GREEN BUILDING INITIATIVE: A CASE STUDY OF THE SJVN CORPORATE HEADQUARTERS, SHIMLA, INDIA

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ABSTRACT

The world is becoming more environmentally conscious and adopting sustainable design practices, thus green building is the need of the hour. The green building is an eco-friendly built environment, as it is based on the fundamental principle of 'reduce, reuse and recycle'. Similarly, a green building rating system is a method that tests the environmental efficiency of a building through its lifecycle. The paper attempts to create awareness about various green building rating systems prevalent in India and further elaborates the evaluation criterion of most widely used and predominant green building rating systems in India. It has been further explained better with a case study. The Shakti Sadan building is the corporate headquarters of a leading government company and the flag bearer of green architecture and sustainability in the remote hill state of Himachal Pradesh in India. The company that owns this building creates sustainable architecture by adopting techniques like minimum ground coverage, adopting building orientation in a way which allows maximum natural light penetration and ventilation. Also, other green measures taken organisation wide in building construction are renewable energy utilisation, solid waste management, storm and rain water drainage provision, use of sustainable building materials, good air quality, access to daylight and views, pleasant acoustic conditions, low flow fixtures of water, sensor-based indoor lighting to save electricity. The case study has been evaluated on a number of criteria including site parameters, microclimate impact, maintenance and housekeeping, energy, renewable energy utilisation, human health, achieving indoor comfort requirements and social aspects. This is the only building to date in the state of Himachal Pradesh in India to be awarded a four star rating in the year 2022.

Keywords: green building, green building rating, green rating for integrated habitat assessment, GRIHA: TERI, GRIHA EB, existing building, SJVN Shimla.

1 INTRODUCTION

The two most significant environmental challenges of today's era are global warming and climate change. Urbanisation and population growth have increased the demand for resources. There is a need for environmental and resource conservation strategies. Buildings have significant environmental impacts throughout their lifetime [1]. However, the impact is largely determined by the use phase, or the demand for energy and water during their operation. Consequently, it is essential to design a green building that addresses these concerns in an integrated and scientific manner [2].

The paper employs a blend of qualitative and quantitative approaches. The qualitative data have been collected through the internet, GRIHA (Green Rating for Integrated Habitat Assessment) manual, GRIHA conference presentations and from other relevant published academic literature. The quantitative data have been collected from different departments of SJVN Shimla and have been analysed using the GRIHA manual for existing buildings.

2 PRINCIPLES OF SUSTAINABILITY AND GREEN BUILDING

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's lifecycle from siting to design, construction, operation, maintenance, renovation and deconstruction [3].

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2.1 Sustainability

Today, the term encompasses much more than the incorporation of recycled materials into a dwelling. Green building focuses on the following seven areas [3]:

1. Energy efficiency and renewable energy;
2. Water efficiency;
3. Environmentally preferable building materials and specifications;
4. Waste reduction;
5. Toxics reduction;
6. Indoor air quality;
7. Smart growth and sustainable development.

2.2 Essential concepts of green building

All professionals in the building industry, including site planners, architects, engineers and general contractors, have the ability to increase the use of green building practices when selecting locations, designing buildings, and specifying materials and methods of construction. In addition, buyers can influence green construction by requesting or mandating green building practices [4]. The following rules may be considered while planning a green building [5]:

1. Create outlines for the building.
2. Identify site needs, atmosphere, and neighbourhood conditions.
3. Augment the utilisation of normal sunlight.
4. Research building materials.
5. Reuse existing materials, use less materials, and use building materials that are thought to be naturally cordial.
6. Plan for better indoor air quality.
7. Set high lighting-effectiveness measures.
8. Select machines that are productive and save money on water use.
9. Plan for simplicity of upkeep.

2.3 Green building rating system followed in India

Construction has both direct and indirect effects on the environment. As a result, several green building rating systems have been created to encourage, evaluate, and reward the performance of sustainable buildings.

In India, the four most popular certifying agencies are:

1. LEED rating system: The Leadership in Energy and Environmental Design (LEED) is administered by the United States Green Building Council (USGBC), founded in 1993. The building types under this rating are commercial (all types), industrial (all types), mixed use (all types) and residential (all types). The ratings are given as certified, silver, gold and platinum [6], [7].
2. IGBC rating system: The Confederation of Indian Industry (CII) and the Indian Green Building Council, which was founded in Hyderabad in 2001, support the IGBC rating system. There are nine distinct certification types, for new and existing buildings, schools, factories, homes, townships, special economic zones (SEZ), landscapes, and metro systems. From 100 points, a building can be awarded certified, silver, gold and platinum [8].

3. GRIHA: The Energy and Resources Institute (TERI) in India has created the GRIHA rating system. It is supported by the Indian Government's Ministry of New and Renewable Energy. The building types under this are EB (existing building), day school, SVA (simple versatile affordable), LD (large development), cities and AH (affordable housing). One to five stars are awarded with five star indicating the highest ranking according to GRIHA's star-based rating system [9].

3 UNDERSTANDING GRIHA

India is a land with varied climate typologies, categorised under five predominant zones as per the Energy Conservation Building Code (ECBC) 2017: hot–dry, warm–humid, composite, temperate, and cold due to which the indoor thermal comfort conditions and energy demands vary in different regions. There is a need for an indigenous rating system which is tailored to meet the requirements of each climate zone and could provide definitive, sustainable solutions to the increasing energy strain and diminishing natural resources. With the vision to promote sustainable architecture, TERI developed the TERI-GRIHA green building rating system in 2005 [10]. GRIHA means 'Abode' in Sanskrit [5].

3.1 GRIHA: The national green building rating system

The rating system has been developed with the aim to achieve the following goals [10]:

1. Minimise the detrimental impact of construction and built structures on the environment while ensuring comfort for users.
2. Preserve the ecosystem to the extent possible.
3. Assess the performance of 'green' buildings.

Objectives:

1. Preserve the ecosystem to the extent possible. To study the environmental impact of the life cycle of built structures.
2. To increase the demand for green buildings and products among the various stakeholders.
3. To create recognition for buildings that considered sustainable design and construction strategies.

4 EXISTING BUILDING RATING UNDER GRIHA

GRIHA for Existing Buildings rating system is a 100 point system consisting of 12 criteria categorised under seven sections such as site parameters, maintenance and housekeeping, energy, water, human health and comfort, social aspects, and bonus points. Six of these 12 criteria are mandatory, while the rest are optional. Each criterion, except from the six mandatory criteria, has a few points assigned to it. It means that a project intending to meet the criterion would qualify for the points. The minimum points required for certification is 25 [11]. The complete process from feasibility check to award of rating is explained in Fig. 1.

4.1 Eligibility

All operational buildings with a built-up area greater than 2,500 m^2 are eligible for GRIHA for Existing Buildings certification [11].

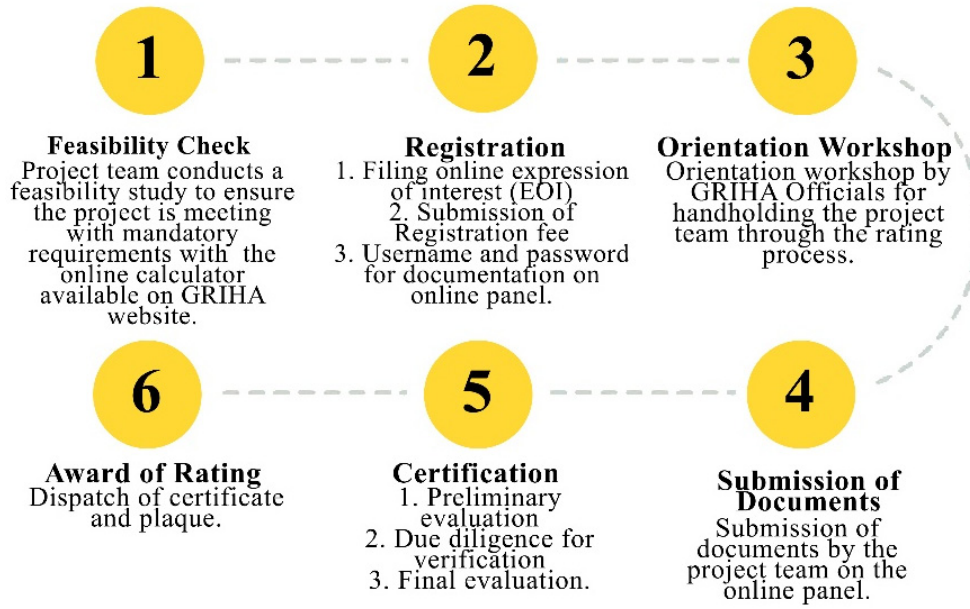

Figure 1: Rating process [11].

5 CASE STUDY: SJVN CORPORATE OFFICE HEADQUARTERS, SHIMLA

SJVN Limited, a Mini Ratna, Category-I and Schedule 'A' CPSE under administrative control of Ministry of Power, Government of India, was incorporated on 24 May 1988 as a joint venture of the Government of India (GOI) and the Government of Himachal Pradesh (GOHP) [12].

The project is located on NH-22 on Dhalli and ISBT bypass at Shanan in Shimla, Himachal Pradesh, India (Fig. 2). Shimla is the capital of Himachal Pradesh state, which is in northwest of India. The city lies on the Himalayan mountain range in the altitude of 2,200 m above sea level and falls under seismic zone IV. The average temperature is 13°C with an average rainfall of 1,700 mm.

5.1 Project brief

SJVN Limited corporate headquarters consists of three buildings which are office, guest house and auditorium. There were two stages of construction, the first stage consisted of an office building and in the second stage a guest house and auditorium are being constructed. The first stage started in 2011 and was completed in 2016. The second stage started in 2019 and is still under construction (as of 2023) (Figs 3 and 4; Table 1).

SJVN is very cautious about the environmental impact of its projects considering this, the whole project is being developed as a green project. As the office building was completed before the registration in GRIHA, it was registered in the GRIHA Existing Building category. The guest house and auditorium is registered under GRIHA New Projects as these buildings are under construction. So this paper only discusses the first stage, that is, the office building as it has been certified under GRIHA Existing Building.

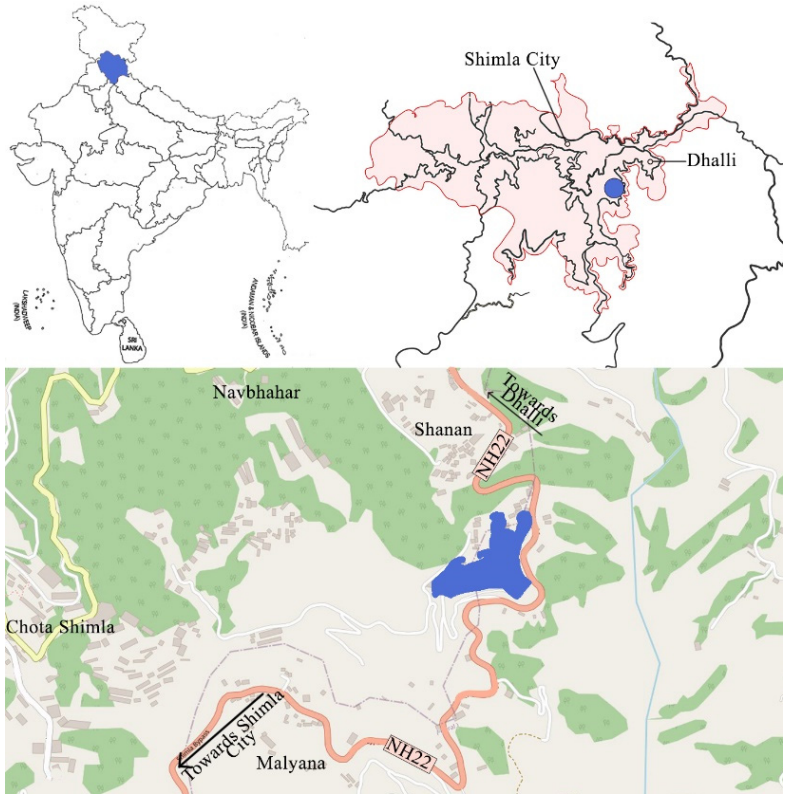

Figure 2: Map showing location of (a) Himachal Pradesh in India (top left corner); (b) Map of Shimla (top right corner); and (c) Location of site in Shimla (in blue).

Figure 3: SJVN corporate headquarters building office block, bird's eye view.

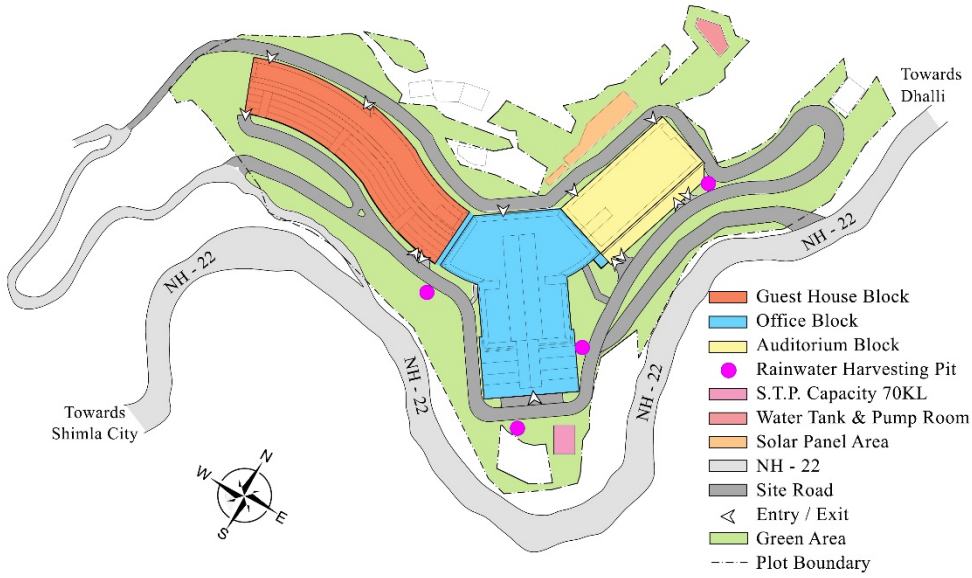

Figure 4: Site plan of SJVN building.

Table 1: Project brief of SJVN corporate headquarters building.

Project name	SJVN Corporate Headquarters Building, Shimla, Himachal Pradesh
GRIHA project code	21EB0004
Location	Shimla, Himachal Pradesh
Number of building blocks	3
Plot area (m^2)	29,835.00
Ground coverage (m^2)	9,737.60 (32.63%)
Area under internal roads (m^2)	5,267.46 (17.65%)
Green area (m^2)	14,829.94 (49.70%)
Built-up area (m^2)	31,733.03 (32.58%)
Existing office block (1)	14,033.48
Under construction blocks (2)	17,699.55

5.2 About the building

1. The SJVN office building is a seven-storey structure with escalators leading through the middle of the building to the top floor, thus creating an empty space in between.
2. The building has been planned in a way such that it does not look like a typical rectangular office building.
3. The atrium has a glass roof providing natural light into the building.
4. Motion sensor lights have been installed to save on electricity.

5.3 Project explanation

GRIHA rating system has categorised the project on the evaluation criterion mentioned in Fig. 5 and the percentage wise marks are allocated to various categories.

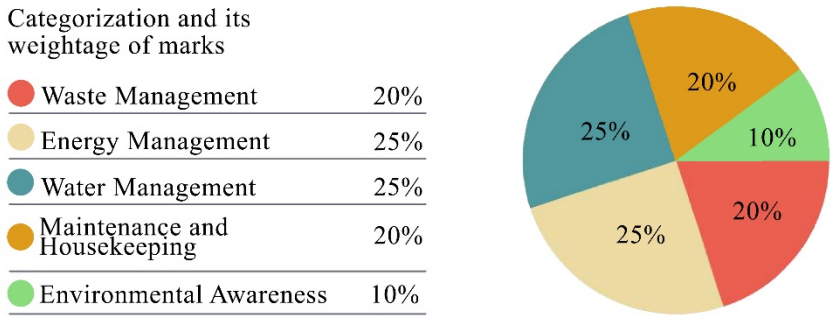

Figure 5: Categorization and its weightage of marks.

5.3.1 Waste management (20% weightage)
The facility management team takes care of collection of waste in colour coded bins. All recyclable waste is being sent for recycling by maintaining contracts with local recyclers. The landscape and food waste is treated on-site using the organic waste composter.

The project team needs to demonstrate that the waste is handled sensibly on site such that the stress on the landfill is reduced.

Amount of organic waste (landscape and kitchen) generated: 0.14 kg/capita/day (Fig. 6).

Figure 6: Onsite organic waste converter.

5.3.2 Energy management (25% weightage)
The facility management team conducts regular preventive and corrective maintenance operations to ensure efficient working of the system and avoid energy loss. Additional third party energy audits are carried out frequently and the recommendations are carried to improve the energy savings of the facility. Policies are drafted to procure green and energy rated products. The project team needs to demonstrate optimization of energy consumption by the use of efficient appliances, use of renewable energy, etc. (Table 2; Fig. 7).

Table 2: Energy management.

Total annual energy consumption is offset through installation of renewable energy sources on site (source, on-site and off-site generation)	97.16%
Reduction of energy consumption is achieved	15.46%
Total annual energy consumption: Existing case – 2001	1,150,190.45 KWh/year
Total annual energy consumption: Base case	1,360,515.75 KWh/year

Figure 7: On-site solar PV 120 kw (left); Off-site Charanka solar park 1,500 kw (right).

5.3.3 Water management (25% weightage)
The facility has installed water efficient plumbing fixtures. Smart water metres are installed to log the water consumption pattern and to check leaks. The waste water generated is treated using an on-site sewerage treatment plant (STP) and the treated water is reused for irrigation. The project team needs to demonstrate the water saving, recycling and reuse on site (towards net zero/net positive approach) (Table 3; Figs 8 and 9).

Table 3: Water management.

Water demand side reduction	64.29%
Irrigation demand side reduction	83.25%
Quantity of treated water generated (fixture, cleaning, vessel washing and miscellaneous capacity of STP)	13 kld, 90%
Percentage of water treated	100%
Water footprint (plumbing fixture)	2.94 kl/capita/day

kl = kilo litre; kld = kilo litre per day.

5.3.4 Maintenance and housekeeping (20% weightage)
Utilisation of chlorofluorocarbons (CFC)/hydro chlorofluorocarbons (HCFC) free refrigerants and insulation to reduce impact on ozone depletion. The fire extinguishers used are halon free as well. All the cleaning products used are green certified and environment friendly. Annual maintenance contract has been maintained for all electro-mechanical items used in the facility.

The project team must ensure good practices for maintenance and green procurement as a step towards sustainability.

Figure 8: On-site water treatment.

Figure 9: Rain water harvesting (left); sewage water treatment (right).

CFC-free heating ventilation and air conditioning and cooling equipment used in the building (Table 4).

Table 4: Refrigerant used in heat pump, chiller, firefighting.

System	Heat pump	Chiller	Firefighting
Make	Climaveneta	Climaveneta	STAT-X
Refrigerant	R-410A	R-134A	Aerosol gas suppression system

5.3.5 Environmental awareness (10% weightage)

In-house and neighbourhood activities to increase environmental awareness are being carried on a regular basis. Many tree plantations have been carried out as part of CSR activities. Measures such as putting up green education, signage and labelled water pipelines are maintained to increase awareness and responsible usage of resources by the building occupants.

The project team must submit strategies to promote environmental awareness.

The building uses EKAM-Care products which are non-toxic and made from natural ingredients. The company is CII-IGBC (Indian Green Council) Green Pro Certified.

5.4 Appraisal point table

The SJVN office block scored a total of 73 points out of the total 104 points. With this the building was awarded four star rating by GRIHA for Existing Building (Table 5).

Table 5: Points scored in GRIHA for existing building.

Criteria	Point table	Maximum points	Points scored
Section I. Site parameters			
C1	Accessibility to basic services	2	2
	Basic amenities	1	1
	Collective transport service	1	1
C2	Microclimatic impact	4	2
	Numbers of trees	2	0
	Urban heat island reduction	2	2
Section II. Maintenance and housekeeping			
C3	Maintenance, green procurement and waste management	7	7
	Environment friendly cleaning chemicals	1	1
	Policy-purchase of BEE star rated appliances	1	1
	Multi-coloured bins	1	1
	Space to segregate and store waste	1	1
	Contractual tie-ups – Waste recyclers	1	1
	Treat organic waste on-site	2	2
C4	Metering and monitoring	10	6
	Advanced metering – Energy	1	1
	Advanced metering – Water	1	1
	Advanced metering – Air quality	1	1
	One-way meter	3	3
	Two-way meter	4	0
Section III. Energy			
C5	Energy efficiency	20	7
	EEM – Implemented	5	5
	Reduction in energy consumption	15	2
C6	Renewable energy utilisation	15	15
Section IV. Water			
C7	Water footprint	15	13
	Reduction in building water consumption	3	3
	Minimise lawn area	2	2
	Water efficient irrigation system	2	2
	On-site STP	4	4
	Rainwater harvesting	4	2
C8	Reduction in cumulative water performance	10	0

Table 5: Continued.

Criteria	Point table	Maximum points	Points scored
Section V. Human health and comfort			
C9	Achieving indoor comfort requirements (thermal, visual and acoustic)	8	8
	Thermal comfort	2	2
	Artificial lighting	2	2
	Daylight factor	2	2
	Indoor noise level	2	2
C10	Maintaining good IAQ	4	4
	Fresh air quality	2	2
	Fresh air quantity	2	2
Section VII. Bonus points			
C11	Universal accessibility and environmental awareness	5	5
	Universal accessibility	2	2
	Environmental awareness	3	3
Section VII. Bonus points			
C12	Bonus points	4	4
	Organic waste management	2	2
	Bio-diversity park	2	2
Total points		104	73

5.5 Certificate

As per the GRIHA rating system for Existing Buildings the building scoring between 71–85 falls under four star category. Hence four star rating was awarded to the projects. The certificate of the same is displayed as Fig. 10.

Figure 10: GRIHA certificate for SJVN.

6 CONCLUSION

Growing awareness about green buildings and sustainability has resulted in an environment where many individuals and organizations are doing their bit to protect mother earth. SJVN is such one organization which is committed to the sustainability of the earth. SJVN is demonstrating commitments by employing green building technologies and solutions to most of its projects. The corporate headquarters of SJVN is a perfect example in the region to demonstrate such commitments. At SJVN not only this building but all the infrastructural projects are being undertaken to protect sustainability of mother earth. Though a lot of effort are being put in at individual, organization, national and international levels, there is a lot more to be done to achieve the Paris Agreement goal of limiting global temperature increase to well below 2°C, while pursuing efforts to limit the increase to 1.5°C.

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