Optimization of cost and energy for residential building using double glazing window and cool roof paint

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Abstract **Energy efficient building is becoming more and more vital as energy emerges as a critical economic issue due to high demand for energy and unsustainable supplies of energy. The cool roof paint is eco-friendly and isn't dangerous for the atmosphere. cool roof paint reflects away UV and IR rays, protecting a home or building. When a roof is cooled, it can bring many benefits to the environment as it is. Cool roof paint also restores a roof surface and extends resistance to abrasion of a roof. Double glazed windows reduce ultraviolet rays by as much as 75 percent. windows is reducing heating bills by improving energy efficiency. When less heat is lost through windows, less heat is required to heat a home for a longer duration. The digital thermometer gives accurate value of temperature and it is essential to find the optimization of energy. A cool roof paint can reduce temperature inside a house by up to twenty degrees. It means the AC will have to work less to achieve and maintain the desired temperature.The aim of the project is to setup an energy efficient building to reduce cost and energy by using cool roof paint and double glazing window. This study is used to reducing energy consumption by decreasing cooling aids, Improving indoor comfort for spaces that are not air conditioned, decreasing room temperature which may extend roof service life. A sample model is created is created in a test room and its temperature effects and analysed and noted for some months. The effects are analysed and using HVAC code system,suitable design is done for the required room.**

Keywords: *Double glazing window,Cool roof paint,Thermometer,Energy efficient building*

I. INTRODUCTION

Efficient energy use, sometimes simply called energy efficiency, is the goal to reduce the amount of energy required to provide products and services. For example, insulating a home allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Installing LED lighting, fluorescent lighting, or natural skylight windows reduces the amount of energy required to attain the same level of illumination compared to using traditional incandescent light bulbs. Improvements in energy efficiency are generally achieved by adopting a more efficient technology or production process or by application of commonly accepted methods to reduce energy losses. There are many motivations to improve energy efficiency. Reducing energy use reduces energy costs and may result in a financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy-efficient technology. Reducing energy use is also seen as a solution to the problem of reducing greenhouse gas emissions. According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases. Another important solution is to remove government-led energy subsidies that promote high energy consumption and inefficient energy use in more than half of the countries in the world. Using proper amounts of insulation in the walls and roof, being sure to reference regional standards Properly weatherizing the building using weather stripping and caulking. Installing high quality windows that utilize low-e coatings and gas filling, while choosing the glazing and window frame material that will be most beneficial in the .Installing high-performance systems and appliances and evaluate their performance over their life cycle Monitoring and verifying performance through energy audits to see where energy is being wasted in a building and where it is most cost-effective to make improvements through retrofitting.

1.1 Energy efficient building

Energy efficient building is becoming more and more vital as energy emerges as a critical economic issue due to high demand for energy and unsustainable supplies of energy. This means that even households must evaluate how well energy is being used to heat and light a home. Energy efficient buildings offer opportunities to save money as well as reduce greenhouse gas emissions As well, the reliance on non-renewable fuels is not sustainable, and it involves using more

and more destructive processing means to obtain these fuels. Homes and other buildings account for nearly 40% of total US energy use (Canada is lower with just under 29%), and thus increasing their efficiency will improve the reliance on non-renewable fuels for the future. This environmental benefit of reducing the number of greenhouse gases is both local and global. There are local benefits due to the fact that a buildings energy demand requires a local supply of energy, which causes local pollution and negative health side-effects. This allows communities to focus on investing funds in other places instead of in building power plants.

In addition to overall environmental benefits that arise from a more energy efficient building, there are also personal benefits. Reduced heating and electrical bills are one major benefit to upgrading a home or building a more energy efficient home. As well, installing these energy-efficient technologies effectively works to "future-proof" the building by making investments that will be selling points well into the future. Overall, even though there is an initial amount of money that must be put in to improve energy efficiency, homeowners will often recover these costs in a short period of time due to the reduced energy expenses. This payback time can be short, taking only a few years.

As well, if there is more support and interest in energy saving technologies, associated prices will go down on certain devices while encouraging more and more developments in energy saving technologies to occur. Along with this, the more new practices that are adopted in construction, the more these measures will become standard practice and this in turn will lessen the environmental impact of buildings by making more efficient buildings necessary by law. The best time to focus on energy efficiency is when a building is first being built, as this new construction offers opportunities to integrate new energy efficiency measures more simply than in a building that is already complete. As well, building a more energy efficient home to begin with is more cost effective than renovating a home to be more energy efficient.

II. MATERIALS

2.1 Double glazing window

Double glazed windows are an ideal energy efficient choice with the added benefit of minimising noise. The sealed air gap between the two panes acts as an added layer of insulation. This added thermal resistance reduces the amount of heat escaping in winter and keeps your home at a more comfortable temperature. Double glazing is the term used for using two panes of window glass instead of one. Single glazed windows waste a lot of energy. The most common complaint of single pane windows is the drafts that can be felt. Uncomfortable drafts are caused when air next to a window cools and descends to the floor. The movement pattern increases heat loss and feels drafty. Comfort is affected by the glass temperature. Double glazing makes the transfer of unwanted outside temperature through the window more difficult. The inside pane remains close to the temperature of the room.

2.1.1 Double Glazing Is Energy Efficient

Double glazing creates almost twice the insulation provided by single glazed units. Thermal insulation reduces the flow of outgoing and ingoing heat. The ability to retain heat makes double glazing much more energy efficient than single pane windows.Less energy is used to cool down or heat up the space. An estimated 50 percent decrease in the amount of heat that escapes a home through windows has been the determined statistic. Energy efficient windows keep warm air in and cold air out.Two panes of glass, filled with gas and sealants are watertight. Often, Krypton, Xenon, or Argon is sandwiched between the panes. Inert gas, having low conductivity, inserted between panes increases performance. Once the windows are sealed, they become airtight.

2.1.2 Double Glazing Reduces Condensation

Water molecule levels in the air cause condensation. When warm inside air meets cold outside air condensation forms. Condensation appears on cold surfaces. Moisture on a surface that is warm forms water droplets that freeze in cold weather.

The frost makes a room feel colder. People on the inside are forced to make heat adjustments. The need to overcompensate for air entry and leakage during both the winter and summer months is eliminated. A reduction in condensation also reduces unhealthy mold formation.

2.1.3 Double Glazed Window Construction

Different glass types are used to provide desired results. Double glazed windows may have a low-E coating. Low-E glass reduces the amount of heat that escapes. Double glazed windows do not have to be tinted. Tinting reduces visible light and obstructs views. Double glazed windows reduce ultraviolet rays by as much as 75 percent. l. The spacer is a polymer or metal strip separating the two glass panes. Typically, it contains a drying agent to remove trapped moisture from the space.The type of spacer used and how well the is sealed are important factors. A double glazed unit, not properly sealed,

or a spacer with an inadequate drying agent can reduce performance. High-quality frames and edge spacers are common energy efficient window enhancements. The most popular option is a frame made of quality UPVC. Security and compression shoot bolt locks are the most common locking mechanism. There is an array of others available.

2.1.4 Double Glazing Reduces Heating Bills

The biggest reason homeowners choose to replace old windows is reducing heating bills by improving energy efficiency. The same reasons that make double glazing energy efficient also mean a reduction in heat bills. When less heat is lost through windows, less heat is required to heat a home for a longer duration.The protection against condensation, drafts, and leaks reduces peak cooling and heating loads. Homeowners can install smaller cooling and heating systems, which is a money saving aspect. Double glazed windows put a dent in energy bills and are a significant factor to potential home-buyers when selling a property.

2.1.5 Double Glazing is Eco-Friendly

Double glazing reduces the carbon footprint of the home. When less heat is required, less fuel is burnt. It does not matter whether the heat source is an open fire, electricity, or gas. Ultimately, CO_2 is reduced which is a good thing in environmental terms. People who purchase double glazed windows are doing their part of protecting the environment. Greenhouse gases that contribute to change in the climate are reduced.

2.1.6 Double Glazing Reduces Noise

An added benefit of modern double-glazing units is a reduction in noise. Double glazed windows create a barrier between the outside environment and the home which improves sound insulation. The careful construction eliminates drafts and considerably reduces noise pollution. Medium to high-frequency noise like the human voice is reduced. A difference in the thickness of the glass between the outer and inner panes improves sound reduction even more. Modern double glazing typically has a 16 mm gap between the two panes. The space between panes ranges from six to 20 mm. A minimum of 12 mm is recommended for optimal thermal performance. Lower frequency noise reduction, such as that caused by aircraft and traffic, or good acoustic control is obtained by a gap of at least 150 mm. However, a gap of this size allows convection between the panes to occur. Insulation performance is reduced. The space between panes that provides better energy efficient performance is recommended to be from 10 to 20 mm.

2.2 Cool roof paint

A cool roof is one that has been designed to reflect more sunlight and absorb less heat than a standard roof. Cool roofs can be made of a highly reflective type of paint, a sheet covering, or highly reflective tiles or shingles. Nearly any type of building can benefit from a cool roof, but consider the climate and other factors before deciding to install one. It is a heat insulation paint and works as heat reducing paint which can be applied on all types of roof. It aims to achieve better heat reduction results. It is a thermo reflective paint & stops excessive solar heat to enter the roof. cool roofs material that is designed to reflect more sunlight and absorb less heat than a standard roof. Standard or dark roofs can reach temperatures of 150°F or more in the summer sun. A cool roof under the same conditions could stay more than 50°F cooler and save energy and money by using less air conditioning.

2.2.1 Benefits of using cool roof paint

The cool roof paint is eco-friendly and isn't dangerous for the atmosphere. Furthermore, cool roof paint reflects away UV and IR rays, protecting a home or building. When a roof is cooled, it can bring many benefits to the environment as it is. Cool roof paint also restores a roof surface and extends resistance to abrasion of a roof. Reducing temperature in a house keeps it comfortable during hot sunny days. With the application of a cool roof paint, it's easy to enjoy lower power bills and therefore money is saved. Running air conditioning systems in a house is an expensive affair and a cool roof can save some money. A cool roof paint can reduce temperature inside a house by up to twenty degrees. It means the AC will have to work less to achieve and maintain the desired temperature. A cool roof can benefit a building and its occupants by: Reducing energy bills by decreasing air conditioning needs. Improving indoor comfort for spaces that are not air conditioned, such as garages or covered patios. Decreasing roof temperature, which may extend roof service life.

2.2.2 Cool Roof Paint: How it Works

Cool roof paint is also known as reflective paint – a solution offered for homeowners in order to reduce the heat transfer to a house during hot days. When the sun shines on a roof, it increases the temperature of a roofing material. When temperature increases, heat is transferred from a roof to the inside of a house that results in increase of temperature inside.

A cool roof paint is made of a high reflective type of paint which increases the reflectivity of a roof. This means that more rays of the sun are reflected away when they come into contact with a roof. A cool roof increases the reflectivity of any kind of roof, whether it's concrete, asbestos, metal and is made of precoated roofing sheets. Cool roof paint is the best way of controlling heat in a house because it prevents the sun heat from entering a house. Other methods like insulation and ceilings do not prevent heat from entering a house, but just delay heat.

2.2.3 How are cool roof paints applied?

A roof should be cleaned thoroughly before the paint is applied and let it dry under the sun. Any algae or mold on a roof should be removed and treated as required. If there are places that require any kind of repairs, it should be done before the paint is applied. After a roof becomes dry, the first coat of the paint is applied on a roof. The coat is given two hours to dry and another coat is applied. The thicker the coating is, the better a roof will be at reflecting sun rays away.

2.3 Thermometer

One of the most common devices for measuring temperature is the glass thermometer. This consists of a glass tube filled with mercury or some other liquid, which acts as the working fluid. A thermometer is a device that measures temperature over a given range. If the range includes room temperature, then of course the thermometer could be used to measure the temperature in room.Digital/infrared thermomet The reading will be fast to display and accurate.

2.4 Test methods

2.4.1 Installation of window

Installation process done in this project is fixing additional window over the existing window. The type of the window is Double glazed aluminum frame window. The size of double-glazing window is 1.5x1.5m and 1.5x1.2m.

Fig 2.1 – Installation of window

2.4.2 Cool paint coating

After the installation coating process is done .The paint used in the coating process is weather coat paint (shown in fig4.3).The amount of paint used for coating is 1 litres. A cool roof paint can reduce temperature inside a house by up to twenty degrees. The size of the room is 3x3m

Fig 2.2 – Cool paint coating

2.4.3 Temperature reading

Digital thermometer is used for taking readings of room temperature. The digital thermometer contains temperature, humidity and time. The thermometer gives accurate value of temperature and it is essential to find the optimization of energy.

2.5 Data collection

2.5.1 Normal room temperature

DATE / TIME	8.00 AM	12.00 PM	4.00 PM	REMARK

8/9/2018	29.4	30.2	29.8	
9/9/2018	29.6	30.4	29.6	
10/9/2018	28.2	30.8	29.1	
11/9/2018	29.4	30.7	29.6	
12/9/2018	29.8	30.4	28.9	
13/9/2018	29.6	31.2	29.4	
14/9/2018	30.4	31.6	29.8	
15/9/2018	29.8	30.9	30.1	
16/9/2018	28.9	30.2	29.4	
17/9/2018	28.4	29.7	28.8	
18/9/2018	28.2	30.2	29.6	
19/9/2018	28.6	29.7	28.6	Rain
20/9/2018	28.4	28.9	27.8	Rain
21/9/2018	28.4	29.8	28.8	
22/9/2018	27.8	29.4	28.4	Rain
23/9/2018	28.9	29.8	28.6	
24/9/2018	29.6	30.2	28.6	
25/9/2018	29.2	30.3	28.8	
26/9/2018	28.9	29.5	28.6	
27/9/2018	29.8	30.8	29.2	
28/9/2018	28.8	29.6	28.7	Rain
29/9/2018	28.6	30.1	29.1	
30/9/2018	29.4	30.4	28.9	
1/10/2018	29.8	31.2	29.1	
2/10/2018	28.9	30.2	29.4	
3/10/2018	28.6	29.7	28.6	
4/10/2018	28.8	30.1	29.7	Rain
5/10/2018	29.3	30.6	29.1	
6/10/2018	29.4	30.2	29.8	
7/10/2018	28.9	30.6	29.2	Rain

2.5.2 Insulated room temperature

Table 2.2 – Insulated Room temperature

DATE / TIME	8.00 AM	12.00 PM	4.00 PM	REMARK
8/9/2018	29.2	29.8	29.6	
9/9/2018	29.3	30.2	29.3	
10/9/2018	28.1	30.6	29	
11/9/2018	28.9	30.6	29.4	
12/9/2018	29.4	30.1	28.6	
13/9/2018	29.2	30.8	29.1	
14/9/2018	29.9	30.6	29.4	
15/9/2018	29.4	30.8	29.8	
16/9/2018	28.2	30	29.2	
17/9/2018	28.3	29.4	27.6	
18/9/2018	28.1	30	29.2	
19/9/2018	28.3	29	28.4	Rain
20/9/2018	28.2	28.6	27.4	Rain
21/9/2018	28.2	29.4	28.6	
22/9/2018	27.1	28.9	27.6	Rain
23/9/2018	28.8	29.3	28.5	
24/9/2018	29.4	30	28.3	
25/9/2018	29	30.2	28.2	
26/9/2018	28.3	29.4	28.3	
27/9/2018	29.6	30.4	29	
28/9/2018	28.7	29.3	28.5	Rain
29/9/2018	28.6	29.8	29	
30/9/2018	29	30.1	28.6	
1/10/2018	29.7	31	28.9	
2/10/2018	28.4	30.1	29.2	
3/10/2018	28.6	29.3	28.4	
4/10/2018	28.7	29.9	29.6	Rain
5/10/2018	29.1	30.3	28.9	
6/10/2018	29.3	30	29.4	
7/10/2018	28.7	30.4	28.9	Rain

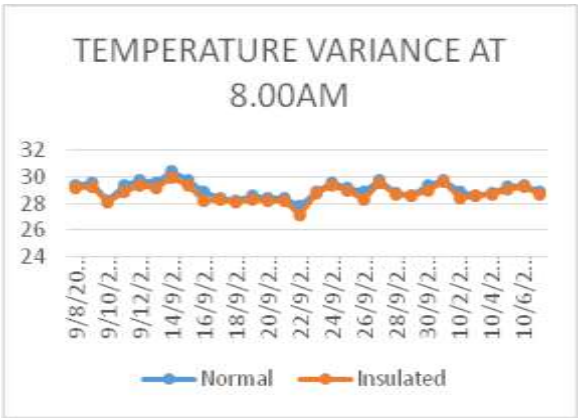

Fig 2.3 – temperature variance at 8.00 AM

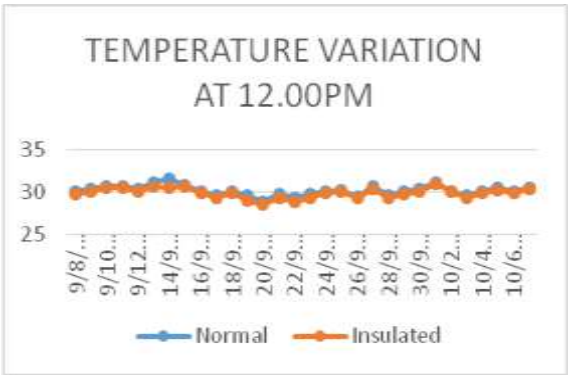

Fig 2.4 – Temperature variance at 12.00 PM

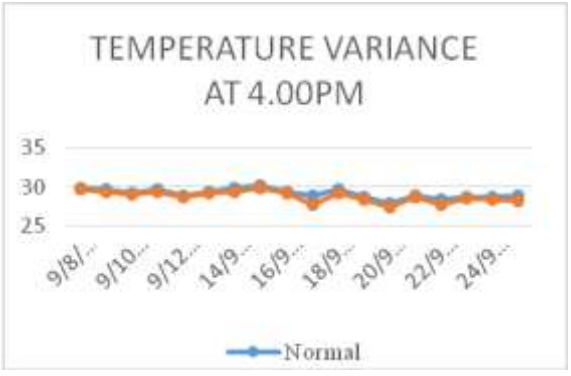

Fig 2.5 – Temperature variance at 4.00 PM

3 Results and discussion

3.1 Insulated room

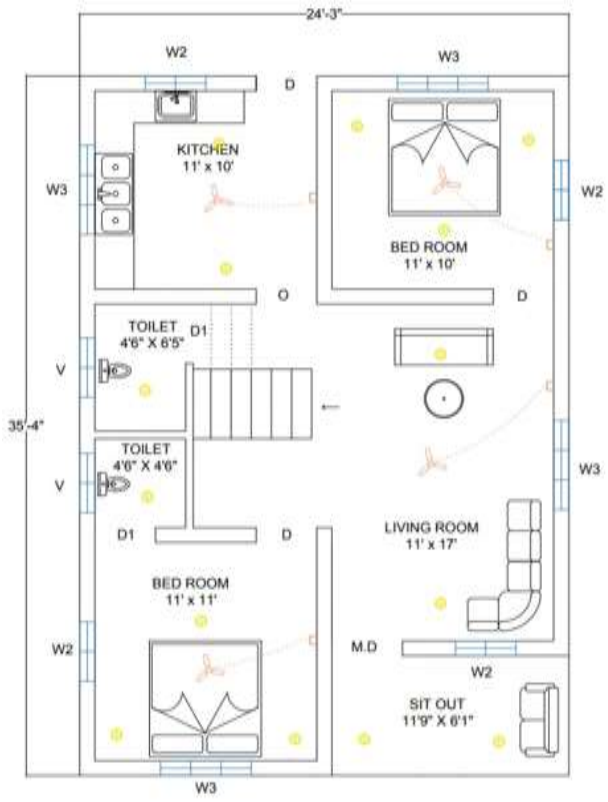

Fig 2.6 – Insulated room

3.1.1 Electricity consumption

Electricity consumption for fan per hour=65 watt (usha)

Electricity consumption for fan per day =WxHxNo of fan used

No of hour used=12hours

$= 65 \times 12 \times 4$

= 3124 Watt

3.1.2 Cost analysis

Energy consumption for fan per hour=65 watt(usha)

No of hour used=12hours

Energy consumption for four fan per day=3.12 units

Cost consumption for four fan per year=3.12x365

= 1138.8 units

Energy consumption for fan per month=94.9 units

Cost consumption for fan per month= Rs 0(As per Tamil Nadu government)

3.2 Without insulated room

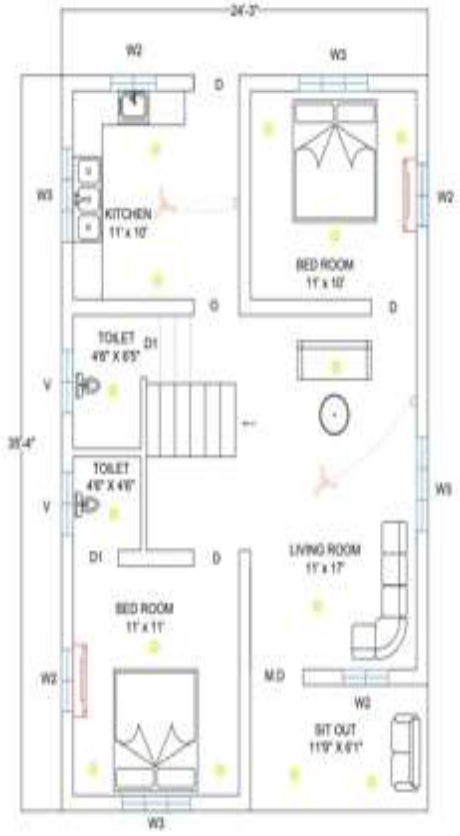

Fig 2.7 – Without Insulated room

3.2.1 Electricity consumption

Electricity consumption for air conditioner per hour=3000 watt(voltas)

Electricity consumption for air conditioner per day =WxHxNo of fan used.

Average usage of air conditioner=9 hours(Wikipedia)

No of hour used=4.5hours

=3000x4.5x2

= 27000 watt

Electricity consumption for fan per hour=65 watt(usha)

Electricity consumption for fan per day =WxHxNo of fan used

No of hour used=12hours

=65x12x2

=1560 watt

Total=28560watt/day

3.2.2 Cost Analysis

Energy consumption for air conditioner per hour=3000 watt(voltas)

No of hour used=4.5hours

Energy consumption for two air conditioner and two fan per day=28.56units

Cost consumption for two air conditioner and two fan per year=28.56x365 = 10424.4units

Cost consumption for air conditioner and fan per month = 868.7 units
=100x0+100x3.5+300x4.60+368x6.60

=0+350+1380+2428.8

= Rs 4158.8 (As per Tamil Nadu government)

Cost consumption for two air conditioner and two fan per month=Rs 4158.8

Cost consumption for two air conditioner and two fan per year=Rs 49905.6

3.2.3 Energy and cost analysis

YEAR	INSULATED ROOM		NOT INSULATED ROOM	
	Energy	**Cost**	**Energy**	**Cost**
2019	**1138.8**	**0**	**9855**	**45888**
2020	**2277.6**	**0**	**19710**	**91776**
2021	**3416.4**	**0**	**29565**	**137664**
2022	**4555.2**	**0**	**39420**	**183552**
2023	**5694**	**0**	**49275**	**229440**
2024	**6832.8**	**0**	**59130**	**275328**
2025	**7971.6**	**0**	**68985**	**321216**

Table 2.3 – Energy and cost analysis

CONCLUSION

The result of the method is well effective in buildings, the energy consumption get reduced by this method. The temperature is reduced by applying the double glazing window and cool roof paint as insulation material. The energy calculations by manual method, give the result as the energy reduction by applying the buildings. By comparing the temperature were reduced moderately. These could be applying in a model that there is a changes in temperature. In future there must be a reduction at huge amount of electricity consumption and get benefits in reduction of cost. In urban areas the energy consumption is more, so that the reduction temperature method is most suitable for urban areas. The cost and energy consumption is reduced by applying this method.

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