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GREEN TECHNOLOGIES FOR SUSTAINABLE BUILDING

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Abstract: *Nowadays, there are so much pollution and problem to the earth which make the human realize to work on something in order to save the world holistically.. Meeting made by United Nation (UN) to take this issue as a main agenda is being use by all country around the world. It might take a long time to make sure the process of agenda being using around the world. Green Building Index (GBI) indicator and Agenda 21 for sustainable development have been introduced to decrease the effect of pollution during the development and surrounding. Since the industrial Revolution, the world has witnessed incalculable technological achievements, population growth, and corresponding increases in resource use. We are recognizing the side effects of human activities like population landfills at capacity, toxic waste, global warming, resource and ozone depletion, and deforestation. These efforts are straining the limits of the Earth's carrying capacity and its ability to provide the resources and required to sustain life while retaining the capacity to generate and remain viable. As the world's population continues to expand around the world, the implementation of resource-efficient measures in all areas of human activity is imperative and the build environment is one clear example of the impact of human activity on resources. Buildings have a significant impact on the environment, accounting for one-sixth of the world's freshwater withdrawals, one-quarter of its wood harvest and energy flow.*
Keywords: *green technology, green building, sustainable development, global warming*

INTRODUCTION

Green technology is a technology whose use is intended to mitigate or reverse the effects of human activity on the environment. Green Technology is the development and application of products, equipment and systems used to conserve the natural environment and resources, which minimizes and reduces the negative impact of human activities.

The green technology definition explained here basically gives you an idea about the messing up of the environment due to human intrusion and the important need to slow down and adopting healthier ways towards life. By adopting green technology wisely, the earth can be protected against environmental pollution (Ahmad and Abughres, 1985).

Green Technology is the development and application of products, equipment and systems used to conserve the natural environment and resources, which reduce the negative impact of human activities. It is believed to overcome environmental degradation and natural resources, improve health and lives, protect ecosystems, costs to the government in its efforts to migrate the impact of development and serve as an alternative in order to boost the economy. There are some criteria of the green technology (Carpenter, 1994):

i. *Minimizes the degradation of the environment*
ii. *Zero or low green house gas emission to the surrounding.*
iii. *Safe for use and promotes healthy and improved environment for all forms of life.*
iv. *Conserves the use of energy and natural resources*
v. *Promote the use of renewable resources or energy like solar energy and rainwater)*

The green technology nowadays is use not only save the cost for long term, but also friendly to the earth and renewable energy that being less maintenance. There are examples of the green technology:

1) *Solar panel or solar tube- Solar panel and solar tube is using to decrease using an electricity supply by TNB and it also save the cost for the long term.*
2) *Natural Ventilation-Nowadays, air-conditioning is most famous useful for ventilation. However, the cost for the electricity is expensive. By using natural ventilation, it can decrease the electricity cost (Ahmad and Abughres, 1985)..*
3) *Rainwater Harvesting-This is an old technology but not practice by all designer and people. Rainwater can be used for daily purpose. However, It need a some system to make sure the water is clean.*

TECHNOLOGIES FOR SUSTAINABLE BUILDING

In order to discuss the technologies for sustainable building, it will be discussed on the following main areas:

i. Energy
ii. Water Technology
iii. Natural Lighting
iv. Natural Ventilation

Energy

✓ *Passive Solar*

In passive solar building design, windows, walls, and floors are made to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. This is called passive solar design or climatic design because, unlike active solar heating systems, it doesn't involve the use of mechanical and electrical devices. The key to designing a passive solar building is to best take advantage of the local climate. Elements to be considered include window placement and glazing type, thermal insulation, thermal mass, and shading. Passive solar building design not only suitable in tropical country but also four seasons country since it is based on the building design not the climate. For example its stressed more on the openings like the degree window (Labs, 1988).

Figure 1 shows how the opening can have a direct lighting into the building. It does not use any technology, its by playing around with the windows door and louvers. It not only for lighting it also suitable for ventilation.

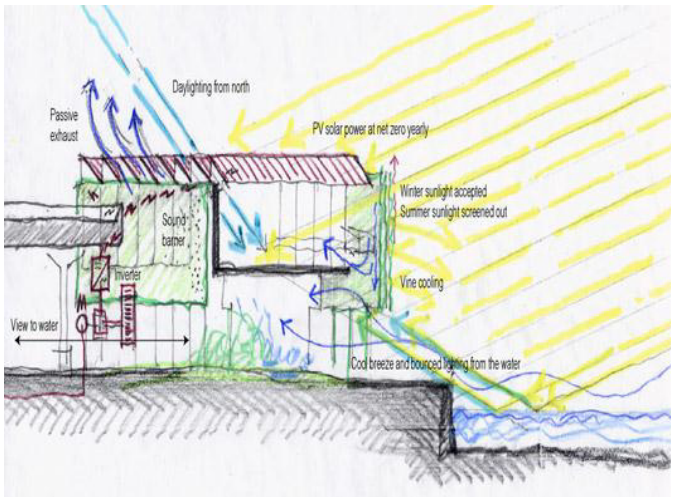

Figure 1. Function of opening to direct natural lighting into the building

✓ *Heat Pumps*

Heat pumps use the time proven refrigeration cycle to transfer heat from a source such as the ground, the ambient air or water through a heat distribution circuit to an internal space. A working fluid (or refrigerant) is driven around a circuit, comprising an evaporator, compressor , condenser and an expansion valve. The heat source transfers heat to liquid refrigerant, which causes it to evaporate. The refrigerant is now at a low temperature and pressure it then enters the compressor where the temperature and pressure are increased, as a result of work done by the compressor (Golany, 1983).

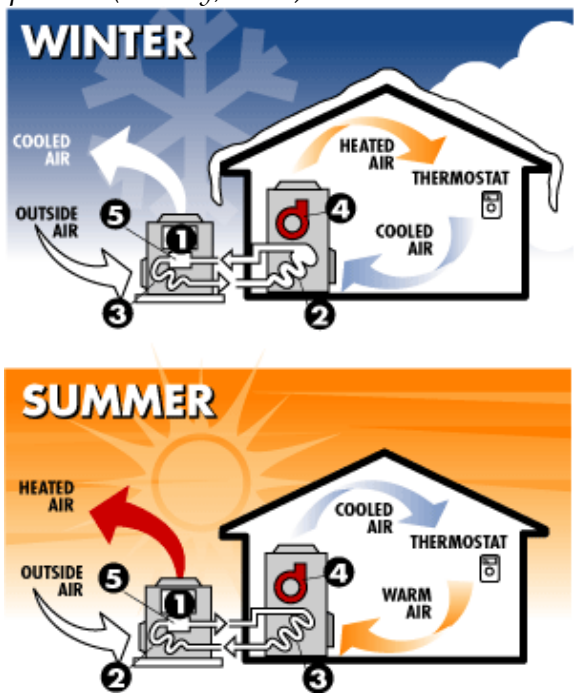

Figure 2. Heat Pump mode of operation during winter and summer

The refrigerant gas enters the condenser, where the heat absorbed by the refrigerant in the evaporator, is released to be used in the building, via low a low temperature distribution system, such as underfloor heating or low temperature radiators. The refrigerant, which is still in the form of a gas but reduced in pressure and temperature, is throttled back further in the expansion valve before the cycle starts again (Ahmad and Abughres, 1985).

Heat pumps will consume electricity, since it is requires by the compressor. However, for every one units of heat energy is produced. The total amount of heat energy delivered to the building is equal to the energy input through the compressor, plus the energy extracted from the heat source.

Figure 2 shows how heat pumps works. During summer time it will pumps cooled air into the house while during winter it will pump hot air into the house to heat the house. Usually heat pumps is used at 4 season country since they will faced high temperature during summer and low temperature during winter (Golany, 1983).

✓ ***Solar Energy***

Solar photovoltaic cells (PVs) offer a clean way to produce electricity for use in our buildings. whilst a solar cell will produce the largest amount of power on a clear, bright sunny day, even on comparatively dull days, a solar array will still be providing cheap, green electricity.

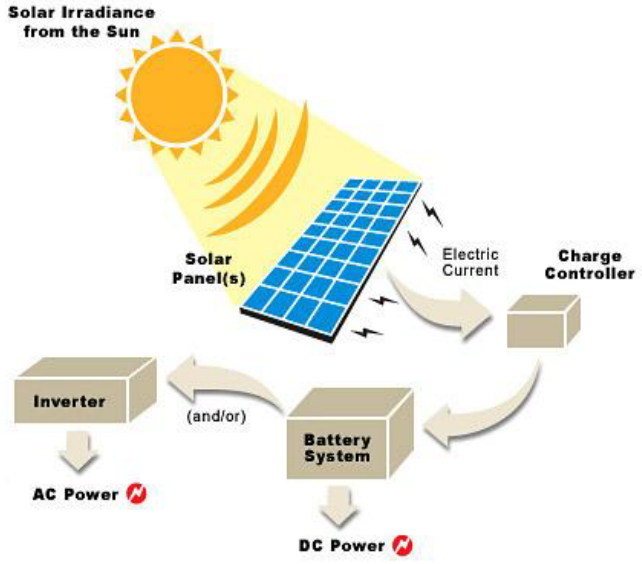

Figure 3. Energy generated from solar irradiance through solar panels

The amount of power a solar cell produces is proportionate to the amount of light that it receives. The more light the more power. The building must be placed in an area with maximise sun and minimise obstruction. Figure 3 shows how energy is generated from solar irradiance through solar panels (Golany, 1983).

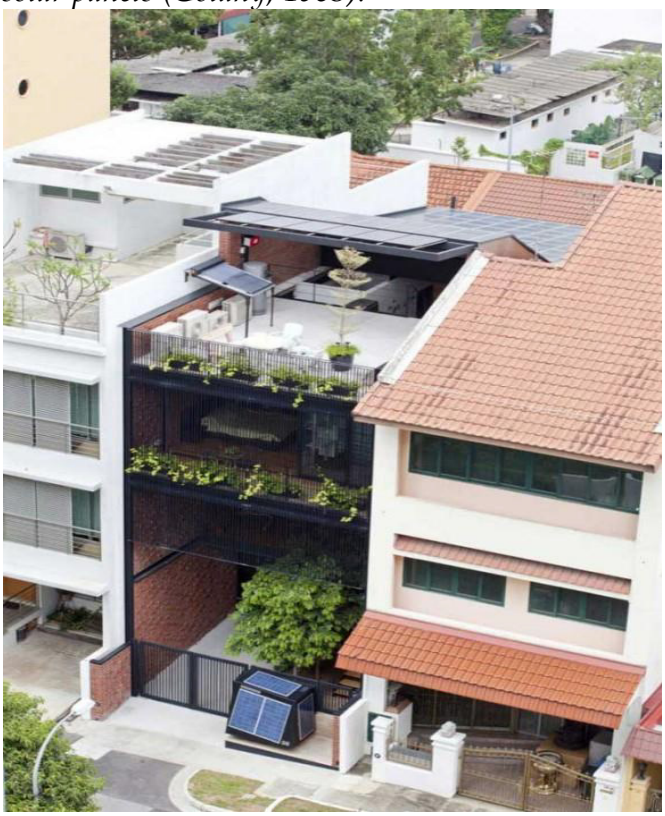

Figure 4. Building fixed with photovoltaic panels

Figure 4 shows a building that has been fixed with photovoltaic panels which generate the Hybrid DC air-conditioner. To power a DC hot water heater for a zero to low energy system, the solar thermal collectors are also installed. Building Integrated Photovoltaic (BIPV) panels clad entire roof (Golany, 1983).. An innovative BIPV and ceiling composite design integrates ventilation slots, water, and heat and noise insulation so that the BIPV ceiling composite roof replaces the need for the conventional roof. PV external landscape lighting is also installed. And to achieve a zero to low energy residence, all artificial lights are energy efficient LEDs (Goldfinger, 1969). To further promote a green lifestyle, a solar charging unit integrated with the external metering compartment has been fitted for charging of electronics and solar bicycle.

Water Technology

✓ ***Water Harvesting***

The principle of collecting and storing rainwater are fairly simple and easy to follow. The water

must be stored in the dark below 18°C, and then the system will supply clean, perfectly usable water for most purposes other than drinking (Kumar et' al., 2007). The water is collected by normal roof gutters and is directed to the rainwater filter where the water is separated from leaves and other debris at the bottom of the rainwater downpipes (Figure 5).

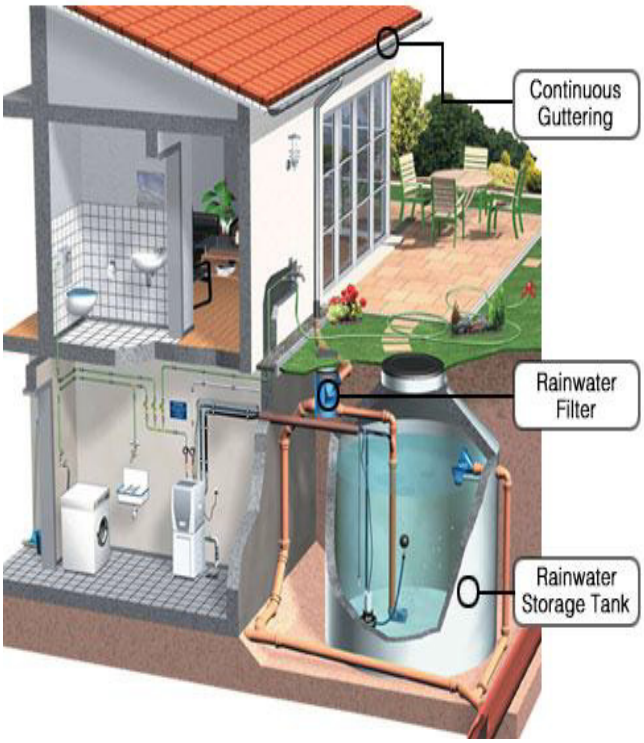

Figure 5. Principle of water harvesting

✓ ***Aqueduct System***

An aqueduct is system that water supply or navigable channel constructed to convey water. The term of engineer is used for any system of pipes, ditches, canals, tunnels, and other structures used for this purpose. The word is derived from the Latin aqua (water) and ducere (to lead).

In a more restricted use, aqueduct (occasionally Water Bridge) applies to any bridge or viaduct that transports water instead of a path, road or railway across a gap. Large navigable aqueducts are used as transport links for boats or ships. Aqueducts must span a crossing at the same level as the watercourses on each end (Goldfinger, 1969). Figure 6 shows and example of house in India that use aqueduct irrigation system with water harvested from four on-site wells, which also provide water for the house. Locally quarried black basalt stone was used to construct aqueducts, boundary walls, plinths, and paving. Four wells on the site supply the house with water as well as irrigating the plantation via aqueducts, which are typical of the area (Schoenauer, 1981).

Figure 6. Palmyra house in India that utilizes a local aqueduct irrigation system with water harvested from four on-site wells

Natural Lighting

Natural light occurs as a by product of natural chemical processes. This is because when electrons get excited enough to jump an energy level and then return to their original energy level, the extra energy is released as photons, which are light. Light originates from stars like the sun, so solar light is the form of natural light with which people are most familiar and use most. It also can occur as a result of chemical processes on or in the earth (Goldfinger, 1969).

Natural light has several benefits when compared to artificial light. The production of artificial light requires the consumption of some kind of fuel, such as coal or petroleum, to produce electricity. The consumption of these fuels produces emissions and other waste products. In contrast, no fuel is needed to produce natural light, since the light is a by product of natural reactions. Also, natural light because it doesn't require fuel is free. Resources for artificial light production are limited when compared to the chemical reactions that produce natural light (Carmody and Sterling, 1984)

Light sources can be either natural or artificial. Sun is the primary source of natural light, and lightbulbs or lamps are the artificial sources. Light is a form of electromagnetic energy that, in the case of natural light, comes from the sun as the source and, in case of artificial light, illuminates via

energy from another source. No matter what the source, light has an impact on life on earth as a whole

Natural light is self-generated and comes in a spectrum of colors the visible colors of the rays we experience. The colour spectrum contains light with shorter wavelengths near the violet on one end and light with higher wavelength near the red (Carmody and Sterling, 1984). Called ultraviolet and infrared rays respectively, these rays are not visible to us. The complete spectrum of light from the natural source is ideal for plant and animal life on earth. Plants and animals thrive on natural light. The darkness that follows photo activity in organisms helps rejuvenate and repair life forms at the cellular level. A moderate amount of exposure to the healthy sunlight benefits humans, as it increases one's energy and metabolism, boosts the immune system and helps build vitamin D --- all of which are essential for the body. Overexposure, on the other hand, has detrimental effects on living organism. The harmful ultraviolet rays can cause conditions such as skin cancer and cataracts while also damaging the texture of the skin. For plants, the need for light and dark periods helps balance the cell activity in terms of growth and repair. Sunlight is also harmful since we cannot alter or control it to suit our condition (Carmody and Sterling, 1984).

Artificial light is man-made light generated from another energy source. Most of our activities would come to a halt if we didn't have an alternate source of light. The advantage with this light lies in the fact that we can control it at our own will. We can monitor the intensity, quantity and quality of light to suit each situation. Artificial light does not have as broad a spectrum of colors and wavelengths as natural light; hence, it is not as beneficial. Since the light has comparatively poorer quality, its effect on plant and animal life is also not as beneficial. Plants and animals exposed for prolonged periods to artificial light tend to yield poorer quality of life forms in plants and cause cellular degeneration or death in living beings.

✓ ***Design with Retractable Awnings***

Design isn't an item. Design is a strategy. Retractable awnings can improve the lighting of a room or save cash just by being installed. But you can actually maximize your investment and get genuinely spectacular results with a small bit of planning (Schoenauer, 1981).

First and most important: look at the fabric. High-good quality retractable awnings (even in budget lines) use solution-dyed acrylic. It is a durable, stain-resistant, fade-resistant fabric with excellent color top quality. Even better, it is approved by the American Skin Cancer Association for its UV protection (Schoenauer, 1981). Simply because solution-dyed acrylic is synthetic, it is accessible in an astonishing array of colours and patterns. For maximum impact on natural lighting designs, think about retractable awnings fabrics in warm, honey-coloured tones like dark yellows, beige, orange, or cream. That palette provides really soft colour that reduces glare although still being bright and cheerful.

Another significant factor are accessories for the retractable awning. Motors are a cinch motorized retractable awnings are used four times much more usually than manual retractable awnings according to business research. Other features like remote controls or switches permit awnings to be installed in otherwise inaccessible areas – over really high windows, sides of buildings, or over walkways – and be opened and closed easily. Other attributes like timers, wind sensors, and rain sensors can protect the retractable awning in threatening weather (and times with lowlight, when any natural light should be maximized).

And constantly keep in mind to look at the frame. Virtually all of the function of a retractable awning comes from what it offers indoors (light control, energy efficiency) but its beauty comes from how it looks outside. There are numerous frame styles, and high-end assemblers can custom-size retractable awnings to the inch. Strategies where you require an awning based on your lighting and energy needs inside – but match the style to the outside for the greatest curb appeal (Carmody and Sterling, 1984).

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

(Schoenauer, 1981). 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 Design***

The most sustainable lighting is natural daylight. It is not only a free renewable resource but it also has well-documented health benefits. Careful architectural design is required to maximise natural light in a building while maintaining indoor temperature regulation and reducing direct light glare. The strategic placement of windows, skylights, light shafts, atriums and translucent panels in harmony with other building components, such that light is reflected evenly throughout internal spaces, is known as daylighting design.

i. Sunlight Transportation Systems

An emerging new technology is that of sunlight transportation. Natural sunlight is collected on roof panels and transported into a building via fibre optic cables for distances up to 15 metres. These sunlight-piping systems can be used in combination with solar panels to integrate natural and artificial light systems, so that there is always light in the home.

ii. Energy Efficient Light Bulbs

The sustainable building industry is primarily focused on energy efficient lighting solutions. Standard light bulbs, known as incandescent bulbs, are known to be highly inefficient. Electricity is passed through a metal (tungsten) filament that heats to over 2000º Celsius and glows to give off light. Only 10% of the electrical energy is converted to light; 90% is wasted as heat. Halogen bulbs are similar but instead have a small pocket of halogen gas that reacts with tungsten to produce light. They burn brighter, use less electricity and last twice as long as a standard bulb, but are still inefficient compared with other forms of bulbs (Schoenauer, 1981).

Energy efficient light bulbs use significantly less energy than incandescent bulbs, and also last longer. There are two main kinds: Compact Fluorescent Lights and Light Emitting Diodes.

iii. Compact Fluorescent Lights (CFL)

These are small versions of full fluorescent lights, and consist of a glass tube coated with phosphor, filled with gas and a small amount of mercury. Electricity jumps off electrodes on the end of each tube, and excites the mercury molecules to emit ultraviolet light. This excites the phosphor coating, which emits visible light that shines out of the tube. CFLs give off the same amount of light as incandescent bulbs, but they are up to 80% cooler, are 4 times more energy efficient (to replace a 60-watt incandescent, you only need a 15-watt CFL), last 10 times longer (up to 20,000 hours), and are responsible for the emission of 70% less carbon dioxide (Schoenauer, 1981).

CFLs come in many different configurations and wattages, and are suitable for all lighting purposes. Although more expensive to buy than a standard bulb, they easily recover their costs in energy savings. On the downside, they contain trace amounts of mercury, which is hazardous to health and the environment. Care needs to be taken to ensure the glass tube doesn't break and that the bulbs are disposed of safely (Schoenauer, 1981).

iv. Light Emitting Diodes (LED)

LEDs are small, solid light bulbs that are lit by the movement of electrons in a solid semi-conductor material as electricity is passed through it. This is also called 'solid state lighting', because it uses a solid material, as opposed to gas (CFL) or filament (incandescent). LEDs are extremely energy efficient, lasting over 100 times longer than incandescent bulbs, and up to 10 times longer than CFLs. They have low heat generation, low power requirements, and are highly durable because there is no filament or tube to break.

LED is a relatively new technology, and currently the bulbs are most suitable for track and recessed lighting, where a pointed light is required rather than radiated light. They are more expensive than CFLs, but energy savings over their lifetime means their cost is soon recouped. Because their power inputs are minimal, LEDs are readily combined with solar panels to provide reliable, energy efficient lighting day and night.

v. The Future is Bright

Along with technological solutions like energy efficient light bulbs, and using renewable energies

for their electricity source, simple practices such as turning lights off, using dimmers and timing switches can all help to make lighting more environmentally friendly. Unfortunately these practices are not yet available with all energy efficient bulbs. Furthermore manufacturers still need to address issues of waste, pollution and energy in their products' life cycle. The building industry is committed to reducing the environmental impact of lighting, and new buildings now include lighting design issues from the outset. While there is still a long way to go before lighting can be said to be truly sustainable, the future of sustainable lighting looks bright

vi. Sustainable Lighting

Sustainable lighting plays an important role in green building and energy efficiency. Designers in this field select fixtures and lighting technologies that balance current needs with the needs of future generations. Sustainable lighting design allows current occupants to perform tasks with ease and comfort while minimizing short- and long-term environmental damage (Schoenauer, 1981).

Natural lighting and passive solar design play an important role in sustainable lighting, according to "Architectural Lighting Magazine Online." Designers position the building to maximize daylight and reduce the need for electric lights. Buildings designed with sustainability in mind often feature a large number of windows and skylights, which are strategically located to provide light where it's most needed. Instead of complex overhead lighting systems, these buildings utilize appropriate task lighting and energy-efficient technologies. Many also include motion sensors and timers to switch lights off automatically and minimize wasted energy.

Natural Ventilation

Natural ventilation is the process of supplying and removing air by means of purpose-provided aperture (such as openable windows, ventilators and shafts) and the natural forces of wind and temperature-difference pressures. Natural ventilation may be divided into two categories:

i. Controlled natural ventilation is intentional displacement of air through specified openings such as windows, doors, and ventilations by using natural forces (usually by pressures from wind and/or indoor-outdoor temperature differences). It is usually controlled to some extent by the occupant (Aughenbaugh, 1980).

ii. Infiltration is the uncontrolled random flow of air through unintentional openings driven by wind, temperature-difference pressures and/or appliance-induced pressures across the building envelope. In contrast to controlled natural ventilation, infiltration cannot be so controlled and is less desirable than other ventilation strategies, but it is a main source of ventilation in envelope-dominated buildings.

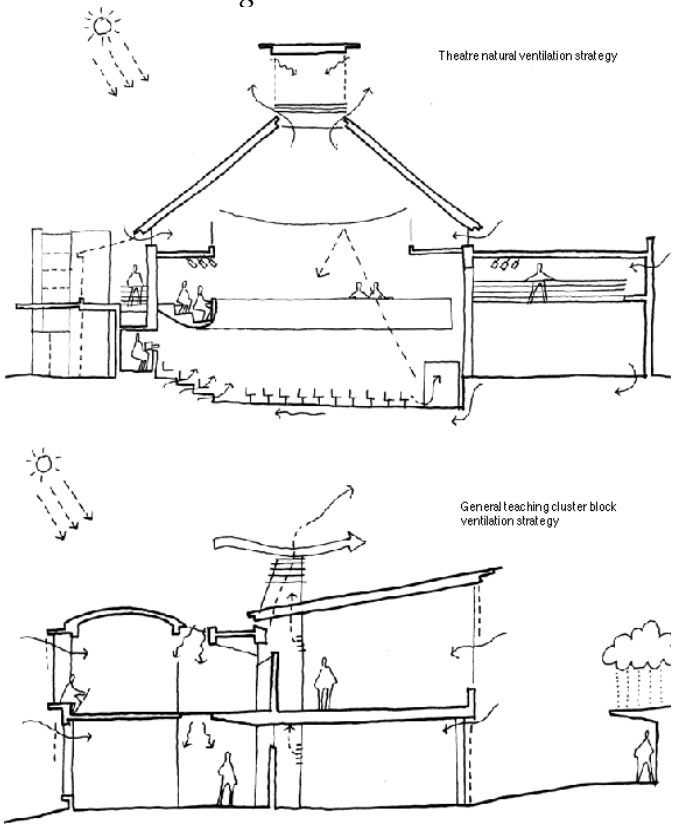

Figure 7. Natural ventilation strategy

Figure 7 shows the natural ventilation strategy. For air to move into and out of a building, a pressure difference between the inside and outside of the building is required. The resistance to flow of air through the building will affect the actual air flow rate. In general, controlled natural ventilation and infiltration are driven by pressure difference across the building envelope. The pressure difference is caused by:

- *wind (or wind effect);*
- *difference in air density due to temperature difference between indoor and outdoor air (stack or chimney effect); or*
- *combination of both wind and stack effects.*

CONCLUSIONS

Future building design should aim to cause the minimum possible harm to both users and the environment. This philosophy should be incorporated throughout the design, construction, use, repair and eventual end of life recycling of the building. Green building, as a concept, is straightforward and makes perfect sense. It means making thoughtful design choices and using ecological materials in ways that create quality, long-lasting environments with minimum damage to the planet. Natural ambient resources (sunshine, light, wind and rain) can and should be used for services such as energy, heating, cooling and water.

Solar and wind energy can be utilised at many sites and we should make better use at many sites and we should make better use of these independent, renewable resources. Using renewable energy makes us more dependent on climate and reduces or vulnerability to scarce, imported and increasingly costly fossil fuels.

The natural daylight can be used to displace the need for artificial lighting. However, glazed openings are often associated with excessive heat loss in winter and gains in summer and should be designed carefully. Artificial lighting is needed when there is insufficient daylight and lighting system and their control to maximise efficiency. In the heating section, passive solar heating can be used to displace the use of fossil fuel.

The availability of water depends on the amount of rainfall, the catchment area, the quality and extent of the treatment and distribution infrastructure. System of rainwater harvesting is collect rainwater from a down sprout draining the roof. Rainwater harvesting needs to be considered as a part of long term and overall environmental plan towards more sustainable development.

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