



(Green Rating for Integrated Habitat Assessment)



GRIHA MANUAL

Volume 1

Introduction to National Rating System - GRIHA
An evaluation tool to help design, build, operate, and maintain
a resource-efficient built environment



Ministry of New and Renewable Energy,
Government of India

and



The Energy and Resources Institute
New Delhi

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दीपक गुप्ता
Deepak Gupta



सचिव
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SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF NEW AND RENEWABLE ENERGY

Message

Our country is witnessing a boom in the construction sector and in real estate development. The construction sector contributes 10% of India's GDP and is growing at about 9%, as against the world average of 5.5%. Urban areas have emerged as one of the biggest sources of Green House Gas (GHG) emissions, with buildings alone contributing to around 40% of the total GHG emissions globally. As per latest UN report, one million people are moving to urban areas each week. It is estimated that around two-thirds of the world population will be living in cities in 2050. India is also going through the process of rapid urbanization. This will lead to a tremendous increase in energy demand in urban areas. It is vital that this demand be controlled.

Energy efficient solar buildings, or green buildings, can reduce energy demand by as much as 40%. The designs can be such that the working and living environment in buildings is quite comfortable during different seasons without too much dependence on conventional energy. In fact, it has been suggested that the building sector has the greatest potential to reduce GHG emission.

Building Rating Systems have been quite effective in raising awareness and popularizing energy efficient and green building design. Most of the internationally devised rating systems have been tailored to suit the building sector of the country where they were developed. Keeping in view our climatic conditions, and in particular the construction of non-AC buildings. A National Rating System – GRIHA has been developed by the Ministry which is suitable for all types of buildings in different climatic zones of the country. Through various qualitative and quantitative assessment criteria, GRIHA would be applied to different types of new and existing buildings, whether commercial, institutional or residential.

The Ministry has incentivised GRIHA with a view to promote large scale design and construction of green buildings in the country. The incentives includes the reimbursement of registration fee to applicant, cash awards to design architects/consultants and support for installation of solar photovoltaic power plants.

The Government of India has mandated minimum GRIHA 3 star rating for all upcoming central government and Public Sector Undertaking buildings. CPWD has also adopted GRIHA.

We have now to go beyond buildings also. It is important that we develop green habitats so that all new urban complexes or cities adhere to these principles.

Energy efficient solar buildings and green habitats will be an important focus area of the Ministry and we hope to adopt a mission approach. The Ministry along with TERI and other stakeholder institutions are also pursuing a comprehensive capacity building programme. The set of 5 manuals provides technical details on all GRIHA criteria and the process that needs to be adopted to complete the documentation that is required for GRIHA rating. Process and technical guidelines to be followed for evaluation of GRIHA documents is also covered in detail. I hope that these manuals shall be great learning resource and shall help the design community to construct green buildings.

September 17, 2010.


(Deepak Gupta)



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Foreword

The time has come where we can no longer ignore the benefits of green building practices that have a major impact on our environment. The Government is taking appropriate steps to ensure that green building practices are mainstreamed through a mix of regulations and voluntary schemes. The National Action Plan on Climate Change has, therefore, announced a mission on sustainable habitats. In addition, the recently launched ECBC 2007 (Energy Conservation Building Code 2007), the appliance labelling programme of the Bureau of Energy Efficiency, and the rating system for appraisal and clearance of large construction projects by the Ministry of Environment and Forests are some of the significant steps to move towards green buildings. Several corporate organizations and institutions have mandated the use of green practices in their new construction. Development of a holistic framework that meets all the regulatory norms and responds to the needs of differing agro-climatic zones in India is felt to be an urgent need. GRIHA (Green Rating for Integrated Habitat Assessment) was developed in response to this need.

Keeping in view agro-climatic conditions in India and, in particular, the preponderance of non-air-conditioned buildings, the National Rating System – GRIHA – has been developed as a suitable system for all kinds of buildings in different climatic zones of the country. The system, initially developed by TERI as TERI-GRIHA, has been modified to GRIHA as the country's

National Rating System after incorporating various modifications suggested by a group of architects and experts.

The GRIHA rating system takes into account the provisions of the National Building Code 2005; the Energy Conservation Building Code 2007 announced by BEE (Bureau of Energy Efficiency) and other IS codes.

GRIHA – the National Rating System will evaluate 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 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 improvement in the environment by reducing GHG (greenhouse gas) emissions, improving energy security, and reducing the stress on natural resources.

This book provides a comprehensive understanding of GRIHA, its underlying criteria and the rating procedure. The book also covers best practices that could be followed to achieve desired GRIHA ratings.



(R K Pachauri)
Director-General, TERI



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INTRODUCTION

1.0 Green buildings: global and local perspective

The construction sector poses a major challenge to the environment. Globally, buildings are responsible for at least 40% of energy use. An estimated 42% of the global water consumption and 50% of the global consumption of raw materials is consumed by buildings when taking into account the manufacture, construction, and operational period of buildings. In addition, building activities contribute an estimated 50% of the world's air pollution, 42% of its greenhouse gases, 50% of all water pollution, 48% of all solid wastes and 50% of all CFCs (chlorofluorocarbons) to the environment.

India too faces the environmental challenges of the construction sector. The gross built-up area added to commercial and residential spaces was about 40.8 million square metres in 2004–05, which is about 1% of annual average constructed floor area around the world and the trends show a sustained growth of 10% over the coming years. With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase, from a low 14% in the 1970s to nearly 33% in 2004–05.¹ Energy consumption would continue to rise unless suitable actions to improve energy efficiency are taken up immediately. As per TERI estimates, there is an increased demand of about 5.4 billion units (kWh) of electricity annually for meeting end-use energy requirement for residential and commercial buildings.

Buildings are major consumers of water during construction and operation (for occupants, cooling, and landscaping). Per capita water consumption in 1990 was 2464 m³ per capita per annum, but by 2025 with an expected population of 1.4 billion, it will almost certainly be in the stress category with less than 1700 m³ per capita per annum. In terms of accessibility to water supply, as per the information received from the State Governments of India, as of March 2004, about 93% of urban population has access to drinking water supply facilities. The coverage figures indicate only the accessibility, whereas adequacy and equitable distribution and per-capita provision of these basic services may not be as per the prescribed norms in some cases. For instance, the poor, particularly those living in slums and squatter settlements, are generally deprived of these basic facilities. Similarly, the issue of water supply is critical not only for day to day needs of drinking water but also for agriculture and allied activities.

While we grapple with water shortage, there is a huge potential of meeting the resource gap through treatment of waste water and reuse of the same for various applications. As per an assessment made by the Central Pollution Control Board (CPCB) on the status of wastewater generation and treatment in Class I cities and Class-II towns during 2003–04, about 26 254 million

¹ Construction Industry Development Council, India. India Country Report, 2005–06; Address: 801, Hemkunt Chambers, 89, Nehru Place, New Delhi 110 019



litres per day (MLD) (9.51 billion cubic metre (BCM) was generated in 921 Class I cities and Class II cities in India (housing more than 70% of urban population). The waste water treatment capacity developed so far is about 7044 MLD accounting for only 27% of waste water generated in these two classes of urban centres (2.57 BCM/year).

Management of construction and demolition waste and solid waste generated by occupants of building pose another major challenge which needs attention. The CPCB has estimated current quantum of solid waste generation in India to the tune of 48 million tonnes per annum, out of which 25% of waste accounts for construction industry. Management of such high quantum of waste puts enormous pressure on solid waste management system. In addition, about 42 million metric tonnes (MMT) of solid waste is generated daily in the urban areas of the country. Most urban centres lack appropriate segregation, management and treatment facilities for solid waste. Currently, municipal solid waste is hardly segregated at source. Mixed waste is being dumped into the depression or earmarked low lying areas in and around the towns. Municipal solid waste comprises of 30% to 55% of bio-degradable (organic) matter, 20% to 35% inert matter and 5% to 15% recyclables. The organic fraction of municipal solid waste contains bio-degradable matter ranging from 30% to 55%, which can be profitably converted into useful products like compost (organic manure), methane gas (used for cooking, heating, lighting, production of energy), and so on.

At macro level, extensive urbanization is leading to uncontrolled 'heat island' effect. Vegetation and tree cover give way to urban areas with large expanses of pavements, buildings, and other structures, thus eliminating cooling provided by vegetation through both shade and evapo transpiration. This contributes to the formation of ground-level ozone, which is detrimental to human health. Urban heat island impacts give rise to increased temperatures by up to ten degrees Fahrenheit. This also results in increased demand for air conditioning. Increased air conditioning demands increased generation of electricity which again contributes to the emission of greenhouse gases. These need to be addressed at settlement (can settlements be deleted-OK to delete) planning level as well as micro planning level during site development and planning for buildings.

As we chart our developmental path, it is important for us to keep our eyes on the environmental damage that we create. It is extremely important to pause for a while and carry out necessary course correction for benefit of the Mother Earth and our future generations. It is a well established fact that green buildings offer immense potential to reduce consumption and regenerate resources from waste and renewable sources and offer win-win solution for user, owner and the environment.

1.1 What is a green building?

Buildings have major environmental impacts during their life. Resources such as ground cover, forests, water, and energy are dwindling to give way to buildings. Resource-intensive materials provide structure to a building and landscaping adds beauty to it, in turn using up water and pesticides to maintain it. Energy-consuming systems for lighting, air conditioning, and water heating provide comfort to its occupants. Hi-tech controls add intelligence to 'inanimate' buildings so that they can respond to varying conditions, and intelligently monitor and control resource use, security, and usage of fire fighting systems and other such systems in the building. Water, another vital resource for the occupants, gets consumed continuously during building construction and operation. Several building processes and occupant functions generate large amounts of waste, which can be recycled for use or can be reused directly. Buildings are thus one of the major pollutants that affect urban air quality and contribute to climate change. Hence, the need to design a green building, the essence of which is to address all these issues in an integrated and scientific manner. It is a known fact that it costs more to design and construct a green building compared to other buildings. However, it is



also a proven fact that it costs less to maintain a green building that has tremendous environmental benefits and provides a better place for the occupants to live and work in. Thus, the challenge of a green building is to achieve all its benefits at an affordable cost.

A green building depletes the natural resources to a minimum during its construction and operation. The aim of a green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources when in use, and maximize the reuse, recycling, and utilization of renewable resources. It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bioclimatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions. It is evolved through a design process that requires input from all concerned – the architect; landscape designer; and the air conditioning, electrical, plumbing, and energy consultants – to work as a team to address all aspects of building and system planning, designing, construction, and operation. They critically evaluate the impacts of each design decision and arrive at viable design solutions to minimize the negative impacts and enhance the positive impacts on



LEGEND:

- | | |
|---|--|
| 1. SHADED CAR PARKING | 9. CONSOLIDATED PEDESTRIAN WALKWAY AND UTILITY CORRIDORS |
| 2. GRASS PAVED CAR PARKING | 10. PERGOLA SHADING HARD PAVED SURFACES |
| 3. TREES SHADING THE CAR PARK AS WELL AS THE BUILDING | 11. SOLAR WATER HEATER |
| 4. BICYCLE PARKING | 12. SOLAR PHOTOVOLTAIC |
| 5. OUTDOOR LIGHTING ON RENEWABLE ENERGY | |
| 6. NATIVE SHRUBS | |
| 7. ECBC COMPLAINT GLAZING | |
| 8. SHADING DEVICES FOR COMPLIANCE WITH ECBC SHADING COEFFICIENT FOR GLASS | |

Figure 1 Schematic diagram highlighting select green building features



the environment. In sum, the following aspects of a green building design are looked into in an integrated way.

- Site planning
- Building envelope design
- Building system design (HVAC [heating ventilation and air conditioning], lighting, electrical, and water heating)
- Integration of renewable energy sources to generate energy on-site
- Water and waste management
- Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, and so on)
- Indoor environmental quality (maintain indoor thermal and visual comfort and air quality)



LEGEND:

1. ECBC* COMPLIANT WALL WITH INSULATION
2. ECBC* COMPLIANT ROOF WITH INSULATION
3. LOW VOC PAINT
4. BEE* STAR LABELLED EFFICIENT ARTIFICIAL LIGHTING (T5 AND CFL)
5. BEE* STAR LABELLED SPLIT AIR-CONDITIONER
6. DOOR FRAMES MADE USING RECYCLED MATERIALS
7. FLOORING TILES MADE USING RECYCLED MATERIALS
8. DUAL FLUSH WATER CLOSETS
9. LOW FLOW FAUCETS

*ECBC-ENERGY CONSERVATION BUILDING CODE
*BEE-BUREAU OF ENERGY EFFICIENCY

Figure 2 Cross section through a typical building highlighting select green features

1.1.1 Benefits of green building

A green building has lower resource consumption as compared to conventional buildings. The following is the percentage reduction of various resources in a building and their respective reasons.

- Green buildings consume 40% to 60% (depending on the range of measures adopted) lesser electricity as compared to conventional buildings. This is primarily because they rely on passive architectural interventions in the building design, and high efficiency materials and technologies in the engineering design of the building.
- Green Buildings also attempt to work towards on-site energy generation through renewable energy utilization to cater to its energy needs. For instance, solar thermal systems can help generate hot-water and replace the conventional electrical geyser in buildings. Solar PV panels can help generate electricity which can reduce the buildings dependence on grid power.
- Green buildings consume 40% to 80% (depending on the range of measures adopted) lesser water as compared to conventional buildings. By utilizing ultra low-flow fixtures, dual plumbing systems, waste-water recycling systems and rain-water harvesting, green buildings not only reduce their demand for water use but also look at on-site supply options to cater to its internal and external (landscape) water demands.
- Green buildings generate lesser waste by employing waste management strategies on site. They may also employ waste to energy or waste to resource (like manure, or compost) strategies on site, to minimize their burden on municipal waste management facilities and land fills.
- Green buildings generate lesser pollution both during construction as well as while in use. Through best-practices such as proper storage of construction materials, barricading of the site to prevent air and noise pollution during construction, proper storage and disposal of waste during construction and operation, and so on, ensures reduced impact on the surrounding environment.
- Green buildings ensure proper safety, health and sanitation facilities for the labourers (during construction) and the occupants (while in use).
- Green buildings restrict the use of high ODP (ozone depleting potential) substances in their systems as well as in finishes.
- Green buildings offer higher image and marketability.

All of these can be achieved at a minimal incremental cost with an estimated payback period of about 3–5 years (excepting renewable energy for power generation).

1.1.2 What is green building rating system?

A green building rating system is an evaluation tool that measures environmental performance of a building through its life cycle. It usually comprises of a set of criteria covering various parameters related to design, construction and operation of a green building. Each criterion has pre-assigned points and sets performance benchmarks and goals that are largely quantifiable. A project is awarded points once it fulfils the rating criteria. The points are added up and the final rating of a project is decided. Rating systems call for independent third party evaluation of a project and different processes are put in place to ensure a fair evaluation. Globally, green building rating systems are largely voluntary in nature and have been instrumental in raising awareness and popularizing green building designs.



1.2 Some of the successful international rating programmes

1.2.1 BREEAM

Building Research Establishment's Environmental Assessment Method (BREEAM) was developed in the United Kingdom in 1990 and is one of the earliest building environmental assessment methods. BREEAM covers a range of building types including—offices, homes, industrial units, retail units, and schools. When a building is assessed, points are awarded for each criterion and the points are added for a total score. The overall building performance is awarded a 'Pass', 'Good', 'Very Good' or 'Excellent' rating based on the score. BREEAM has separate criteria/checklist for evaluation of Design and Procurement and for Management and Operation of buildings. There is also a set of core credits that can be applied for, in case if the building wishes to go in for 'Core only' assessment for building performance.

BREEAM major categories of criteria for Design and Procurement include the following:

- Management (commissioning period and process adopted, monitoring of commissioning, energy use in site activities, waste management, pollution minimization)
- Health and comfort (adequate ventilation, humidification, presence of controllable blinds, energy efficient lighting, thermal and visual comfort, low noise levels)
- Energy (sub-metering)
- Transport (modes of transport to and from site, alternative transport facilities)
- Water (consumption reduction, metering, leak detection)
- Materials (asbestos mitigation, storage facilities, reuse of structures, specifications of envelope, use of crushed aggregate and sustainable timber)
- Land use (previously used land, use of re mediated contaminated land)
- Ecology (land with low ecological value or minimal change in value, maintaining major ecological systems on the land, minimization of biodiversity impacts)
- Pollution (leak detection systems, on-site treatment, local or renewable energy sources, light pollution design, avoid use of ozone depleting and global warming substances)

Further details on the system can be obtained from Building Research Establishment Ltd, UK.

1.2.2 CASBEE

Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was developed in Japan, in 2001. The family of assessment tools is based on the building's life cycle: pre-design, new construction, existing buildings, and renovation. CASBEE presents a new concept for assessment that distinguishes environmental load from environmental quality and building performance. Under CASBEE there are two spaces, internal and external, divided by the hypothetical boundary, which is defined by the site boundary and other elements, with two factors related to the two spaces, in which the 'negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)' and 'improving living amenity for the building users' are considered side by side. Under CASBEE, these two factors are defined below as Q and L, the main assessment categories, and evaluated separately.

Q (Quality): Building Environmental Quality and Performance

Evaluates 'improvement in living amenity for the building users, within the hypothetical enclosed space (the private property)'.



L (Loadings): Building Environmental Loadings

Evaluates 'negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)'.

By relating these two, factors, CASBEE results are presented as a measure of eco-efficiency or BEE (Building Environmental Efficiency). Results are plotted on a graph, with environmental load on one axis and quality on the other – the best buildings will fall in the section representing lowest environmental load and highest quality. Each criterion is scored from level 1 to level 5, with level 1 defined as meeting minimum requirements, level 3 defined as meeting typical technical and social levels at the time of the assessment, and level 5 representing a high level of achievement.

CASBEE major categories of criteria include

Building Environmental Quality and Performance

- Indoor environment (noise and acoustics, thermal and visual comfort, and indoor air quality)
- Quality of services (functionality and usability, amenities, durability and reliability, flexibility and adaptability)
- Outdoor environment on site (preservation and creation of biotope, townscape and landscape, local characteristic and outdoor amenities)

Building Environmental Loadings

- Energy (Building thermal load, utilization of natural energy, efficiency in building service systems, and efficient operations)
- Resources and materials (water conservation, materials of low environmental loads)
- Off-site environment (air pollution, noise and vibration, odour, sunlight obstruction, light pollution, heat island effect, and load on local infrastructure)

1. 2.3 GBTool

GBTool was developed by the International Framework Committee for the Green Building Challenge, an international project that has involved more than 25 countries since 1998. GBTool is designed to be adapted by sponsors to reflect regional conditions and context. It includes criteria in categories such as Site Selection, Project Planning and Development; Environmental Loadings; Energy and Resource Consumption; Indoor Environmental Quality; Functionality; Long-Term Performance; and Social and Economic Aspects. Criteria are assessed using scales that are based on local benchmarks of 'typical' practice; buildings can score –1 if below typical practice or from +1 to +5, representing good to very high performance. All criteria must be attempted. The benchmarks of typical practice and weightings of criteria are set by the sponsoring organization to represent national, regional, or local codes, practice, context, conditions, and priorities.

GBTool major categories of criteria include the following.

- Energy consumption is assessed through total use of non-renewable energy (embodied and operational), electrical demand, usage of renewable energy, and commissioning.
- Resource consumption is assessed through materials use (salvaged, recycled, bio-based and sustainably harvested, locally produced, designed for disassembly, re-use, or recycling) and water use for irrigation, building systems, and occupant use.
- Environmental loadings include GHG emissions, other atmospheric emissions, solid wastes, storm water, waste water, site impacts, and other local and regional impacts.



- Indoor environmental quality is assessed through indoor air quality, ventilation, temperature and relative humidity, daylight and illumination, and noise and acoustics.
- Other criteria include selection of appropriate site (in terms of land use, brown fields, access to transportation and amenities), project planning, urban design (density, mixed uses, compatibility, native species, and wildlife corridors), building controls, flexibility and adaptability, maintenance of operating performance, and a few social and economic measures.

1.2.4 LEED®

Leadership in Energy and Environmental Design (LEED®) was developed and piloted in the US in 1998 as a consensus-based building rating system based on the use of existing building technology. The rating system addresses specific environmental building related impacts using a whole building environmental performance approach. The Indian Green Building Council has adapted LEED system and has launched LEED India version for rating of new construction. In addition, Indian Green Building Council (IGBC) has launched several other products for rating of different typologies of buildings including homes, factories, among others. The following are key components of the LEED system.

- Sustainable sites (construction related pollution prevention, site development impacts, transportation alternatives, storm water management, heat island effect, and light pollution)
- Water efficiency (landscaping water use reduction, indoor water use reduction, and waste water management strategies)
- Energy and atmosphere (commissioning, whole building energy performance optimization, refrigerant management, renewable energy use, and measurement and verification)
- Materials and resources (recycling collection locations, building reuse, construction waste management, and the purchase of regionally manufactured materials, materials with recycled content, rapidly renewable materials, salvaged materials, and FSC certified wood products)
- Indoor environmental quality (environmental tobacco smoke control, outdoor air delivery monitoring, increased ventilation, construction indoor air quality, use low emitting materials, source control, and controllability of thermal and lighting systems)
- Innovation and design process (LEED® accredited professional, and innovative strategies for sustainable design)

1.2.5 HK-BEAM

The Hong Kong Building Environmental Assessment Method (HK-BEAM) is a voluntary scheme first launched in December 1996. HK-BEAM is a performance based system that takes holistic view of building performance with emphasis on life cycle impacts. In HK-BEAM, the assessment is not finalized until a building is completed ensuring that 'Green and Sustainable' practices are implemented through the entire project cycle and the project meets the desired goals and performance. The 'New Building' certification system of HK-Beam is also well synchronized with its 'Existing Building' certification, for example, a new building certified under the HK-BEAM 4/04 and suitably operated and maintained would attain a similar grade under HK-BEAM 5/04 some years later.

HK-BEAM integrates the assessment of many key aspects of building performance embracing

- Hygiene, health, comfort amenity
- Land use, site impacts and transport



- Use of materials, recycling and waste management
- Water quality, conservation and recycling
- Energy efficiency, conservation and management

HK-BEAM also exempt building from attempting certain criteria when an issue or part of an assessment is not applicable to particular circumstance or building type.

The overall assessment grade is based on percentage (%) of applicable credits. Given the importance of indoor environment quality, it is necessary to obtain a minimum percentage (%) of credits for IEQ in order to qualify for the overall grade.

1.3 Introducing GRIHA

Most of the internationally devised rating systems have been tailored to suit the building industry of the country where they were developed. TERI, being deeply committed to every aspect of sustainable development, took upon itself the responsibility of acting as a driving force to popularize green buildings by developing a tool for measuring and rating a building's environmental performance in the context of India's varied climate and building practices. This tool, by its qualitative and quantitative assessment criteria, would be able to 'rate' a building on the degree of its 'greenness'. The rating shall evaluate 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, seeks to strike a balance between the established practices and emerging concepts, both national and international. The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period. 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, improving energy security, and reducing the stress on natural resources.

The rating applies to new building stock – commercial, institutional, and residential – of varied functions. Endorsed by the Ministry of New and Renewable Energy, Government of India as of November 1 2007, GRIHA is a five star rating system for green buildings which emphasises on passive solar techniques for optimizing indoor visual and thermal comfort. In order to address energy efficiency, GRIHA encourages optimization of building design to reduce conventional energy demand and further optimize energy performance of the building within specified comfort limits. A building is assessed on its predicted performance over its entire life cycle from inception through operation.

GRIHA was developed as an indigenous building rating system, particularly to address and assess non-air conditioned or partially air conditioned buildings. GRIHA has been developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions, and indigenous solutions.

GRIHA stresses passive solar techniques for optimizing visual and thermal comfort indoors, and encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort.

GRIHA integrates all relevant Indian codes and standards for buildings and acts as a tool to facilitate implementation of the same.



1.4 Introducing TERI

TERI (The Energy and Resources Institute), a dynamic and flexible organization with a global vision and a local focus, was established in 1974. Initially the focus was on documentation and information dissemination. Research activities in the fields of energy, environment, and sustainable development were initiated towards the end of 1982. All these activities were rooted in TERI's firm conviction that efficient utilization of energy, sustainable use of natural resources, large-scale adoption of renewable energy technologies, and reduction of all forms of waste would move the process of development towards the goal of sustainability.

A unique developing-country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy requirements to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across continents to helping conserve forests; from advancing solutions to the growing urban transport and air pollution, to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. Although TERI's vision is global, its roots are firmly entrenched in the Indian soil. All activities in TERI move from formulating local- and national-level strategies to shaping global solutions to critical energy and environment-related issues. To this end, TERI has established regional centres in Bangalore, Goa, Guwahati, Kolkata, and Mumbai. It has set up affiliate institutes: TERI- NA (The Energy and Resources Institute, North America) in Washington, DC, USA and TERI-Europe, London, UK; and it also has a presence in Japan, Malaysia and UAE.

TERI fulfils its mandate of sustainable development by advocating the concept of green buildings, which register minimal impact on the environment. In practicing what it preaches, TERI has constructed its buildings, in Gurgaon, Bangalore and Mukteshwar, along these lines. Resource- and energy-efficient, these habitats are exemplary constructs demonstrating the sustainable implementation of green practices. TERI has also introduced GRIHA, a rating system to adjudge the 'greenness' of buildings, which has now been adopted by the Ministry of New and Renewable energy, Government of India as a national rating system. The TERI buildings include the following.

1.4.1 RETREAT

Resource Efficient TERI Retreat for Environmental Awareness and Training, RETREAT, a residential training facility for executives, is designed to be self-sufficient, and independent of any external power supply. It consists of living quarters with 24 single-occupancy rooms and 6 suites complete with conference centre with a large hall, a dining room, a lounge, recreational facilities, and a library.

- The complex has harnessed both traditional and modern means of tapping renewable sources of energy to offer modern amenities such as lighting, air conditioning, cooking, laundry, and so on at substantially reduced costs.
- The complex saves 40%–50% of energy costs over conventionally designed buildings at an additional investment of about 25%.
- Twenty-four solar water-heating panels provide up to 2000 litres of hot water every day.
- The building is powered by a hybrid system comprising of Solar photovoltaic system (with battery back up) and a 100 kW biomass gasifier

Effective insulation, shade provided by trees, and a network of underground earth air tunnels circulating cool subterranean air throughout the residential block ensure that the temperature in the complex remains more or less even all year round at 20 °C in winter, 28 °C in the dry summer, and



ENERGY EFFICIENT SUSTAINABLE HABITAT

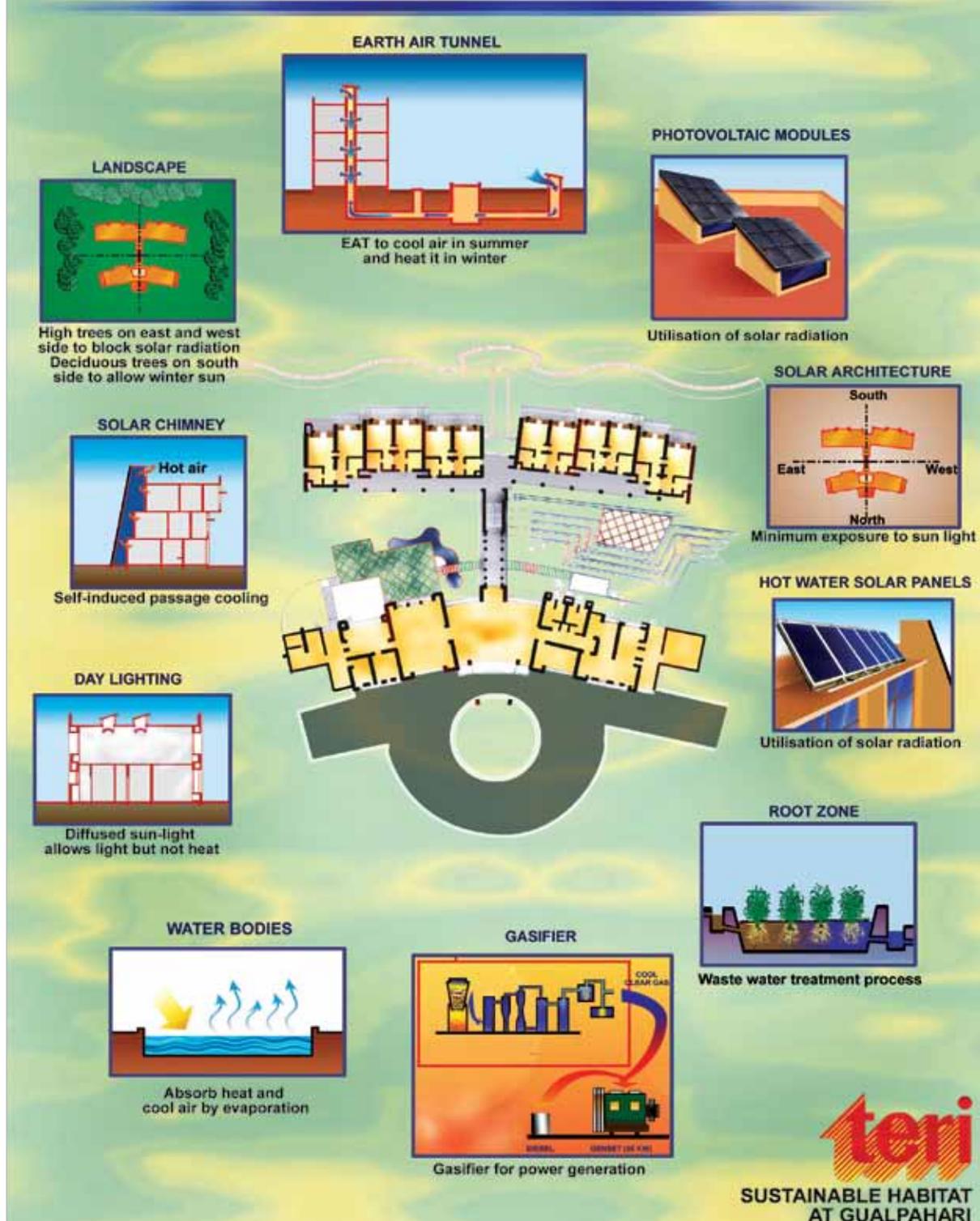


Figure 3 Green features of RETREAT Complex, Gual Pahari, Haryana



30 °C in the monsoon. The system has been augmented by adding chillers for dehumidification and additional cooling during the monsoon.

Specially designed skylights, energy-efficient lights, and a sophisticated system of monitoring and controlling electricity consumption, light up the complex with less than 10 kilowatts; a comparable conventionally designed structure would require nearly 28 kilowatts to provide the same level of lighting.

A bed of reed plants (Phragmites) clarifies 5 cubic metres of waste water from the toilets and kitchen every day; the recycled water is used for irrigation.

1.4.2 TERI University

The TERI University is situated at Plot No. 10, Institutional Area, Vasant Kunj, New Delhi, close to the Grand Hotel. An architectural marvel, the campus has been planned to provide a setting that enhances learning, while simultaneously showcasing the concept of green building. Besides passive energy saving architectural designs, the buildings boast of the use of solar energy and an earth-air tunnel to meet part of the air-conditioning requirements.

The campus is equipped with three types of cooling systems, integrated to take advantage of different innovative technologies to achieve energy efficiency. They are discussed briefly as under.

- Variable refrigerant volume systems (VRV)
- Earth Air Tunnel (EAT)
- Thermal storage

The VRV system is a modern air-conditioning system, similar to an efficient version of a split air conditioner. The VRV system is highly efficient under partial load conditions and therefore, has been used in areas with varying occupancies such as the office block, laboratories, administrative block and recreation and dining areas of the hostel block. It features customized control of individual zones. Depending on the cooling demands of the building, variable refrigerant volumes circulate through the chillers. The VRV system also eliminates the requirement of a plant room; piping and ducting for chilled water; and contributes to 15% energy savings as compared to a conventional air conditioning system.

Earth air tunnel system is used for free cooling/heating of the building for a major part of the year. This technology uses the heat sink property of earth to maintain comfortable temperatures inside the building. Supplementary systems have been used for extreme conditions (monsoon). In such a system energy savings of nearly 50% compared to conventional system can be achieved. At the campus, this system is used for providing comfort for the rooms in hostel block.

Thermal mass storage is used in the classrooms. It involves storing energy when available and using it when required. In the proposed arrangement, cooling of the thermal mass is done during night (when ambient temperatures are lower). During daytime when ambient temperatures are high, the thermal storage is used as sink for the fresh air requirement.

The campus has an efficient artificial lighting system designed for minimizing the energy consumption without compromising the visual comfort in the building.

The measures contribute to 40% energy savings in comparison to a conventionally designed building. Water saving measures have 25% reduction in the potable water use only by use of efficient fixtures. In addition, reuse of wastewater for irrigation purpose through resource and energy efficient biological processes and rainwater harvesting for aquifer recharge also contribute to efficient water management.



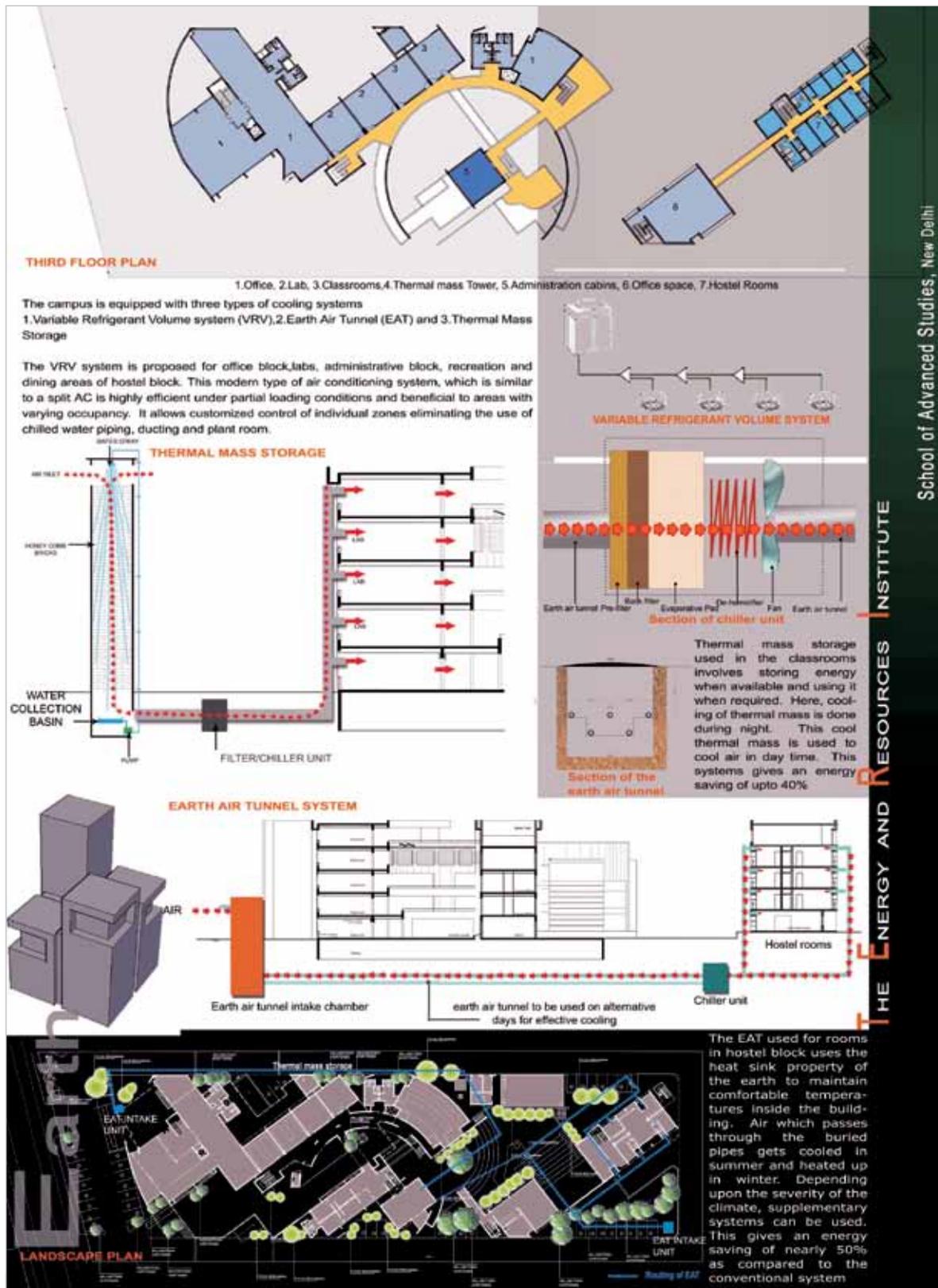


Figure 4 Low energy space conditioning system in TERI-University, New Delhi



1.4.3 TERI, Bangalore

TERI has provided a unique environmental solution with its model energy-efficient building at Domlur, Bangalore, and affording maximum comfort through minimum use of conventional electricity. Bangalore being in a moderate climate zone of India has comfortable temperature round the year.

The building boasts of an innovative design to make maximum use of the natural resources. It opens towards the northern side facilitating access to glare-free light.

A solar wall towards the south (drain side) of the building directs the flow of the breeze over the building. This, in turn, creates a negative pressure and pulls fresh air from the north into the building. Air conditioning is fully avoided and the building maintains comfortable conditions round the year.

Optimum use of appropriate building envelope, use of energy-efficient lamps, luminaries, control strategies have been employed to reduce dependence on artificial means of lighting and to create comfortable conditions.

By creating atrium spaces with skylights, sections of the Centre are designed in such a way that natural daylight enters into the heart of the building, considerably reducing the dependence on artificial lighting. This is supplemented by a skylight roof and energy-efficient artificial lighting. A roof garden has also been developed to reduce heat gain.

Solar water heating meets the hot water requirements of the kitchen and other utilities. A 2-kW peak solar photovoltaic system meets a part of the power requirement. Rainwater harvesting is used to manage water in the complex. The collected water is treated and used for various maintenance purposes, like use in sprinklers for landscape covers. The sections are worked out so as to allow hot air to rise towards the top. Natural ventilation occurs with the air flowing from the ground floor to the terrace because of the open nature of the volumes. The building does not need air conditioning round the year and has minimum lighting requirement during daytime. The annual average energy consumption is only about 30 kWh/sq m.

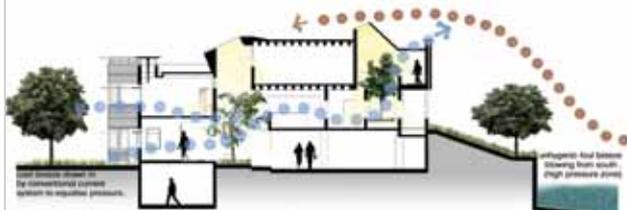
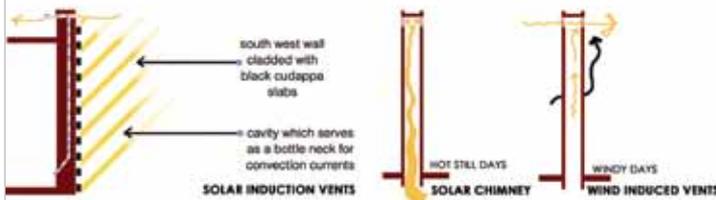
1.4.4 TERI, Mukteshwar

TERI's Himalayan centre is located in Latey Bunga, Mukteshwar, 2300 metres above sea level. The facility has a residential wing, in addition to conference hall, meeting area, and rest rooms.

The general orientation of the building is south-east, ensuring that all major openings are in line with the sun. In accordance with strategic landscaping principles, trees have been planted on the northern side of the building to provide a buffer against cold winds. The building is thus optimally day lit and receives solar radiation for heating. Furthermore, each suite comes attached with unique solar passive features known as 'sun-spaces'. These enhance heat gain by day and emit it by night, when it is required. Judiciously planned corridors in front of the habitable spaces dilute the glare of the sunlight, while trapping solar radiation.

Renewable energy systems in the form of photovoltaic solar panels have been integrated into the roof of the utility building and conference hall to meet a portion of the electrical requirements. An effective solar water heating system is in place to meet the hot water requirements of the building's inhabitants. In the absence of sufficient sunlight, battery banks provide a power back-up for three days. Fibreglass panels in the ceilings and walls act as insulation, preserving heat and improving acoustics.





The primary winds blow from south to north over the nallah, hence the building needs to react to this if, the foul unhygienic air has to be prevented from entering the building. Thus the development of the south wall was a prime design factor in achieving this purpose. Here the south wall was treated as an independent system linking the rear walls of the building over a cavity. This cavity creates a negative pressure setting up the convectional currents. The entire system works very effectively in generating the desired reverse wind circulation. The blank wall carries a cladding system of black cudappa. The colour black was deliberately chosen because of its heat absorptive power which is the highest among all colours. The working of the system is very simple. The sun's rays heat the black south wall increasing the temperature of the immediate environment around. This causes the air in the cavity to rise upwards through convectional means. These conventional currents are pulled away by the natural winds blowing south to north. This creates a vacuum at the top core of the structure. To fill this vacuum, air from inside is drawn up which is again pulled up by the moving convectional currents. This system of the hot air rising and drawing in of the cool fresh air is a continuous process. Hence reverse wind circulation is established by bringing in the fresh air from the north open face of the building and drawing it through the entire section of the structure and removing it by convectional means up through solar wind vents.



teri THE ENERGY RESEARCH INSTITUTE

air

Figure 5 Passive ventilation strategy in TERI-Bangalore building





Figure 6 Low energy strategies in TERI - Mukteshwar building

Despite the ample rainfall in the area, it faces a severe shortage of potable water. As a result, innovatively designed, twin-chambered water tanks are deployed in the harvesting and subsequent filtering of rainwater for human consumption.

1.5 The Ministry of New and Renewable Energy

The Ministry of New and Renewable Energy has been promoting energy efficient / solar buildings in the country since its inception in 1982 through wide ranging programmes including research and development, demonstration through construction of pilot projects, development of design tools and supporting capacity building and awareness generation activities. In order to lead by example, the Ministry constructed all buildings at its Solar Energy Centre based on solar passive concepts. Through a study sponsored by MNRE to IIT Delhi, classification of six climatic zones were established which has formed the basis of developing design strategies for each of these climatic zones. Various concepts, like, earth-air tunnel system, were evaluated and designing protocols were set under R&D programme of the MNRE. The Ministry provided incentives under its Solar Building Programme to prepare detailed project reports for constructing solar passive buildings and partial financial assistance was also provided for construction of such buildings. Finding the concept of solar buildings useful, the state governments of Himachal Pradesh, Punjab, Haryana and Nagaland made it mandatory to construct all new buildings in government and public sector on this concept.

A comprehensive and suitable to Indian climate and buildings, National Rating System, called GRIHA, was developed by MNRE based on the initial work carried out at The Energy and Resources Institute (TERI) and feedback received from group of architects and experts. Currently, MNRE is implementing a Scheme on 'Energy Efficient Solar/Green Buildings' with the main objective to promote the widespread construction of energy efficient solar/green buildings in the country through a combination of financial and promotional incentives to save a substantial amount of electricity and other fossil fuels apart from having peak load shavings in cities and towns. To achieve the objectives, the scheme has provisions for (i) providing reimbursement of 90% of the rating-cum-registration fee for buildings rated for their performance under National Rating System, (ii) providing incentives to architects and consultants to design buildings on Green Architectural concepts and get them rated under GRIHA, (iii) providing financial support for promotional activities, (iv) providing incentives to local urban bodies, (v) institution of awards/incentives for green buildings rated 5 star, and (vi) organizing various other activities related to development of web based tools, e-learning modules, and so on. The Ministry is also providing financial support to establish ADaRSH (GRIHA Secretariat) as an independent autonomous body for the operation of the rating system. With an aim to expedite implementation of the rating system, MNRE has modified the provisions of scheme to exempt first 100 Govt/Public Sector Buildings from paying registration-cum-rating fee in advance at the time of registration.

In order to develop the training and awareness material and tools, the Ministry is supporting TERI to develop detailed manuals for trainers and evaluators. Web-link tools are also being developed to create awareness generation through Internet. The Ministry is working with CEPT University, Ahmedabad; and IIIT, Hyderabad for the development of e-learning modules. A 'Green Pledge' has also been drafted with an aim to sensitize 100 top corporate about the necessity to adopt green building designs for new buildings. In order to outreach to private architects, MNRE has supported programmes for capacity building and awareness generation through Indian Institute of Architects (IIA), Society for Energy Engineers and Managers (SEEM), and CII. Programmes with special focus on SEZs are being organized through CII supported by the Ministry. A detailed plan to train CPWD engineers and architects has been drawn and is being implemented by ADaRSH (GRIHA secretariat).



The Ministry is also supporting research and development activities, and has sanctioned a project recently to establish solar calorimeter at CEPT University for characterization of glazings for building applications.

1.6 Development of GRIHA – the national rating system

GRIHA, the national green building rating system, was developed by TERI after a thorough study and understanding of the current internationally accepted green building rating systems and the prevailing building practices in India. The rating system was developed by the Centre for Research on Sustainable Building Science (CRSBS), TERI. CRSBS has been set up in TERI to facilitate development and mainstreaming of sustainable buildings, to improve performance levels of existing buildings, and raise awareness on sustainable buildings. CRSBS comprising architects, planners, engineers, and environmental specialists has been offering environmental design solutions for habitat and buildings of various complexities and functions for nearly two decades. With extensive experience in the field of sustainable and green building design and operation, the team came up with the GRIHA framework in 2005. Prior to coming up with the indigenous rating system for India, the team has extensively researched on several international rating systems (some of them have been listed above). The team has effectively utilized the several multidisciplinary strengths and experiences of their colleagues at TERI to arrive at the tool that addresses crosscutting issues in the design, development, and operation of a green building.

The primary objective of the rating system is to help design green buildings and, in turn, help evaluate the 'greenness' of buildings. The rating system follows best practices along with national/international codes that are applicable to the green design of buildings.

The green building rating system devised by TERI is a voluntary scheme. It has derived useful inputs from the building codes/guidelines being developed by the BEE (Bureau of Energy Efficiency), the MNRE (Ministry of New and Renewable Energy), MoEF (Ministry of Environment and Forests), and the BIS (Bureau of Indian Standards). The rating system aims to achieve efficient resource utilization and to enhance resource efficiency and quality of life in buildings.

GRIHA has been adopted as a NRS (national rating system) under the MNRE, Government of India, as of 1 November 2007. The MNRE has set up a technical advisory committee comprising of eminent professionals.

1.6.1 Operationalization of GRIHA – the national rating system

National Advisory Council

A NAC (National Advisory Council) has been constituted by the MNRE and is convened by the Advisor of the Ministry. It comprises eminent architects, senior government officials from the Central Ministry, the BEE, the Central Public Works Department, and select state nodal agencies; representatives from the IT sector, real estate sector and developers; and representatives from ADaRSH (GRIHA secretariat) and TERI. The NAC is chaired by the Secretary, MNRE, and co-chaired by the Dr R K Pachauri, Director-General, TERI.

The NAC provides advice and direction to the NRS and is the interface between the MNRE and ADaRSH (GRIHA secretariat). Its broad functions are as listed below.

- Guide the administrative structure for GRIHA
- Decide a fee structure
- Endorse the rating
- Recommend incentives and awards by the Government of India/state governments
- Endorse modifications/upgrades periodically



Technical Advisory Committee

A TAC (Technical Advisory Committee) has been constituted by the MNRE for providing technical advice to the GRIHA team on modifications and upgradation of the GRIHA framework. The technical advisory team comprises eminent architects and experts well versed with design and construction of green buildings.

The Ministry has incentivised the NRS (current incentive scheme is available in Annexure 1 with a view to promote large-scale design and construction of green buildings in the country.

The basic features

At present, the system has been developed as 'design and evaluate' new buildings (buildings that are still at the inception stages). A building is assessed based on its predicted performance over its entire life cycle — from inception to operation. The stages of the life cycle that have been identified for evaluation are pre-construction, building design and construction, and building O&M (operation and maintenance). The issues that are addressed in these stages are as follows.

- Pre-construction stage (intra- and inter-site issues)
- Building planning and construction stages (issues of resource conservation and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well-being). The prime resources that are considered in this section are land, water, energy, air, and green cover.
- Building O&M stage (issues of O&M of building systems and processes, monitoring and recording of consumption, and occupant health and well-being, and also issues that affect the global and local environment).

1.6.2 How to get your building rated?

All buildings, except for industrial complexes, which are in the design stage, are eligible for certification under the GRIHA system. Buildings include offices, spaces, institutional buildings, hotels, hospital buildings, health care facilities, housing complexes.

Registration

- A project has to be registered with ADaRSH (GRIHA secretariat) by filling in an online registration form available on the GRIHA website (www.grihaindia.org)
- Registration cost details are available on the Web. Registration should preferably be done at the beginning of a project, as there are several issues that need to be addressed at the pre-design stage.
- The registration process includes access to the essential information related to rating, application form, list of submissions, score points, and the weightage system, and one day training for the registered projects.

During the training session, the following areas will be covered.

- Overview of the green building design
- Explanation of the rating system and criteria and points related to rating
- Online access to the rating tool
- Documentation process through use of online forms
- Evaluation process



GRIHA is supported by a complete web based on line document submission and evaluation system. The following process explains in details the use of the GRIHA rating.

Tool

Using the Tool

The GRIHA evaluation tool has the following capabilities.

- It facilitates online registration of projects
- It facilitates online submission of compliance forms for attempted criteria
- The GRIHA rating coordinator from client side is able to control inputs from all consultants who are responsible for documentation
- Online evaluation by third party evaluators
- It provides a 'Project Summary Sheet' that displays a summary of all the criteria attempted and achieved and their status
- Easy to use calculators for criteria that require calculations to be carried out

Step 1

Building owner/architect/consultants/developers keen on getting their projects registered and rated under the GRIHA system, are first required to express interest of doing so, by filling in the project registration form with project details and submit to ADaRSH (GRIHA secretariat). ADaRSH (GRIHA secretariat) shall evaluate the project to judge its applicability for rating. The secretariat shall communicate to the client on its applicability of rating.

Once the project is cleared by ADaRSH (GRIHA secretariat) for registration, the client shall register the project formally with ADaRSH by paying the applicable fees (one time, non refundable).

Step 2

On successful registration of the project with ADaRSH (GRIHA secretariat), the secretariat staff along with TERI professionals shall conduct a one day training programme to familiarize the client/design/

GRIHA Evaluation Tool

Home | Project Details | Project Summary Sheet | Add Consultants | [Griha Home](#) | [Change Password](#) | [Logout](#)

Welcome Sunanda

You have logged in as a Client.
Registered Project: Green Building
Project Status: Pending at GRIHA's Level

Currently, you are viewing your project account to manage, monitor and track the progress of your registered project. This account will exist throughout the duration of the project.

Kindly read [Using the Tool](#) before you begin with the procedure.

© 2009 GRIHA

Member Zone
Hi, GRIHA3B3
[Logout](#)

- Understanding GRIHA Process
- Features of the Tool
- Using the Tool
- Ask Us

consultant/contractor team with all criteria of GRIHA and the procedure for filling the forms. On the day of the training, the client (coordinator from the client side) shall be given formal access to the web portal for online submission of GRIHA compliance forms. An independent and exclusive project account is created on registration of a project and the coordinator from the client side is provided with a unique user ID and password

- The coordinator has to login to the web portal for access to the main project page.
- The coordinator is the *focal point* for a project and has access to the project details, project summary sheet, the consultants' work, and the first volume of GRIHA manual.

Step 3 Select criteria

- After reading the manual, the client and design team shall decide on the criteria that the project attempts to accomplish. All mandatory criteria have to be attempted and fulfilled to qualify for rating.

Step 4 Create team of consultants who shall fill the templates/calculators for attempted criteria

- The coordinator has to create a team of consultants who shall fill in the compliance documents/ do necessary calculations for the chosen criteria. To do so, go to 'Add Consultants'
- In order to enable the consultants to access their project accounts, the coordinator must enter their details in the specific fields. Editing or additions are allowed at a later date. Any such change has to be informed to ADaRSH (GRIHA secretariat).

The screenshot displays the GRIHA Evaluation Tool web interface. At the top left is the GRIHA logo. The main header contains the text "GRIHA Evaluation Tool" and a navigation menu with buttons for "Home", "Project Details", "Project Summary Sheet", and "Add Consultants". On the right side of the header, there are links for "Griha Home", "Change Password", and "Logout".

The central area is titled "Add/Edit Consultant" and contains a form with the following fields:

- Name* (Essential information)
- E-mail*
- Address
- Telephone
- Fax

At the bottom of the form are buttons for "Save", "Clear", and "Close".

On the right side of the form, there is a "Member Zone" section with the text "Hi, GRJHA3B3" and a "Logout" button. Above this, there is a list of links: "Understanding GRIHA Process", "Features of the Tool", "Using the Tool", and "Ask Us".

At the bottom center of the page, there is a copyright notice: "© 2009 GRIHA".

Step 5 Assign criteria

- Green design and rating involves engagement of consultants from multidisciplinary background (landscape architect, energy consultant, mechanical, electrical and plumbing consultants, contractors and architect). Thus multiple consultants shall be responsible for fulfilment of compliance under respective GRIHA criteria, for example, Criteria 13 compliance is under ambit of the architect and energy consultant whereas compliance under Criteria 2 is responsibility of landscape architect, architect and the project manager. Hence the compliance templates subsequently get filled in by respective consultants. Thus it is important that while the coordinator has overall control of the entire documentation process, individual consultants are able to upload their respective compliance documents for review by the coordinator.
- The coordinator thus assigns respective criteria to various consultants who shall be responsible for uploading the compliance documents under their respective purview.
- The consultants shall then be required to fill up the forms of the criteria assigned to them and on behalf of the consultants the coordinator can also fill the forms.
- Predefined templates are another feature of this tool. These are structured formats for providing certain information for a particular criterion.
- There are online calculators available for a particular criterion, for performing any criteria related compliance calculation, with ease.

Instructions for consultants

Gaining access

- In order to access the project accounts, the system shall provide the consultant with unique User ID and password once the coordinator has filled in the consultant's details for his/her project. Any editing or additions to be made at a later date can be done so by clicking on the appropriate button. Any such changes have to be forwarded to ADaRSH (GRIHA secretariat).
- Once logged in, the following page will appear.

The screenshot displays the GRIHA Evaluation Tool interface. At the top left is the GRIHA logo. The main header reads 'GRIHA Evaluation Tool'. Below the header are three navigation buttons: 'Home', 'Project Details', and 'Project Summary Sheet'. On the right side of the header, there are links for 'GRIHA Home', 'Change Password', and 'Logout'. The main content area features a green banner with the text 'Welcome Peter'. Below this, a message states: 'You have logged in as a Consultant. Registered Project: Green Building. Project Status: Pending at GRIHA's Level. Currently, you are viewing your project account that will exist throughout the duration of the project. Kindly read [Using the Tool](#) before you begin with the procedure.' At the bottom of this message is the copyright notice '© 2009 GRIHA'. On the right side, there is a sidebar with an information icon and a list of links: 'Understanding GRIHA Process', 'Features of the Tool', 'Using the Tool', and 'Ask Us'. Below the sidebar is a 'Member Zone' section with the text 'Hi, 09GR81_638' and a 'Logout' button.

The consultant shall be able to access the compliance pages for the criteria that have been assigned to him/her by the coordinator and shall be able to fill in requisite information and upload compliance documents for the respective criteria.

Predefined templates

Criterion 8: Provide minimum level of sanitation/safety facilities for construction workers

Maximum Points: 2
Points Attempted: 0

Goals
Total points attempted :

- Compliance with National Building Code (NBC) 2005 norms on construction safety for ensuring safety during construction.
- Provision for Health and sanitation facility as specified above.

Compliances (supportive file / document / certificates / files to be attached)

8.2.1. Signed letter by competent authority to demonstrate compliance with National Building Code Part 7 constructional practices and safety (latest revision) and proposed additions.
Upload file:

8.2.2. Proof in form of relevant sections of tender document to show that the safety norms and procedures as committed to be compiled with are included in scope of work of the contractor .
Template: Upload file:
 Supporting Document

8.2.3. Site photographs with short description to demonstrate compliance by the contractor .
Template: Upload file:
 Supporting Document

8.2.4. Detailed narrative (not more than 250 words) on provision for safe drinking water and sanitation facility for construction workers and site personnel.

Member Zone
Hi, sunanda_griha

Online calculator for Criterion 13

Table 13.3 Provide lighting level simulation results			
Space name (should be same as in architectural drawing)	Room area (sq. m)	Calculated average lighting (lux) levels on workplane	Recommended lighting as per NBC (link to select list of spaces with NBC 2005 recommended lux levels) Help File
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
			<input type="button" value="Submit"/>

Step 6 Project details and project summary sheet

- The 'Project Details' is a page that gives an overall view of all the criteria and their current status. The coordinator can monitor and track the progress of the project through this page and the project summary sheet.
- The consultant can view in detail and update only those criteria that they have been assigned.
- They will then be able to upload the compliance documents to the GRIHA webportal.
- Once all the compliance documents for the attempted criteria are submitted, the summary sheet is ready for onward submission to ADaRSH (GRIHA secretariat) for evaluation. All compliance documents related to mandatory criteria need to be submitted in addition to the compliance documents of the attempted optional criteria.(the fields for the attempted optional criteria shall be activated by the coordinator during project registration).
- Submission of the summary sheet can be done by the coordinator only after all compliance documents related to all attempted criteria are filled. If the coordinator attempts to submit the summary sheet without fully completing it, he/she shall receive an error message and the erroneous areas shall be highlighted.

- The files should be saved after filling the forms. The calculation sheets do not have a save button, this is because the texts are automatically saved as each set of calculations are completed.
- Folders are permitted to be uploaded if multiple files need to be uploaded for the same compliance requirement (maximum file size of 6 MB)
- The manual can be referred to for technical details, examples and recommendations.
- For any queries, please go to 'Ask Us'.

Project Details								
Registered Project : Green Building						Project Code : 09GR81		
Project status : Pending at GRIHA's level.								
Criteria	Points		Status	Attempt Criteria	Consultant			
	Max	Attempted						
<input type="checkbox"/> Criterion 1: Site Selection	1		N.A.	<input checked="" type="checkbox"/>	<input type="button" value="Attempt"/>	Un-assigned		<input type="button" value="Assign"/>
<input checked="" type="checkbox"/> Criterion 2: Preserve and protect the landscape during construction/compensatory depository forestation	5	1	L2 : Under Process	<input checked="" type="checkbox"/>	<input type="button" value="View"/>	Peter		<input type="button" value="Edit"/>
<input type="checkbox"/> Criterion 3: Soil conservation (till post-construction)	4		N.A.	<input checked="" type="checkbox"/>	<input type="button" value="Attempt"/>	Un-assigned		<input type="button" value="Assign"/>
<input checked="" type="checkbox"/> Criterion 4: Design to include existing site features	2	0	L2 : Under Process	<input checked="" type="checkbox"/>	<input type="button" value="View"/>	Un-assigned		<input type="button" value="Assign"/>
<input type="checkbox"/> Criterion 5: Reduce hard paving on-site and /or provide shaded hard - paved surfaces.	2		N.A.	<input checked="" type="checkbox"/>	<input type="button" value="Attempt"/>	Un-assigned		<input type="button" value="Assign"/>
<input type="checkbox"/> Criterion 6: Enhance outdoor lighting system efficiency.	3		N.A.	<input checked="" type="checkbox"/>	<input type="button" value="Attempt"/>	Un-assigned		<input type="button" value="Assign"/>
<input type="checkbox"/> Criterion 7: Plan utilities efficiently and optimize on-site circulation efficiency	3		N.A.	<input checked="" type="checkbox"/>	<input type="button" value="Attempt"/>	Un-assigned		<input type="button" value="Assign"/>

Project Summary Sheet						
Registered Project : Green Building					Project Code : 09GR81	
Project status : Pending at GRIHA's level.						
Criteria	Points		Status	Attempt Criteria	Consultant	
	Max	Attempted				
<input type="checkbox"/> Criterion 1: Site Selection	1		N.A.	<input checked="" type="checkbox"/>	Un-assigned	
<input checked="" type="checkbox"/> Criterion 2: Preserve and protect the landscape during construction/compensatory depository forestation	5	1	L2 : Under Process	<input checked="" type="checkbox"/>	Peter	
<input type="checkbox"/> Criterion 3: Soil conservation (till post-construction)	4		N.A.	<input checked="" type="checkbox"/>	Un-assigned	
<input checked="" type="checkbox"/> Criterion 4: Design to include existing site features	2	0	L2 : Under Process	<input checked="" type="checkbox"/>	Un-assigned	
<input type="checkbox"/> Criterion 5: Reduce hard paving on-site and /or provide shaded hard - paved surfaces.	2		N.A.	<input checked="" type="checkbox"/>	Un-assigned	
<input type="checkbox"/> Criterion 6: Enhance outdoor lighting system efficiency.	3		N.A.	<input checked="" type="checkbox"/>	Un-assigned	
<input type="checkbox"/> Criterion 7: Plan utilities efficiently and optimize on-site circulation efficiency	3		N.A.	<input checked="" type="checkbox"/>	Un-assigned	
<input checked="" type="checkbox"/> Criterion 8: Provide at least, the minimum level of sanitation/safety facilities for construction workers.	2	0	L2 : Under Process	<input checked="" type="checkbox"/>	Un-assigned	

Instructions for external evaluators

Step 1 Login

- The external evaluator shall be provided with a login ID and password, using which he/she can access the project account which he/she shall be evaluating. For each project there shall be a separate login ID.

Step 2 View criteria

- The 'Project Details' page consists of all the criteria, the points attempted, their status and a feedback button for each of the attempted criteria.
- The evaluator can view only those criteria which are assigned to him/her, by clicking on 'View' under 'Criteria Attempted'.
- If the evaluator needs additional information that may be part of some other criteria, a request should be sent to the secretariat and the information shall be made available.

Project Details						
Registered Project : Green Building			Project Code : 09GRB1			
Project status : Pending at GRIHA's level.						
Criteria	Max	Points Attempted	Status	Criteria Attempted	Feedback	
Criteria 1: Site Selection	1		N.A.	<input checked="" type="checkbox"/>	View	Feedback
Criteria 2: Preserve and protect the landscape during construction/compensatory depository forestation	5	1	L2 : Under Process	<input checked="" type="checkbox"/>	View	Feedback
Criteria 3: Soil conservation (till post-construction)	4		N.A.	<input checked="" type="checkbox"/>	View	Feedback
Criteria 4: Design to include existing site features	2	0	L2 : Under Process	<input checked="" type="checkbox"/>	View	Feedback
Criteria 5: Reduce hard paving on-site and /or provide shaded hard - paved surfaces.	2		N.A.	<input checked="" type="checkbox"/>	View	Feedback
Criteria 6: Enhance outdoor lighting system efficiency.	3		N.A.	<input checked="" type="checkbox"/>	View	Feedback
Criteria 7: Plan utilities efficiently and optimize on-site circulation efficiency	3		N.A.	<input checked="" type="checkbox"/>	View	Feedback
Criteria 8: Provide at least, the minimum level of sanitation/safety facilities for construction workers.	2	0	L2 : Under Process	<input checked="" type="checkbox"/>	View	Feedback

Step 3 Evaluation

- After viewing each assigned criteria, the evaluator can provide feedback by clicking on individual 'Feedback' buttons for each criterion.
- The feedback can be sent back to ADaRSH (GRIHA secretariat) only once, in case of some discrepancies. Feedback of all evaluators shall be compiled and sent to the client for resubmission of forms that did not meet the evaluation requirements for award of points. The client shall re-submit the criteria forms and the evaluator shall evaluate the assigned criteria again and finally approve or reject the criteria by clicking on 'Submit' or 'Send back Selected Criteria to GRIHA Coordinator', respectively. Points shall be awarded on approval of the criteria.
- For any query, please go to 'Ask Us'.

1.7 GRIHA evaluation process

The buildings shall be evaluated and rated in a three-tier process. The process that would be followed has been explained previously.

The GRIHA team shall first review the mandatory criteria and reject a project in the event of non-compliance with such criteria. The team shall then check the documentation submitted for the optional criteria. The checking is done by the GRIHA team to ensure that all templates and drawings are filled-in and to ensure that the documentation is complete in all respects (for the attempted criteria). All documents shall be checked and vetted through the appraisal process as outlined by GRIHA. The GRIHA team compiles the first evaluation report and sends to the client. The client is then required to resubmit details as requested for by the Secretariat in the first evaluation report.

The documentation shall now be sent to the GRIHA evaluators comprising of renowned sector experts from landscape architecture, lighting and HVAC design, renewable energy, water and waste management, and building materials. The evaluators shall vet the documentation and independently review the documents for the award of points. The evaluator shall award provisional points (if documentation is in order as per his/her evaluation) and also comment on specific criteria, if need be. The evaluation report shall be sent to the project proponent to review the same and, if desired, take steps to increase the score. The report shall elaborate on the results of the evaluation committee along with its comments. The report shall also list the criteria for which the documentation is incomplete/inadequate/inconsistent, detailing all the required information. The client shall then be given one month to resubmit the document with necessary modifications. The resubmitted report should comprise only of additional documents/information desired in the evaluation report, which shall again be put through the vetting process as described above. The evaluation committee shall then award the final score, which shall be presented to an advisory committee comprising of eminent personalities and renowned professionals in the field for approval and award of rating. Provisional rating is awarded that is converted to final confirmed rating on meeting compliance as per Criterion 32. The rating shall be valid for a period of five years from the date of commissioning of the building. GRIHA reserves the right to undertake a random audit of any criteria for which points have been awarded.

1.7.1 Modifications to GRIHA

Over the process of rating various projects registered for GRIHA rating, ADaRSH (GRIHA secretariat) carried out a realistic assessment of applicability of GRIHA criteria to various projects. After carrying out this exercise it was recognized that some criteria in the current GRIHA framework may not apply to a particular project due to technical constraints that are specific to the particular project (for example the criteria related to tree preservation and compensatory forestation may not apply to a site that is devoid of trees).

It was also recognized that relative weightage of points within the current framework needs to be reassessed so that green interventions in a project are given points based on its relative advantage to a project. This resulted in modifications to the GRIHA document which have been mentioned below. Criteria have been classified as 'Applicable/Selectively-Applicable'. Certain mandatory clauses have been modified/removed based on the applicability /selective-applicability of the criterion.

1.7.2 Scoring method and award of rating

- The registration form shall request details of top soil, tree cover, hot water requirement, waste water generation, organic solid waste generated .
- The selectively applicable criteria cannot be attempted by projects that do not meet the threshold values for the selectively applicable criteria.
- The project shall be rated on applicable criteria only and shall be given percentage scoring for example, a project scoring 81% out of applicable points shall qualify for a 4 star rating.
- The information will be provided to ADaRSH (GRIHA secretariat) by the applicant and the Secretariat will decide the points which are applicable or inapplicable for the particular project.

1.8 Scoring points under GRIHA

GRIHA is a guiding and performance-oriented system where points are earned for meeting the design and performance intent of the criteria. Each criterion has points assigned to it. It means that a project intending to qualify have to meet with each criterion and earn points. Compliances, as specified in the relevant criterion, have to be submitted in the prescribed format. While the intent of some of the criteria is self-validating in nature, there are others (for example energy consumption, thermal and visual comfort, noise control criteria, and indoor pollution levels) which need to be validated on-site through performance monitoring. The points related to these criteria (specified under the relevant sections) are awarded provisionally while certifying and are converted to firm points through monitoring, validation, and documents/photographs to support the award of point.

The set of 34 criteria of GRIHA shall be broadly classified into two categories – applicable and selectively applicable.

The applicable criteria has two further sub categories – mandatory and optional/non mandatory.

1.8.1 Selectively applicable criteria

These are the criteria that may not apply to a project due to technical constraints or due to the fact that its application may not add sufficient environmental benefit in the rating scale. The registered project shall not apply for this/these criteria and all the selectively applicable criteria shall be decided at registration stage. The registration form shall be expanded to ensure that requisite details are obtained to enable ADaRSH to decide on applicability of these criteria for the project. These criteria and corresponding non applicability conditions are as follows.



Criterion 2 : Preserve and Protect Landscape during Construction

Current Commitment : Preserve top soil by employing requisite measures.

Non Applicability condition proposed: Contaminated sites/sites that do not have good quality top soil (as per soil test report) that is considered worth storing for reuse. Soil test has to be carried out as per criteria 3 and the test report has to be endorsed by the landscape architect. The landscape architect has to provide certificate that the top soil is not worth storing for landscaping purposes and cannot be restored to applicable standard.

Current Commitment : Preserve existing vegetation by means of non-disturbance or damage to the trees and other form of vegetation or, Trees/plants replanted within site premises in ratio of 1:3.

Non Applicability condition proposed : Sites that are devoid of trees.

Criterion 3: Soil Conservation

Current Commitment: Proper top soil laying for vegetative growth.

Non Applicability condition proposed: For sites in which top soil could not be stored for reasons as sited in Criteria 2 above.

Criterion 19: Renewable Energy Based Hot Water System

Current commitment: Annual energy saved by proposed renewable energy system is 20% to 100% of annual energy required for water heating to meet the hot water requirement of the occupants in the building.

Non applicability condition proposed: If hot water requirement is less than 500 litres per day.

Criterion 20: Waste Water Treatment

Current commitment: Treated water should meet the disposal standards and/or reuse standards.

Non applicability condition proposed: If waste water generation on site is less than 10 kL/day.

Part of Criterion 21: Water Recycle and Reuse (including Rainwater)

Current commitment: Recharge of surplus rain water into aquifer.

Non applicability condition proposed: For sites that have high water table where recharge is not advisable as per Central Government Water Board (CGWB) norms.

Criterion 24: Storage and Disposal of Wastes

Current commitment: Provision of space for hygienic storage of segregated waste as per clause.

Non applicability condition proposed: If organic waste generation is below 100 kg/day.

1.8.2 Applicable criteria

All other criteria other than mentioned above shall be applicable to all registered projects.

The criteria that are not applicable for a project shall be determined by ADaRSH (GRIHA secretariat) during registration. Information of top soil quality, mature trees on site, hot water demand, quantum of waste water generated, groundwater table, quantum of waste generated shall be sought during registration. The respective criteria as mentioned above shall not apply in case if the non applicability condition applies. The project shall be rated on the applicable points only.



1.9 Synopsis of the criteria for rating (Mandatory and optional/non mandatory clauses as per GRIHA rating system)

The criteria have been categorized as follows.

Sustainable site planning

Conservation and efficient utilization of resources

Objective

To maximize the conservation and utilization of resources (land, water, natural habitat, avian fauna, and energy) and enhance efficiency of the systems and operations.

Criterion 1 Site selection

Mandatory clause

The site plan must be in conformity with the development plan/master plan/UDPFI guidelines (mandatory). This should comply with the provisions of eco-sensitive zone regulations, coastal zone regulations, heritage areas (identified in the master plan or issued separately as specific guidelines), water body zones (in such zones, no construction is permitted in the water-spread and buffer belt of 30 metre minimum around the FTL), various hazard prone area regulations, and others if the site falls under any such area (**mandatory with no point allocation**).

Responsibility: Project Manager, Architect

Optional clause

The site should be located within ½ km radius of an existing bus stop, commuter rail, light rail or metro station and/or the proposed site must be a Brownfield site (to rehabilitate damaged sites where development is hindered by environmental contamination, thereby reducing pressure on undeveloped land) (**1 point**)

Responsibility: Project Manager, Architect

Criterion 2 Preserve and protect landscape during construction (selectively applicable)

Commitment

Proper timing of the construction, preserve topsoil and existing vegetation, staging and spill prevention, and erosion and sedimentation control. Replant on-site trees in the ratio of 3:1 to those removed during construction, for every removal one tree plant 3 saplings.

Mandatory clause

Preserve existing vegetation by means of non-disturbance or damage to trees and other forms of vegetation, as per GRIHA

OR

Trees/plants replanted within site premises in ratio of 3:1, as per GRIHA (**1 point – mandatory, if applicable**).

Responsibility: Landscape Architect



Non-Mandatory/Optional clause

Ensure proper timing of construction with respect to rain as per GRIHA

Responsibility: Architect, Project Manager

and

Confine construction activity to pre-designated areas, as per GRIHA **(1 point)**.

Responsibility: Landscape Architect

Proper implementation of staging and spill prevention plan

and

Effective erosion and sedimentation control to prevent erosion, as per GRIHA **(1 point)**.

Responsibility: Landscape Architect

Preserve topsoil by employing measures as per GRIHA **(1 point, if applicable)**.

Responsibility: Project Manager and Architect

Non applicability condition proposed (for top soil preservation only): Contaminated sites/sites that do not have good quality top soil (as per soil test report) that is considered worth storing for reuse. Soil test has to be carried out as per criteria 3 and the test report has to be endorsed by the landscape architect. The landscape architect has to provide certificate that the top soil is not worth storing for landscaping purposes and cannot be restored to applicable standard.

Trees/plants replanted within site premises in excess of 25% than minimum requirement, as per GRIHA **(1 point)**.

Responsibility: Landscape Architect

Non applicability condition proposed (for tree preservation and protection clause only): Sites that are devoid of trees

Criterion 3 Soil conservation (till post-construction) 2 points*Commitment*

Proper topsoil laying, stabilization of the soil, and maintenance of adequate fertility of the soil to support vegetative growth.

Optional clause

Proper topsoil laying for vegetative growth, as per GRIHA **(1 point)**.

Responsibility: Landscape Architect

Proper stabilization of soil, as per GRIHA **(1 point)**.

Responsibility: Landscape Architect

Non applicability condition proposed: For sites in which top soil could not be stored for reasons as sited in Criteria 2 above.

Criterion 4 Design to include existing site features*Commitment*

Minimize the disruption of the natural ecosystem and design to harness maximum benefits of the prevailing micro-climate.



Non mandatory/optional clause

If all compliances are fulfilled, as per GRIHA. **(4 points)**

Criterion 5 Reduce hard paving on-site and/or provide shaded hard-paved surfaces*Commitment*

Minimize storm water run-off by reducing hard paving on-site. **(2 points)**

Non mandatory/optional clause

Net paved area of site under parking, roads, paths or any other use not to exceed 25% of site area or net imperviousness of site should not exceed the imperviousness factor, as prescribed by NBC 2005 (BIS 2005b), whichever is more stringent, as per clause Equations 1 and 4 (reference documents: 5.2.1 and 5.2.2 in GRIHA). **(1 point)**

Responsibility: Landscape Architect

Mandatory clause

Total surface parking not to exceed as permitted by local by-law **(mandatory)**

Responsibility: Architect

AND

More than 50% of the total paved area to have pervious paving/open-grid pavement/grass pavers.

Responsibility: Landscape Architect

OR

Minimum 50% of the total paved area (including parking) to have shading by vegetated roof/ pergola with plants.

Responsibility: Landscape Architect

OR

Minimum 50% of the total paved area (including parking) to be topped with solar reflectance of 0.5 or higher.

OR

Minimum 50% of the total paved area (including parking) to have any combination of the above mention strategies where common areas having two or more strategies shall be calculated only once. **(1 point)**

Responsibility: Landscape Architect

Criterion 6 Enhance outdoor lighting system efficiency and use renewable energy system for meeting outdoor lighting requirements*Commitment*

Meet minimum allowable luminous efficacy (as per lamp type) and make progressive use of a renewable-energy-based lighting system. **(3 points)**

Optional clause

Luminous efficacy of 100% of lamps used in outdoor lighting to meet the corresponding lamp luminous efficacy as mentioned in Table 6.1, as per GRIHA **(1 point)**.

Responsibility: Electrical Consultant

Automatic controls for 100% of outdoor lights, as per GRIHA **(1 point)**.

Responsibility: Electrical Consultant



Percentage of total outdoor lighting fixtures with solar lighting system, as per GRIHA (a minimum of 25% of total number or 15% of total connected load, whichever is higher) **(1 point)**

Responsibility: Electrical Consultant

Criterion 7 Plan utilities efficiently and optimize on-site circulation efficiency

Commitment

Minimize road and pedestrian walkway length by appropriate planning and provide aggregate corridors for utility lines.

Optional clause

Demonstrated use of minimization and consolidation of transportation/service corridors and shading of pedestrian roads, as per GRIHA **(1 point)**.

Responsibility: Architect

Use of aggregate utility corridors, as per GRIHA **(1 point)**.

Responsibility: Architect

Consolidation of utility corridors along the previously disturbed areas or along new roads in order to minimize unnecessary cutting and trenching and ensure easy maintenance, as per GRIHA **(1 point)**.

Responsibility: Architect

Health and well-being

Objective

To protect the health of construction workers and prevent pollution.

Criterion 8 Provide minimum level of sanitation/safety facilities for construction workers

Commitment

Ensure cleanliness of workplace with regard to the disposal of waste and effluent, provide clean drinking water and latrines and urinals as per applicable standard. **(2 points)**

Mandatory clause

Compliance with National Building Code norms on construction safety for ensuring safety during construction **(1 point)**, as per GRIHA

Responsibility: Project Manager

Provision for health and sanitation facilities as specified above **(1 point)**, as per GRIHA

Responsibility: Project Manager

Criterion 9 Reduce air pollution during construction

Commitment

Ensure proper screening, covering stockpiles, covering brick and loads of dusty materials, wheel-washing facility, and water spraying facility.



Mandatory clause

Demonstrated use of air pollution preventive measures, as per clauses in GRIHA **(2 points)**.

Responsibility: Project Manager

Building planning and construction

Conservation and efficient utilization of resources

Objectives

To maximize resource (water, energy, and materials) conservation and enhance efficiency of the system and operations.

Water

Criterion 10 Reduce landscape water requirement

Commitment

Landscape using native species and reduce lawn areas while enhancing the irrigation efficiency and reducing the water requirement for landscaping purposes. **(3 points)**

Optional clause

Reduction in water consumption by 30%, as per GRIHA **(1 point)**.

Responsibility: Landscape Consultant and Water Consultant

Reduction in water consumption by 40%, as per GRIHA **(additional 1 point)**.

Responsibility: Landscape Consultant and Water Consultant

Reduction in water consumption by 50%, as per GRIHA **(additional 1 point)**.

Responsibility: Landscape Consultant and Water Consultant

Criterion 11 Reduce water use in the building

Commitment

Reduce building water use by applying low-flow fixtures and other similar tools. **(2 points)**

Optional clause

Reduction in water consumption by 25%. For calculation, refer to Table 11.1 as per GRIHA **(1 point)**.

Responsibility: Plumbing Consultant and Water Consultant

Water-use reduction by 50%. For calculation, refer to Table 11.1 as per GRIHA **(additional 1 point)**.

Responsibility: Plumbing Consultant and Water Consultant

Criterion 12 Efficient water use during construction

Commitment

Use materials such as pre-mixed concrete for preventing loss during mixing. Use recycled treated water and control the waste of curing water.

Optional clause

Efforts to minimize potable water use for construction, as per GRIHA **(1 point)**.

Responsibility: Project Manager and Architect



Energy: end use

Criterion 13 Optimize building design to reduce conventional energy demand

Commitment

Plan appropriately to reflect climate responsiveness, including adequate daylighting as well as efficient artificial lighting. **(8 points)**

Mandatory clause

Appropriate planning which reflects climate responsiveness, as per GRIHA **(2 points)**.

Responsibility: Architect and Energy Consultant

Adequate day lighting is provided, as per GRIHA **(2 points)**.

Responsibility: Architect and Energy Consultant

Over-design of lighting system is avoided, as per GRIHA **(2 points)**.

Responsibility: Architect and Energy Consultant

Optional clause

Increase in daylighted area as per GRIHA **(2points)**

Criterion 14 Optimize energy performance of building within specified comfort limits

Commitment

Ensure that the building complies with the mandatory compliance requirement of ECBC 2007 and meet thermal comfort conditions as per NBC 2005 as well as minimum benchmark for EPI as per GRIHA. Ensure reduction in EPI up to 40% under a specified category.

- Meet thermal comfort conditions as per National Building Code 2005 and, minimum benchmark for energy performance index as per GRIHA
- Ensure that energy consumption in building under a specified category is 10%–40% less than that benchmarked through a simulation exercise. **(16 points)**

Mandatory Clause

- Compliance with Energy Conservation Building Code 2007. **(6 points)**.
- Compliance with thermal comfort condition as per National Building Code 2005 and minimum benchmark index as per GRIHA. **(2 points)**

Responsibility: Mechanical Consultant, Electrical Consultant, Plumbing Consultant and Energy Consultant

Non-mandatory/optional clause

Every 10% reduction in EPI after building under a specified category shall fetch additional 2 points to a maximum of 8 points. **(2–8 points)**

Responsibility: Mechanical Consultant, Electrical Consultant, and Energy Consultant

Energy: embodied and construction

Criterion 15 Utilization of fly-ash in building structure

Commitment

Use of fly-ash for RCC (reinforced cement concrete) structures with in-fill walls and load bearing structures, mortar, and binders. **(6 points)**



Optional clause

Minimum 15% replacement of Portland cements with fly-ash (by weight of cement used) in structural concrete, as per GRIHA — **1 point (additional 1 point if more than 30%)**.

Responsibility: Architect, Project Manager and Structural Consultant

Minimum 40% usage of fly-ash (by volume of materials used), for 100% load-bearing and no-load bearing walls, as per GRIHA — **2 points**.

Responsibility: Architect, Project Manager and Structural Consultant

Minimum 30% replacement of Portland cements with fly-ash (by weight of cement used) in plaster/masonry mortar, as per GRIHA — **2 points**.

Responsibility: Architect, Project Manager and Structural Consultant

Criterion 16 Reduce volume, weight, and construction time by adopting efficient technologies (such as pre-cast systems)

Commitment

Replace a part of the energy-intensive materials with less energy-intensive materials and/or utilize regionally available materials, which use low-energy/energy-efficient technologies. **(4 points)**

Optional clause

- Structural application: Use of low-energy materials/efficient technologies in structural application clearly demonstrating a minimum 5% reduction in the embodied energy, when compared with equivalent products for the same application, for 100% structural system used in a building, meeting the equivalent strength requirements, as per all compliance clauses (2 points)

Responsibility: Architect/project manager and structural consultant

- Non-structural application: Use of low-energy materials/efficient technologies (not based on the utilization of industrial waste), which are used for non-structural applications such as infill wall system and cause a minimum five per cent reduction in the embodied energy, when compared with equivalent products for the same application, for 100% infill wall system used in a building, meeting the equivalent strength requirements, as per all the compliance clauses (2 points).

Responsibility: Architect/project manager and structural consultant

Criterion 17 Use low-energy material in interiors

Commitment

Minimum 70% in each of the three categories of interiors (internal partitions, panelling/false ceiling/interior wood finishes/in-built furniture door/window frames, flooring) from low-energy materials/finishes to minimize the usage of wood. **(4 points)**

Optional clause

A minimum of 70% of the total quantity (gross area) of all interior finishes and products used for each of the category, as applicable, to be low-energy finishes, for each of the following category.

Sub-assembly/internal partitions/panelling/false ceiling/in-built furniture **(2 points)**, as per GRIHA.

Responsibility: Architect

Flooring **(1 point)**, as per GRIHA.

Responsibility: Architect



Doors/windows and frames (**1 point**), as per GRIHA.

Responsibility: Architect

Energy: Renewable

Criterion 18 Renewable energy utilization

Commitment

Rated capacity of proposed renewable energy systems is equal to or more than 1% of internal lighting and space conditioning connected loads and meets energy requirements for a minimum of 5% of the internal lighting consumption (for general lighting or its equivalent from renewable energy sources[solar, wind, biomass, fuel cell and others]). Energy requirements will be calculated based on realistic assumptions which will be subject to verification during appraisal. (**5 points**)

Mandatory clause

Rated capacity of proposed renewable energy system is equal to or more than 1% of internal lighting and space conditioning connected loads or its equivalent in the building (**1 point-mandatory**), as per all compliance clauses.

Responsibility: Electrical Consultant

Optional clause

Rated capacity of proposed renewable energy system meets annual energy requirements of equal to or more than 5% of internal lighting consumption or its equivalent in the building (**1 point**), as per all compliance clauses.

Responsibility: Energy Consultant

Rated capacity of proposed renewable energy system meets annual energy requirements of equal to or more than 10% of internal lighting consumption or its equivalent in the building (**2 point**), as per all compliance clauses.

Responsibility: Energy Consultant

Rated capacity of proposed renewable energy system meets annual energy requirements of equal to or more than 20% of internal lighting consumption or its equivalent in the building, as per all compliance clauses (**3 points**).

Responsibility: Energy Consultant

Rated capacity of proposed renewable energy system meets annual energy requirements of equal to or more than 30% of internal lighting consumption or its equivalent in the building, as per all compliance clauses (**4 points**).

Responsibility: Energy Consultant

Note: Lighting design shall be based on minimum requirements as per NBC 2005 (BIS 2005d) (criterion 13.1.5).

Criterion 19 Renewable-energy-based hot water system

Commitment

Meet 20% or more of the annual energy required for heating water through renewable energy based water-heating systems. (**3 points**)



Non applicability condition proposed: This criteria shall not apply to projects that have hot water demand (minimum) of less than 500 litres per day

Optional clause

Annual energy saved by proposed renewable energy system is 20% to 50% of annual energy required for water heating to meet the hot water requirements of the occupants in the building, as per all compliance clauses **(1 point)**.

Responsibility: Energy Consultant and Plumbing Consultant

Annual energy saved by proposed renewable energy system is 50% to 70% of annual energy required for water heating to meet the hot water requirement of the occupants in the building, as per all compliance clauses **(2 points)**.

Responsibility: Energy Consultant and Plumbing Consultant

Annual energy saved by proposed renewable energy system is more than 70% of annual energy required for water heating to meet the hot water requirements of the occupants in the building, as per all compliance clauses **(3 points)**.

Responsibility: Energy Consultant and Plumbing Consultant

Recycle, recharge, and reuse of water

Objective

To promote the recycle and reuse of water.

Criterion 20 Waste water treatment

Commitment

Provide necessary treatment of water for achieving the desired concentration of effluents. **(2 points)**

This criteria shall not apply to projects that have waste water generation on site less than 10 kL/day

Optional Clause

Treated water should meet the disposal/reuse application standards **(2 points)**.

Responsibility: Project Manager and Plumbing Consultant

Criterion 21 Water recycle and reuse (including rainwater)

Commitment

Provide on-site waste water treatment for achieving prescribed concentration, rainwater harvesting, reuse of treated waste water and rainwater for meeting the building's water and irrigation demands. **(5 points)**

Non applicability condition proposed: The first three appraisal points shall not apply to projects that have waste water generation on site less than 10 kL/day and the fourth and fifth appraisal points shall not apply to projects in which the ground water table is high and recharge of rain water into ground is not advisable as per Central Ground Water Board norms.

Mandatory clause (if applicable)

Details of filtration system to show that adequate preventative measures are being taken to avoid contamination of aquifer by the recharged rainwater **(mandatory)**.

Responsibility: Water Consultant and Plumbing Consultant



Optional clause

Annual water reuse of 25%, as per clause 21.2.5 **(1 point)**

Responsibility: Water Consultant and Plumbing Consultant

Annual water reuse of 50%, as per clause 21.2.5 **(additional 1 point)**.

Responsibility: Water Consultant and Plumbing Consultant

Annual water reuse of 75%, as per clause 21.2.5 **(additional 1 point)**.

Responsibility: Water Consultant and Plumbing Consultant

Recharge of surplus rainwater into aquifer, as per Table 21.2 of GRIHA **(2 points)**.

Responsibility: Water Consultant and Plumbing Consultant

Waste management

Objective

To minimize waste generation; streamline waste segregation, storage, and disposal; and promote resource recovery from waste.

Criterion 22 Reduction in waste during construction

Commitment

Ensure maximum resource recovery and safe disposal of wastes generated during construction and reduce the burden on landfill. **(1 point)**

Optional clause

Segregation of inert and hazardous wastes, as per GRIHA

Responsibility: Architect and Project Manager

and

Recycling and safe disposal of segregated wastes, as per GRIHA **(1 point)**.

Responsibility: Architect and Project Manager

Criterion 23 Efficient waste segregation

Commitment

Use different coloured bins for collecting different categories of waste from the building. **(1 point)**

Optional clause

Provision of multi-coloured bins for waste segregation at source **(1 point)**.

Responsibility: Architect and Project Manager

Criterion 24 Storage and disposal of wastes

Commitment

Allocate separate space for the collected waste before transferring it to the recycling/disposal stations. **(1 point)**

Non applicability condition proposed: This criteria shall not apply to projects that have organic solid waste generation on site less than 100 kg/day



Optional clause

Provision of space for hygienic storage of segregated waste, as per GRIHA **(1 point)**.

Responsibility: Architect and Project Manager

Criterion 25 Resource recovery from waste*Commitment*

Employ resource recovery systems for biodegradable waste as per the *Solid Waste Management and Handling Rules, 2000 of the MoEF*. Make arrangements for recycling of waste through local dealers.

(2 points)

Optional clause

Zero waste generation through appropriate resource recovery measures as per GRIHA **(2 points)**.

Responsibility: Project Manager

Health and well-being

Objective

To ensure healthy indoor air quality, water quality, and noise levels, and to reduce the global warming potential.

Criterion 26 Use low-VOC paints/adhesives/sealants*Commitment*

Use only low VOC paints in the interior of the building. Use water-based rather than solvent-based sealants and adhesives. **(3 points)**

Optional clause

Zero/low-VOC paints: Zero/low-VOC paints for 100% of all paint used in the interior of the building as per GRIHA **(1 point)**,

Responsibility: Architect and Project Manager

Low-VOC sealants and adhesives: 100% of all the sealants and adhesives used are water based rather than solvent oil based/low in oil solvent content, as per GRIHA **(1 point)**.

Responsibility: Architect and Project Manager

100% of composite wood products with no urea-formaldehyde resins, as per GRIHA **(1 point)**.

Responsibility: Architect and Project Manager

Criterion 27 Minimize ozone depleting substances*Commitment*

Employ 100% zero ODP (ozone depletion potential) insulation, HCFC (hydrochloro-fluorocarbon)/ and CFC (chlorofluorocarbon), free HVAC, and refrigeration equipment/and halon-free fire suppression and fire extinguishing systems. **(1 point)**



Mandatory clause

All the insulation used in building is chloro fluoro carbon (CFCs) and hydro chloro fluoro carbon (HCFCs) free, as per GRIHA

Responsibility: Mechanical Consultant and Architect

and

All the HVAC and refrigeration equipment are CFCs free, as per GRIHA .

Responsibility: Mechanical Consultant

and

The fire suppression systems and fire extinguishers installed in the building are free of halon, as per GRIHA **(1 point)**.

Responsibility: Mechanical Consultant, Electrical Consultant, and Plumbing Consultant

Criterion 28 Ensure water quality*Commitment*

Ensure water from all sources (such as groundwater, municipal water, treated wastewater) meets the water quality norms as prescribed in the Indian Standards for various applications (Indian Standards for drinking [IS 10500-1991], irrigation applications [IS 11624-1986]), cooling towers (as given in NBC 2005). In case the water quality cannot be ensured, provide necessary treatment of raw water for achieving the desired concentration for various applications. **(2 points)**

Mandatory clause

Water quality conforming to IS standards, as per GRIHA **(2 points)**.

Responsibility: Plumbing Consultant & Project Manager

Criterion 29 Acceptable outdoor and indoor noise levels*Commitment*

Ensure outdoor noise level conforms to the CPCB (Central Pollution Control Board)– Environmental Standards–Noise (ambient standards) and indoor noise level conforms to the NBC (*National Building Code of India*) 2005 (BIS 2005a). **(2 points)**

Optional clause

The outdoor noise levels are within the acceptable limits as set in Central Pollution Control Board (CPCB). Environmental Standards–Noise (ambient standards), as per GRIHA **(1 point)**.

Responsibility: Project Manager

The indoor noise levels are within the acceptable limits as set in NBC 2005 (BIS 2005a), as per GRIHA **(1 point)**.

Responsibility: Architect

Criterion 30 Tobacco smoke control*Commitment*

Zero exposure to tobacco smoke for non-smokers, and exclusive ventilation for smoking rooms. **(1 point)**



Mandatory clause

The company policy for ban/prohibition of smoking within the building premises, a signed template by HVAC/ Architect consultant certifying that all compliances are met **(1 point)**

Responsibility: Mechanical consultant/Architect

Criterion 31 Provide at least the minimum level of accessibility for persons with disabilities

Commitment

To ensure accessibility and usability of the building and its facilities by employees, visitors, and clients with disabilities **(1 point)**

Optional clause

Compliance with National Building Code norms on requirements for planning of public buildings meant for use of physically challenged, as per GRIHA **(1 point)**.

Responsibility: Project Manager and Architect

Building operation and maintenance

Criterion 32 Energy audit and validation

Commitment

Energy audit report to be prepared by approved auditors of the Bureau of Energy Efficiency (BEE), Government of India. **(0 point)**

Mandatory clause

Energy audit report by an energy auditor approved by the BEE, Government of India.

Responsibility: Project Manager

Criterion 33 Operation and maintenance

Commitment

Validate and maintain 'green' performance levels/adopt and propagate green practices and concepts.

Ensure the inclusion of a specific clause in the contract document for the commissioning of all electrical and mechanical systems to be maintained by the owner, supplier or operator. Provide a core facility/service management group, if applicable, which will be responsible for the O&M of the building and the electrical and mechanical systems after commissioning. Owner/builder/occupants/service or facility management group to prepare a fully documented operations and maintenance manual, CD, multimedia or an information brochure listing the best practices/dos and don'ts/maintenance requirements for the building and the electrical and mechanical systems along with the names and addresses of the manufacturers/suppliers of the respective system. **(2 points)**

Mandatory clause

Appendage of specific clause in the contract document for the commissioning of all electrical and mechanical systems to be maintained by the owner, supplier or operator, as per compliance clauses in GRIHA document. Provision of a core facility/service management group, if applicable, or the owners or occupants themselves (in the case of single owner commercial buildings) undertaking the



responsibility for O&M of the building, documentation of the O&M best practices for the building's electrical and mechanical systems. **(2 points)**

Responsibility: Project Manager

Innovation points

Criterion 34 Innovation points

Commitment

Four innovation points are available under the rating system for adopting criteria which enhances the green intent of a project, and one can apply for the innovation points. Some of the probable points are as follows.

- alternative transportation
- environmental education
- company policy on green supply chain
- life cycle cost analysis
- any other criteria proposed by applicant

Please note that these innovation points are beyond the 100 points and a project can apply for 104 points in all, while the scoring shall be given on a 100-point scale only.

1.10 Evaluation system of GRIHA

GRIHA has a 100-point system consisting of some core points, which are mandatory to be met while the rest are non mandatory or optional points, which can be earned by complying with the commitment of the criterion for which the point is allocated.

Different levels of certification (one star to five stars) are awarded based on percentage of points earned. The minimum percentage required for certification is 50. Buildings scoring 50–60 percentage points, 61–70 percentage points, 71–80 percentage points, and 81–90 percentage points will get one star, two stars, three stars, and four stars, respectively. A building scoring 91–100 percentage points will receive the maximum rating, which is five stars.

% Points scored	Rating
50–60	One star
61–70	Two stars
71–80	Three stars
81–90	Four stars
91–100	Five stars



Evaluation system of GRIHA criteria			
S.no	Description	Points	
Criterion 1	Site Selection	1	Partly mandatory
Criterion 2	Preserve and protect landscape during construction/compensatory depository forestation.	5	Partly mandatory, if applicable
Criterion 3	Soil conservation (post construction)	2	
Criterion 4	Design to include existing site features	4	
Criterion 5	Reduce hard paving on site	2	Partly mandatory
Criterion 6	Enhance outdoor lighting system efficiency	3	
Criterion 7	Plan utilities efficiently and optimize on-site circulation efficiency	3	
Criterion 8	Provide, at least, minimum level of sanitation/safety facilities for construction workers	2	Mandatory
Criterion 9	Reduce air pollution during construction	2	Mandatory
Criterion 10	Reduce landscape water requirement	3	
Criterion 11	Reduce building water use	2	
Criterion 12	Efficient water use during construction	1	
Criterion 13	Optimize building design to reduce conventional energy demand	8	Mandatory
Criterion 14	Optimize energy performance of building within specified comfort limits	16	Partly mandatory
Criterion 15	Utilization of fly-ash in building structure	6	
Criterion 16	Reduce volume, weight, and time of construction by adopting efficient technology for example, pre-cast systems, ready-mix concrete, and so on)	4	
Criterion 17	Use low-energy material in interiors	4	
Criterion 18	Renewable energy utilization	5	Partly mandatory
Criterion 19	Renewable energy based hot- water system	3	
Criterion 20	Waste water treatment	2	
Criterion 21	Water recycle and reuse (including rainwater)	5	
Criterion 22	Reduction in waste during construction	1	
Criterion 23	Efficient waste segregation	1	
Criterion 24	Storage and disposal of wastes	1	
Criterion 25	Resource recovery from waste	2	
Criterion 26	Use of low VOC paints/adhesives/sealants	3	
Criterion 27	Minimize ozone depleting substances	1	Mandatory
Criterion 28	Ensure water quality	2	Mandatory
Criterion 29	Acceptable outdoor and indoor noise levels	2	
Criterion 30	Tobacco and smoke control	1	Mandatory
Criterion 31	Universal accessibility	1	
Criterion 32	Energy audit and validation		Mandatory
Criterion 33	Operations and maintenance protocol for electrical and mechanical equipment	2	Mandatory
Criterion 34	Innovation (beyond 100)	4	
		104	



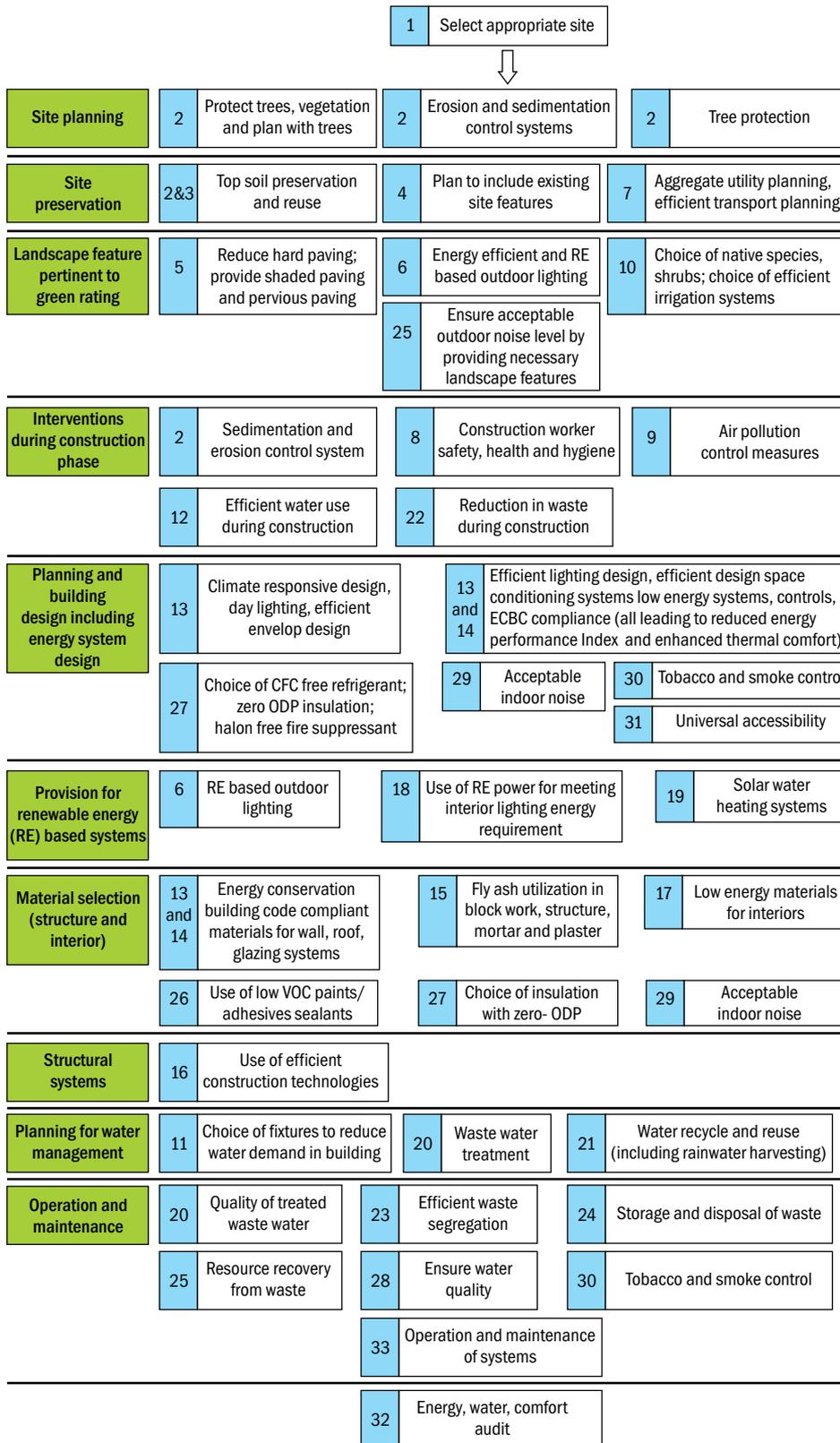
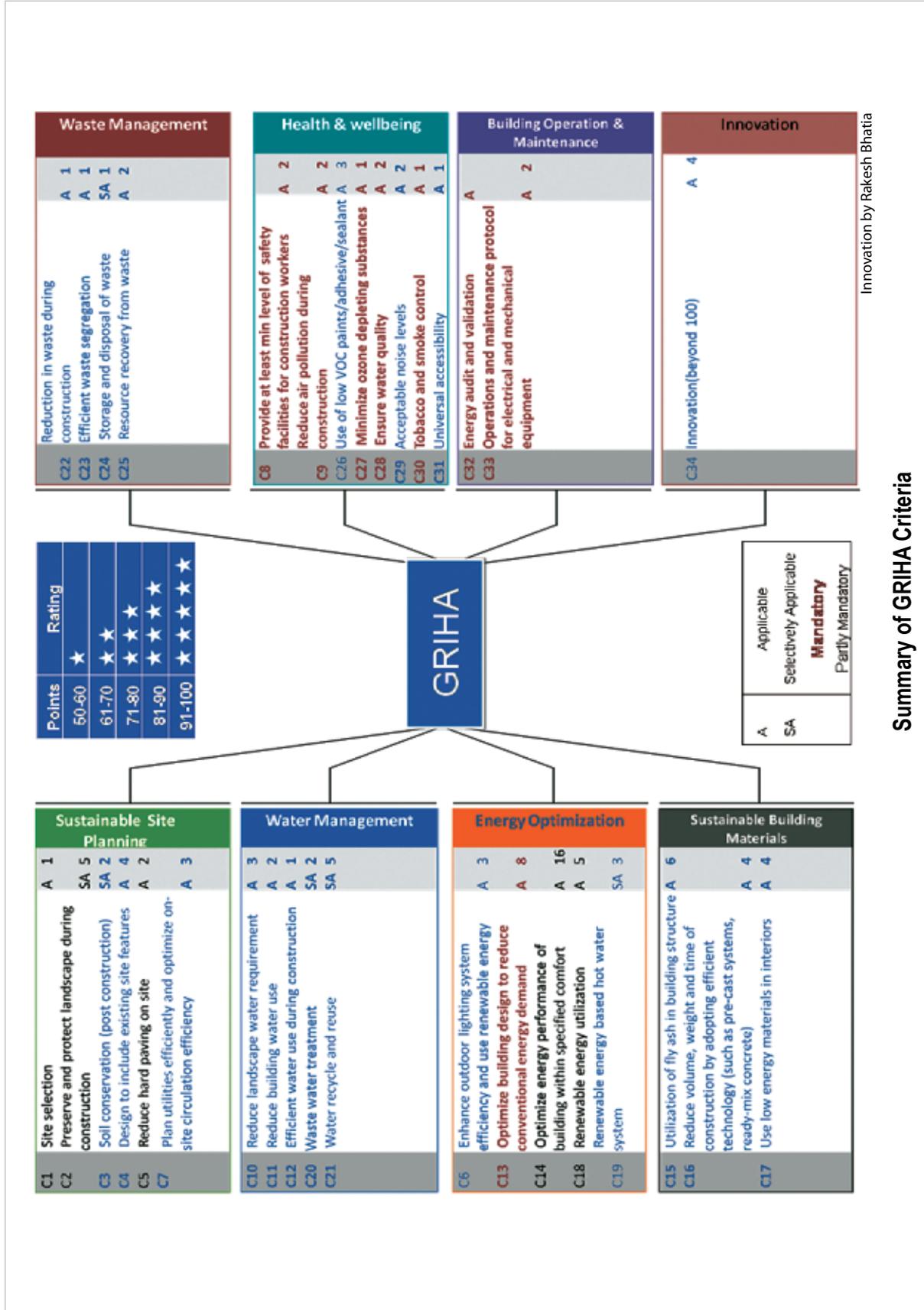


Figure 7 This figure demonstrates stages of application of various criteria





Innovation by Rakesh Bhatia

Summary of GRIHA Criteria





CASE STUDIES OF GRIHA REGISTERED/RATED BUILDINGS

2.1 Common Wealth Games Village, New Delhi

Project Management/Project In-charge
Design / Architect (In-house)
GRIHA Facilitator

Architect
Landscape consultant
MEP consultant
Energy consultant

Maj Gen (Retd) A K Singh
Mr Nishant Sabharwal
Mr Devendra Mahajan
Ms Swati Mahashabdey
Sikka Associates – Mr Raman Sikka
Integral Designs: Mr Samir Mathur
Spectral: Mr Sanjay Piplani
TERI

The Common Wealth Games 2010 is being scheduled to be held in the capital city of New Delhi. The games village shall accommodate the players during the games and shall be occupied by individual private homeowners after the games. A 47.3 hectare (118 acre) picturesque site has been selected on the banks of holy river Yamuna for the purpose of construction of the games village. The project site is within the immediate vicinity of heritage monuments and historical landmarks, combined with dense green natural covers on the sides.

2.1.1 Site and landscape

The proposed development consists of 4000 bedrooms spread across 34 towers varying in heights (such as; 7 storeys to 9 storeys high). The proposed apartment's blocks are arranged in site in a way so as to create visual links with heritage sites in the vicinity. The topsoil of the entire excavated site has been collected and stored separately and special measures have been taken for soil stabilization, such as- stockpiling, mulching, and so on. Pervious paving has been provided extensively in the site. All the service lines and utility corridors on the site are well aggregated and ensure minimum disruption during future maintenance work.

2.1.2 Health and well-being

The sanitation/safety facilities for the construction workers are provided as per National Building Code 2005. These include provision of clean and hygienic accommodation, toilet facilities, purified drinking water, general store, a subsidized canteen, medical facilities, day care centre and onsite safety equipment, and so on. Significant measures have been taken to reduce air pollution during construction, such as – site roads are regularly sprayed with water; wheels of all vehicles are washed, and so on.



2.1.3 Water

Water efficient landscaping is being practiced to minimize post construction water usage. This is being done by providing native species, efficient irrigation systems and by limiting lawn areas. The building water consumption also has been reduced by use of high efficiency low-flow fixtures. The construction water management on site is very efficient in terms of reuse of waste water and less utilization of potable water in construction.



Figure 1 Site plan



Figure 2 Toilet facilities for workers



Figure 3 Safety wears during construction



Figure 4 Safety nets at construction site



Figure 5 Worker's accommodation facilities



2.1.4 Building design and energy

The building design has also included the existing site features, such as, the visual linkages with historical monuments, solar geometry, and so on. Due to high density planning requirements, the design did not permit optimum orientation for all apartment blocks. As a result, the apartment blocks have equal exposure towards all cardinal directions. However, the critical facades are shaded and have high performance glazing to negate impact of direct incident radiation. The buildings are fully compliant with the Energy Conservation Building Code 2007. Several energy efficiency measures such as roof insulation, high performance glazing, energy efficient lighting and variable refrigerant volume (VRV) based air conditioning system have been provided to reduce the energy consumption of the apartments significantly.



Figure 6 Snapshot of CommonWealth Games Village

2.1.5 Renewable energy

Solar photo voltaic system is proposed to meet the 10% of total energy requirements for internal lighting. 31% of outdoor lighting is provided through solar energy. Solar hot water systems are provided to meet part of water heating needs.

2.1.6 Other features

Waste water recycling and solid waste management for the entire campus are being planned by the Delhi Jal Board at a macro level for the village as well as adjoining properties.

2.2 Suzlon One Earth

Principal architect	Christopher Charles Benninger Architects
Landscape architects	Ravi and Varsha Gavandi
Interior architects	Tao Architecture and Space Matrix
Electrical consultants	Power Engineers
HVAC consultants	Refrysinth
Plumbing consultant	Rahul Dhadphale
Lighting consultants	Ministry of Lights
Green Building Design and Certification	Environmental Design Solution

One Earth is Suzlon's corporate headquarters office which is coming up in Pune, India. The project, in keeping up with the spirit of the parent company, attempts to showcase itself as a building project with minimal impact on the environment. The complex consists of an office block and a corporate learning centre. The buildings are positioned on a site area of 45 392 sq.m. The total built-up area is 70 865 sq.m. The project is registered for green building certification under GRIHA. There are various salient features which enable it to become an iconic green building.

One of the first steps taken in the project was to ensure that the architectural aspects of design are well taken care of. Passive design strategies help in ensuring that visual and thermal comfort is maintained within the building with minimum interventions of technologies. The orientation of the blocks is such that the majority of the building's facades face north, south, north-west and south-east. This enables adequate day lighting and glare control. Glazing on the first and second floors has been shaded from direct solar radiation using louvers. These also act as important design elements of the building and give it a visual identity. Architectural design of the office block is such that various extrusions on various floors shade portions of the building. Therefore, the building is partly self-shaded. In order to create an interesting office atmosphere, break-out spaces have been created in the form of small terraces which have been interspersed all over the office block.

In order to minimize disturbance on site and to ensure easy maintenance, various utility corridors have been provided coupled with the roads and pathways on site. This ensures minimum site disruption post-occupancy.



Figure 7 Views of the Suzlon One Earth building

Photo courtesy: Suzlon One Earth – global headquarters of Suzlon Group

High efficiency mechanical systems in the building ensure that the energy consumption of the building is significantly reduced. All desks are equipped with LED lights for task lighting which are governed by motion sensors. So they turn on only when people are seated on their seats. This reduces lighting load to 0.8 W/sq.ft. Extremely high efficiency HVAC systems have been chosen. The HVAC system has various components like pre-cooling of fresh air heat recovery/exchanger mechanisms to minimize energy consumption in HVAC. Overall, the complex has managed to reduce its energy consumption by 47% below the GRIHA criterion 14 benchmark figures.

Once the energy performance index of the building was reduced, renewable energy systems in the form of solar PV and windmills were installed to generate approximately 250 000 units of electricity through renewable sources annually. The project has an installed 13.44 kWp of solar PV and 18 windmills with power capacity of 4.75 kW each.

The project has taken drastic steps in order to reduce its water consumption as well. Use of low-flow fixtures throughout the complex has ensures that the building requires 65% less water than conventional buildings for sanitary purposes. By planting only native trees and shrubs and using high efficiency sprinkler and drip irrigation systems, the complex has reduced its landscape water requirement by about 50%. Over 55% of the water in the building is recycled and reused within the complex.

The intent of making a green building is also reflected in various materials used in the structural systems and in interiors. Use of Post Tension slabs help in reducing concrete requirement in slabs and beams by 37%. Use of PT structural system has helped reduce the requirement of structural steel by almost 50%. Use of Siporex blocks gives the walls of the buildings good insulation while simultaneously using waste material like fly-ash. Majority of the materials used for interior application have high recycled content and are low-energy materials.

Overall, the One Earth complex has adopted very high standards for energy and water management which is reflected in their projected energy and water savings. The One Earth complex has taken strong steps to minimize its environmental impact at various levels while simultaneously projecting a very contemporary feel to the buildings and spaces, thereby proving the point that green buildings can be as aesthetically pleasing as any conventional building and yet are able to have minimal negative impact on environment.





Figure 8 View of CESE building, IIT, Kanpur

2.3 Centre for Environmental Science and Engineering building (CESE) at IIT, Kanpur

Architect	Kanvinde Rai and Chowdhury Architects and Planners
Energy consultant	TERI (The Energy and Resources Institute)
HVAC consultant	Gupta Consultants and Associates
Electrical consultant	Kanwar Krishen Associates Pvt. Ltd
Landscape architect	Mr Yogesh Kapoor

Centre for Environmental Science and Engineering Building at IIT, Kanpur has been taken as an example to illustrate how the building attempted various GRIHA criteria to make it into a green building.

2.3.1 Sustainable site planning

In order to minimize impact of site development on the environment and surroundings, several best practice guidelines were adopted like demarcation of site for construction, installation dust screen around the disturbed area to prevent air pollution and spillage to undisturbed site area. Top soil was excavated, stored and preserved outside the disturbed construction site. Erosion control systems were adopted and several trees on site were protected. To increase the perviousness of site and to reduce heat island effect caused due to hard paving around the building, total paving around the building was restricted to 17%, and more than 50% of the paving is either pervious or shaded by trees. Irrigation water demand has been reduced by more than 50% in comparison to GRIHA benchmark. Adequate health and safety measures related to construction were taken.



Figure 9 Tree preservation



Figure 10 Sedimentation tank

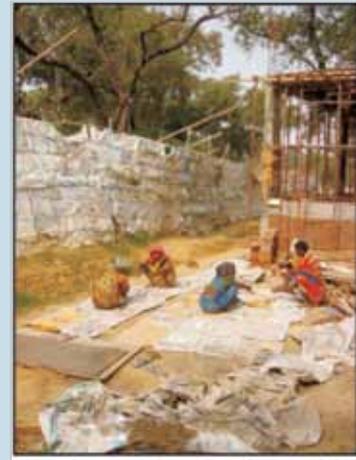


Figure 11 Air pollution control

2.3.2 Water conservation

There are two ways of conserving water during post construction and after the building is occupied. One is landscape water demand and second is building water demand. In this building, reduction in landscape water demand by more than 50% was achieved by use of minimum grass/lawn area, maximum green area under native vegetation and native trees. Low flow plumbing fixtures are used in the building resulting in reduced water consumption from GRIHA's benchmark in this building by 62%. Waste water is treated and reused for irrigation. Rain water harvesting has been designed.

2.3.3 Conservation and efficient utilization of resource: energy

Maximum points weightage in GRIHA is given for energy conservation. The criteria and commitment for energy conservation could be divided into three parts.

- a. Energy: end use
- b. Energy: embodied and construction
- c. Energy: Renewable energy utilization

Energy: end use

The objective and the aim is to reduce annual energy consumption of the building. This has been achieved in CESE building at IIT, Kanpur through following ways.

1. Architectural design optimized as per the climate of Kanpur, sun path analysis, predominant wind direction, and existing vegetation.
2. Optimized building envelope to comply to the Energy Conservation Building Code, to reduce cooling load in the air conditioned spaces and to achieve thermal comfort in the non air conditioned areas.
3. Efficient window design by selecting efficient glazing, external shading to reduce solar heat gain but at the same time achieve glare free natural daylight inside all the laboratory spaces of the building.
4. Roof shaded by bamboo trellis and green cover to reduce external solar heat gains from the roof.



5. Common circulation areas are natural day lit and naturally ventilated through integration of skylights and ventilators.
6. Water cooled chiller selected that complies with the efficiency recommended by the Energy Conservation Building code.
7. Variable Frequency Drive installed in the Air Handling Units (AHUs).
8. Low energy strategies such as replacement of water cooler by water body to cool the condenser water loop, integration of thermal energy storage and earth air tunnels enabled reduction in chiller capacity.
9. Integration of energy efficient lighting design that complies to the recommendations of ECBC.
10. Integration of daylight with artificial lighting.
11. Optimized architectural design and integration of energy efficient fixtures has resulted in the reduction in annual energy consumption by 41% from GRIHA's benchmark.

Energy: embodied and construction

GRIHA encourages replacement of high energy intensive materials with low energy intensive materials, to utilize regionally available materials, materials which use low energy in their manufacturing process. Following are the measures incorporated at CESE building, IIT, Kanpur:

1. Portland Pozzolona Cement (PPC) with fly-ash content is used in plaster and masonry mortar.
2. Wood for doors is procured from commercially managed forests. Modular furniture made from particle board is used for interiors.

Energy: renewable energy utilization

Following are the measures incorporated at CESE building, IIT, Kanpur to integrate renewable sources of energy with the building:

1. Renewable energy from photovoltaic panels provide annual energy requirements equivalent to 30% of internal lighting connected load.
2. Hot water demand is met by solar hot water system.



CRITERIA FOR GRIHA RATING





RESOURCE CONSERVATION AND EFFICIENT UTILIZATION OF RESOURCES

Sustainable site planning

The process of site selection for sustainable development involves identifying and analysing the site with respect to the sustainable building design criteria. The development of the site for building purposes requires disruption and interventions. The most sustainable and environment-sensitive development is one that entails minimal site disturbance. Thus, resource conservation in a given site is of prime importance. The criteria for getting points under this head have been elaborated below. The resource efficiency measures are aimed at applying appropriate site planning techniques, concepts and design utilization of site resources, minimize on-site vehicular pollution, enhance energy efficiency of site lighting, and enhance functional efficiency of the utility lines.

Criterion 1 Site selection

Objective

Site selection is the first step to a sustainable habitat and needs to be done appropriately, prior to commencement of design phase. Site selection and analysis should be carried out to create living spaces that are in harmony with the local environment. The development of a project should not cause damage to the natural surroundings of the site but, in fact, should try to improve it by restoring its balance. Thus, site selection should be carried out in light of a holistic perspective of

- Preservation and optimal use of the environment
- Land use
- Development intensity
- Social well-being

(in accordance with NBC 2005 Part 3 development control rules and general building requirements)

1.1 Commitment

- 1.1.1** The selected site should be in conformity with the development plan/master plan/UDPFI (Urban Development Plans Formulation and Implementation) guidelines (mandatory). This should comply with the provisions of eco-sensitive zone regulations, coastal zone regulations, heritage areas (identified in the master plan or issued separately as specific guidelines), water body zones (in such zones, no construction is permitted in the water-spread and buffer belt of 30 m minimum around the FTL [full tank level]), various hazard prone area regulations, and others if the site falls under any such area.
- 1.1.2** The selected site should be located within ½ km radius of an existing bus stop, commuter rail, light rail or metro station and/or select Brownfield site (to rehabilitate damaged sites where development is hindered by environmental contamination, thereby reducing pressure on undeveloped land.



1.2 Compliance

The following documents are to be submitted.

- 1.2.1 Document to prove conformity to the development plan/master plan/UDPFI guidelines.
- 1.2.2 Site plan (one AutoCAD [computer aided design] drawing) showing the site and its surrounding areas (up to 2 km radius)
- 1.2.3 Site plan (one AutoCAD drawing) showing the site connectivity to public transport corridors and details of the existing site and/or its feasibility to be converted for redevelopment if the selected site is a brown field site.

1.3 Appraisal (maximum points 1) partly mandatory

- 1.3.1 The site plan must be in conformity to the development plan/master plan/UDPFI guidelines (mandatory). This should comply with the provisions of the eco-sensitive zone regulations, coastal zone regulations, heritage areas (identified in the master plan or issued separately as guidelines), water body zones (in such zones, no construction is permitted in the water spread and buffer belt of 30 m minimum around the FTL), various hazard prone area regulations, and others if the site falls under any such area (**mandatory with no point allocation**).
- 1.3.2 The site should be located within ½ km radius of an existing bus stop commuter rail, light rail or metro station and/or select Brownfield site (to rehabilitate damaged sites where development is hindered by environmental contamination, thereby reducing pressure on undeveloped land. **(1 point)**)



Criterion 2 Preserve and protect landscape during construction

Objective

To preserve the existing landscape and protect it from degradation during the process of construction.

(in accordance with NBC 2005 Part 10)

2.1 Commitment

- 2.1.1** Select proper timing for the construction activity to minimize site disturbance such as soil pollution due to spilling of the construction material and its mixing with rainwater.
- 2.1.2** Use staging and spill prevention and control plan to restrict the spilling of the contaminated material on site.
- 2.1.3** Protect the top soil from erosion. Use collection storage and reapplication of the top soil, sediment basin, contour trenching, mulching, soil stabilization methods to protect the top soil from erosion during construction.
- 2.1.4** Specify and limit construction activity in pre-planned/designated areas.
- 2.1.5** Preserve existing mature trees on-site during the course of construction by preserving and transplanting them.
- 2.1.6** Compensate the loss of vegetation (trees) due to the construction activity by compensatory plantation. Replant the same number of mature or fully grown trees as eliminated during the construction of the proposed landscape design. Replant the same, native and/or non-invasive species, which existed on the site before elimination in the proportion of 1:3.
- 2.1.7** Plant in excess of 25% to the minimum required (that is in addition to the requirement prescribed in commitment 2.1.6) within the site premises (plantation to follow same criteria as above).

2.2 Compliance

The following documents are to be submitted

- 2.2.1** Certificate of architect in prescribed format confirming the proper timing of construction.
- 2.2.2** CAD (computer aided design) drawing showing site plan of existing and proposed buildings, existing vegetation, existing slopes, and drainage pattern. Demarcate areas on the site plan to which site activities will be limited.
- 2.2.3** Site plan showing staging and spill prevention measures, erosion and sedimentation control measures.
- 2.2.4** One document to be submitted after construction of the building, a brief description along with photographic records to show that other areas have not been disrupted during construction. The document should also include brief explanation and photographic records to show erosion and sedimentation control measures adopted. (Document CAD drawing showing site plan details of existing vegetation, existing buildings, existing slopes and site drainage pattern, staging and spill prevention measures, erosion and sedimentation control measures and measures adopted for top soil preservation during construction).
- 2.2.5** Site plan (one CAD drawing) along with a narrative to demarcate areas on site from which top soil has to be gathered, designate area where it will be stored, measures adopted for top soil preservation.



- 2.2.6 One CAD drawing showing proposed landscape plan with identification of trees (different colour coding for trees to be used for protected, preserved, transplanted, removed trees) corresponding to the existing tree survey table (to be included in the drawing), existing and new buildings, proposed site drainage pattern. Explain in brief measures adopted for protecting existing landscape (limit to 250 words).
- 2.2.7 Certificate of landscape architect confirming proper protection and preservation of existing trees during construction process.
- 2.2.8 Landscape plan, clearly highlighting the trees removed areas (indicating the number of trees), if applicable, with the number of replanted trees in the proportion of 1:3 in the proposed landscape design. List details about species, which existed, and the species that have been replanted on-site.
- 2.2.9 Landscape plan to show that plantation in excess of 25% than minimum requirement has been done.

2.3 Appraisal (maximum points 5) partly mandatory, if applicable

- 2.3.1 Ensure proper timing of construction with respect to rain, as per clause 2.2.1. and
- 2.3.2 Confine construction activity to pre-designated areas, as per clause 2.2.2 **(1 point)**.
- 2.3.3 Proper implementation of staging and spill prevention plan and
- 2.3.4 Effective erosion and sedimentation control to prevent erosion, as per clause 2.2.3 **(1 point)**.
- 2.3.5 Preserve top soil by employing suitable measures **(1 point)**.
Non Applicability condition: Contaminated sites/sites that do not have good quality top soil (as per soil test report) that is considered worth storing for reuse. Soil test has to be carried out as per criteria 3 and the test report has to be endorsed by the landscape architect. The landscape architect has to provide certificate that the top soil is not worth storing for landscaping purposes and cannot be restored to applicable standard.
- 2.3.6 Preserve existing vegetation by means of non-disturbance or damage to the trees and other form of vegetation, as per clauses 2.2.6 and 2.2.7 Or
- 2.3.7 Trees/plants replanted within site premises in ratio of 1:3, as per clause 2.2.8 **(1 point – mandatory)**.
Non Applicability condition: Sites that are devoid of trees.
- 2.3.8 Trees/plants replanted within site premises in excess of 25% than minimum requirement as per clause 2.2.9 **(1 point)**.
Non Applicability condition: Sites that are devoid of trees.

Note If mandatory points are not complied, other points in this criterion will not be considered.



Criterion 3 Soil conservation (till post-construction)

Objective

Conserve top soil till after completion of construction activity.
(in accordance with NBC 2005 Part 10)

3.1 Commitment

- 3.1.1 Ensure adequate fertility of the soil to support vegetative growth.
- 3.1.2 Ensure adequate topsoil laying for vegetative growth.
- 3.1.3 Ensure stabilization of soil in the area where the topsoil is vulnerable to erosion.

3.2 Compliance

The following documents to be submitted.

- 3.2.1 Site contour plan (one CAD drawing) showing drainage pattern and demarcating (a) areas where top soil laying is done, and (b) area where vegetation cover is provided for top soil protection.
- 3.2.2 Narrative explaining the methods of soil stabilization used; wherever required, accompanied by photographs with brief discription.
- 3.2.3 Certificate by the landscape architect on topsoil laying, soil stabilization, and adequate primary soil nutrient and pH [(supported by test results performed at Indian Council of Agricultural Research (ICAR)–accredited laboratory)].

3.3 Appraisal (maximum points 2)

- 3.3.1 Proper top soil laying for vegetative growth, as per clauses 3.2.1 (a), 3.2.2, 3.2.3 **(1 point)**
- 3.3.2 Proper stabilization of soil, as per clauses 3.2.1 (b), 3.2.2, 3.2.3 **(1 point)**
Non Applicability condition: For sites in which top soil could not be stored for reasons as cited in Criterion 2.



Figure 1 Top soil preservation in Doon School, Dehradun

Criterion 4 Design to include existing site features

Objective

The natural functions of a plot of land (hydrologic, geologic, and microclimatic) can be disrupted by the placement of a building on it. The design of a green building will factor in ways in which the natural site features can be protected or even restored.

Layout the site activities and building requirements after carrying out detailed site analysis so as to ensure sustainable site development in tune with its topographical, climatic, and ecological character.

4.1 Commitment

- 4.1.1** Carry out a comprehensive site analysis to identify site characteristics that can be used to harness natural resources (like solar energy, wind, and water) and the potential qualities of the landforms that could contribute to making different areas of the site visually and thermally more comfortable for users.
- 4.1.2** Locate various activities of the scheme after careful site analysis and assessment so as to protect ecologically sensitive areas and reduce damage to the natural ecosystem.
- 4.1.3** Identify areas of the site that were damaged during construction.

4.2 Compliance

The following documents to be submitted.

- 4.2.1** Provide drawings along with a narrative to demonstrate that the zoning of areas on-site is appropriate to existing site features (such as slopes, vegetation, water bodies, and other natural formations). Support these with visual documentation such as photographs and land survey records before and after construction.
- 4.2.2** Carry out detailed site analysis and provide narrative to demonstrate sustainable site planning.

4.3 Appraisal (Maximum points 4)

If all compliances are fulfilled as per clause, 4.2.1,4.2.2. **(4 points)**



Figure 2 The CESE building in IIT, Kanpur has been designed to maximise tree preservation and proper orientation.

Criterion 5 Reduce hard paving on-site and/or provide shaded hard-paved surfaces

Objective

To reduce hard paving on-site (open areas surrounding building premises) and/or provide shade on hard-paved surfaces to minimize the heat island effect and imperviousness of the site.

5.1 Commitments

- 5.1.1** Net paved area of the site under parking, roads, paths, or any other use not to exceed 25% of the site area or net imperviousness of the site not to exceed the imperviousness factor as prescribed by the National Building Code of India, Bureau of Indian Standards, 2005; Part 9 (Plumbing services) Section 5.5.11.2.1, whichever is more stringent.
- 5.1.2** Total surface parking not to exceed the area as permissible under the local bylaw and
- more than 50% of the total paved area to have pervious paving/open grid pavement/ grass pavers, or
 - a minimum 50% of the total paved area (including parking) to have shading by vegetated roof/pergola with planters, or
 - a minimum 50% of the total paved area (including parking) to be topped with finish having solar reflectance of 0.5 or higher.

Combination

Minimum 50% of total paved area to have any combination of above mentioned strategies for pervious paving shaded paved area or area with SRI (solar reflectance index) > 50% where common area having 2 or more strategies shall be calculated only once.

5.2 Compliance

The following may be submitted.

- 5.2.1** Calculations to support design commitment, as per following equations (1–6)

$$\text{Net paved area (\%)} = \frac{\text{Net impervious area on ground (sq. m.)}}{\text{Total site area minus building footprint (sq. m.)}} \times 100 \quad \text{equation (1)}$$

Impervious paved area on-site to include parking, driveways, sidewalks, roads, boundary wall, often plazas walkways, etc. Exclude areas that have pervious paving (grass pavers, open grid pavements, gravel paving, etc.) Total site area is an area of plot used for calculation of floor area ratio/floor space index.

$$\text{Net imperviousness of site (m}^2\text{)} = \text{Surface area} \times \text{Runoff coefficient} \quad \text{equation (2)}$$

(from table 5.1)

$$\text{Imperviousness (\%)} = \frac{\text{Net imperviousness of site as per equation 2(m}^2\text{)}}{\text{Total site area(m}^2\text{)}} \times 100 \quad \text{equation (3)}$$

$$\frac{(\text{Pervious paving} + \text{paving with vegetated roof/shading} + \text{paving with high SRI}) > 50\%}{\text{Total Paved area}} \quad \text{equation (4)}$$



Total paved area onsite include parking, dry waste, side walks, roads, boundry walls, often plazas, walkways etc.

5.2.2 Site plan (one drawing) with area statements clearly showing all paved areas (paved areas should be labelled as per use, e.g. walkways, driveways, parking, sit out etc.). The following details should be followed as applicable.

- Demarcate areas that have vegetated roof. Provide details of vegetated roof.
- In case high reflectance surface is provided, submit details of reflectance of surface finish.
- Demarcate areas having previous paving.

5.2.3 Certificate by Architect to certify that total surface parking not to exceed as permitted by local bylaw.

5.3 Appraisal (maximum points - 2) partly mandatory

5.3.1 Net paved area of site under parking, roads, paths, or any other use not to exceed 25% of site area or net imperviousness of site should not exceed the imperviousness factor as prescribed by National Building Code 2005, Part 9 (Plumbing services) section 5.5.11.2.1, whichever is more stringent. As per clause equation 1 and equation 4 (Reference documents: 5.2.1 and 5.2.2) **(1 point)**

5.3.2 Total surface parking not to exceed as permitted by local bylaw (mandatory) and

- more than 50% of the total paved area to have pervious paving/open grid pavement/ grass pavers (equation 4), or
- minimum 50% of the total paved area (including parking) to have shading by vegetated roof/pergola with planters (equation 4), or
- minimum 50% of the total paved area (including parking) to be topped with finish with solar reflectance of 0.5 or higher (equation 4). (Reference documents: 5.2.1 and 5.2.2)
- Minimum 50 % of total paved area (including parking) to have any combination of the above mentioned strategies where common area having two or more strategies shall be calculated only once (equation 4). **(1 point)**



Criterion 6 Enhance outdoor lighting system efficiency and use renewable energy system for meeting outdoor lighting requirement

Objective

Enhance energy efficiency of outdoor lighting and promote usage of renewable forms of energy to reduce the use of conventional/fossil fuel based energy resources.

Commitment

- 6.1.1** Luminous efficacy of external light sources used for outdoor lighting shall equal or exceed as specified.
- 6.1.2** All outdoor lighting to be fitted with an automatic on/off switch.
- 6.1.3** A minimum of 25% of the total number or 15% of the total connected load of outdoor lighting fixtures (whichever is higher) to be powered by solar energy. Outdoor lighting system includes
 - (i) security lighting,
 - (ii) street lighting,
 - (iii) landscape lighting,
 - (iv) façade lighting, and
 - (v) parking lighting.

6.2 Compliance

The following documents are to be submitted.

- 6.2.1** Luminous efficacy of each type of lamp used in outdoor lighting.
Luminous efficacy (lm/W) = {lamp lumen output (lm)}/{lamp wattage (W) + ballast power loss (W)}.
- 6.2.2** Outdoor lighting layout with manufacturers' details of lamps, ballasts, luminaires, and automatic controls. Wiring diagram and placement of automatic switch(es) for outdoor lighting.
- 6.2.3** Demarcate solar lighting systems for outdoor lighting in outdoor-lighting layout and give details of the same.

6.3 Appraisal (maximum points -3)

- 6.3.1** Luminous efficacy of 100% of lamps used in outdoor lighting meets the corresponding lamp luminous efficacy as per clause 6.2.1 **(1 point)**.
- 6.3.2** Automatic controls for 100% of outdoor lights, as per clause 6.1.2 **(1 point)**.
- 6.3.3** Percentage of total outdoor lighting fixtures with solar lighting system, as per clause 6.1.3 (a minimum of 25% of total number or 15% of total connected load, whichever is higher) **(1 point)**



Criterion 7 Plan utilities efficiently and optimize on-site circulation efficiency

Objective

To reduce site disruption due to laying, maintain utility lines, and minimize energy use by on-site utilities. To reduce transportation corridors on-site, thus reducing the pollution loads.

7.1 Commitment

- 7.1.1** Design a site plan to minimize road length and building footprint. Shade all pedestrian roads by vegetated roofs/any other shading devices.
- 7.1.2** Use aggregate utility corridors.
- 7.1.3** Consolidate utility corridors along the previously disturbed areas or along new roads, in order to minimize unnecessary cutting and trenching and to ensure easy maintenance. Local codes and requirements for water, sewer, and electrical/telecommunication lines should be considered.
- 7.1.4** Consolidate services, pedestrian, and automobile paths.

7.2 Compliance

The following documents are to be submitted.

- 7.2.1** A narrative (maximum 300 words) along with supporting drawings to prove that road lengths and building footprint are minimized and that all pedestrian roads have permanent shading.
- 7.2.2** Site plan (CAD file) showing section of aggregate utility corridor with utility lines.
- 7.2.3** Site plan (CAD file) showing that all services along with the pedestrian and vehicular paths are consolidated.

7.3 Appraisal (maximum points - 3)

- 7.3.1** Demonstrated use of minimization and consolidation of transportation/service corridors and shading of pedestrian roads, as per clause 7.2.1 **(1 point)**.
- 7.3.2** Use of aggregate utility corridors, as per clause 7.2.2 **(1 point)**.
- 7.3.3** Consolidation of utility corridors along the previously disturbed areas or along new roads in order to minimize unnecessary cutting and trenching and ensure easy maintenance, as per clause 7.2.3 **(1 point)**.



Health and well-being

Construction activities are large polluters of environment. Large volumes of suspended particulate matters are released during construction work leading to air pollution. Unhygienic site sanitation facilities cause damage to the environment and to the health of the construction workers. Green buildings should address these issues.

Criterion 8 Provide minimum level of sanitation/safety facilities for construction workers

Objective

To ensure the health and safety of workers during construction, with effective provisions for the basic facilities such as sanitation and drinking water, and safety of equipment or machinery.

8.1 Commitment

- 8.1.1** Comply with the safety procedures, norms and guidelines (as applicable) as outlined in NBC 2005 (BIS 2005c).
- 8.1.2** Adopt additional best practices and prescribed norms as in NBC 2005 (BIS 2005c).
- 8.1.3** Provide clean drinking water to all workers.
- 8.1.4** Provide adequate number of decentralized latrines and urinals to construction workers.

8.2 Compliance

The following documents are to be submitted.

- 8.2.1** Signed letter by competent authority (architect/contractor) to demonstrate compliance with NBC 2005 (BIS 2005c) and proposed additions.
- 8.2.2** Proof in the form of relevant sections of tender document to show that the safety norms and procedures as committed to be complied with are included in the scope of work of the contractor.
- 8.2.3** Site photographs to demonstrate compliance by the contractor.
- 8.2.4** Detailed narrative (not more than 250 words) on provision for safe drinking water and sanitation facility for construction workers and site personnel.

8.3 Appraisal (maximum points - 2) mandatory

- 8.3.1** Compliance with National Building Code norms on construction safety for ensuring safety during construction (**1 point**), as per clauses 8.2.1, 8.2.2, and 8.2.3.
- 8.3.2** Provision for health and sanitation facilities as specified above (**1 point**), as per clause 8.2.4.



Figure 3 Safety measures in construction site

Criterion 9 Reduce air pollution during construction

Objective

The dust generated by various construction site activities can contribute significantly to air pollution. Dust and outdoor air pollutants can cause respiratory problems. Good construction practices involve major mitigation measures for prevention or minimization of air pollution from construction activities. This criterion aims to reduce air pollution due to on-site construction.

9.1 Commitment

- 9.1.1** Adopt measures to prevent air pollution in the vicinity of the site due to construction activities. There is no standard reference for this. The best practices should be followed (as adopted from international best practice documents and codes).
- 9.1.2** Provision in the contract document that the contractor will undertake the responsibility to prevent air pollution (dust and smoke); ensure that there will be adequate water supply/storage for dust suppression; devise and arrange methods of working and carrying out the work in such a manner so as to minimize the impact of dust on the surrounding environment; and provide experienced personnel with suitable training to ensure that these methods are implemented. Prior to the commencement of any work, the methods of working, plant equipment, and air-pollution-control system to be used on-site should be made available for the inspection and approval of the engineer-in-charge to ensure that these are suitable for the project.

9.2 Compliance

The following documents are to be submitted.

- 9.2.1** Narrative (not more than 300 words) explaining the air pollution preventive measures that have been adopted on-site. Site photographs showing different stages of construction along with preventive measures to support the claim.
- 9.2.2** Relevant sections of tender document showing that air pollution prevention measures are mandatory are to be adopted by contractors during construction.

9.3 Appraisal (maximum points - 2) mandatory

- 9.3.1** Demonstrated use of air pollution preventive measures, as per clauses 9.2.1 and 9.2.2 **(2 points)**.



BUILDING PLANNING AND CONSTRUCTION

An integrated approach to building planning and construction is required to achieve maximum benefit in terms of the environment. Appropriate interventions at the design and construction stages are critical to any sustainable building. These interventions lead to reduced demand for depletable resources and efficient resource utilization. Options for recycling and reuse of waste adds to the sustainability of the building as a system.

Conservation and efficient utilization of resources

Appropriate interventions at the planning and design stage can save valuable resources (water, energy, and materials) throughout the life cycle of a building. The following criteria aim to ensure saving such valuable resources.

Criterion 10 Reduce landscape water requirement

Objective

To reduce the landscape water requirement so as to minimize the load on the municipal water supply and depletion of groundwater resources.

10.1 Commitment

10.1.1 Design the landscape so as to reduce water consumption by 30% or more (up to 50%).

10.2 Compliance

The following documents are to be submitted.

- 10.2.1** Narrative demonstrating water saving measures adopted in the landscape plan.
- 10.2.2** Plan indicating the plants list, nature of species, and area covered.
- 10.2.3** Calculation of the water requirement after establishment for landscape in LPD (litres per day) for each month due to variation in PET (potential evapo-transpiration rate).
- 10.2.4** Provide cut sheets of the irrigation equipment showing technical specifications, such as flow rate and dimensions.

10.3 Appraisal (maximum points - 3)

- 10.3.1** Reduction in water consumption by 30%, as per clause 10.2.3 (1 point).
- 10.3.2** Reduction in water consumption by 40%, as per clause 10.2.3 (1 point).
- 10.3.3** Reduction in water consumption by 50%, as per clause 10.2.3 (1 point).



Criterion 11 Reduce the water use by the building

Objective

To reduce water consumption in the building by using efficient fixtures.

11.1 Commitment

Reduce the total water consumption in the building (by 25% or more) by using low-flow fixtures.

11.2 Compliance

The following documents are to be submitted.

- 11.2.1** Narrative demonstrating adopted water-saving measures adopted.
- 11.2.2** Specification sheets from manufacturers for each fixture, indicating the flow rates (at design pressure of 80 psi for faucets).
- 11.2.3** Bill of quantities from the plumbing tender indicating the number and flow rates of various fixtures.
- 11.2.4** Provide design basis calculations demonstrating the reduction in the building's water demand as 25% or more.

11.3 Appraisal (maximum points - 2)

- 11.3.1** Reduction in water consumption by 25%. **(1 point)**
- 11.3.2** Water-use reduction by 50%. **(additional 1 point)**



Figure 4 Low flow faucets



Criterion 12 Efficient water use during construction

Objective

To minimize use of potable water during construction activity.

12.1 Commitment

- 12.1.1** Use materials such as pre-mixed concrete for preventing water loss during mixing.
- 12.1.2** Use recycled treated water.
- 12.1.3** Control the wasting of curing water .

12.2 Compliance

The following documents should be submitted.

- 12.2.1** Certificate of architect, confirming the initiatives taken on site to minimize the use of potable water during construction.
- 12.2.2** Narrative on the initiatives on water use minimization, indicating the various sources of water.

12.3 Appraisal (1 point)

- 12.3.1** Efforts to minimize potable water use for construction as per clause 12.2.1, 12.2.2 **(1 point)**

Note: This point is completely subject to evaluator's discretion



Criterion 13 Optimize building design to reduce conventional energy demand

Objective

To apply climate responsive building design measures, including day-lighting and efficient artificial lighting design, in order to reduce the conventional energy demand.

13.1 Commitment

13.1.1 In order to optimize the building design appropriate climate responsive design strategies should be adopted, such as-

- 1 Optimize the orientation of the building; and/ or
- 2 Place the buffer spaces (such as- toilets, corridors, staircases, lifts and service areas etc.) along western and eastern facades and/ or
- 3 Provide maximum openings on North and South; and/or
- 4 Shade the building surfaces getting maximum solar exposure (such as- wall, roof, courtyard) with the use of external shading devices; eg. space frame, jallis, pergola, trees, green wall, terrace garden etc. and/ or
- 5 Design appropriate shading for all the fenestrations getting direct solar radiation by using sun path analysis or shading norms (prescribed in the table-9 & 10 of Handbook on functional requirements of buildings other than industrial buildings) etc.

13.1.2 The WWR (window to wall ratio) is limited to a maximum of 60% of gross wall area and the SRR (skylight to roof ratio) is limited to a maximum of 5% of gross roof area as prescribed in Energy Conservation Building Code (ECBC)-2007.

13.1.3 Demonstrate that the effective Solar Heat Gain Coefficient (SHGC) of the fenestration (accounting for glazing, overhangs and/ or vertical fins) is compliant with the maximum SHGC requirement prescribed by ECBC-2007. (Refer ECBC Table-4.3)

13.1.4 Ensure that the total daylighted area (Refer Appendix-A, ECBC-2007) of the proposed building is $\geq 25\%$ of the total living area (Refer table-2, SP41) and achieve the recommended daylight factor (DF) (Refer Table-2, SP41) at the centre of the daylighted area or the average on the daylighted area in a design sky condition (Refer Part-8, National Building Code -2005) to fetch two mandatory points.

- For every 25% increase in the total daylighted area upon the total living area shall fetch one additional point on each. This shall however be non mandatory.

Note: The daylight clause is not mandatory for all other living spaces that are not listed in the Table-2, Sp41; however similar points can be awarded for respective daylighted area as mentioned above and DF can be decided based on project specific daylight requirement.

13.1.5 Perform artificial lighting simulation to demonstrate that the lighting levels in indoor spaces are maintained as recommended in NBC 2005 (BIS 2005d).

13.2 Compliance

The following documents are to be submitted.

13.2.1 Site plan giving north line, all the building plans with internal layout showing all functional spaces and interior layout, four side elevations, building sections and fenestration details (if



available). (The drawings shall be referred to during post-occupation review).

- 13.2.2** Perform a sun path analysis for each exposed fenestration or use shading norms (prescribed in the Table 9 & 10 of Handbook on functional requirements of buildings other than industrial buildings) to demonstrate the optimum shading requirement.
- 13.2.3** Detail Window & Skylight schedule of the proposed building.
- 13.2.4** Submit the detail calculation in the prescribed format for WWR and/ or format for SRR; to demonstrate the percentage of vertical fenestration on gross wall area and/ or percentage of horizontal fenestration on gross roof area. (Refer table-13.3.1 & 13.3.2).
- 13.2.5** Provide the calculated SHGC in the prescribed format for window details (Table 13.4) to support that all proposed fenestration meet the SHGC requirement as prescribed in ECBC 2007. (Use the online SHGC calculator to calculate the effective SHGC for each fenestration accounting for Glazing and Overhangs and/ or Side fins).
- 13.2.6** Submit the calculated daylighted area in the following format (table-13.5.1 & 13.5.2) to show that the total daylighted area is $\geq 25\%$ of the living area of the proposed building (as specified in table-13.2) and provide the calculated DF in the format for daylight factor calculation (table 13.5.3) to demonstrate that all the living areas compliance with IS: 2440-1975.
- 13.2.7** Lighting level simulation result outputs for all areas to demonstrate lighting level compliance with BIS (Refer table-13.6).
- 13.2.8** Provide certificates from architect/service consultant on compliance with clause 13.1.4.
- 13.2.9** Provide certificates from architect/service consultant on compliance with clause 13.1.5.

13.3 Appraisal (Maximum points - 8 and Mandatory points- 6)

- 13.3.1** By adopting appropriate climate responsive building design with the limited WWR and/ or SRR as mentioned above and all the fenestrations meet the SHGC requirement of ECBC-2007, as per clause 13.2.3 to 13.2.5 **(2 points - Mandatory)**
- 13.3.2** Minimum of 25% of the living area (as mentioned above) should be daylighted and adequate level of daylight is provided as prescribed by IS code as per clause 13.2.6 & 13.2.8 **(2 points- Mandatory)** and/ or
 - If the total daylighted area $> 50\%$ of total living area **(1 point - Additional)** and/ or
 - If the total daylighted area $\geq 75\%$ of total living area **(1 point - Additional)**
- 13.2.3** Over-design of lighting system is avoided as per clause 13.2.7 and 13.2.9 **(2 points - mandatory).**



Figure 5 Downdraft cooling system

Criterion 14 Optimize energy performance of building within specified comfort limits

Objective

To optimize use of energy systems in buildings that maintain a specified indoor climate conducive to the functional requirements of the building.

14.1 Commitment

- 14.1.1** Follow mandatory compliance measures (for all applicable buildings) as recommended in the Energy Conservation building Code 2007 of the BEE, Government of India.
- 14.1.2** Perform hourly calculation to show that in air conditioned areas the thermal comfort conditions as specified in the NBC 2005 (BIS 2005e) are met for 100% of all occupied hours.
- 14.1.3** Perform hourly calculations to show that in non-air conditioned areas, the thermal comfort conditions as specified in the NBC 2005 (BIS 2005e) are met for 90% of all occupied hours for buildings in composite, moderate and hot-dry climate and are met for 60% of all occupied hours for buildings in warm-humid climate .
- 14.1.4** Show that utilization of energy systems in a building, under a specified category is less than the benchmarked energy consumption figure, through a simulation exercise. The energy systems includes air conditioners, indoor lighting systems, water heaters, air heaters and air circulation devices.
- 14.1.5** The annual energy consumption of energy systems in a fully air-conditioned building (for day and 24 × 7 use) should not exceed the limits of benchmarked energy consumption figure in GRIHA.
- 14.1.6** The annual energy consumption of energy systems in a non-air-conditioned building for day use should not exceed limits of benchmarked energy consumption figures in GRIHA.
- 14.1.7** In a building that includes both air-conditioned and non-air-conditioned areas, the annual energy consumption of energy systems should not exceed the benchmarked energy consumption limits.
- 14.1.8** Quantify energy usage for all electrical, mechanical, and thermal systems for which either electrical or thermal energy is used. Quantify energy usage for each system used in providing lighting , air conditioning , ventilation , heating (water and air), and air circulation.

14.2 Compliance

The following documents should be submitted.

- 14.2.1** A narrative and drawings from architect/services consultant along with manufacture cutsheet, describing compliance of the building with the mandatory provisions (section 4.2, 5.2, 6.2, 7.2 and 8.2) of the ECBC 2007 of BEE (GoI).
- 14.2.2** Annual energy consumption data for the building and the unmet comfort conditions for non-AC area, as per GRIHA, supported by the simulation results from the software used.



14.3 Appraisal (16 points) partly mandatory

- 14.3.1** Compliance with ECBC as per clause 14.2.1 (**6 points mandatory**).
- 14.3.2** Compliance with thermal comfort condition as prescribed in NBC 2005 as per clause fo14.2.1 and achievement of EPI as per clause 14.2.2. (**2 points mandatory**)
- 14.3.3** Every 10% reduction in EPI of the building under a specified category shall fetch additional two points to a minimum of 8 points (40% reduction in EPI from the benchmark). (**2–8 points**)



Criterion 15 Utilization of flyash in building structure

Objective

To use low embodied energy industrial waste fly ash as the construction material. Fly ash, an industrial waste having the properties of cement and very low embodied energy is used in combination with cements that are high in embodied energy.

15.1 Commitment

- 15.1.1** RC (reinforced concrete) (including ready-mix concrete) to make use of fly ash by using PPC (Portland pozzolona cement) containing fly ash. A minimum of 15% replacement of cement with fly ash in PPC (by weight of the cement used) in the overall RC for meeting the equivalent strength requirements.
- 15.1.2** Use fly ash in building blocks for the walls.
- 15.1.3** Use fly ash in Plaster/masonry mortar by employing PPC. Use plaster and/or masonry mortar, which utilizes a minimum 30% of fly ash in PPC, in 100% wall/ceiling finishes and wall construction, meeting the required structural properties.

15.2 Compliance

The following documents should be submitted.

- 15.2.1** Fly ash use in RC: Minimum 15% replacement of cement with fly ash by weight of cement used in the total structural concrete. Provide supporting document from the manufacturer of the cement specifying the fly ash content in PPC used in reinforced concrete.
- 15.2.2** For use of fly ash in building blocks of load bearing and non-load bearing wall: Minimum 40% utilization of fly ash by volume of materials, for 100% load bearing and non-load bearing walls. Provide supporting document from the manufacturer of the pre-cast building blocks specifying the fly ash content of the blocks used in an infill wall system.
- 15.2.3** For use of fly ash in plaster and masonry mortar: Minimum 30% use of fly ash in place of cement by weight in overall plaster and mortar requirement. Provide supporting document from the manufacturer of the cement/ready mix concrete, specifying the fly ash content in PPC used in plaster and masonry mortar.
- 15.2.4** Certificate from the architect specifying overall replacement of cement in the RC, pre-cast building blocks plaster and masonry in specified format (in prescribed certificate format).

15.3 Appraisal (maximum points - 6)

- 15.3.1** Minimum 15% replacement of Portland cement with fly ash by weight of cement used in structural concrete, as per clause 15.2.1 – **1 point** (additional 1 point if more than 30%).
- 15.3.2** Minimum 40% usage of fly ash by volume of materials used for 100% load bearing and non-load bearing walls, as per clause 15.2.2 – **(2 points)**
- 15.3.3** Certify minimum 30% replacement of OPC with fly ash by weight of cement used in plaster/masonry mortar, as per clause 15.2.3 **(2 points)**.



Criterion 16 Reduce volume and weight, and time of construction by adopting efficient technologies (for example, pre-cast systems, and so on.)

Objective

Replace a part of energy-intensive materials with less energy-intensive materials and/or utilize regionally available materials, which use low-energy/energy-efficient technologies.

16.1 Commitment

16.1.1 Structural application

Use of low-energy technologies/materials (not based on the utilization of fly ash), such as roofing/flooring, columns, and load-bearing walls, for structural applications. Use such technologies to demonstrate a minimum 5% reduction in the overall embodied energy, when compared to equivalent products for the same application, for a 100% structural system used in a building, thus meeting the equivalent strength requirements.

Examples of low-energy products and technologies used in structural applications

Technologies such as pre-stressed slab, extruded structural clay joist and filler slab, hollow floor/roof slabs, burned clay filler pots with RCC structure, micro-concrete roofing, precast hollow plank roofing, funicular shells, zipbloc system, composite columns, reinforced grouted brick masonry, stone masonry, precast stone blocks, pre-cast concrete blocks, pre-cast finished concrete blocks, light-weight concrete blocks over dense concrete blocks, and rat trap masonry.

16.1.2 Non-structural application: masonry/infill wall system

Use of low-energy technologies/materials (not based on the utilization of fly ash) for non-structural applications. Use such technologies to demonstrate a minimum 5% reduction in the embodied energy, when compared to equivalent products for the same application, for 100% infill wall system used in a building, meeting the equivalent strength requirements.

Examples of low-energy product and technologies in non-structural applications

Infill wall system using traditional mud walling system, stabilized adobe walling, compressed earth blocks, hollow, perforated/ modular bricks, interlocking bricks, traditional stone masonry, pre-cast non-load-bearing concrete blocks, finished concrete blocks, light weight concrete blocks over dense concrete blocks, pre-cast brick panels, composite ferrocement walling, interlocking concrete blocks, rat trap masonry, and so on.

16.2 Compliance

The following documents are to be submitted.

- 16.2.1** Cut sheets, specification sheets and bill of quantity demonstrating the percentage reduction in embodied energy with the use of low-energy materials/efficient technologies.
- 16.2.2** Document to demonstrate the use of the aforesaid technologies in the relevant floor plans, with clear dimensions and enlisting of specifications.



16.2.3 Narrative showing how the selected technology has amounted to reduction in high-energy materials or regional availability when compared with equivalent products for the same application. On-site photographs and construction project management plan, which would clearly demonstrate the use/ construction/specifications of low-energy technologies.

16.3 Appraisal (maximum 4 points)

16.3.1 Structural application

Use of low-energy materials/efficient technologies in structural application clearly demonstrating a minimum 5% reduction in the embodied energy, when compared with equivalent products for the same application, for 100% structural system used in a building, meeting the equivalent strength requirements, as per all compliance clauses **(2 points)**.

16.3.2 Non-structural application

Use of low-energy materials/efficient technologies (not based on the utilization of industrial waste), which are used for non-structural applications such as infill wall system and cause a minimum five per cent reduction in the embodied energy, when compared with equivalent products for the same application, for 100% infill wall system used in a building, meeting the equivalent strength requirements, as per all the compliance clauses **(2 points)**.



Criterion 17 Use low-energy material in interiors

Objective

To use low-energy/recycled materials/finishes/products in the interiors, which minimize the use of wood as a natural resource. To use low-energy materials and products, such as composite wood products/renewable materials/reused wood/low embodied energy products/products which utilize industrial waste/recycled products.

The various interior finishes used in the sub-system of the building or the interior, which serve the aim of the credit, have been divided into the following three major categories. If any interior finish, acclaimed for credit, falls beyond this classification, the applicant has to clearly confirm the criteria that meet the requirements of the credit.

Sub-assembly/internal partitions/interior wood finishes/panelling/false ceiling/in-built furniture/cabinetry flooring doors/windows and frames.

17.1 Commitment

A minimum of 70% of the total quantity of all interior finishes and products used in each of the categories mentioned above should be low-energy finishes/materials/products, which minimize wood as a natural resource or utilize industrial waste by using products in any category.

17.2 Compliance

The following documents are to be submitted.

- 17.2.1 Cut sheets, specification sheets, commercial brochures or certificate from the manufacturer of the low energy finishes or products used in each category.
- 17.2.2 For each category, clearly demonstrate and differentiate the use of the aforesaid finishes/products in the relevant interior layouts/plans in a CAD drawing, either by shading, rendering or highlighting with clear dimension and enlisting specifications.
- 17.2.3 The bill of quantity for each of the category, as applicable to the applicant, clearly demonstrating that minimum 70% of the total quantity of all interior finishes and products are low energy.
- 17.2.4 A narrative and photographs showing how the selected low-energy finishes or products have minimized wood as natural resource or utilized low energy material and products, when compared with equivalent products for the same application.
- 17.2.5 Certificate from architect/interior designer for use of low-energy material/product in various categories meeting required criteria as described in the Commitment.

17.3 Appraisal (maximum 4 points)

Minimum 70% of the total quantity (gross area) of all interior finishes and products used for each of the category, as applicable to the applicant, to be low-energy finishes, for each of the following category.

- 17.3.1** Sub-assembly/internal partitions/panelling/false ceiling/in-built furniture (**2 points**) – as per clauses 17.2.1–17.2.5.
- 17.3.2** Flooring (**1 point**) as per clauses 17.2.1–17.2.5
- 17.3.3** Doors/windows, frames (**1 point**) as per clauses 17.2.1–17.2.5.



Criterion 18 Renewable energy utilization

Objective

To use renewable energy sources in buildings to reduce the use of conventional/fossil-fuel-based energy resources.

18.1 Commitment

- 18.1.1** Renewable energy system (solar, wind, biomass, fuel cells, and so on) with a rated capacity of a minimum of 1% of internal lighting load (for general lighting*) and space conditioning or its equivalent is installed on site. Calculations of energy requirements shall be based on realistic assumptions, which are subject to verification.
- 18.1.2** On-site renewable energy system sized to meet the minimum of the above load. Feasibility of the proposed renewable energy system to be verified by the competent authority.

Note Internal lighting load is the total connected load in kW (kilowatts) for lighting equipment (lamp and accessories). In case it is proposed to use renewable energy sources for applications other than lighting, the criterion of energy consumption equivalent of energy consumption of 1% of lighting load (for general lighting*) and space conditioning should still be met. This shall, however, exclude the water heating loads for which each separate criterion applies.

18.2 Compliance

The following documents should be submitted.

- 18.2.1** Detailed listing of connected load for lighting and space conditioning in the prescribed format.
- 18.2.2** Calculation of connected load for lighting and energy requirement for the same.
- 18.2.3** List of all loads that are being powered by renewable energy sources (other than lighting load) and their energy requirements.
- 18.2.4** Design calculations for renewable energy system sizing and performance including annual energy generation.
- 18.2.5** Cut sheets of renewable energy systems with necessary details.
- 18.2.6** Drawings in CAD format to show location of renewable energy systems.

18.3 Appraisal (maximum points - 5)

- 18.3.1** Rated capacity of proposed renewable energy system is equal to or more than 1% of internal lighting and space conditioning connected loads or its equivalent in the building (**1 point-mandatory**), as per all compliance clauses.
- 18.3.2** Rated capacity of proposed renewable energy system meets annual energy requirements of equal to or more than 5% of internal lighting consumption or its equivalent in the building (**1 point**), as per all compliance clauses.
- 18.3.3** Rated capacity of proposed renewable energy system meets annual energy requirements of equal to or more than 10% of internal lighting consumption or its equivalent in the building (**2 point**), as per all compliance clauses.
- 18.3.4** Rated capacity of proposed renewable energy meets annual energy requirements of equal to or more than 20% of internal lighting consumption or its equivalent in the building, as per all compliance clauses (**3 points**).

* exemptions as per clause 7.3 of ECBC would apply.



18.3.5 Rated capacity of proposed renewable energy system meets annual energy requirements of equal to or more than 30% of internal lighting consumption or its equivalent in the building, as per all compliance clauses **(4 points)**.

Note Lighting design shall be based on minimum requirements as per NBC 2005 (BIS 2005d) (criterion 13.1.5)



Figure 6 Solar powered building

Criterion 19 Renewable-energy-based hot water system

Objective

To use renewable energy sources to meet the hot-water requirement.

19.1 Commitment

19.1.1 Ensure that a minimum 20% of the annual energy requirement for heating water (for applications such as hot water for all needs, like for canteen, washing, and bath rooms/toilets, except for space heating) is supplied from renewable energy sources.

19.2 Compliance

The following documents are to be submitted.

19.2.1 Detailed calculations of hot water requirements.

19.2.2 Detailed calculations on energy required for heating water for all needs except for space heating (in kWh or litres of fossil fuel).

19.2.3 Detailed design calculations for renewable energy system sizing and performance including annual energy generation.

19.2.4 Layout of the proposed renewable energy system.

19.2.5 Test reports from approved test centre for system performance and efficiency.

19.3 Appraisal (maximum points - 3)

19.3.1 Annual energy saved by proposed renewable energy system is 20% to 50% of annual energy required for water heating to meet the hot water requirement of the occupants in the building, as per all compliance clauses **(1 point)**.

19.3.2 Annual energy saved by proposed system is 50% to 70% of annual energy required for water heating to meet the hot water requirement of the occupants in the building, as per all compliance clauses **(2 points)**.

19.3.3 Annual energy saved by proposed renewable energy system is more than 70% of annual energy required for water heating to meet the hot water requirements of the occupants in the building, as per all compliance clauses **(3 points)**.

Non applicability condition: If hot water requirement is less than 500 litre per day.



Recycle, reuse, and recharge of water

Recycle and reuse of resources enables us to reduce pressure on our valuable natural resources. Recycling of resources and putting these back into use for the building is significant.

Criterion 20 Waste-water treatment

Objective

To provide facility for the treatment of waste-water generated in the building so as to have safe disposal and use of by-products.

20.1 Commitment

- 20.1.1** Provide necessary treatment of waste water for achieving the desired concentrations for disposal/reuse.
- 20.1.2** Carry out water testing for various parameters prescribed in the Pollution Control Acts, Rules and notifications, CPCB, 1998, for disposal in surface water and on land or other reuse application.

20.2 Compliance

- 20.2.1** Narrative on the type of treatment system being employed. Drawings with specifications of the system indicating the capacity of water treated.
- 20.2.2** Indicate the quantum of treated water generated along with the use/disposal steps.
- 20.2.3** Provide the characteristics of waste water and expected characteristics after treatment from the supplier.
- 20.2.4** Quality checking frequency and sampling plan of the treatment plant.
- 20.2.5** Narrative on disposal and reuse of other by – products such as sludge.

20.3 Appraisal (maximum points - 2)

- 20.3.1** Treated water should meet the disposal/reuse application standards (**2 points**).

Non Applicability condition: If waste water generation on site is less than 10 kL/day



Figure 7 Root zone system for waste water treatment

Criterion 21 Water recycle and reuse (including rainwater)

Objective

To utilize the treated waste water and rainwater for various applications (including groundwater recharge) where potable municipal water is normally used, to reduce the load on both the municipal supplies as well as the sewerage system and to improve the groundwater level.

21.1 Commitment

- 21.1.1** Provide necessary treatment of wastewater for achieving the desired composition for various applications.
- 21.1.2** Implement rainwater harvesting and storage systems depending on the site-specific conditions. All necessary steps to prevent possible contamination of ground water by rainwater harvesting should be taken (design requirements as per Central Ground Water Board). This is a mandatory requirement.
- 21.1.3** Reuse the treated wastewater and rainwater for meeting the building water and irrigation demand.
- 21.1.4** Recharge the surplus water (after reuse) into the aquifer.

21.2 Compliance

The following documents are to be submitted.

- 21.2.1** Narrative along with drawings and specifications of the type of treatment and harvesting system being employed.
- 21.2.2** Drawings indicating the specifications of dual plumbing system.
- 21.2.3** Documents indicating the projected quality of water, as per specifications.
- 21.2.4** Drawings with specifications of the systems, along with delivery lines, indicating the capacity of water treated and harvested.
- 21.2.5** Calculation sheet representing the total quantity of water treated and harvested and the amount being used for different applications including use within the building, landscape, and fraction recharged into ground.
- 21.2.6** Details of filtration system to show that adequate preventative measures are being taken to avoid contamination of aquifer by the recharged rainwater (mandatory if applicable).

21.3 Appraisal (maximum points - 5)

- 21.3.1** Annual water reuse of 25%, as per clause 21.2.5 (**1 point**).
- 21.3.2** Annual water reuse of 50%, as per clause 21.2.5 (**1 point**).
- 21.3.3** Annual water reuse of 75%, as per clause 21.2.5 (**1 point**).
- 21.3.4** Recharge of surplus rainwater into aquifer (**2 points**).

Non applicability condition: For sites that have high water table where recharge is not advisable as per CGWB norms, 2 points related to ground water recharge shall not be applicable to sites in which recharge is not feasible and the points related to reuse does not apply to projects which do not qualify for criterion 20.



Criterion 22 Reduction in waste during construction

Objective

To ensure maximum resource recovery and safe disposal of wastes generated during construction, and to reduce the burden on the landfill.

22.1 Commitment

- 22.1.1** Employ measures to segregate the waste on-site into inert, chemical or hazardous wastes.
- 22.1.2** Reuse/Recycle the segregated waste and unused chemical/ hazardous wastes such as oil, paint and batteries.
- 22.1.3** Inert waste to be disposed off by municipal corporation/local bodies at landfill sites.

22.2 Compliance

The following documents are to be submitted.

- 22.2.1** Narrative indicating the quantum of waste generated during the construction activity, and the storage facility for segregated inert and hazardous waste before recycling and disposal
- 22.2.2** Layout (showing the location) and photo of the storage facility for segregated inert and hazardous waste. The capacity of the storage facility has to be provided.

22.3 Appraisal (maximum 1 points)

- 22.3.1** Segregation of inert and hazardous wastes, as per clause 22.2. and
- 22.3.2** Recycling and safe disposal of segregated wastes, as per clause 22.2 (**1 point**).



Figure 8 Construction waste disposal

Criterion 23 Efficient waste segregation

Objective

To promote the segregation of waste for efficient resource recovery

23.1 Commitment

23.1.1 Use different coloured bins for the collection of different categories of wasted from the building

23.2 Compliance

The following documents are to be submitted.

23.2.1 Narrative along with photographs/plan indicating space, locations and capacity for multi-coloured bins.

23.3 Appraisal (maximum points - 1)

23.3.1 Provision of multi-coloured bins for waste segregation at source (**1 point**).



Figure 9 Use of multi colored bins for storage of segregated waste

Criterion 24 Storage and disposal of wastes

Objective

To prevent the mixing up of segregated waste before processing or disposal

24.1 Commitment

24.1.1 Allocate a separate space for the collected waste before transferring it to the recycling/disposal stations.

24.2 Compliance

The following documents are to be submitted

24.2.1 Narrative along with photographs/plan indicating space, locations, and capacity of the storage area.

24.3 Appraisal (maximum points - 1)

24.3.1 Provision of space for hygienic storage of segregated waste, as per clause 24.2 **(1 point)**.

Non Applicability condition: If organic waste generation is below 100 kg/day



Criterion 25 Resource recovery from waste

Objective

To maximize the recovery of resources from the recyclable and biodegradable waste and to reduce the burden on landfills.

25.1 Commitment

- 25.1.1** Employ resource recovery systems for biodegradable waste as per the Solid Waste Management and Handling Rules, 2000 of the MoEF.
- 25.1.2** Arrangement for recycling of waste through local dealers.

25.2 Compliance

The following documents are to be submitted.

- 25.2.1** Narrative indicating the plan and arrangement with local dealers for recycling of materials generated.
- 25.2.2** Details of plan and design of the waste treatment plant along with capacity for the disposal of biodegradable waste.
- 25.2.3** Narrative indicating the generation and reuse of by-products from the waste treatment plant.

25.3 Appraisal (maximum points - 2)

- 25.3.1** Zero waste generation through appropriate resource recovery measures as per clauses 25.2.1, 25.2.2, and 25.2.3 **(2 points)**.



Figure 10 Team process

Health and well-being

Building construction and its operation affects the health and well-being of people in many ways. Green building practices and measures should be integrated into the design process to ensure the health and well-being of the occupants.

Criterion 26 Use low-VOC paints/adhesives/sealants

Objective

To select and use paints, adhesives and sealants with low quantities of chemical substances and VOCs (especially formaldehyde, urea formaldehyde and urethanes).

26.1 Commitment

- 26.1.1** Use only zero/low VOC paints. All paints used in the interior of the building (defined as inside of the weather proofing systems and applied onsite) must be certified to contain zero VOC or less than the limits specified in GRIHA.
- 26.1.2** Prefer water-based acrylics over solvent-based oil paints.
- 26.1.3** Ensure all the sealants and adhesives used are water based rather than solvent based or have a low solvent content. Most construction adhesives offer adequate bond strengths in water-based varieties. Acrylics, silicones, and siliconized acrylics are the safest sealants for use in the interiors and have the lowest solvent content. While solvent-based products, such as urethanes and butyls, should preferably not be used indoors, sealants used for exterior do not pose any concern.
- 26.1.4** Adhesive usually have a high-VOC emission potential. Hence, use adhesives with low-VOC or no – VOC emissions such as acrylics or phenolic resins (phenol formaldehydes indoors).
- 26.1.5** Ensure all composite wood products/agri –fibre products do not contain any added urea formaldehyde resin.

26.2 Compliance

The following documents should be submitted

- 26.2.1** Cut sheets, specification sheets, and commercial brochures of the low VOC-emission finishes or products used.
- 26.2.2** A certificate from the manufacturer for each of the category as applicable to the applicant, clearly stating that the materials used have zero VOCs or low VOCs (gms/litre) as specified under limits.
- 26.2.3** The bill of quantity for each of the category, as applicable, clearly demonstrating that 100% of all the interior paints, sealants, adhesives, and composite wood/agri-fibre products meet the mentioned criteria.

26.3 Appraisal (maximum points - 3)

- 26.3.1** Zero/low – VOC paints: Zero/low-VOC paints for 100% of all paints used in the interior of the building (1 point), as per clauses 26.2.1 26.2.2 and 26.2.3.



- 26.3.2** Low – VOC sealants and adhesives: 100% of all the sealants and adhesives used are water based rather than solvent based/low in solvent content, as per clause 26.2.1, 26.2.2 and 26.2.3 **(1 point)**
- 26.3.3** 100% of composite wood products with no urea – formaldehyde resins, as per clauses 26.2.1, 26.2.2 and 26.2.3 **(1 point)**



Criterion 27 Minimize ozone depleting substances

Objective

Eliminate or control the release of ozone-depleting substances into the atmosphere. The ozone depleting materials commonly used in buildings are CFCs or HCFCs in refrigeration and air-conditioning systems, halons in fire suppression systems and extinguishers, and in insulation.

27.1 Commitment

- 27.1.1** Use insulation with zero-ODP (ozone depletion potential) such as HCFC-free rigid foam insulation, mineral fibre cellulose insulation, glass fibre, wood fibre board, cork wool, expanded (bead) polystyrene, recycled newspaper, and jute and cotton. Avoid materials that do not inherently have a zero-ODP, such as polyurethane foams and polyisocyanurates.
- 27.1.2** Install CFC-free equipment for refrigeration and air conditioning.
- 27.1.3** Install halon-free fire suppression systems and fire extinguishers in the building.

27.2 Compliance

Following documents are to be submitted.

- 27.2.1** A certificate from the manufacturer/supplier, signed by the architect or the engineer, stating that 100% of the insulation used in the building is free of CFCs and HCFCs.
- 27.2.2** The bill of quantity clearly demonstrating that 100% or total quantity of all the insulation used in the building is free of CFCs and HCFCs.
- 27.2.3** A certificate from the HVAC consultant or supplier, signed by the architect or the engineer, stating that the HVAC and refrigeration equipments/systems installed in the building are free of CFCs.
- 27.2.4** A list showing each type of HVAC and refrigeration equipments/systems, their numbers and type of refrigerant used along with the manufacturers' brochures clearly stating the type of refrigerant being used in their products.
- 27.2.5** A certificate from the fire-fighting-service consultant or the equipment supplier, signed by the architect or the engineer, stating that the fire suppression systems and fire extinguishers installed in the building are free of halon.

27.3 Appraisal (maximum point - 1) mandatory

- 27.3.1** All the insulation used in building are CFCs and HCFCs free, as per clauses 27.2.1 and 27.2.2. and
- 27.3.2** All the HVAC and refrigeration equipment are CFCs free, as per clauses 27.2.3 and 27.2.4. and
- 27.3.3** The fire suppression systems and fire extinguishers installed in the building are free of halon as per clause 27.2.5 (**1 point**).



Criterion 28 Ensure water quality

Objective

To provide the occupants of the building with good potable quality water for drinking/washing purposes as prescribed by the standards and to ensure that the treated wastewater is meeting the desired standards for reuse/disposal.

28.1 Commitment

28.1.1 Ensure water from all sources (such as groundwater and municipal water) meets the water quality norms as prescribed in the IS for various applications (Indian Standards for drinking [IS 10500–1991], irrigation applications [IS 11624-1986]), cooling towers (as given in NBC 2005).

Note In case the water quality cannot be ensured, provide necessary treatment of raw water for achieving the desired concentrations for various applications.

28.2 Compliance

28.2.1 Provide water optimization plan (water flow diagram giving the complete collection, treatment, and distribution for different applications).

28.2.2 Provide the water quality details from various sources before and after treatment.

28.2.3 Report/certificate from the local municipal authority for municipal water.

28.2.4 Provide the specification details indicating the capacity and components of the treatment plant along with drawings (product details from the manufacturer).

28.2.5 Quality checking frequency and sampling plan for potable water (as per given standard).

28.3 Appraisal (maximum points - 2) mandatory

28.3.1 Water quality conforming to IS standards, as per clauses 28.2.1–28.2.5 (**2 points mandatory**).



Criterion 29 Acceptable outdoor and indoor noise levels

Objective

To use appropriate noise controls for providing acceptable levels of outdoor and indoor noise levels to enhance comfort.

29.1 Commitment

29.1.1 Ensure that the outdoor noise level conforms to the CPCB-Environmental Standards- Noise (ambient standards).

29.1.2 Ensure that the indoor noise levels conform to the levels described in NBC 2005 (BIS 2005a).

29.2 Compliance

The following documents are to be submitted:

29.2.1 A sound audit report in the specified format, on measured average ambient noise level at site and indoor noise levels at different locations inside the building. Noise measurement should be conducted by an organization recognized by a competent authority and it should follow procedures laid down by a competent authority (report to be submitted after the building is occupied).

29.2.2 The building site plan duly signed by the architect/ applicant showing all the measures to control outdoor noise.

29.2.3 The drawings and narratives showing measures as described in NBC 2005 (BIS 2005a), to control indoor noise.

29.2.4 Cut sheets, specification sheets, commercial brochures of sound absorbent materials and bill of quantity demonstrating the use of sound absorbent materials in the building design.

29.3 Appraisal (maximum points - 2)

29.3.1 The outdoor noise levels are within the acceptable limits as set in CPCB-Environmental Standards- Noise (ambient standards), as per clauses 29.2.1 and 29.2.2 (**1 point**).

29.3.2 The indoor noise levels are within the acceptable limits as set in NBC 2005 (BIS 2005a), as per clauses 29.2.3- 29.2.5 (**1 point**).



Criterion 30 Tobacco smoke control

Objective

To put in place health strategies such as prohibiting smoking in the indoor areas/building or providing designated/isolated smoking zones within the building designed with separate ventilation systems with higher ventilation rates than the non-smoking areas. This will ensure zero exposure of the non-smoking occupants to passive smoking.

30.1 Commitment

- 30.1.1** In both an air-conditioned/non-air-conditioned buildings, ensure zero exposure of non-smokers to the tobacco smoke; prohibit smoking on the building premises supported with the company policy.
- 30.1.2** Ensure that both air-conditioned/non-air-conditioned buildings provide a designated smoking zone with a controlled environment that ensures restriction of the smoke to the designated area, preferably in the peripheral spaces of the buildings or within the buildings (for multiple-occupancy buildings such as hotels, non-smoking and smoking rooms to be clearly identified).

30.2 Compliance

The following documents should be submitted.

- 30.2.1** Company policy for the ban/prohibition on smoking within the building premises, if applicable, with the supportive documents verified and signed by a responsible authority or
- 30.2.2** The building plan/interior layout signed by the architect, demonstrating the internal planning for the smoke control by locating the designated smoking zone on the building periphery separated from the nonsmoking areas by full height impermeable internal partitions.
- 30.2.3** For a conditioned space, clearly demonstrate with the help of the AC system design documents, signed by the HVAC consultant or the site engineer, that
- designated smoking area is independent of the non-smoking areas in the building.
 - smoking zone is exhausted directly to the outdoors such that there is no recirculation of the tobacco smoke air to the nonsmoking zone of the building.
 - Smoking zone is operated on separate ventilation systems, with higher ventilation rates than the non-smoking areas, and is designed for at least 60 cfm (cubic feet per minute)/ person.
 - Smoking zone operates at a negative pressure in comparison with the surrounding non-smoking zone.
- 30.2.4** For a non-conditioned space, clearly demonstrate in the internal floor plans/interior layout that the designated smoking zone is properly ventilated with the appropriate location of the air inlets/outlets.
- 30.2.5** For a non-conditioned space, clearly demonstrate with the help of a design narrative.
- Designated smoking zone if mechanically ventilated is designed for not less than 30 ACH (air changes per hour).
 - Smoking zone is properly ventilated and at a minimum, exhausted directly to the outdoors, such that there is no recirculation of the tobacco smoke air to the nonsmoking zone of the building.



- Properly enclosed with full height, impermeable internal partitions with respect to the surrounding spaces.

30.3 Appraisal (maximum point - 1) mandatory

The following documents are to be submitted.

- 30.3.1** Company policy for ban/prohibition of smoking within the building premises, as per clause 30.2.1. or
- 30.3.2** A signed template by HVAC/ architectural consultant certifying that all compliances are met, as per clauses 30.2.2– 30.2.5. **(1 point mandatory)**



Criterion 31 Provide at least the minimum level of accessibility for persons with disabilities

Objective

To ensure accessibility and usability of the building and its facilities by employees, visitors, and clients with disabilities.

31.1 Commitment

- 31.1.1** Ensure access to facilities and services by adopting appropriate site planning to eliminate barriers as per the recommended standards (NBC 2005 [BIS 2005f]), layout and designing of interior and exterior facilities as per principles of universal design such as prescribed by the National Building Code of India, building management policies and procedures, provision of auxiliary aids and appliances, and staff training in disability awareness, and
- 31.1.2** Comply with planning and design guidelines as outlined in NBC 2005 Annex D (Clause 12.21) (BIS 2005f).

31.2 Compliance

The following documents must be submitted.

- 31.2.1** Signed letter by competent authority (architect/access auditor) to demonstrate compliance with NBC 2005 Annex D (Clause 12.21) (BIS 2005f) and proposed additions.
- 31.2.2** Site photographs to demonstrate compliance.
- 31.2.3** Detailed narrative (not more than 250 words) on provision of infrastructure accessibility features, auxiliary aids and appliances, and appropriate building management policies to ensure nondiscrimination against persons with disabilities.

31.3 Appraisal (maximum point - 1)

- 31.3.1** Compliance with National Building Code norms on Requirements for Planning of Public Buildings Meant for Use of Physically Challenged, as per clauses 31.1.1 and 31.1.2 **(1 point)**.

Note The intention is to validate and maintain 'green' performance levels/adopt and propagate green practices and concepts. It is important to monitor and verify the measures and evaluate the criteria adopted in the green design process; its actual performance vis à-vis predicted performance. It is also important to identify the need for upgradations/modifications in the systems.



BUILDING OPERATION AND MAINTENANCE

Criterion 32 Energy audit and validation

Objective

Validate the performance of the energy and environmental systems in the building as predicted during the design and development stage.

32.1 Commitment

32.1.1 After occupying the building, conduct audits for the following within two years of full occupancy and submit audit data as per the specified format. The energy consumption data submitted should be for at least 12 months.

1. Energy audit
 - a. Energy consumption
 - b. Thermal comfort
 - c. Visual comfort
2. Water and waste audit
 - a. Water quality
 - b. Solid waste generation
 - c. Solid waste disposal process

32.1.2 After occupying the building, conduct sound level audit as specified in Criterion 29, to measure the following:

- a. Indoor noise levels
- b. Outdoor noise levels

Note Clause 32.1.2 is only applicable to projects that have attempted GRIHA Criterion 29: Acceptable outdoor and indoor levels. The audit data should be submitted to ADaRSH in the format specified in Criterion 29.

These audits should be conducted for typical representative days. The audit reports should be submitted to ADaRSH in the specified format for validation of the information provided at the time of award of provisional rating.

In case the audit data is not corresponding with the data and documents provided at the time of award of provisional rating, the provisional GRIHA rating will be taken back from the project. However, if the audited data is corresponding with the data and documents provided at the time of award of provisional rating, the final GRIHA rating will be awarded to the project.

32.1.3 The energy audit should be conducted by an energy auditor approved by the Bureau of Energy Efficiency, Government of India. Water and waste audit should be conducted by a competent authority.



32.2 Compliance

The following documents should be submitted.

- 32.2.1 Completed audit forms signed by competent authority (building owner/authorized representative) demonstrating that all energy and environment systems of the building are performing as predicted and match the information provided at the time of award of provisional GRIHA rating.
- 32.2.2 Certificate stating that the energy audit has been conducted by an energy auditor approved by the Bureau of Energy Efficiency, Government of India.

32.3 Appraisal (mandatory and no points)

- 32.3.1 The energy systems and water and waste management systems of the building are performing as predicted and match the information provided at the time of award of provisional GRIHA rating (mandatory).



Criterion 33 Operation and maintenance

Objective

To ascertain efficient functioning of the building's systems through regular monitoring of building's energy and water consumption and implementation of appropriate operation and maintenance program.

33.1 Commitment

- 33.1.1** Ensure regular monitoring of building's energy and water consumption by installing digital meters as per the following:
1. Electrical meters installed to measure energy units purchased from the utility and energy units generated on site (through DG/ GG sets).
 2. Electrical sub meters for measuring energy consumption by HVAC plant, AHU fans and indoor lighting.
 3. BTU meters to be installed for each chiller at entering and leaving points to measure the cooling generated by chillers.
 4. BTU meter to be installed on the chilled water loop to measure building's total cooling demand.
 5. Water meter should be installed at all main supply points to measure the total water consumption of the building.
- 33.1.2** Provide a core facility/service management group that will be responsible for the O&M of the building's electrical and mechanical systems after installation. In case of small-scale/single-owner commercial buildings, the owner or the occupants themselves should undertake the responsibility for the O&M of the building's systems after installation.
- 33.1.3** Include a specific clause in the contract document of the systems supplier for the commissioning (installation and test run) and systematic handing over of all electrical and mechanical systems to the core facility/ service group responsible for the O&M of the building systems after installation.
- 33.1.4** Include a specific clause in the contract document of the systems suppliers for providing training to the core facility/ service group responsible for the O&M of the building systems after installation, on the operating instructions/dos and don'ts/ maintenance requirements, of specific systems.
If the systems supplier themselves have been assigned the responsibility of the O&M after system installation, this clause is not applicable.
- 33.1.5** Prepare a fully-documented O&M manual/ CD/ multimedia/ an information brochure listing the best practices/dos and don'ts/maintenance requirements for the building's systems along with the name and address of the manufacturer/supplier of the respective systems. This should be carried out by the owner/builder/occupants/service or facility management group.

33.2 Compliance

- 33.2.1** Submit drawings and documents showing locations of energy and water meters.
- 33.2.2** Applicant shall provide the proof of provision for a core facility/service group responsible



for the O&M of the building's systems after installation. This should be supported with the contract (mutually signed between the respective parties) document or supportive documents, verified and signed by the responsible parties.

- 33.2.3** Applicant shall provide proof of inclusion of specific clause in the contract document of the system supplier for commissioning (installation and test run) of all electrical and mechanical systems.
- 33.2.4** Applicant shall provide proof of inclusion of a specific clause in the contract document of the systems supplier for providing training to the core facility/ service group responsible for the O&M of the building systems after installation, on the operating instructions/dos and don'ts/ maintenance requirements for the specific system.
- 33.2.5** Submit a copy of the fully documented O&M manual/ CD/ Multimedia / information brochure enlisting the best practices for O&M of the building's systems. The name and address of the manufacturer/supplier of the respective system, owner/builder to be given to the occupants or to the service/facility management group at the time of occupation.

33.3 Appraisal (maximum points-2) mandatory

- 33.3.1** Provision of meters for monitoring building's energy and water consumption, as per clause 33.2.1 **(1point mandatory)**.
- 33.3.2** Provision for a core facility/service group responsible for the O&M of the building's systems after installation as per clause 33.2.2. Inclusion of a specific clause in the contract document of the systems supplier for commissioning (installation and test run) of all electrical and mechanical systems as per clause 33.2.3. Inclusion of a specific clause in the contract document of the systems supplier for providing training to the core facility/ service group responsible for the O&M of the building systems after installation, on the operating instructions/dos and don'ts/ maintenance requirements for the specific system, as per clause 33.2.4. Development of a fully documented O&M manual/ CD/ Multimedia / information brochure enlisting the best practices for O&M of the building's systems, as per clause 33.2.5 **(1point mandatory)**.



INNOVATION POINTS

Criterion 34 Innovation points

The enlisted criteria in the rating system are the most critical components contributing to the evolution of a green building. Green building design and operation extend beyond the boundaries defined by the rating system and may cover strategies and options that lead to environmental benefits. The purpose of this category of points is to recognize the measures adopted, which contribute to the overall objective of designing and maintaining of green buildings, and those that are otherwise not covered in the rating system. The following is an indicative list of innovation points. The applicant may submit any other criterion, which they consider as deserving for the award of points, under the rating system. The applied criterion will be evaluated on the merits and demerits of its sustainability benefits. Each Innovation Criterion will carry one point, subject to a maximum of four points.

Environmental education

Objective

To promote awareness of significant environmental issues by imparting environmental education to the owner or the occupants of the building and to the community as a whole.

34.1. Commitment

- 34.1.1** Formulate a company policy on environmental education that facilitates instructional or environmental tours by keeping the building open on weekends. The tours may be supplemented with a small video/multimedia presentation or a documentary focusing on sustainable measures taken in the building design to save energy and to reduce the degree of environmental impact.
- 34.1.2** Provide the owner/occupants or visitors with brochures, CD, information leaflets or a manual on environmental education and concerned issues.
- 34.1.3** Create environmental awareness through small efforts in the building itself such as showcasing energy-efficient building systems, technologies, and materials, and properly labelling or documenting their respective energy performance or savings. The building can also be equipped with data loggers and be put on extensive monitoring so that the performance data for various building systems can be used by students, researchers, and others, and the visitors can observe the same.
- 34.1.4** Adopt innovative strategies such as labelling the water fixtures for the water source. For example, 'this tap uses rainwater harvested from the roof'. Also demonstrate different spaces connected with different waste-water treatment schemes with proper documentation.



- 34.1.5** A landscape labelled for native species or aromatic herbs, which would raise awareness towards low maintenance and low water-consuming native species as compared to high-maintenance exotic species.
- 34.1.6** Include a column on environmental awareness in the monthly newsletter or newspaper of the company/organization.

34.2 Compliance

- 34.2.1** Applicants shall provide the proof of the company policy for the promotion of environmental awareness, if applicable, with the supportive documents verified and signed by a responsible authority.
- 34.2.3** Submit the building brochures, CD, information leaflets or properly compiled manual, small video or documentary used to create awareness towards environmental issues in the owner or the building occupants.
- 34.2.4** If applicable, applicants shall have to provide a small narrative (300 words), supported with the photographs, demonstrating the innovative strategies incorporated in the building, which raises environmental awareness, such as labelling or documenting the low maintenance/less water-consuming species in landscaping and labelling, and documenting the building systems as per the efficient energy performance and savings, or labelling the water fixtures for harvested water source, and so on.

34.3 Appraisal (maximum points - 1)

- 34.3.1** Formulation of a company policy for the promotion of environmental education or awareness in the form of instructional/ environmental tours to the building, as per clause 34.2.1, and
- 34.3.2** Preparation of the building brochures, CD, information leaflets or properly compiled manual, small video or documentary on environmental education, as per clauses 34.2.2 and 34.2.3 (1 point).

Company policy on 'green supply chain'

Objective

To encourage company policies on the 'green supply chain', so that the business uses the most efficient methods available for sourcing, manufacturing, and transporting and post-sales support for green building materials and products. This will serve as a 'corporate access system for sustainable development'— a single-source solution to meet the total logistics and distribution needs which, in turn, will ensure that the companies integrate the supply, manufacturing, and distribution of green building materials or products into sustainable development. As a result, this will facilitate a supply chain process to improve service, reduce or eliminate excess/fluctuating inventories, shortages/ stockouts, longer lead times, higher transportation and manufacturing costs, and increase the flow of information between the supply chain partners by boosting supplier-to-customer relations.

34.1 Commitment

- 34.1.1** Formulate a company policy on the 'green supply chain', which will facilitate sourcing, manufacturing, transportation, and post-sales support for green building materials and products.



- 34.1.2** Set up a 'corporate access system for sustainable development', which will serve as an easy and single-source access to green resources that can help enlist and search green suppliers, vendors, and manufacturers across the globe. This system can be put online so that other corporate communities and research organizations working towards sustainable development and green building consultants can share and enhance the services.
- 34.1.3** Corporate houses can form a small group comprising of executives responsible for the development and management of the global supply chain for the promotion of sustainable development.

34.2 Compliance

- 34.2.1** Applicants shall provide proof of company policy on 'green supply chain' for the promotion of sustainable development, terms of agreement with the single/association of vendors, suppliers or manufacturers. If applicable, with the supportive documents verified and signed by a responsible authority.
- 34.2.2** Applicants shall provide the details of the 'corporate access system on sustainable development' in any mode, as applicable, either as a web page, database or a shared information service information service across the corporate communities.

34.3 Appraisal (maximum points - 1)

- 34.3.1** Formulation of company policy on 'green supply chain' for the promotion of sustainable development, demonstrating the terms of agreement with the single/association of vendors, suppliers or manufacturers. If applicable, with the supportive documents verified and signed by a responsible authority.
- 34.3.2** Development of a 'corporate access system on sustainable development' either in paper or electronic media, or a database or a shared information services across the corporate communities. Applicants shall have to certify their association with the other corporate houses.

Integrated pest management

Objective

To develop and implement an integrated pest management programme to control and manage weeds and pests within tolerable limits so as to achieve healthy growth for plants and people.

34.1 Commitment

- 34.1.1** Develop and implement a landscape management/maintenance plan with emphasis on non-chemical based/organic pest management.
- 34.1.2** Apply pesticides only 'as needed' after prevention and physical controls have been implemented in the interiors.
- 34.1.3** Select the least hazardous pesticides for the control of targeted pests.

34.2 Compliance

- 34.2.1** Applicants shall demonstrate the integration of pest management plan in the facility or service management contract, verified with supportive documents and signed by the responsible authority.



34.2.2 Applicants shall demonstrate the implementation of pest management plan, including a monitoring plan and schedule.

34.3 Appraisal (maximum points - 1)

34.3.1 Integration of pest management plan with the maintenance plan as submitted by the core facility or service management group.

Life cycle costing

Objective

To provide comprehensive lifecycle cost analysis of the project, considering the costs arising from owning, operating, maintaining and other considered important for the project viability.

34.1 Commitment

34.1.1 Conduct a comprehensive lifecycle cost analysis of the project, considering the costs arising from owning, operating, maintaining and other considered important for the project viability.

34.2 Compliance

34.2.1 Applicants to provide a detailed life cycle cost analysis supporting the decisions made for the project viability during its lifecycle.

34.3 Appraisal (maximum points - 1)

34.3.1 Life cycle cost analysis of the project.

Any other criteria proposed by applicant

Submit any other criteria proposed by applicant.



ANNEXURE-I

No. 3/5/2008-UICA(ST)
Government of India
Ministry of New and Renewable Energy
Solar Thermal Group

Block No.14, C.G.O. Complex, Lodi Road
New Delhi-110003, dated : 28th July 2009

To

Heads of SNAs and Municipal Commissioners,

Subject: Addition / amendments in the on-going Scheme on “Energy Efficient Solar/ Green Buildings” for implementation during 2009-10 & rest of 11th Plan period.

Sir / Madam,

In continuation of this Ministry's Administrative Approval issued vide sanction of even no. dated 05.02.09 on the above mentioned scheme, I am directed to convey sanction of the President for adding / amending the following provisions in the aforesaid existing scheme on “Energy Efficient Solar/ Green Buildings” for implementation during 2009-10 and rest of 11th Plan period :-

Addition:

The following provision may be added above the heading “Incentive to Architects/Design Consultants” in the existing scheme:

“The first 100 Govt. / Public Sector Buildings shall be exempted from paying registration-cum-rating fee in advance at the time of registration under GRIHA and 100% fee will be released in respect of such cases to GRIHA Secretariat under TERI in the following manner:

- (i) *50% after the projects are registered with GRIHA Sectt. and documents sent to MNRE. The institutions will give undertaking that they will put their best efforts in getting their buildings rated 3 or 4 stars as per scheme / guidelines. They will also give commitment to achieve all mandatory points under GRIHA.*
- (ii) *Rest 50% after they get a provisional rating of 3 or 4 stars as per scheme guidelines.*

The cases of exemption will be considered on first come first served basis. The relaxation in any of the above conditions shall be considered & granted by the competent authority on merits of each case in line with the scheme.”

..21-

Amendments:

The existing provisions in the scheme/AA dated 05.02.09 under heading 'Institution of Awards / Incentive' and 'Other Activities' on Page 6, may be amended to read as under:

- **Institution of awards/incentives** : Annual awards to green buildings which are rated as 5 stars under GRIHA and platinum rated under other rating systems will be given in the form of Shields / Certificates. Cash incentive of Rs. 50 lakhs will be provided to Municipal Corporations and Rs. 25 lakhs to municipalities/ other Urban Local Bodies (one each to them) who perform the best in promoting construction of Green Buildings in their respective areas from 2011-12 onwards.
- **Other activities**: Funds will be provided for other activities to promote green buildings in the country. These activities may include: development of web based tools, short films on best practices, FAQs on MNRE website, course contents as part of curriculum, e-learning modules, organizing specific groups to initiate changes in National Building Code, support to architectural magazines to bring out special features on green buildings and related activities.

2. The other terms and conditions, guidelines and provisions as mentioned in the sanction order / AA of even no. dated 05.02.09 on 'Energy Efficient Solar/Green Buildings" would remain same. This Addendum may be read as part of this Ministry's sanction order / AA dated 05.02.09.

3. This issues with the approval of competent authority and with the concurrence of IFD dated 23/07/09 vide their Dy.No.IFD/676/09 dated 21/07/09

Yours faithfully,

(Prem Chand)
Under Secretary to the Govt. of India
Ph:24360707/Extn.1023

Copy for information and necessary action to:

1. Director of Audit, Scientific Audit-II, AGCR Building. I.P. Estate, N.D - 110002



2. MD, IREDA, 3rd Floor, August Kranti Bhawan, Bhikaiji Cama Place, New Delhi – 110 066.
3. Director General, Bureau of Indian Standards, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi-11002
4. PS to Minister(NRE)
5. Sr. PPS to Secretary, MNRE
6. Adviser(ST) / Dir (AK)
7. AS & FA / DS(F) / US (F) /AO(F) / SO(F)
8. All Group Heads / Solar Energy Centre
9. Director(TIFAD), MNRE, to upload this Addendum on the Ministry's website.
10. Cash Section & PAO,MNRE
11. Sanction folder

(Prem Chand)
Under Secretary to the Govt. of India



No. 3 / 5 / 2008-UICA (SE)
Government of India
Ministry of New and Renewable Energy
(Urban, Industrial and Commercial Group)

**Block NO. 14, CGO Complex,
Lodi Road, New Delhi-110 003**

Dated: 5th February, 2009

To

Heads of State Nodal Agencies and
Municipal Commissioners

Sub.: Scheme on “Energy Efficient Solar/ Green Buildings” – Modification of the Building component of the ongoing Scheme on “Promotion of Solar Thermal Systems for air heating/ steam generating applications, Solar Buildings and Akshay Urja Shops” for implementation during 2008-09 & rest of 11th Plan period

Sir/ Madam,

In continuation of this Ministry’s sanction of no. 3/2/2008-UICA(SE) dated 26th June, 2008 issued for continuation of the above mentioned scheme during 2008-09, I am directed to convey the sanction of the Government of India for modifying the Building component of the Scheme on “Promotion of Solar Thermal Systems for air heating/ steam generating applications, Solar Buildings and Akshay Urja Shops” for implementation during 2008-09 & rest of 11th Plan period as per the details given below:

1.0 Objective

The main objective of the modified component of the scheme is to promote the widespread construction of energy efficient solar/ green buildings in the country through a combination of financial and promotional incentives, and other support measures so as to save a substantial amount of electricity and other fossil fuels apart from having peak load shavings in cities and towns.

The objective will be achieved by providing incentives to buildings rated for their performance under National Rating System being promoted by the Ministry and financial support for organizing workshops and seminars for engineers, planners, builders, architects, consultants, housing financing organizations and potential users and for compilation and publishing of documents related to solar/ green buildings.

2.0 Physical Targets

Indicative targets as per the following has been set for 2008-09 and rest of the 11th period:

Activity	2008-09		Rest of 11 th Plan	
	Physical	Financial	Physical	Financial
Solar/ Green Buildings rated under NRS	5 lakh sq. m. of covered area	Rs. 0.50 crore	35.00 lakhs sq. m. of covered area	Rs. 40.00 crore
Promotional & other activities including GRIHA Secretariat	-	Rs. 0.50 crore	-	Rs. 9.00 crore
Total	-	Rs.1.00 crore	-	Rs.49.00 crore

3.0 Implementation Arrangement

The scheme will be implemented through State Nodal Agencies/ Municipal Corporations/ Govt. Bodies / reputed NGOs etc. The Guidelines for implementation of the scheme and financial provisions for various activities are given in the Annexure. The scheme will be reviewed after two years or before as felt necessary.

4.0 Monitoring Mechanism

The Implementing Agencies will set up arrangements to closely monitor the implementation of their projects covered under the scheme. The agencies will furnish progress reports and other information to MNRE on a regular basis. In addition, Regional Offices of MNRE will be involved in monitoring the implementation and performance of the systems. The progress of the scheme will also be monitored by the Ministry independently, including third party inspection and reporting

5.0 Expenditure

An expenditure of Rs.49.00 Crore is expected to be incurred under the activity on “Energy efficient solar/ green buildings” during 2008-09 and rest of the 11th Plan period. Rs. 1.00 Crore will be spent during 2008-09, and the rest during the remaining period of the Plan. The budget will be met from the allocated budget for Solar Thermal Energy Programme under Demands-for-Grants of the Ministry.

6.0 This issues in exercise of delegated powers to this Ministry and with concurrence of IFD vide their Diary No. IFD/1995/08 dated 5.2.2009

Yours faithfully,

Sd/-

(B.K. Trikha)

Under Secretary to the Government of India

Copy for information and necessary action to:

1. Director of Audit, Scientific Audit-II, AGCR Building. I.P. Estate, N.D -110002
2. PPS to Secretary, MNRE
3. Ps to MOS
4. Adviser(SE) / Dir (AKS) / Dir (AKT) / Dir(DN)
5. All Group Heads / Solar Energy Centre
6. AS & FA / Dir (F) / US (F) /AO(F) / SO(F)
7. Cash Section & PAO,MNRE
8. Sanction folder
9. Director(TIFAD), MNRE
10. MD, IREDA
11. Director General, Bureau of Indian Standards, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi-11002



Guidelines for Implementation of Energy efficient solar/ green building Programme

Background

Energy efficient solar buildings are constructed based on the techniques of solar passive design with a view to provide comfortable living and working conditions, both in winter and in summer. These buildings can be integrated with renewable energy and energy conservation devices and systems and can save over 30 to 40 % of conventional energy that is used for lighting, cooling or heating. Such buildings have been tried out in a few States as a result of the initiatives taken by the Ministry. Finding the concept of solar buildings useful, the state governments of Himachal Pradesh, Punjab, Haryana and Nagaland have already made it mandatory to construct all new buildings in government & public sectors on this concept. Necessary G.O.s have been issued and the development authorities have been asked to approve building plans for construction only if the designs incorporating solar passive features are certified by approved architects or the experts. Over 40 experts/architects are presently involved in the country in practicing energy efficient solar buildings. Bureau of Energy Efficiency (BEE) have recently introduced Energy Conservation Building Code (ECBC) which includes energy efficient design features. National Building Codes have also been developed by the Bureau of Indian Standards (BIS) which incorporates some of the concepts of energy efficient solar buildings. Sufficient literature/ publications are also available for design of such buildings.

Efforts are now being made to construct Green Buildings all over the country which not only take care of energy conservation but also look into water and waste management, environmental impact, minimum destruction of natural resources and various other aspects in an integrated way. Building Rating Systems have been quite effective in raising awareness and popularizing energy efficient and green building design. Most of the internationally devised rating systems have been tailored to suit the building sector of the country where they were developed. In India, a US based LEED (Leadership in Energy and Environmental Design) Rating System is under promotion by CII-Godrej Green Business Center (GBC) which is more on energy efficiency measures in AC Buildings. A couple of other Rating systems suitable for Indian conditions e.g. TERI-GRIHA and Eco-Housing System have also been developed by TERI and Pune Municipal Corporation respectively and are under promotion in the country.

Keeping in view our climatic conditions, and in particular the construction of non-AC buildings, a National Rating System – GRIHA (Details available at MNRE website: www.mnre.gov.in) has been developed which is suitable for all types of buildings in different climatic zones of the country. The Rating System was initially conceived and developed by The Energy & Resources Institute, TERI. It has been modified as a National Rating System after incorporating various suggestions by a group of architects and experts. It takes into account the provisions of the National Building Code 2005, the Energy Conservation Building Code 2007 and other IS codes, local bye-laws, etc. Through various qualitative and quantitative assessment criteria, GRIHA would be able to 'rate' a building on the degree of its 'greenness'. It will operate on a 100 point marking system with 70 to 80 points to be obtained for 3 star rated buildings and 81-90 points for 4 star rated buildings. The rating would be applied to different types of new and existing buildings, whether commercial, institutional or residential.



A Memorandum of Understanding has been entered into between the Ministry and TERI towards development and operationalisation of the National Rating System 'GRIHA' for Green Buildings. A National Advisory Council (NAC) has been constituted to provide advice and directions to the National Rating System. A Technical Advisory Committee (TAC) has also been constituted to provide technical oversight towards modifications and constant up-gradation of the GRIHA framework. GRIHA will be operated through GRIHA secretariat which will be hosted by TERI. It is understood that large scale promotion of GRIHA will help in getting the new buildings constructed on the concepts of Green Building design suitable for Indian conditions.

Financial Provisions

A GRIHA Secretariat

GRIHA Secretariat will act as an independent autonomous body. It will be registered by TERI under Society's Act. A seed funding of upto Rs. 1.00 crore will be made available to the Society for its establishment and infrastructure facility as non recurring grant based on the proposal received from TERI with details of the budget required. However, till the society is formed by TERI the Secretariat will function from the office of TERI at Delhi.

B. Buildings rated under National Rating System -GRIHA

The scheme is presently confined to commercial and institutional building including housing complexes with minimum built area of around 2500 sq.m. All the houses in a complex will be considered as single project individual houses are not covered in the Scheme.

➤ Registration –cum-Rating Fee

90% of the fee as given below for projects rated 3 star having built area up to 5000 sq. m. and for projects rated 4 star having built area above 5000 sq. m. will be reimbursed by MNRE

Owners of buildings under design and construction, interested to be rated under GRIHA will get their buildings registered with GRIHA Secretariat as per the procedure given at GRIHA/ MNRE Website. Registration-Cum-Rating Fee for the projects registered under GRIHA will be as per below which will be paid to GRIHA Secretariat by the owners at the time of registration.

Project size (total built up area)	Rating cum registration fee
<= 5000 sqm	Rs 3,14,000 (Rs 2,50,000 fixed cost for registration and secretariat fees + Rs 64,000 for evaluation)
>5000 sq m	Rs 3,14,000 (fixed cost for projects up to 5000 sq. m.) + Rs 3.75/sq m over and above 5000 sq m of built area

Release of Registration-cum-Rating Fee to the owners will be made by MNRE on reimbursement basis through GRIHA Secretariat after validation of Star Rating Post - Construction by the National Advisory Council.



➤ **Incentive to Architects/ Design Consultants**

To encourage Architects and consultants to design buildings on Green Architectural concepts and get them rated under GRIHA, and incentive as per below will be available from MNRE.

- Rs. 2.50 lakhs for projects upto 5000 sq.m. built-up area with minimum 3 star rating
- Rs. 5.0 lakhs for projects > 5000 sq.m. built-up area with minimum 4 star rating

Procedure for release of the incentives to architects/ design consultants and settlement of account with MNRE will remain same as given in para A above.

➤ **Capital subsidy for SPV installations**

One of the criteria under GRIHA is to meet 1% of total connected load for interior lighting and space conditioning through solar photovoltaics. It has been decided to support such photovoltaic system through capital subsidy which will be made available under Ministry's scheme on Solar Photovoltaic Systems/Devices for Urban Areas.

C. Other Items

- **Promotional Activities:** A financial support of upto Rs. 2.00 lakh for each activity could be provided for organizing workshops/ seminars/ training programmes/ meetings of NAC/ publications/ awareness campaigns etc. to implementing agencies including GRIHA Secretariat.

Submission of proposals & Release of funds: The proposals on promotional activities could be generated by SNAs/ Municipal Corporations/ Govt. bodies/ Reputed NGOs/GRIHA Secretariat etc. and submitted to MNRE in the prescribed format (**Appendix 1**). 80% of the CFA sanctioned will be released in advance on merit and rest on progressive achievements/ completion of the activities with detailed reports and utilization certificates/SOE received in the Ministry (**Appendix II & III**). To private bodies, the funds will be released on re-imburement based or on the basis of the bond submitted to the Ministry.

- **Incentives to Urban Local bodies :** A one-time incentive of Rs. 50 lakhs to Municipal Corporations and Rs. 25.00 lakhs to other Urban Local Bodies will be available to those who i) announce rebate in property tax for energy efficient solar/green buildings rated under GRIHA, ii) make it compulsory to get the new buildings under Govt. & Public Sector rated under GRIHA and iii) sign an MOU with GRIHA Secretariat in presence of MNRE for large scale promotion of Green Buildings in their area.

Submission of proposals & release of funds : To avail the incentive, Municipal corporations/ Municipalities/ Urban Local Bodies will submit an application to the Ministry with a copy marked to SNA giving details of notifications / orders announcing rebate in property tax for energy efficient solar buildings and mandatory provisions of new Government/ Public Sector Buildings rated under GRIHA. Release will be made directly to them in two parts, one immediate



after receiving the application complete in all respect and other after receiving the progress report of Green Buildings after a period of one year.

- **Institution of Awards/ Incentive:** Annual awards to green buildings rated 5 Star under GRIHA will be given away by the Ministry in the form of Shields/ Certificates. Cash incentive of Rs. 50 lacs to Municipal corporations and Rs.25 lakh to municipalities/other Urban Local Bodies (one each to them) will also be given away that perform the best in promoting Green Buildings in their areas from 2011-12 onwards.
- **Other Activities:** Funds for other activities as felt necessary by GRIHA Secretariat to promote GRIHA as large scale in the country may also be considered by MNRE with the approval of NAC subject to availability.



Appendix-I

Format for submission of proposals for organizing seminars/ symposia/ workshops/ training programmes etc.

1. Name of Institution organizing the event :
2. Type of event to be organized :
3. Date(s)/ venue of the event :
4. Category of participants :
5. Tentative programme with topics to be covered (copy to be enclosed) :
6. Budget break up (item-wise) :
7. Expected outcome :

**Signature with name & seal of Head
of Implementing organization**

Format for submission of proposals for organizing publicity and awareness campaign/ publication of documents

1. Name of Institution organizing the activity :
2. Type of activity to be organized :
3. Details of activities to be organized :
4. Budget break up (item-wise; supporting documents for arriving at the figures to be provided) :
5. Expected outcome :

**Signature with name & and seal of
Head of Implementing organization**



Appendix-II**Statement of Expenditure**

1. Name of implementing organization :
2. Type of activity/ event sanctioned :
3. MNES sanction No. & Date :
4. Amount released by MNES :
5. Item-wise Statement of Expenditure :

(In Rupees)

Sr. No.	Item	Amount sanctioned	Expenditure incurred
1.			
2.			
3.			
	Total		

6. Balance to be released/returned :
7. Report on the activity/event (to be enclosed) :

(Signature of
Account Officer

(Signature of Head of
Implementing organization
with seal)

(Signature and seal
of the Auditor)



Appendix-III

GFR 19-A
[See Rule 212 (1)]

Form of Utilization Certificate

Sl. No.	Letter No. and date	Amount
	Total	

Certified that out of Rs.....of grants-in-aid sanctioned during the year..... in favour ofunder this Ministry/ Department Letter No. given in the margin and Rs..... on account of unspent balance of the previous year, a sum of Rs.....has been utilized for the purpose offor which it was sanctioned and that the balance of Rs.....remaining unutilized at the end of the year has been surrendered to Government (vide No....., dated)/ will be adjusted towards the grants-in-aid payable during the next year.....

2. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled / are being fulfilled and that I have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned.

Kinds of checks exercised

- 1.
- 2.
- 3.
- 4.
- 5.

Signature.....
Designation.....
Date



**Revised Scheme on
“Energy Efficient Solar/ Green Buildings”**
(Issued vide sanction No. 3 / 5 / 2008-UICA (SE) dated 5th February, 2009)

Salient Features

Keeping in view our climatic conditions, and in particular the construction of non-AC buildings, a National Rating System – GRIHA for Green Buildings has been developed by MNRE in association with TERI. The Rating System is suitable for all types of buildings in different climatic zones of the country and will be operated through GRIHA secretariat. It will operate on 100 point marking basis with 43 points related to energy and waste management and will be promoted through various incentives under the scheme as per below:

Incentives

Building Owners*

Reimbursement of 90% of the registration-cum-rating fee for projects upto 5000 sq. m. built-up area with minimum 3 star rating & for projects > 5000 sq.m. built-up area with minimum 4 star rating

Architects/ design consultants*

Rs.2.5 lakhs for projects upto 5000 sq. m. built-up area with minimum 3 star rating & Rs. 5 lakhs for projects > 5000 sq.m. built-up area with minimum 4 star rating

Municipal Corporations/ Urban Local Bodies

Rs. 50 lakhs to Municipal Corporations & Rs. 25 lakhs to other Urban Local Bodies that announce rebate in property tax for Green Buildings & make it mandatory to get the new buildings under Govt. & Public Sector rated under GRIHA.

** Scheme presently confined to commercial and institutional buildings including housing complexes with minimum built area of around 2500 sq.m. Release of incentives will be made by MNRE on reimbursement basis through GRIHA Secretariat after validation of Star Rating Post - Construction by the National Advisory Council.*

Benefits of Green Buildings

- Reduced energy & water consumption without sacrificing 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)
- Limited waste generation due to recycling and reuse
- Reduced pollution loads
- Increased user productivity
- Enhanced image and marketability
- No increase in building cost

Annual Awards

Awards of Rs. 50 lakhs to Municipal Corporation & Rs. 25 lakhs to other Urban Local Body who performs best. Annual Awards to 5 star rated buildings under GRIHA also.

Promotional Activities

Upto Rs. 2.00 lakh for each activity to specialized Institutions for organizing workshops/ seminars/ training / publications/ awareness campaigns etc.

Separate support available for solar water heating & photovoltaic systems in Green Buildings. Details available at MNRE website: www.mnre.gov.in