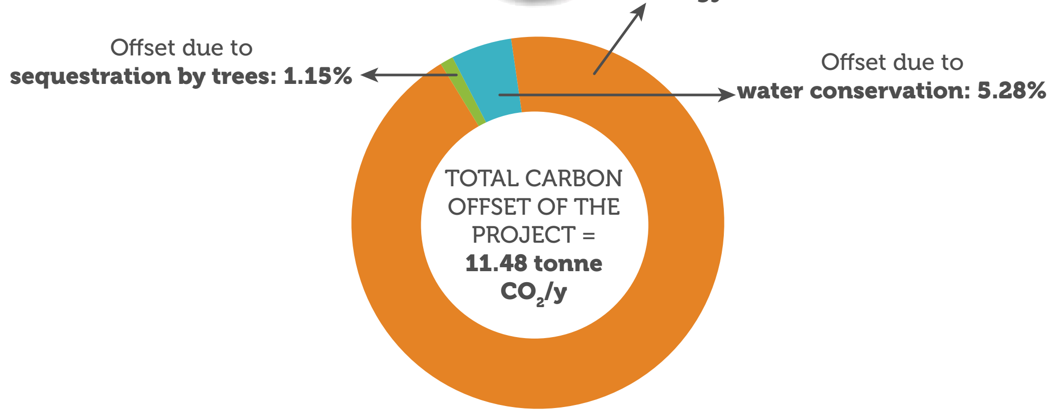
WATER PERFORMANCE

- Water consumption before retrofit = 2322057 L/y
- Water consumption after retrofit = 74764 L/y
- Reduction in building water demand = 30.78%
- Reduction in landscape water demand = 100%

Total reduction in UHIE achieved = 69.89%

Total energy offset by renewables = 204.14%

Total Water reduction achieved = 96.78%



After applying reflective paint (Credits: Author)

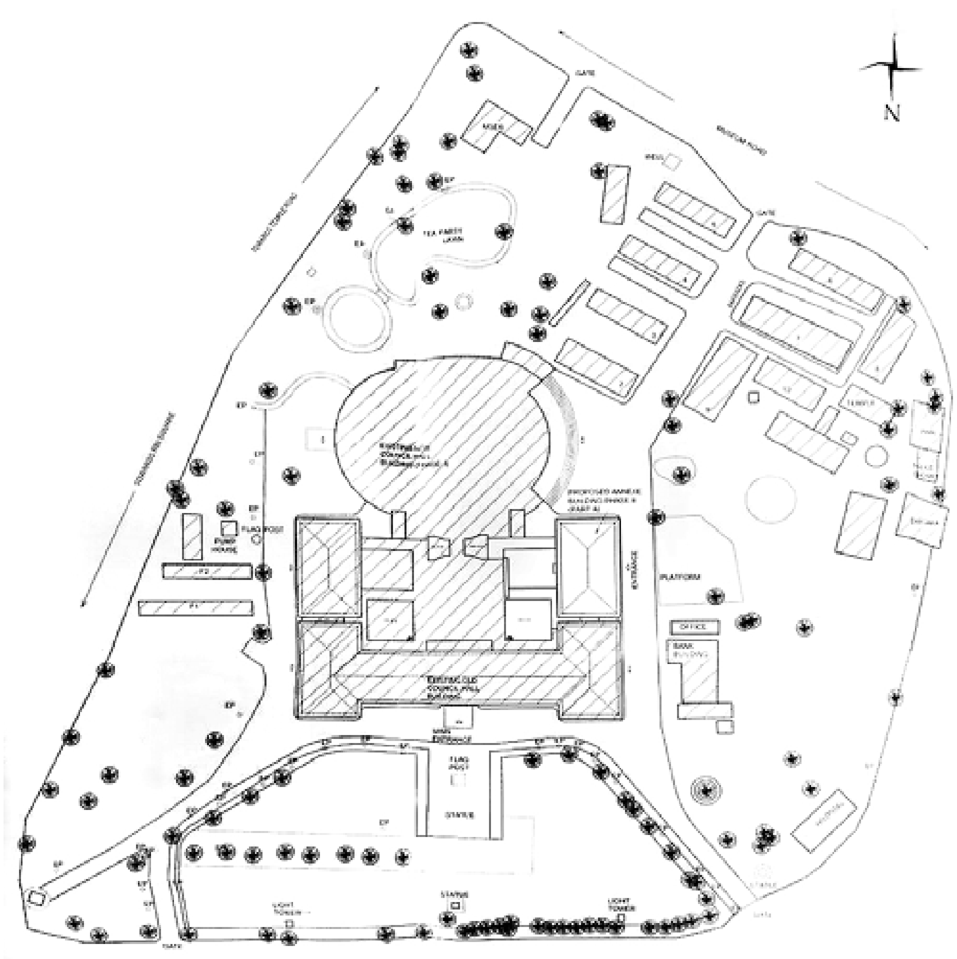
Four buildings of the PWD premises in Nagpur availed the GRIHA EB rating. These were the Dy Chief Architect's office, Bandhkam Bhavan, the SE N.H Circle Office and the Chief Engineer's office. We met some criteria at a broader level benefitting the site at large and even buildings that were not registered for rating. These included the provision of bicycle parking and rentals at site, provision for preferred parking for pooled vehicles, a common composting pit and recycling area as well as labelling and protecting all trees on-site. All in all, this rating process helped us understand and implement sustainable strategies and it made us feel proud to have contributed towards saving the environment.

Shri C. Giri, Deputy Engineer, Public Works Sub Dn.1, Nagpur

5. Vidhan Bhavan, Nagpur

The Vidhan Bhavan at Nagpur (Credits: Mr Jayesh Vira)

★★★



Plan of the Vidhan Bhavan (Credits: Mr Jayesh Vira)

About

Location: Nagpur

Typology: Commercial

Purpose: Office

Site area: 18516 m^2

Built up area: 20485 m^2

Ground coverage: 10242.6 m^2

Constructed post-Independence and the seat of the winter session of the Maharashtra Legislative Assembly, the Vidhan Bhavan in Nagpur is classified as a Grade One Heritage building. While the colonnaded façade of red brick, ornate portico, gabled roof, and manicured lawns are reminiscent of the Colonial aesthetic, an extensive network of rainwater harvesting channels, energy-efficient electrical fixtures, and a rooftop solar PV array ensure that the heritage structure operates with the efficiency required of a modern green building.

GRIHA for Existing Buildings:
Awarded = 56.3% (*3 Star Rating: 56–70%)

SITE PARAMETERS

- Number of trees at site = 84
- Soft landscape area = 5199 m^2
- Percentage of lawn area = 53.13%
- Hard paved area with SRI>50% = 6210 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 188081 kWh/y
- Energy consumption after retrofit = 238850 kWh/y
- Proposed PV panel system = 40 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 11582.12 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 21248492 L/y
- Water consumption after retrofit = 8032245 L/y
- Reduction in building water demand = 41.61%
- Reduction in landscape water demand = 65.85%

Total reduction in UHIE achieved = 61.62%

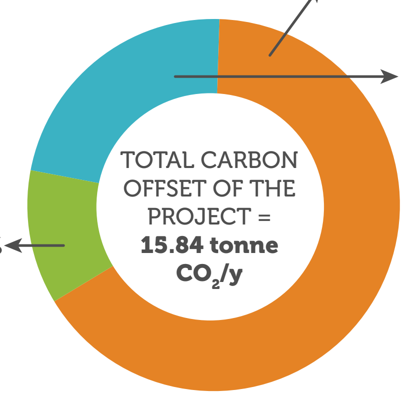
Total energy offset by renewables = 25.26%

Total water reduction achieved = 62.19%

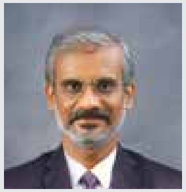
Offset due to **energy conservation: 65.83%**

Offset due to **water conservation: 22.50%**

Offset due to **sequestration by trees: 11.67%**



View of the Vidhan Bhavan (Credits: Mr Jayesh Vira)



This is a building that by virtue of its purpose, is only occupied by 10% of its users on a daily basis. As it has a low regular occupancy, its demands are low too. Despite this, a new solar PV system was proposed and planned so as to cater to the requirements of the annex building upon its completion as well as the main Vidhan Bhavan whenever it is occupied, thereby ensuring both that a shift to renewable sources is made and that the PV system is harnessed to its full potential. A rainwater harvesting system was also added to offset the landscape water demand.

Shri C. Giri, Deputy Engineer, Public Works Sub Dn.1, Nagpur

6. Collector Office, Dhule

Front view of the collector office at Dhule (Credits: Author)

Aerial view of the office (Credits: after Google Earth Pro)

About

Location: Dhule

Typology: Commercial

Purpose: Office

Site area: 10525 m^2

Built up area: 3156 m^2

Ground coverage: 1578 m^2

Typical of the government office buildings, this too has a simple linear plan with offices lined along a double loaded corridor. Amongst the sustainability measures taken, the project had installed PV panels to provide for a fifth of their demand. They had also worked towards creating awareness about the measures taken such as waste segregation, firefighting systems, preferred parking for non-motorized transport and electric vehicles as well as preferred parking for the specially abled.

GRIHA for Existing Buildings:
Awarded = 57.5% (*3 Star Rating: 56–70%)

SITE PARAMETERS

- Number of trees at site = 153
- Soft landscape area = 2230 m^2
- Percentage of lawn area = 5.4%
- Hard paved area with SRI>50% = 1052 m^2
- Hard paved area with other strategies = 2625 m^2

Total reduction in UHIE achieved = 56.1%

ENERGY PERFORMANCE

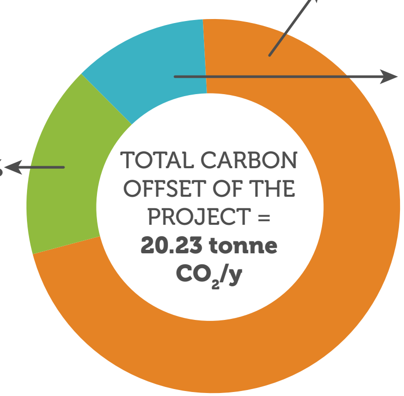
- Energy consumption before retrofit = 59037 kWh/y
- Energy consumption after retrofit = 58142 kWh/y
- Installed PV panel system = 8 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 16125.67 kWh/y

Total energy offset by renewables = 21.4%

WATER PERFORMANCE

- Water consumption before retrofit = 9498493 L/y
- Water consumption after retrofit = 787193 L/y
- Reduction in building water demand = 44.3%
- Reduction in landscape water demand = 95.2%

Total water reduction achieved = 91.7%



Facades and fenestrations of the office (Credits: Author)

The design of **facades and fenestrations** especially for determining the glazing percentage is crucial to maintain indoor daylight and thermal comfort levels. Thus, to ensure the same, GRIHA mandates in its new buildings compliance with the Energy Conservation Building Code (ECBC) for the minimum Visual Light Transmittance (VLT), the maximum Solar Heat Gain Coefficient (SHGC) permitted of all vertical fenestration and that window to wall ratio (WWR) does not exceed 60%. For existing buildings, an on-site measured temperature profile data recorded for more than 80% of area along with temperature and relative humidity measured by GRIHA Council officials during the due diligence visit determined the buildings' indoor thermal compliance. Simulations indicating that minimum 25% of all living area meets the daylight factor requirements as prescribed in *SP41: Handbook on Functional Requirements of Buildings* (Other than Industrial Buildings) along with daylight measured using a calibrated lux meter determines visual compliance. This project was found to meet the requirements as per Indian Model for Adaptive Comfort as well as be compliant with the SP41 limits.

7. Rajbhavan, Nagpur

View of the Rajbhavan at Nagpur (Credits: Mr Jayesh Vira)

Aerial view of the Rajbhavan (Credits: after Google Earth Pro)

About

Location: Nagpur

Typology: Residential

Purpose: Residence

Site area: 13900 m^2

Built up area: 8084 m^2

Ground coverage: 2964 m^2

Built in 1891, this majestic building is also known as the Governor Kothi. Primarily used by the Governor of Maharashtra as his winter residence, it is also used by the President, Vice President, and Prime Minister of India during their visits to Nagpur. The architecture represents both vernacular and colonial styles. Characteristic of this building is the roof laid in rows of Allahabad clay tiles. While the virtual site boundary considered for this assessment was 13900 m^2, the entire premises spreads over 94 acres. A remarkable initiative taken here was the creation of a bio-diversity park on 70 acres of the site in 2011 (Government of Maharashtra n.d.)*.

GRIHA for Existing Buildings:
Awarded = 56.3% (*3 Star Rating: 56–70%)

**Government of Maharashtra. n.d. Raj Bhavan Nagpur: Witness to History. Accessed November 09, 2020. https://rajbhavan-maharashtra.gov.in/en/rajbhavannagpur/.*

SITE PARAMETERS

- Number of trees at site = 60
- Soft landscape area = 7101 m^2
- Percentage of lawn area = 42.71%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 18366 kWh/y
- Energy consumption after retrofit = 18366 kWh/y
- Proposed PV panel system = 4 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 7301.14 kWh/y

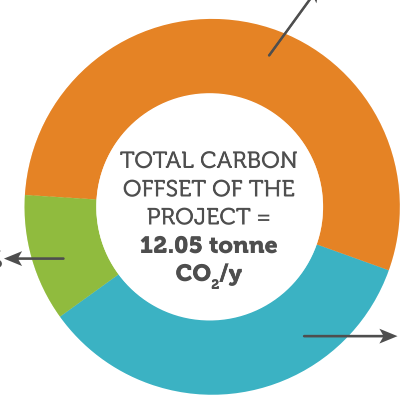
WATER PERFORMANCE

- Water consumption before retrofit = 25255153 L/y
- Water consumption after retrofit = 9833713 L/y
- Reduction in building water demand = 40.79%
- Reduction in landscape water demand = 61.56%

Total reduction in UHIE achieved = 51.09%

Total energy offset by renewables = 32.85%

Total water reduction achieved = 61.06%



Clerestory windows in the Rajbhavan (Credits: Mr Jayesh Vira)

This was a challenging project as it is a heritage building and therefore before making any modification, we had to first consider its aesthetic and historical implications. For example, in case of lighting fixtures, only the bulbs could be upgraded from fluorescent ones to LEDs, however, ornamental shades or glass casings could not be changed. The fans too were old and considered historically important, hence they could not be replaced with energy efficient ones. Despite this, the team went on to alter that which they were permitted to, such as upgrading the solar PV system and making functional their vermicomposting pit.

Mr Jayesh Vira, Managing Director, Gadin Consultancy & Co.

8. Rest House, Pimpalner

Rest House at Pimpalner (Credits: Mr Gaurang Lele)

★★★★

Aerial view of the rest house (Credits: after Google Earth Pro)

About

Location: Pimpalner, Parner Taluka, District Ahmednagar

Typology: Hospitality

Purpose: Rest House

Site area: 2212.59 m^2

Built up area: 384.66 m^2

Ground coverage: 384.66 m^2

The picturesque little rest house at Pimpalner is located well off the beaten track on a small hillock in the Nashik Division of Central Maharashtra. Generating over twice the energy it requires to operate, the interior spaces are illuminated through skylights that ensure no artificial illumination is required at all during the daytime. Modern energy-efficient appliances complement the energy savings obtained through passive architectural design while the surrounding native vegetation is minimally managed in order to encourage native biodiversity to flourish.

GRIHA for Existing Buildings:
Awarded = 77.5% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 29
- Soft landscape area = 1400 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 385 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 1381 kWh/y
- Energy consumption after retrofit = 1201 kWh/y
- Proposed PV panel system = 2 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 3989.37 kWh/y

WATER PERFORMANCE

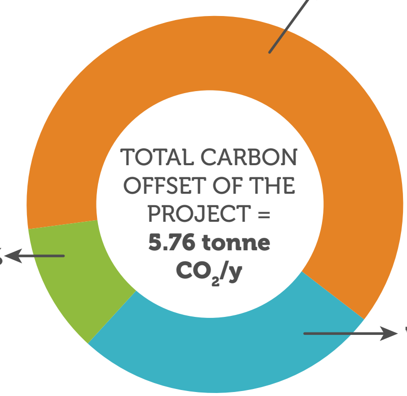
- Water consumption before retrofit = 5801624 L/y
- Water consumption after retrofit = 137159 L/y
- Reduction in building water demand = 43.49%
- Reduction in landscape water demand = 100%

Total reduction in UHIE achieved = 80.67%

Total energy offset by renewables = 259.53%

Total water reduction achieved = 97.64%

Offset due to **energy conservation: 62.38%**



Offset due to **sequestration by trees: 11.08%**

Offset due to **water conservation: 26.53%**

Extracting ground water at the rest house (Credits: Mr Gaurang Lele)

This building had a relatively small footprint and attributes its indoor comfort in large part to the architecture and heavy thermal mass construction. What was unique about this project was the well on-site, which was used to collect and store rainwater, use the same on the premises and recharge it as well. This project was well supported throughout the process by both the GRIHA and PWD management, thus, easily facilitating the process of data collection. Funding was made a priority allowing for faster implementation of green strategies on all sites. We, at Shashwat, are pleased to have contributed to such an impactful activity!

Mr Gaurang Lele, Director, Shashwat

9. Divisional Commissioner Office, Nashik

Front elevation of the Divisional Commissioner's office in Nashik (Credits: Author)

Aerial view of the office (Credits: after Google Earth Pro)

About

Location: Nashik

Typology: Commercial

Purpose: Office

Site area: 10305 m^2

Built up area: 6191 m^2

Ground coverage: 2211.5 m^2

This project had been designed keeping environmental parameters as a part of its original brief. Therefore, it contained many sustainable measures such as designing for storm water management, a tank for filtration and collection of rainwater, and a solar PV system. Of the two departments housed in this building, one had been 100% dependent on rooftop-generated solar energy since 2018. A switch to eco-friendly cleaning materials and additions to their waste segregation system were made on the instructions of the consulting team.

GRIHA for Existing Buildings:
Awarded = 77.5% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 53
- Soft landscape area = 6500 m^2
- Percentage of lawn area = 5.35%
- Hard paved area with SRI>50% = 1950 m^2
- Hard paved area with other strategies = 200 m^2

Total reduction in UHIE achieved = 83.94%

ENERGY PERFORMANCE

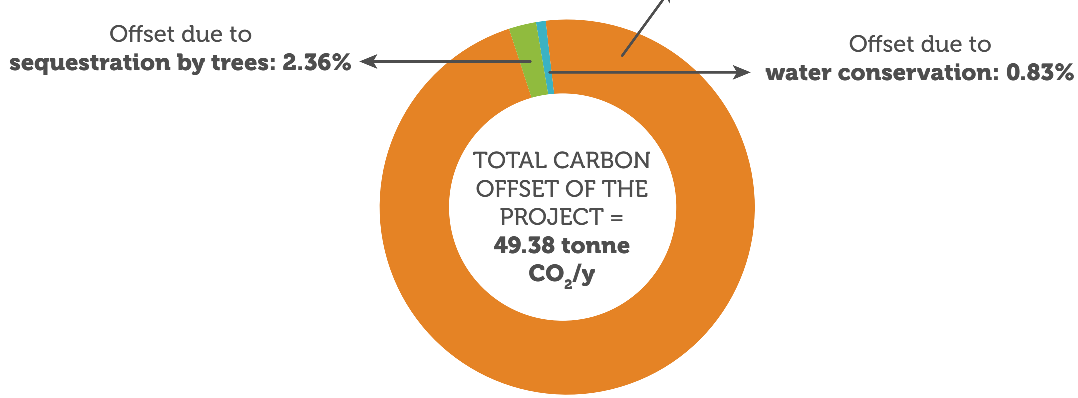
- Energy consumption before retrofit = 51544 kWh/y
- Energy consumption after retrofit = 38841 kWh/y
- Proposed PV panel system = 20 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 53114.16 kWh/y

Total energy offset by renewables = 80.31%

WATER PERFORMANCE

- Water consumption before retrofit = 2824166 L/y
- Water consumption after retrofit = 1311107 L/y
- Reduction in building water demand = 38.58%
- Reduction in landscape water demand = 91.58%

Total water reduction achieved = 53.58%



Tactile paving for the visual challenged (Credits: Manasi Kulkarni)

A distinctive aspect of this project was that along with ramps and railings for the specially abled, **tactile paving** was laid throughout the building. Tactile paving can be described as a paving system that incorporates a textured ground surface in order to assist visually impaired people. The pattern embossed on the surface as well as the colours, indicate whether it is a controlled or uncontrolled crossing, the direction of movement, and the degree of obstacles that lie ahead. In this case, the corridors contain yellow tactile tiling with a stripe pattern which indicates that the route along the strips is clear of obstacles. The blistered red ones indicate a change in level of the surface ahead.

10. Super Speciality Hospital, Nagpur

Front elevation of the hospital (Credits: Author)

Aerial view of the hospital (Credits: after Google Earth Pro)

About

Location: Nagpur

Typology: Healthcare

Purpose: Hospital

Site area: 17464 m^2

Built up area: 21795.8 m^2

Ground coverage: 4359.2 m^2

One of the larger buildings assessed during this pilot project, this hospital building is an auxiliary wing of the Government Medical College of Nagpur. The building benefits from the dense vegetation present on its site with a total of 128 trees contributing to an over 80% reduction in the UHIE of the project. Waste collection is given a priority, with a separate and isolated enclosure assigned for bio-medical waste collection and segregation. Open areas adjoining this room contain bins for non-hazardous waste collection.

GRIHA for Existing Buildings:
Awarded = 56.3% (*3 Star Rating: 56–70%)

SITE PARAMETERS

- Number of trees at site = 128
- Soft landscape area = 8169 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 6233 m^2
- Hard paved area with other strategies = 0 m^2

Total reduction in UHIE achieved = 82.5%

ENERGY PERFORMANCE

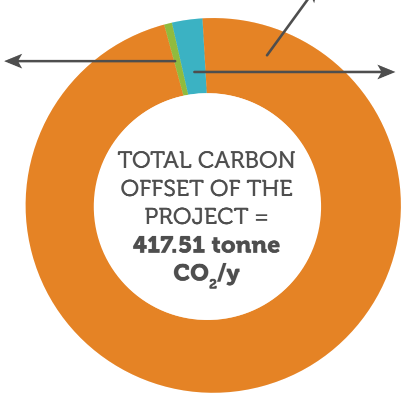
- Energy consumption before retrofit = 820714 kWh/y
- Energy consumption after retrofit = 532952 kWh/y
- Proposed PV panel system = 55 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 448584.51 kWh/y

Total energy offset by renewables = 15.6%

WATER PERFORMANCE

- Water consumption before retrofit = 77016557 L/y
- Water consumption after retrofit = 36345079 L/y
- Reduction in building water demand= 25.3%
- Reduction in landscape water demand= 100%

Total water reduction achieved = 52.8%



Defined and segregated area for waste collection within the hospital premises (Credits: Author)

This project had taken numerous sustainable measures in its design and functioning which were noted during the first audit. However, the chief issue for us was that despite their measures, due to lack of awareness, the strategies were not being used as designed for. The GRIHA EB rating allowed us a chance to reduce this performance gap. We were reintroduced to these strategies and ensured that all mechanisms were made operational and that policies and teams were in place to maintain the same.

Shri B.D. Ramteke, Deputy Engineer, P. W. Sub Dn. No. 5, Nagpur

3.4 Divisions: Pune and New Delhi

1. Rajbhavan, Pune

Punya Bhushan at the Rajbhavan in Pune (Credits: Mr Gaurang Lele)

★★★★★

Aerial view of the Rajbhavan (Credits: after Google Earth Pro)

About

Location: Pune

Typology: Residential

Purpose: Guest House

Site area: 38373.61 m^2

Built up area: 1140 m^2

Ground coverage: 1140 m^2

Also known as the Dhapooree House, this small residential building now named as the Punya Bhushan is tucked away amidst the beautifully maintained landscape. It is primarily used by the Governor of Maharashtra but is also frequented by the President of India. Another similar building, named the Punya Laxan is located within the premises and was also within the purview of the Existing Buildings rating. Both buildings are built in the old British colonial architectural style with an envelope made of the local basalt stone, large windows, and a Mangalore tiled sloped roof. Large porches define the entrance to each building. A notable point in this project is that they cultivate their own fruits and vegetables within their site.

GRIHA for Existing Buildings:
Awarded = 86.3% (*5 Star Rating: 86–100%)

SITE PARAMETERS

- Number of trees at site = 481
- Soft landscape area = 30966.04 m^2
- Percentage of lawn area = 9.78%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 53803 kWh/y
- Energy consumption after retrofit = 40048 kWh/y
- Installed PV panel system = 10 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 35600.62 kWh/y

WATER PERFORMANCE

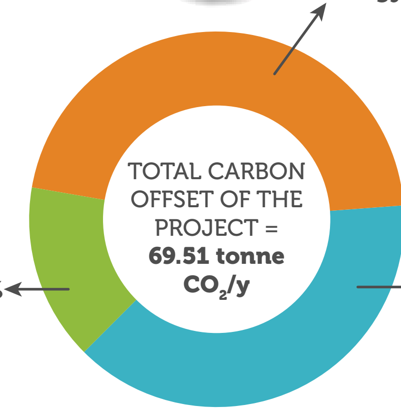
- Water consumption before retrofit = 114480106 L/y
- Water consumption after retrofit = 14768909 L/y
- Reduction in building water demand = 10.12%
- Reduction in landscape water demand = 87.25%

Total reduction in UHIE achieved = 80.69%

Total energy offset by renewables = 39.12%

Total water reduction achieved = 87.09%

Offset due to **energy conservation: 46.09%**



Offset due to **sequestration by trees: 15.22%**

Offset due to **water conservation: 38.68%**

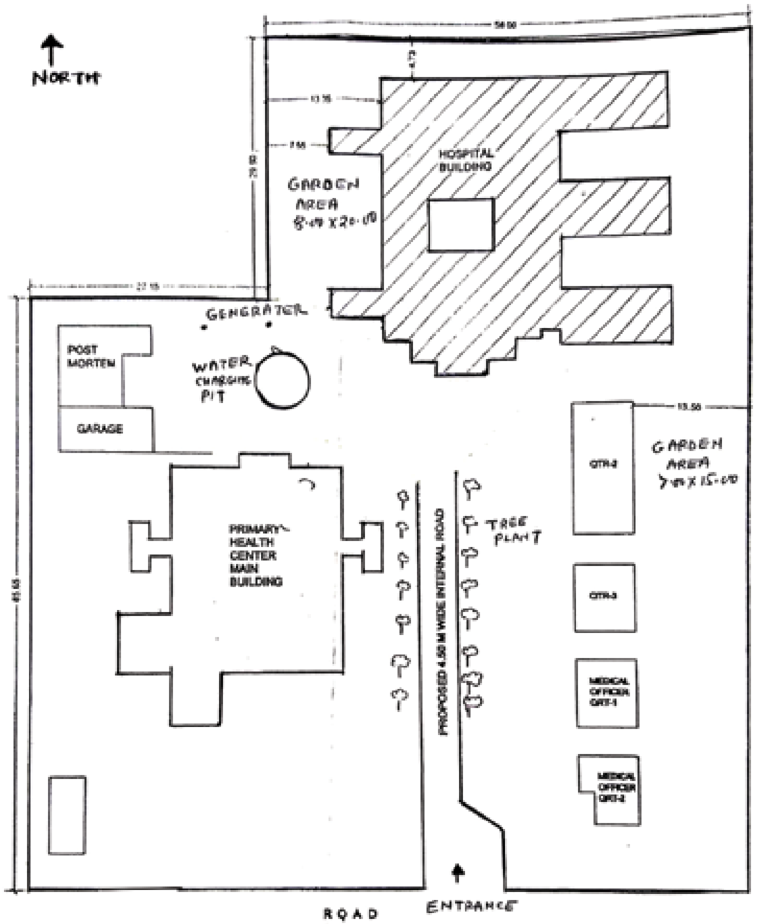
Bicycle parking demarcated at the Rajbhavan (Credits: Mr Gaurang Lele)

As with most of the old British stone construction, in this building too, thermal comfort was an easily met criteria. We have also upgraded each system, appliance, and electrical fixtures in these buildings to meet with the GRIHA compliance. The use of artificial light is rare, as the buildings easily attain the SP41 benchmarks for daylight, owing to their large and well-placed windows. We have provided a rainwater harvesting system to cater to 100% of the catchment area on-site. Moreover, bicycle parking and rental systems are provided for and encouraged, and urban farming is practiced on-site as well. All in all, we are proud that our self-contained project received a 5-star rating.

Shri S.S. Salunkhe, Chief Engineer, Public Works Region, Pune

2. Rural Hospital, Karkamb

Gramin Rungnalaya at Karkamb (Credits: Mr Jayesh Vira)



Plan of the hospital (Credits: after PWD Maharashtra)

About

Location: Karkamb, Taluka Pandharpur, District Solapur

Typology: Healthcare

Purpose: Hospital

Site area: 3000 m^2

Built up area: 901.32 m^2

Ground coverage: 901.32 m^2

The Gramin Rugnalaya in Karkamb is a ground floor structure. It has a rectangular plan with two deep recesses on the eastern façade. The central entry is shaded by a porch and flanked by a ramp on either side. A cut out in the wall in the shape of a cross makes the building easily identifiable as a healthcare provider. The efforts made by the project team specially to create awareness amongst all visitors were remarkable. The team conducted multiple training programmes, labelled every sustainability measure taken on-site in the local language and many in English as well. A water recharging pit and a charging point for e-vehicles were some of the additions made in pursuit of the rating.

GRIHA for Existing Buildings:
Awarded = 86.3% (*5 Star Rating: 86–100%)

SITE PARAMETERS

- Number of trees at site= 10
- Soft landscape area= 710 m^2
- Percentage of lawn area= 17.61%
- Hard paved area with SRI>50%= 901 m^2
- Hard paved area with other strategies= 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 19266 kWh/y
- Energy consumption after retrofit = 14050 kWh/y
- Proposed PV panel system = 5 kWp
- Installed solar hot water system = 500 L
- Reduction in conventional energy demand at source = 23323.96 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 3688554 L/y
- Water consumption after retrofit = 1153615 L/y
- Reduction in building water demand = -5.15%
- Reduction in landscape water demand = 84.15%

Total reduction in UHIE achieved = 53.71%

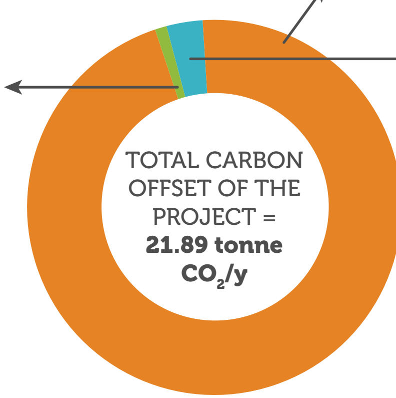
Total energy offset by renewables = 100.07%

Total water reduction achieved = 68.72%

Offset due to **energy conservation: 95.87%**

Offset due to **water conservation: 3.12%**

Offset due to **sequestration by trees: 1.01%**



Native plants labelled at the Karkamb hospital (Credits: PWD Maharashtra)

Native plants are those that grow naturally at the local habitat, and therefore are well adapted to the environment. They require less water and maintenance when compared to non-native, i.e. exotic plants. The project team also opted to reduce their lawn area, which demands exorbitant volumes of water, to a mere 17.6%. The importance of planting native trees and reducing lawn area were evident in the drastic drop of the landscape water demand witnessed by the Rural Hospital at Karkamb. Moreover, apart from taking these measures to save water, they also labelled the native saplings and trees on-site in order to create awareness amongst all visitors about the positive impact of growing local flora on the environment.

3. North Tehsil Office, Solapur

Uttar Tehsil Karyalaya at Solapur (Credits: Author)

Aerial view of the Tehsil office (Credits: after Google Earth Pro)

About

Location: Solapur

Typology: Commercial

Purpose: Office

Site area: 3700 m^2

Built up area: 950 m^2

Ground coverage: 950 m^2

This basalt stone building, constructed in 1869, has a C-shaped plan. Its architecture is simple and inspired from the Maratha style 'wadas' with a dominant entrance way or 'darwaza', a semi-enclosed courtyard and sloping roofs. The wide stone masonry, verandas along the west facing walls, shallow rooms, cross-ventilation and shade from overhangs and trees has resulted in the building being compliant with all indoor comfort parameters, that is it is within the prescribed limits for thermal, daylight, and acoustic performance.

GRIHA for Existing Buildings:
Awarded = 72.7% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 8
- Soft landscape area = 450 m²
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 950 m²
- Hard paved area with other strategies = 0 m²

Total reduction in UHIE achieved = 37.84%

ENERGY PERFORMANCE

- Energy consumption before retrofit = 19788 kWh/y
- Energy consumption after retrofit =15344 kWh/y
- Proposed PV panel system = 3 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 11047.3 kWh/y

Total energy offset by renewables = 30.54%

WATER PERFORMANCE

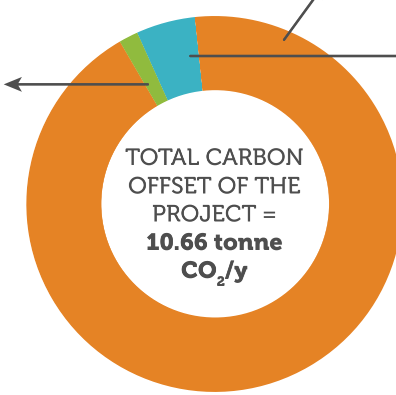
- Water consumption before retrofit = 2106363 L/y
- Water consumption after retrofit = 104064 L/y
- Reduction in building water demand = 39.68%
- Reduction in landscape water demand = 100%

Total water reduction achieved = 95.05%

Offset due to **energy conservation: 93.28%**

Offset due to **water conservation: 5.07%**

Offset due to **sequestration by trees: 1.65%**



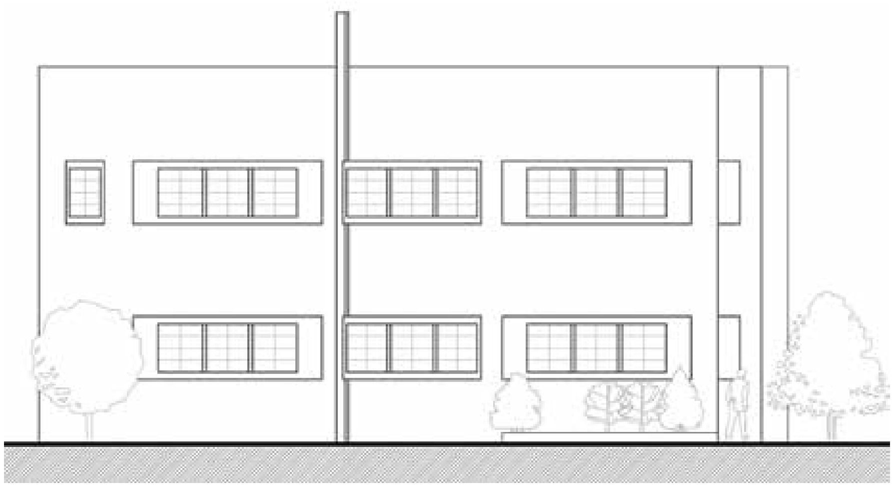
Shaded courtyard of the Tehsil office (Credits: Mr Jayesh Vira)

Courtyards have long been known for their ability to regulate a building's microclimate temperature. Its extent of impact is greatly influenced by its orientation, proportions, and surface finish. By introducing vegetation in the courtyards, the microclimate can be further lowered as compared to the open surroundings and, hence, they are widely seen in hot climates. Apart from regulating the operative temperature, courtyards encourage gentle air movement, by providing an outlet from the warm indoor air, while protecting the buildings from high wind speeds. Courtyards also provide its buildings with an abundance of diffused daylight.

4. District Treasury Office, Satara

Jhila Koshagar Karyalaya at Satara (Credits: Author)

Aerial view of the Treasury office (Credits: after Google Earth Pro)



Elevation of the Treasury office (Credits: Author)

About

Location: Satara

Typology: Commercial

Purpose: Office

Site area: 3680 m^2

Built up area: 1773 m^2

Ground coverage: 886.5 m^2

The District Treasury office in Satara is a Ground +1 floor structure. It has a rectangular and deep floor plan with a central double height space to break the depth and introduce light and generate natural wind movement. The façade is characterized by projecting box windows which protects the indoors from a direct ingress of both light and heat. The project is has integrated a rainwater harvesting system to collect runoff from 100% of the catchments areas in order to provide for their water demand. The District Treasury office has also worked towards densifying the vegetative cover to reduce areas directly exposed to the sun and in turn reduce UHIE.

GRIHA for Existing Buildings:
Awarded = 70% (*3 Star Rating: 56–70%)

SITE PARAMETERS

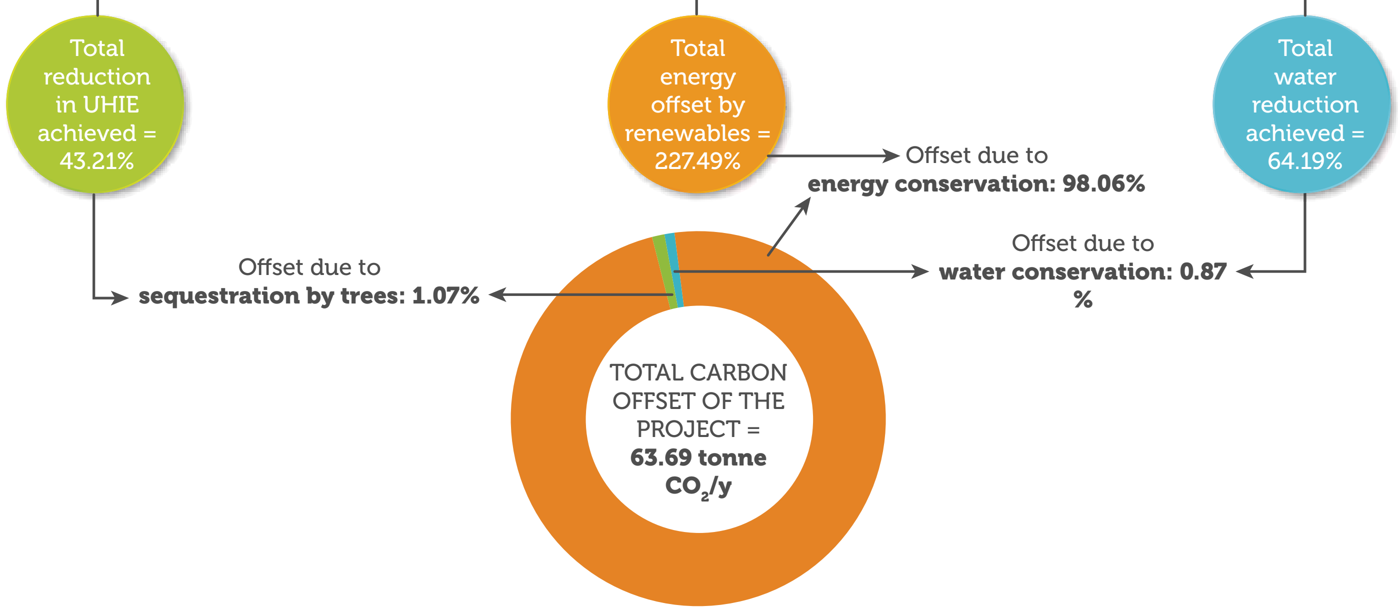
- Number of trees at site = 31
- Soft landscape area = 703 m^2
- Percentage of lawn area = 12.23%
- Hard paved area with SRI>50% = 887 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 30205 kWh/y
- Energy consumption after retrofit =21291 kWh/y
- Installed PV panel system = 31 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 69393.5 kWh/y

WATER PERFORMANCE

- Water consumption before retrofit = 3204907 L/y
- Water consumption after retrofit = 1147745 L/y
- Reduction in building water demand = 32.24%
- Reduction in landscape water demand= 75.19%



PV panels installed at the Treasury office (Credits: Author)

An outstanding step by this project is 100% shift to **renewable energy** sources. An on-site rooftop solar photovoltaic was set up for generation of clean solar energy. While for a daytime occupied commercial building, the Existing Buildings appraisal requires a mandatory 2.5% on-site or a 10% off-site generation of renewable energy, this project went even beyond the maximum on-site ask of 25%. Not only that, as its annual energy generation is double of its demands, the District Treasury Office of Satara can now give back clean energy to the grid as well, setting an example for the rest of the city.

The project team made significant changes in this building in trying to achieve GRIHA EB Rating, and the improvements are quite noticeable. The measurements taken by the auditors established that the window design was what allowed the users to comfortably work indoors during the day without using artificial lighting. By installing water meters, solar panels and planting native trees, they have taken additional steps toward greening the project campus.

Mr Rahul Ahire, Deputy Engineer, PWD Maharashtra

5. Bandhkam Bhavan, Satara

Bandhkam Bhavan at Satara (Credits: Author)

Aerial view of the PWD office (Credits: after Google Earth Pro)

About

Location: Satara

Typology: Commercial

Purpose: Office

Site area: 2380 m^2

Built up area: 1717 m^2

Ground coverage: 572 m^2

The Bandhkam Bhavan is located on a long narrow site with the building footprint designed in line with the site plan. With a corridor along its longitudinal axis, a core cutting across the same, and the rooms lined up on either side of the corridor, this buildings plan is straightforward and easily navigable. The orientation of the building and lack of mutual shading exposes it to direct solar radiation especially during the morning. The egg crate façade, while regulating daylight levels, falls short in controling the indoor thermal quality and, thus, the building is dependent on artificial cooling mechanisms. However, it efficiently overcomes this setback by utilizing rooftop generated solar energy to offset 100% of its annual demand.

GRIHA for Existing Buildings:
Awarded = 75% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 30
- Soft landscape area = 560 m^2
- Percentage of lawn area = 44.64%
- Hard paved area with SRI>50% = 572 m^2
- Hard paved area with other strategies = 150 m^2

Total reduction in UHIE achieved = 53.86%

ENERGY PERFORMANCE

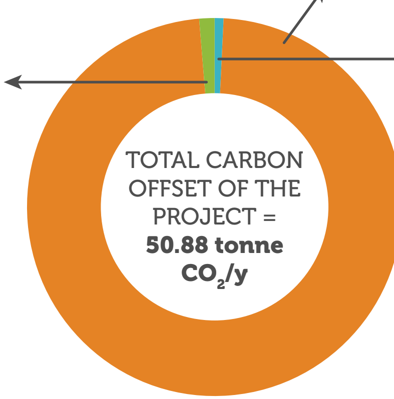
- Energy consumption before retrofit = 35915 kWh/y
- Energy consumption after retrofit =29485 kWh/y
- Installed PV panel system = 25 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 55374.44 kWh/y

Total energy offset by renewables = 133.40%

WATER PERFORMANCE

- Water consumption before retrofit = 2719947 L/y
- Water consumption after retrofit = 1303100 L/y
- Reduction in building water demand = 32.24%
- Reduction in landscape water demand = 60.67%

Total water reduction achieved = 52.09%



78. Fenestrations of the PWD office at Satara (Credits: Author)

This project was a good environmental performer to start with and needed less interventions. However, there were certain other aspects that had not previously occurred to the project team, for example, that refrigerants could contribute to climate change. Thanks to the EB rating, they now have a procurement policy in place to replace existing systems with BEE rated air conditioners. A thank you to the local team for being very receptive and helpful throughout the rating process.

Mr. Mihir Save, Director, Beratung Consultants Pvt. Ltd.

6. Ashakiran Mahila Hostel, Karad

Front elevation of the hostel (Credits: Author)

Aerial view of the hostel (Credits: after Google Earth Pro)

About

Location: Karad, District Satara

Typology: Hospitality

Purpose: Hostel

Site area: 6321.25 m^2

Built up area: 993.04 m^2

Ground coverage: 993.04 m^2

A fairly new construction, this building is isolated in its location. Given its function as a hostel for women, the safety of its occupants is the hostels top priority and, thus, it was ensured that all facilities were provided within its site. The site area when compared to the ground coverage was high, and to maximize land utilization, the team proposed to plant 80 native trees on site. Another benefit of the large site was that they could accommodate all preferred parking allotments and charging facilities on site. They also upgraded their electricity and water meters to meet the compliances.

GRIHA for Existing Buildings:
Awarded = 73.8% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 2
- Soft landscape area = 4200 m²
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 993 m²
- Hard paved area with other strategies = 0 m²

Total reduction in UHIE achieved = 82.15%

ENERGY PERFORMANCE

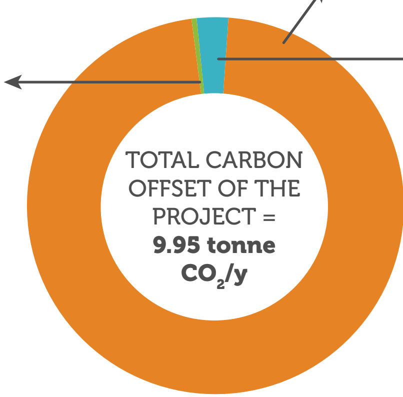
- Energy consumption before retrofit = 8856 kWh/y
- Energy consumption after retrofit = 7872 kWh/y
- Proposed PV panel system = 5 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 10707.29 kWh/y

Total energy offset by renewables = 99.91%

WATER PERFORMANCE

- Water consumption before retrofit = 1238068 L/y
- Water consumption after retrofit = 239833 L/y
- Reduction in building water demand = 69.33%
- Reduction in landscape water demand = 99.91%

Total water reduction achieved = 80.63%



Central courtyard of the hostel (Credits: Mihir Save)

Waste segregation is not a norm here and the residents were not familiar with segregation beyond the traditional wet and dry categories. Acknowledging the need to ensure good waste management practice, the project team implemented a multi-bin system. An organic compost pit was also made in the backyard to complete the cycle. I take this opportunity to thank the enterprising team and users who were very open and accepting to new ideas and new systems, making these changes a successful one.

Mr Mihir Save, Director, Beratung Consultants Pvt. Ltd.

7. Extension of Collector Office Building, Satara

Extension to the Collector Office at Satara (Credits: Mr Gaurang Lele)

★★★★

Aerial view of the Collector office (Credits: after Google Earth Pro)

About

Location: Satara

Typology: Commercial

Purpose: Office

Site area: 9542.43 m^2

Built up area: 3442 m^2

Ground coverage: 1721 m^2

Recently constructed, it is a single building built with a stone front façade and framed windows. Due to the spacious site, all parking requirements, such as the provision for preferred parking for the specially abled, charging points and demarcated parking for electric vehicles as well as for bicycles, were met with ease. Indoor thermal comfort and daylighting levels were also satisfactorily met by the building. In order to improve facilities for the specially abled, along with the handicapped toilets within the buildings, one was provided at site level as well for ease of accessibility throughout the campus. Ramp, elevators, and suitable railings were also provided that have made this project's architecture not only aesthetic but also inviting to all.

GRIHA for Existing Buildings:
Awarded = 73.8% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 30
- Soft landscape area = 4689.74 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 1565.08 m^2
- Hard paved area with other strategies = 0 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 83625 kWh/y
- Energy consumption after retrofit = 34063 kWh/y
- Proposed PV panel system = 10 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 79003.32 kWh/y

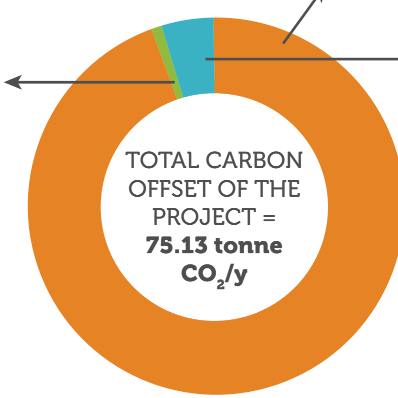
WATER PERFORMANCE

- Water consumption before retrofit = 17067421 L/y
- Water consumption after retrofit = 4570213 L/y
- Reduction in building water demand = 23.45%
- Reduction in landscape water demand = 76.08%

Total reduction in UHIE achieved = 65.55%

Total energy offset by renewables = 46.18%

Total water reduction achieved = 73.22%

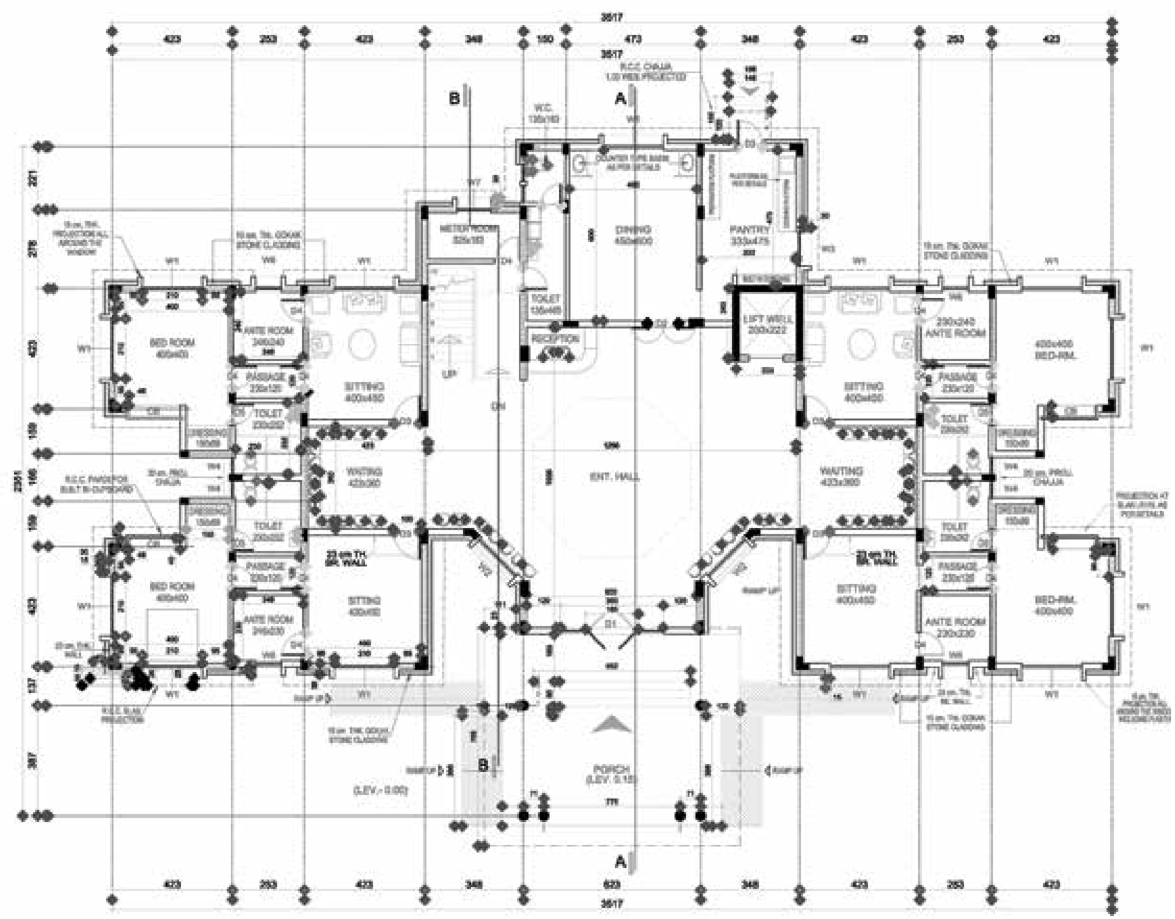


Waste processing at the Collector office (Credits: Author)

In existing buildings, facility management, especially **waste management** plays a key role in operation and maintenance of all functions in the building. In this project, infrastructure in the form of multi-coloured dustbins with labels had been installed at each floor level to encourage segregation at source. Further, a dedicated and centralized storage facility has been provided at site level to collect and store this segregated waste. Lastly, a compost pit has been set up at site to naturally convert organic matter, specifically leaves and other landscape wastes, into fertilizer for reuse.

8. New VVIP Circuit House, Kolhapur

The new Circuit House at Kolhapur (Credits: Author)



Ground floor plan of the new circuit house (Credits: after PWD Maharashtra)

About

Location: Kolhapur

Typology: Hospitality

Purpose: Guest House

Site area: 4301 m^2

Built up area: 1250 m^2

Ground coverage: 447 m^2

Just over a year old, this newly constructed building has a central core, and four suites on each floor. A cladded brick façade and symmetry in planning makes the building an aesthetically pleasing one. The building incorporated quite a few environmental measures such as installation of fans and other appliances certified by the Bureau of Energy Efficiency (BEE), use of only LEDs for artificial lighting, use of a waste management system from segregated collection to composting, and the provision of charging points on-site for electric vehicles. The project also went on to install all possible signage to create maximum awareness amongst users.

GRIHA for Existing Buildings:
Awarded = 71.3% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 20
- Soft landscape area = 3002 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 447 m^2
- Hard paved area with other strategies = 0 m^2

Total reduction in UHIE achieved = 80.2%

ENERGY PERFORMANCE

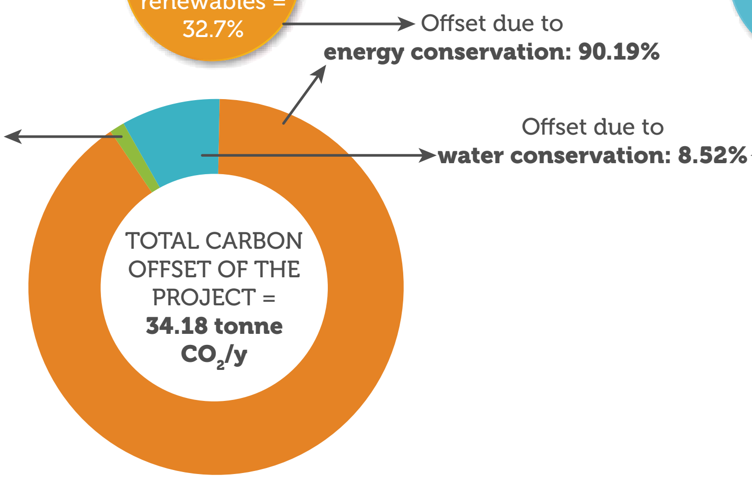
- Energy consumption before retrofit = 41249 kWh/y
- Energy consumption after retrofit = 19233 kWh/t
- Proposed PV panel system = 4 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 34253.89 kWh/y

Total energy offset by renewables = 32.7%

WATER PERFORMANCE

- Water consumption before retrofit = 11447867 L/y
- Water consumption after retrofit = 639466 L/y
- Reduction in building water demand = 19.5%
- Reduction in landscape water demand = 100%

Total water reduction achieved = 94.4%



Rainwater harvesting pit with a water meter (Credits: Author)

Rainwater harvesting has always been an integral part of sustainable development as it is one of the cleanest water sources, especially in urban settings. It consists of three parts: a catchment area, a filtration and conveyance system, and storage. The catchment may be the roof of the building or any other clean paved surface, whose runoff is directed towards the filtration system. The filtration system is designed depending on the contamination expected from the harvested surface runoff. For example, in the case of rainwater harvesting from surfaces that come in contact with vehicles, there is a possibility of oil contamination and here an advanced system such as the charcoal filter is required. Conveyance may be in the form of bio-swales for large sites or a simple pipe network from single buildings. Care must be taken to avoid contamination during conveyance. The storage system too depends on the scale of the project and is constructed in a wide variety of materials with reinforced concrete tanks and polyethylene tanks being the most commonly used.

9. Rural Hospital, Shetphal

Gramin Rungnalaya at Shetphal (Credits: Author)

★★★★

Aerial view of the hospital (Credits: after Google Earth Pro)

About

Location: Shetphal, Taluka Madha, District Solapur

Typology: Healthcare

Purpose: Hospital

Site area: 6130 m^2

Built up area: 1040 m^2

Ground coverage: 1040 m^2

A single storied building located in a sparsely developed setting, it has an 'E' shaped plan. Sufficient overhangs along with a deep porch over the entrance protect the interiors from harsh sun. With its easy accessibility to year-long direct solar radiation, this hospital has proposed a renewable energy system that will generate five times in excess of its demand and is on track to become a net positive project. As it is a hospital, waste segregation is being given priority with bio-medical waste bins present at site along with dry waste bins. A separate space including a room for biomedical waste is allocated for collection before the waste is sent for recycling/disposal. Apart from this, clear signage in the local language is present all over the building.

GRIHA for Existing Buildings:
Awarded = 72.5% (*4 Star Rating: 71–85%)

SITE PARAMETERS

- Number of trees at site = 15
- Soft landscape area = 2150 m^2
- Percentage of lawn area = 0%
- Hard paved area with SRI>50% = 0 m^2
- Hard paved area with other strategies = 1040 m^2

ENERGY PERFORMANCE

- Energy consumption before retrofit = 8666 kWh/y
- Energy consumption after retrofit = 535 kWh/y
- Proposed PV panel system = 2 kWp
- Installed solar hot water system = 0 L
- Reduction in conventional energy demand at source = 13618.55 kWh/y

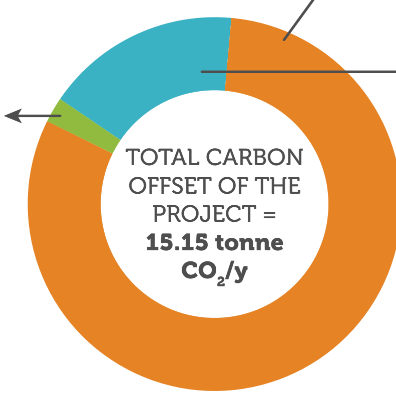
WATER PERFORMANCE

- Water consumption before retrofit = 10016099 L/y
- Water consumption after retrofit = 501549 L/y
- Reduction in building water demand = 35.4%
- Reduction in landscape water demand = 100%

Total reduction in UHIE achieved = 52%

Total energy offset by renewables = 583.9%

Total water reduction achieved = 95%



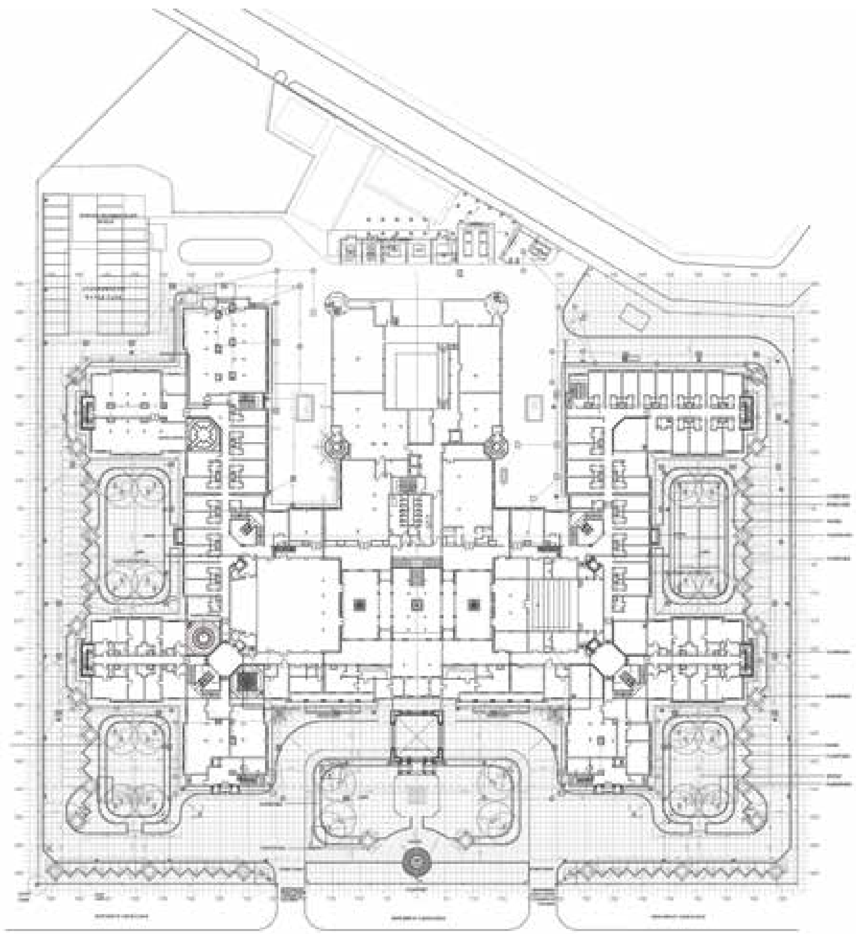
Water meters installed at the hospital (Credits: Author)

Being located in the semi-arid district of Solapur, water conservation is equally important for us, the users, and the environment. During the feasibility check we realised that though we had water efficient fixtures like taps with aerators and dual flush WCs installed in the building, we did not have water meters on-site to monitor our usage. GRIHA gave us the opportunity to upgrade our project with easily implementable and cost-effective interventions. We can now quantify our impact made in terms of water savings.

Shri V. H. More, Executive Engineer, PW Division Solapur

10. New Maharashtra Sadan, New Delhi

View of the New Maharashtra Sadan at New Delhi (Credits: Mr Ashutosh Dwivedi)



Plan of the New Maharashtra Sadan building(Credits: Mr Ajit Madkaiker)

About

Location: New Delhi

Typology: Commercial

Purpose: Office

Site area: 23361.5 m^2

Built up area: 16309.5 m^2

Ground coverage: 8,154.75 m^2

The architecture of the New Maharahtra Sadan in New Delhi designed by Mumbai-based architect, Mr P.G. Patki, is deeply inspired by the Vishrambaug wada of Pune. It is a grand and monumental structure. An ornately patterned walkway leads up to the front façade which is articulated with a meghadambari (a cloud-capped balcony) projecting from it. Situated in front of the entrance is a towering statue of Chhatrapati Shivaji Maharaj. There are two other statues within the premises, those of Dr Ambedkar and Mahatma Phule. Upon entering, the double height courtyard and overlooking windows with their full height openings, cusped arch and wood railings are fine examples of elements of the architecture of the Peshwa period. The building accommodates 138 rooms and 2 suites. These rooms are located along the north and south wings of the building while the central space contains two auditoriums, a cultural centre, library, canteen, and gymnasium.

GRIHA for Existing Buildings:
Awarded = 71.3 % (*4 Star Rating: 71–85%)

De-superheater at New Maharashtra Sadan (Credits: Mr Ashutosh Dwivedi)

The Maharashtra Sadan building has installed a desuperheater in its chillers in order to reduce the energy consumption of the condenser of the HVAC system and improve its efficiency; thereby functioning as an energy conservation measure. The waste heat recovered by desuperheater is used to raise the temperature of Hot Plate Heat Exchanger that in turn increases the temperature of water stored in domestic tank, which is then utilized for the purpose of washing and bathing.

Due to the installation of the desuperheater, the project can offset the Piped Natural Gas (PNG) supply for nearly 6–7 months annually, as they do not require hot water generator systems. This totals to nearly 4000–4500 Standard Cubic Meter (SCM) of PNG savings per month. In turn, due to not using the allied pumps of hot water generation, electricity saving is seen as well. To further reduce their conventional energy consumption, the project has also installed a 150 kWp PV system, which offsets 10.5% of their energy demand annually.

Another sustainability measure taken by the project team is the installation of a STP of capacity 180 KLD which as a by-product generates 5–8 kg of organic manure daily. This manure is then used within the landscape of the development, in a phase-wise manner.

Inside the New Maharashtra Sadan (Credits: Mr Ashutosh Dwivedi)

New Maharashtra Sadan building is one of the iconic buildings of Maharashtra government situated in New Delhi. It was commissioned in 2012 and is relatively new and up to date with the latest technology installed, we had not anticipated any issues in obtaining an EB rating. We already had a sewage treatment system on-site, as well as measures for harvesting rainwater and barrier-free design for the differently abled, a solar PV system of 150 kWp, LED Fixtures, Heat Recovery System. However, the exercise with the help of GRIHA highlighted the importance of maintenance protocols – we were able to identify and replace non-functional meters and implement better policies for the procurement of green housekeeping chemicals.

Shri Ashutosh Dwivedi, Assistant Engineer (Elect.) (PWD)

4. ABC of Going Green

4.1 Aspect of Finance- Is it a Myth that Green Buildings Are Too Expensive?

Well, some building components do cost more. But, if green measures become part of the initial planning process, then it is significantly less expensive. To explain the same with an example – if we look around, glass is used predominantly in almost all types of buildings irrespective of the climatic condition. Therefore, the selection of the right kind of glass, which will allow adequate daylight but cut out the glare and heat gain, is extremely critical in buildings. With advancement in technology, many varieties of low-emissivity glass are available in the market, which allow optimum daylight and reduce heat ingress as much as possible. However, as we enhance the specification spectrum, the cost also increases significantly. A cost-effective strategy is to first optimize the wall to window ratio and introduce design interventions for shading so that the direct incident solar gains are minimized. This intervention would lead to providing a much cheaper glass without compromising the thermal and visual comfort of the occupants. Therefore, it is extremely important to strike a balance between design and material specifications to provide comfortable spaces that have minimal impact on the cost. This may be easier and less expensive to incorporate in a new construction as against in an already built environment. The upfront cost drastically increases; nevertheless, the rewards on the other side of the ledger for the latter are substantial, if computed for the life cycle of the building.

As buildings are seemingly perpetual and an enormous portion of the total building stock existing today will still exist in 2050, it is critical to invest in shallow or deep retrofits to ensure long-term value associated to the buildings in terms of improved health and well-being of the occupants, increased productivity, and resource optimization. The case of Solapur, PWD Division (Table 1) as presented to GRIHA Council has been given here, to understand the cost implication for green measures that were implemented in the given restrictive setup. The cost incurred was broadly classified into two:

Civil cost: It included activities such as construction of rainwater harvesting system, ramp for universal accessibility, replacement of water fixtures, installation of dedicated waste bins, plantation of new native saplings, printing and display of environmental posters, and so on.

Electrical cost: It included activities such as replacement of electrical fittings, fans, air conditioning units, installation of solar PV system, providing car charging point and so on.

Note: The soft cost which includes registration fee for certification and consultant's professional fee has not been considered in this estimation.

Case of Solapur presented to understand financial implications of green measures

S. No.	Name of the project	Rating awarded	Built up area (m^2)	Cost incurred (in lakh)	
				Civil	Electrical
1	Construction of rural hospital (30 bedded) at Karkambh, Taluka Pandharpur, Solapur	5 star GRIHA EB	901.32	5.76	8.06
2	North Tahsil Office Solapur	4 star GRIHA EB	600	2	6.45
3	Rural Hospital Shetphal		1040	6.7	13.24
4	Animal Husbandry Polyclinic, Solapur		700	2.5	7.21
5	Tahsil office Mangalvedha		1590	2.94	8.11
6	Rural Hospital Madha		1050	4.4	13.24
7	Shri Chatrapati Shivaji Maharaj Sarvopchar Rugnalaya, Solapur	3 star GRIHA EB	57976	10	51.42
8	South Tahsil office Solapur		700	1.5	7.53
		Total	**64557**	**35.8**	**115.26**
		Civil cost (INR/m^2)	**55.00**		
		Electrical cost (INR/ m^2)	**180.00**		

The analysis indicates that the upfront capital cost may be higher in some cases; but the return on investment (ROI) is attractive, along with environmental benefits. It is possible for this expenditure to be absorbed in the routine maintenance work of PWD, GoM, excluding a few items that fall under the electrical work category. Ambitious efforts are required to introduce and induce behavioral and lifestyle changes to have resource savings in a green building, in addition to implementation of technologies and architecture. In fact, multiple projects across various typologies rated by GRIHA are evidence that a project, designed to be sustainable from its initiation can even cost much less than a conventional building.

4.2 Benefits of Social Doing

A built environment is capable of leaving innumerable impressions on the minds of the people associated with it. Architecture, when done right, not only provides functional living and working spaces but also has the potential to improve the quality of life of the users. The intangible benefits offered by a thoughtfully created built environment, one that aims at benefitting the occupants as well as the society at large, are numerous and lead to the creation of a positive social environment and nurturing natural environment.

A few of such benefits are attributed to the provision of universal accessibility to spaces and to creating environmental awareness amongst users. GRIHA integrates these holistic aspects of green architecture to enhance the sustainability quotient of new as well existing construction.

Universal accessibility

An integral part of a built environment is accessibility; an unseen aspect that develops as a result of the provision of various design elements that allow the built environment to be used independently and smoothly. Often it has been observed that architecture as an experience gets limited to only those who are 'abled'. The ones with the limitation of age and physical ability are unable to access built structures because the essential aspect of accessibility is not provided based on their basic needs. The usability of a project increases when it integrates the concept of universal design, wherein the idea of accessibility is not just limited to people without physical disabilities but expands to all regardless of their age and levels of physical ability. While universal design is easy to adopt in a new construction project, it is important to note that it can also very well be incorporated in existing structures.

This intent was well understood by the 301 existing PWD buildings and was adopted extensively in the building's existing design to welcome all, irrespective of their age and ability. Parking spaces for those with special needs was identified and demarcated. Ramps were constructed at ground floor level, while all steps were fitted with railings for support (Photo 4.1). Toilets were modified as per the 'Harmonised Guidelines and Space Standards for Barrier-Free Built Environment for Persons with Disability and Elderly Persons'.

Persons with special needs, which arise due to either age or certain disability, experience day-to-day struggle in order to meet their basic needs owing to barriers in accessing public buildings and other infrastructure. Universal design measures enabled such people in being more socially engaged and self-reliant.

PHOTO 4.1 Providing for universal accessibility

Environmental awareness

Green construction is the need of the time. Being efficient in the usage of energy, water, and reuse of waste is the act of the wise. General masses have realised the effects of climate change caused due to insensitive human activities, with the building industry being one of the larger contributors. This realization led to the idea of sustainable construction and sustainable living to minimize the detrimental impact of anthropogenic activities on Mother Nature.

But there remains a large section of our society that are either ignorant or live in denial of the ever-increasing resource crisis the world is facing right now. In both the cases, lack of information is the cause of concern, which may lead to further wastage of resources. Also, the incorporation of sustainable mechanisms is futile if they are used incorrectly. In such a situation, knowledge becomes the keystone of sustainability and awareness, the prerequisite of environmental protection and sustainable development. Considering the same, GRIHA encourages the incorporation of environment awareness in its projects as an important parameter.

To meet this criterion, building owners and managers of these existing PWD building took upon themselves the onus of spreading the benefits of living sustainably, through environmental awareness drives such as awareness sessions for general masses, cleaning, and tree plantation drives (Photo 4.2). Additionally, graphical posters, many in the native language, were displayed at all common locations indicating the appropriate usage of systems or the benefits attained by the same (Photo 4.3). Innovative strategies such as labelling sustainable systems like rainwater harvesting pits or labelling native trees were also implemented.

4.3 Comfort of the Occupants

One of the most important functions of a built environment is to ensure the comfort of its occupants through control over environmental factors such as heat, light, and sound. Each of these factors has prescribed levels that they must be within, in order for occupant comfort conditions to be met. The details of these parameters have been mentioned in the ensuing sections.

The three parameters

Depending upon indoor room temperature, a person may witness a particular physiological temperature, which might be either hot and sweaty or cold and

PHOTO 4.2 Environmental awareness programme conducted for users

PHOTO 4.3 Posters for environmental awareness

chilly. It is, therefore, important to maintain the operative temperatures inside the building within the prescribed comfort band for the geographical location and climatic zone. Additionally, there are other factors such as metabolic rate, air movement, clothing levels, acclimatization that influence the thermal comfort of an individual.

Visual comfort is the second parameter that needs to be catered to by the building envelope – high levels of illumination cause glare whereas lower levels of light make it difficult to see clearly. Either of the two conditions leads to discomfort. Adequate illumination, natural and/or artificial, is therefore essential for visual comfort within a building.

The third parameter for comfort is acoustics. Sound can be pleasing up to certain thresholds beyond which it becomes noise. Prolonged exposure to loud noise can decrease productivity and may lead to hearing impairment. It is, therefore, important to block out unnecessary noise by acoustic insulation using materials with high NRC (Noise Reduction Coefficient) or by planting trees as buffers, to name a few, in order to ensure acoustic comfort within the building.

With various codes and models designed to establish comfort condition ranges, all these parameters can be evaluated based on the same. In order to evaluate comfort conditions within a building, the parameters need to be measured and checked for whether they fall within the prescribed range of comfort conditions or not.

Thermal comfort: Requirements are defined by the National Building Code (NBC) or the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE 55) or the Indian Model for Adaptive Comfort (IMAC).

Visual comfort: Artificial lighting including space/task specific Lux level to fall within limits (lower and higher range limits) as per NBC 2005. Daylight factor (DF) limits are prescribed in the SP 41: Handbook on Functional Requirements of Buildings by the Bureau of Indian Standards.

Acoustics comfort: The indoor noise levels should be within the acceptable limits as specified in NBC 2005

If the comfort conditions are not within the prescribed range then mitigation actions/policies must be adopted to make conditions comfortable for the building occupant. GRIHA carried rigorous measurement of all three comfort parameters for the public buildings registered with it under the Existing Buildings category: strategies such as the use of high reflective paints (Photos 4.4 and 4.5) on roof surfaces which reflect back maximum insolation, planting of tree saplings and the preservation of mature trees on-site, which keep the microclimate cool, and provide diffused light inside the building and also act as a buffer against noise sources to ensure maximization of comfort at minimum cost. These strategies helped building operators achieve an average reduction between 2 and 3°C in indoor temperatures, maintain optimum daylight, and reduce noise, as verified through actual on-site readings/measurements taken for air and surface temperature, relative humidity, illuminance, and noise levels.

PHOTO 4.4 PWD officer inspecting the application of high SRI paints on roofs

PHOTO 4.5 Roof painted with high SRI paint

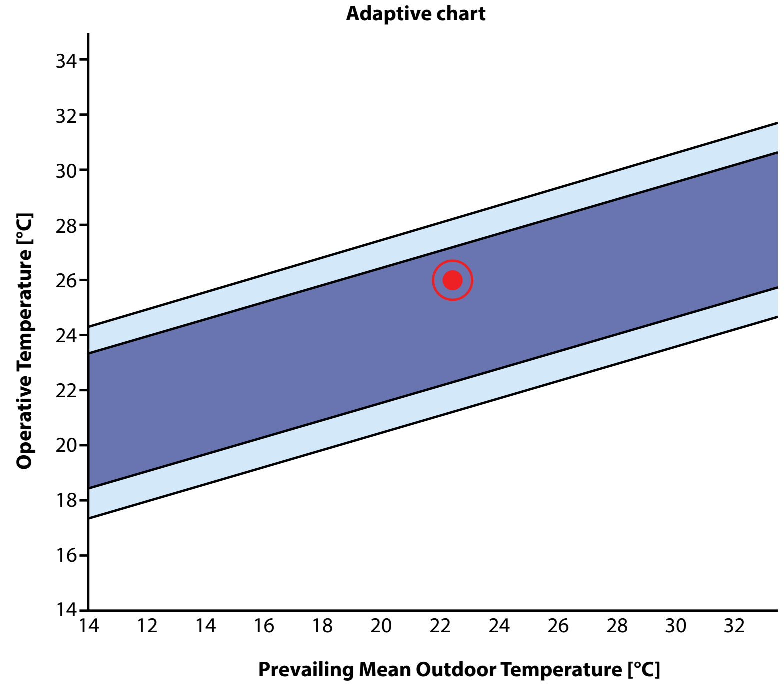
Analysis

All the three comfort parameters were analysed and evaluated to check whether they were meeting the prescribed comfort levels. The Centre for the Built Environment (CBE) comfort tool (Figure 4.1) allows for visualizing the thermal comfort zones on a chart with indoor operative temperature as ordinate and different outdoor temperature indices as abscissa, in compliance with the adaptive models provided in the ASHRAE 55–2017 or the EN 16798–1:2019 Standards. The red dot is the plotting of operative indoor temperature with respect to the prevailing mean outdoor temperature. The blue bands indicate the comfort limits. If the red dot falls within the dark blue band, then it indicates 90% of the users/occupants feel comfortable with the existing indoor operative temperature; further if the red dot falls in the light blue band then it indicates 80% of the users/occupants feel comfortable with the existing operative temperature. Beyond that if the red dot falls anywhere apart from that band then it indicates the building is not comfortable thermally. Similarly, during the site visits lux levels and noise levels were measured (Photos 4.6 and 4.7) and recorded to check visual and acoustics comfort.

A comfort survey form (Photo 4.8) was circulated among the occupants in each building and the feedback was evaluated to develop an understanding of general occupant comfort. All the three comfort parameters were measured on a scale from 1 to 5, 1 being unbearably uncomfortable and 5 indicating perfect comfort. The survey indicated that approximately 90% of occupants were thermally, visually, and acoustically comfortable by the conclusion of the Existing Buildings rating activity.

Complies with ASHRAE Standard 55-2017

80% acceptability limits	Operative temprature: 21.2 to 28.2°C
I, Status	Comfortable
90% acceptability limits	Operative temprature: 22.2 to 27.2°C
I, Status	Comfortable



NOTE: Method is applicable only for occupant-controlled naturaly conditioned spaces that meet all of the following criteria: (a) There is no mechinical cooling system installed. No heating system is in operation; (b) Metabolic rates ranging from 1.0 to 1.3 met; and (c) Occupants are free to adapt their clothing to the indoor and/or outdoor thermal conditions within a range at least as wide 0.5-1.0 clo.

FIGURE 4.1 CBE thermal comfort tool for ASHRAE-55

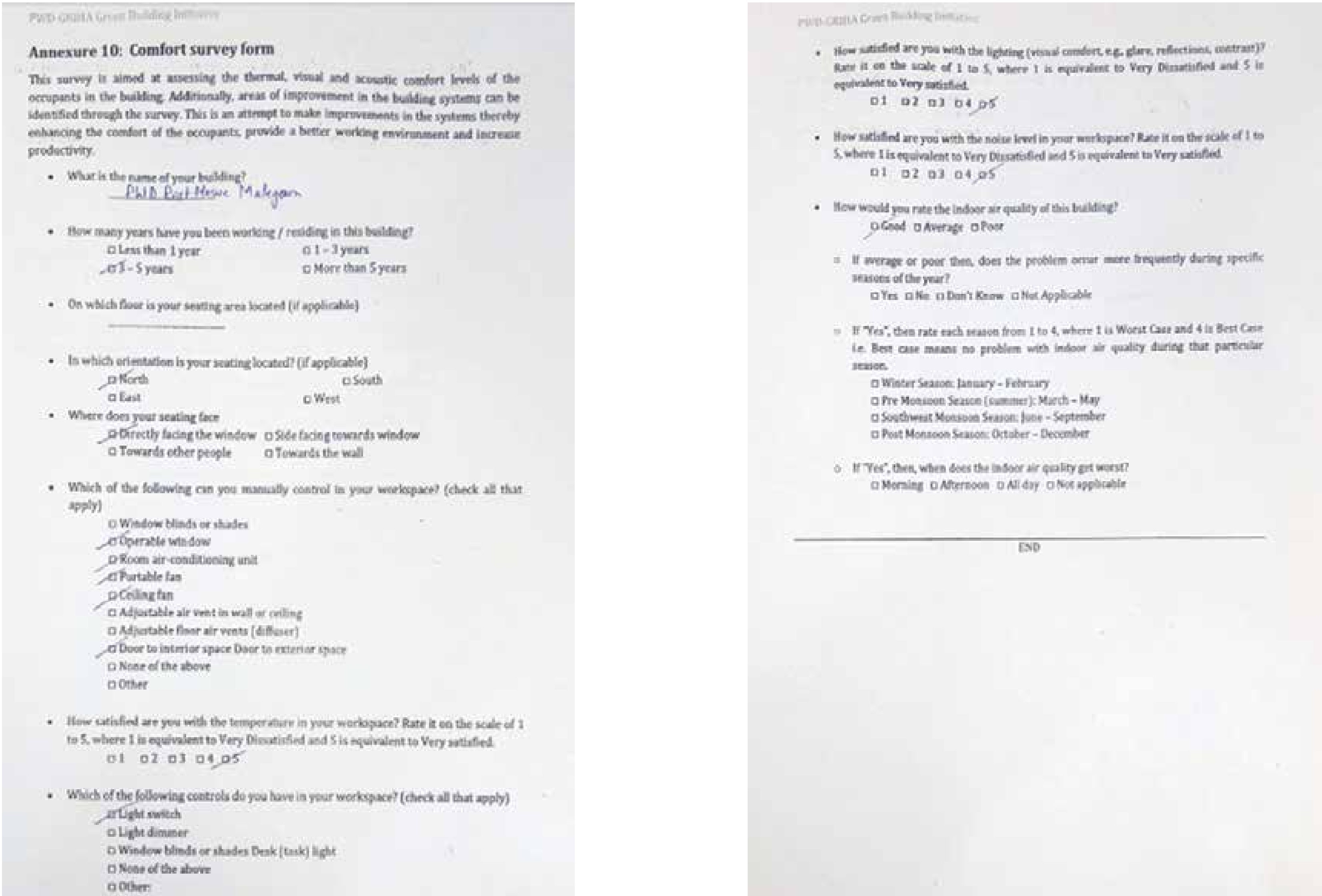
PHOTO 4.6 Measuring comfort parameters

PHOTO 4.7 Measuring comfort parameters during site visit

There were various letters of appreciation received from the user department, corporates, government representatives etc. stating that the initiative taken up by Public Works Department, Government of Maharashtra and GRIHA Council is commendable and has led to a positive impact on the environment as a result of retrofitting the existing building in a sustainable manner. A few of the sustainable strategies and their benefits that were highlighted in the letter (Figure 10) are as follows:

- Use of high SRI paints resulted in decrease in the indoor temperature leading to reduced dependency on the artificial cooling systems. This further helped in reduction in electricity bills.
- Making provision for rainwater harvesting systems will potentially lead to replenishment of groundwater table of that area.
- Making provisions of ramps for universal accessibility has made the building accessible to elderly and physically challenged people and creating social equity.
- Increase in the green cover by planting more native trees has helped to reduce pollution and enhance the air quality of the surrounding.
- The environmental awareness posters which have been displayed in the building premises have helped to increase awareness regarding environment among the general masses.

Thus, this green building initiative taken up by the PWD, Government of Maharashtra and GRIHA Council was a grand success in all aspects.



PWD GRIHA Green Building Initiative

Annexure 10: Comfort survey form

This survey is aimed at assessing the thermal, visual and acoustic comfort levels of the occupants in the building. Additionally, areas of improvement in the building systems can be identified through the survey. This is an attempt to make improvements in the systems thereby enhancing the comfort of the occupants, provide a better working environment and increase productivity.

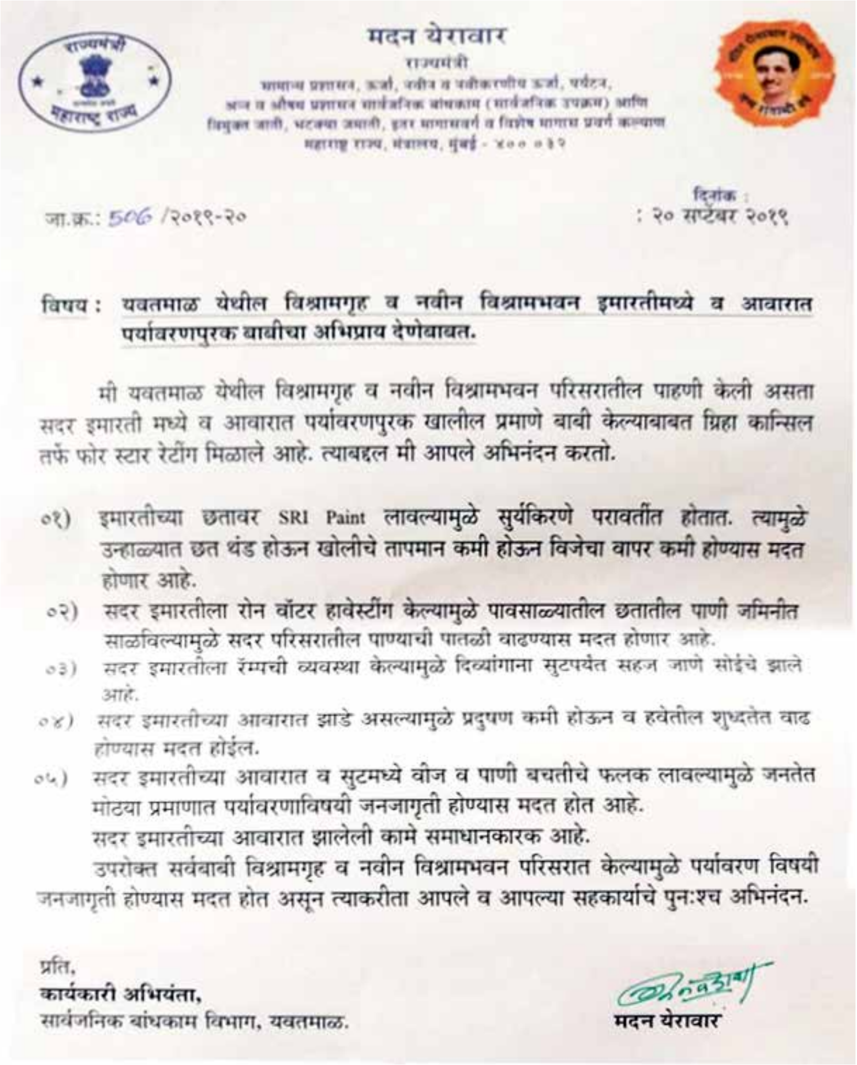
- What is the name of your building?
  PWD Rest House Malegaon
- How many years have you been working / residing in this building?
  ☐ Less than 1 year ☐ 1 - 3 years
  ☐ 3 - 5 years ☐ More than 5 years
- On which floor is your seating area located (if applicable)
  ____
- In which orientation is your seating located? (if applicable)
  ☐ North ☐ South
  ☐ East ☐ West
- Where does your seating face
  ☐ Directly facing the window ☐ Side facing towards window
  ☐ Towards other people ☐ Towards the wall
- Which of the following can you manually control in your workspace? (check all that apply)
  ☐ Window blinds or shades
  ☐ Operable window
  ☐ Room air-conditioning unit
  ☐ Portable fan
  ☐ Ceiling fan
  ☐ Adjustable air vent in wall or ceiling
  ☐ Adjustable floor air vents (diffuser)
  ☐ Door to interior space Door to exterior space
  ☐ None of the above
  ☐ Other
- How satisfied are you with the temperature in your workspace? Rate it on the scale of 1 to 5, where 1 is equivalent to Very Dissatisfied and 5 is equivalent to Very satisfied.
  ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
- Which of the following controls do you have in your workspace? (check all that apply)
  ☐ Light switch
  ☐ Light dimmer
  ☐ Window blinds or shades Desk (task) light
  ☐ None of the above
  ☐ Other:

PWD GRIHA Green Building Initiative

- How satisfied are you with the lighting (visual comfort, e.g. glare, reflections, contrast)? Rate it on the scale of 1 to 5, where 1 is equivalent to Very Dissatisfied and 5 is equivalent to Very satisfied.
  ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
- How satisfied are you with the noise level in your workspace? Rate it on the scale of 1 to 5, where 1 is equivalent to Very Dissatisfied and 5 is equivalent to Very satisfied.
  ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
- How would you rate the indoor air quality of this building?
  ☐ Good ☐ Average ☐ Poor
  - If average or poor then, does the problem occur more frequently during specific seasons of the year?
    ☐ Yes ☐ No ☐ Don't Know ☐ Not Applicable
  - If "Yes", then rate each season from 1 to 4, where 1 is Worst Case and 4 is Best Case i.e. Best case means no problem with indoor air quality during that particular season.
    ☐ Winter Season: January - February
    ☐ Pre Monsoon Season (summer): March - May
    ☐ Southwest Monsoon Season: June - September
    ☐ Post Monsoon Season: October - December
  - If "Yes", then, when does the indoor air quality get worst?
    ☐ Morning ☐ Afternoon ☐ All day ☐ Not applicable

END

PHOTO 4.8 Comfort survey form



मदन येरावार

राज्यमंत्री

सामान्य प्रशासन, ऊर्जा, नवीन व नवीकरणीय ऊर्जा, पर्यटन,
अन्न व औषध प्रशासन सार्वजनिक बांधकाम (सार्वजनिक उपक्रम) आणि
विमुक्त जाती, भटक्या जमाती, इतर मागासवर्ग व विशेष मागास प्रवर्ग कल्याण
महाराष्ट्र राज्य, मंत्रालय, मुंबई - ४०० ०३२

जा.क्र.: 506 /२०१९-२० दिनांक : २० सप्टेंबर २०१९

विषय : यवतमाळ येथील विश्रामगृह व नवीन विश्रामभवन इमारतीमध्ये व आवारात पर्यावरणपुरक बाबीचा अभिप्राय देणेबाबत.

मी यवतमाळ येथील विश्रामगृह व नवीन विश्रामभवन परिसरातील पाहणी केली असता सदर इमारती मध्ये व आवारात पर्यावरणपुरक खालील प्रमाणे बाबी केल्याबाबत ग्रिहा कान्सिल तर्फे फोर स्टार रेटींग मिळाले आहे. त्याबद्दल मी आपले अभिनंदन करतो.

०१) इमारतीच्या छतावर SRI Paint लावल्यामुळे सुर्यकिरणे परावर्तीत होतात. त्यामुळे उन्हाळ्यात छत थंड होऊन खोलीचे तापमान कमी होऊन विजेचा वापर कमी होण्यास मदत होणार आहे.

०२) सदर इमारतीला रेन वॉटर हार्वेस्टींग केल्यामुळे पावसाळ्यातील छतातील पाणी जमिनीत साठविल्यामुळे सदर परिसरातील पाण्याची पातळी वाढण्यास मदत होणार आहे.

०३) सदर इमारतीला रॅम्पची व्यवस्था केल्यामुळे दिव्यांगाना सुटपर्यंत सहज जाणे सोईचे झाले आहे.

०४) सदर इमारतीच्या आवारात झाडे असल्यामुळे प्रदुषण कमी होऊन व हवेतील शुध्दतेत वाढ होण्यास मदत होईल.

०५) सदर इमारतीच्या आवारात व सुटमध्ये वीज व पाणी बचतीचे फलक लावल्यामुळे जनतेत मोठया प्रमाणात पर्यावरणाविषयी जनजागृती होण्यास मदत होत आहे.

सदर इमारतीच्या आवारात झालेली कामे समाधानकारक आहे.

उपरोक्त सर्वबाबी विश्रामगृह व नवीन विश्रामभवन परिसरात केल्यामुळे पर्यावरण विषयी जनजागृती होण्यास मदत होत असून त्याकरीता आपले व आपल्या सहकार्याचे पुनःश्च अभिनंदन.

प्रति,
कार्यकारी अभियंता,
सार्वजनिक बांधकाम विभाग, यवतमाळ.

मदन येरावार

PHOTO 4.9 Letter of appreciation

30 Stories | Beyond Buildings


GRIHA COUNCIL
10th REGIONAL
GRIHA SUMMIT, NAGPUR
CURTAIN RAISER
Organisers

About GRIHA Council

GRIHA is an acronym for Green Rating for Integrated Habitat Assessment. GRIHA is a Sanskrit word meaning – 'Abode'. Human Habitats (buildings) interact with the environment in various ways. Throughout their life cycles, from construction to operation and then demolition, they consume resources in the form of energy, water, materials, etc. and emit wastes either directly in the form of municipal wastes or indirectly as emissions from electricity generation. GRIHA attempts to minimize a building's resource consumption, waste generation, and overall ecological impact to within certain nationally acceptable limits / benchmarks.

Going by the old adage 'what gets measured, gets managed', GRIHA attempts to quantify aspects such as energy consumption, waste generation, renewable energy adoption, etc. so as to manage, control and reduce the same to the best possible extent.

GRIHA is a rating tool that helps people assesses the performance of their building against certain nationally acceptable benchmarks. It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. The rating system, based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international.

On a broader scale, this system, along with the activities and processes that lead up to it, will benefit the community at large with the improvement in the environment by reducing GHG (greenhouse gas) emissions, reducing energy consumption and the stress on natural resources.

Some of the benefits of a green design to a building owner, user, and the society as a whole are as follows:

- Reduced energy consumption without sacrificing the comfort levels
- Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc.
- Reduced air and water pollution (with direct health benefits)
- Reduced water consumption
- Limited waste generation due to recycling and reuse
- Reduced pollution loads
- Increased user productivity
- Enhanced image and marketabiliy

For more information, please visit: **https://www.grihaindia.org/**

About TERI

The Energy and Resources Institute (TERI) is an independent, non-profit organization, with capabilities in research, policy, consultancy and implementation. TERI has multi-disciplinary expertise in the areas of energy, environment, climate change, resources, and sustainability.

With the vision of creating innovative solutions for a sustainable future, TERI's mission is to usher in transitions to a cleaner and more sustainable future through the conservation and efficient use of the Earth's resources and develop innovative ways of minimizing waste and reusing resources.

TERI's work across sectors is focused on:

Promoting efficient use of resources across sectors

Increasing access and uptake of sustainable practices

Reducing the adverse impact on environment and climate

TERI works with a diverse range of stakeholders across governments, both at the national and state levels, international agencies, and civil society organizations to help deliver research-based transformative solutions. Headquartered in New Delhi, TERI has regional centres and campuses in Bengaluru, Gurugram, Guwahati, Mumbai, Nainital, and Panaji.

Currently, TERI's work is structured around seven sectors:

- Agriculture
- Climate
- Energy
- Environment
- Habitat
- Health and Nutrition
- Resources

TERI brings out Discussion Papers on key contemporary issues in sectors such as energy, agriculture, water and environment with multi-disciplinary and multi-sectoral implications for use by policy makers, legislators, researchers and practitioners.

For more information, please visit: **http://www.teriin.org/**

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