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A SUSTAINABLE CONSTRUCTION TECHNIQUES: VENTILATION AND LIGHTING IN ZERO ENERGY BUILDING

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Abstract: *This paper is an introduction to the Ventilation and Lighting techniques in Zero energy Building. The term zero energy building refers to buildings with maximum comfort conditions for the occupants during winter and summer, without traditional heating systems and without active cooling. Ventilation refers to the exchange of air inside the home, in the space inhabited by human occupants. It is separate from attic or roof ventilation and has a very different purpose. The results of a study conducted clearly demonstrates that the Primary Energy Demand for Electrical Appliances and Lighting remains very significant in Net Zero Energy Buildings.& Mitigation of Electric Lighting Power can be achieved by the way of Greenlighting Technology.*

Keywords: *Ventilation, Types of Ventilation, Lighting Techniques.*

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INTRODUCTION

Buildings have a significant impact on energy use and the environment. Commercial and residential buildings use almost 40% of the primary energy and approximately 70% of the electricity in the United States (EIA 2005). The energy used by the building sector continues to increase, primarily because new buildings are constructed faster than old ones are retired. Electricity consumption in the commercial building sector doubled between 1980 and 2000, and is expected to increase another 50% by 2025 (EIA 2005). Energy consumption in the commercial building sector will continue to increase until buildings can be designed to produce enough energy to offset the growing energy demand of these buildings. Toward this end, the U.S. Department of Energy (DOE) has established an aggressive goal to create the technology and knowledge base for cost-effective zero-energy commercial buildings (ZEBs) by 2025.

In concept, a net ZEB is a building with greatly reduced energy needs through efficiency gains such that the balance of the energy needs can be supplied by renewable technologies.

Ventilation refers to the exchange of air inside the home, in the space inhabited by human occupants. It is separate from attic or roof ventilation and has a very different purpose. It has two essential functions: to exhaust pollutants, moisture, and odors from inside the house to the outside, and to bring in outdoor air to mix with the indoor air. This guide is designed to help homeowners understand the need for indoor ventilation, the options for achieving a satisfactory ventilation system, and how to operate the system effectively. It is intended for both buyers of newly constructed homes and for those thinking of installing a ventilation system in their present home.

II. VENTILATION

Now all these closing the door and window is all well and good for temperature but comfort in a building is effected by several other factor,that can be negatively impacted by the attempt to fix the internal temperature. “Ventilation is a process by which we balance these other factor to create a much better living environment in the property.”

Need of Ventilation:-

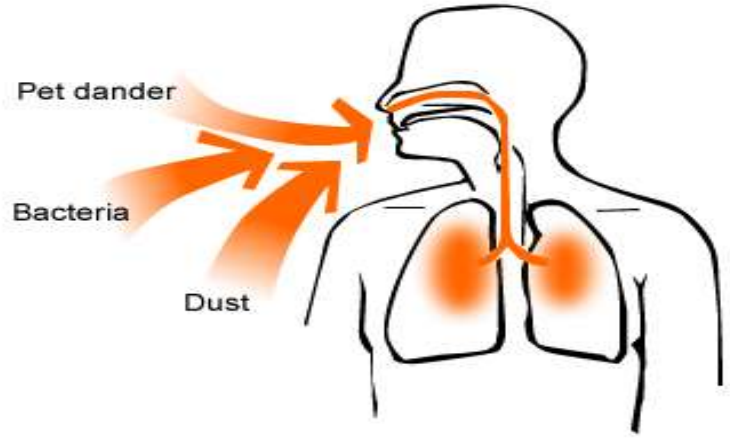
Quite often in a home, you want to maintain a pleasant temperature, usually around 23 to 24 degrees - not too cold nor not too hot. This is often achieved first by stopping the external temperature from interacting with the internal temperature, usually by closing all the

doors and windows. Then secondly by applying some form of temperature control to the internal space - so ensuring the temperature is in your personal 'Goldilocks zone' of comfort.

Disadvantages of Improper Ventilation:-

- **Indoor air quality:-**

For a typical home owner indoor air quality is a difficult thing to evaluate, but it plays a major role in your health and how comfortable or habitable your home is. Modern buildings are built to be airtight so as to improve energy efficiency, but shutting yourself off from fresh air can be very dangerous. This is why ventilation is a particularly important concern. Yes, there are air pollutants everywhere in the outside world, but there are just as many inside your home.



Indoor air quality can dramatically affect your health.

- **Poor ventilation:-**

Most of the time, sick buildings are created by inefficiencies with air conditioning and ventilation. The most common causes of sick building syndrome are a build-up of moisture and mould. Living in such a home can lead to eye, nose, throat or skin problems, or hypersensitivity. In fact, some figures suggest that up to 21% of asthma is caused by poor ventilation.

Types of Ventilation:-

➢ **Natural Ventilation:-**

Almost all historic buildings were ventilated naturally, although many of these have been compromised by the addition of partition walls and mechanical systems. With

an increased awareness of the cost and environmental impacts of energy use, natural ventilation has become an increasingly attractive method for reducing energy use and cost and for providing acceptable indoor environmental quality and maintaining a healthy, comfortable, and productive indoor climate rather than the more prevailing approach of using mechanical ventilation. In favorable climates and buildings types, natural ventilation can be used as an alternative to air-conditioning plants, saving 10%-30% of total energy consumption.

Description:-

Natural ventilation, unlike fan-forced ventilation, uses the natural forces of wind and buoyancy to deliver fresh air into buildings. Fresh air is required in buildings to alleviate odors, to provide oxygen for respiration, and to increase thermal comfort. At interior air velocities of 160 feet per minute (fpm), the perceived interior temperature can be reduced by as much as 5°F. However, unlike true air-conditioning, natural ventilation is ineffective at reducing the humidity of incoming air. This places a limit on the application of natural ventilation in humid climates.

A. Types of Natural Ventilation Effects:-

Wind can blow air through openings in the wall on the windward side of the building, and suck air out of openings on the leeward side and the roof. Temperature differences between warm air inside and cool air outside can cause the air in the room to rise and exit at the ceiling or ridge, and enter via lower openings in the wall. Similarly, buoyancy caused by differences in humidity can allow a pressurized column of dense, evaporatively cooled air to supply a space, and lighter, warmer, humid air to exhaust near the top.

B. Design Recommendations:-

The specific approach and design of natural ventilation systems will vary based on building type and local climate. However, the amount of ventilation depends critically on the careful design of internal spaces, and the size and placement of openings in the building.

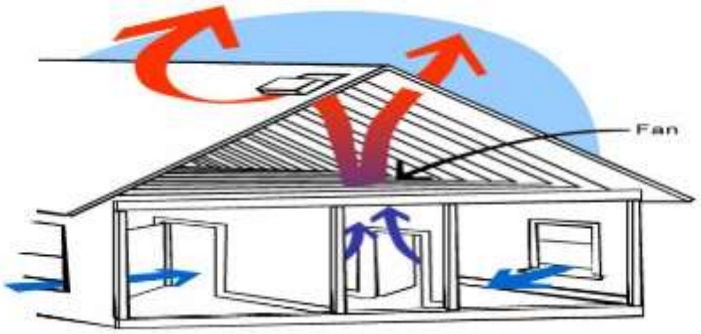
- Maximize wind-induced ventilation by siting the ridge of a building perpendicular to the summer winds.
- Naturally ventilated buildings should be narrow.
- Each room should have two separate supply and exhaust openings. Locate exhaust high above inlet to maximize stack effect. Orient windows across the room and offset from each

other to maximize mixing within the room while minimizing the obstructions to airflow within the room.

- Window openings should be operable by the occupants.
- Provide ridge vents.
- Allow for adequate internal airflow.
- Consider the use of clerestories or vented skylights.
- Provide attic ventilation.

➢ **Mechanical Ventilation:-**

Mechanical or powered ventilators are a step up from natural ventilation (like wind-driven ventilation) in that they create a more powerful and controllable cooling effect, but they also carry the price tag that reflects this difference. Powered ventilators are particularly important in passive style houses that are sealed tightly, where natural ventilation isn't a viable option. Because of the control they allow, they're also a lot more reliable in providing fresh air (without pollutants) and help to prevent unwanted temperature fluctuations.



***A whole house fan is an example of mechanical ventilation*.**

Types of mechanical ventilators:-

There are three main types of powered ventilators – exhaust fans, heat recovery ventilators (HRVs) and energy recovery ventilators (ERV). These systems forcibly remove warm, stale or humid air from your home and replace it with fresh air, usually a lot faster than natural alternatives. Heat recovery ventilators and energy recovery ventilators also help to regulate the indoor temperature.

Exhaust fans :-Exhaust fans are most often found in bathrooms and kitchens, and are designed to forcibly remove steam and odour from these areas. They work by sucking air out from a localised area through a vent, then transporting it outdoors through a duct.

Heat recovery ventilators (HRVs):- Heat recovery ventilators are complicated devices that help to ventilate a room with fresh air while maintaining warmth. HRVs use heat exchange technology to capture the warmth and use it to actively heat the incoming fresh air.

Energy recovery ventilators(ERVs):- Less common and more expensive than HRVs, ERVs can best be described as the ventilation equivalent of reverse cycle air conditioners, in that they can be effective for both cooling and heating a space. While very similar to HRVs, ERVs also capture any moisture in older air and uses it to cool warmer air in summer months. HRVs are considered to be a specific, single purpose type of ERV.

- **Active Ventilation:-**

Active ventilation often uses a powered fan to either push air into the house or suck air out of the house both have the same end resulting in making the air to be changed with the outside.

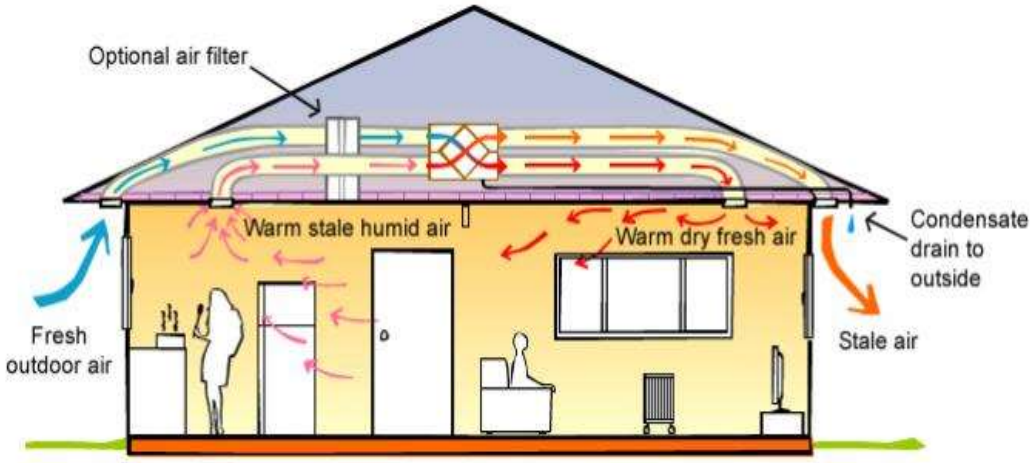
Now given that there is a fan employed , you can play around with where that fan is deployed and to where the air is sent to get additional benefits .For instance a roof or attic base fan combined with an air filter allow one to use the warmer air in the roof in winter to provide heating to your house whilst changing the air for cleaner air. The other benefit with this approach if you get what is termed ”Passive pressure ventilation”. i.e. pressure is higher in the house than outside. So unclean air from outside can not get in the property.

- **Passive Ventilation:-**

Passive ventilation typically relies on using physical principles like the thermal updraft that naturally results from the tendency of warm air to rise and cool air to sink, and by the effect of cross ventilation, by creating unimpeded air flow through building.

Many passive ventilation systems rely on the building users to control windows and vents as dictated by site conditions and conditions within the building. The building's situation and relation to land forms or, for example, adjacent woods, determines the capacity for passive ventilation to be effective in cooling and ventilating a building.

- **Heat Recovery Ventilator (HRV):-**



HRVs remove stale air, while transferring heat to incoming fresh air.

A heat recovery ventilator (or HRV) is a ventilation system that is able to remove stale air and bring fresh air into the home, while at the same time using the heat from the air being removed to either heat or cool the incoming fresh air. These systems are popular in homes with a tight building envelope because of the degree of control they allow over both ventilation and heating systems.

III. LIGHTING

Lighting accounts for around 15% of the energy bill in most homes, and around 25% in commercial buildings. It is supplied by electrical power plants using fossil fuels, and is responsible for a significant percentage of carbon dioxide emissions, a leading cause of global climate change. Because of this, the building industry has targeted lighting as a key element in sustainable design, and there is now a global movement to develop and implement lighting solutions that meet people's needs and concerns, and address environmental regulations.

- **Daylighting:-**

A skylight providing internal illumination

Daylighting is the practice of placing windows or other openings and reflective surfaces so that during the day natural light provides effective internal lighting. Particular attention is given to daylighting while designing a building when the aim is to maximize visual comfort or to reduce energy use. Energy savings can be achieved either from

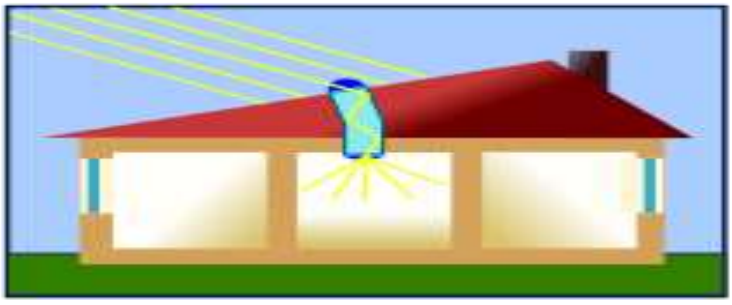
the reduced use of artificial (electric) lighting or from passive solar heating or cooling. Artificial lighting energy use can be reduced by simply installing fewer electric lights because daylight is present, or by dimming/switching electric lights automatically in response to the presence of daylight, a process known as daylight harvesting.

- **Skylights:-**

Oculus at the Pantheon

Skylight is any horizontal window, roof lantern or oculus, placed at the roof of the building, often used for daylighting. White translucent acrylic is a 'Lambertian Diffuser' meaning transmitted light is perfectly diffused and distributed evenly over affected areas. This means, among other advantages, that light source quality standards are measured relative to white acrylic transmission. White acrylic domes provide even light distribution throughout the day. Skylights admit more light per unit area than windows, and distribute it more evenly over a space.

- **Light tubes:-**



Another type of device used is the light tube, also called a solar tube, which is placed into a roof and admits light to a focused area of the interior. These somewhat resemble recessed ceiling light fixtures. They do not allow as much heat transfer as skylights because they have less surface area. Tubular Daylighting Devices (TDDs) use modern technology to transmit visible light through opaque walls and roofs. The tube itself is a passive component consisting of either a simple reflective interior coating or a light conducting fiber optic bundle. It is frequently capped with a transparent, roof-mounted dome 'light collector' and terminated with a diffuser assembly that admits the daylight into interior spaces and distributes the available light energy evenly (or else efficiently if the use of the lit space is reasonably fixed, and the user desired one or more 'bright-spots').

- **Occulus:-**

An Oculus, circular window, or rain-hole is a feature of Classical architecture since the 16th century. They are often denoted by their French name, oeil de boeuf, or "bull's-eye". Such circular or oval windows express the presence of a mezzanine on a building's façade without competing for attention with the major fenestration. Circular windows set in dormers have been a feature of French Classical architecture since the beginning of the seventeenth century. For structural reasons, they are also found as the portholes of ships.

Oculus (plural oculi) is the Latin word for eye,[1] and the word remains in use in certain contexts, as the name of the round opening in the top of the dome of thePantheon in Rome, and in reference to other round windows, openings, and skylights.

III. CONCLUSION

- Primary Energy Demand for Electrical Appliances and Lighting remains very significant in Net Zero Energy Buildings.
- Mitigation of Electric Lighting Power can be achieved by the way of Greenlighting Technology (LPD ≈ 3.5 W/m2).
- Integration of Highly Efficient Daylighting and Electric Lighting Systems are basic for Greenlighting Technology .
- Focus must be placed on other Electrical Appliances than Lighting as well as on Embodied Energy for Net Zero Energy Buildings.

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