JK-GreenTech
Greener Smarter Sustainable

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Guideline for Construction of Energy Efficient Homes in cold climatic conditions of Kashmir

A compendium of the WhatsApp/Face Book posts of: Er. Bashir Ahmad Dar, Managing Director, JK Green Technologies Former, MD, JKPTCL/Secretary Technical, JKPDD

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1. Introduction:

The temperate climate of Kashmir, marked by harsh winters with sub-zero temperatures, presents significant challenges for housing in the region. The existing architectural designs are ill-equipped to handle these cold conditions, leading to homes that fail to provide adequate thermal comfort and proper ventilation. This results in cold indoor environments that contribute to increased winter mortality and morbidity, particularly affecting vulnerable groups like the elderly and children. Research shows that prolonged exposure to low temperatures in homes can lead to serious health issues such as raised blood pressure, strokes, respiratory diseases, and exacerbation of conditions like arthritis. The lack of proper insulation and heating further aggravates these health risks, underscoring the urgent need for better-designed homes that can ensure warmth, ventilation, and overall well-being for Kashmir's residents during the harsh winter months.

Improper ventilation during the winter months is a major health concern in Kashmiri homes, where residents often seal their living spaces to conserve heat. This results in the buildup of stale air, which can lead to fatigue, headaches, and an increased risk of respiratory infections. Additionally, poor ventilation can aggravate asthma, irritate the eyes, nose, and throat, and trigger allergic reactions. Unlike the tropical plains of India, where natural ventilation is sufficient during winter, cold regions like Kashmir face a unique challenge. With limited airflow and reduced exposure to sunlight due to poor home orientation, the lack of proper air change and sunlight contributes to a sense of tiredness and lethargy, further impacting the overall health and well-being of residents during the cold winter months.

In Kashmir, where space heating and hot water are essential for much of the year, energy consumption in homes is a major concern due to poorly insulated building structures and inefficient water heating systems. These inefficiencies result in significant energy loss, which can be mitigated through the adoption of passive house techniques. By incorporating better insulation, airtightness, and energy-efficient heating systems, homes in the region could significantly reduce their energy consumption. Currently, buildings in Jammu and Kashmir consume around 50% of the electrical energy, but by designing homes with energy efficiency in mind, there is great potential for substantial energy savings. This shift towards energy-efficient homes would not only lower energy costs but also contribute to reducing greenhouse gas emissions, playing a key role in mitigating climate change and global warming.

The growing trend of designing homes with multi-slope roofs has posed a significant challenge to the installation of solar rooftop systems in Kashmir. While older houses, with simpler and flatter roof designs, can accommodate solar panels effectively, the complex roof structures of newer homes with multiple gables and slopes make it difficult to install solar panels of adequate capacity. These intricate designs are not suitable for the uniform placement of solar panels, which require large, uninterrupted surfaces to capture maximum sunlight. As a result, despite the potential benefits of solar energy, many new houses are unable to utilize this sustainable energy source, limiting efforts to reduce energy consumption and combat climate change.

Thermal power plants supply about one-third of the J&K's electricity, contributing significantly to greenhouse gas emissions. During 2023-24, J&K consumed 20,985 million units (MU) of electricity, with 7,223 MU (34%) coming from thermal plants that burn coal. Given that the carbon intensity of electricity generation in India is 0.82 kg of CO_2 per kilowatt-hour, J&K is responsible for producing approximately 6 million tons of carbon dioxide annually. This substantial carbon footprint could be greatly reduced by adopting energy-efficient building designs, such as passive houses, which reduce energy demand. Additionally, transitioning to solar energy, with just a 1kW solar plant being equivalent to planting 33 trees, offers a sustainable solution to cut emissions and help mitigate climate change.

2. Passive House Design:

Passive house design can be important in Kashmir because as it can help homes to be more comfortable and reduce energy consumption especially during cold seasons. Passive house design is a voluntary standard for energy efficiency that aims to reduce a building's carbon footprint. It's based on six principles: Maximum exposure to South Sun during winter, Airtightness, Thermal insulation, Mechanical ventilation heat recovery, High performance windows, and Thermal bridge free construction. Passive house design maximizes solar gain during winter and minimizes the same during summer. Passive houses use the sun's rays during winter to heat the building through strategic window placement and heat-absorbing surfaces. Passive houses also use insulation and air tightness to avoid heat loss during winter and heat gain during summer. They also use heat recovery systems and eliminate thermal bridges, which allow heat to travel through walls.

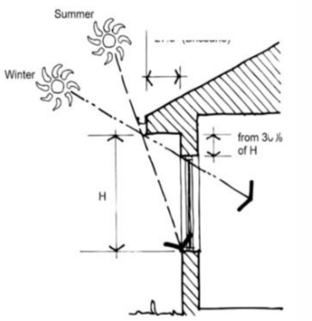
3. Orientation:

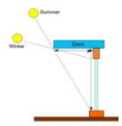
To ensure maximum solar gain during winter, it is crucial to orient the house to face south, as this direction captures the most sunlight when the sun is low in the sky. In the northern hemisphere, the sun's path shifts toward the southern part of the sky during winter, making a south-facing orientation ideal for maximizing exposure to sunlight and warming the house naturally. If perfect south alignment is not possible, the next best orientations are south-west and south-east. These directions still provide substantial solar gain, with south-west offering afternoon sunlight and south-east providing warmth in the morning. Prioritizing a southward orientation, followed by south-west and south-east, helps optimize energy efficiency and natural heating during colder months.

In the design and development of housing colonies, whether by government or private builders, it is beneficial to orient the houses towards the South to maximize solar gain, especially during the winter months. A south-facing orientation allows homes to capture the most sunlight, providing natural warmth and reducing the need for artificial heating. To achieve this, the last-mile access roads leading to the homes should be constructed in an East to West direction. This layout ensures that each house is properly aligned with the south, while also providing convenient and efficient connectivity to the residences. Such planning not only enhances the sustainability of the colony but also improves the quality of life for residents by optimizing natural energy resources like sunlight.

To ensure that sunlight penetrates into the house through south-facing windows during winter while being effectively blocked during the summer, the eave depth over these windows needs to be carefully calculated. This will allow maximum solar gain in winter when the sun is lower in the sky, while preventing overheating in the summer by blocking the higher angle of the sun. To achieve this, you can use online calculators designed to determine the optimal eave depth. One such tool is available at EcoWho Passive Solar Eaves Calculator, which helps in calculating the correct dimensions based on geographical location, window size, and the angle of the sun at different times of the year. By using such a calculator, you can ensure that your home remains energy efficient and comfortable throughout the seasons.The link to the calculator is given below:

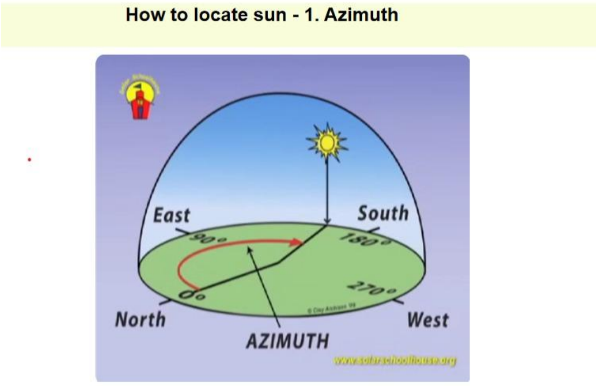
https://www.ecowho.com/tools/passive_solar_eaves_calculator.php

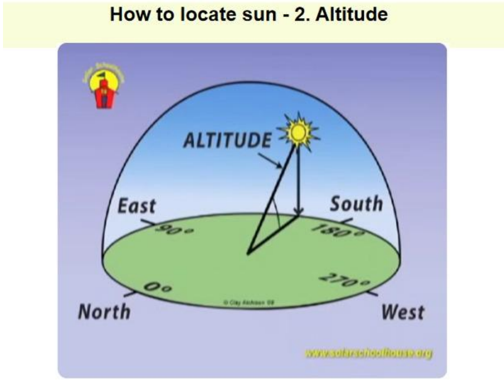


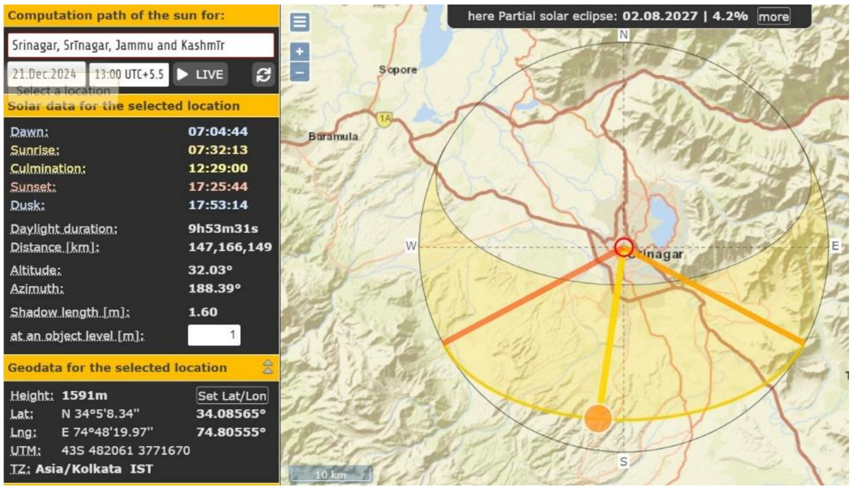


Latitude:	34° 1'N
Window Height:	7.00
Ideal Eave Depth (from top of window to edge of Eave)	3.20
Top Window Winter Shade (from top of window down)	1.65

The ideal eave depth for south-facing windows can also be determined through trigonometric calculations, which take into account the sun's position throughout the year. The sun's exact position is determined by two key parameters: **azimuth** (the compass direction of the sun) and **altitude** (the angle of the sun above the horizon). These parameters can be used to calculate the angle of sunlight that enters the window and determine the correct eave depth to maximize solar gain in winter while blocking the sun during the summer months. To find the azimuth and altitude for any location on Earth at any time of the year, you can use online tools such as SunCalc. By inputting the desired date, time, and geographical location, you can retrieve the sun's position and apply it to your trigonometric calculations to ensure that the eave depth is optimized for seasonal solar control.The link to the tool is as follows: https://www.suncalc.org/







Azimuth and Altitude of Sun for Srinagar City on winter solstice

Based on the data from the website SunCalc, the altitude of the sun for Srinagar on the Summer Solstice (June 21-22) at 12 noon is 77.25 degrees, and on the Winter Solstice (December 21-22) at 12 noon, the altitude is 32.07 degrees. These values are critical for calculating the ideal eave depth for south-facing windows, as they provide the angles of sunlight at different times of the year.

To calculate the eave depth using trigonometry, you would need to know:

Summer Solstice (77.25 degrees): At this time, the sun is at its highest altitude, so you need to block its rays to prevent overheating in the house. The eave must be deep enough to ensure that the sun's rays are blocked from directly entering the windows.

Winter Solstice (32.07 degrees): During this time, the sun is much lower in the sky, and you want the rays to penetrate deep into the house for maximum heating. The eave should be designed to allow sunlight to enter through the windows and provide natural warmth.

By using these altitude values, you can calculate the eave depth that will block sunlight during the summer while allowing it to enter the house during the winter.

1.

In designing homes to maximize the benefits of solar energy, it is important to position the living spaces in such a way that they take full advantage of sunlight, particularly during the winter months. Rooms like bedrooms, sitting rooms, and hammams, which require ample natural light and warmth, should ideally be positioned with maximum southern exposure to capture the sun's rays. On the other hand, areas like staircases, drawing rooms, kitchens, and bathrooms can be placed in other directions, such as the northern or eastern parts of the house, where sunlight is less direct.

The **South-Western corner** of the house, which we may refer the 'Precious Corner' in Kashmir, is especially advantageous during the winter due to its exposure to sunlight throughout the day. This corner is ideal for the sitting room, as it maximizes solar gain when the sun is low in the sky. In many Kashmiri homes, the room adjacent to the kitchen is typically used as a common sitting room, making the South-Western corner a perfect location for this purpose. By strategically positioning these key spaces, homes can harness the power of the sun, improving both comfort and energy efficiency throughout the year.

4. Net Zero Building:

Designing homes on the net-zero principle means creating buildings that produce as much renewable energy as they consume over the course of a year. This approach significantly reduces the reliance on nonrenewable energy sources, promoting environmental sustainability and energy efficiency. Achieving a net-zero energy status requires the integration of renewable energy systems, particularly Solar Photovoltaic (PV) modules, which harness solar energy to generate electricity.

For a home to be truly net-zero, it is essential to plan for the installation of these solar PV modules from the very beginning of the design process. Sufficient roof area must be allocated to accommodate the number of solar panels needed to meet the home's energy demands. This planning ensures that the house is capable of producing enough energy to cover its heating, cooling, lighting, and appliance needs throughout the year. By incorporating solar energy into the design, homeowners can reduce their carbon footprint and create a sustainable living environment that minimizes energy consumption and environmental impact.

2. To achieve net-zero status for a building, the roof should be designed to maximize solar energy collection throughout the year. The most effective orientation for solar gain is **South-facing**, as this direction receives the most sunlight throughout the day, especially in the northern hemisphere. For optimal solar energy capture, the roof should have a **30-degree tilt angle in Kashmir**, which allows for maximum exposure to sunlight year-round.
In terms of priority for roof orientations, after South, the next best directions are **South-West**, **South-East**, **West**, and **East**, in that order. These orientations still offer significant solar potential, though less efficient than direct south-facing roofs.
South-West and South-East provide good solar access in the afternoons and mornings, respectively, while **West and East** combination face more challenging angles but still contribute to energy production.
On the other hand, **North-facing roofs** have little to no solar potential in the northern hemisphere, as they are exposed to minimal direct sunlight, making them unsuitable for solar panel installations aimed at achieving net-zero energy. Therefore, orienting the roof towards the southern half of the compass is crucial to ensure that the building generates enough renewable energy to meet its needs and reduce dependency on nonrenewable sources.

When designing homes with the goal of achieving net-zero energy status, it is advisable to avoid **multi-slope roofs**, as they present several challenges that can hinder both the installation of solar modules and the overall functionality of the building. Multi-slope roofs, which feature multiple pitches and angles, can be difficult to work with when installing solar photovoltaic (PV) modules. The irregular angles make it challenging to position the panels optimally for maximum solar gain, which is crucial for generating enough energy to meet the building's needs.
Additionally, multi-slope roofs are often more complex to insulate, leading to higher costs and potential inefficiencies in energy conservation. Their design also increases construction and maintenance costs, making them less economical in the long run. Moreover, these roofs can pose safety risks to workers such as carpenters, solar technicians, and painters, who may have to navigate steep or uneven surfaces during installation or repairs. For these reasons, simpler roof designs with a uniform pitch, ideally oriented toward the south, are more practical and safer for both solar energy generation and the overall functionality of the building.

Multislope Designer Roof unfavourable for Solar Modules, insulation and maintenance

Simple Roof favourable for Solar Modules, insulation and maintenance

5. Use of AAC Blocks in Building Construction:

To ensure both seismic stability and thermal efficiency, houses can be constructed with a **Reinforced Cement Concrete (RCC) beam-column structure** combined with **AAC (Autoclaved Aerated Concrete) Blocks** for the envelope walls. This combination not only provides structural integrity, especially in earthquake-prone areas, but also significantly improves the thermal performance of the building. Most of Kashmir Valley and parts of the Jammu region of J&K fall within Seismic Zone V, which is a very high damage risk zone for earthquakes. AAC blocks are lightweight and have superior thermal properties compared to traditional clay bricks. While high-density clay bricks have a thermal conductivity of 0.980 W/m.K, AAC blocks have a much lower conductivity of 0.184 W/m.K, making them five times more heat-insulating than brick. The thermal conductivity of RCC is 1.58, while materials like high-density timber (0.144) and plyboard (0.174) have similar insulating properties as AAC blocks.

To further enhance thermal efficiency, it is essential to avoid **thermal bridges**, which can occur when heat is transferred through building materials such as RCC beams, columns, or slabs. This can lead to heat loss, undermining the energy efficiency of the house. To prevent this, the building should be designed in such a way that no direct heat flow occurs between the interior and exterior walls through these structural elements. **Thermal breaks** or insulation materials should be strategically added in the design to block the path of heat transfer. These measures should be implemented in close consultation with the architect and engineer to ensure that the structure maintains both its seismic stability and energy efficiency. By incorporating these practices, the building can achieve better thermal comfort and lower energy consumption while ensuring safety and durability.

Low-budget houses can also be designed to meet energy efficiency standards by following **passive house principles**, even when using traditional building materials like **clay bricks**. While clay bricks are not as thermally efficient as modern materials like AAC blocks, their energy efficiency can be significantly enhanced by incorporating **appropriate thermal insulation** into the building envelope. This insulation can be strategically applied to walls, roofs, floors, and windows to reduce heat loss in the winter and prevent heat gain during the summer, thus improving the building's overall energy performance.

Working with a **Green Architect** is essential to ensure that the right type of insulation materials and techniques are used, tailored to the local climate and specific needs of the building. The architect can recommend cost-effective options such as foam boards, mineral wool, or natural insulation materials, which can be added without significantly increasing the construction cost. By incorporating these energy-efficient strategies, even low-budget houses can achieve **passive house standards**, ensuring that the home remains comfortable year-round while minimizing energy consumption and environmental impact.

Floor Height:

To improve energy efficiency and comfort, it is recommended to limit the **finished floor height** of homes to **8.5 feet**. While higher ceilings can create a sense of spaciousness and aesthetic appeal, they can present significant challenges in terms of heating efficiency. As the ceiling height increases, the volume of air that needs to be heated also increases, requiring more energy to bring the room to a comfortable temperature. Additionally, during winter, hot air naturally rises and accumulates near the ceiling, leaving the cooler, denser air near the floor. This results in a temperature disparity, where the lower, occupied zones of the room remain cold, and the upper areas stay warmer but are often unused. Consequently, heating systems may struggle to maintain an even distribution of warmth, leading to higher energy consumption and discomfort for the occupants. By reducing the floor height to 8.5 feet, the volume of air that needs to be heated is minimized, promoting a more balanced temperature throughout the room and enhancing overall heating efficiency. This approach not only reduces energy consumption but also improves occupant comfort by ensuring consistent warmth at the living level.

6. Large Protruding Thermal Bridges Structural Disaster for a Passive House.

Protruding large building components like verandas, balconies, and window shades, especially when constructed using reinforced concrete (RCC), can significantly undermine the energy efficiency of a passive house. These elements act as large thermal bridges, facilitating heat loss during winter and heat gain in summer, which disrupts the building's ability to maintain a stable internal temperature. In colder months, these projections can increase heating demand by allowing heat to escape, while in the summer, they can absorb excessive solar energy, leading to higher cooling costs. To optimize energy efficiency, passive house design principles typically avoid such projections, instead using alternatives like internal shading, insulated facades, and overhangs that offer effective sun control without compromising thermal performance. By minimizing these external elements, a building can achieve better insulation, reduce energy consumption, and maintain comfort throughout the year.

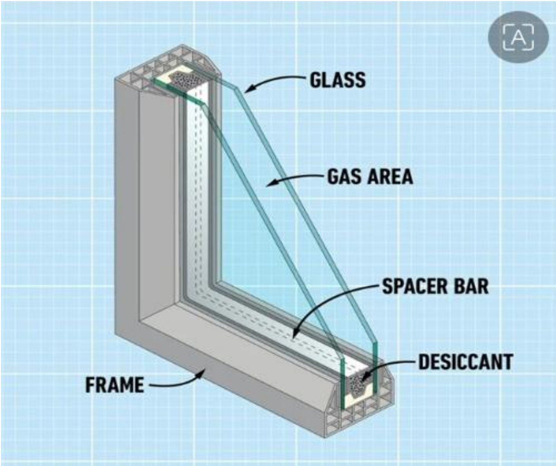
Window shades, verandas, balconies, cause of heat loss during winter and heat gain during summer

7. Windows:

The windows in Southern direction may be kept large enough so that glazed area of these windows is at least 17% of the floor area. In a passive house design, placing larger windows on the southern-facing side is an effective strategy to maximize solar heat gain during the winter months. By ensuring that the glazed area of these windows makes up at least 17% of the floor area, the building can harness the sun's energy to naturally warm the interior, reducing the need for artificial heating. This approach is a key feature of passive solar design, which capitalizes on the sun's path across the sky to provide free, renewable energy. Large south-facing windows allow for maximum daylight penetration, improving indoor lighting and reducing the need for electric lighting during the day. However, it is crucial to balance the size of the windows with proper shading devices, such as overhangs or louvers, to prevent overheating during the summer months. The combination of optimal window placement and insulation ensures that the building remains energy-efficient year-round.

In passive house design, it is advisable to keep the windows on the eastern, western, and northern sides small to minimize energy losses and manage heat gain. Large windows on the eastern and northern sides can lead to significant heat loss during the winter months, reducing the building's energy efficiency. Similarly, large windows on the western side can result in overheating in the afternoon and evening during the summer, as the sun's rays penetrate these windows from noon until sunset. To mitigate this, planting large deciduous trees such as apricot, pear, or apple trees on the western side can provide natural shading in the summer, preventing excessive heat gain. In winter, when the trees shed their leaves, the bare branches allow sunlight to reach the windows, providing natural warmth and reducing the need for artificial heating. This thoughtful combination of window sizing and strategic landscaping optimizes the building's energy efficiency throughout the year.

Double-glazed UPVC windows filled with argon gas are ideal for passive house designs, as they provide superior insulation, helping to prevent heat loss during winter and minimize heat gain during summer. The argon gas within the glazing acts as an additional thermal barrier, reducing heat transfer between the interior and exterior of the building. If wooden windows with double glazing are used, it is important to limit the air gap between the panes to about 18mm. Too small an air gap can lead to heat loss through conduction, while a gap that is too large can result in heat loss due to convection. In larger air gaps, internal air circulation occurs, where the warm air near the inner glass surface rises, and the cooler air near the outer glass surface descends. This circulation causes convective heat loss, making it crucial to optimize the air gap to maintain the desired thermal performance of the window.



uPVC Window Design

Double Glazed Wooden Window with Spacer Bar

For wooden windows with double glazing, it is advisable to have the double glass units pre-assembled with a spacer bar in a factory that specializes in manufacturing UPVC windows. The spacer bar, typically made of aluminum or other insulating materials, helps maintain a consistent air gap between the two glass panes, ensuring proper insulation. Once the glass units are assembled, they can then be fixed into the wooden window frames. This factory-based assembly process ensures precision in the glass installation, improving the overall thermal performance and durability of the windows. It also eliminates potential errors that could occur during on-site assembly, helping to maintain the intended energy efficiency of the building.

Single-glazed UPVC windows behave similarly to ordinary windows when it comes to heat loss during winter and heat gain during summer, making them unsuitable for energy-efficient buildings like passive houses. The lack of an insulating layer between the panes allows heat to easily escape in cold weather and lets excessive heat enter during the warmer months. This undermines the very purpose of using UPVC windows, which are intended to offer improved insulation and energy efficiency. As a result, single-glazed UPVC windows are not compatible with the principles of passive house design and should be avoided to ensure the building remains energy-efficient and comfortable throughout the year.

8. Insulation for Building Envelope:

To enhance the energy efficiency of the building, the exterior walls forming the building envelope may be provided with **interior or exterior thermal insulation**. This insulation can take various forms, such as **Rock Wool**, **Air Gaps**, **Thermal Wall Panels**, or a combination of these materials, depending on the specific requirements and design of the building. The choice of insulation should be made in consultation with a **Green Architect**, who can assess factors such as climate, building orientation, and budget to recommend the most effective solution.

Among the available options, **Rock Wool** is highly preferred due to its excellent **fire resistance properties** and its safety, as it poses no health hazard when properly installed. Rock wool is an effective thermal insulator and also provides soundproofing benefits, making it ideal for maintaining a comfortable indoor environment while enhancing the building's safety. Whether used as part of the exterior or interior insulation strategy, Rock Wool helps reduce heat loss in winter and heat gain in summer, contributing to the overall energy efficiency of the home. The Green Architect can help determine the best insulation strategy, ensuring that the building is both sustainable and comfortable while meeting the necessary performance standards.

9. Roof Insulation:

When designing the roof insulation for a house, which forms a critical part of the building envelope, two different scenarios need to be considered, depending on the roof structure and the design of the top floor.

Scenario 1: Slanting Roof with Visible Inclination

In many houses, the top floor features a **Common Hall** used for social gatherings, with a slanting roof that is designed to allow the inclination to be visible from the hall. In this case, the **CGI sheets** (Corrugated Galvanized Iron sheets) form the exterior envelope of the building. To enhance thermal efficiency, insulation can be applied directly **under the CGI sheets**, as this is the outermost layer. Insulation materials like **Rock Wool** or **XLPE (Cross-Linked Polyethylene) insulation with a reflector on both sides** can be used to improve energy efficiency. The top-side reflector will bounce back the sun's radiant heat during the summer, keeping the indoor spaces cooler, while the bottom-side reflector will help retain indoor heat during the winter, contributing to energy conservation. This approach helps in regulating the temperature of the Common Hall and of complete house, making it comfortable throughout the year.

Scenario 2: Flat False Ceiling with Attic

In some homes, the Common Hall may be designed with a **flat false ceiling**, which forms an attic space between the ceiling and the slanting CGI roof. Since the roof's inclination is not visible from the Common Hall, in this scenario, the false ceiling itself acts as part of the building envelope. In this case, insulation should be applied directly to the **false ceiling** above the Common Hall, rather than beneath the CGI sheets. This method effectively excludes the attic space from the building envelope, saving on insulation costs while improving thermal performance. The insulation materials used here, such as **Rock Wool** or **XLPE**, still feature reflectors to optimize energy savings: the top reflector reflects heat away during summer, and the bottom reflector helps retain warmth during the winter. By insulating the false ceiling, the attic is kept separate from the thermal envelope of the house, contributing to cost savings and enhancing overall energy efficiency.

In both scenarios, the **U-value** (thermal transmittance) of the insulation should be determined in consultation with a **Green Architect** to ensure optimal performance. The architect will assess the best type of insulation and its properties, such as its effectiveness in preventing heat loss or gain, based on the specific climate and design requirements of the building. This approach ensures that the house remains energy-efficient, comfortable, and cost-effective throughout the year.

10. **Water Heating:**

A suitable platform may be provided at a suitable place for the solar geyser (Solar Water Heater). To optimize the performance of a **solar geyser** and ensure maximum solar gain throughout the year, the platform should be positioned on the **South side** of the house. This orientation allows for the best exposure to sunlight, which is essential for the efficient operation of the solar water heating system. If positioning on the South side is not possible, the next best options are the **South-West**, **South-East**, and **West** sides. The **Northern side** should be avoided for the installation of the solar geyser, as it receives significantly less direct sunlight.

The platform for the solar geyser should be positioned in such a way that it minimizes the length of the **outlet water pipe** running from the geyser to the kitchen and bathrooms. This ensures that the water reaches these areas quickly and efficiently, reducing heat loss during the transfer.

From Installation Point of view two types of solar geysers are available; Sleeper Type Solar Geyser (for slanting roofs) and Support Type Solar Geyser (for flat roofs). Sleeper type solar geyser is specifically designed for sloped or slanting roofs. The geyser is mounted with an angle that mimics the slope of the roof.It is ideal for slanted roofs because it allows the solar collectors to face the sun directly, which increases the efficiency of heat absorption. This type of geyser is often simpler to install on sloping roofs and ensures optimal performance.

For flat or horizontal roofs, a support-type solar geyser is typically used. This involves a structure that supports the solar collector at the right angle, as the roof itself does not provide a slope. It allows flexibility in positioning the collectors to capture sunlight effectively, even on flat surfaces. A frame or support structure is used to angle the panels towards the sun, optimizing energy collection and efficiency.

In terms of capacity, two units of **100 LPD** (Liters Per Day) or **150 LPD** each are generally sufficient for a family, depending on the household size and hot water needs. It is recommended to install **two units**, as they can be connected in **parallel** during the summer months, and in **series** during winter. The series connection during winter will reduce the discharge but will significantly improve the temperature of the output water, especially during times of reduced sunlight.

When positioning the **overhead water tank** and **solar geyser**, it is important to maintain at least a **one-foot head** between the top of the solar geyser tank and the bottom of the overhead water tank. This head ensures adequate water flow and pressure. Additionally, the **head** between the solar geyser and the overhead water tank should not exceed **6 feet** to avoid excessive length for the vent pipe, which can be difficult to install and maintain. If the vent pipe is properly supported, the head can be increased to **13 feet** without difficulty.

Solar Geyser uses free energy of sun to heat water. A 100 LPD capacity solar geyser can replace an electric geyser for residential use and may save approximately 1500 units of electricity annually (125 units per month) and prevent emission of 1.5 tones of carbon dioxide per year.

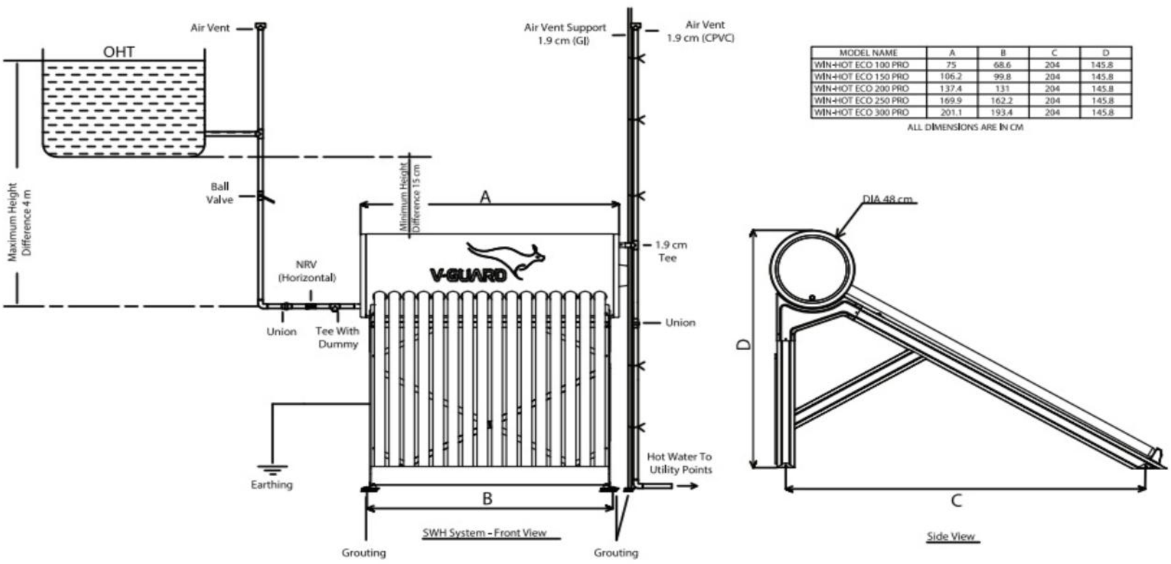
An electricity consumer is entitled to rebate of Rs. 150/- per month in J&K on electricity bill for minimum capacity of 100 Ltr Solar Geyser.

Solar Geysers are being used extensively world-wide. In Rizhao, China, a city of 3 million people 98% of homes use the sun to heat their water. 90% of all homes in Israel/Palestine use the sun to heat their water. In neighboring Ladakh Solar Geysers are being used extensively, inspite of the fact that it is extremely difficult to maintain free flow of water through pipe work during winter.

Before finalizing the installation parameters, it is crucial to refer to the **manual** of the specific solar geyser model, as dimensions and requirements may vary between manufacturers. The manufacturer's guidelines will provide precise instructions on the optimal installation practices, ensuring that the solar water heating system functions efficiently and effectively.

3.

Solar Water Heater



MODEL NAME	A	B	C	D
WIN-HOT ECO 100 PRO	75	68.6	204	145.8
WIN-HOT ECO 150 PRO	106.2	99.8	204	145.8
WIN-HOT ECO 200 PRO	137.4	131	204	145.8
WIN-HOT ECO 250 PRO	169.9	162.2	204	145.8
WIN-HOT ECO 300 PRO	201.1	193.4	204	145.8

Installation diagram for Solar Water Heater

The combination of a **Heat Pump** with a **Solar Water Heater** is a highly **economical and efficient solution** for meeting hot water requirements throughout the year. This combination ensures minimal energy consumption while providing an abundant supply of hot water for daily use. The synergy between solar energy and the heat pump optimizes energy use, reducing the reliance on electrical geysers and eliminating the need for extensive heating circuit wiring to bathrooms and kitchens.

A typical heat pump system with a **300-liter water tank** is considered sufficient for a typical family. The system operates at a **rated power input** of **670 watts** and provides a **rated output heating capacity** of **2850 watts**, resulting in a **Coefficient of Performance (COP)** of 4.25 (calculated as 2850/670). This indicates that for every unit of electricity consumed, the heat pump provides over four times the heating capacity, making it highly efficient. Additionally, the system is equipped with a **2500-watt (2.5 kW)** electrical heating element that acts as a backup. This heating element is activated during periods of excessive demand, such as social gatherings, or during extreme weather conditions, like the cold winter days of **Chila Kalan**, ensuring that hot water is available even under challenging circumstances.

Another alternative to consider for budget-conscious applications is the combination of a **Solar Water Heater** with a **Water Boiler (Steamer)**, which offers a more affordable solution while still utilizing solar energy for heating water. This combination may not be as energy-efficient as the heat pump system, but it remains an effective and cost-effective option for meeting basic hot water needs. The integration of solar energy with traditional heating methods allows for significant savings on energy bills, while reducing the environmental impact.

The **domestic water boiler**, locally known as a **'steamer'**, is commonly used in many households for centralized hot water supply. This system operates under the principle of **gravity head**, utilizing the height difference between the **overhead water storage tank** and the **boiler** to circulate hot water to various points in the house, such as **washrooms** and **kitchens**. The water tank is typically placed in the **attic** or on the roof, while the boiler is installed on the **ground floor**, creating the necessary gravitational force to ensure smooth and efficient water circulation.

The **water boiler** is usually powered by **electrical heating elements**, which heat the water directly. However, it also has backup heating options, such as **wood, gas, kerosene, or diesel** burners, which come into play when there is a power outage or when electricity is not available. This flexibility ensures that the system can provide hot water even during electricity shortages or in areas where the power supply is unreliable.

The boiler itself is typically made of **copper**, which is known for its excellent thermal conductivity and durability. The **capsule-shaped tanks** at both the top and bottom of the boiler are designed to withstand both **positive and negative pressures**. The capsule shape enhances the structural integrity of the tank, making it stronger and more resilient under varying pressure conditions. This type of tank construction ensures that the water boiler can function effectively and safely, providing a consistent and reliable supply of hot water for the household.

The main drawback of domestic water boilers, particularly those used in Kashmir, is that the **hot water storage copper tanks** of these boilers are often **not thermally insulated**. This lack of insulation leads to significant **heat loss** from the water tank, especially during the colder months, making the system less efficient. The heat retained in the water dissipates quickly, leading to higher energy consumption as the system has to continuously reheat the water.

In contrast, a **well-insulated boiler tank**, such as the one shown in the second image, offers a much more energy-efficient solution. This type of tank is typically **insulated with materials**

like PoP (Plaster of Paris) or other effective thermal insulation materials. Proper insulation ensures that the heat in the water remains contained within the tank for a longer period, reducing the need for constant reheating and thus saving energy. Insulated tanks not only improve the thermal efficiency of the system but also reduce the strain on backup heating systems, contributing to lower energy costs and a more sustainable solution for providing hot water.

In regions like Kashmir, where the winters are cold, it becomes especially important to implement such insulation techniques to maximize the performance of domestic water boilers, ensuring that they provide consistent hot water with minimal energy wastage. Insulating the boiler tanks can significantly enhance the comfort and cost-effectiveness of the hot water supply system.

It would be an excellent idea to provide a **layer of Glass Wool** or **Rock Wool** under the **PoP (Plaster of Paris)** insulation layer in the domestic water boilers used in Kashmir. The reason for this recommendation lies in the **thermal conductivity** of the materials involved.

Plaster of Paris (PoP), with a thermal conductivity (λ) of **0.13 W/(m.K)**, has moderate insulating properties but is not as effective as some of the other materials available for thermal insulation. When used alone, PoP can still allow a significant amount of heat to escape, especially in regions with cold winters like Kashmir.

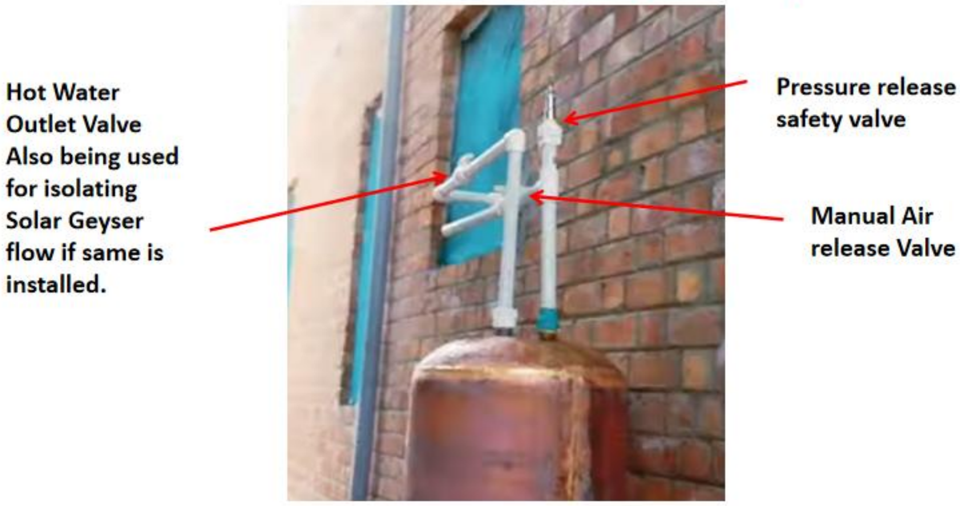
On the other hand, **Rock Wool** and **Glass Wool** are **highly effective insulating materials**. Their thermal conductivities are much lower—**Rock Wool** at **0.030 W/(m.K)** and **Glass Wool** at **0.045 W/(m.K)**—making them **20 to 30 times less conductive** than the commonly used **brickwork**, which has a **thermal conductivity** of **0.980 W/(m.K)**. This means that the use of **bricks** as insulating material in Kashmir would result in a considerable amount of heat loss, which is inefficient for energy conservation.

By introducing a layer of **Rock Wool** or **Glass Wool** beneath the PoP layer, the overall insulation efficiency of the water boiler would be significantly improved. These materials would prevent heat from escaping, ensuring that the water retains its temperature for a longer period, thereby reducing the need for frequent reheating. This approach would save energy, lower operational costs, and improve the overall effectiveness of the water boiler, especially in the harsh, cold climate of Kashmir.

However bottom of tank is to be left uninsulated to facilitate water heating by burning of fuels like; wood, gas, kerosene or diesel.

The picture below depicts various components of a domestic water boiler. First valve at the top is used for control of hot water output and 2nd for automatic pressure release/manual air release. The hot water outlet valve is to be kept closed if solar geyser is installed and working. In case vent pipe is used at the top there is no need for pressure release valve. The vent pipe should go straight right upto the storage tank, about 6 inch above top of the storage tank.

4. **Domestic Water Boiler (Steamer) Valves**



5.

Water Boiler tank with thermal insulation.

The primary challenge in installing a **Heat Pump** or **Water Boiler** in existing houses is the **plumbing work** required to connect the system to various water outlets, such as **bathrooms** and **kitchens**. However, during the initial construction phase, this process is relatively easier as all the plumbing lines can be set up in a **common vertical axis**, making it simpler to connect multiple outlets in series and return water to the heat pump.

In simpler terms, the plumbing can be configured such that the **incoming hot water pipe** from the heat pump is first connected to the **bathroom on the top floor**. Then, the water can flow from **bathroom #1 to bathroom #2** (directly below the top floor) and continue this circuit all the way back to the heat pump for the return flow. For efficiency, the **input hot water pipe** could be **32mm PPR** (Polypropylene Random Copolymer), while the **return pipe** could be slightly smaller at **25mm PPR**. Similarly, similar circuits can be established for **other bathrooms** and **kitchens** in the house.

While it is possible to have water fed without return pipes, the disadvantage is that you may lose **half a bucket of cold water** before you receive hot water, which would be wasteful and inefficient. The ideal setup involves having both **supply** and **return** pipes to ensure a continuous and efficient circulation of hot water.

In terms of the **heat pump's installation**, it can be placed anywhere in the building, but the most effective location is the **attic**. By placing the unit in the attic, you can take advantage of the natural **gravity head**, which helps in water circulation. However, the heat pump can also be installed at lower elevations, with a small **booster pump** added to maintain the **hot water pressure** throughout the house.

A significant advantage of using a heat pump or water boiler is not only the **energy savings** but also the elimination of the need for multiple **geysers**, **wiring**, **sockets**, and **high-rated MCBs** (miniature circuit breakers). Unlike traditional electric geysers, a **heat pump** works by **extracting heat from the cold outside air** and transferring it into the home, much like an air conditioning unit in reverse. In cooling mode, an air conditioner extracts heat from the indoor air and releases it outside, but a heat pump transfers that external heat to warm the water inside. As a result, the system requires less electricity, making it more energy-efficient and cost-effective in the long run.

Electrical geysers are widely regarded as **safe and efficient water heating appliances** with **high Energy Factors** (EF), which typically range between **75% to 95%**. This impressive energy efficiency is achieved through the use of **high-quality thermal insulation** between the **outer body** and the **water tank**, ensuring that minimal heat is lost during the water heating process. As a result, electrical geysers consume less energy to maintain the desired water temperature, making them an energy-efficient option for households.

One of the key features of electrical geysers is the **inbuilt thermostat**, which helps regulate the water temperature by automatically turning the heating element on or off as needed. This ensures that the water does not overheat, providing both energy conservation and safety by preventing excessive heating, which could lead to potential hazards or increased energy consumption.

To further enhance energy savings, it is advisable to use **star-rated geysers**. **Star ratings**, provided by various energy efficiency certification systems, indicate the level of energy efficiency a particular geyser offers. **Higher star ratings** correspond to better energy performance, meaning they use less electricity to heat water while providing the same or better performance. By opting for **star-rated geysers**, households can significantly reduce their energy consumption and lower their electricity bills, making them an excellent choice for those seeking both **cost-effectiveness** and **sustainability**.

However solar geyser with heat pump or solar geyser with water boiler are superior combinations than electrical geyser in terms of thermal efficiency and economics of water heating.

11. Ventilation of Air Tight Homes:

In airtight **passive houses** equipped with **UPVC windows** or other types of airtight windows, it is crucial to maintain an optimal **Air Change per Hour (ACH)** to ensure healthy indoor air quality. **ACH** refers to the number of times the air inside a room or building is replaced, either by ventilation or other means, within the span of one hour. Maintaining the appropriate ACH is vital because it directly affects the quality of indoor air, helping to ensure that fresh air circulates while stale air is expelled.

Without proper ventilation, **stale air** in occupied spaces can lead to a range of negative health effects, such as **fatigue**, **headaches**, and an increased risk of **respiratory infections**. For individuals suffering from conditions like **asthma**, poor air quality can exacerbate symptoms, while others may experience **eye, nose, and throat irritation**. Additionally, a lack of proper ventilation can promote **mould growth**, leading to allergic reactions and further compromising indoor air quality.

According to the **American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)**, ACH levels are recommended based on building type and its use. In homes, especially passive houses, it is essential to follow these standards to ensure the indoor environment remains healthy and comfortable. Table below provides required ACH level for various types of buildings per their use.

In addition, **winter fatigue** and a sense of tiredness in cold weather can often be attributed to poor ventilation and reduced exposure to natural sunlight. During winter months, many homes suffer from inadequate **solar orientation**, particularly lacking sufficient **South-facing windows**, which would allow the maximum intake of sunlight. This lack of **sunlight** combined with poor **ventilation** can cause a drop in energy levels and contribute to a sense of lethargy, making it even more important to focus on maintaining the recommended ACH and improving the home's exposure to sunlight.

12. Heat Recovery Ventilator:

Proper ventilation of energy efficient passive house shall require Air Change Per Hour (ACH) to be maintained at least 0.35 to 1 for domestic installations. Spaces like offices, schools etc may require ACH of 4. The occupied spaces with high occupancy per unit area may require ACH as high as 10. The examples are religious places and other social gatherings. Since opening of windows or use of exhaust fan in an air tight house will cause heat loss, the required ACH is maintained by Heat Recovery Ventilator (HRV) which is also known as lung of a passive house. The HRV sucks stale air from say Kitchen and Bath Room and pushes fresh air into living rooms but in this process transfers heat from the stale sucked air to the incoming fresh air. Since heat is recovered from the warm stale air, it is as such known as Heat Recovery Ventilator (HRV). This is the simplest air flow circuit. The actual requirement is a design issue best suited for the installation. The wattage of HRV fans for domestic purpose may be 50 to 100 watts. Although use of Double Glazed uPVC Windows has picked up in Kashmir but without proper ventilation, the users are reporting excessive condensation and suffocation during winter which forces them to open windows for sometime during the day to allow fresh air to come in. The opening of windows defeats the very purpose for which these windows were designed ie to prevent heat loss during winter and heat gain during summer. The excessive condensation may promote formation of black mould growth which is also a health hazard.

A single HRV unit is sufficient for a residential house

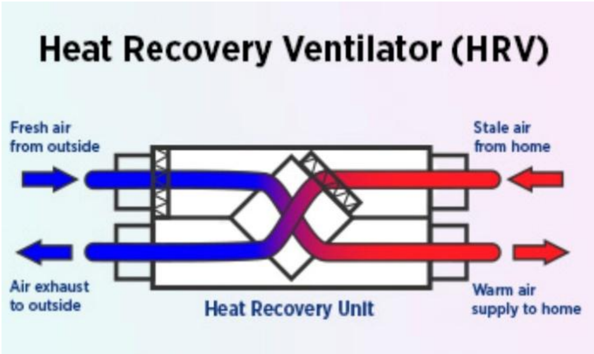
6.

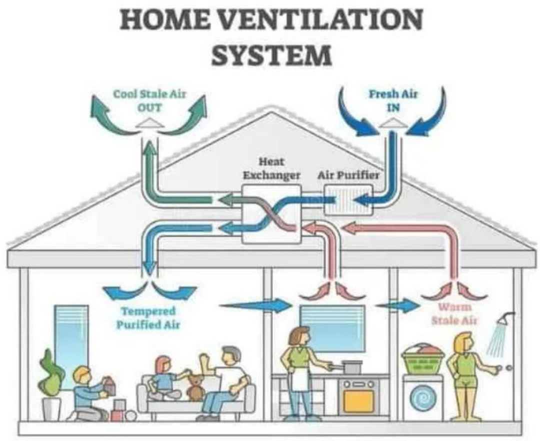
Location Type	Suggested Outdoor Air Ventilation Rate (ACH)
Homes	0.35-1
Hotel Rooms	1-2
Offices	2-3
Retail Shops	2-3
Schools (Except lecture halls)	5-6
Sports facilities	4-8
Resturants	6-8

ACH requirement as per ASHRAE

Heat Recovery Ventilator

7.





Air flow in HRV

Energy recovery ventilator (ERV) is another equipment used for ventilation purpose. The main difference between a heat recovery ventilator (HRV) and an energy recovery ventilator (ERV) is that an ERV transfers both heat and moisture, while an HRV only transfers heat. Both HRVs and ERVs are installed to improve indoor air quality and reduce heating costs. They both supply fresh air, exhaust stale air, and recover energy from the exhausted air. ERV can help keep humidity out during warm, humid months, and allow some humidity to stay inside during cool, dry months. This makes ERVs a good choice for climates with extreme humidity, such as humid summers and dry winters.

HRV and ERV have following advantages:

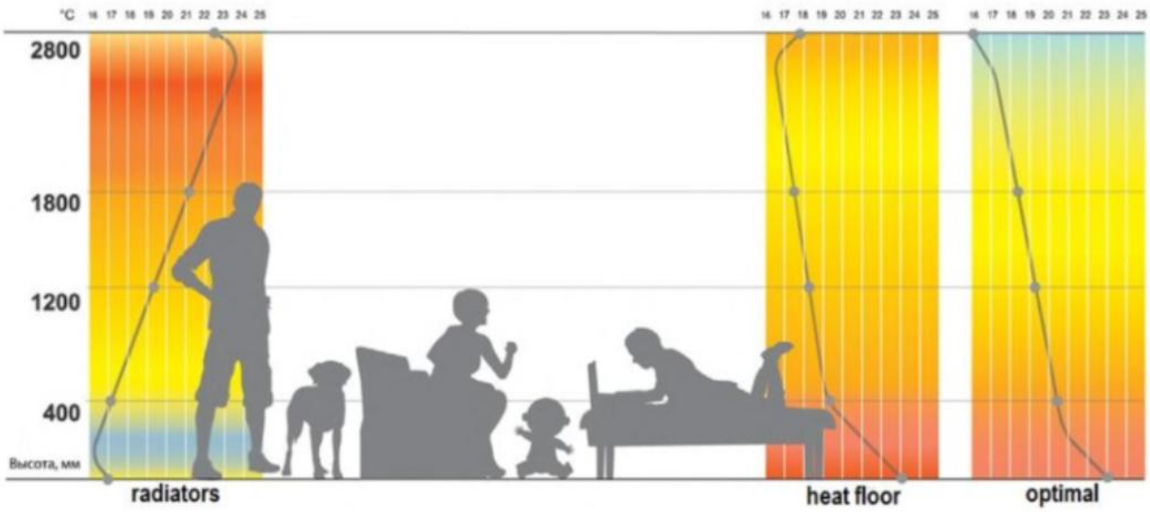
- Bring a continuous supply of fresh outside air into your house
- Exhaust environmental contaminants for improved indoor air quality.
- Save energy in the winter by recovering heat from exhaust air.
- Save energy in the summer by recovering cool indoor air from exhaust air.
- Help prevent mound and mildew.
- Minimize odour and cooking residue.

Mould is a type of fungus which grows in dark and damp environments. It is cause of number of health issues like; allergies, asthma and other lung infections. HRVs and ERVs prevent Mould Formation in air tight homes.

To facilitate the smooth installation of Heat Recovery Ventilation (HRV) or Energy Recovery Ventilation (ERV) systems, it is highly beneficial to provide pre-planned holes or provisions in RCC structures or walls during the initial construction phase. These provisions ensure that ducts can be easily laid out during the later stages of construction, eliminating the need for disruptive modifications to finished walls. This proactive approach not only reduces installation time and costs but also helps in maintaining the building's structural integrity and aesthetic appeal. By planning for HRV/ERV systems from the outset, the building can better support energy-efficient ventilation solutions, enhancing indoor air quality and long-term sustainability while minimizing potential retrofitting challenges in the future.

13. Room Heating:

Which type of room heating should be preferred; Underfloor or other types? Graph attached below depicts a man with his family in two similar rooms; one with underfloor heating and another with radiator. The man is standing. The pet and a child is on ground. 2nd child is sitting in a chair. Another family member is lying on the bed. Look at the temperature distribution in the room; The red colored zones are warmer zones and blue coloured zones are colder zones. Yellow zones have temperature in between red and blue zones. For underfloor heating, the temperature at floor level is 23 deg centigrade and the temperature at the roof of room 2.8 mtr high (9 feet) is 18 deg. Three family members and pet are in the temperature zone of 23 to 18 deg . The standing man is in 23 to 17 deg zone. For other types of heating, the floor is at 17 deg cent and roof at 22.5 deg cent. Three family members and pet are in 17-to-18-degree zone and the body of man is in 17 to 19.5 deg zone. So the family is at an advantage of higher temperature in the room which has got under floor heating. 3rd Graph depicting Optimal graph for best thermal comfort is also provided, which almost matches with under floor heating.



Temperature distribution according to the height of the room.

In passive heated rooms (heated by South Sun) also, heat accumulates at the roof of room because hot air rises while cold air sinks. This is the reason that finished floor height of living rooms may be restricted to maximum 8.5 feet only in cold climatic areas. It is very difficult to heat rooms with large height at lower levels because heat accumulates at top of room, beyond the reach of occupants. Underfloor heating doesn't use forced air to distribute heat. It is generally better than convection fans for people with allergies because it doesn't circulate dust and allergens, and it can help reduce moisture. Underfloor heating provides even, comfortable warmth that rises from the floor. It can be more comfortable than traditional radiators, which can overheat a space and make you feel stuffy. Thermodynamics fully supports underfloor heating as natural convection, maintains a constant gradient from floor to ceiling with radiation supporting the convection. And this temperature gradient physiologically comforts the inhabitants. In cold areas blood vessels in the extremities, such as the hands and feet, constrict. This reduces the blood flow to these areas, as such we feel very comfortable if our feet and hands get warmed. Under floor heating is best solution to warm these extremities as well.

Underfloor heating is the best option among all for a host of scientific reasons. Hamams are centuries tested and trusted in our part of globe as we have inherited this from our ancestors. But the problem with Fire Wood type Hamamas is that these are pollutants. The wooden burns in an oxygen deficient enclosure so there is possibility of production of Carbon Monoxide in addition to Carbon Dioxide. Carbon Monoxide is a poisonous gas. Carbon Dioxide is also a green house gas and main cause for global warming. Extensive use of fire wood hammams can make atmosphere of Kashmir Valley worst than that of Delhi. Another problem with Fire Wood Hammam is that the heat gets lost towards ground and to four side walls of hammam. The heat flow towards top only is utilized. The stone or bricks being used on side walls are highly heat conducting. The efficiency of fire wood hammam may therefore be less than 50%. The distribution of heat on the floor is also uneven. The place under which wood is burnt gets overheated and the temperature of floor decreases gradually as we move away from the fire place. Electrical hammam uses insulation under the heating coils to prevent flow of heat downwards. Almost all heat generated flows to the living area. The concrete layer over the heating coils acts as a thermal mass ie a thermal battery which releases heat slowly once the power goes off. The insulation under the heating coils of electrical hammam is a critical component of the hammas. It should, as such be provided in consultation with a green architect.

Still use of fire wooded hammam is recommended especially for rural areas of Kashmir due to power curtailments during winter and availability of fire wood there. Those who can afford to pay power bills of electrical hammam may install the same in view of its numerous advantages explained above.

14. Thermal Mass:

Thermal mass refers to a material's ability to absorb, store, and release heat. Materials with high thermal mass, like concrete, bricks, and tiles, can help reduce temperature fluctuations in buildings. This can reduce the need for heating and cooling, and in some cases, eliminate the need for air conditioning.

A black body is an idealized object that absorbs all electromagnetic radiation and emits thermal radiation in a continuous spectrum. The concrete floor of the attic hall which is generally un-utilised in Kashmir except for rare social gatherings can be utilized as thermal mass. Similarly concrete stair case can also be used as thermal mass. Other potential thermal masses can be beams and columns on the sides of South Side Windows. These RCC components of a building may be painted black or finished with dark coloured tiles to absorb heat of the South Sun during winter in day time which can release during night hours for regulating the temperature in a passive house during cold night hours. Thermal mass is effective in well insulated buildings only.

15. Electrical Wiring:

i. An **Electrical Room** of a minimum size of **6 x 6 square feet to** be provided to house the **Electrical Distribution Board**. This room must be located in a place that is **easily accessible** during emergencies such as fires, earthquakes, or other disasters, ensuring safe and quick access to the electrical system when needed. It is strongly advised to **avoid placing electrical enclosures** under staircases, as such locations tend to be **congested, unventilated, and inaccessible**, posing potential safety risks during emergencies. Proper placement of the electrical distribution system contributes to the overall safety and efficiency of the building.

ii. The electrical room should provide sufficient space for Distribution Board, Voltage Stabilizer, Batteries, Solar Inverter, AC/DC DB for Solar Roof Top, Conduits, Battery Water, Electrical Spares, Electrical Tools, Fire Extinguisher etc. In addition to this electrical room should also provide sufficient working space of at least 1 mtr in front of all equipment.

iii. The electrical room must be kept ventilated for exhaust of battery gases and for heat dissipation by the voltage stabilizer and the solar inverter.

iv. Concealed conduits may be preferred over surface conduits for safety and better aesthetics. Conduits may also be laid upto the roof for routing the wires of Solar Roof Top.

v. Since load of residential installations is generally more than 5kW, the three-phase wiring may be provided instead of single-phase wiring as per Discom standard. The phase current of three phase wiring is one-third of single-phase wiring. A 10kW load will draw around 45 Amps phase current from single phase supply on unity power factor. Same load will draw around 15 Amps per phase only from the 3-phase supply. The reduction in phase current to one third therefore improves quality and reliability of supply by improvement in voltage and reduction in faults due to overloading. The three-phase wring must be colour coded; Red for R-Phase, Yellow for Y-Phase, Blue for B-Phase, Black for Neutral and Green for Earth Wire. The colour coding helps in tracing of wires and faults. Wherever Smart Meters and AB Cables are laid by the Discoms, three phase supply is made available to every house. In case three phase supply is not available, still three phase wiring may be provided which can be easily interconnected and operated as single-phase wiring until three phase supply is made available by the Discoms.

vi. It is highly recommended to **use HRFR wires** in the electrical system. **HR** stands for **Heat Resistant** and **FR** stands for **Flame Resistant**. Unlike ordinary wires, which can catch fire and contribute to the spread of flames, **HRFR wires** are designed to **resist both heat and flame**, preventing them from catching fire and helping to reduce the risk of fire spreading throughout the building. This critical safety measure enhances the overall fire resistance of the electrical system.

vii. For loads upto 5kW, the single phase wiring may also be colour coded; Red for phase, black for neutral and green for earth.

viii. The wire size of service line shall be based on the load current and voltage drop calculation. The permissible voltage drop for house wiring in India is 2% of the supply voltage plus 1 volt for light load wiring, and 5% of the supply voltage for power load wiring. This shall be got done by a qualified electrical engineer.

ix. The wiring may be divided into two types of circuits; Critical Load and Non Critical Load. The Critical Load may include; Some Lights, Fridge, some Fans, some Electrical Blankets, Communication Equipment, an Electrical Iron of 500 Watt rating, Rice Cooker etc. The Non Critical Load may include; Geysers, Remaining Fans, Remaining Electrical Blankets, Electrical Room Heaters etc. The Critical Load may be fed from the Battery/ Inverter System when main supply fails and Non Critical Load may be fed directly from the mains.

x. Continuous Earth Wire must be provided and all earth pins of three phase sockets meant for Geyser, Electrical Iron, Rice Cooker, Oven, Fridge, Heat Convector, Radiator, Grinder etc. must be connected to Earth Wire. In case of fault in electrical appliances, the metallic body may get charged and pose risk of electrical shock to the family members. However, in case metallic body is earthed through appliance cord, plug top, plug socket and then to earth wire, the MCB feeding the appliance will trip and remove the risk of shock. The Earth Wire may be earthed through two electrodes of Copper or GI pipe or Copper Bonded Steel Rod at two locations preferably at a place which remains wet round the year. Earthing Chemical may be mixed with the backfill material of the earth pits to reduce earth resistivity for effective discharge of the earth fault current.

xi. RCCB to be provided to monitor the balance between the live and neutral currents in a circuit. If there's a leakage current, the RCCB immediately disconnects the circuit to prevent electric shocks and fires. RCCB stands for Residual Current Circuit Breaker, an electrical safety device that cuts off power when it detects a current leak. Leakage from electrical circuits can take place from wash room sockets under wet conditions or due to fault between wiring and steel rods of RCC or due to fault in electrical appliances etc.

xii. Under Voltage and Over Voltage Protection Devices are also available at affordable price in the market which may be provided for prevention of damage to home appliances under abnormal voltage conditions.

xiii. Modern homes may be provided with smart switches. The use of smart switches is picking up in Kashmir. These can be controlled locally or remotely through mobile App. These have also touch facility for local operation. The smart switches are the basic building blocks for home automation. Wi-Fi, Blue Tooth and other mobile communication technologies are being used for remote operation of these switches. If you have a micro grid at home comprising of multiple supplies like; grid supply, solar roof top and batteries, you can integrate same with home automation system for optimum utilization of the various energy sources. You can programme the switching operation of your geysers and HVAC in such a manner that the system will detect your return journey from your office through your mobile phone and keep hot water ready and ensure comfortable room temperature on your arrival.The system has the capacity to estimate the time of arrival and heating/cooling time taking into account traffic congestion, if any, en-route, which it takes from Google Maps. You can also schedule the on-off timing of devices. Motion sensors can automatically switch off certain devices when they detect that occupants have gone to rest. The system will also report to you in case it detects abnormal temperature, smoke or flame or intrusion in any part of the house, provided sensors are in place. Home automation requires open-source smart home platform like Home Assistant that allows users to connect and control a variety of devices in their home on different communication protocols.

xiv. The dry type Voltage Stabilizer may be preferred over oil filled ones for indoor use because transformer oil is highly flammable and may cause uncontrolled fire.

xv. It may be ensured that all switches are connected in the phase wire only, not in the neutral wire to ensure that phase voltage supply to the appliance is fully disconnected when the switch is put off.

xvi. In the areas with poor voltage profile, the service line, MCBs etc may be overrated depending upon the reduction in voltage from the standard level. Pertinent to mention the standard LT three phase voltage (line to Line) is 400 Volts and standard single phase LT voltage is 230 Volts.

xvii. Tall buildings, buildings on hills and lonely buildings are vulnerable to lightening strikes. These may be provided lightening protection by installation of Lightening Rod with spikes at the highest point of the building. The Lightening Rod shall be connected to a separate Earth Electrode through shortest length of down conductor which should not touch any metallic part of the building from the Rod upto Earth Electrode.

xviii. The electrical wiring system with proper location of Electrical Room and solar equipment may be got designed by a qualified electrical engineer for safety, reliability and for better quality of supply.

16. Sparrow Nests:

The disappearance of sparrows has been widely reported in India. The reduction in population may be 20 to 80% from various regions of country which is a matter of serious concern. Loss of habitat is a major reason for the decline of the house sparrow population in India. Other factors include pollution, the introduction of invasive species, and the replacement of natural habitats with modern infrastructure. Thatched houses of old houses provided living space for sparrow. It is therefore our duty to provide nesting space in our houses to prevent extinction of sparrows. Bird lovers have conducted research for design of sparrow nests. One such research has been conducted by Jawale Chetan, Department of Zoology H.P.T. Arts R.Y.K. Science College, Nashik 422005 (M.S). His online paper is available with title, "IMPROVED DESIGN OF NEST BOX FOR INDIAN HOUSE SPARROW, PASSER DOMESTICUS INDICUS". As per this paper the best dimensions for sparrow nest is 5 inch width, 6 inch height and 3 inch depth (Front to back). Round entry hole of 1.25 inch (32mm) is to be provided at a height of 3.50 inch from base. During experimentation it was observed that, when depth was reduced to 3 inch, nesting efforts were also reduced In the final designed no provision for the opening and cleaning was kept because it was observed that Passer domesticus indicus prefer to use the previous nesting material by little cleaning and addition into it. This may be reducing their nesting period and enabling them to use same nest box maximum time in the season. Ventilation slits keep the nest box airy and dry, where as drainage hole at the bottom help in case the eggs are broken. Successful Nesting was observed from 3 meter to 21 meter heights. Ideal height was found to be around 6 meters, with no restriction of directions. (However western side may not be preferred due to scorching and direct sun shine on that side during summers). The safe location for installation was keenly observed, where ever the nest boxes were fixed near the predator's approachable location, no nesting was found. When such nest boxes were shifted to safe location, they are attempted and used. Boxes with multiple nests can also be designed as depicted in the pics below:

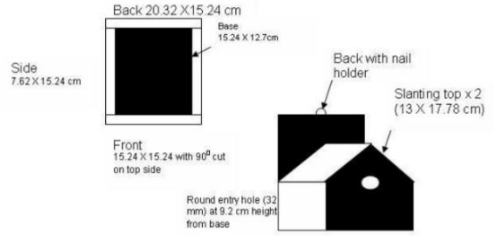
8. 

Fig. 2: Improved design of artificial nest box for Indian house sparrow.

Fig. 3: Improved artificial nest box used in present study.

9. 

17. Energy Conservation Tips at Home:

Inefficient and Crude Heating Gadgets not the be used:

Consumers who can't afford Electrical Geyser for heating water use crude water heating gadgets, locally known as "Boiler".The heater is immersed in water without any insulation between the coil and water. This may be the only electrical heating gadget on the surface of earth in which electricity remains in touch with water during operation. It is therefore a safety hazard. The metallic tap fitted in the water tank is generally earthed in crude manner. While in operation, two current paths are formed, one through the heater and other from heater to earth which causes huge loss of electricity.No thermal insulation for the water tank and no thermal cut off is being used due to which Energy Factor, ie the ratio of the energy in the heated water to the total energy consumed by the water heater is less than 50% which implies that more than 50% energy is lost to atmosphere. It does not conform to any national or international standard. The crude water heaters are therefore highest loss making devices.

Due to above disadvantages bare nichrome coils being used for these heaters are banned by the J&K Government.

The immersion rods are a better option for those who cannot afford electrical geyser. The electricity doesn't come in contact with water because heating element is electrically insulated. It is therefore safe. It has also got inbuilt thermostat which saves energy when water attains desired temperature. The heating element and thermostat can also be fitted separately. It should be fitted in the tank below water outlet so that it remains always immersed in water, otherwise it may get damaged.The tank should also be covered preferably with thermal insulation to prevent heat loss. In case water tank in which immersion rod is fitted, is not insulated thermally, the heat loss can be as high as 40%, therefore, the efficiency of these waters can also be very low of the order of 60% only.

10.

Crude Cooking Heater

Immersion Rod with Thermostat

18. Electrical Cooking Heaters:

In conventional cooking heaters lot of heat is wasted to surroundings . Electrical Energy is converted into heat energy in the nichrome coil of the heater. The heat is then transmitted to the cookware (pot or pan). In this process lot of heat gets wasted.

Most of the crude cooking heaters being used here are substandard and do not conform to any national or international standard. The efficiency of these heaters is expected to be still lower may be around 60% only.

Further like crude water heaters, conventional crude cooking heaters are also a safety hazard. Often boiling liquid spills over on to the bare nichrome coil creating a conducting path from the coil to the utensil and to the human body, which happens to touch the utensil at that point of time.

The heating element of Standard Coil Cooking Heaters is insulated electrically. It is therefore safe as compared to crude cooking heater.

The heat loss to surroundings is lower than crude cooking heater due to its design as the cookware is placed directly on the heater coil and most of the heat transfer is through conduction but still it is high in this case also, of the order of 30% because a good amount of heat gets lost to the surroundings. The efficiency of these heaters is therefore around 70% only.

Some customers confuse this heater with Induction Cook Top. It doesn't work on induction principle rather on the principles of heat transfer through conduction and radiation.

11.

Crude Cooking Heater

Standard Coil Cooking Heater

12. Induction Cooktops are 90% efficient because these transfer energy directly to the pots and pans on their surfaces, rather than heating the surrounding room.
An induction cooktop uses an electromagnetic field to directly heat cookware, which works by:
Passing an alternating electric current through a copper coil under the cooktop
Creating a magnetic field that induces an eddy current in the cookware
Combining the eddy current with the electrical resistance of the cookware to produce resistive heating.
These are the safest cooking electrical heating gadgets available in the market.

19. Rice Cookers:

Since rice cooker consists of an insulated exterior body, its energy efficiency is good because heat loss is minimal. The wattage of rice cookers ranges from 300 Watt to 1000 Watt. Rice cookers work by using a combination of heat, sensors, and a thermostat. It consists of an insulated exterior body with an inner bowl coated with a non-stick surface. When you add rice, and water to the cooker, and turn the power button on, the cooker's heating element starts to work. Once it hits the boiling point, the thermostat detects this. At this point, the cooker reduces the temperature and switches from 'cook' mode to 'keep warm' mode, depending on the model you have.

On the slow cooking mode, the consumption drops to about 30-45 watts. The reduced power in the heating element helps in maintaining a stable temperature to prevent the rice from overcooking

13.

Fire Safety Recommendations:
Lastly, it is crucial to ensure that **Fire Extinguishers** are placed in easily accessible locations throughout the building, particularly in areas where they can be quickly reached during emergencies such as fires or earthquakes. These fire extinguishers should be **refilled annually** to ensure they are always in optimal working condition.
Additionally, a **mock fire safety drill** should be conducted annually, ideally on a holiday to encourage full participation from all family members. During the drill, a fire should be lit specifically for this purpose, and the fire extinguisher should be used to extinguish it, allowing everyone to practice the procedure and become familiar with the equipment. This proactive approach helps ensure preparedness in case of an actual emergency.

Suggested further readings:

i. Draft J&K Energy Conservation Building Code (JKECBC), 2022
ii. Draft J&K Eco Niwas Samhita,2022
(ie Draft J&K ECBC for residential buildings)

Disclaimer:
The purpose of this guideline is to raise awareness among Engineers, Architects, Contractors, and House Owners about the design of energy-efficient homes suited to the cold climatic conditions of Kashmir. The recommendations provided herein are meant to serve as general guidelines for achieving energy efficiency in such environments.
However, it is essential that these recommendations be implemented only after thorough consultation with a **qualified Architect or Engineer** to ensure that the building's **structural integrity** and other critical design factors are not compromised. Each project may have unique requirements, and professional oversight is necessary to achieve optimal results while maintaining safety and compliance with local building codes.

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14. Readers are requested to furnish their valuable comments on this guideline on following e.mail address so that same could be incorporated in the next revision:

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