

GRIHA HABITATS – A COLLECTION OF SUSTAINABLE BUILDINGS IN SOUTH INDIA



Message from the President, GRIHA Council

Dear Friends,

The growth of the Indian economy is projected to be amongst the highest—if not the highest—amongst all the countries of the world; and this would be accompanied by high growth rate in the building sector as well. It is also predicted that the building energy consumption will grow at about 2.7% per year over the next 10 years. This unprecedented urban growth would also impact India's carbon emission, which is currently are the third highest in the world.

The Government of India (Gol), in its Nationally Determined Contribution (NDC) pledge to the United Nations Framework Convention on Climate Change, has committed to reduce the emission intensity of its GDP by 33%- 35% by 2030 from 2005 levels. Given that the bulk of our infrastructure is yet to be built, herein lies a tremendous opportunity for us to ensure that these constructions follow green and sustainable practices which would contribute significantly to emission reduction.

The NDC recognizes GRIHA, our indigenous rating system for green buildings as a powerful tool to both enable and measure energy savings due to green-building construction. I am pleased to see that GRIHA is adding momentum to the green-ness of upcoming and existing buildings across the country to create sustainable tomorrow. I congratulate the colleagues in the GRIHA Council for the compilation of case studies for GRIHA rated projects in the Southern region.

I hope you enjoy the book.

Dr. Ajay Mathur, President, GRIHA Council



GRIHA Council, Bengaluru

GRIHA Council southern zone office is located in the TERI SRC building, at Domlur Bengaluru. The 2,450 sq.m office is known to be the first complex in the city to integrate energy efficient features.

The building shows how orientation plays an important role in "solar architecture". The structure was oriented along the east-west axis so as to have maximum exposure along north and south, taking advantage of glare-free light.

Roof insulation is provided in the form of terrace gardens, which act as good insulation and moderates fluctuations in temperature. The section of the building is designed in such a way that natural daylight enters into the building, by creating atrium spaces with skylights and considerably reducing the dependence on artificial lighting. Passive cooling strategies like solar chimney were used to create reverse wind circulation, thereby reducing demand on mechanical air conditioning system of the building.



Ajay Mathur President



Sanjay Seth CEO



Shabnam Bassi Secretary



Akash Deep Senior Manager



Gagan Kechira Manager Business Development, Rating Review & Trainings gagan.kechira@grihaindia.org



GRIHA – Southern Cell

Bishal Goswami Deputy Manager Technical bishal.goswami@grihaindia.org



K. Anitha Secretary k.anitha@grihaindia.org



Message from the CEO, GRIHA Council

Dear friends and colleagues,

The construction sector in India emits about 22% of the total annual emission of CO² resulting from the Indian economy. The United Nations mentioned that buildings and construction are tools for promoting more sustainable patterns of consumption and production. As the world stands at a tipping point, GRIHA, as a rating tool, has been helping people assess the performance of their projects against nationally acceptable benchmarks since its inception in 2007. It evaluates the environmental performance of a building holistically over its entire life cycle. GRIHA emphasizes cost effectiveness and the integration of traditional heritage with scientific tools, and has been mentioned in the INDC document as an indigenous tool to measure GHG mitigation in the country.

It has been established that the built environment can contribute to a more equal, inclusive, and cohesive society if the places where we live, the facilities we use, our neighbourhoods and meeting places are accessible, resource efficient and user centric. GRIHA, a versatile tool, ensures enhanced occupant comfort, decreased energy bills, and healthier spaces for the users. Social aspects are an integral part of the rating system, which makes it distinctive. GRIHA's underlying principle— what gets measured gets managed—has been imbibed into the relevant policies and guidelines and continues to enjoy the patronage of reputed public and private construction agencies, developers, users, and consultants.

This coffee table book showcases some of the GRIHA rated projects in the southern part of the country. We hope that this book will inspire and galvanize the green building movement in the region.

Sanjay Seth Chief Executive Officer, GRIHA Council



Final Rating

GRIHA is a point-based rating system which guides a project in achieving sustainable design and at the same time helps assess the greenness of a project. Rating selection criteria: Built-up area > 2,500 sq.m



Grand Chola, ITC Hotels Limited

Location	:	Chennai
Site Area	:	32,330 sq.m
Total Built-up Area	:	1,32,598 sq.m
Air- conditioned Area	:	1,32,598 sq.m
Non Air-conditioned Area	:	NA
Energy Consumption Reduction	:	41.5% reduction from GRIHA benchmark
Water Consumption Reduction	:	50.7% reduction from GRIHA benchmark
Energy Performance Index (EPI)	:	186 kWh/sq.m/year
Occupancy Hours	:	24 hours/day (24×7)
Renewable Energy Installed on Site	:	12600 kWp
GRIHA Final Rating	:	5 Star

The following strategies were adopted to reduce the impact of the proposed building on natural environment:

Sustainable site planning

- Existing trees were preserved and transplanted along the periphery of the site.
- Excavation and construction started after the monsoon season to prevent soil erosion and soil run-off from the site.
- Top soil was preserved and re-used to raise the ground level along the periphery.
- Service corridors are planned to cause minimum damage to the site and natural topography.
- Orientation of the building is east-west but zoning of the building has been appropriately done to reduce negative impact of bad orientation.

Reduction in water consumption (compared to GRIHA benchmark)

- Reduction in building water consumption by use of low-flow fixtures: 50.7%.
- Water recycled and reused within the complex: 90%.
- Reduction in landscape water consumption by planting native species of trees and shrubs and by using efficient irrigation systems: 62.3%.

Passive architectural design strategies adopted in the building

- Recessed windows to cut direct sun rays and glare inside the building.
- 99% of living areas are daylit and window to wall ratio restricted to 25% to reduce solar heat gain inside the building.

Reduction in energy consumption (compared to GRIHA benchmark) while maintaining occupant comfort

- For achieving visual comfort
 - » Energy-efficient artificial lighting design is compliant with ECBC.
 - » Occupancy sensors in rooms to reduce energy consumption.

- » All electrical fixtures (lights, space conditioners, appliances) controlled by i-pad.
- » External shading and efficient glazing have been installed to reduce solar heat gain and have glare- free daylight.
- For achieving thermal comfort
 - » Building envelope is ECBC compliant.
 - » Installation of centralized air conditioning through variable refrigerant flow technology.

Renewable energy technologies installed on site

- Installed capacity of wind energy: 12,600 kWp
- Units of electricity generated annually : 2,79,00,000 kWh

Use of low-energy/green materials

- Use of plywood and MDF boards certified by SGS and recyclable fabric .
- Use of high density composite wood panels.

Building performance as per audit report

Energy

- Energy generated through wind energy: 16,788,909 kWh/year
- Final EPI achieved: 71.52 kWh/sg.m/year
- Reduction in EPI from proposed case: 7.78%. •
- Thermal comfort is met as per NBC 2005. •
- Lighting lux levels are met as recommended by NBC 2005.

Water and waste

- Water test report indicates conformity to IS code 10500.
- Total quantity of waste generated: Approx. 12 kg/day

Noise level

- Outdoor noise levels are within acceptable limits as per CPCB.
- Indoor noise levels are within acceptable limits as per NBC 2005.

Integrated Team

- **Project Owner Project Coordinator Principal Architect** Landscape Architect **Project Management Consultant Civil Contractors Structural Consultant Electrical Consultant**
- **Green Facilitation**
- Green Building Design and Energy Consultant : The Energy and Resources Institute

- : M/s ITC LTD
- : M/s Larsen & Toubro
- : M/s Smallwood Reynold Stewart, Singapore
- : M/s Belt Collins, Singapore
- : M/s ITC LTD
- : M/s Larsen & Toubro
- : M/s Sterling Engineering Consultants
- : M/s Spectral Consultants
- : Green Dimensions



Rail Nirman Nilayam

Location	:	Secunderabad, Andhra Pradesh
Site Area	:	7,800 sq.m
Built-up Area	:	4,405 sq.m
Air-conditioned Area	:	3,234.9 sq.m
Non Air-conditioned Area	:	1,175.8 sq.m
Energy Consumption Reduction	:	36.5% reduction in energy consumption
		as compared to GRIHA benchmark
Energy Performance Index (EPI)	:	71.1 kWh/sq.m/year
Renewable Energy Installed on Site	:	Rated capacity of solar PV installed on site is 38.63 kW
GRIHA Final Rating	:	3 Star
Year of Completion	:	2011–12

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Existing trees preserved and protected.
- Building designed with due respect to existing contours-minimum cutting and filling of soil.
- Proper timing of construction ensured to minimize soil erosion and pollution.

Reducing water consumption

- 50% reduction in building water consumption by use of low flow fixtures.
- · Reduction in water consumption during construction.

Reducing energy consumption (compared to GRIHA benchmarks) while maintaining occupant comfort

For achieving visual comfort

- » External shading and efficient glazing to reduce solar heat gain and ensure glare-free daylight.
- » ECBC compliant energy-efficient artificial lighting design.
- » Multi sensors compatible to DALI-based dimming of light system.

• For achieving thermal comfort

- » ECBC compliant building envelop to reduce cooling loads in AC spaces. Thermal comfort levels in non-AC spaces achieved.
- » Centralized air conditioning through variable refrigerant flow technology. Facility of controlling each indoor unit centrally as well as individually, based on occupancy censor.

Renewable energy technologies installed on site

- Installed capacity of solar energy to meet space conditioning and internal lighting loads: 38.63 kW.
- Installed 12 LED solar street lights with 360 W loads.

Use of low-energy/green materials

• Fly ash blocks used in block work for better insulation.

Building performance as per audit report

Energy

- Energy generated through solar PV: 50,374.1 kWh/year
- Final EPI achieved: 34.12 kWh/sq.m/year
- Actual reduction in EPI from base case: 60% (24% more than predicted).
- Thermal comfort is met as per NBC 2005.
- Lighting lux levels are met as recommended by NBC 2005.

Water and wastewater

- Water test report indicates conformity to IS code 10500.
- Water consumption in building: 25,31,000 lt/annum
- Total quantity of waste generated: Approx. 12 kg/day

Noise level

- Outdoor noise levels are within acceptable limits as per CPCB.
- Indoor noise levels are within acceptable limits as per NBC 2005.

Integrated Design Team

- Project Coordinator Principal Architect Landscape Architect Project Management Consultant Civil Contractors Structural Consultant Electrical Consultant Green Building Design and Certific
- : Deputy Chief, Engineer/con-I/S C
- : Designer Group, Hyderabad
- : Sri M V V Satyanarayana, Hyderabad
- : Unit of Dy.CE/C-I/SC
- : Sri. MVVSatyanarayana
- : Sri Putrayya, Aadhaarshila
- : M/s Watson, Hyderabad
- Green Building Design and Certification : Sri Gunjan Srivastava, M/s Inertia, Hyderabad



SDB 1, Infosys Limited, Hyderabad

Location	:	Hyderabad
Site Area	:	64,806.92 sq.m
Built-up Area	:	24,730 sq.m
Air-conditioned Area	:	17,338 sq.m
Non-Air-conditioned Area	:	7,392 sq.m
Energy Consumption Reduction	:	56% reduction from GRIHA benchmark
Water Consumption Reduction	:	56% reduction from GRIHA benchmark
Energy Performance Index (EPI)	:	51.85 kWh/sq.m/year
Occupancy Hours	:	8.5 hrs/day
Renewable Energy Installed on Site	:	44 kWp
GRIHA Provisional Rating	:	5 Star

The following strategies were adopted to reduce the impact of the proposed building on the natural environment:

Sustainable site planning

- Existing trees were preserved and native trees were planted on site.
- Excavation and construction started after the monsoon season to prevent soil erosion and soil runoff from the site.
- Top soil was preserved and reused during the construction period for landscaping.
- Construction activities were confined to the pre-designated areas.

Reduction in water consumption (compared to GRIHA benchmark)

- Reduction in building water consumption by use of low-flow fixtures : 56%.
- Water recycled and reused within the complex : 78%.
- Reduction in landscape water consumption by planting native species of trees and shrubs and by using efficient irrigation systems : 53%.

Passive architectural design strategies adopted in the building

- The building's longer axis is oriented on the East–West axis in order to reduce solar heat gain.
- 78.54% of living areas are daylit and the window to wall ratio is restricted to less than 38% to reduce solar heat gain inside the building.
- Natural ventilation is introduced in the building.

Reduction in energy consumption (compared to GRIHA benchmark) while maintaining occupant comfort

• For achieving visual comfort

- » Energy-efficient artificial lighting design is compliant with ECBC recommendations.
- » Occupancy sensors in rooms to reduce energy consumption.
- External shading and efficient glazing have been installed to reduce solar heat gain and have glare-free daylight.
- For achieving thermal comfort
 - » The building envelope is ECBC compliant, which helps reduce cooling loads in AC spaces and meets thermal comfort levels in non-AC spaces.
 - » The radiant cooling technology has been installed.
 - External shading and light shelves to cut glare and reduce solar heat gain have been used.

Renewable energy technologies installed on site

• Installed capacity of solar energy: 44 kWp.

Use of low-energy/green materials

- Use of ceramic tiles and carpets with recycled content.
- Use of low-energy material for internal partitions, panelling, false ceiling, and inbuilt furniture.

Integrated Design Team

Project Owner Project Head Infrastructure : Rohan M. Parikh **Principal Architect** Landscape Architect **Green Facilitation**

: Infosys Limited

- : Sundaram Architects Pvt. Ltd
- : M/s MASTERPLAN Landscape Architects
- : AECOM



SDB 7&8, Infosys Limited, Chennai

Location	:	Chennai
Site Area	:	33,599 sq.m
Total Built-up Area	:	59,134 sq.m
Air-conditioned Area	:	42,950 sq.m
Non Air-conditioned Area	:	16,880 sq.m
Energy Consumption Reduction	:	64% reduction from GRIHA benchmark
Water Consumption Reduction	:	73.1% reduction from GRIHA benchmark
Energy Performance Index (EPI)	:	40.80 kWh/sq.m/year
Occupancy Hours	:	8.5 hrs/day
Renewable Energy Installed on Site	:	51.45 kWp
GRIHA Provisional Rating	:	5 Star

The following strategies were adopted to reduce the impact of the proposed building on the natural environment:

Sustainable site planning

- Existing trees were preserved and native trees were planted on site.
- Excavation and construction started after the monsoon season to prevent soil erosion and soil run-off from the site.
- Topsoil was preserved and reused during the construction period for landscaping.
- Construction activities were confined to the pre-designated areas.

Reduction in water consumption (compared to GRIHA benchmark)

- Reduction in building water consumption by use of low-flow fixtures: 73.1%.
- Water recycled and reused within the complex: 78%.
- Reduction in landscape water consumption by planting native species of trees and shrubs and by using efficient irrigation systems: 60%.

Passive architectural design strategies adopted in the building

- Recessed windows to cut direct sun rays and glare inside the building.
- 45.62% of living areas are daylit and the window to wall ratio is restricted to less than 60% to reduce solar heat gain inside the building.
- Natural ventilation induced in the building.

Reduction in energy consumption (compared to GRIHA benchmark) while maintaining occupant comfort

• For achieving visual comfort

- » Energy-efficient artificial lighting design is compliant with the ECBC recommendations.
- » Occupancy sensors in rooms to reduce energy consumption.

Integrated Team

- **Project Owner Project Head Infrastructure** : Rohan M. Parikh **Principal Architect** Landscape Architect **Civil Contractors Structural Consultant Electrical Consultant HVAC consultant Green Facilitation**
- : Infosys Limited.

 - : M/s C. R. Narayana Rao Architects & Engineers
 - : M/s MASTERPLAN Landscape Architects
 - : Sobha Developers Ltd
 - : TRC Engineering (I) Pvt. Ltd
 - : Sobha Developers Ltd
 - : ARCO
 - : Environmental Design Solutions

» External shading and efficient glazing have been installed to reduce solar heat gain and have glare-free daylight.

For achieving thermal comfort

- » The building envelope is ECBC compliant, which helps reduce cooling loads in AC spaces and meets thermal comfort levels in non AC spaces.
- » External shading and light shelves are used to cut glare and reduce solar heat gain.

Renewable energy technologies installed on site

Installed capacity of wind energy: 51.45 kWp

Use of low-energy/green materials

- Use of ceramic tiles and regionally available granite stone.
- Use of low-energy material for internal partitions, panelling, false ceiling, and in-built furniture.
- Use of post-tensioned slabs in the building structure.



Sona College of Technology – Sona Sigma block

Location
Built-up Area
Air-conditioned Area
Non Air-conditioned Area
Energy Consumption Reduction

Energy Performance Index (EPI) Renewable Energy GRIHA Provisional Rating Year of Completion

- : Salem, Tamil Nadu
- : 3,382 sq.m
- : 2,613 sq.m
- : 769 sq.m
- : 55.79 % reduction in energy consumption com pared to GRIHA benchmark
- : 61.89 kWh/sq.m/year
- : Rated capacity of solar PV installed on site is 10 kW
- : 5 Star
- : 2014

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Efficient site planning considering the existing site features with minimal hardscape along with integrated utility corridors along the pathway.
- Preservation and protection of landscape during construction.

Reducing water consumption

- 64.27% reduction in water by using water-efficient fixtures.
- 100% of generated wastewater is treated onsite and reused for irrigation
- Efforts to reduce construction water requirement are adopted during construction.

Reducing energy consumption (compared to GRIHA benchmarks) while maintaining occupant comfort.

The building has been oriented in the best manner based on sun path analysis and detailed site study

- For achieving visual comfort:
 - » Natural daylight is brought to the interior space through fenestrations such as windows and roof lights to the possible extent and are also provided with the necessary shading device to prevent glare.
 - » The shading device for all the non-AC area are designed to provided 100% shading throughout the year.
 - » Artificial lighting design is done inline with NBC recommendation & hence over illumination is avoided.

• For achieving thermal comfort:

- » ECBC complaint Building envelope design with energy efficient glass which permits minimal heat but allows light and is used to minimize the AC load.
- » Direct evaporative cooling methodology is adopted for air-conditioning most spaces, which is an efficient technology.
- » Exterior roof has been provided with insulation and the exposed roof surfaces are provided with reflective finish.

Renewable energy technologies installed on site

• Installed solar panels of 10kW capacity to cater the need of 30% of internal lighting and 1% external lighting and HVAC load.

Use of low-energy materials

- High grade steel and concrete has been adopted to optimize the embodied energy of the materials used in structural concrete.
- Materials with recycle content such as flyash brick are used for block work .
- Regionally available materials such as athangudi tiles are used in the project .
- All the paints, adhesives and sealants used in the project are low VOC products.

Integrated Design Team

- Client
- Principal Architect Landscape Architect Structural Consultant Electrical Consultant HVAC Consultant Plumbing Consultant Green Building Design and Certific
- : Sona College of Technology
- : M/s Kadri consultants Pvt. Ltd
- : M/s Kadri consultants Pvt. Ltd
- : Sona college Civil Department
- : Sona college Electrical Department
- : M/s Airton Consulting Engineers Pvt. Ltd
- : Mr. A. K. Nagabhushana
- Green Building Design and Certification : En3 Sustainability Solutions Pvt. Ltd



BEL Academy for Excellence

Location	:	Bengaluru
Site Area	:	23,239.5 sq.m
Built-up Area	:	7,671 sq.m
Air-conditioned Area	:	4,856 sq.m
Non Air-conditioned Area	:	2,815 sq.m
Гуроlоду	:	Training Centre
Energy Consumption Reduction	:	66.73% reduction in energy consumption compared to GRIHA benchmark
Energy Performance Index (EPI)	:	43.40 kWh/sq.m/year
Renewable Energy	:	Rated capacity of solar PV installed on site is 90kW
GRIHA Provisional Rating	:	5 Star
Year of Completion	:	2017

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Out of 110 existing mature trees which were located within the site boundary, only 45 trees were cut and 65 trees were transplanted. Furthermore, 260 new saplings were planted on the project site.
- Air pollution control measures, such as site barricading, coverage of dusty material and other appropriate measures, were strictly adhered to during construction.
- Consolidated utility corridor has been constructed on site to reduce site disturbances and ensure scalability for future expansion ensuring maintenance on site is simple and easy.

Water management

- 73% of building water demand has been reduced against the GRIHA baseline by using measures, such as installation of low flow water fixtures and dual flushing system.
- 46% savings were achieved in landscape water requirement as against the GRIHA baseline by adopting native species of vegetation.
- The rainwater harvesting tank constructed on site has the capacity to hold complete rainfall received in a year.

Energy optimization

- For achieving visual comfort
 - » Facades with WWR 18.6% were built with a good visual connection between the occupants and the outside environment.
 - » 55.6% of the habitable spaces in the building are day lit and meet the daylight factors as prescribed by the National Building Code of India.

For achieving thermal comfort

- » Project has been designed with passive design measures and thermal insulating envelope comprising fly-ash bricks and double glazing units.
- » All regularly occupied spaces are conditioned with high efficient VRF systems of 3.70 COP to maintain comfort condition.
- » The energy efficient measures incorporated in the project helped the project achieve 64.27% reduction in EPI from GRIHA benchmark EPI.

Renewable energy technologies integration

- The project has installed 90 kWp capacity of solar PV panel. The energy generated by these solar PV meets the energy requirement of more than 100% of the installed lighting load.
- The capacity of installed solar panels is capable to handle 16.80% of lighting and HVAC load.

Sustainable building materials

- The embodied energy of the structural system is reduced up to 5.31% by deploying post-tensioned beams against the conventional RCC beams.
- Sustainable materials such as gypsum plaster boards and calcium silicate tiles for false ceiling, gypsum board partitions and FSC-certified wall panelling, MDF boards for in-built furniture and composite based wooden material for the internal doors, have been used in the project.
- 28% of cement is replaced with fly-ash by weight in structural concrete and plaster and masonry mortar and 60% of cement is replaced with fly-ash by volume in building blocks to reduce embodied energy of the project.
- 100% of all paints and adhesives used in the building interiors have low or zero-VOC.

Integrated Design Team

- Client **Project Coordinator Principal Architect** Landscape Architect **Project Management Consultant Structural Consultant Electrical Consultant** Green Building Design and Certification : M/s Conserve Consultants Pvt. Ltd
 - : M/s Bharat Electronics Ltd
 - : BEL Project Management Group-2/ES
 - : Sr. DGM (CNP/ES) BEL
 - : M/s Green Valley Landscapes
 - : BEL Project Management Group-2/ES
 - : BEL Construction New Projects/ES
 - **BEL Construction New Projects/ES**



Hostel Block – 1 & 2 For Manipal Integrated Services Private Limited at Manipal County

Location
Site Area
Built-up Area
Air-conditioned Area
Non Air- conditioned Area
Energy Performance Index (EPI)
Renewable Energy
GRIHA Provisional Rating
Year of Completion

- : Bengaluru
- : 25,494 sq.m
- : 13,536 sq.m
- : 6,465 sq.m
- : 11,020 sq.m
- : 35.66 kWh/sq.m/year
- : 150 kWp solar PV installation
- : 5 Star
- : 2015

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- The project site is densely vegetated, thus minimizing the cutting of trees was a challenge.
- Out of the 53 existing mature trees, 31 mature trees were cut and 22 trees were transplanted. The project has also planted 130 new trees and exceeded 25% than the requisite compensatory plantation requirement of GRIHA.
- Sustainable Urban Drainage Strategies (SUDS) have been incorporated on site to manage storm water.

Water management

- A zero-discharge site has been achieved through managing water efficiently on site by reducing the overall water demand, efficient water reuse, and recharge.
- Reduction of 53.28% from the GRIHA base case has been demonstrated in landscape water demand through the use of efficient landscape methodologies and native plant species.
- Reduction of 58% from the GRIHA base case has been demonstrated in building water use by installing water efficient flush and flow fixtures.

Energy optimization

 Strong visual connection has been maintained between all the occupied spaces and public spaces.

- 86% of the habitable spaces are day lit and meet the daylight factors as prescribed by the National Building Code of India.
- All operable windows face the vegetated areas on site.
- The Energy Performance Index of the project has been reduced by 58.05% below the GRIHA base case through envelope optimization, and integrating high performance systems.
- Ambient temperature of 26 $^{\circ}C \pm 1^{\circ}C$. is being maintained for 100% of the occupied hours.
- The massing of the buildings was designed to enhance cross ventilation.

Renewable energy technologies installed on site

- A 150 kWp solar PV system has been installed for the project which meets 100% interior lighting requirement.
- The installed solar hot water system is offsetting 73% of annual energy required for water heating.

Sustainable building materials

- 30% cement is replaced with fly ash by weight in both structural and nonstructural application that is concrete and masonry work.
- Materials such as gypsum board for false ceiling, glazed ceramic tiles for ceiling, • kota stone, vitrified tiles and granite for flooring and flush doors made of block board and laminates, have been used, all of which have low carbon footprint.
- Indoor air quality has been maintained by using 100% interiors finishes with no or low VOC content.

Integrated Design Team

- Client
- **Principal Architect** Landscape Architect
- **Project Management Consultant**
- **HVAC Consultant**
- Green Building Design and Certification : Terra Viridis
- Manipal Integrated Services
- Architect Hafeez Contractor
- Masterplan Architects
- **Diligent Project Management Consultancy**
- ARCO



Engineers India Bhawan

Location	:	SIPCOT IT Park, Siruseri,
Site Area	:	3,944 sq.m
Built-up Area	:	10,734 sq.m
Air-conditioned Area	:	5,430 sq.m
Non Air- conditioned Area	:	5,304 sq.m
Туроlоду	:	Commercial/Office
Energy Consumption Reduction	:	25.7%
Energy Performance Index (EPI)	:	kWh/sq.m/year
Renewable Energy	:	35 kWp solar PV panels
GRIHA Provisional Rating	:	4 Star
Year of Completion	:	2014

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Excavation and construction activities were completed prior to monsoon season to prevent soil erosion and soil run-off from project site.
- More than 73 trees were planted though the site was bereft of trees.
- Utilities were planned in such a way that the on-site circulation efficiency was optimized.
- Grass pavers are provided to reduce imperviousness of project site.

Water management

- High efficient drip irrigation has been utilized for irrigating landscapes which results in reduction of more than 70% of landscape water demand.
- Reduction of 67% has been demonstrated on building water use by installing water-efficient flush and flow fixtures.
- A 50-KLD capacity of fluidized bed reactor is installed to treat wastewater on-site and reuse for flushing, landscaping, and cooling tower makeup.

Energy optimization

- High efficacy lamps are installed for exterior lightings which have been operated by timer controller.
- Double glazing windows with a solar heat gain coefficient of 0.18 used as building envelope.
- Reduction of 25.7% from GRIHA established Energy Performance Index for office building has been demonstrated.

- Water cooled chiller with high COP of 6.05 has installed for space cooling application.
- ECBC mandatory criterions complied lighting, HVAC, and electrical power system have been implemented.
- 35 kWp solar PV panels have been installed to reduce use of electricity from fossil fuel.
- More than 50% of the living spaces is daylighted and meets the daylight factor as prescribed by the National Building Code of India.

Waste management

- Multi-coloured bins have been provided on floor level to collect and segregate waste at source.
- A dedicated place has been provided on site to store segregated waste prior to dispose of.
- Sludge from Sewage Treatment Plant is proposed to be used as fertilizer for landscapes.

Low energy materials

- PPC is used for structural and plaster masonry application.
- Flyash bricks and Autoclaved Aerated Concrete (AAC) blocks have been used in the project to reduce embodied energy of the building.
- Use of low energy flooring, doors, and windows.

Integrated Design Team

Client

- **Project Coordinator**
- **Principal Architect**
- Landscape Architect
- **Project Management Consultant**
- **Structural Consultant**
- **Electrical Consultant**

INNOWELL

- : M/s. Engineers India Limited
- : M. Rajendran, Assistant General Manager (Projects)
- : M/s. STUP Consultants Pvt. Ltd
- : M/s. Engineers India Limited & M/s. STUP
- : M/s. Engineers India Limited
- : M/s. STUP Consultants Pvt. Ltd
- : M/s. AECOM Pvt. Ltd
- Green Building Design and Certification : Air Design Engineered Solution Pvt. Ltd & Engineering International Pvt. Ltd



Sabarmati Hostel, IIT Madras

Location	:	Sardar Patel Road, Adyar, Chennai
Site Area	:	11,726 sq.m
Built-up Area	:	17,300 sq.m
Air-conditioned Area	:	0 m ²
Non Air-conditioned Area	:	17,300 sq.m
Туроlоду	:	Residential
Energy Consumption Reduction	:	80.1% reduction in energy consumption compared to GRIHA benchmark
Energy Performance Index (EPI)	:	19.9 kWh/sq,m./year
Renewable Energy	:	Rated capacity of solar PV installed is 360 kWp
GRIHA Provisional Rating	:	4 Star
Year of Completion	:	2016

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Excavation and construction activities were completed prior to monsoon season to prevent soil erosion and soil run-off from project site.
- More than 100 trees were planted onsite as well as offsite to compensate the number of trees cut during construction.
- Utilities were planned in such a way that the efficiency of on-site circulation was optimized.
- More than 50% of hardscape area is shaded by trees.

Water management

- Efficient landscape design with manual irrigation resulted in reduction of more than 50% of landscape water demand.
- Reduction of 61.4% has been demonstrated on building water use by installing water-efficient flush and flow fixtures.
- A centralized 4 MLD capacity SBR-based sewage treatment plant is installed to treat wastewater off-site and facilitate reuse of treated water for flushing and landscaping purpose.

Energy optimization

- High efficacy lamps are installed for exterior lighting which is operated by timer controller.
- EPI reduction of 80.1% from GRIHA established EPI for office building has been demonstrated.

- ECBC mandatory clauses compliant lighting, HVAC and electrical power system have been implemented.
- 360 kWp solar PV panels have been installed to reduce use of electricity generated from fossil fuels.

Waste management

- Multi-coloured bins have been provided on each floor level to collect and segregate waste at source.
- A dedicated place has been provided on site to store segregated waste prior to disposal.
- Sludge from sewage treatment plant is used as manure for landscape.

Sustainable building materials

- Fly-ash bricks have been used in the project to reduce embodied energy of the building.
- Use of low energy flooring, doors, and windows has been adopted.

Integrated Design Team

Client

- Project Coordinator:Principal Architect:Landscape Architect:Project Management Consultant:Electrical Consultant:Green Building Design and Certification:
- : M/s. Indian Institute of Technology Madras
 - Dr. M. Ramachandran
 - M/s. C. R. N. Architects & Engineers
 - M/s. Engineering Division of IIT Madras
 - M/s. Central Public Works Department
 - M/s. Engineering Division of IIT Madras
 - Air Design Engineered Solution Pvt. Ltd & Innowell Engineering International Pvt. Ltd



Tunga and Bhadra Hostel, IIT Madras

Location	:	Sardar Patel Road, Adyar, Chennai
Site Area	:	18,614 sq.m
Built-up Area	:	23,104 sq.m
Air-conditioned Area	:	0 m ²
Non Air-conditioned Area	:	18,614 sq.m
Туроlоду	:	Residential
Energy Consumption Reduction	:	78.4% reduction in energy consumption
		compared to GRIHA benchmark
Energy Performance Index (EPI)	:	21.6 kWh/sq.m/year
Renewable Energy	:	Rated capacity of solar PV installed is 360 kWp
GRIHA Provisional Rating	:	4 Star
Year of Completion	:	2016

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Excavation and construction activities were completed prior to monsoon season to prevent soil erosion and soil run-off from project site.
- Utilities were planned in such a way that the efficiency of on-site circulation was optimized.
- More than 50% of hardscape area is shaded by trees.

Water management

- Efficient landscape design with manual irrigation resulted in reduction of more than 59% of landscape water demand.
- Reduction of 61.7% has been demonstrated on building water use by installing water efficient flush and flow fixtures.
- A centralized 4 MLD capacity SBR-based sewage treatment plant is installed to treat wastewater off-site and facilitate reuse of treated water for flushing and landscaping purpose.

Energy optimization

- High-efficacy lamps are installed for exterior lighting which is operated by timer controller.
- EPI reduction of 78.4% from GRIHA established EPI for office building has been demonstrated.
- ECBC mandatory clauses compliant lighting, HVAC and electrical power system have been implemented.

• 360 kWp solar PV panels have been installed to reduce use of electricity generated from fossil fuels.

Waste management

- Multi-coloured bins have been provided on each floor level to collect and segregate waste at source.
- A dedicated place has been provided on site to store segregated waste prior to disposal.
- Sludge from sewage treatment plant is used as manure for landscape.

Sustainable building materials

- Fly-ash bricks have been used in the project to reduce embodied energy of the building.
- Use of low energy flooring, doors, and windows has been adopted.

Integrated Design Team

- Client:Project Coordinator:Principal Architect:Landscape Architect:Project Management Consultant:Electrical Consultant:Green Building Design and Certification:
 - : M/s. Indian Institute of Technology Madras
 - Dr. M. Ramachandran
 - M/s. C R N Architects & Engineers
 - M/s. Engineering Division of IIT Madras
 - : M/s. Central Public Works Department
 - : M/s. Engineering Division of IIT Madras
 - Air Design Engineered Solution Pvt. Ltd &
 - Innowell Engineering International Pvt. Ltd



Manipal Hospitals – Mangalore, A Unit Of Manipal Healthcare Services Pvt. Ltd

Location
Site Area
Built-up Area
Air-conditioned Area
Non Air-conditioned Area
Energy Performance Index (EPI
Renewable Energy
GRIHA Provisional Rating
Year of Completion

- : Mangalore
- : 2,994.78 sq.m
- : 15,065 sq.m including parking
- : 11,642.73 sq.m
- : 3,422.27 sq.m
- : 223.89 kWh/sq.m/year
- : 20 kWp solar PV installation
- : 4 Star
- : 2015

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- The only existing tree on site was protected during construction and additional plantation has been done along the site boundary post construction.
- Air pollution control measures, such as site barricading, coverage of dusty material, and appropriate stack height of DG sets, were implemented during construction to contain pollution.

Water management

- Construction water requirement was minimized by adopting curing and ponding techniques.
- Reduction of 51.77% from the GRIHA base case has been demonstrated in building water use by installing water-efficient flush systems and flow fixtures.
- Potable water demand reduced by reclaiming 37.2% STP-treated water for landscaping, flushing, and air-conditioning make-up water.

Energy optimization

- Visual comfort
 - » WWR of 13.11% has been achieved to create a strong visual connection between the building occupants and the outside environment.
 - » 54.4% of the habitable spaces in the building are day lit and meet the daylight factors as prescribed by the National Building Code of India.
- Thermal comfort
 - » Double glazing with SHGC of 0.2 and horizontal shading devices have been integrated in the project to reduce the solar heat ingress.

- Water cooled chillers with a COP of 6.29 have been installed to achieve » thermal comfort.
- » CO₂ sensors have been used in the project near all AHUs to monitor the quality of air.
- By adopting the above-mentioned strategies, the project achieved a reduction of 50.25% in Energy Performance Index over the GRIHA base case.

Renewable energy technologies installed on site

- A 20 kWp solar PV has been installed which meets 16.24% of interior lighting requirement.
- The installed solar hot water system is offsetting 56.17% of annual energy required for water heating.

Sustainable building materials

- Sustainable materials, such as gypsum board, mineral fibre and veneer finish for false ceiling; veneer, gypsum, laminate and MDF for panelling; vitrified tiles and granite for flooring; composite wood and laminate sheets for in-built furniture have been used.
- 26.3% cement is replaced with fly-ash by weight in structural concrete.
- The embodied energy of the non-structural applications has been reduced by 48.6% by use of solid concrete blocks.
- Indoor air quality has been maintained by using 100% interiors finishes with no/ low VOC content.

Integrated Design Team:

- Client
- **Project Coordinator Principal Architect** Landscape Architect **Project Management Consultant Electrical Consultant**
- Green Building Design and Certification : Terra Viridis
- : Manipal Health Enterprise
- : Khilesh Surana
- : RSP Architects
- : RSP Architects
- : Cushman & Wakefield
- : ARCO



Power Grid SR-II RHQ Office Building, Bengaluru

Location	:	Singanayakanahalli Village Dodballapur Road, Bengaluru
Site Area	:	13,787.32 sq.m
Built-up Area	:	3,204 sq.m
Air-conditioned Area	:	925 sq.m
Non Air- conditioned Area	:	2,315 sq.m
Туроlоду	:	Commercial/Office
Energy Performance Index (EPI)	:	32.70 kWh/sq.m/year
Renewable Energy	:	4.2 kWp Solar PV installation
GRIHA Provisional Rating	:	4 Star
Year of Completion	:	2017

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- · Barricading of site was done to prevent air pollution.
- Existing trees were preserved and native trees were planted.
- Adequate ventilation has been ensured to facilitate and maintain optimal thermal comfort in the non A/C public spaces.
- Systematic site management practices were adopted such as confining the construction activities to pre-designated areas and minimal damage to the existing topography of site.

Water management

- Reduction of 53.35% from the GRIHA base case has been demonstrated in building water use by installing water efficient flush and flow fixtures.
- Strategies, such as use of native shrubs, trees; minimal turf area; and efficient irrigation systems have been utilized to achieve 44.74% reduction in landscape water consumption from the GRIHA base case.
- Construction water consumption was reduced by use of RMC, and curing techniques, such as gunny bags and ponding.

Energy optimization

- The Energy Performance Index of the project has been reduced by 72.75% below the GRIHA base case through envelope optimization, and integrating high performance systems.
- Lighting Power Density has been reduced over ECBC prescribed values with the use of efficient lighting fixtures, such as T5 and LEDs; which further aided in indirectly reducing the air conditioning consumption due to less heat emission.

- Installed glass with low SHGC value of 0.26, in combination with the shading devices has reduced the heat gain into the building. Walls were constructed using concrete blocks which have thermal breathability.
- 76% of total living area is daylit and meets daylight factor as prescribed by National Building Code (NBC) 2005.
- Light pipes have been used to enhance day lighting.
- 4.2 kWp solar photovoltaic PV system has been installed on site to reduce the dependence on fossil fuels.

Sustainable building materials

- High grade steel and concrete have been used to optimize the embodied energy of the materials used in structural concrete.
- Materials with recycle content such as fly ash bricks have been used for block work.
- Regionally available materials such as Sadaralli stones are used in the project.
- All paints, adhesives and sealants used in the project have low VOC content.
- Insulation, refrigerant, and firefighting system are zero ODP compounds.

Integrated Design Team:

Client **Principal Architect Project Management Consultant** Green Building Design and Certification : The Energy and Resources Institute

- : Power Grid Corporation of India Ltd
- : Klimart Pvt. Ltd
- : KBR Infratech Ltd



SABIC Research & Technology Pvt. Ltd

Location :	: Sarjapura, Bengaluru, Karnataka	
Site Area :	: 1,80,773.0 sq.m	
Built-up Area :	: 17,096 sq.m (B1, B3 and B5 block only)	
Air-conditioned Area :	: 11,840 sq.m	
Non-Air-conditioned Area :	: 5,256 sq.m	
Energy Consumption Reduction :	19.38% reduction in energy consumption compared to	
	GRIHA benchmark	
Energy Performance Index (EPI) :	: 104 kWh/sq.m/year (weighted avg. of 3 blocks)	
Base Case Benchmark EPI :	: 129 kWh/sq.m/year (weighted avg. of 3 blocks)	
Renewable Energy :	Rated capacity of solar PV installed on site is 9 kW	
GRIHA Provisional Rating :	: 4 Star	
Year of Completion :	: 2013	

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Demonstration of exemplary site management practices through effective top soil preservation and stormwater management during construction.
- Protection of existing trees at site during construction. In addition, tree transplantation and extensive re-plantation of native trees as part of landscape plan.
- Effective air pollution control strategies through site barricading, regular water sprinkling on loose soil, truck wheel washing, and seeding the road banking.
- Initiatives for staff and construction workers' health, safety, and sanitation include clean hygienic accommodation and toilet facilities, RO drinking water, crèche and schools for children of construction workers, etc.

Reducing water consumption

- Use of low flow plumbing fixtures and faucets to cut down water use inside the building by about 78% compared to GRIHA base case.
- About 50% reduction in landscape water consumption by planting native species of trees and shrubs and by using efficient irrigation systems.
- 100% on site treatment of wastewater generated through CETP plant installed and reuse of treated wastewater for flushing and landscaping at site.

Reducing energy consumption (compared to GRIHA benchmarks) while maintaining occupant comfort

• For achieving visual comfort

» Selection of high performance double glazing assisted with effective external shading to reduce solar heat gain and have glare-free daylight in lab and office areas.

» ECBC compliant energy-efficient artificial lighting design.

• For achieving thermal comfort

- » High performance building envelope, double glazing assisted with external shading and over deck roof insulation to cut down heat gains inside the building.
- » Efficient HVAC system with high COP water cooled screw chillers, heat pumps, heat recovery/exchanger mechanisms, AHUs with VAVs along with VFDs on motors, etc. to minimize overall cooling energy consumption.
- » HVAC system designed in line with ASHRAE 55 to meet the thermal comfort requirements of the occupants.

Renewable energy technologies installed on site

- 5.5 kWp of solar photovoltaic system is used to compensate part of internal lighting load.
- Solar photovoltaic-based outdoor lights of 3.5 kWp are installed on site.
- About 94% of annual energy for hot water requirement of B1, B3, and B5 block is saved by solar hot water system of 800 litres capcity installed at site.

Use of low energy materials

- Portland Pozzolona cement (PPC) with 30% replacement by fly ash has been used in structural concrete, masonry blocks, and plaster works.
- Many of the interior finishes used in the project have recycled content within them and are procured locally within 800 km from project site.

Integrated Design Team:

Client

- Project Coordinator Principal Architect Landscape Architect Project Management Consultant Structural Consultant Electrical Consultant Green Building Design and Certificat
- : Saudi Basic Industries Corporation (SABIC)
- : Mr Subrato Dey (SABIC)
- : Venkataramanan & Associates, Bengaluru
- : Design milieu, Bengaluru
- : Cushman & Wakefield
- : Nadig Consulting Pvt. Ltd
- : PM engineering Services(India) Pvt. Ltd, Bengaluru
- Green Building Design and Certification : Eco 3 Design Consultants, Bengaluru



New Interim Terminal Building (Domestic), Vijayawada Airport

Location	:	Krishna District, Vijayawada, Andhra Pradesh		
Site Area	:	70,150 sq.m		
Built-up Area	:	12,999 sq.m		
Air-conditioned Area	:	11,660 sq.m		
Non Air- conditioned Area	:	1,339 sq.m		
Energy Consumption Reduction	:	42.67% reduction in energy consumption compared to		
		GRIHA benchmark has been achieved by the project		
Energy Performance Index (EPI)	:	257.99 kWh/sq.m/year		
Renewable Energy	:	15 kWp solar PV installation		
GRIHA Provisional Rating	:	3 Star		
Year of Completion	:	2018		

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Top soil was preserved and mulched with organic matter to maintain its fertility and was later reused for landscaping.
- · Air pollution control measures, such as site barricading were implemented during construction to contain pollution.
- · Out of 4 existing mature trees, 2 mature trees were preserved, and in addition, compensatory plantation of 254 trees was done on site.

Reducing water consumption

- Reduction of 64.4% from the GRIHA base case has been demonstrated in building water use by installing water efficient flush systems and flow fixtures.
- STP with 200 KLD capacity is proposed on site with MBBR technology process to treat 100% of the wastewater generated on site.
- Water stored in temporary sedimentation tank on site was used for curing during construction.

Energy optimization

- For achieving visual comfort:
 - » 54% of the habitable spaces in the building are day lit and meet the daylight factors as per GRIHA requirements.
 - » 36% of the habitable spaces in the building are day lit and meet the daylight factors as per GRIHA.
 - » Longer sides of most of the building blocks are facing eastern and western direction.

For achieving thermal comfort:

- » AAC blocks and rock wool insulation were considered for external wall and roof respectively, to maintain the thermal comfort within the building.
- » Water cooled screw chillers and VRF system have been installed to achieve cooling load and thermal comfort of the project.
- » Longer sides of most of the building blocks are facing Northern and Southern direction.

Renewable energy technologies integration

 15kW solar PV system has been installed, which will offset 8.37% of the total internal lighting energy consumption requirement.

Sustainable building materials

- The embodied energy of the non-structural applications has been reduced by 8.48% by using solid AAC block and fly ash bricks.
- Indoor air quality has been maintained by using 100% interiors finishes with no/ low VOC content (adhesives and sealants).

Integrated Design Team

- Client
- **Main Contractor, Structure Consultant**
- & Electrical Consultant
- **Project Management Consultancy**
- **Design Consultant**
- Main Architect & Landscape Architect : M/s Studio Dra Architects
- **Green Building Design & Certification**
- : M/s., Airports Authority of India
- : M/s., Simplex Infrastructure Limited
- M/s STUP Consultants Pvt. Ltd
- M/s MEINHARDT
- M/s GreenTree Building Energy Pvt. Ltd



Madanjeet School of Green Energy Technologies, Pondicherry University, Puducherry

Location	:	Pondicherry University, Puducherry
Site Area	:	12,248 sq.m
Built-up Area	:	4,728 sq.m
Air-conditioned Area	:	2,414 sq.m
Non-Air-conditioned Area	:	2,314 sq.m
Typology	:	Institutional
Energy Performance Index (EPI)	:	85.88 kWh/sq.m/year (38.65% reduction in energy consumption compared to GRIHA benchmark)
Renewable Energy	:	Rated capacity of solar PV installed is 15 kWp
GRIHA Provisional Rating	:	3 Star
Year of Completion	:	2015

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Excavated topsoil was reused within the Pondicherry University campus.
- Total 132 trees were cut, 62 were protected and 16 were transplanted out of 210 existing trees. Compensatory plantation was done in more than 1:4 ratio, by planting 660 new trees within the Pondicherry University boundary.
- Sitting areas for students were created underneath the existing preserved trees.

Water management

- Reduction of 51.34% from the GRIHA base case has been demonstrated in building water use by installing water-efficient flush and flow fixtures.
- Reduction of 30% from the GRIHA base case has been demonstrated in landscape water demand through use of efficient landscape methodologies and native plant species.

Energy optimization

- Energy Performance Index has been reduced by 38.65% compared to GRIHA benchmark.
- 15 kWp solar PV panels have been installed in the project which meets 54% of interior lighting requirement.
- For achieving visual comfort
 - » Energy efficient artificial lighting, including sensors was installed as per the ECBC norms.

» 53.63% of the habitable spaces are day lit and meet the daylight factors as prescribed by the National Building Code of India.

• For achieving thermal comfort

» Double-glazed windows with a Solar Heat Gain Coefficient of 0.25; cavity wall and roof insulation were installed as a part of building envelope.

Sustainable building materials

- Fly ash bricks containing 40% fly ash content by volume have been used in the interior and exterior walls.
- 30% of cement was replaced with fly ash by weight in the structural concrete.
- Pozzolana Portland Cement indicating use of 30% fly ash content by weight has been used in plaster and masonry mortar.
- Granite stone and vitrified tiles were used as flooring material in the building.

Integrated Design Team:

- Client Project Coordinator Principal Architect Landscape Architect Project Management Consultant Structural Consultant Electrical Consultant
- Pondicherry University, Puducherry
- Mukesh & Associates, Salem
- Mukesh & Associates, Salem
- Mukesh & Associates, Salem
- Rites Ltd, Gurgaon
- Mukesh & Associates, Salem
- Mukesh & Associates, Salem
- **Green Building Design and Certification** : Mukesh & Associates, Salem



New Atmospheric Research Facility at NARL, Gadanki

Location	:	Gadanki, Andhra Pradesh
Site Area	:	750 sq.m
Built-up Area	:	1,300 sq.m
Air-conditioned Area	:	1,105.1 sq.m
Non-air-conditioned Area	:	558.2 sq.m
Туроlоду	:	Institutional
Energy Consumption Reduction	:	73.63% reduction in energy consumption compared to GRIHA benchmark
Energy Performance Index (EPI)	:	36.91 kWh/sq.m/year
Renewable Energy	:	Rated capacity of solar PV installed is 50 kWp
GRIHA Provisional Rating	:	4 Star
Year of Completion	:	2014

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- 3 meters high barricade was constructed around the site to prevent air pollution.
- All the 5 existing mature trees were preserved and 6 new native species of trees were planted.
- Major portion of the habitable areas of building were oriented along north and east façade to maximize thermal comfort.
- Systematic site management practice was followed for construction activities ensuring minimum damage to the existing topography of the site.
- The building levels followed the natural site contours, thus minimizing cut and fill on site.

Water management

- Reduction of 59.87% from the GRIHA base case has been demonstrated in building water use by installing water-efficient flush and flow fixtures.
- Reduction of 46.33% from the GRIHA base case has been demonstrated in landscape water demand through use of native shrubs and trees, drip irrigation system and minimizing turf area on site.
- Construction water consumption was reduced by use of wet hessian cloths for curing of RCC members and ponding technique for curing of slabs during construction.

Energy optimization

- Rat trap bond walls were constructed using clay blocks which are thermally breathable ensuring reduced conduction of heat from the building.
- Window to wall ratio has been maintained at 16%.

- Glass installed in the building has a low Solar Heat Gain Coefficient value of 0.37 which in combination with the shading devices has reduced the heat gain into the building. The corresponding Visual Light Transmission of the glass is 48% which helps in bringing in diffused daylight into the living spaces.
- 73.1% of the habitable spaces are day lit and meet the daylight factors as prescribed by the National Building Code of India.
- Lighting power density has been reduced against the ECBC prescribed values with the use of efficient lighting fixtures like T5 and LEDs ensuring reduction in lighting consumption while emitting less heat resulting in reduction of air conditioning consumption.
- 50 kWp solar PV panels have been installed on site which meets 69.6% of connected load (lighting and HVAC).
- 75,725 kWh of energy is generated annually by the renewable energy system which meets 100% of the energy requirement of internal building lighting.

Sustainable building materials

- Rat trap bond technique has been adopted to optimize the amount of building materials used in wall construction, thus reducing embodied energy of the building.
- All the paints and adhesives used in the project have low volatile organic compound content.
- Insulation, refrigerant and fire-fighting system used in the building have no ozone depletion potential components.

Integrated Design Team

- Client **Project Coordinator Principal Architect** Landscape Architect **Project Management Consultant Structural Consultant Electrical Consultant** Green Building Design and Certification : The Energy and Resources Institute
- : National Atmospheric Research Laboratory
 - National Atmospheric Research Laboratory
 - Indian Space Research Organization
 - Indian Space Research Organization
 - : National Atmospheric Research Laboratory
 - : Indian Space Research Organization
 - : Indian Space Research Organization



Western Side Teaching Block Complex, National Institute of Technology Karnataka, Surathkal

Location	:	National Institute of Technology, Surathkal, Mangaluru
Site Area	:	11,700 sq.m
Built-up Area	:	4,647.64 sq.m
Air-conditioned Area	:	625.48 sq.m
Non-air-conditioned Area	:	4,022.15 sq.m
Гуроlоду	:	Institutional
Energy Consumption Reduction	:	60.93% reduction in energy consumption
		compared to GRIHA benchmark
Energy Performance Index (EPI)	:	15.81 kWh/sq.m/year
Renewable Energy	:	Rated capacity of solar PV installed is 30 kWp
GRIHA Provisional Rating	:	4 star
Year of Completion		2017

The following strategies were adopted to reduce the building impact on the natural environment:

Sustainable site planning

- Buffer strip of vegetation including existing mature trees between the building and the National Highway has been maintained on site.
- Out of the 15 existing trees, 9 trees were cut and 45 new trees were planted, all of which are native species to the region.
- Topsoil of the site was well preserved and has been reused in landscaping work on site.
- The building design took advantage of the natural contours on site and ensured that minimum amount of cut and fill is carried out.

Water management

- Reduction of 50.6% from the GRIHA base case has been demonstrated in building water use by installing water-efficient flush and flow fixtures.
- Reduction of 33.6% from the GRIHA base case has been demonstrated in landscape water demand through use of native shrubs and trees, sprinkler irrigation system and minimizing turf area on site.
- Regular metering and monitoring is also practiced on the site to ensure efficient management of water resource.

Energy optimization

- Window to wall ratio has been maintained at 8%.
- High efficacy lamps are installed for exterior lighting which is operated by timer controller.

- Lighting power density has been reduced against the ECBC prescribed values with the use of efficient lighting fixtures like T5 and LEDs ensuring reduction in lighting consumption, while emitting less heat resulting in reduction of air conditioning consumption.
- 52.37% of the habitable spaces are daylit and meet the daylight factors as prescribed by the National Building Code of India.
- EPI reduction of 60.93% from GRIHA benchmark has been demonstrated.
- ECBC mandatory clauses compliant lighting, HVAC and electrical power system have been implemented.
- 30 kWp solar PV panels have been installed on site.
- 32712 kWh of energy is generated annually by the renewable energy system which meets 58.92% of the energy requirement of internal building lighting.

Sustainable building materials

- 30% of cement was replaced with Ground Granulated Blast furnace Slag (GGBS) content by weight in the structural concrete.
- Pozzolana Portland Cement indicating use of 30% fly ash content by weight has been used in plaster and masonry mortar.
- Use of low energy flooring, false ceiling, and panelling has been demonstrated.

Integrated Design Team:

- Client
- Project Coordinator Principal Architect Landscape Architect Structural Consultant Electrical Consultant

Green Building Design and Certification :

- : National Institute of Technology Karnataka, Surathkal
- : Central Public Works Department
- Arkie Atelier Design India (P) Limited
- Green Sketch Consultants



Final Rating

SVA GRIHA is a rating system for small homes, offices, and commercial buildings with built-up area of less than 2,500 sq.m It is significantly simplified, faster, easier, and functions as a design cum-rating tool.



Plot No. 25, Zed Earth Villa

Location	:	Bengaluru, Karnataka
Site Area	:	270 sq.m
Built-up Area	:	290 sq.m
Typology	:	Residential
SVA GRIHA Rating	:	5 Star

The following strategies were adopted to reduce the building impact on the natural environment:

Landscape

- Almost 70% of the total open area on site is soft paved and/or shaded under trees.
- Native trees have been planted on site.

Energy

- Fenestrations and floor plan layouts have been designed to facilitate natural ventilation through all spaces.
- About 88% of total living area falls under daylit zone.
- Fenestration design of the villa reduces the direct incident heat penetration by about 38% as compared to the SVA GRIHA base case for Bengaluru
- Lighting power density is 4.78 W/sq.m and thermal efficiency of the project is 289.82 sq.ft./TR (26.93 sq.m/TR), which is 5% better than the SVAGRIHA base case for Bengaluru.
- Solar photovoltaic panels of size 1.4 kWp and solar water heater of 150 lpd capacity have been installed on the villa.
- All air-conditioning systems, fans, and geysers comply with BEE 5-Star efficiencies.

Water and waste

- Use of low-flow fixtures reduces the building water demand by almost 74% compared to the SVA GRIHA base case.
- Rainwater storage tank of 1,500 litre capacity has been installed on site to capture and utilize rainwater.

• Organic kitchen waste is converted into manure through the use of 'Dailydump's Khamba'.

Materials

- Use of hollow concrete blocks helps in reducing the embodied energy of the building by about 40% compared to SVA GRIHA base case.
- Use of low-VOC and lead free paints helps in maintaining good indoor air quality.
- Over 70% of interior finishes are low-energy like bamboo flooring, rough local granite etc.

Lifestyle

- There is provision for basic amenities like grocery store, pharmacy, etc. within the campus.
- Each villa has a Retainer's room for accommodation of service staff.
- Each villa has a kitchen garden and brochures to promote environmental awareness.

Integrated Design Team

Client
Architect
Green Building Design and Certification

Biodiversity Conservation India Ltd, Bengaluru Biodiversity Conservation India Ltd, Bengaluru Biodiversity Conservation India Ltd, Bengaluru



Environmental Management & Policy Research Institute (EMPRI) Annexe Building

Location	:	Bengaluru, Karnataka
Site Area	:	1,623.30 sq.m
Built-up Area	:	1,199.71 sq.m
Typology	:	Commercial/Office
SVA GRIHA Rating	:	4 Star

- Office

The following strategies were adopted to reduce the building impact on the natural environment:

Landscape

- 21 new native trees have been planted on site, 6 existing mature trees have been preserved on site.
- Over 71% of the hard paved area is shaded with trees and asbestos sheet.

Energy

- Over 85% of total living area falls under daylit zone.
- The LPD of the project is 3.29 W/sq.m which is lower than the ECBC specified LPD limit of 10.80 W/sq.m for offices.
- The thermal efficiency of the building envelope is 125 W/sg.m
- 2.5 kWp solar photovoltaic panels have been installed on the roof top of the building.
- All fans installed in the office are BEE 5-Star rated. As the building is naturally ventilated, no air conditioners have been installed.

Water and waste

- The project has reduced building water demand by 55% below the SVA GRIHA base case through the use of low-flow fixtures.
- Rainwater storage tank of 18,277 litre capacity has been installed on site to capture and utilize rainwater.

Materials

• Use of low-VOC and lead free paints have been used to maintain good indoor air quality.

The project has demonstrated a reduction in embodied energy by 29.55% by using Compressed Soil Earth Blocks (CSEB) for external and internal walling application.

Lifestyle

- All basic amenities like park, grocery store, convenience store, pharmacy, etc. are in close proximity to the site.
- There is a provision of dedicated rest room and toilet for the service staff within the site.
- The project takes several environmental awareness initiatives and fosters the • same through panels, brochures, magazines, newsletters, etc. to create awareness on environmental issues and concerns in Karnataka.
- Organic housekeeping products are used for activities like cleaning floors, toilets, and other associated operations in the project.
- Waste generated from the building (dry waste, wet waste, paper waste, electronic waste) is properly segregated on site.

Integrated Design Team

Client **Project Management**

: Environmental Management & Policy Research Institute : Karnataka Rural Infrastructure Development Limited **Green building consultant** : Centre for Research on Sustainable Building Science (TERI-Southern Regional Centre)



Mount Royale – Jade Block, Coimbatore

Location	:	Coimbatore, Tamil Nadu
Site Area	:	796 sq.m
Built-up Area	:	1,682 sq.m
Typology	:	Residential
SVA GRIHA Rating	:	2 Star

The following strategies were adopted to reduce the building impact on the natural environment:

Landscape

• 4 new native trees have been planted on site.

Passive architecture design

• High Solar Reflective Index (SRI) coating cool roofs have been applied on the roof top to reduce the energy consumption.

Energy

- Over 91% of total living area falls under daylit zone.
- The reduction in overall insolation of the project is 33%.
- Thermal efficiency of the building envelope is 402 sg. ft/TR.

Water and waste

- Use of low-flow fixtures reduces the building water demand by 63% as compared to SVA GRIHA base case.
- Native shrubs and trees have been planted to reduce the landscape water demand by 84% below the SVA GRIHA base case.

Materials

- Use of low-VOC and lead free paints have been used to maintain good indoor air quality.
- The project has demonstrated a reduction in embodied energy of over 44% against the SVA GRIHA base case by using porotherm bricks.
- Portland Pozzolana cement (PPC) has been used in the entire construction of the project.

Lifestyle

- A dedicated toilet and resting area has been provided for service staff in the office building.
- The project has taken initiative to spread green building awareness by preparing brochures highlighting green measures of the project, for information of the future apartment owners.
- The project has basic amenities such as park, grocery store, convenience store and pharmacy in close proximity to the site, to reduce the carbon footprint of the building occupants.

Integrated Design Team

- Client
- **Developer** : Mr. Kalpesh Bafna, Mount Housing





GRIHA Council

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