SVAGRIHA Rating And Design Tool For Green Buildings: A Case Study of Use of Renewable Energy

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Abstract- *A city consists of various types of building structures according to their sizes, design and use. But anyhow the largest portion in the city is of building structures which are small-scale and used mainly for residential and commercial purposes. So, for measuring resource efficiency of these small-scale building footprints, GRIHA (Green Rating for Integrated Habitat Assessment) Council has made a rating tool called SVAGRIHA (Simple Versatile Affordable Green Rating Integrated Habitat Assessment).*

This paper aims to analyze performance of a building according to SVAGRIHA. Only single criterion from SVAGRIHA rating system is been dicussed in the paper and also cost analysis for this criterion is done.

Keywords- Green Building, SVAGRIHA, Rating System, Cost analysis.

I. INTRODUCTION

India is a fast citifying country; Urban population of India in 2011 has grown from 290 million in 2001 to 386 million in 2011 approximately according to Census and rapidly increasing since. Contribution of construction industry is estimated in 2011-12 is at 308 billion to the national Gross Domestic Product (GDP) and share by 19%. The largest consumer of energy, material & water is the construction industry. To achieve the sustainable growth in construction industry Green can help greatly. (Indian Mirror 2011-12)

It has been seen an increase by nearly 8% consistent increase in annual energy consumption in the housing and merchandise sectors from 14% (1970's) to approx 33% (2004–05). Energy consumption will continue to grow unless proper measures are taken immediately to improve energy efficiency. As per The Energy and Resource Institute (TERI) estimation annually there is rised demand of about 5.4 billion units (kWh) of electricity for minimum necessity for housing and merchandise buildings.

As we move towards developmental path, environmental damage is created and we should observe it. It is a well known fact that green buildings gives great potential to decrease consumption and restore resources from waste offering accord solution for occupant, owner and the environment.

II. SVAGRIHA (Simple Versatile Affordable Green Rating Integrated Habitat Assessment)

SVAGRIHA has been jointly developed by GRIHA, jointly by TERI (The Energy and Research Institute) and MNRE (Ministry of New and Renewable Energy) and ADaRSH (Association for Development and Research of Sustainable Habitats). SVAGRIHA is a simple, fast, easy and much affordable rating system and design tool as well. SVAGRIHA mainly focuses on small-scale buildings which has quick development and high density occupation instead of large-scale developments. SVAGRIHA is rating and design tool for small-scale developments having built-up area less than 2500 sqm.

SVAGRIHA rating system consist of 14 criterias giving 50 points to the building. Below is table 1 showing all the criterias and classification of criterias is given in table 2 below. The classification is done as per very basic concerns of energy efficiency and resource efficiency. As per points gained, star rating is given to the building as per table 3.

Table 1. SVAGRIHA rating system criterias

Criterion number	Criterion name	Points
1	Reduce exposed, hard paved surface on site and maintain native vegetation cover on site	6
2	Passive architectural design and systems	4
3	Good fenestration design for reducing direct heat gain and glare while maximizing daylight penetration	6
4	Efficient artificial lighting system	2
5	Thermal efficiency of building envelope	2
6	Use of energy efficient appliances	3
7	Use of renewable energy on site	4
8	Reduction in building and landscape water demand	5
9	Rainwater harvesting	4
10	Generate resource from waste	2
11	Reduce embodied energy of building	4
12	Use of low-energy materials in interiors	4
13	Adoption of green Lifestyle	4
14	Innovation	2
Total		50

Table 2. Classification of Rating System

Sub-Group	Maximum points	Minimum points to be achieved
Landscape	6	3
Architecture & Energy	21	11
Water & waste	11	6
Materials	8	4
Lifestyle	4	1

Table 3. Star ratings for buildings

Points achieved	SVAGRIHA Ratings
25-29	★
30-34	★★
35-39	★★★
40-44	★★★★
45-50	★★★★★

III. SPECIFIC PARAMETER STUDIED

Since SVAGRIHA consist of 14 criterias from which criterion no. 7 is been studied which is Use of Renewable Energy. This criteria is to encourage use of renewable energy having weightage of 4 points i.e 8% in the rating system. Its consist of two parts.

A. Renewable energy system for electricity generation

In this part renewable energy generation system is to be installed in a building (eg. Solar panel, solar windmill hybrid system, windmill system etc.) which meets the minimum size requirement given in the table 4 below. This will give two points to the building.

Table 4. Minimum size of renewable energy

Built-up area (sq.m.)	Renewable energy system (kW)
100-500	1
500-1000	2
1000-1500	2.5
1500-2000	3
2000-2500	3.5

B. Solar Water Heater

In this part for water heating solar water heater can be used efficiently and to be installed as per hot water requirement per day by different types of buildings mentioned in table 5 below. This will give two points to the building.

Table 5. Hot water requirement per day

Different types of building	Hot water requirement (lpd)
Per residence	100
4/5 star hotel (lpd/room)	150
3 star hotel (lpd/room)	125
2 or less star hotel (lpd/room)	50
Small hospital/dispensaries (lpd/bed)	30
Restuarants (lpd/table/meal)	25
Hostel (lpd/student)	30

IV. ANALYSIS OF BUILDING FOR CRITERION NO. 7

Name of Owner: Prashant Gole.
Location: Vidhyanagar, Karad.
Name of Builder: Prashant Gole.
T.B.U.A = 105.17m²
Total Plot/Land Area =232.25m²
Date of Commencement: October 2017.
Date of Completion: December 2018.
No. of Persons: 05

A. Renewable energy system for electricity generation

Built-up Area = 105.17 m²

Since built-up area is between 100-500 m², So by mentioned in table 4, 1kW energy must be generated by renewable energy generartion system.

No renewable energy system is used for electricity generation #0 point

B. Solar Water Heater

No of persons = 5
Hot water requirement per day per person = 30 lpd
Total Hot water requirement per day= 5 X 30 lpd = 150 lpd
No solar water heater for hot water requirement #0 point

Table 6. Criterion points obtained by site

Cr. No.	Criterion name	Points Gained
7	Use of renewable energy on site	0

V. RECOMMENDATIONS FOR SITE

As per SVAGRIHA for 100-500 square meter built up area 1kW renewable energy system to be installed. So 1 kW solar panel should installed. For heating of water approximately 50% of total energy used. If we use some measures to heat the water then we can save much more energy. For residential purpose near about 150 lpd hot water is required. So provide 100 lpd solar water heater.

1. Provide 1 kW solar panel, which will provide 2 points to the building
2. Provide 100 LPD solar water heater which meet 66.66% of total hot water requirement provine 1 point to the building.

By providing above recommendations 3 points can be obtained.

Table 7. Criterion points obtained by site

Cr. No.	Max pts.	Gained pts.	Suggestions	Pts. can be gained	Final pts.
7	4	0	Provide 1 kW solar panel	2	3
			Provide 100 LPD solar water heater.	1	

VI. COST ANALYSIS FOR CRITERION NO. 7

A. Use of Renewable energy system

Energy produced by 1kW solar system (on grid system) = (9 months x 4 Units x 30 days) + (3 months x 1 Unit x 30 days) = 1170 Units/year

Cost of 1kW Solar System is approx 1,00,000 Rs. with installation. Government provides 30% subsidy for solar panel installation.

So, Total cost of Solar System = 70,000 Rs.

Table 8. Net Present Value of Solar Panel

Year	Rs./Unit	Units	Rs./Year	Cumulative	Net Present Value
0	Initial Investment				-70000
1	7	1170	8190	8190	7654
2	7.1	1170	8307	16497	7256
3	7.2	1170	8424	24921	6876
4	7.3	1170	8541	33462	6516
5	7.4	1170	8658	42120	6173
6	7.5	1170	8775	50895	5847
7	7.6	1170	8892	59787	5537
8	**7.7**	**1170**	**9009**	**68796**	**5243**
9	7.8	1170	9126	77922	4964
10	7.9	1170	9243	87165	4699
11	8	1053	8424	95589	4002
12	8.1	1053	8529.3	104118.3	3787
13	8.2	1053	8634.6	112752.9	3583
14	8.3	1053	8739.9	121492.8	3389
15	8.4	1053	8845.2	130338	3206
16	8.5	1053	8950.5	139288.5	3032
17	8.6	1053	9055.8	148344.3	2867
18	8.7	1053	9161.1	157505.4	2710
19	8.8	1053	9266.4	166771.8	2562
20	8.9	1053	9371.7	176143.5	2422
21	9	936	8424	184567.5	2035
22	9.1	936	8517.6	193085.1	1923
23	9.2	936	8611.2	201696.3	1817
24	9.3	936	8704.8	210401.1	1716
25	9.4	936	8798.4	**219199.5**	1621
Total					**31438**

Payback Period = 70,000 / 8,307 = 8.14 years ≈ 8 year and 2 months
Total Benefit from the Solar Panel from 25 years of life is Rs. 219199.5
Considering 7% interest rate, Net Present Value of the Solar Panel is Rs. 31438

B. Use of Solar Water Heater

Energy saved by solar water heater
To heat 100 liters (20°C - 50°C) approx 3.5 kWh is required = 3.5 Units
Therefore 3.5 Units x 300 days = 1050 Units/year

Energy saved by solar water heater in terms of money = 1050 Units x 7 Rs. = 7350 Rs./year
Cost of Solar water heater of 100 lpd is approx. 15,000 Rs.

Table 9. Net Present Value of Solar Water Heater

Year	Rs./Unit	Units	Rs./Year	Cumulative	Net Present Value
0	Initial Investment				
1	7	1050	7350	7350	6869
2	**7.1**	**1050**	**7455**	**14805**	**6511**
3	7.2	1050	7560	22365	6171
4	7.3	1050	7665	30030	5848
5	7.4	1050	7770	37800	5540
6	7.5	1050	7875	45675	5247
7	7.6	1050	7980	53655	4970
8	7.7	1050	8085	61740	4706
9	7.8	1050	8190	69930	4455
10	7.9	1050	8295	78225	4217
11	8	1050	8400	86625	3991
12	8.1	1050	8505	95130	3776
13	8.2	1050	8610	103740	3573
14	8.3	1050	8715	112455	3380
15	8.4	1050	8820	**121275**	3197
Total					**57450**

Payback Period = 15,000 / 7,402 = 2.03 years ≈ 2 year and 1 month
Total Benefit from the Solar Water Heater from 15 years of life is Rs. 121275
Considering 7% interest rate, Net Present Value of the Solar Water Heater is Rs. 57450

VII. RESULT

Total cost increase for criterion no. 7 = 70,000 Rs. + 15,000 Rs. = 95000 Rs.

Total benefit by providing the recommended systems by criterion no.7 to the building = 219200 Rs. + 121275 Rs. = 340475Rs.

Net Benefit over life span of systems = 340475 Rs. - 95000 Rs. = 245475 Rs.

VIII. CONCLUSION

The systems recommended for the building if installed will help building to become greener by 8% according to SVAGRIHA rating system.

Though the investment is much but the benefits by the both systems is quite more in terms of all economical, social and environmental.

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