ECO-FRIENDLY BUILDINGS

A REPORT

Submitted in partial fulfillment of the requirements for the project presentation of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

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CERTIFICATE

This is to certify that the first project report entitled "Eco-Friendly Buildings" is a bonafide record of the work carried out by Umesh Munjal(131639) , Kartik Makkar(131695) and Suraj Gautam(131709) under the supervision and guidance of Prof. Dr. Veeresh Gali & Mr. Abhilash Shukla. This report is submitted in partial fulfillment of the Project for the award of B-Tech at Jaypee University of Information Technology.

Date:-
-

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CHAPTER 1 – INTRODUCTION

1.1 GENERAL

Eco-friendly building (also referred to as green construction or sustainable building) refers to each a structure and also the utilising of processes that ar environmentally accountable and resource-efficient throughout a building's life-cycle: from siting to style, construction, operation, maintenance, renovation, and demolition.

Eco-friendly buildings are designed, made and operated to increase environmental, economic, health and productivity performance over that of standard buildings. As mirrored within the USGBC's voluntary LEED rating system, wide accepted because the national customary for eco-friendly buildings, AN integrated style approach addresses the potential of the location itself, water conservation, energy-efficiency and renewable energy, choice of materials and indoor environmental quality.

Projects that meet higher levels of LEED certification will embrace a large array of options like storm water retention through landscaping, innovative sewer water technologies, reflective roofs, energy generating sources and private comfort controls. And, of course, energy-saving technologies like Water chamber energy and water supply heating and cooling.

Eco-friendly building style involves finding the balance between homebuilding and also the property surroundings. this needs shut cooperation of the planning team, the architects, the engineers, and also the consumer in the least project stages.[2] The eco-friendly Building follow expands and enhances the classical building style issues of economy, utility, durability, and luxury.

CHAPTER 2 - PRINCIPAL AND FEATURES OF ECO-FRIENDLY BUILDING

2.1 PRINCIPLES OF ECO-FRIENDLY BUILDING

1. Sustainable site style
2. Water Quality and Conservation
3. Energy and surroundings
4. Indoor Environmental Quality
5. Materials and Resources

2.2 OBJECTIVES OF ECO-FRIENDLY BUILDING

1. Eco-friendly Buildings are designed to cut back the general impact on human health and also the natural surroundings by different ways: using energy, water and alternative resources with efficiency.
   - By reducing waste, pollution, and environmental degradation.
   - The aim of Eco-friendly building idea is to develop buildings that use the natural resources to the lowest at the time of construction also as operation. Eco-friendly buildings emphasize on the resource usage potency and additionally press upon the 3 R's - reduce, reuse and Recycle.
2. The technique of Eco-friendly building maximizes the utilization of efficient construction materials and practices; boosts the utilization of natural sources and sinks within the building's surroundings; minimizes the energy usage to run itself; uses extremely skillful instrumentality for the indoor area; uses extremely practiced ways for water and waste management. The indoor instrumentation includes lighting, air-conditioning and every one alternative required instrumentality.
3. Eco-friendly Building may be a team effort and therefore the planning and therefore the every and each style on the setting, keeping in mind the value construction embrace consultants from design and landscaping, air con, plumbing, energy and electrical areas. These consultants need to assess the impact of concerned. the ultimate style must be possible and will minimize the negative impacts that the building would act on the surroundings.
4. Implementation of the Eco-friendly building idea will result in reduction of carbon emission by thirty five percent, water usage by forty percent, solid waste reduction by seventy percent and reduction in energy consumption by half. Eco-friendly

Building idea additionally emphasizes on the actual fact that a neighborhood with high diversity ought to be avoided as a site for the development of a building.

5. To confirm minimum negative impact on the surroundings by the development and operation of a building, the factors that are to be unbroken in mind are - to preserve the external surroundings to the building location; to boost the inner space for the residents of the building; and additionally preserve the areas that aren't near the building.
6. Energy saving through Eco-friendly building idea happens in 2 ways that. 1st is reduction within the quantity of energy that's consumed in lighting, air conditioning and different building operations. Second is that the usage of energy sources that don't turn out any Eco-friendly house gases and are renewable in nature. Eco-friendly Buildings emphasize a lot of on natural lighting and ideas of temperature management and economical style to any cut back the carbon footprint similarly as cut back price of operation.
7. Eco-friendly Buildings use varied ways to cut back water usage, treat and utilize waste water and filter water from sourced from precipitation. The target is to be able to accomplish zero groundwater level negative impact from the Eco-friendly building.

    - Reducing Waste

Waste reduction is one amongst the foremost vital problems that are to be handled. Within us alone, the waste from construction and demolition of buildings accounts for sixty percent of the entire non-industrial waste. Eco-friendly Building idea emphasizes on rising the planning of building, re-using and use materials. It ends up in tremendous waste reduction and additionally helps to cut back the environmental impact of the building.

Hygiene and standard conditions within the building additionally facilitate in boosting human productivity. Therefore, numerous businesses target this side. Eco-friendly Building idea provides for cleanliness and sound operating conditions for workers and different inhabitants.

2.3 FUNDAMENTAL PRINCIPLES OF ECO-FRIENDLY BUILDING

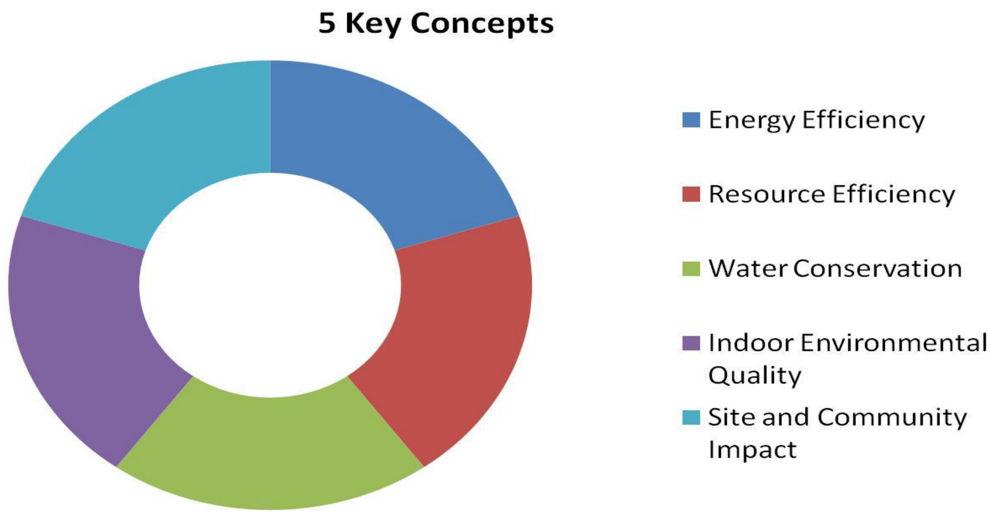


Fig: 2.1 FUNDAMENTAL PRINCIPLES OF ECO-FRIENDLY BUILDING

2.3.1 STRUCTURE DESIGN EFFICIENCY:

1. It's the idea of sustainable building and has largest impact on price and performance.
2. It aims to reduce the environmental impact related to all life-cycles.
3. In planning environmentally best buildings, the target is to reduce the whole environmental impact related to all life-cycle stages of the building project.

2.3.2 ENERGY EFFICIENCY:

1. The layout of the development is often strategized so natural light pours for extra heat.
2. Shading the roof with trees offers AN Eco-friendly in respect to air conditioning.
3. Solar water heating helps in reduces energy prices.
4. Onsite generation of renewable energy through solar energy, wind power, hydro power, or biomass will considerably cut back the environmental impact of the building. Power generation is mostly the foremost costly feature to add to a building.

2.3.3 WATER EFFICIENCY:

Reducing water consumption and protective water quality are key objectives in sustainable building. One crucial issue of water consumption is that in several areas, consumption on the supply aquifer exceeds its ability to refill itself.

To reduce water consumption one ought to aim to use the water that has been collected, used, purified and reused.

Waste-water could also be reduced by utilizing water preserving fixtures like ultra-low flush bathrooms and low-flow shower heads.

2.3.4 MATERIAL EFFECIENCY:

1. Materials should be use that may be recycled and may generate surplus quantity of energy.
2. An example of this is solar energy panels, not solely they supply lightening however they're additionally a helpful energy supply.
3. Eco-friendly building material/product choice criteria:
   a. Resource efficiency.
   b. Indoor air quality

2.3.5 RESOURCE EFFICIENCY:

1. Recycled Content- product with identifiable recycled content, together with postindustrial content with a preference for post, client content.
2. Resource efficient producing process- product factory-made with resource-efficient processes together with reducing energy consumption, minimizing waste (recycled, recyclable and or supply reduced product packaging), and reducing Eco-friendly house gases.
3. Locally available- Building materials, components, and systems found locally or regionally saving energy and resources in transportation to the project site.
4. Durable- Materials that are longer lasting or are similar to standard product with long life expectations.

2.3.6 INDOOR AIR QUALITY:

1. Indoor Air Quality seeks to cut back volatile organic compounds, or VOCs, and alternative air impurities like microbe contaminants. Buildings rely on a properly designed ventilation system (passively/naturally- or mechanically-powered) to produce adequate ventilation of cleaner air from outdoors or recirculated, filtered air as well as isolated operations (kitchens, dry cleaners, etc.) from different occupancies.

2. Low or non-toxic- Materials that emit few or no carcinogens, reproductive toxicants, or irritants as demonstrated by the manufacturer through applicable testing.

3. Moisture resistant- product and systems that resist moisture or inhibit the expansion of biological contaminants in buildings.

4. Systems or equipment- product that promote healthy IAQ by distinctive indoor air pollutants or enhancing the air quality.

2.3.7 WASTE REDUCTION:

Well-designed buildings additionally facilitate cut back the quantity of waste generated by the occupants also, by providing on-site solutions like compost bins to cut back matter aiming to landfills.

To cut back the impact on wells or water treatment plants, many choices exist. "Greywater", sewer water from sources like washing or laundry machines, are often used for subsurface irrigation, or if treated, for non-potable functions, e.g., to flush bathrooms and wash cars. rain collectors are used for similar functions.

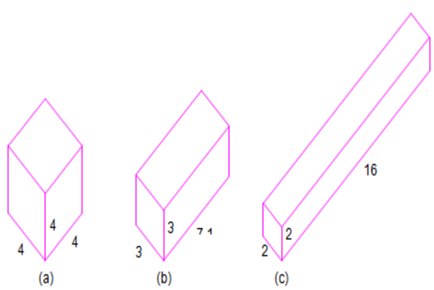
Centralized sewer water treatment systems are often expensive and use lots of energy. an alternate to the present method is converting waste and sewer water into fertilizer, that avoids these prices and shows different advantages.

It is probable to utilize resources.

What may be waste to us could have another profit to something else.

2.4 BUILDING CONFIGURATION

- Surface area to volume ratio (S/V ratio): The ratio of the surface area to the volume of the building (S/V ratio) determines the magnitude of the heat transfer in and out of the building. The larger the S/V ratio, the greater the heat gain or loss for a given volume of space. Conversely, a smaller S/V ratio will result in the reduction of heat gain/loss. For example, in cold climates it is preferable to have compact house forms with minimum S/V ratio. Fig shows the surface to volume ratios for various building shapes.



SOLID SHAPE	SURFACE AREA 'S'	VOLUME 'V'	SURFACE AREA/ VOLUME RATIO 'S/V'
a	96	64	1.5
b	103.2	64	1.61
c	136	64	2.13

2.5 LITERATURE REVIEW

2.5.1 RESEARCH PAPERS

S.No.	Title	Publication year	Authors
1	Eco-friendly building materials	2015	Akshay b. mokal
2	Eco-friendly buildings to achieve a net neutral community	2014	Abdul salam darwish
3	Bamboo:eco-friendly building material in indian context	2013	Rushabh a.Shah
4	Eco-friendly building policy and school performance	2012	S.Kelting
5	Comparative analysis of energy consumption of eco-friendly and non-eco-friendly building	2012	Pramen P.Shrestha and nitisha pushpala

TABLE 3.1 RESEARCH PAPERS

2.5.2 ENERGY EFFICIENCY AND SUSTAINABILITY IN BUILDINGS

2.5.1(a) INDIA CLIMATE

India is characterized by a hot tropical climate that varies from region to region. The winters fall between Nov to mid-March and summers from april to June. Northern India remains dry, dusty, and unpleasant throughout the summer months. the nature of monsoon, that lies between mid-july and september is erratic where some areas experience significant rains the others experience drought and still others get flooded.

CLIMATIC ZONES AND THEIR CHARACTERISTICS

Regions having similar characteristic options of climate are sorted below one zone. Supported the climatically factors mentioned within the previous section, the country can be divided into variety of climatical zones. Bansal et al. had applied elaborated studies and rumored that india can be divided into six climatical zones, namely, hot and dry, warm and humid, moderate, cold and cloudy, cold and sunny, and composite. the standards of classification are given in Table a pair of.1 shows the climatical zones. an area is allotted to at least one of the primary 5climatical zones only if the outlined conditions prevail there for over six months. In cases wherever none of the outlined classes can be known for 6 months or longer, the zone is termed composite. In line with a recent code of Bureau of Indian Standards, the country is also divided into 5 major environmental condition zones. Table 2.1 presents the standards of this classification as well; Fig. 2.13(b) shows the corresponding environmental condition classification map of India. It’s seen that the recent classification isn't terribly completely different from the earlier one except that the cold and cloudy, and cold and sunny are classified along as cold climate; the moderate climate is renamed as temperate climate. it should be mentioned that every zone doesn't experience a similar climate for the full year. it's a specific season for quite six months and will experience alternative seasons for the remaining time.

Table 2.1 Classification of Climates

Criteria of Bansal et al. [1]			Criteria of SP 7: 2005 [9]		
Climate	**Mean monthly temperature (°C)**	**Relative humidity (%)**	**Climate**	**Mean monthly maximum temperature(°C)**	**Relative humidity (%)**
Hot and dry	>30	<55	Hot and dry	>30	<55
Warm and humid	>30	>55	Warm and humid	>30 >25	>55 >75
Moderate	25-30	<75	Temperate	25-30	<75
Cold and cloudy	<25	>55	Cold	<25	All values
Cold and sunny	<25	<55			
Composite	This applies, when six months or more do not fall within any of the above categories		Composite	This applies, when six months or more do not fall within any of the above categories	

Table3.2 Classification of climates

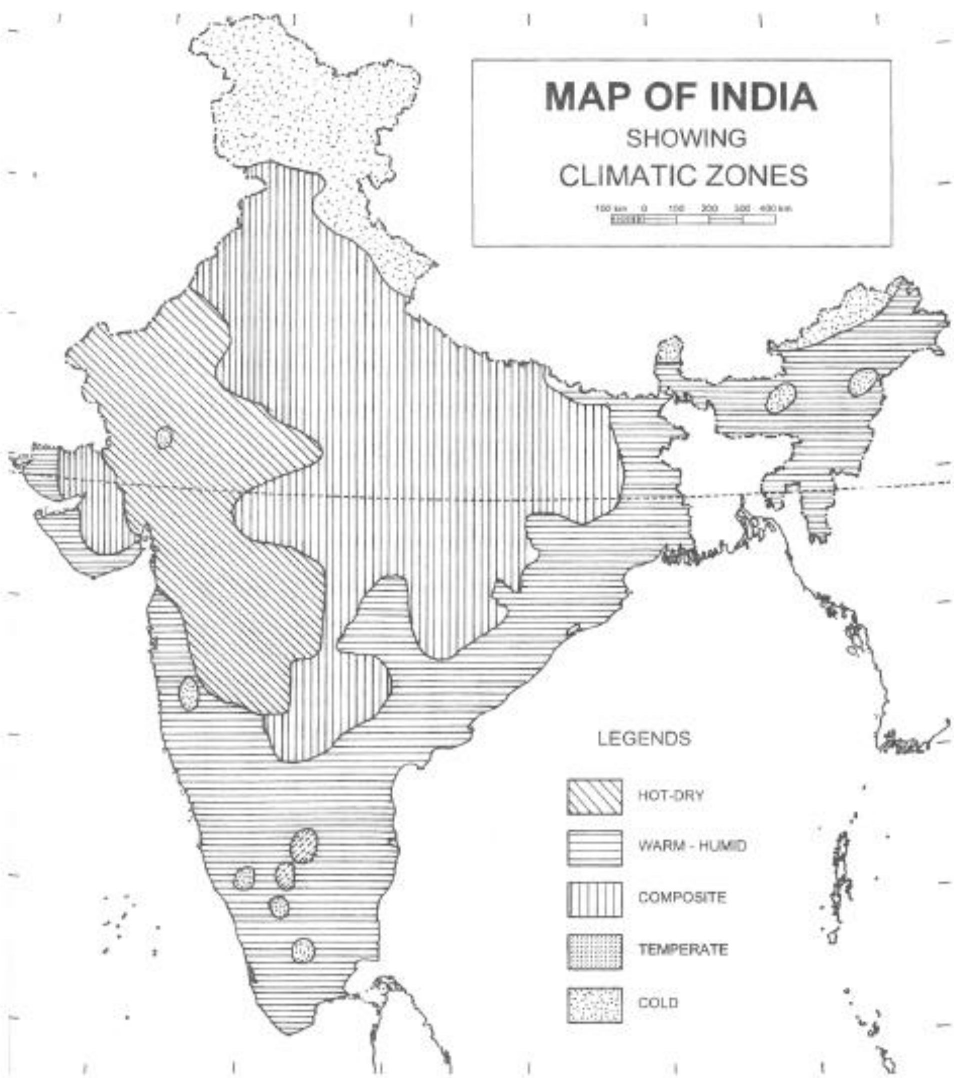


Fig. 2.13b Climatic zones of India [9]

CHAPTER 3 - CLIMATE AND FEATURES IN GREEN BUILDING FOR COLD AND CLOUDY CLIMATE

3.1 ABOUT THE BUILDING

A single story 2 BHK, rectangular building plan of area 1325 sq. ft is made for Cold and Cloudy Climate like Shimla. The front elevation phasing south guides entry into the house that leads to the Hall and the dining area of the house. Moreover there is also an entry from east facing that leads to the Drawing Room of the House. Using Autodesk REVIT Architecture, the plan is modeled both in a traditional conventional technique and in an innovative energy efficient green building.

3.2 PATH OF SUN IN SUMMER AND WINTER IN THE NORTHERN HEMISPHERE

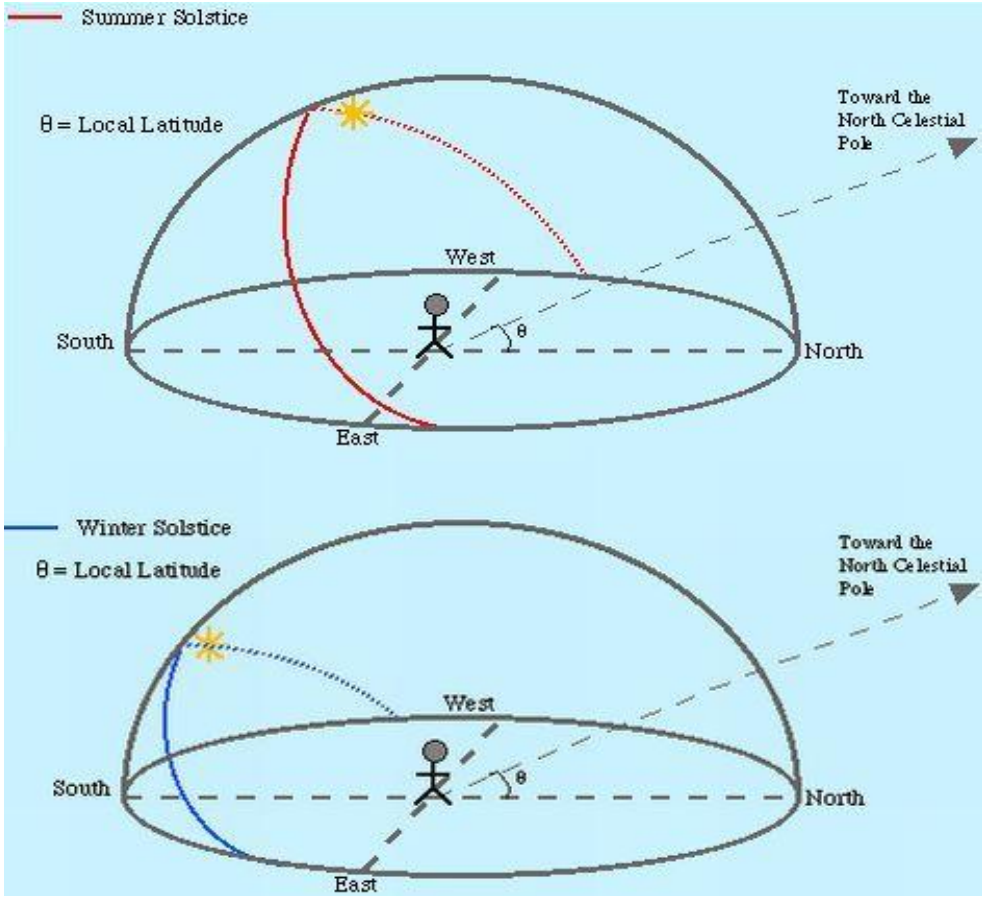
In the summer season the days are long and the Sun is high in the sky. The figure at the left shows the path of the Sun through the sky on the longest day of the year, the Summer Solstice (June 21). This is also the day when the Sun is the highest in the southern sky. Because the day is so long the Sun does not rise exactly in the east, but rises to the north of east and sets to the north of west allowing it to be in the sky for a longer period of time.

After the Summer Solstice the Sun follows a lower and lower path through the sky each day until it reaches the point where it is in the sky for exactly 12 hours again. This is the Fall Equinox (September 21). Just like the Spring Equinox, the Sun will rise exactly east and set exactly west on this day and everyone in the world will experience a 12 hour day. After the Fall Equinox the Sun will continue to follow a lower and lower path through the sky and the days will get shorter and shorter until it reaches its lowest path and then we are back at the Winter Solstice.

In the winter the days are short and the Sun in low in the sky. The shortest day of year falls on December 21 when the Sun is also lowest in the southern sky as shown in the diagram at the left. Each day after the Winter Solstice, which falls on December 21, the Sun’s path becomes a little higher in the southern sky. The Sun also begins to rise closer to the east and set closer to the west until we reach the day when it rises exactly east and sets exactly west. This day is called the

Spring Equinox (March 21).

During the short winter days the Sun does not rise exactly in the east, but instead rises just south of east and it sets south of west.



3. 3 RELEVANCE OF SOLAR PASSIVE HOUSING TECHNOLOGY FOR HILLY REGIONS

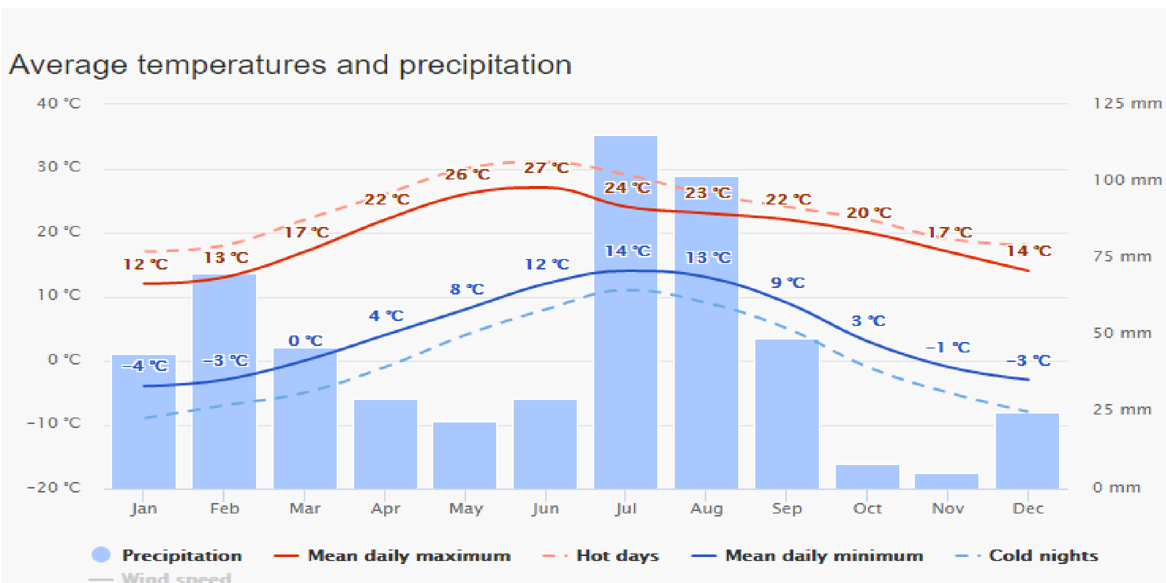
Large energy consumption in building sector is of major concern today. In hilly areas, the modern building design practices give little consideration to climatic conditions, resulting in uncomfortable living during winters requiring large quantity of fuel wood, fossil fuels & electricity for space heating. The State of Himachal Pradesh in the Western Himalayas, extends from snow covered Himalayan mountains separating Tibet in the North to plains of Punjab in the Southland West. The State with a geographical area of 55673 sq km is located between latitude 30^{o} 22' 40" to 33^{o} 12' 40" North and longitude 75^{o} 45' 55" to 79^{o} 4' 20"East. The altitude ranges from 250 m in the foothills and up to 6,975 m above mean sea level in the high hills. Due to peculiar topography, it experiences severe winters. In Himachal Pradesh, the climate ranges from sub-tropical to alpine desert. Areas above 2000 metres receive light to heavy snowfall where as alpine zone remains under snow for 5-6 months in a year thus space heating of building is of major concern. The Govt. buildings require central electric / fossil fuel heating systems to create comfortable indoor conditions. In private sector, hotels, industrial units, shopping/residential complexes and houses consume large amounts of electricity & other fuels like wood, char coal,

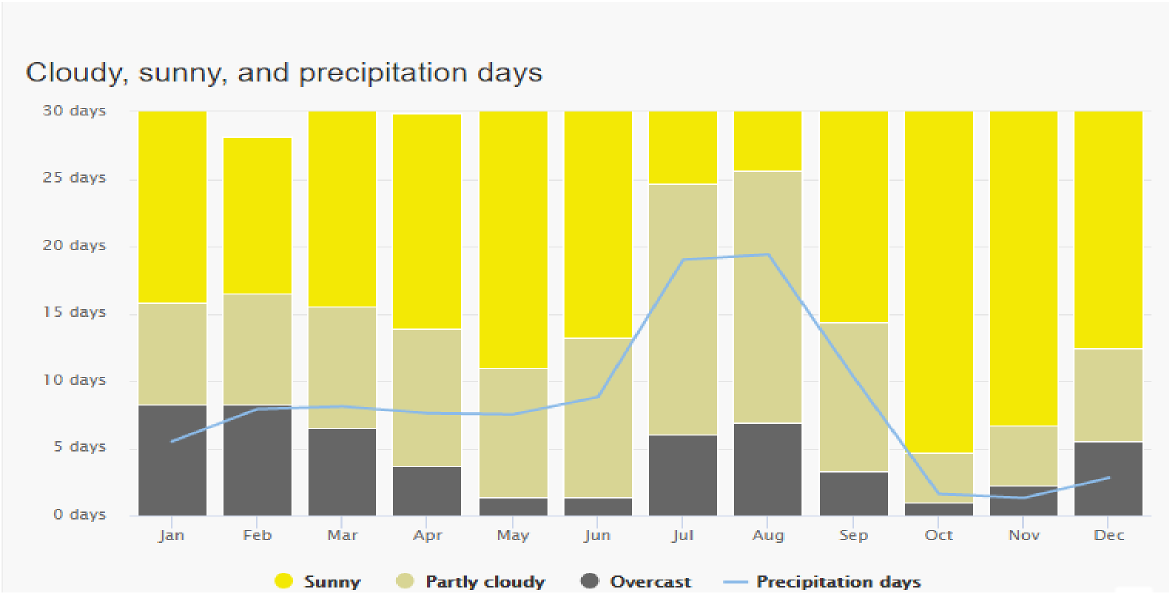
coal, LPG for space heating in winters or cooling in summers as these are not designed without any consideration to climatic conditions.
Solar passive housing is one of the well tested and proven technology which is very useful for the climatic conditions of HP, in providing comfortable living conditions, besides saving 50-60% of energy required for winter space heating. The cost-effective innovative designs as per climatic requirements have not been followed by the rural communities in the absence of proper demonstration of these technologies. The costs of the central electric/oil/wood fired heating in urban areas can be considerably reduced if the building is designed as per solar passive technology.

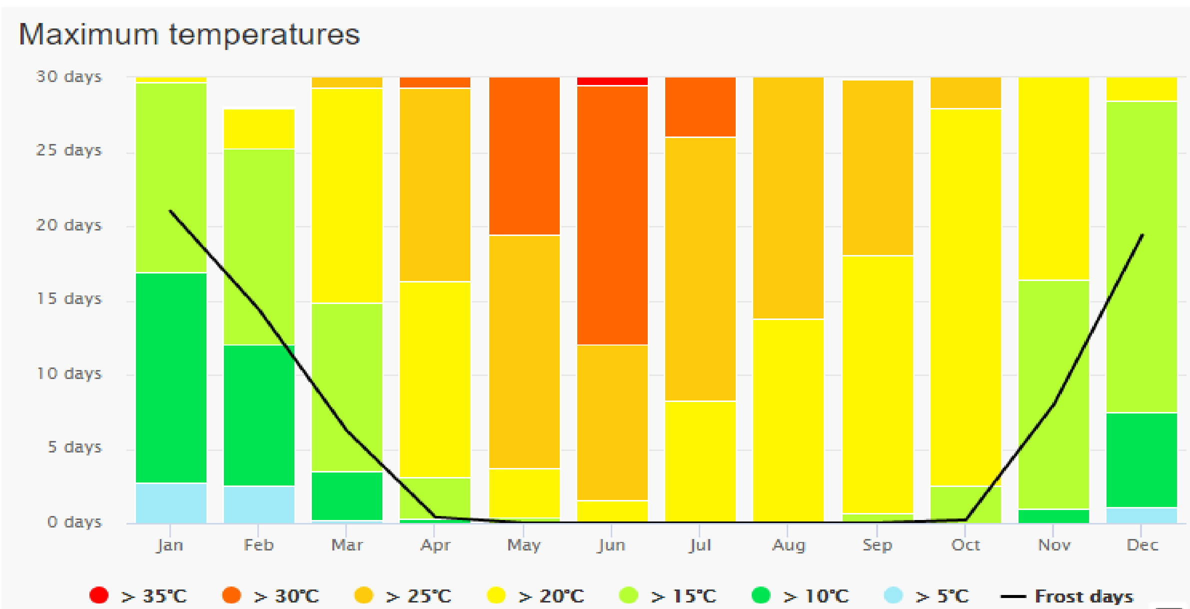
The other benefits of this technology include reduction of green house gas emissions, saving women & children from indoor smoke pollution and providing with healthy living environment.

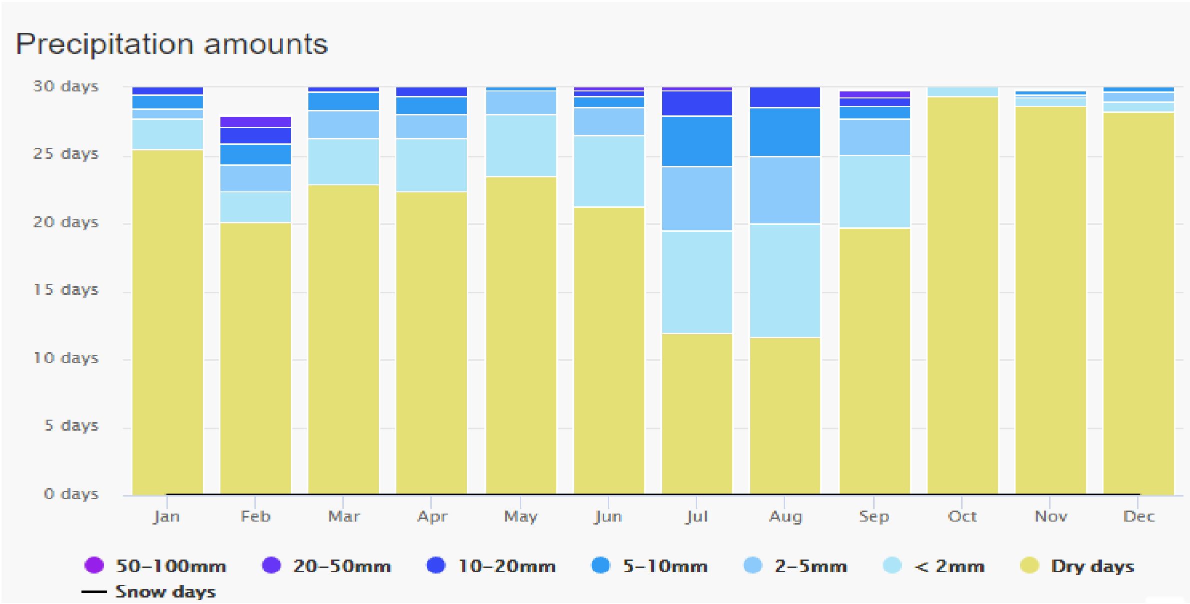
With about 250 days of Sunshine per year, Himachal Pradesh has an ideal climate for solar passive heating.

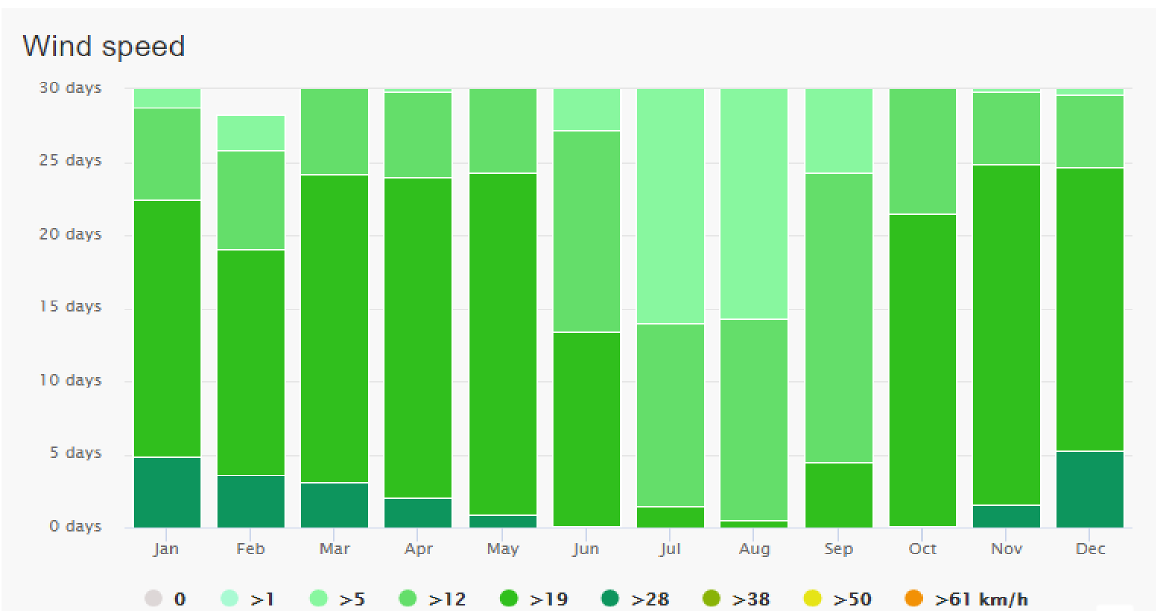
3.4 LOCATION'S WEATHER DATA




Cloudy, sunny, and precipitation days
30 days
25 days
20 days
15 days
10 days
5 days
0 days
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Sunny
Partly cloudy
Overcast
Precipitation days


Maximum temperatures
30 days
25 days
20 days
15 days
10 days
5 days
0 days
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
> 35°C
> 30°C
> 25°C
> 20°C
> 15°C
> 10°C
> 5°C
Frost days





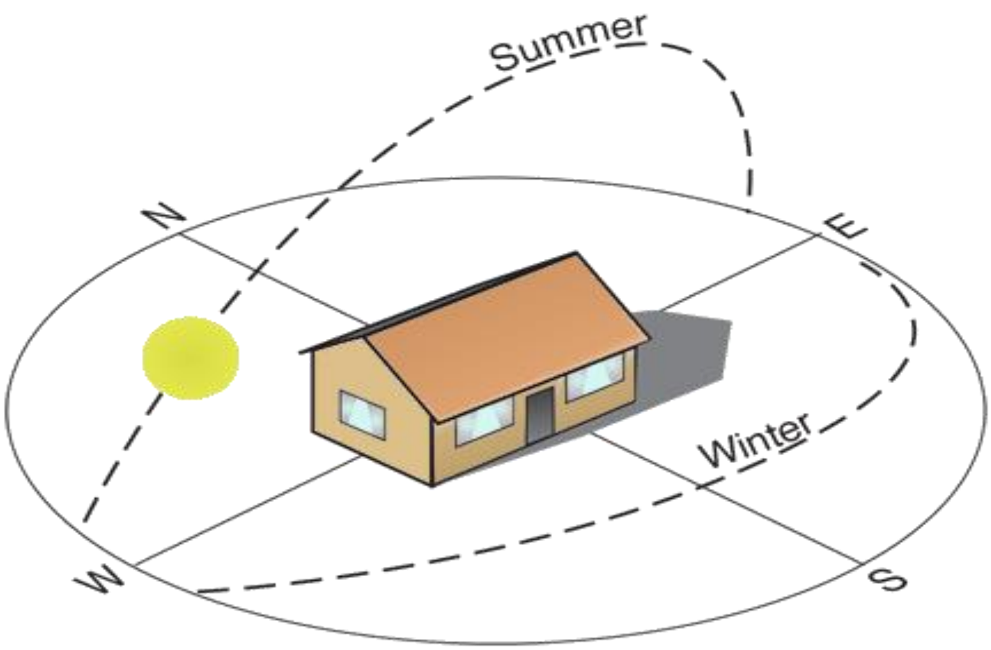
3.5 ENERGY EFFICIENT FEATURES USED:

- Orientation
- Daylighting
- Glazed windows
- Cavity wall
- Trombe wall
- Insulation
- Using sustainable construction materials

- Vegetation
- Energy efficient appliances

ORIENTATION:

- The longer axis is from east to west to attain maximum sunlight.
- In cold climates, a building must be oriented to receive maximum solar radiation into the living areas for warmth on one hand, while keeping out the prevailing cold winds on the other.



DAYLIGHTING WINDOWS ON SOUTH AND WEST SIDE OF HOME :

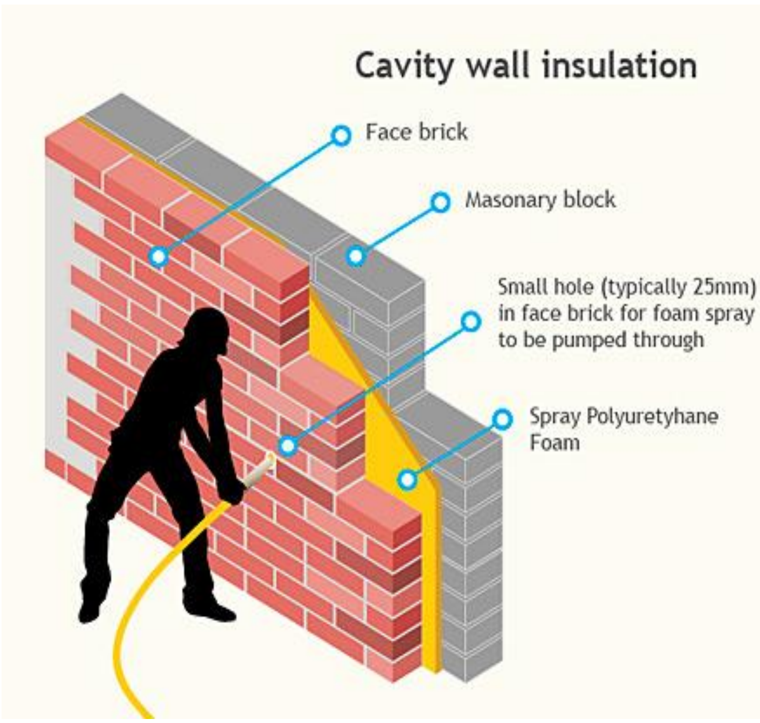
South facing windows introduce sunlight and daylight into the home, particularly in winter when the sun is lower in the sky and direct sunlight contributes to heating the house. Light colored interior surfaces reflect more light and reduce the level of artificial lighting required. A shutter is provided under the sloped roof to not to allow excessive heat during summer.

GLAZED WINDOWS:

Glazed windows are used to moderate interior temperatures by controlling heat loss and gain. The coating filters the heat-producing aspects of solar rays. Glazed windows reduce the need for heating, cooling & artificial lighting. In a typical home, roughly 30% of heating and air conditioning is lost through the windows.

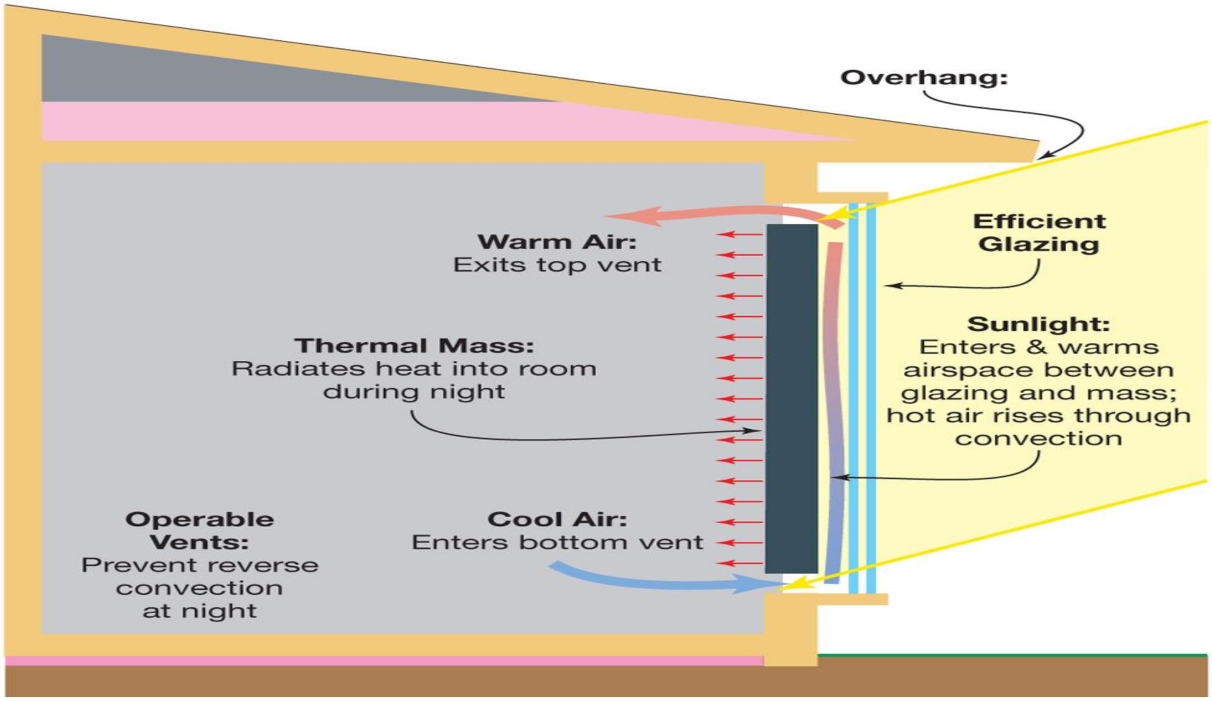
CAVITY WALL:

Cavity wall is provided on the North facing walls to resist winter winds. These walls are good source of insulation and they are mainly helpful from protecting the inner walls from outside walls from attack by moisture (water). Cavity walls consist of two 'skins' separated by a hollow space (cavity). The skins are commonly masonry such as brick or concrete block



TROMBE WALL:

South facing trombe wall is made. Trombe wall consists of a 8" - 16" thick brick wall painted with a dark, heat-absorbing color and faced with a single or double layer of glass. The glass is placed between 2 - 15cm (1" - 6") away from the masonry wall to create a small airspace. Heat from sunlight passing through the glass is absorbed by the dark surface, stored in the wall, and conducted slowly inward through the masonry.



INSULATION:

Insulated floors, roofs and walls are used. Insulating materials may be applied externally or internally to the roofs. Walls are insulated from north and east so as to avoid heat loss during winter and are uninsulated from south and west to allow heat gain. Floors are insulated so as to avoid heat loss during winter. We have used puffed insulation as it is easily available in Shimla.

USING SUSTAINABLE CONSTRUCTION MATERIALS:

Using materials with lower embodied energy. Reducing transport of materials and associated fuel, emissions and road congestion. Preventing waste going to landfill. Using naturally available materials to reduce cost. Sustainable wood products are used.

VEGETATION:

Deciduous trees are planted in the east and west direction. These trees that drop their leaves for part of the year. In summer, they provide shade from intense morning and evening sun deciduous trees shed their leaves in winter and allow solar radiation to heat the building.

ENERGY EFFICIENT APPLIANCES*:*

As our reliance on appliances increases and energy prices are also on the rise, choosing energy-efficient appliances becomes more important. Energy Star is the symbol for energy efficiency. It's a label created by the U.S. Environmental Protection Agency (EPA) and the United States Department of Energy help consumers save money and reduce air pollution. Using energy star labeled appliances.

3.6 MATERIAL USED IN GREEN AND CONVENTIONAL BUILDING:

Construction	Conventional Building	Green Building
Solar Panels	Not Used	Used(250Wh, 6 in no.)
Wall	Brick Wall (225 mm)	Trombe Wall and Cavity Wall
Flooring	Concrete Flooring	PVC Flooring
Roof	Concrete Roof (100 mm)	Warm Roof with Puffed Insulation (200 mm)
Glass	Single Glazing	Double glazing with different SHGC
Window and Door frame	Aluminium	Soft Wood
Water Efficient	Standard Water Flow Fixtures	Low Water Flow Fixtures Native Vegetation, Rain Water Harvesting
Lighting Fixtures	Tube Lights and CFLs	Low watt LED Lights

Table 3.3 Materials used in conventional and green building

CHAPTER 4- CASE STUDY OF DIFFERENT GREEN BUILDINGS

4.1 H.P.STATE CO-OPERATIVE BANK BUILDING, SHIMLA

Location: Shimla, Himachal Pradesh
Climate: Cold and Cloudy

FEATURES INCORPORATED IN THE BUILDING:

This is a three storied building that is located in Shimla. The longer axis is the east-west direction. The winter winds are being experienced by the wall on the north side which are emerged from north-eastern direction. Ventilation and day lighting system is also installed in this building.

ENERGY CONSCIOUS FEATURES:

1. For maintenance of heating inside the building Tromie walls are installed.
2. Solar collectors are provided in the roofs so that heat can get circulated by use of ducts.
3. Cavity walls are constructed facing the northern side.
4. Double glazed systems and proper insulation systems are installed facing the west direction.
5. For air proper exchange air locking systems are provided along with proper ventilation system.

EFFICIENCY AND PERFORMANCE OF THE BUILDING:

1. The total energy savings of this Green building:
2. Western wall double glazed insulation= 43250kWh
3. Roof insulation = 23896 kWh
4. Solar collector= 10288 kWh
5. Trombe wall=7498 kWh
6. Total= 84932 kWh

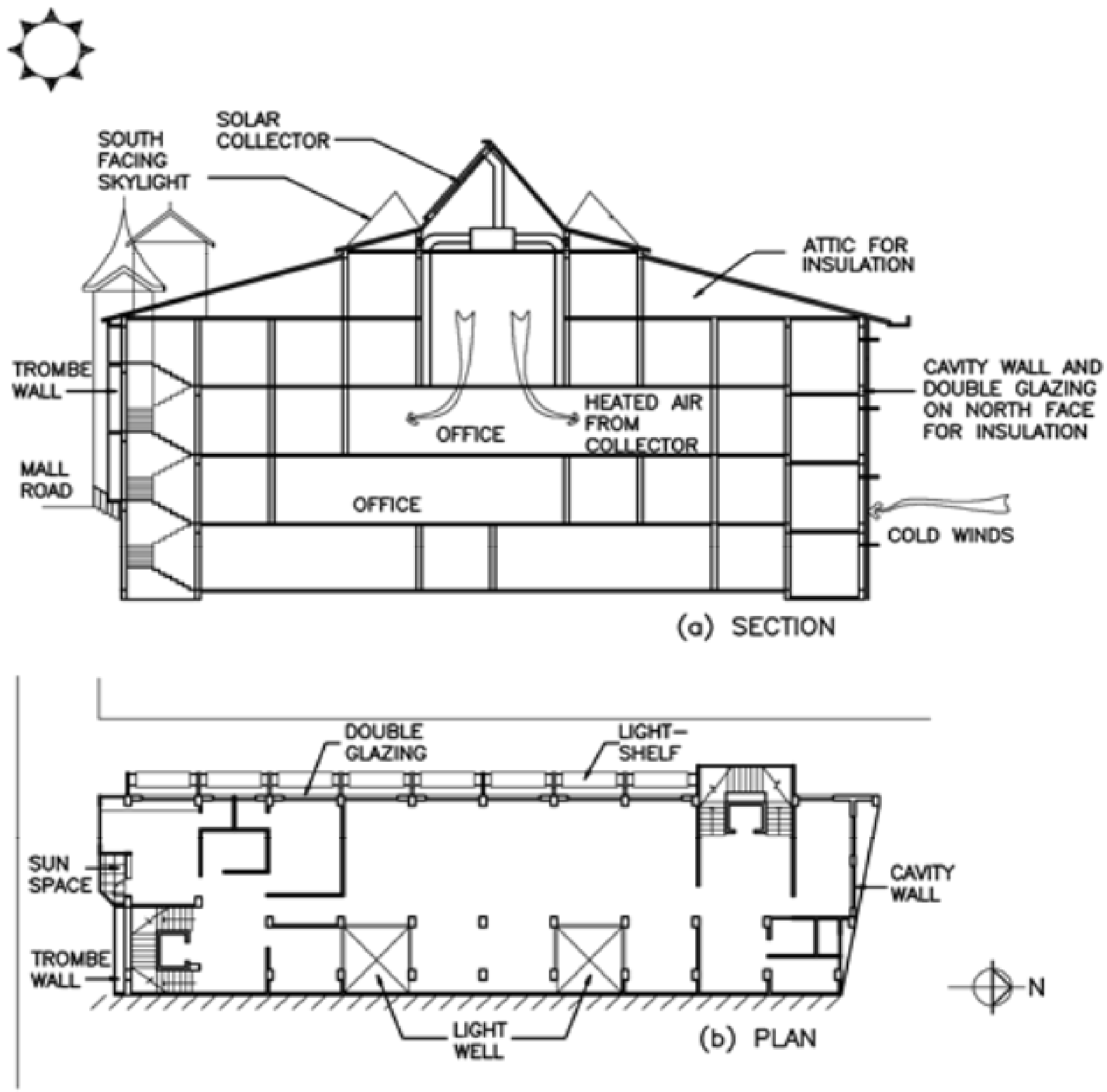


Fig – 4.1 Section and plan of H. P. state co-operative bank, Shimla

4.2 SATLUJ JAL VIDYUT NIGAM LIMITED (SJVNL),SHIMLA

Location: Shimla, Himachal Pradesh
Climate: Cold and Cloudy

BRIEF DESCRIPTION OF BUILDING:

This building is recently constructed in Shimla. It is a four-storied structure with its longer axis facing in the east-west direction.Building relies on a properly designed HVAC (heating ventilation and air conditioning system) to provide adequate ventilation provision.. There is also a provision of natural lighting systems in this building to ensure maximum heat can be used by sun so that it can be used for the lighting systems inside and outside the building. Solar water heating, collector drain pipes, fountain systems are also installed in this building.

ENERGY CONSCIOUS FEATURES:

1. Solar window: Photovoltaic windows not only provide a clear view and illuminate rooms, but also plays vital role in trapping the heat of sunlight for generating electricity.
2. Roof window: A sloped window used for day lighting .
3. Insulation in Walls, ceilings, and floors: Insulation reduces unwanted heat loss or gain and can decrease the energy requirements of heating and cooling systems.
4. Solar Panels are installed upon roof for using Sun light for heating water and making solar energy.
5. Designing for dual plumbing hat recycles water in toilet flushing.
6. Use of ultra-low flush toilets.
7. Use of low-flow shower heads.
8. Reuse of grey water for Watering gardens.
9. Rainwater Harvesting.
10. Internal Lightning of the office area, in which light automatically shut off, if no person is found or all computers are off.

PERFORMANCE OF THE BUILDING:

1. Energy efficient measures to conserve 15-20% of energy.
2. Water efficient fixtures to save water to the tune of 40-45%.
3. Reuse of 100% treated waste water for landscaping and flushing requirements.
4. Over 90% of the construction waste is recycled and reused on the site.
5. 40% of building material is extracted and manufactured locally/ regionally.

Fig.4.2 Solar Window and Roof window used in SJVNL for Energy Efficiency

CHAPTER 5 - INDIAN ECO-FRIENDLY BUILDING COUNCIL

5.1 GENERAL

1. The Indian Eco-friendly Building Council (IGBC) was formed in the year 2001 by Confederation of Indian Industry (CII).

2. The aim of the council is to bring Eco-friendly building movement in India and facilitate India to become one of the global leaders in Eco-friendly buildings by 2015.

Today more than 1053 Eco-friendly buildings (as on April 2011) with a built-up area of over 648,000,000 sq ft (60,200,000 m^2). are being constructed all over India, of which 147 Eco-friendly buildings are certified and fully functional.

a. LEED India for New Construction

b. LEED India for Core and Shell

c. IGBC Eco-friendly Homes

d. IGBC Eco-friendly Factory Building

e. IGBC Eco-friendly SEZ

f. IGBC Eco-friendly Townships

3. IGBC has developed Eco-friendly building rating programmes to cover commercial, residential, factory buildings, etc.

4. Each rating system divided into different levels of certification are as follows:

   a. ‘Certified’ to recognise best practices.
   b. ‘Silver’ to recognise outstanding performance.
   c. ‘Gold’ to recognise national excellence.
   d. ‘Platinum’ to recognise global leadership.

Certification Lev	Points	Recognition
Certified	50-59	Best Practices
Silver	60-69	Outstanding Performance
Gold	70-79	National Excellence
Platinum	80-100	Global Leadership

Table 5.1: Threshold criteria for certification levels.

CHAPTER 6- LEED RATING SYSTEM AND WATERFURNANCE

6.1: GENERAL

1. LEED rating system was developed in USA by the US Eco-friendly Building Council in the year 1998.
2. It defines a set of parameters for eco-sustainable construction of building using a market-based rating system.
3. This rating system is followed in many countries for the analysis of sustainable building.
4. LEED rating system defines a variety of benefits..
5. The benefits include reducing the operating costs, reducing resource utilizations in terms of water and electricity, reducing emissions of Eco-friendly house gases.

The USGBC's LEED Eco-friendly Building Rating System is based on the LEED Letter Template, a dynamic tracking and documentation tool that must be used by Version 3.0 project teams in preparing a complete LEED certification submittal. For each credit, the Letter Template prompts LEED practitioners for data, indicates when documentation requirements have been fulfilled adequately for submittal, and serves as a formatting template for the project's initial submittal. Additional support documents will be requested during the certification auditor's auditing phase.

This rating system provides the basic requirements and documents that are necessary to achieve all pre-requisite and voluntary "credit." Projects earn one or more points toward certification. Points add up to a score that relates to one of four levels of certification.

1. 40-49 points Certification.
2. 50-59 points Silver.
3. 60-79 points Gold.
4. 80+ points Platinum.

6.2 EXPLANATION OF WATER FURNANCE CONSTRUCTIONS

Table 6.1: Points in Water furnnace Constructions.

Energy& Atmosphere		Water Furnance Points	Possible Points
Prerequisite 1:	Fundamental Building Systems Commission Required	YES	
Intent:	Verify and ensure that fundamental building elements and systems are designed,	YES	
	installed and calibrated to operate as intended.		
Prerequisite 2:	Minimum Energy Performance Required	YES	
Intent:	Establish the minimum level of energy effiicency for the base building and systems.	YES	
Prerequisite 3:	CFC Reduction in HVAC&R	YES	
Intent:	Reduce ozone depletion	YES	
Credit 1:	Optimize Energy Performance		
Intent:	Achieve increasing levels of energy performance above the prerequisite standard to reduce	1 to 19 points	1 to 19 points
	standard to reduce environmental impacts associated with excessive energy use.		
Credit 4:	Enhanced Refrigerant Management		
Intent:	Reduce ozone depletion and support early compliance with the Montreal Protocol.	2 points	2 points

Materials and Resources:			21 points
Credit 4:	Local/Regional Materials,if 10% of all material comes from within 500 miles- 1 point	1 points	
Intent:	Increase demand for building materials and products that are extracted and manufactured		
	within the rgion.		
Credit 4:	Local/Regional Materials,if 20% of all material comes from within 500 miles- 2 point	I points	

Indoor Environmental Quality			23 points
Credit 1:	Outdoor Air Delivery Monitoring	1 points	1 points
Intent:	Provide capacity for ventilation system monitoring to help sustain occupant comfort and well-being.		
Credit 5:	Indoor Chemical and Pollutant Source Control- MERV 13 filters	1 points	1 points
Credit 6.2:	Comfortability of Systems: Thermal Comfort	1 points	1 points
Intent:	Provide a high level of thermal comfort system control by individual occupants or by specific groups in multi-occupant spaces.		
Credit 7.1 :	Therma Comfort, Comply with ASHRAE 55-1992	1 points	1 points
Intent:	Provide a thermally comfortable environment that supports the productivity and well-being of building occupants.		
Credit 7.2 :	Therma Comfort,Verification		1 points
Intent:	Provide a permanent monitoring system to ensure building performane mets the desired comfort criteria determined by credit 7.1-1 point.		

Innovation & Design Process			28 points
Credit 1:	Innovaton in Design		
Intent:	Provide exceptional performance above the requirements set by the LEED Green Building Rating System and/or Green Building categories not specifically addressed by the LEED Green Building Rating System	1-5 points	2 points
	Pre- Certification Estimate of Total Points available through Water Furnance Equipment:		30 points

CHAPTER 7 -BENEFITS OF ECO-FRIENDLY BUILDING

7.1 BENEFITS OF ECO-FRIENDLY BUILDING

Here are some financial, economic and environmental benefits of Eco-friendly building technologies and practices.

1. **No increase in first cost-** Many Eco-friendly buildings cost no more to build—or may even cost less—than conventional building alternatives because resource-efficient strategies and integrated design often allow downsizing of more costly mechanical, electrical and structural systems.
2. **High-performance Eco-friendly buildings are cost-effective-** Even for projects loaded with high value features, higher first costs often are recovered within three to five years through lower operating expenses and utility rebates for energy-saving equipment. Savings in energy of 20-50 percent are common through energy-saving technologies, integrated planning and downsized equipment.
3. **Increased resale value of energy-efficient facilities-** Facility owners can reduce their financial risk by making investments in energy-efficiency that earn a higher rate of return than the stock market or bonds.
4. **Increased value for developers and owners-** There is growing confidence in the industry that a high-performance Eco-friendly building can either capture lease premiums or present a more competitive property in an otherwise tough market.
5. **Improved health and productivity-** Many Design features are used that enhance energy-efficiency and indoor air quality are cost-reducing strategies for improvement of worker productivity and product quality.
6. **Enhanced occupant health and well-being-** High-performance Eco-friendly buildings typically offer healthier and more satisfying work environments for tenants. A recent Lawrence Berkley National Laboratory Study reported that commonly recommended improvements to indoor environments could reduce health care costs and work losses from communicable respiratory diseases by 9-20 percent, among other benefits.
7. **Stretch local infrastructure capacity-** Decreased energy and material requirements couple with appropriate siting help stretch the capacity of overburdened public systems for grid supplied power, water, wastewater and transportation.
8. **Enhanced security-** As domestic fossil fuel supplies are depleted; our nation becomes more dependent on sources from foreign countries. Renewable energy sources can reduce the dependence and can help in improving national security.

7.2 URBAN MITIGATION MEASURES

1. **Planting Trees:** vegetation is one of the most important factors in the fight against the heat island effect. Air temperatures directly under plants can be as much as 10^0C cooler than temperature over unshaded blacktop. Trees can be planted statically to roofs, walls, and other surfaces, keeping them cooler and saving energy costs. Trees are also a medium for providing a cooling effect through evapo-transpiration. Other vegetation, like grass etc. also provides cooling effects.
2. **Eco-friendly Roofs:** Eco-friendly roofs are roofs planted with grasses, flowers, or other vegetation. Reducing the urban heat island effect isn't the only benefit of Eco-friendly roofs- they can also be used to grow fresh local products in the city, and they significantly reduce storm water runoff as well. Local birds will be attracted on the roof Eco-friendly and make their nest upon it.

Fig 7.2: Building with Eco-friendly Roofs.

3. **Building Walls:** The walls of building should be painted using heat reflective paints.
4. **Roofs:** The roof of building remains exposed to direct sun rays during the day time. The traditional methods of keeping roof surface cool are lime terracing, mud p and brick bat treatment. These methods are not only costly but also increase the load on roof. The new and convenient method is to paint the roof white. Solar reflective coating is an acrylic based coating which provides weather proofing and heat insulation to the exposed roof. This can be used for coating RB, RCC roof top surface, asbestos cement roofing sheets, galvanized zinc sheets. With such coating temperature may be lower to 10^0C thus giving cooling comfort to the occupants of house and also reduces the load on Air Conditioner.

CHAPTER 8 - MODELLING OF GREEN BUILDING IN REVIT SOFTWARE

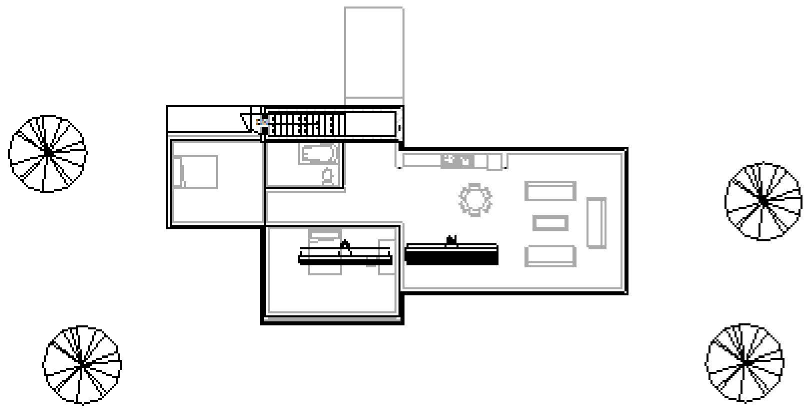
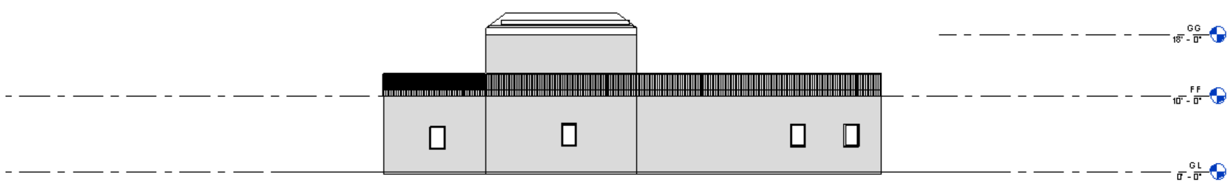


Fig.8.1 Ground plan of 2 bhk building



Fiq.8.2 Front elevation south facing of conventional building

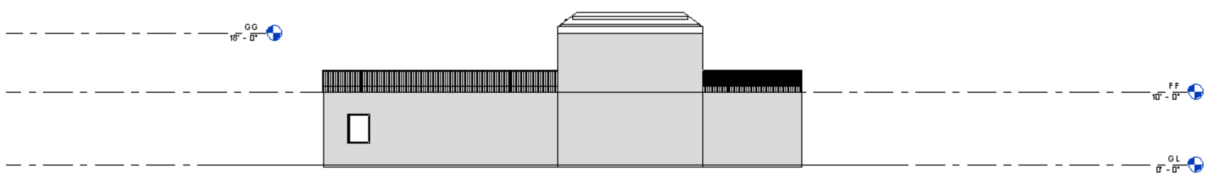


Fig.8.3 Back elevation north facing of conventional building

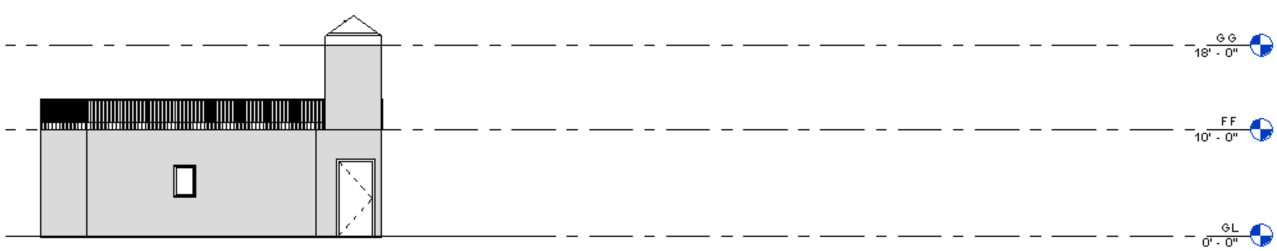


Fig.8.4 Side elevation of east face of conventional building

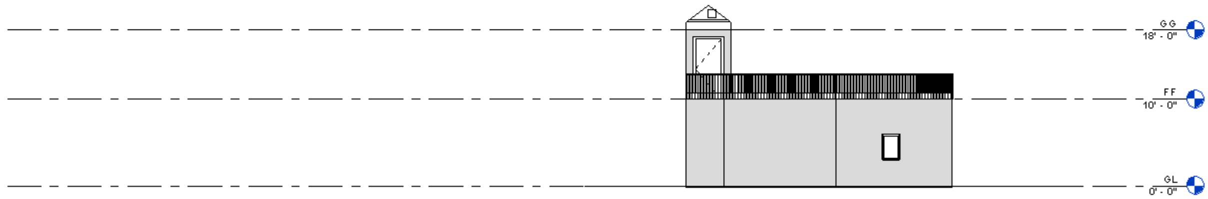


Fig.8.5 Side elevation of west face of conventional building

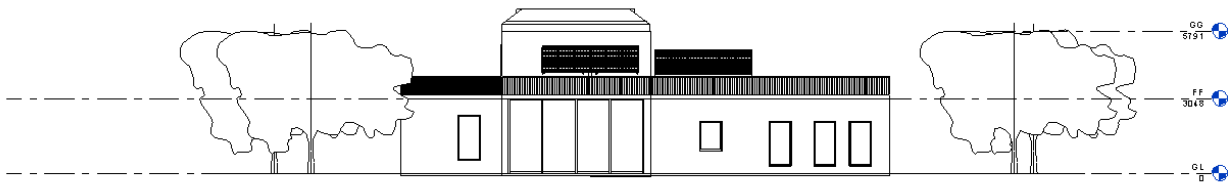


Fig.8.6 Front elevation of south face of green building

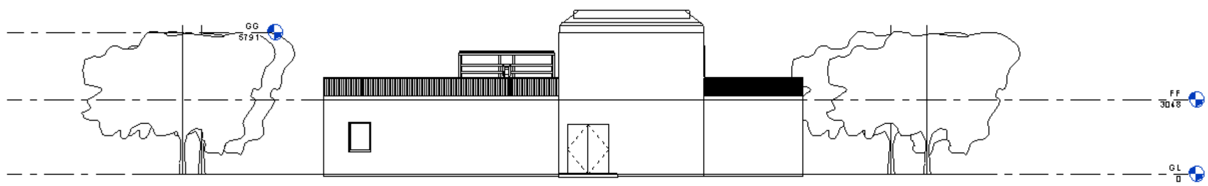


Fig.8.7 Back elevation of north face of green building

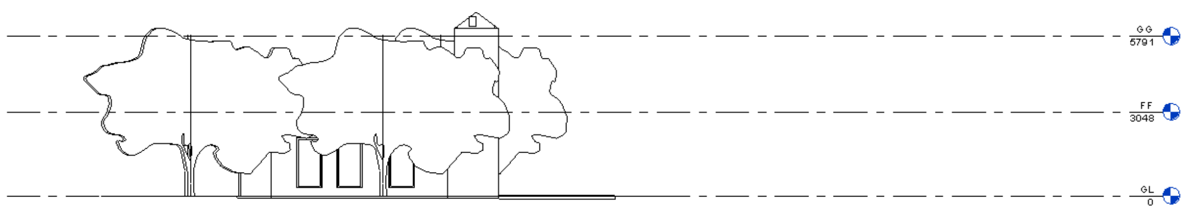


Fig.8.8 Side elevation of east face of green building

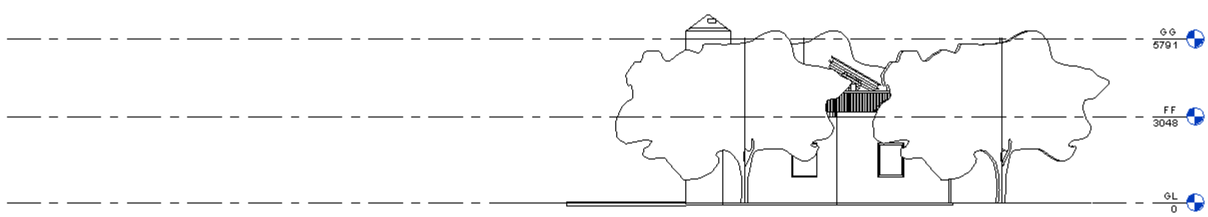


Fig.8.9 Side elevation of west face of green building

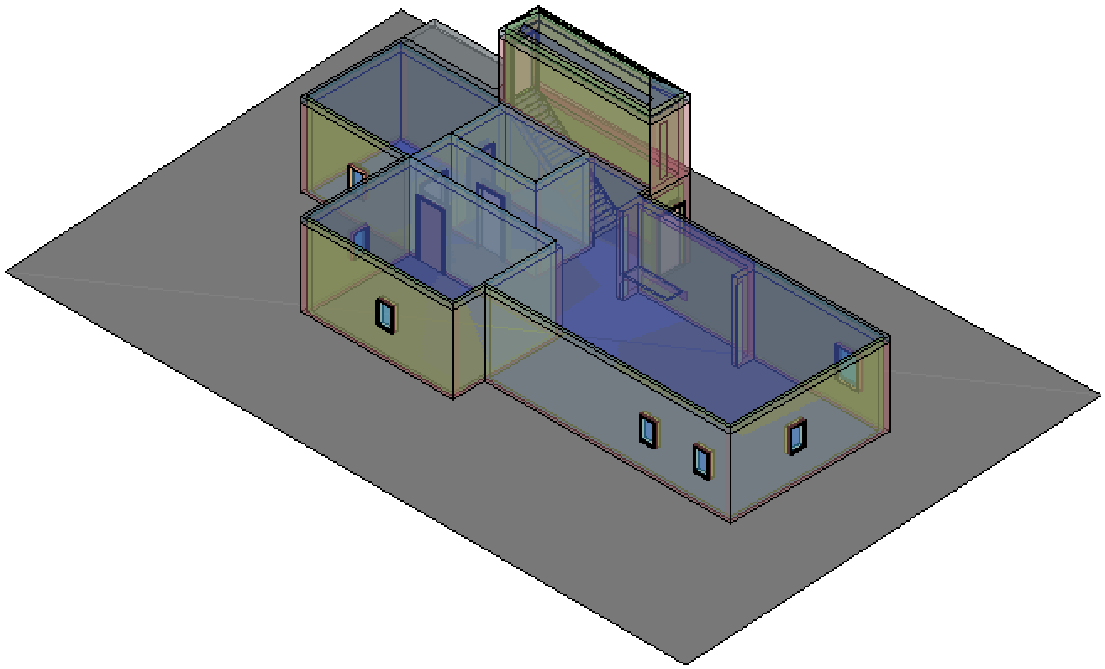


Fig.8.10 Model of conventional building

Fig8.11 model of green building

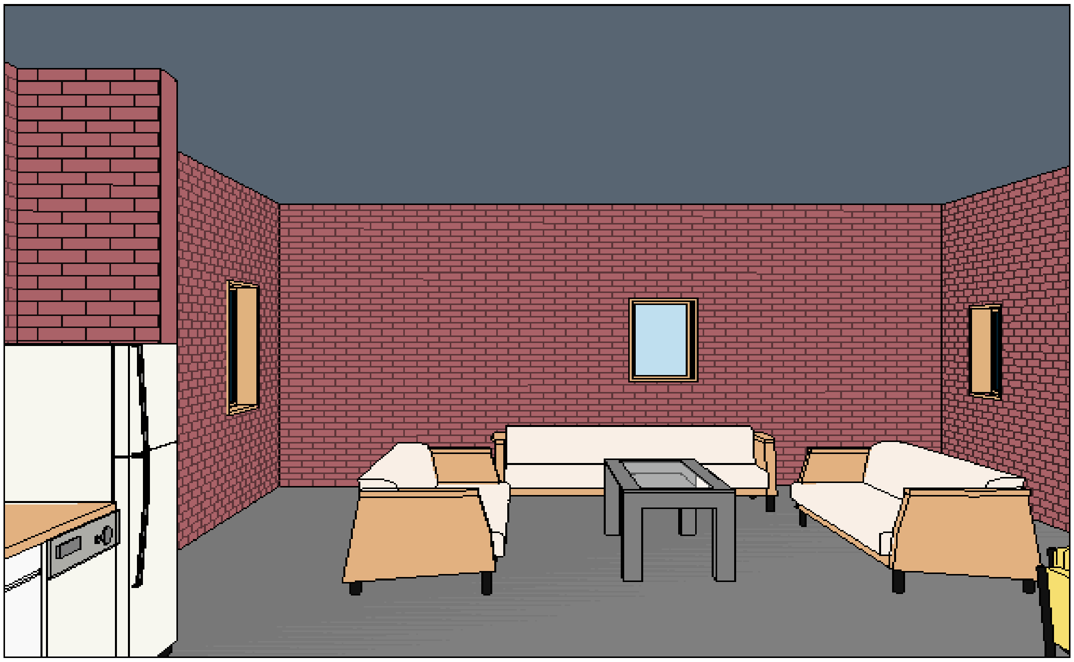


Fig.8.12 Center hall of conventional building

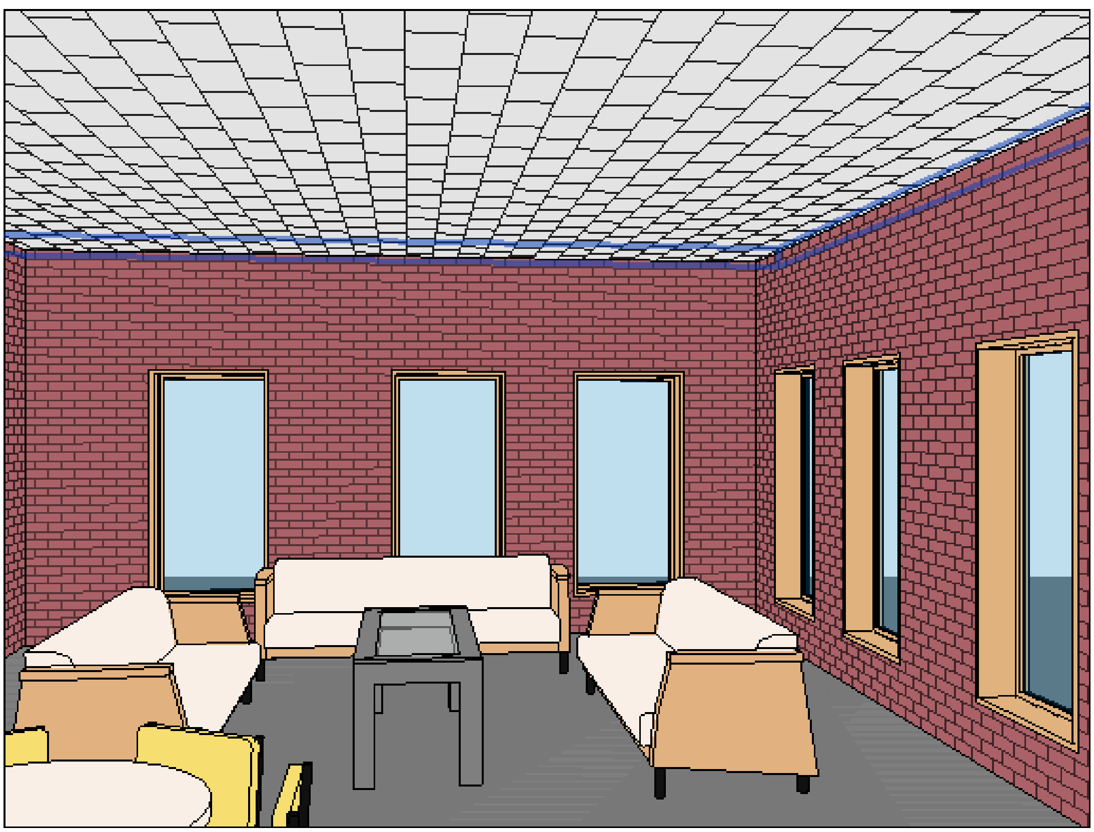


Fig.8.13 Center hall of green building

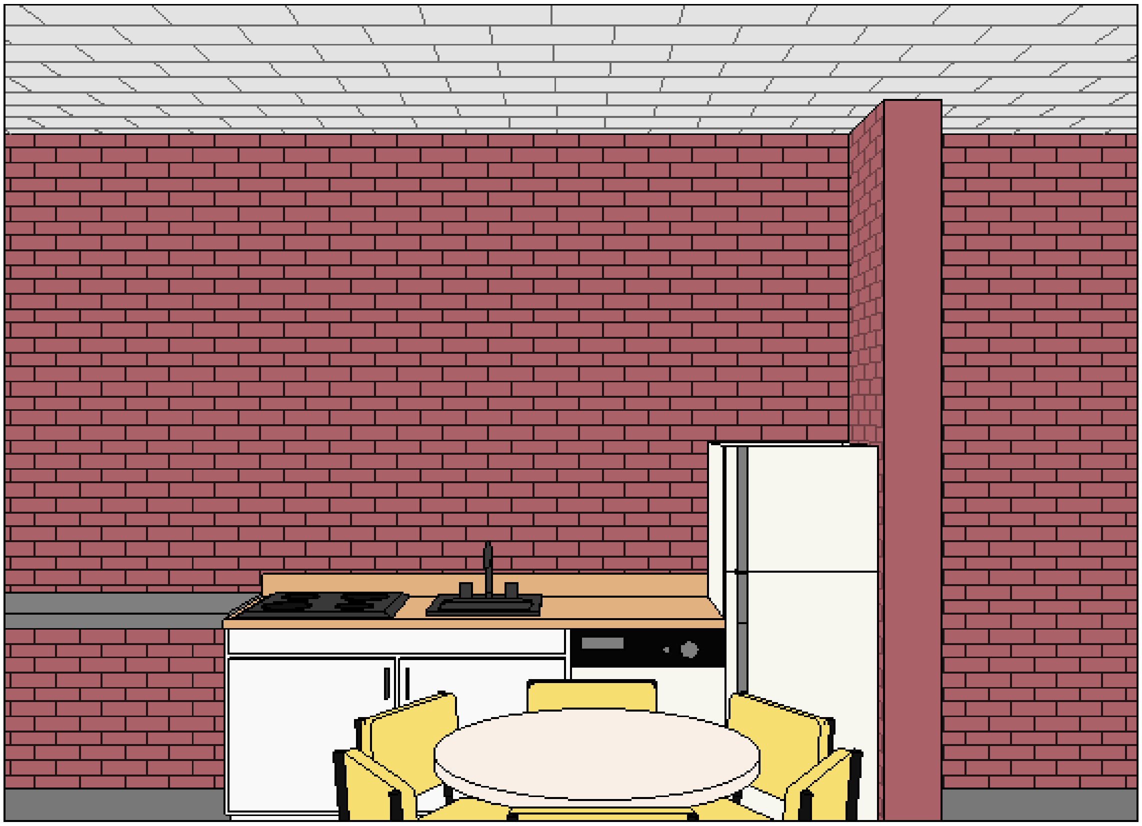


Fig. 8.13 Inside section of building

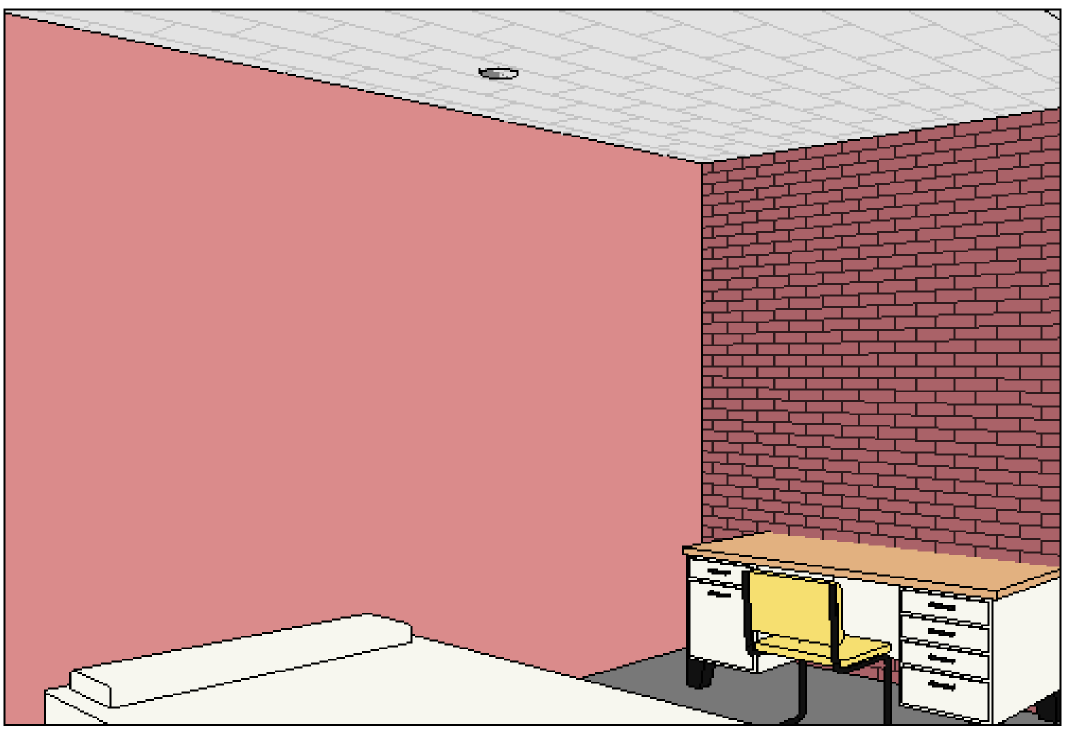


Fig. 8.14 Bedroom view

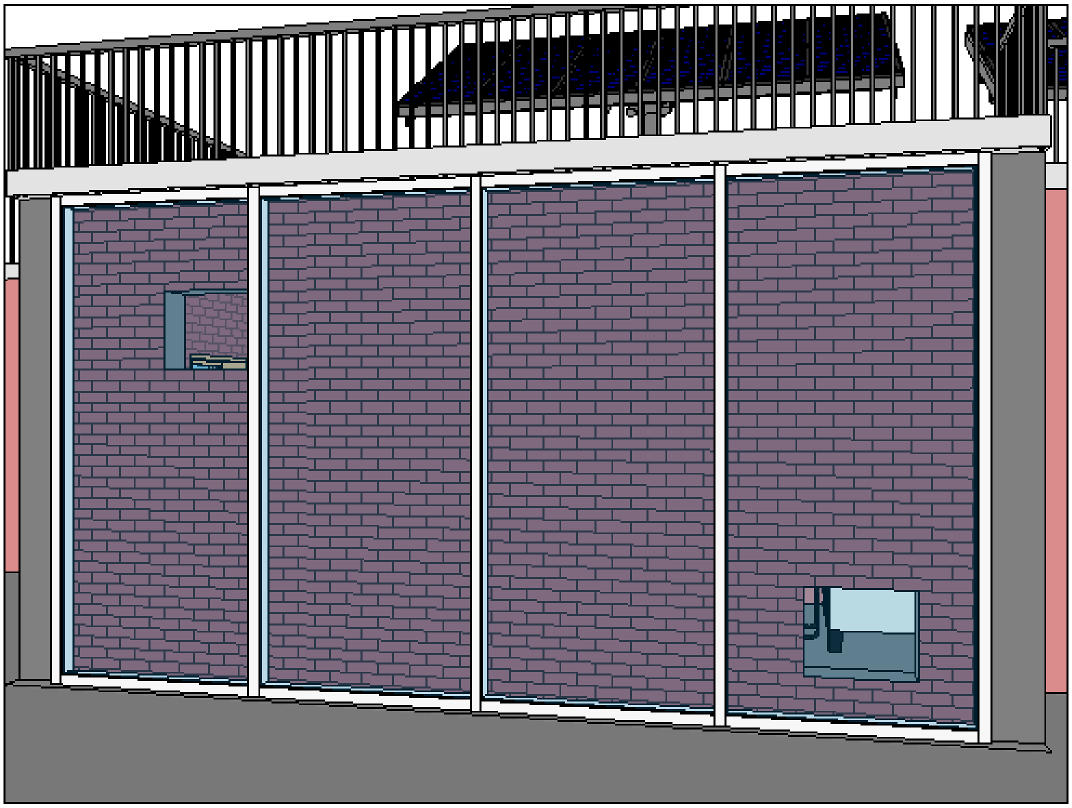


Fig.8.15 Trombe wall

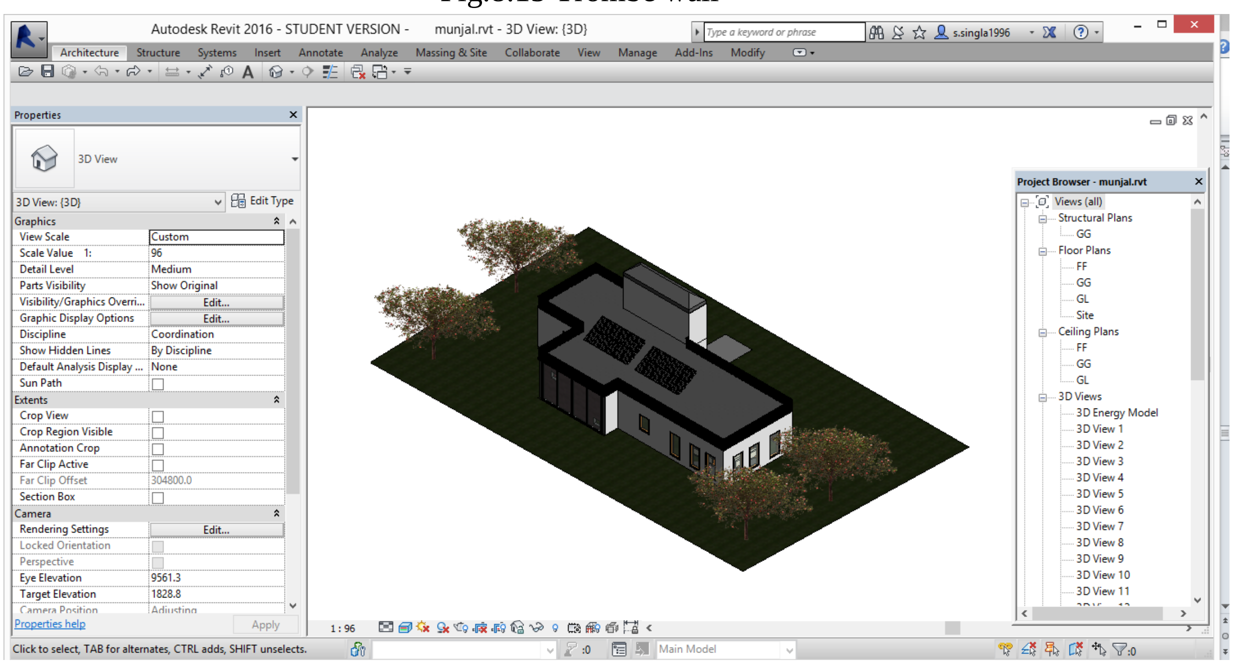


Fig.8.16 3-d View of green building in revit software

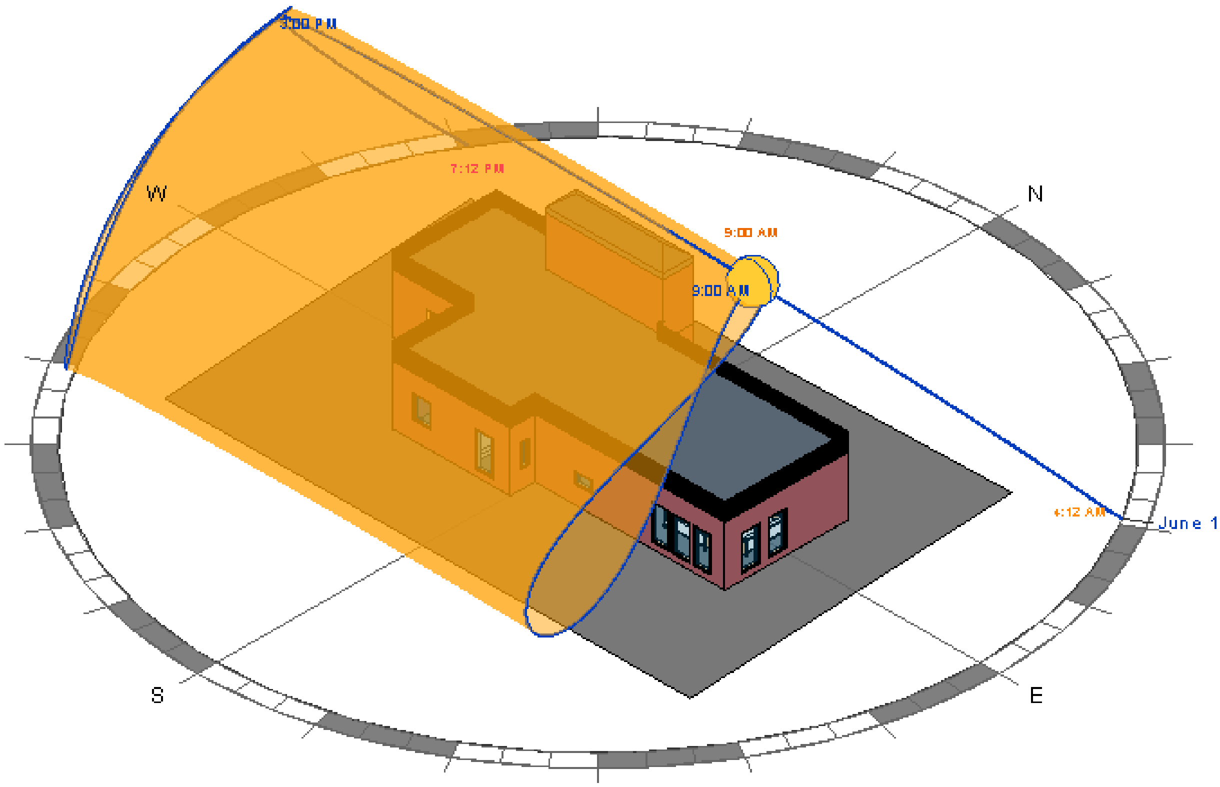


Fig .8.17 conventional building with sun path

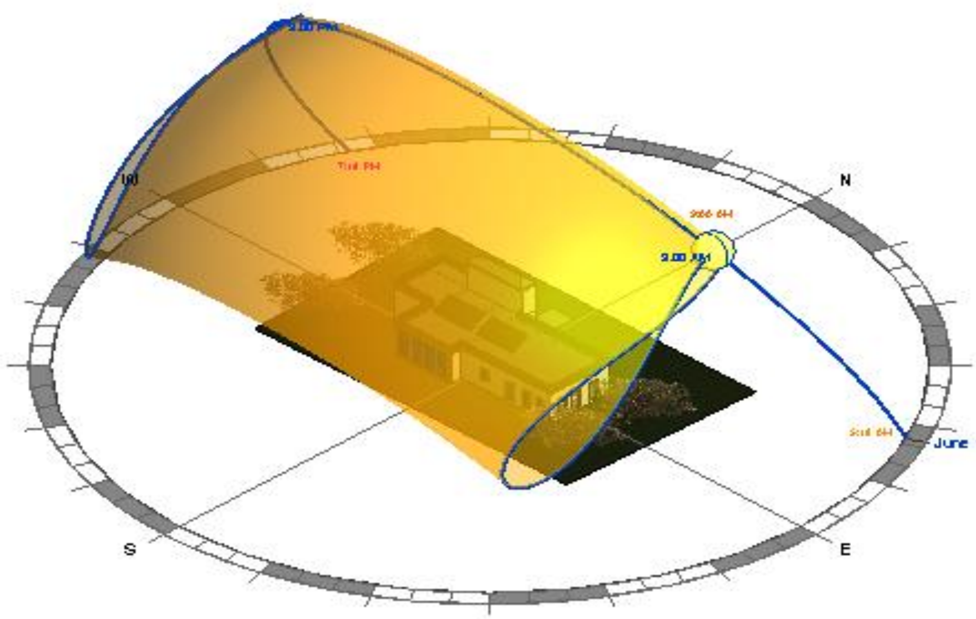


Fig .8.18 Green building with sun path

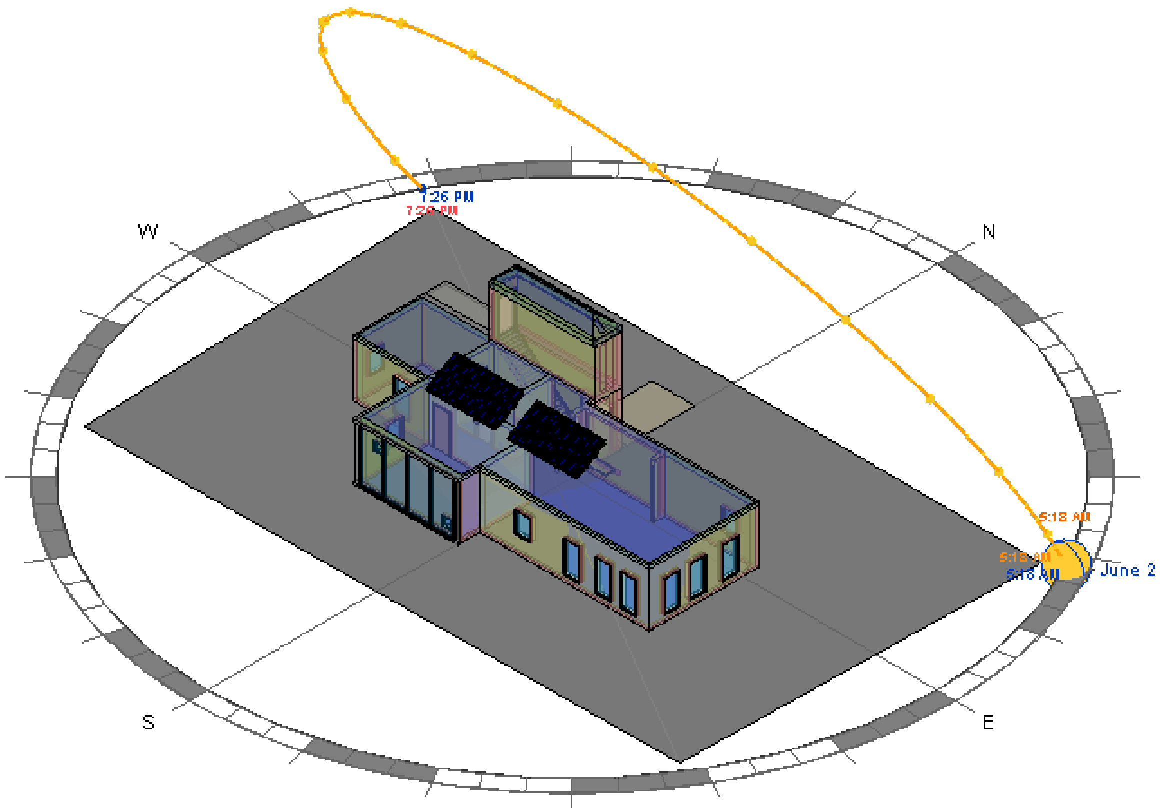


Fig.8.19 sun path on summer solistic solar day (june 21)

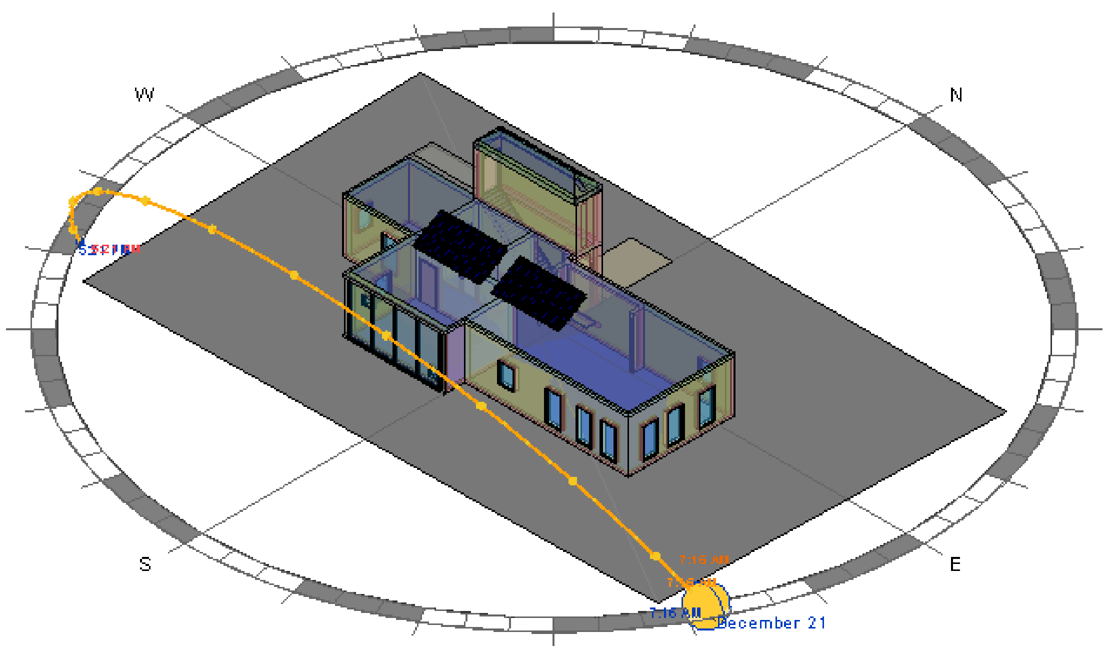


Fig.8.20 Sun path on winter solistic solar day (December 21)

CHAPTER 9- COMPARISON OF CONVENTIONAL BUILDING WITH GREEN BUILDING

9.1 COSTING AND ESTIMATION

The purpose of cost estimating is to forecast the cost of a project prior to its actual construction. Cost estimating is a method of approximating the probable cost of a project before its construction. The exact cost of a project is known after completion of the project. Cost estimate is prepared at various stages during the life of a project on the basis of the information available during the time of preparation of the estimate. Generally for any construction project, three parties are involved namely owner, design professionals and construction professionals. In some cases the design professional and construction professional are from the same company or they form a team through a joint venture for providing service to the owner in the project. It is the responsibility of each party involved in the project to estimate the costs during various stages of the project. An early estimate helps the owner to decide whether the project is affordable within the available budget, while satisfying the project's objectives.

9.2 AIM OF COST ESTIMATION

1. To determine the most economical process.
2. To make decisions.
3. To evaluate the alternate designs.
4. To prepare production budget.
5. To initiate the cost reduction in existing facilities.

9.3 COST ESTIMATION OF CONVENTIONAL BUILDING

The total land area of our 2 bhk building in shimla is 1325 sq. Ft. The grand total of our building is rs 1461516.

Table 9.1 Cost estimation of conventional building

Foundation Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(1- a) Foundation- Plain Cement Concrete of Mix 1 : 2 : 4						
Material Cost	Cement-43 Grade	Bag	1325	27.83	290	8071
	Coarse Sand	CUM	1325	2.65	1200	3180
	Aggregate 10 & 20 Mm	CUM	1325	4.24	900	3816
Manpower Cost	Mens	Nos	1325	15	550	8250
Total						23317

Super Structure Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(2-a) Ground Floor Slab - Column & Slab Work						
Column Work: 9" x 4", M25, Straightening, Cutting & laying Steel						
Material Cost	TMT 8,10, 12, 16 mm Dia	Kg	1325	331.25	38	12588
	Cement-43 Grade	Bags	1325	19.88	290	5765
	Coarse Sand	CUM	1325	3.98	1400	5572
	Aggregate 10 & 20 mm	CUM	1325	5.3	1200	6360
	Shuttering Material	sft	1325	192.13	50	9607
Manpower Cost	Mens	Nos	1325	20	550	11000
Slab Work: M25, Straightening, Cutting & laying Steel Reinforcement						
Material Cost	TMT 8,10, 12, 16 mm Dia	Kg	1325	695.63	38	26434

	Cement-43 Grade	Bags	1325	72.88	290	21135
	Coarse Sand	CUM	1325	30.47	1400	42658
	Aggregate 10 & 20 mm	CUM	1325	18.55	1200	22260
	Shuttering Material	sft	1325	463.75	50	23188
Manpower Cost	Mens	Nos	1325	50	550	27500
(2- b) Brick Work (Masonary Works)						
Providing and Constructing Full Brick (9") walls in super structures						
Material Cost	Cement-43 Grade	Bags	1325	125.88	290	36505
	Coarse Sand	CUM	1325	26.5	1400	37100
	Bricks	Nos	1325	29958	4.5	134812
Manpower Cost	Mens	Nos	1325	25	550	13750
Providing and Constructing Half Brick (4.5") walls in super structures Ma.						
Material Cost	Cement-43 Grade	Bags	1325	35.77	290	10373
	Coarse Sand	CUM	1325	17.62	1400	24668
	Bricks	Nos	1325	19372	4.5	87172
Manpower Cost	Mens	Nos	1325	20	550	11000
Total						569447

Plaster Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
12 - 15 mm thick Plaster on Walls and Ceiling. Cement/ Sand Mortar 1:6, Fine & Coarse sand in equal proportion						
Material Cost	Cement-43 Grade	Bags	1325	108.12	290	31355
	Fine Sand	CUM	1325	12.3	1000	12300
	Coarse Sand	CUM	1325	13.62	1400	19068
Manpower Cost	Mens	Nos	1325	50	550	27500
Total						90223

Flooring Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
Flooring Type						
Providing and laying Cement Concrete flooring, thickness up to 100 mm						
Material Cost	Cement	Bags		178.88	290	51875
	Fine Sand	CUM		19.88	1000	19880
	Brick Blast	CUM		10.6	700	7420
	Coarse Sand, DW	CUM		2.65	1400	3710
Manpower Cost	Labour	Nos		46	550	29150
Total						112035

Wood Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(5- a) Door Frame						
Providing of Teek/ Hard Wooden Door Frames with 3 nos. hold fasts 300 mm long ma						
Matrial Cost	Material	Sqft		563.13	80	45050
Installation Charges	Labour	Nos		250	15	3750
(5- b) Door Shutters						
Providing of Wooden Flush door / Panel Door / Glazed door/ Flush Doors with out						
Material Cost	Material	Sqft		13.25	1800	23850
Manpower Cost	Labour	Nos		13	300	3900
(5- c) Window Shutters						
Providing and fixing single or double Wooden/ Panel/ Teek Window 35 mm thick inc						
Material Cost	Labour	Nos		13.25	850	11263
Manpower Cost	Labour	Nos		20	243	4860
(5- d) Modular Kitchen						
Providing and fixing of Modular Kitcen of selected design with MDF particle Boar						
Material Cost	Material	Sqft		1.32	20000	26400
Manpower Cost	Labour	Nos		1	5000	5000
Total						124073

<u>Kitchen Granite, Water Tank,etc.</u>

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(6 - a) Tiles In Bathroom And Other Areas						
Applicable Area						
Material Cost	Cement-43 Grade	Bags		13.52	290	3921
	Fine Sand	CUM		9.41	1000	9410
	Coarse Sand, DW	CUM		1.07	1400	1498
	Tile	Sqft		265	23	6095
	White Cement	Bags		1.32	850	1122
Manpower Cost	Labour	Nos		13	300	3900
(6 - b) Cement Tiles For Ramp Area						
Providing and laying Pre cast heavy duty Chequered Cement tilesfor Entry Ramp 25						
Material/labour	Material+ Labour	Lump Sum		3710	2.8	10388
(6 - c) Kitchen Granite Stone Counters						
Providing & Laying machine cut 17 - 18 mm thick Pre-polished Granite stone						
Material/labour	Material+ Labour	Lump Sum		7552.5	5.7	43049
(6 - d) Ground Water Tank 1000 Ltrs						
Material/labour	Material+ Labour	Lump Sum		1325	25	33125
(6 - e) Motors For Submersible And Boring						
Material/labour	Material+ Labour	Lump Sum		1325	10	13250
	Material	Kg		300	65	19500
	Labour	Nos		300	25	7500
Total						152758

Painting Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(7-a) Paint						
Material / Labour	Material+ labour	Bags		4000	40	160000
Material/labour	Material+ labour	Sqmtr		1722.5	85	146413
(7-b) Paint On Wooden Doors/ Window/ Ms Frames						
Providing and applying Enamle Paint with necessary repair or Putty application						
Material / Labour	Material+ labour	Sqmtr		150	55	8250
Total						314663

Electrical Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
Electric Fitting, Including Wiring, Switchgear etc.						
Wires and sockets(FRLS Grade)	Wires & Sockets	Complete Work		1000	25	25000
Electrical Switch Gear	Switch-Gear and Control Panel	Complete Set		1000	3	3000
Misc	MS Boxes, etc	Complete Set		1000	5	5000
Labour Charges for Installation & Fixing	Labour	Complete Work		Lump sump	25	13500
Total						46500

Cp Fittings & sanitaryware

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
Plumbing and Sanitaryware (Water Supply Pipes and Various) Fittings.						
1 Toilet + 1 Kitchen +	Material	Misc		600	100	22000

Crome Plated Fitting + Sanitary Pipes (Sewerage)	Labour	Nos		130	50	6500
Total						28500
Grand total						1461516

9.4 COST ESTIMATION OF GREEN BUILDING

Cost Summary of various categories like foundation, super structure, plaster ,etc.

Table 9.2 cost estimation of green building

Foundation Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(1- a) Foundation- Plain Cement Concrete of Mix 1 : 2 : 4						
Material Cost	Cement-43 Grade	Bag	1325	27.83	290	8071
	Coarse Sand	CUM	1325	2.65	1200	3180
	Aggregate 10 & 20 Mm	CUM	1325	4.24	900	3816
Manpower Cost	Mens	Nos	1325	15	550	8250
Total						23317

Super Structure Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(2-a) Ground Floor Slab - Column & Slab Work						
Column Work: 9" x 4", M25, Straightening, Cutting & laying Steel R.						
Material Cost	TMT 8,10, 12, 16 mm Dia	Kg	1325	331.25	38	12588
	Cement-43	Bags	1325	19.88	290	5765

	Grade					
	Coarse Sand	CUM	1325	3.98	1400	5572
	Aggregate 10 & 20 mm	CUM	1325	5.3	1200	6360
	Shuttering Material	Sft	1325	192.13	50	9607
Manpower Cost	Mens	Nos	1325	20	550	11000
Slab Work: M25, Straightening, Cutting & laying Steel Reinforcement						
Material Cost	TMT 8,10, 12, 16 mm Dia	Kg	1325	695.63	38	26434
	Cement-43 Grade	Bags	1325	72.88	290	21135
	Coarse Sand	CUM	1325	30.47	1400	42658
	Aggregate 10 & 20 mm	CUM	1325	18.55	1200	22260
	Shuttering Material	Sft	1325	463.75	50	23188
Manpower Cost	Mens	Nos	1325	50	550	27500
(2- b) Brick Work (Masonary Works)						
Providing and Constructing Full Brick (9") walls in super structures						
Material Cost	Cement-43 Grade	Bags	1325	125.88	290	36505
	Coarse Sand	CUM	1325	26.5	1400	37100
	Bricks	Nos	1325	29958	4.5	134812
	Trombe wall with glass	Sq. ft.	167.28	1	345	57711.6
Manpower Cost	Mens	Nos	1325	27	550	14850
Providing and Constructing Half Brick (4.5") walls in super structures						
Material Cost	Cement-43 Grade	Bags	1325	35.77	290	10373
	Coarse Sand	CUM	1325	17.62	1400	24668
	Bricks	Nos	1325	19372	4.5	87172
Manpower Cost	Mens	Nos	1325	20	550	11000
Total						628258.6

Plaster Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
12 - 15 mm thick Plaster on Walls and Ceiling. Cement/ Sand Mortar 1:6, Fine & Coarse sand in equal proportion						
Material Cost	Cement-43 Grade	Bags	1325	108.12	290	31355
	Fine Sand	CUM	1325	12.3	1000	12300
	Coarse Sand	CUM	1325	13.62	1400	19068
Manpower Cost	Mens	Nos	1325	50	550	27500
Total						90223

Flooring Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
Flooring Type						
Providing and laying Cement Concrete flooring, thickness up to 100 mm						
Material Cost	Cement	Bags	1325	178.88	290	51875
	Pvc flooring	Sq. ft.	1325	1	45	59625
	Fine Sand	CUM	1325	19.88	1000	19880
	Brick Blast	CUM	1325	10.6	700	7420
	Coarse Sand, DW	CUM	1325	2.65	1400	3710
Manpower Cost	Labour	Nos	1325	50	550	29150
Total						170010

Wood Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(5- a) Door Frame						
Providing of Teek/ Hard Wooden Door Frames with 3 nos. hold fasts 300 mm long ma						

Matrial Cost	Material	Sqft		563.13	80	45050
Installation Charges	Labour	Nos		250	15	3750
(5- b) Door Shutters						
Providing of Wooden Flush door / Panel Door / Glazed door/ Flush Doors with out						
Material Cost	Material	Sqft		13.25	1800	23850
Manpower Cost	Labour	Nos		13	300	3900
(5- c) Window Shutters						
Providing and fixing single or double Wooden/ Panel/ Teek Window 35 mm thick inc						
Material Cost	material	Nos	500.12	13.25	850	11263
Manpower Cost	Labour	Nos	500.12	20	243	4860
(5-d) 11 double glazed windows considered as 1						
Material cost	material	Sq. ft.	500.12	1	190	95022.8
Manpower cost	Labour	Nos	500.12	3	300	900
(5- d) Modular Kitchen						
Providing and fixing of Modular Kitcen of selected design with MDF particle Boar						
Material Cost	Material	Sqft		1.32	20000	26400
Manpower Cost	Labour	Nos		1	5000	5000
Total						219995.8

Kitchen Granite, Water Tank,etc.

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(6 - a) Tiles In Bathroom And Other Areas						
Applicable Area						
Material Cost	Cement-43 Grade	Bags		13.52	290	3921
	Fine Sand	CUM		9.41	1000	9410
	Coarse Sand, DW	CUM		1.07	1400	1498
	Tile	Sqft		265	23	6095
	White Cement	Bags		1.32	850	1122
Manpower Cost	Labour	Nos		13	300	3900
(6 - b) Cement Tiles For Ramp Area						
Providing and laying Pre cast heavy duty Chequered Cement tilesfor Entry Ramp 25						
Material/labour	Material+	Lump Sum		3710	2.8	10388

	Labour					
(6 - c) Kitchen Granite Stone Counters						
Providing & Laying machine cut 17 - 18 mm thick Pre-polished Granite stone						
Material/labour	Material+ Labour	Lump Sum		7552.5	5.7	43049
(6 - d) Ground Water Tank 1000 Ltrs						
Material/labour	Material+ Labour	Lump Sum		1325	25	33125
(6 - e) Motors For Submersible And Boring						
Material/labour	Material+ Labour	Lump Sum		1325	10	13250
	Material	Kg		300	65	19500
	Labour	Nos		300	25	7500
Total						152758

Painting Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
(7-a) Paint						
Material / Labour	Material+ labour	Bags		4000	40	160000
Material/labour	Material+ labour	Sqmtr		1722.5	85	146413
(7-b) Paint On Wooden Doors/ Window/ Ms Frames						
Providing and applying Enamle Paint with necessary repair or Putty application						
Material / Labour	Material+ labour	Sqmtr		150	55	8250
Total						314663

Electrical Work

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount

Electric Fitting, Including Wiring, Switchgear etc.						
Wires and sockets(FRLS Grade)	Wires & Sockets	Complete Work		1000	25	25000
Electrical Switch Gear	Switch-Gear and Control Panel	Complete Set		1000	3	3000
Misc	MS Boxes, etc	Complete Set		1000	5	5000
Labour Charges for Installation & Fixing	Labour	Complete Work		Lump sump	25	13500
Total						46500

Cp Fittings & sanitaryware

Description	Item Details	Unit of Measurement	Total Area	Total Qty	Rate per Unit	Total Amount
Plumbing and Sanitaryware (Water Supply Pipes and Various) Fittings.						
1 Toilet + 1 Kitchen + Crome Plated Fitting + Sanitary Pipes (Sewerage)	Material	Misc		600	100	22000
	Labour	Nos		130	50	6500
Total						28500
Installation of 2 solar panel of 250 watts power						30000
Battery cost						11000
Dc –ac convertor						8000
Total cost of installation of solar panel						49000
Grand total						1723225.4

9.5 ENERGY ANALYSIS

AutoDesk Green Building Studio is a flexible cloud- based service that allows to run building performance simulations to optimize energy efficiency and to work towards carbon neutrality in the design process. The Autodesk Green Building Studio web service provides Annual Energy Cost, Life cycle cost (30 years), life cycle Energy Consumption, Cooling load and Heating Load. Analysis Results are presented in a highly visual, graphical format for easy interpretation.

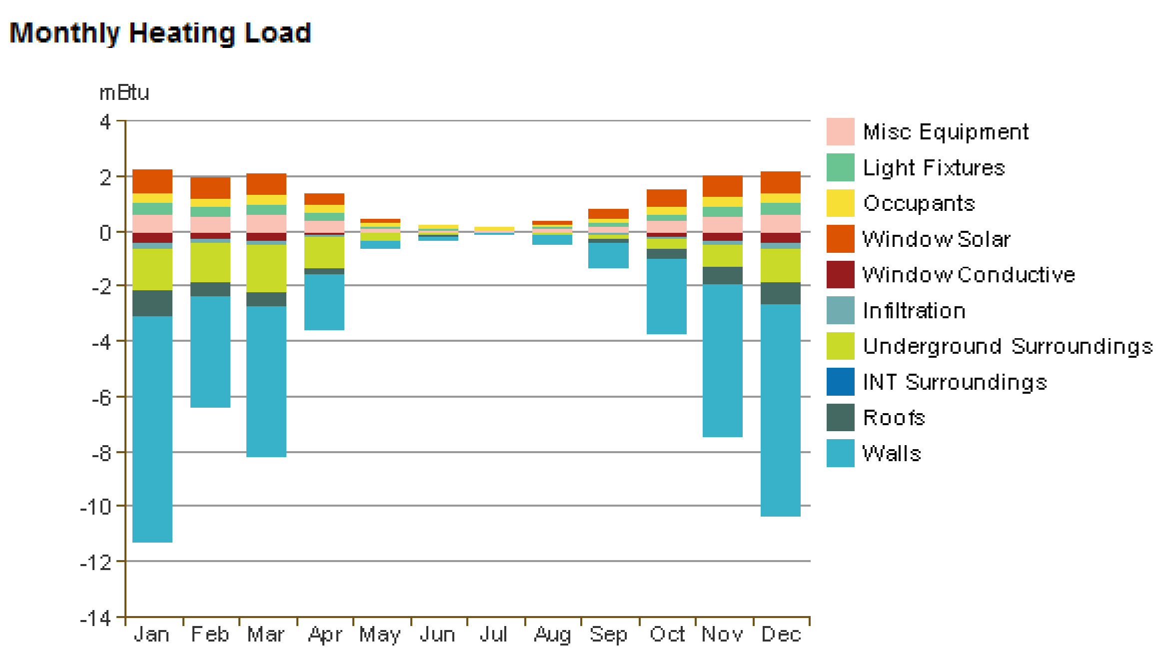
Below is the comparison in the energy analysis of conventional building and green building. The building performance factors of both the buildings are:

Location	Shimla Rural(t), India
Weather Station	431430
Outdoor Temperature	Max 30oC/ Min 0oC
Average Lighting Power	0.6 W/feet2
People	3 people
Floor Area	1325 sq. ft
Electrical Cost	Rs 2.7/Kwh
Exterior window ratio	0.09

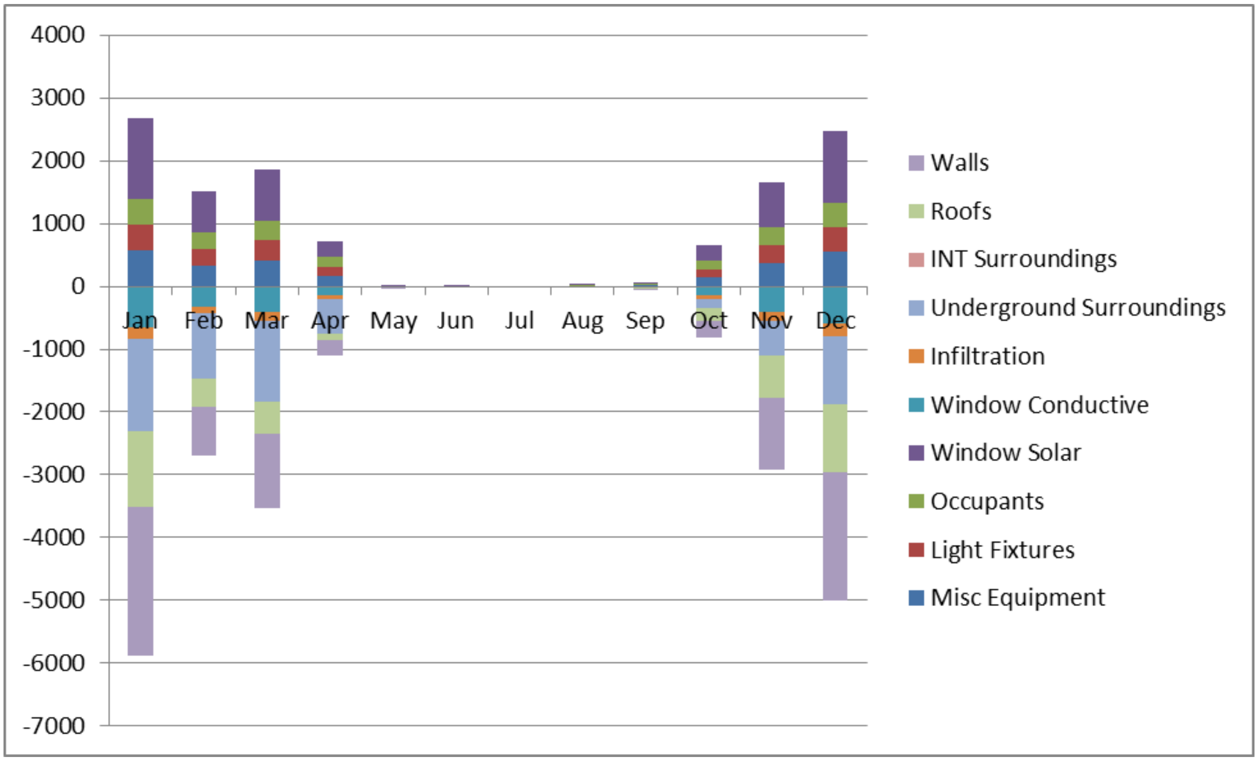
TABLE – 9.3 Building performance factor

9.6 MONTHLY HEATING LOAD

The heating load is the amount of heat energy that would need to be added to a space to maintain the temperature in an acceptable range. It is the rate at which heat is being gained. For ex during the peak summer months such as may, june, we experience maximum heat. So we have to decide the time interval for this heating load. We usually take time between 3pm to 4 pm because it takes 2 to 3 hours for the sun rays to heat up the Building. This is termed as monthly heating load



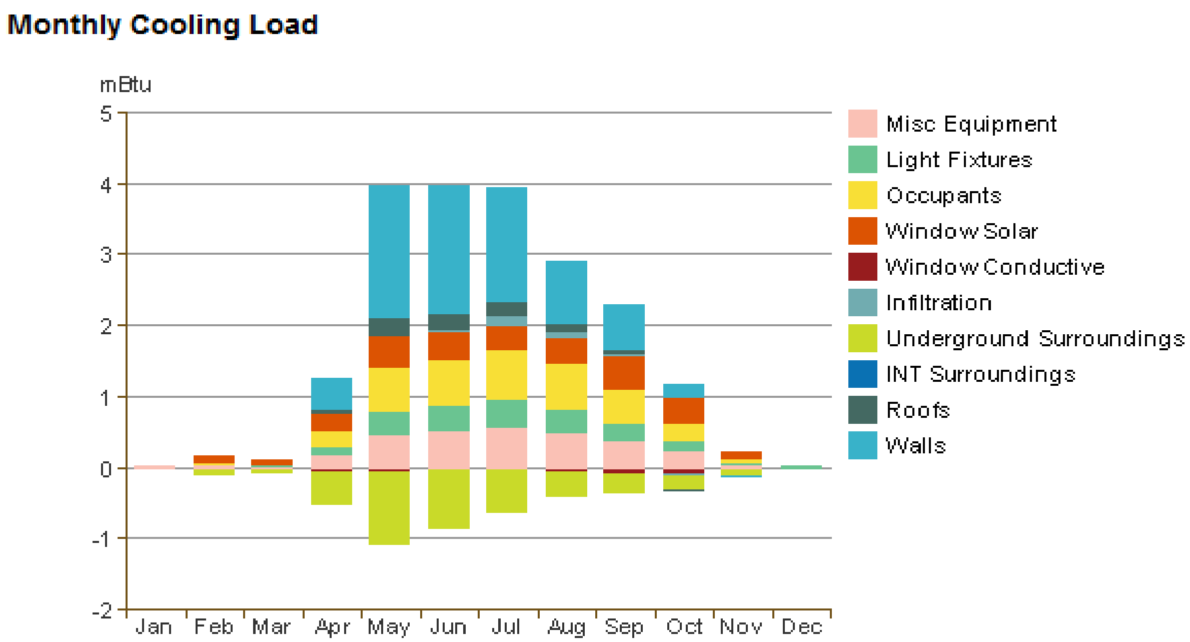
Monthly heating load of conventional building



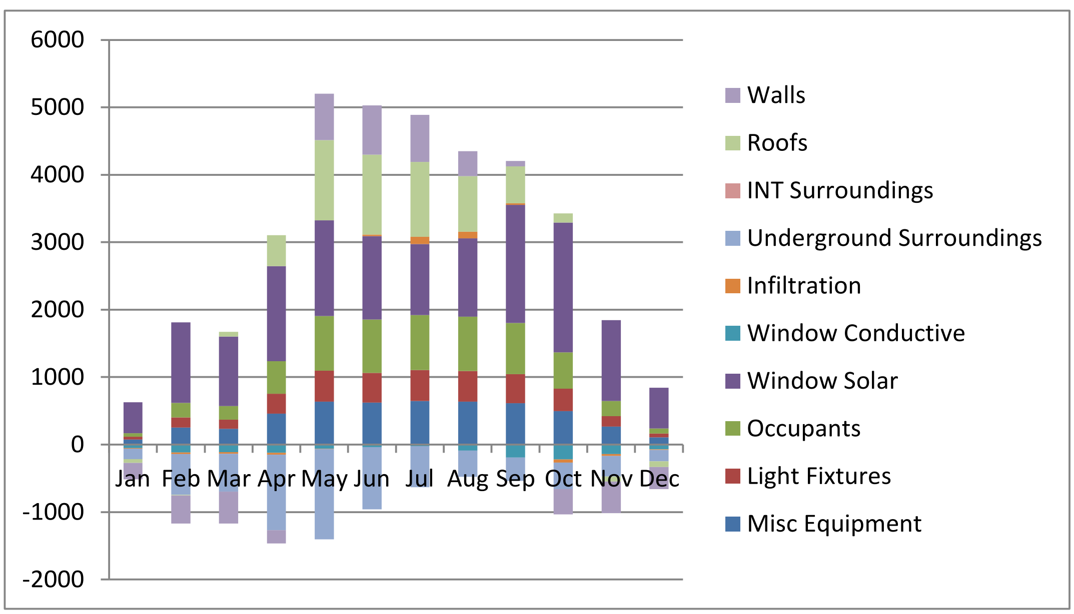
Monthly heating load of green building

9.7 MONTHLY COOLING LOAD

The Cooling Load is the amount of heat energy that would need to be removed from a space (cooling) to maintain the temperature in an acceptable range. It is the rate of heat energy that is being removed by cooling systems. For ex. If we take a building then the mode of transfer of heat in that building can be through walls, roofs, floors, doors, people, light etc. So this heat must be removed through conduction systems such as refrigeration and ventilation etc. This is called monthly cooling load.



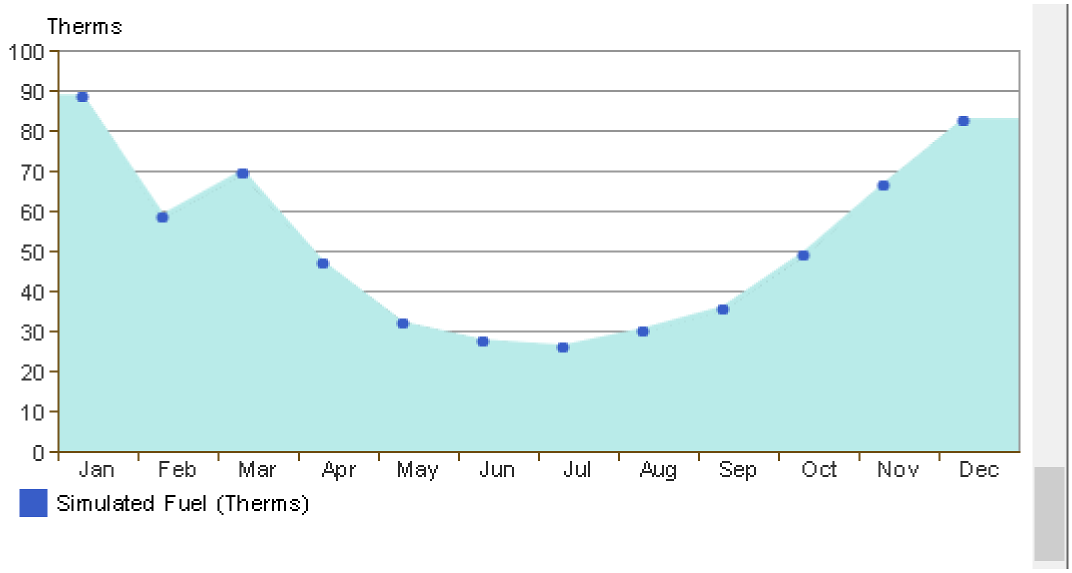
Monthly cooling load of conventional building



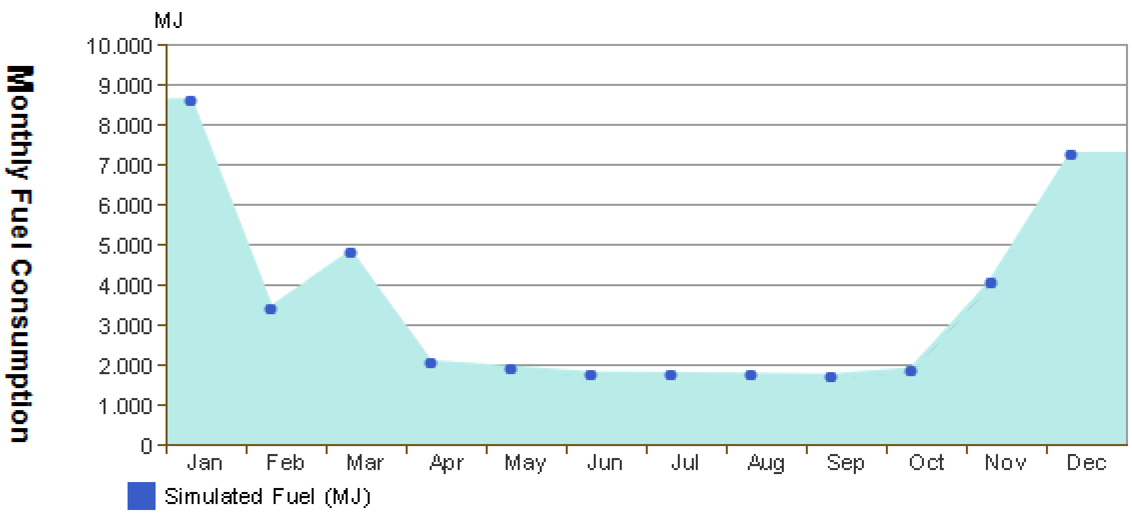
Monthly cooling load of green building

9.8 MONTHLY FUEL CONSUMPTION:

When reviewing an energy analysis in the Results and Compare dialog, this chart displays the project's estimated fuel usage by month. If the project uses fuel for heating (as opposed to electric heating sources), fuel usage increases during the colder months of the year.



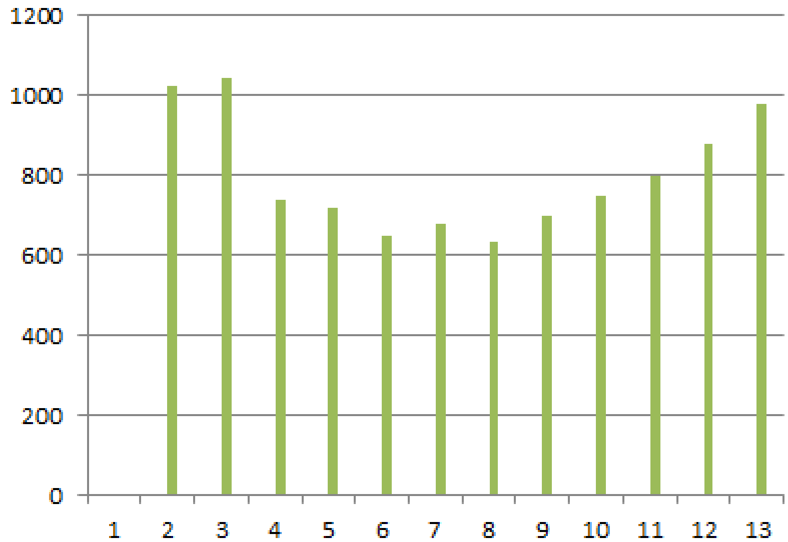
Monthly fuel consumption of conventional building



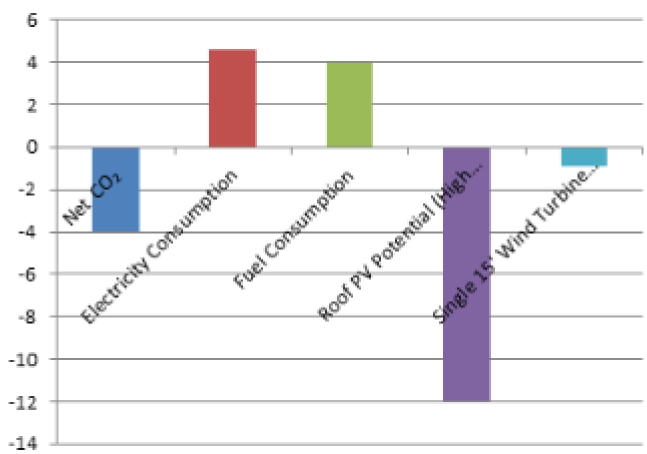
monthly fuel consumption of green building

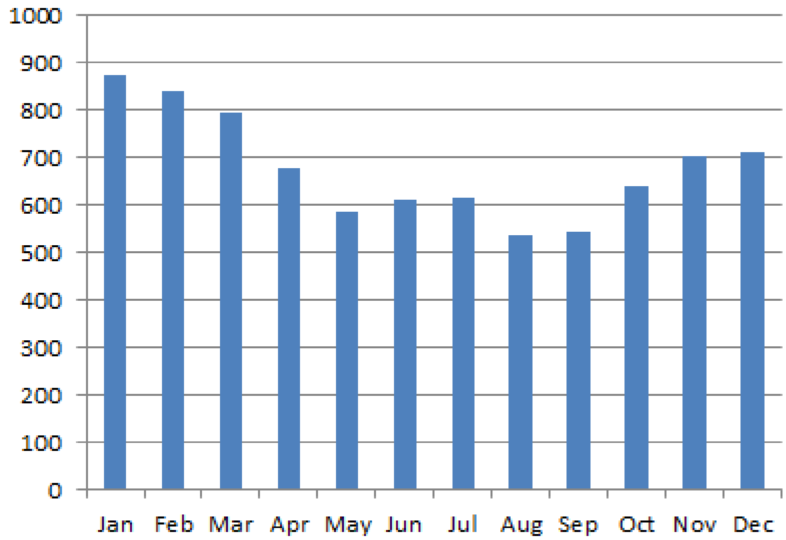
9.8.MONTHLY ELECTRICITY CONSUMPTION:

Energy is a measure of how much fuel is contained within something, or used by something over a specific period of time.energy usage" refers to the rate at which the energy is used (i.e. power). Electricity and other fuels supply energy in a form that we can use to run the equipment in our buildings.it is the average energy used or power consumed by any appliances that runs on electricity per month in kWh. If the project uses air conditioning, electricity usage increases during the hotter months of the year.

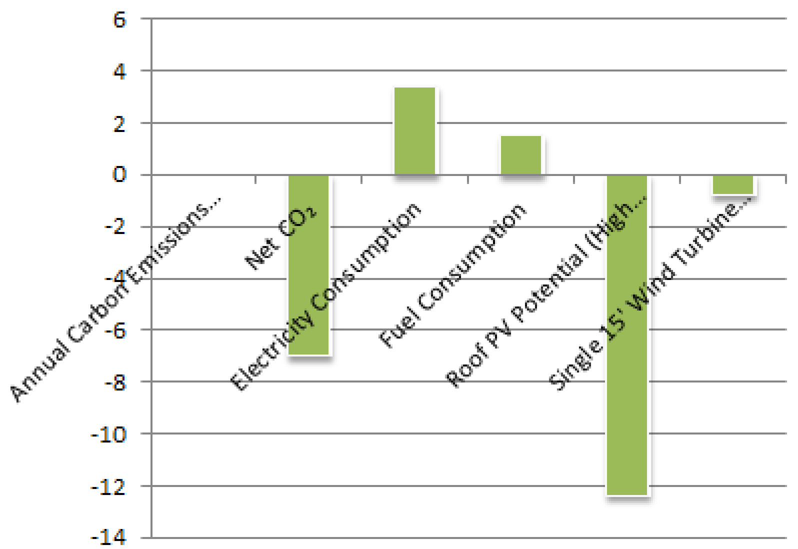


Monthly electricity consumption of conventional building





Monthly electricity consumption of green building



9.9 MANUAL ENERGY ANALYSIS CALCULATION:

Building thermal performance calculations are made for 2 primary reasons. They are made to size and select mechanical equipment or to predict the annual energy consumption of a structure.

Table 9.4 ENERGY CALAULATIONS OF CONVENTIONAL BUILDING:

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
JANUARY	HEATER	2	31	12	1.5	1116
	REFRIGERATOR	1	31	8	0.18	44.64
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	31	7	0.025	21.7
	LIGHT IN HALL	2	31	9	0.025	13.95
	ELECTRIC GEYSER	1	31	3.5	4	434
					TOTAL	**1636.29**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
FEBRUARY	HEATER	2	28	9	1.5	756
	REFRIGERATOR	1	28	12	0.18	60.48
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	28	7	0.025	19.6
	LIGHT IN HALL	2	28	9	0.025	12.6
	ELECTRIC GEYSER	1	28	3	4	336
					TOTAL	**1190.68**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
	HEATER	1	25	4	1.5	150
MARCH	REFRIGERATOR	1	31	24	0.18	133.9
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	31	6	0.025	18.6
	LIGHT IN HALL	2	31	12	0.025	18.6
	ELECTRIC GEYSER	1	31	3	4	372
					TOTAL	**699.1**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
APRIL	REFRIGERATOR	1	30	24	0.18	129.6
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	30	6	0.025	45
	LIGHT IN HALL	2	30	12	0.025	22.5
	ELECTRIC GEYSER	1	30	2	4	240
					TOTAL	**443.1**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
MAY	FAN	3	31	4	0.08	29.76
	REFRIGERATOR	1	31	24	0.18	133.92
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	31	5	0.025	15.5
	LIGHT IN HALL	2	31	10	0.025	15.5
	ELECTRIC GEYSER	0	0	0	4	0
					TOTAL	**200.68**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
JUNE	FAN	3	30	5	0.08	36
	REFRIGERATOR	1	30	24	0.18	129.6
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	30	5	0.025	15
	LIGHT IN HALL	2	30	10	0.025	15
	ELECTRIC GEYSER	0	0	0	4	0
					TOTAL	**201.6**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
JULY	FAN	3	31	5	0.08	37.2
	REFRIGERATOR	1	31	24	0.18	133.92
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	31	5	0.025	15.5
	LIGHT IN HALL	2	31	10	0.025	15.5
	ELECTRIC GEYSER	1	31	1	4	124
					TOTAL	**332.12**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
AUGUST	REFRIGERATOR	1	31	20	0.18	111.6
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	31	6	0.025	18.6
	LIGHT IN HALL	2	31	10	0.025	15.5
	ELECTRIC GEYSER	1	31	2	4	248
					TOTAL	**399.7**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH
SEPTEMBER	REFRIGERATOR	1	30	16	0.18	86.4
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	30	6	0.025	18
	LIGHT IN HALL	2	30	12	0.025	18
	ELECTRIC GEYSER	1	30	2	4	240
					TOTAL	**368.4**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH
OCTOBER	REFRIGERATOR	1	31	14	0.18	78.12
	WASHING MACHINE	1	8	1.5	.5	6
	LIGHT IN BEDROOM	4	31	6	0.025	18.6
	LIGHT IN HALL	2	31	12	0.025	18.6
	ELECTRIC GEYSER	1	31	2.5	4	310
					TOTAL	**431.32**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH
NOVEMBER	HEATER	2	30	3	1.5	270
	REFRIGERATOR	1	30	12	0.18	64.8
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	30	7	0.025	21
	LIGHT IN HALL	2	30	12	0.025	18
	ELECTRIC GEYSER	1	30	3	4	360
					TOTAL	**739.8**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH
DECEMBER	HEATER	2	31	10	1.5	930
	REFRIGERATOR	1	31	10	0.18	55.8
	WASHING MACHINE	1	8	1.5	0.5	6
	LIGHT IN BEDROOM	4	31	7	0.025	21.45
	LIGHT IN HALL	2	31	12	0.025	18.6
	ELECTRIC GEYSER	1	31	3.5	4	434
					TOTAL	**1465.85**

Table 9.5 Energy calculation of green building

MONTH	Appliances	No. of appliances	No. Of days	No. of hours	KWH	KWH PER MONTH	ENERGY SAVED USING SOLAR ENERGY	TOTAL ENERGY
JANUARY	HEATER	2	31	4	1.5	372	150.2	221.8
	REFRIGERATOR	1	31	10	0.18	55.8	30.196	25.604
	WASHING MCHINE	1	8	1.5	0.5	6	2	4
	LIGHT IN BEDROOM	4	31	7	0.012	10.41	0	10.41
	LIGHT IN HALL	2	31	7	0.012	5.208	0	5.208
	ELECTRIC GEYSER	1	31	4	3.5	496	142.24	353.76
						TOTAL		**534.78**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
FEBRUARY	HEATER	2	28	4	1.5	336	100.8	235.2
	REFRIGERATOR	1	28	10	0.18	50.4	15.12	35.28
	WASHING	1	8	1.5	0.5	6	1.8	3.2

	MCHINE							
	LIGHT IN BEDROOM	4	28	7	0.012	9.408	0	9.408
	LIGHT IN HALL	2	28	7	0.012	4.70	0	4.70
	ELECTRIC GEYSER	1	28	3	4	336	100.8	235.2
						TOTAL		**522.98**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
MARCH	REFRIGERATOR	1	31	14	0.18	78.12	23.46	54.68
	WASHING MACHINE	1	8	1.5	0.5	6	1.8	3.2
	LIGHT IN BEDROOM	4	31	6	0.012	8.92	0	8.92
	LIGHT IN HALL	2	31	6	0.012	4.46	0	4.46
	ELECTRIC GEYSER	1	31	2	4	248	64.4	173.6
						TOTAL		**244.86**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
APRIL	REFRIGERATOR	1	30	16	0.18	86.4	25.92	60.48
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	3.2
	LIGHT IN BEDROOM	4	30	6	0.012	8.65	0	8.65
	LIGHT IN HALL	2	30	6	0.012	4.32	0	4.32
	ELECTRIC GEYSER	1	30	1	4	120	108	84
						TOTAL		**160.65**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
MAY	FAN	3	31	4	0.08	29.76	8.92	18.83
	REFRIGERATOR	1	31	24	0.18	133.92	40.176	93.744
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	3.2
	LIGHT IN BEDROOM	4	31	5	0.012	7.44	0	7.44
	LIGHT IN	2	31	5	0.01	3.72	0	3.72

	HALL				2			
	ELECTRIC GEYSER	0	0	0	4	0		0
						TOTAL		**126.93**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
JUNE	FAN	3	30	5	0.08	36	10.8	25.2
	REFRIGERATOR	1	30	24	0.18	129.6	33.88	90.72
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	4.2
	LIGHT IN BEDROOM	4	30	6	0.012	8.64	0	8.64
	LIGHT IN HALL	2	30	5	0.012	3.6	0	3.6
	ELECTRIC GEYSER	1	30	0	4	0	0	0
						TOTAL		**132.16**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
JULY	FAN	3	31	5	0.08	37.2	11.16	26.04
	REFRIGERATOR	1	31	24	0.18	133.92	40.716	93.714
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	4.2
	LIGHT IN BEDROOM	4	31	5	0.012	7.44		7.44
	LIGHT IN HALL	2	31	5	0.012	3.72	0	7.812
	ELECTRIC GEYSER	0	31	0	4	0		0
						TOTAL		**139.7**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
AUGUST	REFRIGERATOR	1	31	16	0.18	89.28	26.78	62.496
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	4.2
	LIGHT IN BEDROOM	4	31	6	0.012	8.92	0	8.92
	LIGHT IN	2	31	6	0.01	4.46	0	4.46

	HALL				2			
	ELECTRIC GEYSER	1	31	1	4	124	37.2	86.8
						TOTAL		**166.876**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
SEPTEMBER	REFRIGERATOR	1	30	16	0.18	86.4	25.9	60.48
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	4.2
	LIGHT IN BEDROOM	4	30	6	0.012	18	5.4	12.6
	LIGHT IN HALL	2	30	6	0.012	4.32	0	4.32
	ELECTRIC GEYSER	1	30	1	4	120	36	84
						TOTAL		**165.6**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
OCTOB	REFRIGERATOR	1	31	14	0.18	78.12	23.436	54.685
	WASHING MCHINE	1	8	2	1.5	6	1.8	4.2

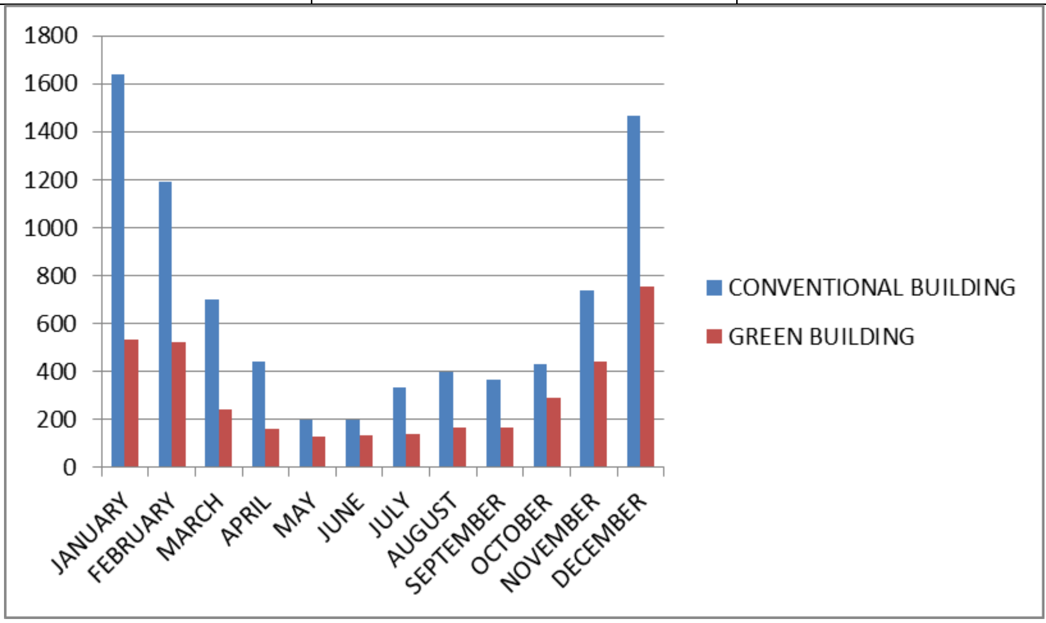
ER	LIGHT IN BEDROOM	4	31	6	0.012	8.928		8.928
	LIGHT IN HALL	2	31	6	0.012	4.464	0	4.464
	ELECTRIC GEYSER	1	31	2.5	4	310	93	217
						TOTAL		**289.277**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
NOVEMBER	HEATER	2	30	2	1.5	180	54	126
	REFRIGERATOR	1	30	12	0.18	64.8	19.44	45.36
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	4.2
	LIGHT IN BEDROOM	4	30	7	0.012	10.08		10.08
	LIGHT IN HALL	2	30	9	0.012	6.48	0	6.48
	ELECTRIC GEYSER	1	30	3	4	360	108	252
						TOTAL		**444.12**

MONTH	APPLIANCES	No. of APPLIANCES	No. of DAYS`	No. of HOURS	KWH	KWH PER MONTH		ENERGY REDUCE BY 30%
DECEMBER	HEATER	2	31	6	1.5	558	167.4	390.6
	REFRIGERATOR	1	31	10	0.18	55.8	16.74	39.06
	WASHING MCHINE	1	8	1.5	0.5	6	1.8	4.2
	LIGHT IN BEDROOM	4	31	7	0.012	10.416		10.416
	LIGHT IN HALL	2	31	9	0.012	6.696	0	6.696
	ELECTRIC GEYSER	1	31	3.5	4	434	130.2	303.8
						TOTAL		**754.77**

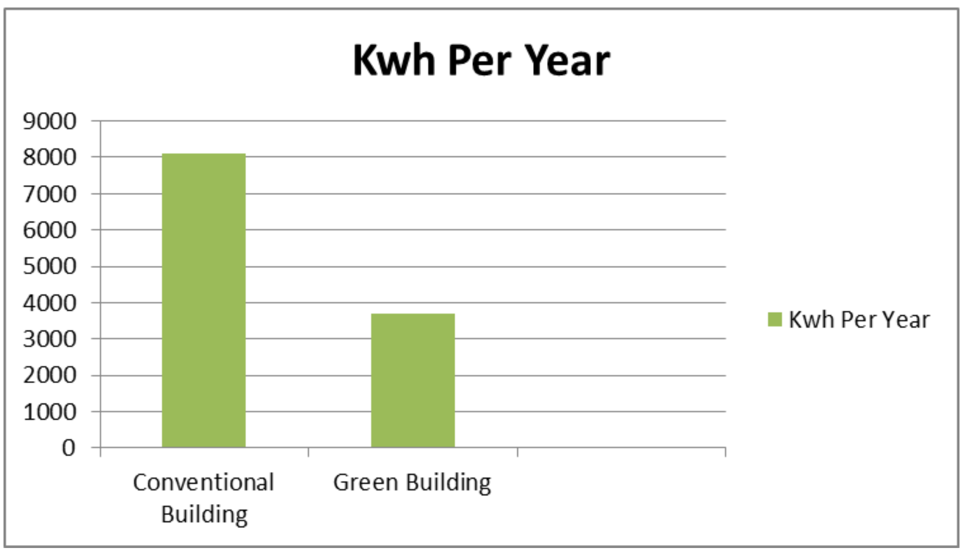
Table 9.6 Monthly Comparison between Conventional Building and Green Building

MONTH	CONVENTIONAL BUILDING	GREEN BUILDING
JANUARY	1636.29	534.78
FEBRUARY	1190.68	522.98
MARCH	699.1	244.86
APRIL	443.1	160.65
MAY	200.68	126.93
JUNE	201.6	132.16
JULY	332.12	139.7
AUGUST	399.7	166.876
SEPTEMBER	368.4	165.6
OCTOBER	431.32	289.777
NOVEMBER	739.8	444.12
DECEMBER	1465.85	754.77



Graphical representation of electricity consumption per year of conventional building and green building after using Solar energy:

Building	Kwh Per Year
Conventional Building	8108.64
Green Building	3683.203



RESULT:

Calculation of payback period:-

Cost of conventional building over a period of 30 yrs = Rs 8108.64*2.7*30

= Rs 656799.84

Cost of green building over a period of 30 yrs = Rs 3683.203*2.7*30

= Rs 298339.443

Extra cost saved over a period of 30 yrs = Rs.358460.397

Construction cost of conventional building = Rs.1461516

Construction cost of green building = Rs.1723225.4

Extra cost incurred in the construction of green building=Rs. 261709.4

Cost that will be saved by green building over a period of 30 yrs

= Rs.358460.397-Rs.261709.4

= Rs.96750.997

Payback period = 25 / 24 years 11 months and 20 days .

Calculation = Rs.(8108.64-3683.203)*2.7*25

= Rs.298716.9975

CONCLUSION:

This research identified the exciting developments taking place on the technology front and analyse their implications for intelligent and Eco-friendly buildings, highlighting examples of "best in class" buildings employing Eco-friendly and intelligent technologies. These buildings are dynamic environments that respond to their occupants' changing needs and lifestyles. This research provided documented evidence to educate and influence end-users, building owners, architects, and contractors that a "Eco-friendlier building" can be achieved using intelligent technology and that this "Eco-friend ling" will provide a tangible and significant return on investment.

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