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Study of Energy Efficient Building

"GREEN BUILDING"

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***Abstract*— In this project prepared a working model on green society which not only provides occupant an ecofriendly environment but it also focuses on re-use of waste materials. Minimal CO2 emission, Less electricity consumption and gives zero discharge. Majority it has solar panels to produce electricity but even biogas plant which emit methane gas (used as cooking fuel) and other gases also produce electricity. Also windmill installed contributes to electricity production .The hydraulic jump in the canal behind the society also helps in electricity production hence the generated electricity can be used to run the appliances in the house of the society .Here the sand filters are used to filter out grey water and sewage water which can be used in watering the plants in the garden.Most importantly green techniques like double coated window , cavity wall, cooling pipes , cooling tower incommercial building , porous pipe , rain water harvesting , zigzag LED light arrangements, low flow fixture in washroom etc... Have been included for thermal insulation, acoustics, proper ventilation and lighting and reduces use of water.**

This whole society is ultimately created on the basis of three important techniques i.e. 3R (Reduce, Reuse, and Recycle)

Keywords*— *Green Building; Bio- Gas Plant; Solar Panel; Wind Mill; Energy Efficiency; Water Efficiency; Materials Efficiency; Design Efficiency; Occupants Health And Safety

INTRODUCTION

What Is An Energy Efficient Building?

A green building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources. The optimum design solution is one that effectively emulates all of the natural systems and conditions of the pre-developed site – after development is complete.

Principles of Green Building

The different elements of a green building are as follows:

1. sustainable site selection
2. Energy efficiency
3. Water efficiency
4. Materials efficiency
5. Design efficiency
6. Occupants health and safety

1 Sustainable site Selection

Architects and engineers including administrators have to consider the factor like

- Number of industries / building existing and proposed
- Surface and ground water quality
- Air quality
- Eco-system
- Land use
- Services exiting near such development
- Flora/fauna conservation,etc. during site selection process

2 ENERGY EFFICIENCY

A. Use a properly sized and energy efficient heating/cooling system in a building
B. Use solar energy for lighting water heating
C. Maximum use of natural lighting and air
D. Maximize light colours for roofing and wall finishing materials
E. Use minimum light colour for roofing and wall finishing materials
F. Use minimum glass on east and west exposures.

3 Water efficiency

Measures to improve water efficiency:

- Potable water should not be used for the purpose other than essential requirement
- For other used water is to be recycled waste water treatment plant should be installed at the project site.
- In building water saving materials are to be used like low capacity cisterns showers waterless urinals.

4 Materials Efficiency

Selection of new construction materials and used of recycled and scrap materials are the two important factors for the construction of green buildings. Such products promote resources conservation and efficiency. Using recycled materials also helps in solid waste management system.

Green building materials after the following benefits

- Energy conservation
- Lower costs
- Greater design flexibility

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- Reduced maintenance
- Improved occupant health and productivity

Some of the green materials are

1 Fly ash
2 Green concrete
3 Blast furnace slag
4 Coconut husk
5 Marble dust
5 Design efficient :

Design of a building is very important it plays a vital role in reducing the energy requirement of a building during its life. Design has to consider the following:

i. Optimum use of solar energy.
ii. Optimum use of renewable energy.
iii. Selection of energy efficient fitting plants and equipment.
iv. Adoption of energy efficient fitting plants and equipment.
v. Adoption energy efficient design and technologies.

6 Occupant health and safety

Research finding reported in different literatures revealed that buildings with good overall environments quality can reduces the rate of respiratory disease allergy asthma and exchange worker performances choose construction materials and interior finish products with zero or low emissions to improve indoor air quality many building materials and cleaning /maintenances products emit toxic gases such as volatile organic compounds and formaldehyde these gases can have a dramatic and positive impact on indoor air quality provide effective drainage from the roof and surrounding landscape.

DIFFERENCE BETWEEN GREEN BUILDING AND ORDINARY BUILDING?

A green building uses as many methods as possible to reduce the use of carbon-based energy. It would contain the highly efficient lighting elements (compact), possibly there would be alternate energy sources like solar units or wind driven units on the building or nearby. Energy efficient design would be built in to a new building, etc.

GREEN BUILDING RATING SYSTEM

GRIHA (Green Rating for Integrated Habitat Assessment), TERI (The Energy and Resources Institute) & SVAGRIHA (Small Versatile Affordable GRIHA) are green building rating system developed for Indian construction sector. GRIHA is a rating system which assesses the environmental performance of buildings on scale of 0-104. On the basis of number of points scored, a building can be rated between 1 & 5stars. GRIHA was developed by TERI and has now been adopted by the Ministry of New and Renewable Energy (MNRE) as the National Rating System for green buildings in India and to promote green buildings in India and to oversee the various activities associated with it, MNRE and TERI jointly established an independently Registered society called ADARSH (Association for Development and Research of Sustainable Habitats). ADARSH functions as a platform for interaction between various stakeholders as well as promotes GRIHA, SVAGRIHA and other similar green building rating systems in India whereas SVAGRIHA is a recently designed system especially for small scale projects i.e. buildings with built up area less than 2500sq.mt [5].

4.1 Centres for Environmental Sciences & Engineering Building, IIT, Kanpur, India

Introduction

The CESE is a 5 star green rating building by GRIHA(India) and research facility at the IIT (Indian Institute of Technology), Kanpur on a plot area of 175, 000 square metre . It has been designed in an environment friendly manner and conceptualized and constructed as a "building in the garden" that is sustainable.

Key Sustainable Features

•The building is fully complaint with the ECBC (Energy Conservation Building Code).

•Sustainable site planning has been integrated to maintain favourable microclimate.

•The architectural design has been optimized as per climate and sun path analysis.

•The building has energy-efficient artificial lighting design and daylight integration.

•Water body to cool the micro climate.

•Orientation of building: North – South.

•It also has energy-efficient air conditioning design with controls integrated to reduce annual energy consumption.

I. BODY OF THE PROJECT

MAIN SCOPE OF THE PROJECT IS ZERO WASTAGE & LESS CO_2 EMISSION &COST EFFECTIVENESS.

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MODEL OF PROJECT

In this paper we tried to design a society of 14 houses, which play a role of "GREEN BUILDING". The design procedure for different component of green building is calculated as follows. In this design procedure we assume that there are 14 families having 4no. Of member in each. According to this data we make some assumption & design a different component for green building such as biogas plant, rain water harvesting system, solar panel & sand filter.

BIOGAS PLANT: The size of the digester, i.e. the digester volume V_d, is determined on the basis of the chosen retention time R_T and the daily substrate input quantity Sd.

$$V_d = S_d * R_T \quad [m^3 = m^3/day \times \text{number of days}]$$

The retention time, in turn, is determined by the chosen/given digesting temperature. For an unheated biogas plant, the temperature prevailing in the digester can be assumed as 1-2 Kelvin above the soil temperature. Seasonal variation must be given due consideration, however, i.e. the digester must be sized for the least favourable season of the year. For a plant of simple design, the retention time should amount to at least 40 days. Practical experience shows that retention times of 60-80 days, or even 100 days or more, are no rarity when there is a shortage of substrate. On the other hand, extra-long retention times can increase the gas yield by as much as 40%

Substrate input (Sd) = biomass (B) + water (W) [m^3/d]

In most residential biogas plants, the mixing ratio for dung (cattle and / or pigs) and water (B: W) amounts to between 1:3 and 2:1. For this calculation we take the ratio of (B: W) is (2:1) and retention time is taken as 30 days.

- Waste produce per day= 0.6kg per person
- In a family of a 4 person daily production of a waste is 2.4kg (2.5kg). From a township of a 14 residential buildings waste produce is 35 kg. so in one month waste produce from a township is 1050kg. Biomass=1050kg.
- Average density of kitchen waste, vegetation & trees is 550kg/m^3.
- Therefore, volume of waste is 1050/550= 1.9m^3

Therefore, Substrate input (Sd) = biomass (B) + water (W)

= 1.9+0.95

=2.85m^3/ month

$$V_d = S_d * R_T$$

=2.85*30m^3

=85m^3 (approx)

Circular type digester tank is to be provided with dimensions: height: diameter= 0.9

Using, $V = \frac{\pi}{4} * (d^2h)$

Diameter (d) = 4.9m and

Height (h) = 4.41m

Calculation for gas production,

From the experimental results it is found that 2.5 kg waste produces 0.2kg methane. So, from 14 residential unit 1050kg is generated in a month which will produce 84 kg methane i.e. 127273 lit.

9091 lit/month/ home gas is generated. By which we can calculate that 13636.5lit/home is generated in 45 days.

In 45 days one 14liter CNG cylinder is used in a residential unit. So, 13636.5 lit can be used in 974days by one residential unit, which is approximately 2.5 years. So there is a savings of approximately 20 cylinders from each home & from 14 residential unit savings of cylinder is 280 i.e., 2,24,000/-

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Primary installation cost of biogas plant is 50,000/- which can be recovered within 1 yr.

Excessive amount of methane gas can be used in industry. Also it can be compressed & used for running cars.

SOLAR PLANT: 200watts of 2 nos. of solar panels has been provided on the roof top the residential building. This will supply 400 watts for 10 hrs. i.e. , 4kwh per day

One basic old-fashioned light bulb uses 60 watts of electricity; a CFL uses 18 watts. Laptops often use about 45 watts, and desktops can run between 150-300 watts. Window air conditioning can range between 500 and 1500 watts, and central air conditioning can use 3500 watts. In total, the average home uses about 958 kilowatts a month– with variations by season, especially if you use air conditioning or electric heat. Usage also varies between day and night. Unless you work at home, most of your electricity usage probably happens at night.

Solar panel Wattage = Daily Power requirement / (Average Sunlight Hours x Efficiency of the system)

- In our case daily power requirement = 5 KWh
- Average Sunlight Hours = 5 hrs
- Efficiency of the system = say 80% = 0.8 (Here the conversion losses of inverters, solar charge controllers, battery and wiring are taken)

Now The solar panel wattage requirement = 5/ (5×0.8) = 1.25Kilo Watts Per day.

We had provided 4 nos. of 200watts solar panel with battery of 48 volts in an area of 64 m2. Installation cost of this solar system is 1,40,000/-. In India average monthly consumption is 400 units. (1unit= 1kwh). 1 unit costs 6Rs. So our monthly electricity bill is 2400/-.

$$\frac{140000}{2400 * 12} = 4.86\, yrs$$

Therefore, we can recover solar panel installation cost in 5yrs.

RAIN WATER HARVESTING:

Suppose the system has to be designed for meeting drinking water requirement of a five-member family living in a building with a rooftop area of 100 sq. m. The average annual rainfall in the region is 600 mm (average annual rainfall in Delhi is 611 mm). Daily drinking water requirement per person (drinking and cooking) is 10 litres.

Design procedure:

Following details are available:
Area of the catchment (A) = 163 sq. m.
Average annual rainfall (R) = 611 mm (0.61 m)
Runoff coefficient (C) = 0.85 1. Calculate the maximum amount of rainfall that can be harvested from the rooftop:
Annual water harvesting potential = 163 x 0.6 x 0.85
= 83.13 cu. m. (83130 liters)
2. Determine the tank capacity: This is based on the dry period, i.e., the period between the two consecutive rainy seasons. For example, with a monsoon extending over four months, the dry season is of 245 days.
3. Calculate drinking water requirement for the family for the dry season
= 245 x 4 x 10
= 9800 liters

As a safety factor, the tank should be built 20 per cent larger than required, i.e., 11,760 liters. This tank can meet the basic drinking water requirement of a 4-member family for the dry period. A typical size of a rectangular tank constructed in the basement will be about 3 m x 2 m x 2 m. construction cost of rectangular tank is about 22,000Rs.

Providing 15 m long PVC pipe having diameter 50mm which costs 600Rs per meter. So the cost of PVC pipe is 9000Rs. So, total cost of rainwater harvesting system is 31,000Rs.

Water requirement is 135lpcd. So in a family of 4 members water requirement per year is 4*135*30*12=1,94,400liters/ year.

So from our calculations 1,11,270liters of water will be used from municipality supply.

SAND FILTRATION:

From experimental result 250 gallons/day sewage is generated from 3BHK unit i.e.946litres/day/unit.14*946=13244litres/day/unit.

Approx 15 liters are used in watering garden per day/unit which is 210 liters for 14 residential units. So out of 13244 liters,210 liters can be used for watering gardens & 13034 liters can be supplied to cisterns of 14 homes & 1commercial building for flushing purpose.

Therefore, we have tried to minimise cost in green building system.

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II. CONCLUSIONS

Green building provides us a healthy & safe environment to occupants. It conserves energy & minimizes CO2 emission, also produces less waste. We had tried to break the myth that green always cost more. From our research we have calculated following details:

1. BIOGAS PLANT: By installation of biogas plant, we can produce 13636.5 lit of methane gas, which can be used in 974days by one residential unit, which is approximately 2.5 years. So there is a savings of approximately 20 cylinders from each home & from 14 residential units savings of cylinder is 280 i.e., 2,24,000/-

2. SOLAR PLANT: Providing 4 nos. of 200watts solar panel with battery of 48 volts in an area of 64 m2, whose installation cost is 1,40,000/-. In India average monthly consumption is 400 units. (1unit= 1kwh). 1 unit costs 6Rs. So our monthly electricity bill is 2400/-, which can be recovered within 5 yrs.

3. RAIN WATER HARVESTING SYSTEM: In a family of 4 members water requirement per year is 1,94,400liters. Annual water harvesting potential is 83.13 cu. m. (83130 liters) from a tank of size 3 m x 2 m x 2 m.

Further we can apply for GRIHA, TERI & LEED ratings.

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