GUIDELINE
ON
GREEN BUILDINGS

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अनुसंधान अभिकल्प और मानक संगठन लखनऊ – 226011
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Synopsis

This report has been prepared as per instruction of Railway Board and covers types, identification of green building aspects & basic concepts, classification and uses of green building criteria and implementation of green building concepts including the details about carbon credits.
1.0 Introduction

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, which in turn use 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 buildings so that they can respond to varying conditions, intelligently monitor and control resource use, security, fire fighting systems and other such systems in the building. Water, another vital resource for the occupants, gets consumed continuously during building construction and its operation. Besides this, 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 environment and contribute to climate change. Hence, there is the need to design a green building, the essence of which is to address all these issues in an integrated and scientific manner. It may cost more to design and construct a green building compared to conventional 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.

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; 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 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 i.e. 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)
2.0 Merits and Demerits of Green Building compared to Conventional Buildings

**Merits**

A green building reduces the adverse impact on environment and occupants. It also consumes less resource compared to conventional buildings. The following are the advantages of green buildings.

- **Energy efficiency:**
  
  Green buildings consume 40% to 60% lesser energy as compared to conventional buildings. This is primarily because of passive architectural building design, and also use of highly efficient appliances & technology during construction and operational phase. Energy consumption also reduces due to 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 & wind power can help generate electricity which can reduce the buildings dependence on grid power.

- **Water efficiency:**
  
  Green buildings consume 40% to 80% lesser water as compared to conventional buildings. It is possible 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.

- **Efficient waste management:**
  
  Green buildings generate lesser waste by employing efficient waste management strategies on site. The building is design & constructed in such a way so as to reduce waste generation. Also waste generated is segregated and recycled so as to reduce demand on virgin material. During operational phase also waste is segregated and useful waste is recycled. Also organic waste can be converted into manure and biogas. This would reduce the requirement of waste disposal and ensure better sanitation & health of occupants.

- **Pollution management:**
  
  Green buildings generate lesser pollution both during construction as well as while in use. Through good 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 restrict the use of high ODP (ozone depleting potential) substances in their systems as well as in finishes.

- **Easier Maintenance:**
  
  Green buildings need less maintenance. For example most green buildings don't require exterior painting so often. Also as far as natural sources were used during its construction, they are not destroyed so quickly.
Use of recycle material:
In green buildings due to extensive use of recycled material like fly ash bricks, fly ash cement, gypsum board, waste wooden chips etc, load on virgin material is reduced. There by saving environment and energy.

Improved indoor air quality:
Indoor air quality is considerably improves due to use of non toxic material such as low VOC (Volatile Organic Content) paints, varnishes etc.

Demerits

Although, there are many advantages of green buildings, but some disadvantages are there as follows.

Extra Initial Cost
Due to design constraints, availability of material at work site, cost of energy efficient fittings and initial cost of renewable energy systems, the initial cost of green building is on the higher side in comparison to conventional building. However, life cycle costs is less due to reduced energy & water requirement during operational phase.

Location:
Site selection is very important for green building. To amend sun exposure green building may need a correct structural orientation. It influences how natural light enters the building, how to shade some part of it. As far as the building will contain recycled resources the location of the building is affected by the land's humidity, the circumstance of the surrounding area.

Availability of materials
Green buildings require special eco-friendly materials during construction. Although, this may not an issue in urban areas, yet, in smaller towns and rural areas it may be difficult to get these materials. However we shall encourage the use of local material.

Green roofs
Buildings with green roofs require additional maintenance cost to keep the vegetation in its proper form. Green roofs consist of several layers plus a vegetation layer, culture medium, drainage, isolation, waterproofing membrane, and roof support. Green roofs are heavier than simple once, so the roof's strength should be improved in order to construct this type of roof correctly. This may lead to increase in cost of construction. However this can be avoided by use of solar panels at roof or covering by solar reflectance tile.

From the above, it can be seen that all the merits and demerits are environmental, economic and social. They are influenced mostly by its cost, energy efficiency and influence to our health. Although the advantages of green building are many, there are still some restrictions. For this reason designers and project managers should look through all the requirements for green building at the time of design so as to optimize the solution.
3.0 Green Building Certification system

3.1 Green Building Rating System:
The Green Building Rating systems available in India are:

3.1.1 Leadership in energy and environment Design Rating system (LEED)

The LEED 2011 for India - New Commercial Construction and Major Renovation (LEED 2011 for India-NC) provides a set of performance standards for certifying the design and construction phases of commercial and institutional buildings and high-rise residential buildings. The specific credits in the rating system provide guidelines for the design and construction of buildings of all sizes in both the public and private sectors. The intent of LEED 2011 for India is to assist in the creation of high performance, healthful, durable, affordable and environmentally sound commercial and institutional buildings.

**The categories are:** Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, Innovation in Design & Regional Priority

Total 100 possible points has been distributed under category Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Materials and Resources (MR), Indoor Environmental Quality (IEQ), 6 points under Innovation in Design (ID) and 4 points for Regional Priority (RP). The details of distribution of rating points are as under:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description of Items</th>
<th>Credit Points</th>
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<tbody>
<tr>
<td>1.</td>
<td>Sustainable Sites (SS)</td>
<td>26 Possible Points</td>
</tr>
<tr>
<td>2.</td>
<td>Water Efficiency (WE)</td>
<td>10 Possible Points</td>
</tr>
<tr>
<td>3.</td>
<td>Energy and Atmosphere (EA)</td>
<td>35 Possible Points</td>
</tr>
<tr>
<td>4.</td>
<td>Materials and Resources (MR)</td>
<td>14 Possible Points</td>
</tr>
<tr>
<td>5.</td>
<td>Indoor Environmental Quality (IEQ)</td>
<td>15 Possible Points</td>
</tr>
<tr>
<td>6.</td>
<td>Innovation in Design (ID)</td>
<td>6 Possible Points</td>
</tr>
<tr>
<td>7.</td>
<td>Regional Priority (RP)</td>
<td>4 Possible Points</td>
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**Credit Point Thresholds for Different Levels of Certification**

<table>
<thead>
<tr>
<th>Points scored</th>
<th>Rating</th>
</tr>
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<tbody>
<tr>
<td>40 - 49</td>
<td>Certified</td>
</tr>
<tr>
<td>50 - 59</td>
<td>Silver</td>
</tr>
<tr>
<td>60 - 79</td>
<td>Gold</td>
</tr>
<tr>
<td>80 points and above</td>
<td>Platinum</td>
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</table>

3.1.2 The Energy and Resources Institute-INDIA (TERI)

Green star certification identifies projects that have demonstrated a commitment to sustainability by designing, constructing or owning a building to a determined standard. GRIHA (Green Rating for Integrated Habitat Assessment) is a tool developed by TERI (The Energy & Resources Institute) for rating the environmental performance of buildings duly supported by Ministry of New & Renewable Energy, Government of India & adopted as a National Rating System in India. GRIHA Rating system takes into account:
The provision of NBC 2005
- Other IS codes

GRIHA (TERI) certification system consists of 34 criteria of the rating under 4 categories.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description of Items</th>
<th>Credit Points</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sustainable Site planning</td>
<td>23 Points</td>
</tr>
<tr>
<td>2.</td>
<td>Building planning and construction</td>
<td>74 Points</td>
</tr>
<tr>
<td>3.</td>
<td>Building operation and maintenance</td>
<td>02 Points</td>
</tr>
<tr>
<td>4.</td>
<td>Innovation</td>
<td>04 Points</td>
</tr>
</tbody>
</table>

Within each category, the credits awarded have an effective weightage by virtue of the numbers of credits awarded versus the total credits available.

The GRIHA Rating System is more relevant to Indian conditions and especially to Government departments.

**Credit Points for Different Levels of Certification**

Different levels of certification (one star to five star) are awarded based on the number of points earned. A building scoring 91 to 100 points will get the maximum rating i.e. five stars.

<table>
<thead>
<tr>
<th>Points scored</th>
<th>Rating</th>
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<tbody>
<tr>
<td>50–60</td>
<td>One star</td>
</tr>
<tr>
<td>61–70</td>
<td>Two stars</td>
</tr>
<tr>
<td>71–80</td>
<td>Three stars</td>
</tr>
<tr>
<td>81–90</td>
<td>Four stars</td>
</tr>
<tr>
<td>91–100</td>
<td>Five stars</td>
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**Basic features of GRIHA:**

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).

- 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)

➢ The registration fee for this purpose is being paid by Ministry of New and Renewable Energy, Government of India under scheme on Energy efficient solar / green building to promote large scale construction of green buildings.

4.0 Green Building Design & Architectural Aspects

Following points are for general guidance during architectural & structural design & planning.

• Orientation for natural lighting
  Day lighting optimizes natural sunlight entry into a building to minimize the need for artificial lighting. Energy efficient lighting should be used for artificial light to receive the optimal level of light for the lowest energy investment.

• Openings and windows
  Window openings should generally be in North direction because sun rays do not give direct effect.

• Roof heights
  To minimize the temperature effect roof height should be adequate.

• Effective roof insulation
  Effective roof insulation is necessary to keep control of temperature. Fibre- Glass, foil-backed felt, fibre rock or mineral fibre blanket insulation is available by roll. These rolls fit snugly between the joints & provide insulation. Other types of techniques can also be adopted to get effective insulation.

• Natural ventilation
  Natural ventilation is a climate control method which relies on the natural movements of air to keep fresh air moving through a building and to control temperature and humidity levels.

• Landscaping
  Landscaping is very important element of Green environment. When choosing plant species, consideration of the local conditions of the area, soil type, microclimate, sun exposure, drainage and naturally/occurring plant communities may be taken.

• Greenery/ Terrace gardens
  It is appropriate to have parks full of greenery in all residential and official complexes however in cases of their non existence, terrace gardening should be adopted. Terrace gardening gives the opportunity to get closer to nature.
• **Fountains and water bodies**  
  Various Fountain Nozzles, Water Falls and Colourful Lights should be used for good looking and energy saving.

• **Use of locally available construction material**  
  Locally available material should be preferred to reduce transport cost and the energy.

4.1 **Environmental friendly measures**

• **Use of fly ash bricks**  
  Fly ash brick is the material made of recycled waste material, it reduces the need for clay bricks, air pollution and global warming. Such bricks can easily be manufactured near thermal power plants.

• **Cavity / Hollow construction**  
  Cavity/Hollow walls have been evolved from construction of two masonry walls side by side along with cavity. These cavity walls have excellent thermal performance when the cavity is utilized as an insulated zone.

• **Avoiding the use of carcinogenic material like asbestos**  
  Carcinogenic material like asbestos should be avoided due to generation of fibrous mineral silicate which breaks and releases fibers into air after breaking even by hand pressure. These fibers are hazardous to human health. However, non friable asbestos containing materials bonded into a form which will not easily release fibers to the air, may be used.

• **Use of minimal /Reclaimed wood**  
  Though use of wood shall be minimal however reclaimed wood can be used judiciously. Reclaimed wood is wood that was previously used in the building of another structure which, when disassembled, is recycled and used in a new building. This is particularly common when large, wooden beams are used and are transplanted from a building such as a barn into another building of a similar size. Reclaimed wood can be used to make floors, furniture or a variety of other things.

• **Rainwater harvesting**  
  Rain Water Harvesting is the collection and storage of rain water with the help of artificial designed system. Number of factors contribute to the amount of water harvested e.g. frequency of rainfall, catchments characteristics, water demands, quantum of runoff and above all speed and ease with which the rainwater percolates through the subsoil to recharge the ground water.

• **Recycling of waste water**  
  Wastewater (sewage) is treated to remove solids and certain impurities and this reclaimed water can be used for non potable uses such as irrigation, dust control, fire suppression etc.
• **Sensor operated water dispenser**
  A control apparatus is provided for a dispensing mechanism having an electrically operated dispensing control member and a sensor for sensing a first predetermined condition and producing a condition control signal for permitting or preventing operation of the dispensing control member in accordance with the predetermined condition. Sensor operated water dispenser can be used for major areas to minimize wastage of water.

• **Use of eco-friendly paints / distemper / varnishes**
  Eco-paints in general are paints that, due to their ingredients, have lesser impact on the environment. This may be due to their low ‘Volatile organic compounds’ (VOC) content. There is no difference between the eco paint to conventional solvent paints in the application, durability and availability of ranges of colors.

4.2 **Energy saving measures**

• **Use of solar panels for supplementing the lighting**
  Solar energy is a general term for the electro-magnetic radiation emitted by the sun. Solar radiation can be captured & converted into useful forms of energy such as heat and electricity by using the latest solar panel technologies. The technical feasibility and economical operation of these technologies at a specific location depends on the available solar radiation. As far as possible solar energy be utilized to facilitate conservation of energy.

• **Use of energy efficient lighting / Intelligent switches & fittings**
  The world of lighting systems serves a wide variety of situations and categories. A typical installation will include many types of lamps including HID, low and high pressure sodium, mercury vapour, metal halide, halogen, and fluorescent lamps. Energy efficient lighting like CFL bulb, CFL tubes, LED etc. with intelligent lighting systems shall be used to reduce electricity consumption.

• **Use of suitable glazed glass for improved lighting**
  Glass has been used for hundreds of years in architecture. Glazing Glass form’s a major part of the outer envelope of building. It is also used to form internal building features such as partitions, doors, windows and enclosures. Of late, glazing is a favoured feature in building. Glazing not only adds to the aesthetic’s but also has a tremendous impact on energy performance of building besides visual and acoustic effect.

• **Use of solar panels for hot water**
  Solar hot water panels are means to harness the Sun’s energy in a unique way. Like traditional solar panels, solar hot water panels are placed in direct sunlight on rooftops.

5.0 **Building Insulation :**
  Insulation in buildings is assuming tremendous importance as it:
  • provides 5-8% energy savings with a payback of 1-2 years
● provides thermal as well as acoustical insulation
● is resistant to moisture
● is resistant to air infiltration

Types of insulation materials:
A range of insulation materials can be installed in the building.

Autoclaved Aerated Concrete Blocks
Autoclaved Aerated Concrete (AAC) blocks are produced using materials including silica sand, lime, cement, gypsum, water, fly-ash and aluminum powder. The special combination of these substances yields a material with excellent construction properties such as thermal insulation, structural strength and fire resistance.

High performance Glass
High performance glass is one which reduces the ingress of heat and at the same time allows higher penetration of day light.

Benefits of using high performance Glass
● It can result in energy saving to the tune of 35-40% as compared to conventional glass.
● Typical payback period varies from 3-4 years.
● It provides access to day lighting which can enhance occupant comfort and productivity.

6.0 Action plan for implementing the concept of green building in Indian Railways:

The concept of green building can be fully implemented on new constructions. For this, the guidelines issued by GRIHA in 5 volumes shall be followed from the site selection stage onwards.

6.1 GRIHA Rating system:

The brief of the criteria for scoring the points for achieving rating (Mandatory and optional/non mandatory clauses as per GRIHA rating system) is as under:

6.1.1. SUSTAINABLE SITE PLANNING
Conservation and efficient utilization of resources

To maximize the conservation and utilization of resources (land, water, natural habitat, avid 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 (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 metre minimum around the FTL (Full Tank Level)}, various hazard prone area regulations, and others if the site falls under any such area (mandatory with no point allocation).

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)

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

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).

Non-Mandatory/Optional clause

Ensure proper timing of construction with respect to rain as per GRIHA
AND
Confine construction activity to pre-designated areas, as per GRIHA (1 point).

Proper implementation of staging and spill prevention plan
AND
Effective erosion and sedimentation control to prevent erosion, as per GRIHA (1 point).

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

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).

Non applicability condition proposed (for tree preservation and protection clause only): Sites that are devoid of trees
➢ **Criterion 3** Soil conservation (till post-construction)

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).*

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

**Non applicability condition proposed**: For sites in which top soil could not be stored for reasons as sited in Criteria 2 (clause 8.1.2) above.

➢ **Criterion 4** Design to include existing site features

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

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. *(1 point)*

*Mandatory clause*

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

AND

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

OR

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

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)*

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

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 per GRIHA (1 point).

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

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)

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

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).

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

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).

6.1.2. HEALTH AND WELL-BEING

To protect the health of construction workers and prevent pollution.

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

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

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

Criterion 9 Reduce air pollution during construction

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

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

6.1.3. BUILDING PLANNING AND CONSTRUCTION

Conservation and efficient utilization of resources:
To maximize resource (water, energy, and materials) conservation and enhance efficiency of the system and operations.
a) Water

- **Criterion 10** Reduce landscape water requirement
  
  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).*
  
  Reduction in water consumption by 40%, as per GRIHA *(additional 1 point).*
  
  Reduction in water consumption by 50%, as per GRIHA *(additional 1 point).*

- **Criterion 11** Reduce water use in the building
  
  Reduce building water use by applying low-flow fixtures and other similar tools. *(2 points)*

  **Optional clause**
  
  Reduction in water consumption by 25% as per GRIHA *(1 point).*
  
  Water-use reduction by 50% as per GRIHA *(additional 1 point).*

- **Criterion 12** Efficient water use during construction
  
  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).*

b) Energy: end use

- **Criterion 13** Optimize building design to reduce conventional energy demand
  
  Plan appropriately to reflect climate responsiveness, including adequate day lighting as well as efficient artificial lighting. *(8 points)*

  **Mandatory clause**
  
  Appropriate planning which reflects climate responsiveness, as per GRIHA *(2 points).*
  
  Adequate day lighting is provided, as per GRIHA *(2 points).*
  
  Over-design of lighting system is avoided, as per GRIHA *(2 points).*

  **Optional clause**
  
  Increase in day lighted area as per GRIHA *(2 points)*

- **Criterion 14** Optimize energy performance of building within specified comfort limits
  
  Ensure that the building complies with the mandatory compliance requirement of ECBC (Energy Conservation Building Code) 2007 and meet thermal comfort conditions as per NBC
2005 as well as minimum benchmark for EPI (Environmental Performance Index) 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 thermal comfort condition as per National Building Code 2005 and minimum benchmark index as per GRIHA. (2 points)

**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)

c) **Energy: embodied and construction**

- **Criterion 15** Utilization of fly-ash in building structure

  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%).

  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.

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

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

  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)

  - 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

Minimum 70% in each of the three categories of interiors (internal partitions, paneling/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/paneling/false ceiling/in-built furniture **(2 points)**, as per GRIHA.

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

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

d) **Energy: Renewable**

- **Criterion 18** Renewable energy utilization

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.

**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.

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.

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)**.
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 19** Renewable-energy-based hot water system

  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).

  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).

  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).

- **e) Recycle, recharge, and reuse of water**

  To promote the recycle and reuse of water.

- **Criterion 20** Waste water treatment

  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).

- **Criterion 21** Water recycle and reuse (including rainwater)

  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).

**Optional clause**
Annual water reuse of 25% (1 point)
Annual water reuse of 50% (additional 1 point).
Annual water reuse of 75% (additional 1 point).

Recharge of surplus rainwater into aquifer (2 points).

f) **Waste management**

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

- **Criterion 22** Reduction in waste during construction
  
  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 and
Recycling and safe disposal of segregated wastes, as per GRIHA (1 point).

- **Criterion 23** Efficient waste segregation
  
  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).

- **Criterion 24** Storage and disposal of wastes
  
  Allocate separate space for the collected waste before transferring it to the recycling/disposal stations. (1 point)

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

- **Criterion 25** Resource recovery from waste
  
  Employ resource recovery systems for biodegradable waste as per the *Solid Waste Management and Handling Rules, 2000 of the MoEF (Ministry of Energy & Forests)*. 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).

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

g) Health and well-being

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

> Criterion 26 Use low-VOC (Volatile organic compounds') paints/adhesives/sealants

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),

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).

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

> Criterion 27 Minimize ozone depleting substances

Employ 100% zero ODP (ozone depletion potential) insulation, HCFC (hydrochloro-fluorocarbon)/ and CFC (chlorofluorocarbon), free HVAC (heating, ventilation, and air conditioning), 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

and

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

and

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

> Criterion 28 Ensure water quality

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).

- **Criterion 29** Acceptable outdoor and indoor noise levels

  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).

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

- **Criterion 30** Tobacco smoke control

  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)

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

  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).

6.1.4. **Building operation and maintenance**

- **Criterion 32** Audit and validation

  To ensure that all energy and environment systems in the building are performing as predicted during the design and development stage. (0 point)

**Mandatory clause**
Conduct audits (energy, water, waste and noise level) within 2 years of full occupancy of the building, to prove that the energy and environmental systems of the building are performing as predicted and match the information provided at the time of award of provisional rating (0 points).

- **Criterion 33** Operation and maintenance

  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 (2 points).
**Mandatory clause**
Provision of meters for monitoring building’s energy and water consumption. Provision for a core facility/service group responsible for the O&M of the building’s systems after installation. 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. 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 instruction/dos and don’ts/ maintenance requirements for the specific system. Development of a fully documented O&M manual/ CD/multimedia/information brochure enlisting the best practices for O&M of the building’s systems. (2 points)

6.1.5 Innovation points

> **Criterion 34 Innovation points**

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

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.

**GRIHA Criteria Checklist:**

<table>
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<tr>
<th>Sl. No.</th>
<th>CRITERION</th>
<th>COMMITMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td><strong>Site planning:</strong> Conservation and efficient utilization of resources</td>
<td></td>
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<tr>
<td></td>
<td><strong>Objective:</strong> To maximize the conservation and utilization of resources (land, water, natural habitat, fauna and energy) and enhance efficiency of the systems and operations.</td>
<td></td>
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<tr>
<td>1.</td>
<td>Site selection</td>
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<td>2.</td>
<td>Preserve and protect the landscape during construction / compensatory depository forestation</td>
<td></td>
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<td>3.</td>
<td>Soil conservation (till post construction)</td>
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<td>4.</td>
<td>Design to include existing site features</td>
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<td>5.</td>
<td>Reduce hard paving on-site and / or provide shaded hard-paved surfaces</td>
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<tr>
<td>6.</td>
<td>Enhance outdoor lighting system efficiency</td>
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<td>7.</td>
<td>Plan utilities efficiently and optimize on-site circulation efficiency</td>
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<tr>
<td>1.2</td>
<td><strong>Health and well – being</strong></td>
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<td></td>
<td><strong>Objective:</strong> To protect the health of construction workers and prevent pollution.</td>
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<td>8.</td>
<td>Provide at least minimum level of sanitation/safety facilities for workers</td>
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<tr>
<td>9.</td>
<td>Reduce air pollution during construction</td>
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<tr>
<td>2. Building planning and construction stage</td>
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<tr>
<td>2.1 Conservation and efficient utilization of resources</td>
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<tr>
<td><strong>Objective:</strong> To maximize resource (water, energy, and materials) conservation and enhance efficiency of the system and operations.</td>
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<tr>
<td>2.1.1 Water</td>
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<tr>
<td>10.</td>
<td>Reduce landscape water requirement</td>
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<tr>
<td>11.</td>
<td>Reduce building water use</td>
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<tr>
<td>12.</td>
<td>Efficient water use during construction</td>
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<tr>
<td>2.1.2 Energy and use</td>
<td></td>
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<tr>
<td>13.</td>
<td>Optimize building design to reduce the conventional energy demand</td>
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<td>14.</td>
<td>Optimize the energy performance of the building within specified comfort limits</td>
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<tr>
<td>2.2 Energy: embodied and construction</td>
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<tr>
<td>15.</td>
<td>Utilization of fly ash in the building structure</td>
<td></td>
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<tr>
<td>16.</td>
<td>Reduce volume, weight, and time of construction by adopting an efficient technology (such as pre-cast systems, ready mix concrete, and others)</td>
<td></td>
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<tr>
<td>17.</td>
<td>Use low-energy material in the interiors</td>
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<td>3. Energy: renewable</td>
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<td>18.</td>
<td>Renewable energy utilization</td>
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<tr>
<td>19.</td>
<td>Renewable-energy-based hot water system</td>
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<tr>
<td>4. Recycle, recharge, and reuse of water</td>
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<tr>
<td><strong>Objective:</strong> To promote the recycle and reuse of water.</td>
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<tr>
<td>20.</td>
<td>Waste-water treatment</td>
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<tr>
<td>21.</td>
<td>Water recycle and reuse (including rainwater)</td>
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<tr>
<td>5. Waste management</td>
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<tr>
<td><strong>Objective:</strong> To minimize waste generation, streamline waste segregation, storage, and disposal and promote resource recovery from waste.</td>
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<td>22.</td>
<td>Reduction in waste during construction</td>
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<tr>
<td>23.</td>
<td>Efficient waste segregation</td>
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<tr>
<td>24.</td>
<td>Storage and disposal of waste</td>
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<tr>
<td>25.</td>
<td>Resource recovery from waste</td>
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<tr>
<td>6. Health and well – being</td>
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<tr>
<td><strong>Objective:</strong> To ensure healthy indoor air quality, water quality, and noise levels, and to reduce the global warming potential.</td>
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<tr>
<td>26.</td>
<td>Use of low VOC paints/ adhesives/sealants</td>
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<tr>
<td>27.</td>
<td>Minimize ozone-depleting substances</td>
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<tr>
<td>28.</td>
<td>Ensure water quality</td>
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<tr>
<td>29.</td>
<td>Acceptable outdoor and indoor noise levels</td>
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<td>30.</td>
<td>Tobacco and smoke control</td>
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<tr>
<td>31.</td>
<td>Provide the minimum level of accessibility for persons with disabilities.</td>
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<tr>
<td>32.</td>
<td>Energy audit and validation</td>
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<tr>
<td>33.</td>
<td>Building operation and maintenance</td>
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<tr>
<td>34.</td>
<td>Innovation points</td>
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</table>
SVA GRIHA (Small Versatile Affordable GRIHA) RATING

SVAGRIHA (Small Versatile Affordable GRIHA) was jointly developed by ADaRSH and TERI. SVAGRIHA is a significantly simplified, faster, easier and more affordable green building rating system and functions as a design-cumrating tool. SVAGRIHA has been designed as a variant of GRIHA specifically developed for projects with built-up area less than 2500 sqm. SVAGRIHA can help in design and rating of individual residences, small offices, commercial and institutional buildings.

The rating comprises only 14 criteria analyzed using software tool, comprising simplified calculators. These calculators can be filled using information from construction drawings like areas and quantities of materials. This can be done easily by the architect/consultant of the project. Once completed, the tool will inform the architect/consultant the number of points that they are able to achieve in that particular criterion as well as the overall points.

- **Process:**
  - Registration of project with ADaRSH
  - Submission of completed software tool and documentation to ADaRSH
  - Internal review of documentation
  - Site visit and post construction due diligence check (mandatory)
  - External evaluation of project
  - Award of Rating

- **Evaluation**

  SVAGRIHA evaluates projects on the following 14 criteria:

<table>
<thead>
<tr>
<th>Criterion No.</th>
<th>Criterion name</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Reduce UHIE and maintain native vegetation cover on site</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>Passive architectural design and systems</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Good fenestration design for reducing direct heat gain and glare while maximising daylight penetration</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>Efficient artificial lighting system</td>
<td>2</td>
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<tr>
<td>5.</td>
<td>Thermal efficiency of building envelope</td>
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<td>6.</td>
<td>Use of energy efficient appliances</td>
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<tr>
<td>7.</td>
<td>Use of renewable energy on site</td>
<td>4</td>
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<tr>
<td>8.</td>
<td>Reduction in building and landscape water demand</td>
<td>5</td>
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<tr>
<td>9.</td>
<td>Rainwater harvesting</td>
<td>4</td>
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<td>10.</td>
<td>Generate resource from waste</td>
<td>2</td>
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<tr>
<td>11.</td>
<td>Reduce embodied energy of building</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td>Use of low-energy materials in interiors</td>
<td>4</td>
</tr>
<tr>
<td>13.</td>
<td>Adoption of green Lifestyle</td>
<td>4</td>
</tr>
<tr>
<td>14.</td>
<td>Innovation</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>
In order to achieve a SVAGRIHA rating each project must achieve a certain number of points in each category as mentioned below. This is to ensure that each project reduces its overall environmental impact and not just the impact through energy and water. Based on the number of points the project attempts, the rating shall be provided as mentioned in the table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Maximum points</th>
<th>Threshold points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape</td>
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<td>3</td>
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<tr>
<td>Energy</td>
<td>21</td>
<td>11</td>
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<tr>
<td>Water &amp; waste</td>
<td>11</td>
<td>6</td>
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<tr>
<td>Materials</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

- **Project scoring**

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<tr>
<th>Points</th>
<th>Rating</th>
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</thead>
<tbody>
<tr>
<td>25-30</td>
<td>1 Star</td>
</tr>
<tr>
<td>31-35</td>
<td>2 Star</td>
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<tr>
<td>36-40</td>
<td>3 Star</td>
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<tr>
<td>41-45</td>
<td>4 Star</td>
</tr>
<tr>
<td>46-50</td>
<td>5 Star</td>
</tr>
</tbody>
</table>

For more information and registration costs, may be contacted at following email ID: info@grihaindia.org / apoorv.vij@grihaindia.org

6.2 **LEED 2011 : for India Rating System**

6.2.1 **SUSTAINABLE SITES (SS)**

**Prerequisite: Construction Activity Pollution Prevention**

To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation.

**Requirements**

Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan must conform to erosion and sedimentation control requirements of Local Standards and Codes (OR) National Building Code of India (NBC), Part 10, Section 1, Chapters 4 & 5, whichever is more stringent.

- **Site Selection: 1 Point**

To avoid the development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

**Requirements**

Permit from the relevant local authority in the form of a land allotment/land use letter; also, where applicable, clearance from the Ministry of Environment and Forests (MoEF). Do not
develop buildings, hardscape, roads or parking areas on portions of sites that meet any of the following criteria:

- High-value farmland as defined by the relevant local, regional, state or central government agency.
- Previously undeveloped land within areas classified at high or very high hydrogeologic risk, including any land whose elevation is lower than 1.5 meters above the elevation of the 100-year flood, as defined by the relevant local, regional, state or central government agency.
- Land specifically identified as habitat for any species listed as threatened or endangered by Wildlife Institute of India.
- Land within 30 meters of a wetland listed as being of high ecological value by the relevant local, regional, state, or central government agency. Renovation of an existing building is allowed if construction impact is limited to the existing development footprint.
- Previously undeveloped land that is within 15 meters of a water body that supports or could support aquatic life, recreation or industrial use, as determined by a professional biologist.
- Land that prior to acquisition for the project was public parkland.

➢ Development Density and Community Connectivity: 5 Points

To channel development to urban areas with existing infrastructure, protect greenfields, and preserve habitat and natural resources.

Requirements

OPTION 1. Development Density

Construct or renovate a building on a previously developed site (AND) in a community with a minimum density of 13,800 square meters per hectare net. The density calculation is based on a typical two-story downtown development and must include the area of the project being built.

OR

OPTION 2. Community Connectivity

Construct or renovate a building on a site that meets the following criteria:

- Is located on a previously developed site
- Is within 800 meters of a residential area with an average density of 10 units per acre net
- Is within 800 meters of at least 10 basic services

➢ Brownfield Re-development: 1 Point

To rehabilitate damaged sites where development is complicated by environmental contamination and to reduce pressure on undeveloped land.

Requirements

OPTION 1: Develop on a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local voluntary cleanup program). OR

OPTION 2: Develop on a site defined as a brownfield by a local, state, or central government agency.
Alternative Transportation—Public Transportation Access : 6 Points
To reduce pollution and land development impacts from automobile use.

Requirements

OPTION 1. Rail Station Proximity
Locate the project within 1800-meter walking distance from a main building entrance of an existing or planned and funded commuter rail, light rail or subway station. OR

OPTION 2. Bus Stop Proximity
Locate the project within 400-meter walking distance from a main building entrance of 1 or more stops for 2 or more public, campus, or private bus lines usable by building occupants. OR

OPTION 3. Public Transportation Proximity
Locate the project within 400-meter walking distance from a main building entrance of 1 or more stops for at least 2 rideshare options for 4 or more passengers. Rideshare options include passenger ferry terminals, vans and human-powered conveyances, such as rickshaws, that are authorized by the local transit authority and that meet the definition of public transportation.

Alternative Transportation—Bicycle Storage and Changing Rooms: 1 Point
To reduce pollution and land development impacts from automobile use.

Requirements

Commercial or Institutional Projects
• Provide secure bicycle racks and/or storage within 200 meters of a building entrance for 5% or more of all building users (measured at peak periods)
• Provide shower and changing facilities in the building, or within 200 meters of a building entrance, for 0.5% of full-time equivalent (FTE) occupants.

Residential Projects
• Provide covered storage facilities for securing bicycles for 15% or more of building occupants.

Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles: 3 Points
To reduce pollution and land development impacts from automobile use.

Requirements

OPTION 1
Provide preferred parking for low-emitting and fuel-efficient vehicles for 5% of the total vehicle parking capacity of the site. Providing a discounted parking rate is an acceptable substitute for preferred parking for low-emitting/fuel-efficient vehicles. OR

OPTION 2
Install alternative-fuel fueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors. OR
OPTION 3
Provide building occupants access to a low-emitting or fuel-efficient vehicle-sharing program.

Alternative Transportation—Parking Capacity: 2 Points

To reduce pollution and land development impacts from automobile use.

Requirements

Non-Residential Projects

OPTION 1
Size parking capacity to meet, but not exceed, minimum Local Regulations (OR) the National Building Code of India (NBC), AND provide preferred parking for Carpools / Vanpools. OR

OPTION 2
For projects that provide parking for less than 5% of full-time equivalent (FTE) building occupants:
Provide preferred parking for carpools or vanpools, for 5% of total parking spaces. Providing a discounted parking rate is an acceptable substitute for preferred parking for carpool or vanpool vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers who opt for vehicle pooling and awareness of this incentive should be given to all customers. OR

OPTION 3
Provide no new parking. OR

OPTION 4
For projects that have no minimum local zoning requirements, provide 25% fewer parking spaces than the applicable standard listed in the 2003 Institute of Transportation Engineers (ITE) “Parking Generation” study at http://www.ite.org.

Residential Projects

OPTION 1
Size parking capacity to meet but not exceed minimum local zoning requirements

Provide infrastructure and support programs to facilitate shared vehicle use such as carpool drop-off areas, designated parking for vanpools, car-share services, ride boards and shuttle services to mass transit. OR

OPTION 2
Provide no new parking.

Site Development—Protect or Restore Habitat: 1 Point

To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Requirements
Limit all site disturbances to
• within 12 meters of the building perimeter
• 4.5 meters beyond primary roadway curbs
- **Site Development—Maximize Open Space: 1 Point**
  
  To promote biodiversity by providing a high ratio of open space to development footprint.

  **Requirements**
  
  Reduce the building area and/or provide vegetated open space within the project boundary as per norms.

- **Storm water Design—Quantity Control: 1 Point**
  
  To limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff and eliminating contaminants.

  **Requirements**
  
  Implement a storm water management plan that results in a 25% decrease in the volume of storm water runoff calculated based upon a 24-hour rainfall that is equal to 30% of the average rainfall for the month with the highest average rainfall.

- **Storm water Design—Quality Control: 1 Point**
  
  To limit disruption and pollution of natural water flows by managing stormwater runoff.

  **Requirements**
  
  Implement a storm water management plan that reduces impervious cover, promotes infiltration and captures and treats the storm water runoff from 90% of the average annual rainfall using acceptable best management practices (BMPs).

- **Heat Island Effect—Non roof: 1 Point**
  
  To reduce heat islands (thermal gradient between developed and undeveloped area)

  **Requirements**
  
  • Provide shade from the existing tree canopy or within 5 years of landscape installation.
  • Provide shade from structures covered by solar panels that produce energy used to offset some nonrenewable resource use.
  • Provide shade from architectural devices or structures that have a solar reflectance index (SRI) of at least 29.
  • Place a minimum of 50% of parking spaces under cover.

- **Heat Island Effect – Roof : 1 Point**
  
  To reduce heat islands (thermal gradient between developed and undeveloped area)

  **Requirements**
  
  **OPTION 1**
  
  Use roofing materials with a solar reflectance index (SRI) equal to or greater than the values in the table below for a minimum of 75% of the roof surface.

<table>
<thead>
<tr>
<th>Roof Type</th>
<th>Slope</th>
<th>SRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-sloped roof</td>
<td>≤ 2:12 (15%)</td>
<td>78</td>
</tr>
<tr>
<td>Steep-sloped roof</td>
<td>&gt; 2:12 (15%)</td>
<td>29</td>
</tr>
</tbody>
</table>
OR

OPTION 2
Install a vegetated roof that covers at least 50% of the roof area. OR

OPTION 3
Install high-albedo and vegetated roof surfaces that, in combination, meet the following criteria:

<table>
<thead>
<tr>
<th>Roof Type</th>
<th>Slope</th>
<th>SRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-sloped roof</td>
<td>≤ 2:12 (15%)</td>
<td>78</td>
</tr>
<tr>
<td>Steep-sloped roof</td>
<td>&gt; 2:12 (15%)</td>
<td>29</td>
</tr>
</tbody>
</table>

Product information is available from the Cool Roof Rating Council Web site at http://www.coolroofs.org/

➢ Light Pollution Reduction: 1 Point

To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve night time visibility through glare reduction and reduce development impact from lighting on nocturnal environments.

Requirements
For Interior Lighting

Reduce the input power (by automatic device) of all non emergency interior luminaires by at least 50% between 11 p.m. and 5 a.m. OR

For Exterior Lighting

Light areas only as required for safety and comfort. Exterior lighting power densities shall not exceed those specified in ANSI / ASHRAE / IESNA Standard 90.1-2007 with Addenda 1 for the documented lighting zone. Justification shall be provided for the selected lighting zone. Lighting controls for all exterior lighting shall comply with section 9.4.1.3 of ANSI / ASHRAE / IESNA Standard 90.1-2007, without amendments.

6.2.2 WATER EFFICIENCY

Prerequisite: Water Use Reduction

To increase water efficiency within buildings to reduce the burden on municipal water supply and waste water systems.

Requirements
Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation).

➢ Water Efficient Landscaping: 2–4 Points

To limit or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site for landscape irrigation.
Requirements

OPTION 1. Reduce by 50% (2 points)

Reduce potable water consumption for irrigation by 50% from a calculated baseline case for the month with the highest evapo-transpiration rate.

Reductions must be attributed to any combination of the following items:
• Plant species, density and microclimate factor
• Irrigation efficiency
• Use of captured rainwater
• Use of recycled wastewater
• Use of water treated and conveyed by a public agency specifically for nonpotable uses

OR

OPTION 2. No Potable Water Use or Irrigation (4 points)

Meet the requirements for Option 1.

AND

PATH 1 : Use only captured rainwater, recycled wastewater or water treated and conveyed by a public agency specifically for non potable uses for irrigation.

OR

PATH 2 : Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed if removed within 1 year.

➢ Innovative Wastewater Treatment and Reuse: 2 Points

To reduce wastewater generation and potable water demand while increasing the local aquifer recharge.

Requirements

OPTION 1 (1 point):
Treat 100% of wastewater on-site to tertiary standards. Treated water must be used on-site

AND/OR

OPTION 2 (1 point):
Use treated wastewater or captured rain water, to reduce potable water consumption for air-conditioning make-up by 50% (if the project uses water-cooled chillers); (AND) Reduce potable water use for building sewage conveyance by 50% through the use of non-potable water (e.g., treated wastewater, municipally treated wastewater, captured rainwater).

➢ Water Use Reduction: 2–4 Points

To further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.
Requirements
Employ strategies that in aggregate use less water than the water use baseline calculated for
the building (not including irrigation). The minimum water savings percentage for each point
threshold is as follows:

<table>
<thead>
<tr>
<th>Percentage Reduction</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>2</td>
</tr>
<tr>
<td>35%</td>
<td>3</td>
</tr>
<tr>
<td>40%</td>
<td>4</td>
</tr>
</tbody>
</table>

6.2.3 ENERGY & ATMOSPHERE

Prerequisite:
• Fundamental Commissioning of Building Energy Systems

Benefits of commissioning include reduced energy use, lower operating costs, fewer contractor
callbacks, better building documentation, improved occupant productivity and verification that
the systems perform in accordance with the owner’s project requirements.

• Minimum Energy Performance

To establish the minimum level of energy efficiency for the proposed building and systems to
reduce environmental and economic impacts associated with excessive energy use. The
desired comfort temperature range can be taken up to a maximum of 26 ± 2 deg C.

• Fundamental Refrigerant Management

To reduce stratospheric ozone depletion. Zero use of chlorofluorocarbon (CFC)-based
refrigerants in heating, ventilating, air conditioning and refrigeration (HVAC&R) systems.

➢ Optimize Energy Performance: 1–19 Points

To achieve increasing levels of energy performance beyond the prerequisite standard to
reduce environmental and economic impacts associated with excessive energy use.

➢ On-site Renewable Energy: 1–7 Points

To encourage and recognize increasing levels of on-site renewable energy self-supply to
reduce environmental and economic impacts associated with fossil fuel energy use.

➢ Enhanced Commissioning: 2 Points

To begin the commissioning process early in the design process and execute additional
activities after systems performance verification is completed.

➢ Enhanced Refrigerant Management: 2 Points

To reduce ozone depletion and support early compliance with the Montreal Protocol while
minimizing direct contributions to climate change.
**Requirements**

**OPTION 1**
Do not use refrigerants. **OR**

**OPTION 2**
Select refrigerants and heating, ventilation, air conditioning and refrigeration (HVAC&R) equipment that minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change.

- **Measurement and Verification: 3 Points**
  
  To provide for the ongoing accountability of building energy consumption over period of time.

**Requirements**

**OPTION 1**
Develop and implement a measurement and verification (M&V) plan consistent with Calibrated Simulation (Savings Estimation Method 2) as specified in the International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003. The M&V period must cover at least 1 year of post-construction occupancy. **OR**

**OPTION 2**

- **Green Power: 2 Points**
  
  To encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

**Requirements**

Engage in at least a 2-year renewable energy contract to provide at least 35% of the building’s electricity from renewable sources, as defined by the Center for Resource Solutions’ Green-e Energy product certification requirements. All purchases of green power shall be based on the quantity of energy consumed, not the cost. Use the annual electricity consumption from the results of EA Credit 1: Optimize Energy Performance, as a basis for the calculations in this credit.

**OR**

Demonstrate performance that is equivalent to the Green-e Energy National Standard requirements by substituting appropriate benchmarks, protocols and metrics for establishing a baseline, and measure performance relative to that baseline.

---

6.2.4 **MATERIALS & RESOURCES**

**Prerequisite Storage and Collection of Recyclables**

To facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.
**Requirements**
Provide easily-accessible dedicated areas for the collection and storage of materials for recycling for the entire building. Materials may include, paper, cardboard, glass, plastics and metals etc.

> **Building Reuse—Maintain Existing Walls, Floors and Roof : 1–3 Points**

To extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

**Requirements**
Maintain the existing building structure (including structural floor and roof decking) and envelope (the exterior skin and framing, excluding window assemblies and non-structural roofing material). The minimum percentage building reuse for each point threshold is as follows:

<table>
<thead>
<tr>
<th>Building Reuse</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>55%</td>
<td>1</td>
</tr>
<tr>
<td>75%</td>
<td>2</td>
</tr>
<tr>
<td>95%</td>
<td>3</td>
</tr>
</tbody>
</table>

> **Building Reuse—Maintain Interior Non-structural Elements: 1 Point**

To extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

**Requirements**
Use existing interior nonstructural elements (e.g., interior walls, doors, floor coverings and ceiling systems) in at least 50% (by area) of the completed building, including additions.

> **Construction Waste Management: 1–2 Points**

To divert construction and demolition debris from disposal in landfills and incineration facilities. Redirect recyclable recovered resources back to the manufacturing process.

**Requirements**
Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that identifies the materials to be sorted on-site or diverted from disposal site. Excavated soil and land-clearing debris do not contribute to this credit. The minimum percentage debris to be recycled or salvaged for each point threshold is as follows:

<table>
<thead>
<tr>
<th>Recycled or Salvaged</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>1</td>
</tr>
<tr>
<td>75%</td>
<td>2</td>
</tr>
</tbody>
</table>
Materials Reuse: 1–2 Points

To reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.

Requirements
Use salvaged, refurbished or reused materials, the sum of which constitutes at least 5% or 10%, based on cost, of the total value of materials on the project. The minimum percentage materials reused for each point threshold is as follows:

<table>
<thead>
<tr>
<th>Reused Materials</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>1</td>
</tr>
<tr>
<td>10%</td>
<td>2</td>
</tr>
</tbody>
</table>

Mechanical, electrical and plumbing components and specialty items such as elevators and equipment cannot be included in this calculation. Include only materials permanently installed in the project.

Recycled Content: 1–2 Points

To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.

Requirements
Use materials with recycled content such that the sum of post consumer recycled content plus 1/2 of the pre consumer content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project. The minimum percentage materials recycled for each point threshold is as follows:

<table>
<thead>
<tr>
<th>Recycled Content</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>1</td>
</tr>
<tr>
<td>25%</td>
<td>2</td>
</tr>
</tbody>
</table>

Regional Materials: 1–2 Points

To increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation.

Requirements
Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 400 kilometers of the project site for a minimum of 10% or 20%, based on cost, of the total materials value. If only a fraction of a product or material is extracted, harvested, or recovered and manufactured locally, then only that percentage (by weight) can contribute to the regional value. The minimum percentage regional materials for each point threshold are as follows:

<table>
<thead>
<tr>
<th>Regional Materials</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>1</td>
</tr>
<tr>
<td>20%</td>
<td>2</td>
</tr>
</tbody>
</table>
➢ **Rapidly Renewable Materials: 1 Point**

To reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.

**Requirements**
Use rapidly renewable building materials and products for 2.5% of the total value of all building materials and products used in the project, based on cost. Rapidly renewable building materials and products are made from plants that are typically harvested within a 10-year or shorter cycle.

➢ **Certified Wood: 1 Point**

To encourage environmentally responsible forest management.

**Requirements**
Use a minimum of 50% (based on cost) of wood-based materials and products that are certified in accordance with the Forest Stewardship Council’s principles and criteria, for wood building components. These components include at a minimum, structural framing and general dimensional framing, flooring, subflooring, wood doors and finishes.

### 6.2.5 INDOOR ENVIRONMENTAL QUALITY

**Minimum Indoor Air Quality Performance**
To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

**Requirements**
Meet the minimum requirements of Sections 4 through 7 of ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality OR

Use a Local standard for establishing a baseline and measure performance relative to that baseline, to demonstrate equivalency with the above requirements of ASHRAE. The following general topics must be addressed in establishing acceptable benchmarks for demonstrating equivalency with ASHRAE Standard 62.1–2007, Sections 4 through 7:

- Outdoor air quality
- Systems and equipment
- Ventilation rate procedure and indoor air quality (IAQ) procedure
- Construction and system start-up

AND

**CASE 1  Mechanically Ventilated Space**

Mechanical ventilation systems must be designed using the ASHRAE 62.1 ventilation rate procedure (OR) the applicable local code, whichever is more stringent.
CASE 2  Naturally Ventilated Spaces
Use a local standard for establishing a baseline and measure performance relative to that baseline, to demonstrate equivalency with the requirements of ASHRAE Standard 62.1–2007, Para 5.1.

Environmental Tobacco Smoke (ETS) Control
To prevent or minimize exposure of building occupants, indoor surfaces and ventilation air distribution systems to environmental tobacco smoke (ETS).

Requirements
CASE 1. Non-Residential Projects
Prohibit smoking in the building except in designated smoking areas.
Prohibit on-property smoking within 8 meters of entries, outdoor air intakes and operable windows.
Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

CASE 2. Residential and Hospitality Projects
Prohibit smoking in all common areas of the building.
Locate any exterior designated smoking areas, including balconies where smoking is permitted, at least 8 meters from entries, outdoor air intakes and operable windows opening to common areas.
Prohibit on-property smoking within 8 meters of entries, outdoor air intakes and operable windows.
Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

Outdoor Air Delivery Monitoring : 1 Point
Provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

Requirements
Install permanent monitoring systems to ensure that ventilation systems maintain design minimum requirements. Configure all monitoring equipment to generate an alarm when airflow values or carbon dioxide (CO2) levels vary by 10% or more from the design values. AND

CASE 1. Mechanically Ventilated Spaces
Monitor CO2 concentrations within all densely occupied spaces i.e., those with a design occupant density of 25 people or more per 1,000 square feet (95 square meters). CO2 monitors must be between 3 and 6 feet (between 1 and 2 meters) above the floor.
Provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow with an accuracy of plus or minus 15% of the design minimum outdoor air rate, as defined by ASHRAE 62.1-2007

CASE 2. Naturally Ventilated Spaces
Monitor CO2 concentrations within all naturally ventilated spaces. CO2 monitors must be between 1 and 2 meters above the floor. One CO2 sensor may be used to monitor multiple non densely occupied spaces. Natural ventilation design should induce airflow through those spaces equally and simultaneously without intervention by building occupants.
Increased Ventilation: 1 Point

Provide additional outdoor air ventilation to improve indoor air quality (IAQ) and promote occupant comfort, well-being and productivity.

Requirements

CASE 1. Mechanically Ventilated Spaces
Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2007 or relevant Local standard.

CASE 2. Naturally Ventilated Spaces
Determine that natural ventilation is an effective strategy for the project by following the requirements of the flow diagram process shown in the CIBSE Applications Manual 10: 2005, Figure 2.8.

OR
Use a Local standard to demonstrate performance that is equivalent to CIBSE by establishing a baseline, and measure performance relative to that baseline. Perimeter zone conditions, including noise and pollution levels
- Control of ventilation by occupants
- Temperature and relative humidity control
- Humidification

AND
Show that the natural ventilation systems design meets the recommendations set forth in the CIBSE manuals appropriate to the project space. (OR) Use a local standard to demonstrate performance that is equivalent to the requirements of CIBSE Applications Manual 10: 2005 or CIBSE AM 13: 2000, Mixed Mode Ventilation, by substituting appropriate benchmarks and metrics for establishing a baseline, and measure performance relative to that baseline. The following general topics must be addressed to demonstrate equivalency with ASHRAE:
- Ventilation rate procedure
- Indoor air quality (IAQ) procedure
- Design documentation procedures

Construction Indoor Air Quality Management Plan -

To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants.

During Construction: 1 Point

Requirements
Develop and implement an IAQ management plan for the construction and preoccupancy phases of the building.

HVAC Protection
a. Avoid using permanently installed HVAC systems. Use temporary systems where possible.
b. If permanently installed air handlers are used during construction, filtration media must be used at each return air grille. Filtration must have a minimum efficiency of 30%.
c. Store equipment in a clean, dry location. Protect ducts and equipment by sealing openings with plastic.
Before Occupancy: 1 Point

Requirements
Develop an IAQ management plan and implement it after all finishes have been installed and the building has been completely cleaned before occupancy.

- Low-Emitting Materials—Adhesives and Sealants: 1 Point

Requirements
All adhesives and sealants used on the interior of the building (i.e., inside the weatherproofing system and applied on-site) must be within the VOC limits as applicable to the project scope.

- Low-Emitting Materials—Paints and Coatings: 1 Point

Requirements
Paints and coatings used on the interior of the building (i.e., inside the weatherproofing system and applied on-site) must be within the VOC limits.

- Low-Emitting Materials—Flooring Systems: 1 Point

Requirements
To reduce the quantity of indoor air contaminants that is odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

- Low-Emitting Materials—Composite Wood Products: 1 Point

Requirements
Composite wood and agri-fiber products used on the interior of the building must not contain added urea-formaldehyde resins. Composite wood and agrifiber products are defined as particleboard, medium density fiberboard (MDF), plywood, wheat board, strawboard, panel substrates and door cores. Materials considered fixtures, furniture and equipment are not considered base building elements and are not included.

- Indoor Chemical and Pollutant Source Control: 1 Point

To minimize building occupant exposure to potentially hazardous particulates and chemical pollutants.

Requirements
Design to minimize and control the entry of pollutants into buildings and later cross-contamination of regularly occupied areas.

- Controllability of Systems—Lighting: 1 Point

To provide a high level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms and conference areas) and promote their productivity, comfort and well-being.

Requirements
Provide individual lighting controls for 90% (minimum) of the building occupants to enable adjustments to suit individual task needs and preferences and also meet group needs and preferences in all shared multi-occupant spaces.
Controllability of Systems—Thermal Comfort: 1 Point

To provide a high level of thermal comfort system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms or conference areas) and promote their productivity, comfort and well-being.

Requirements
Provide individual comfort controls for 50% (minimum) of the building occupants to enable adjustments to meet individual needs and preferences. Operable windows may be used in lieu of controls for occupants located 6 meters inside and 3 meters to either side of the operable window.

Thermal Comfort—Design: 1 Point

To provide a comfortable thermal environment that promotes occupant productivity and well-being.

Requirements
Design heating, ventilating and air conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy. Demonstrate design compliance in accordance with the Section 6.1.1 documentation.

Thermal Comfort—Verification: 1 point in addition to para 4.5.11

To provide for the assessment of building occupant thermal comfort over time.

Requirements
Provide a permanent monitoring system to ensure that building performance meets the desired comfort criteria as determined by Credit para 4.5.11: Thermal Comfort—Design.

Daylight and Views—Daylight: 1 Point

To provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Daylight and Views—Views: 1 Point

To provide building occupants a connection to the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

6.2.6 INNOVATION IN DESIGN

Innovation in Design: 1–5 Points

To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.
Accredited Professional: 1 Point

To support and encourage the design integration required by LEED to streamline the application and certification process.

Requirements
At least 1 principal participant of the project team shall be a LEED Accredited Professional (AP).

6.2.7 REGIONAL PRIORITY:

Regional Priority: 1–4 Points

To provide an incentive for the achievement of credits that address geographically-specific environmental priorities.

Requirements
Earn up to four of the six Regional Priority (RP) credits identified as having environmental importance for projects in the Indian region.

7.0 How to get building rated?

7.1 Rating procedure by GRIHA:

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

7.1.1. 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 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.

7.1.2. Documentation:

The evaluation system covers interdisciplinary areas. Submissions required for meeting any particular criterion are elaborated in specific sections.

7.1.3. Schedule for receipt of documents:

All documents (in soft version) related to the attempted criteria should be submitted along with the application (Pre-construction stage). Only the attempted criteria will be reviewed and a checklist of the same will be attached.
7.2 Rating procedure of LEED 2011 : for India

Project teams interested in obtaining LEED-NC certification for their project must first register their intent with the IGBC, through the ‘Register Your Project’ link on the website (www.igbc.in). The website includes information on registration costs for IGBC member companies as well as non members. The IGBC will acknowledge receipt of application fee and proceed with review when all project documentation has been submitted. Registration is an important step that establishes contact with the IGBC and provides access to software tools, errata, critical communications and other essential information.

Once a project is registered, the project design team begins to collect information and perform calculations to satisfy the prerequisite and credit requirements. The website also gives important details about understanding & applying the Rating System, the certification & review process, documentation schedule, etc. The project must satisfactorily document achievement all of the prerequisites and a minimum number of points to attain the various levels of certification as listed.

7.3 All new constructions (buildings) of Indian Railways can be rated either through GRIHA or LEED as per procedure indicated above. It is also proposed that all new construction on Indian Railway having plinth area more than 2500 sqm shall be made mandatory as Green Building and shall comply to min. 3 star rating based on internal evaluation based on GRIHA rating system as being done by CPWD.

8.0 Green Building and Carbon Credits:

Burning of fossil fuels is a major source of Industrial greenhouse gas (GHG) emissions, major contributors being power, cement, steel and fertilizer industries. Greenhouse gases adversely affect the ozone layer and trap heat in the atmosphere which makes the Earth warmer. The major GHG are carbon dioxide, carbon monoxide, methane, nitrous oxide, hydro fluorocarbons (HFCs) etc.

The concept of carbon credits came into the existence as a result of increasing awareness of the need for controlling emissions. The mechanism was formalized in the Kyoto Protocol, an international agreement between more than 170 countries, and the market mechanisms were agreed through the subsequent Marrakesh Accords.

Buildings as structures are important consumers of energy, taking up to 30-50% of total generation. Green Buildings as compared to conventional buildings consume less energy – ranging up to 50% lower. They also consume 30-70% less water against conventional building, though this saving comes with an additional cost. Green buildings are basically energy efficiency projects that contribute to sustainable development; they have huge potential to earn Carbon Credits. The key areas where energy efficiency can be enhanced in the buildings are the Air handling Units (AHUs), roof insulations, the air conditioning system encompassing chillers, pumping system and cooling towers.

Accrue of carbon credits is not directly related with Green Building Certification. But by designing the building to reduce the conventional energy demand and utilization of renewable energy & minimization of ozone-depleting substances the CER (Certified Emission Reductions) can be achieved and carbon credits may be accrued. CER (Certified Emission Reductions) are the primary units which can be converted into “carbon credits” through an independent mechanism called CDM (Clean Development Mechanism). It should be noted that GRIHA
and CDM are mutually exclusive systems and getting a GRIHA rating does not directly lead to carbon credits. The details are as under:

**8.1. Carbon Credits:** Carbon credits are a key component of national and international emissions trading schemes that have been implemented to mitigate global warming. They provide an incentive to reduce GHG (Green House Gas) emissions on an industrial scale by capping total annual emissions and letting the market assign a monetary value to any shortfall through trading. Credits can be exchanged between businesses or bought and sold in international markets at the prevailing market price. Credits can be used to finance carbon reduction schemes between trading partners around the world.

**8.2 KYOTO PROTOCOL:**

The Kyoto Protocol is an international treaty to reduce GHG emissions blamed for global warming. The Protocol, in force as of 16 February 2005, provides the means to monetize the environmental benefits of reducing GHGs. Kyoto Protocol is a voluntary treaty signed by 141 countries, including the European Union, Japan and Canada for reducing GHG emission by 5.2% below 1990 levels by 2012. However, the US, which accounts for one-third of the total GHG emission, is yet to sign this treaty. The Protocol and new European Union emissions rules have created a market in which companies and governments that reduce GHG gas levels can sell the ensuing emissions ‘credits’. These are purchased by businesses and governments in developed countries – that are close to exceeding their GHG emission quotas.

**8.3 EMISSION MARKETS:**

For the purpose of trading, one CER (Certified Emission Reductions) is considered equivalent to one metric ton of CO$_2$ emissions. These CO$_2$ allowances can be sold privately or in the international market at the prevailing market price. These trades are settled internationally and hence allow allowances to be transferred between countries. Each international transfer is validated by the UNFCCC (United Nations Framework Convention of Climate Change).

Climate exchanges have been established to provide a spot market in allowances, as well as futures and options market to help discover a market price and maintain liquidity. Carbon prices are normally quoted in Euros per ton of carbon dioxide or its equivalent (CO$_e$). Other GHG can also be traded, but are quoted as standard multiples of carbon dioxide with respect to their global warming potential. These features reduce the quota’s financial impact on business, while ensuring that the quotas are met at a national and international level. Carbon, like any other commodity, has been traded on India’s Multi Commodity Exchange (MCX) and National Commodity and Derivatives Exchange (NCDEX).

**8.4 CDM (Clean Development Mechanism)**

The Clean Development Mechanism (CDM), provided for under Article 12 of the Kyoto Protocol, enables developing countries to participate in joint greenhouse gas (GHG) mitigation projects. Under this Protocol, developed countries and economies in transition countries (West and Eastern Europe, North America, Japan, New Zealand, Australia) are required to reduce GHG emissions to below their 1990 levels.

The CDM enables these countries to meet their reduction commitments in a flexible and cost-effective manner. It allows public or private sector entities in developing countries to invest in GHG mitigation projects in developing countries. In return the investing parties receive credits
or certified emission reductions (CERs) which they can use to meet their targets under the Kyoto Protocol.

While investors profit from CDM projects by obtaining reductions at costs lower than in their own countries, the gains to the developing country as host parties are in the form of finance, technology, and sustainable development benefits.

The three areas in which the CDM projects can be implemented in the buildings are:

- **Demand side energy efficiency** - These are the initiatives that reduce power demand through either electric or thermal efficiency. The examples of this include energy efficient light bulbs, pumps, motors and air conditioners, insulation on windows, ceilings and walls

- **Supply side energy efficiency** – These are the initiatives which increase the efficiency of power produced through interventions such as improved fuel combustion, waste heat or gas recovery and its utilization

- **Clean energy production** – By producing energy from cleaner sources, the project can earn carbon credits. This includes renewable energy production such as wind, solar, biomass, hydro or fuel switch to cleaner fuels such as switch from coal or diesel to natural gas.

8.5 Steps involved in a CDM project :

8.5.1 Project identification

The process of developing a CDM project starts by identifying an idea that will reduce GHG emissions. The initial steps require the project proponent to examine the emissions reduction resulting from the project and to ascertain if it contributes to the development priorities of the nation.

8.5.2 Government endorsement

Once the project proponent is convinced the project is relevant under the CDM, a project idea note is prepared and submitted for endorsement to the nodal agency of the country. For India the designated nodal agency is the Ministry of Environment and Forests. After endorsement, the project idea can be developed further.

8.5.3 Project development

To establish the ‘additionality’ of a project, it is necessary to first define a baseline against which project emissions can be measured. This baseline study is carried out in accordance with provisions in the Kyoto Protocol and Marrakesh Accord, and estimates the quantum of GHG reductions in terms of tonnes of carbon dioxide equivalents.

8.5.4 Validation

The project idea note, the baseline study, and other relevant details are submitted for validation by an independent agency identified by the CDM Executive Board as a DOE (designated operational entity). Validation is the independent evaluation of a project activity against the requirements of the CDM.
The DOE checks whether the proposed project activity meets all the requirements of the CDM and submits its validation report to the Executive Board.

8.5.5  Registration

Registration is the formal acceptance by the Executive Board of a validated project as a CDM project activity.

8.5.6  Monitoring

Once registered, the project proponents are responsible for monitoring the actual GHG emissions reduced by the project. A DOE may be approached periodically to verify and certify the reduction in GHG emissions.

8.5.7  Verification

Verification is the periodic independent review and ex post determination of monitored emissions reductions.

8.5.8  Certification

Certification is written assurance by the DOE (designated operational entity) that, during a specified time period, a project activity achieved the GHG emissions reductions as verified.

8.5.9  Issuance of CERs

The DOE along with its certification report submits a request to the Executive Board for the issuance of certified emission reductions (CERs).

A project can continue to earn CERs for a maximum of either 10 years (with no change of the baseline) or 7 years with at most two renewals (i.e. up to 21 years). 2% of the share of proceeds from the CERs must be forwarded towards the adaptation fund of the Kyoto Protocol.

8.6  Approval Process of CDM Project:

Eligibility

The project proposal should establish the following in order to qualify for consideration as CDM project activity:

Additionalities:

- Emission Additionality: The project should lead to real, measurable and long term GHG mitigation. The additional GHG reductions are to be calculated with reference to a baseline.
- Financial Additionality: The procurement of Certified Emission Reduction (CERs) should not be from Official Development Assistance (ODA).

Sustainable Development Indicators

It is the prerogative of the host Party to confirm whether a Clean Development Mechanism project activity assists it in achieving sustainable development. The CDM projects should also be oriented towards improving the quality of life of the poor from the environmental standpoint.
Following aspects should be considered while designing CDM project activity:

1. **Social well being**: The CDM project activity should lead to alleviation of poverty by generating additional employment, removal of social disparities and contribution to provision of basic amenities to people leading to improvement in quality of life of people.

2. **Economic well being**: The CDM project activity should bring in additional investment consistent with the needs of the people.

3. **Environmental well being**: This should include a discussion of impact of the project activity on resource sustainability and resource degradation, if any, due to proposed activity; bio-diversity friendliness; impact on human health; reduction of levels of pollution in general.

4. **Technological well being**: The CDM project activity should lead to transfer of environmentally safe and sound technologies that are comparable to best practices in order to assist in upgradation of the technological base. The transfer of technology can be within the country as well from other developing countries also.

8.7 **Procedure for Submitting CDM Project Reports to the National CDM Authority (NCDMA)**.

The National CDM Authority (NCDMA) is a single window clearance for CDM projects in the country. The project proponents are required to apply to the administrator of National CDM Authority through the website by filling the User Registration form. Upon acceptance of the request, the project proponent shall fill in online the Project Concept Note (PCN) and also upload the Project Design Document (PDD). As notified by National CDM Authority, the project proponents shall also submit 15 hard copies of PCN and PDD in proper format to Member Secretary, NCDMA along with soft copies in CDs, though covering letter signed by the project proponent.

The National CDM Authority examines the documents and if there are any preliminary queries the same are asked from the project proponents. The project proposals are then put up for consideration by the National CDM Authority. The project proponent and his consultants are normally given about 10-15 days notice to come to the Authority meeting and give a brief power point presentation regarding their CDM project proposals. Members seek clarifications during the presentation and in case the members feel that some additional clarifications or information is required from the project proponent, the same is informed to the presenter. Once the members of Authority are satisfied, the Host Country Approval (HCA) is issued by the Member-Secretary of the National CDM Authority.

9.0 **Examples of Green buildings CDM projects in India**:

A number of green buildings projects have been registered under the methodology of Energy efficiency and fuel switching measures for buildings. As on date, India has over 2,085 registered green building projects amounting to over 1.43 billion sq.ft of green building area. Some of the important registered CDM projects in Energy efficiency in building are:

1. ITC Sonar, Kolkata; CDM Project ID 0686: The first Indian hotel to successfully be part of carbon credit trading in India. Improvement in Energy Consumption of a Hotel.
3. Olympia Technology Park, Chennai
9.1 : Technology measures in some of the Green Buildings CDM projects:

9.1.1 *Hotel Sonar Bangla, Kolkata:* The energy efficiency measures were implemented as under:

- Retrofit of existing HVAC system to reduce unwarranted moisture laded air load in the pre-cooled air unit (PAU) by installing U shaped heat pipes improving efficient heat transfer in the PAU pipes and reducing chiller load
- Retrofitting various pumps.
- Enhancement of the treatment efficiency of the sewage treatment unit
- Replacement of electric water heater with solar water heater
- Installations of magnetizer for better fuel atomization
- Re-use of low energy waste heat of the flue gases exhausted from the boiler stack to pre-heat the boiler feed water and improve the generation efficiency of the boiler
- Utilization of the waste heat of the return steam condensate to reduce HSD consumption.

Results: These measures are able to reduce around 3000 tonnes of CO2 eq. per annum – translating into corresponding number of CERs.

9.1.2 *Technopolis, Kolkata:* Technopolis included measures in the demand management side only. The list of measures are as under:

- The demand for cooling was reduced by reducing the solar heat gain by using high performance double glazed panels with reflective low “e” glass panes having low U value
- The heat gain from the roof was reduced by use of roof insulation. The U value of the roof was kept low with R-15 extruded polystyrene insulation and roof gardening.
- The AHUs are provided with VFD (Variable Frequency Drive) driven supply air blower. Each AHU room has a heat recovery wheel (HRW) with supply/ recovery air fan.
- Two 650 TR water cooled centrifugal chillers with COP of 6.1 are installed and a 300 TR water screw with COP of 5.5, kept as a standby.
- There are two 1700 TR cooling towers in the HVAC system for cooling the water used as cooling medium in the HVAC system of the building.

Results: These measures are able to achieve average annual GHG reduction by 9000 tonnes of CO2 eq. per annum, translating into corresponding number of CERs.

9.1.3 *Olympia Technology Park, Chennai:* The energy efficiency measures were used in Demand side energy efficiency management. The list of measures are as under:

- Energy efficient design of wall construction (material with better insulation properties)
- Energy efficient design of the roof construction- Over deck insulation and roof garden.
- Energy efficient glass area – high performance glazing (double glazed with low U- value, optimum light transmission and optimum shading coefficient)
- Energy efficient design of the HVAC system
- High performance chillers
- VFD (Variable frequency drives) for AHU and chilled water pumps
- Heat recovery wheels

Results: The net results achieved is the average annual GHG reduction by 15,000 tonnes of CO2, translating into corresponding CERs.
10.0 Overview:

India being a developing country has no emission targets to be followed. However there is a great need to reduce energy consumption in all sectors of the economy. Building Construction consumes vast natural resources and building account for about 40% of Global Energy use. The pre-construction phase is the optimal time to implement Energy Efficient design with minimal costs. Some results indicate that savings realized during the first twenty years of operation can account for more than 15% of construction costs as indicated below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Name of project</th>
<th>Location</th>
<th>Built up area (Sq. ft.)</th>
<th>Rating received</th>
<th>% increase in cost</th>
<th>Pay back period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CII- Sorabji Godrej</td>
<td>Hyderabad</td>
<td>20,000</td>
<td>Platinum</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>ITC Green Centre</td>
<td>Gurgaon</td>
<td>170,000</td>
<td>Platinum</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Wipro</td>
<td>Gurgaon</td>
<td>175,000</td>
<td>Platinum</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Technopolis</td>
<td>Kolkata</td>
<td>72,000</td>
<td>Gold</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>HITAM</td>
<td>Hyderabad</td>
<td>78,000</td>
<td>Silver</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Grundfos Pump</td>
<td>Chennai</td>
<td>40,000</td>
<td>Gold</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

There are two methods by which Green Buildings on Indian Railway can earn Carbon Credits. The first is mapping the reduction of materials used and also using special eco-friendly materials. As each material has its own embodied energy, the reduction in its use would thereby help reduce the GHG emission. This however is quite difficult because the monitoring, reporting and verification process may be very cumbersome. It will also require careful thought and stringent process to be sure that the method applied is sound both academically and practically.

The next method is to map the reduction in electrical energy and water consumption. This is a simpler approach and proven methodology to use energy efficient techniques along with renewable energy sources which can help getting the CDM process. The use of solar water heating systems, glass panels to allow natural light inside the building, rainwater harvesting, waste minimization, maximizing energy use in buildings, water conservation and use of energy efficient equipment can reduce the energy and water requirement and earn a good amount of carbon credits. As a rough estimate, saving of about one megawatt of energy can lead to the credit of 3000-4000 CERs. For example Technopolis, India’s green building in information technology, is helping the developers earn up to €1 35,000 per year through carbon credits.

References:
1. Green Rating for Integrated Habitat Assessment (GRIHA) www.grihaindia.org
2. Indian Green Building Council www.igbc.in, www.cii.in
3. Clean Development Mechanism website cdm.unfccc.int
4. The National CDM Authority (Ministry of Environment & Forests), Govt. of India website http://www.cdmindia.gov.in.

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