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Accommodating of Climate Changes by Using Renewable Energy in The Sustainable Building Design

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Abstract: This study attempts to understand the energy efficiency main features for different building types that help to improve the performance in the future especially through climate change and its impacts. It is essential for this study to define Sustainable Architecture within the wide scope of energy and its efficiency. As well as analyzing and evaluating the energy performance that improves the buildings. It should be notified that the concept adopted here is to meet the needs of the present without compromising the ability of future generations to meet their own needs. The technical factors which followed in the study offers the main criteria through three elements: climate, energy, and materials. These issues are providing a comfortable and efficient building, therefore, the design solution to an environmental building is completely different from one building to another. So, it is important to understand the new design philosophies and the relationships between internal and external interfaces, which affect the building performance. The research also emphasizes the importance of the energy efficiency as a national interest. Therefore, the study evaluates the positive and negative points in a case study. Furthermore, shows how architects treat these aspects and strategies in their buildings, which had an essential impact all over the world. This study aims to discuss the sustainable building which depends on the environmental sustainable aspects and the renewable energy elements isn't used for the luxury design only but also it is necessary for the ideal architectural design. This design must be used in a widely scope not only for rich buildings but also for conventional buildings.

Keywords: Sustainability, Climate Change, Double Skin, Zero Carbon city, Renewable Energy

1. Introduction:

The quest for environmental values in architecture for a harmonious balance between man and his surroundings is not new. For centuries, and particularly in vernacular architecture, people adopted this approach out of necessity. Since the industrial revolution, it has been increasingly abandoned in favour of man's belief in his ability to unrestrictedly draw the earth's resources. [1]
Today the effects of climate changes which first became evident in the 20th century, are becoming increasingly apparent. This led international conferences to be held, and agreements to be made, to try to save the environment in which we live. These began with the Day of Earth in 1970, passing by Nation's Rio Earth Summit and the Agenda 21 plan in 1992, and the Kyoto Agreement in 1996. The latter stated that progress should be made in three areas: [2]
Reductions in energy consumption, Replacement of energy from fossil reserves by energy from renewable resources also, Zero Carbon city.

2. Definitions:

2.1 Sustainable Development:

Sustainable Development should be notified that the concept adopted here is to meet the needs of the present without compromising the ability of future generations to meet their own needs. as a process designed to create new relationships with the earth. [1]

2.2 Sustainable Architecture:

A basic definition extends that of sustainability itself, an architecture that meets the needs of the present without compromising the ability of future generations to meet their own needs. Those needs differ from society to society and region to region and are best defined by the people involved. [2] In this respect Sustainable Architecture tries to make connections to buildings to take maximum advantage, which solve all the design problems related to the environment and wait for them to be cost-effective. [3]

2.3. Zero Emissions Building:

In buildings, the first two goals -or functions- can be achieved to perform sustainable architecture. The importance of sustainable building design is due to the major impact of both construction and subsequent use of buildings on the environment. Together, these account for 50% of natural resources consumption, 40% of energy, and 16% of water use [2]. The application of sustainable development principles to building is one of the most efficient responses we have to reduce the greenhouse effect and the destruction of our environment. A zero operating emissions building is one that is:

• Highly energy efficient,
• Free of on-site emissions from energy use, and
• Powered solely from clean energy.

3. Research Objectives:

The primary objectives of this study are as follows:

- Introducing the energy crisis and giving a brief outline of the exchangeable affection on other fields.
- presenting alternative energy resources trying to create a friendly relationship with the environment.
- Presenting some suggested solutions to solve the energy crisis.
- More explanation on renewable energy resources.

4. Toward to Zero Emissions Using Renewable Energy Resources:

Renewable energy, at its most basic level, can be thought of as energy that occurs naturally and repeatedly in the environment. Worldwide energy demand continues to increase (currently at a rate of 2% per annum), while the availability of fossil fuel expected to decline in the longer term and concerns over the potential impact of global warming continue to grow. The sustainability of energy supply can therefore be expected to continue rising up the social, economic and political agenda in the years to come. [2]

Renewable sources have a key role to play in the Governments wider Climate Change program: these sources generally produce lower (or even negligible) levels of pollutants (e.g. greenhouse gases) than the conventional sources of energy they displace help to meet its climate change targets. [3]

a. Passive Energy:

It involves absorbing and storing the energy from the sun in the most efficient way, without involving such technologies or transforming the sun's heat into electrical energy and using some treatments such as wind catcher, courtyards and lovers[4]. (Figure 1)

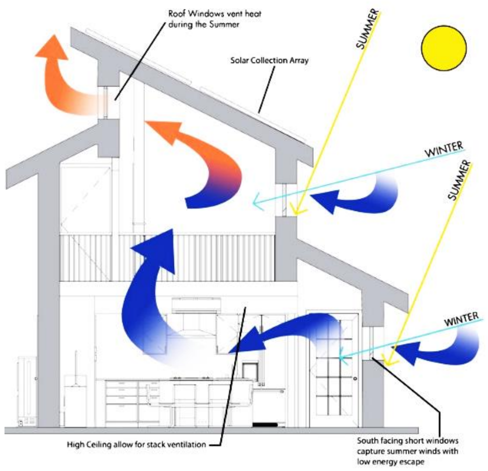


Figure 1 Shows the treatments of Passive Energy [4]

b. Active Energy:

Is a much more complicated process, involving such things as thermostats which valves when appropriate temperatures are reached, employ motors and pumps to circulate heated water or air.

Active solar collector systems take advantage of the sun to provide energy for domestic water heating, pool heating, ventilation air preheat, and space heating. Water heating for domestic use is generally the most economical application of active solar systems [12]. Figure 2

As part of the intensive global search for alternative clean and renewable energy sources, concentrating solar power (CSP) is being considered as one of the key technologies due to its potential to meet base load applications [11]. The International Energy Agency (IEA) has set an electricity generation target of 630 GWe for CSP technology by 2050.

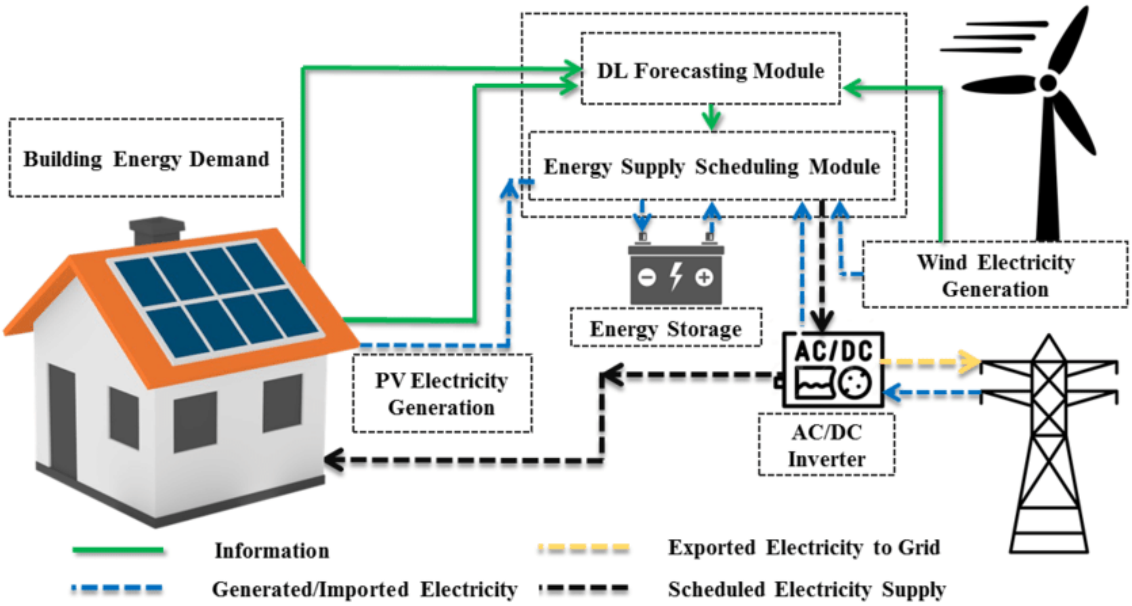


Figure 2 Shows the treatments of Active Energy

4.1 Solar Energy:

To many, solar energy seems to be an obvious solution to our energy problems. There is an inexhaustible supply that is readily available to everyone. However, we do not yet have the technology available to efficiently use it, or to store its energy for times when the sun does not shine.

In the current context of increasing energy demand and related environmental concerns, solar energy appears to be one of the most efficient and effective solutions in the sustainable development [11]. Additionally, solar energy is the most abundant renewable source of energy available on earth in both direct and indirect forms. Only 0.1%

of this energy can be used to generate four times the total world consumption capacity at an efficiency of 10% [2]. In practice, solar energy can be harnessed in two different ways: direct electricity conversion using photovoltaic technology, or indirectly through thermal conversion using solar thermal energy systems. In solar thermal applications, the incoming radiation is absorbed by a solar collector as heat and then transferred to the heat transfer fluid (HTF). Solar collectors can be classified into two main categories: low-temperature for non-concentrating collectors and high-temperature for concentrating collectors.

Direct electricity conversion using Photovoltaics: (Figure 3)
Rack-mount PV systems or mount them directly on roof and wall surfaces. Optimizing the panel's tilt to the sun improves performance. Most existing commercial buildings have large, flat roofs exposed to lots of sun, making them good candidates for PV arrays. New buildings can be designed with sloped surfaces that can optimize PV exposure to the sun. The PV panels can be designed as the primary "weather skin" for sloped roofs or walls and can be integrated into shading devices. (Figure 4)

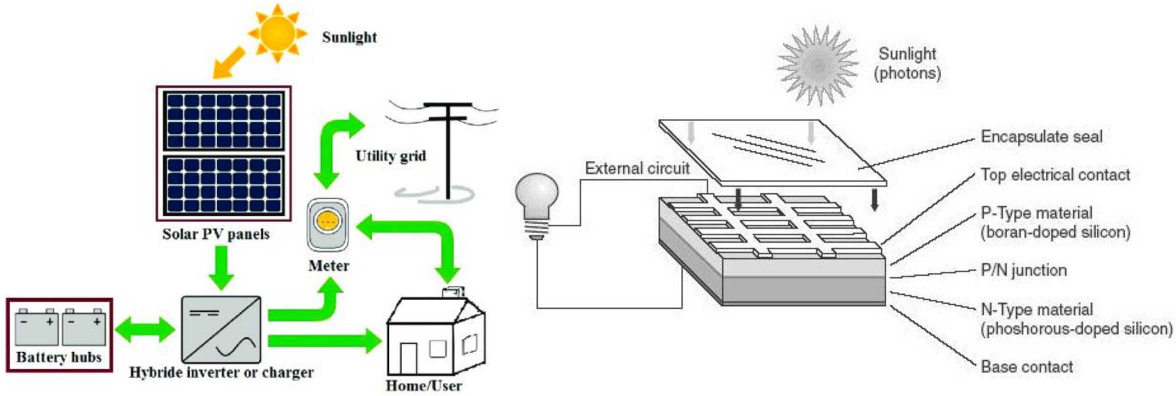


Figure 3 Shows Direct electricity conversion using Photovoltaics.

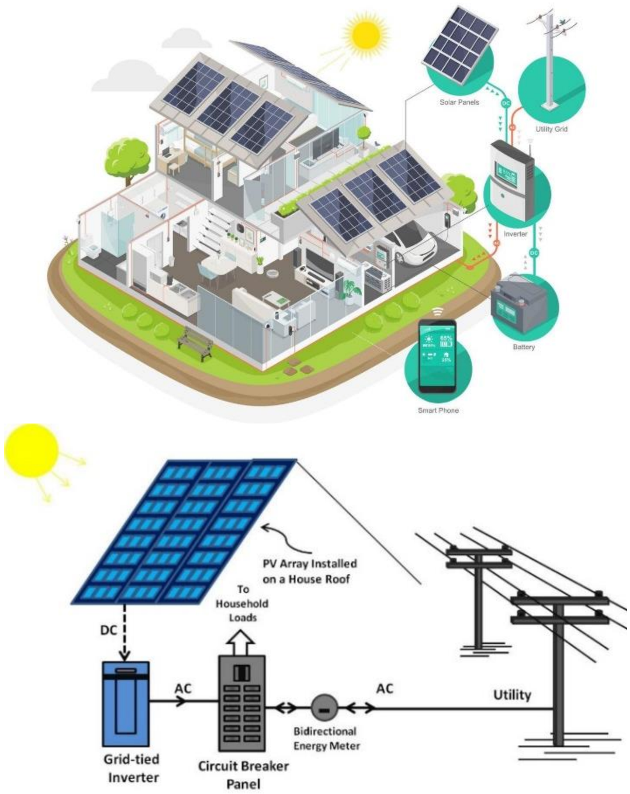


Figure 4 Integration between Building and Photovoltaics.

Indirectly Thermal Conversion using Solar Collector:
A solar collector is a device used to absorb heat that comes from the sun in the form of radiation and to transfer it to a circulating fluid (air or liquid). The flat-plate solar collector consists of a black metal plate covered with glass or plastic and backed with insulation.
- The metal plate is known as an absorber and may have tubing built in to contain the circulating fluid. An air space separates the cover from the absorber. [8]
- The glass or plastic is transparent to incoming solar radiation, yet glass in particular is opaque to radiation of longer wavelengths (heat). [13]
- Solar radiation passes through the cover and is absorbed by the black surface, increasing the temperature of the metal. (Figure 5)

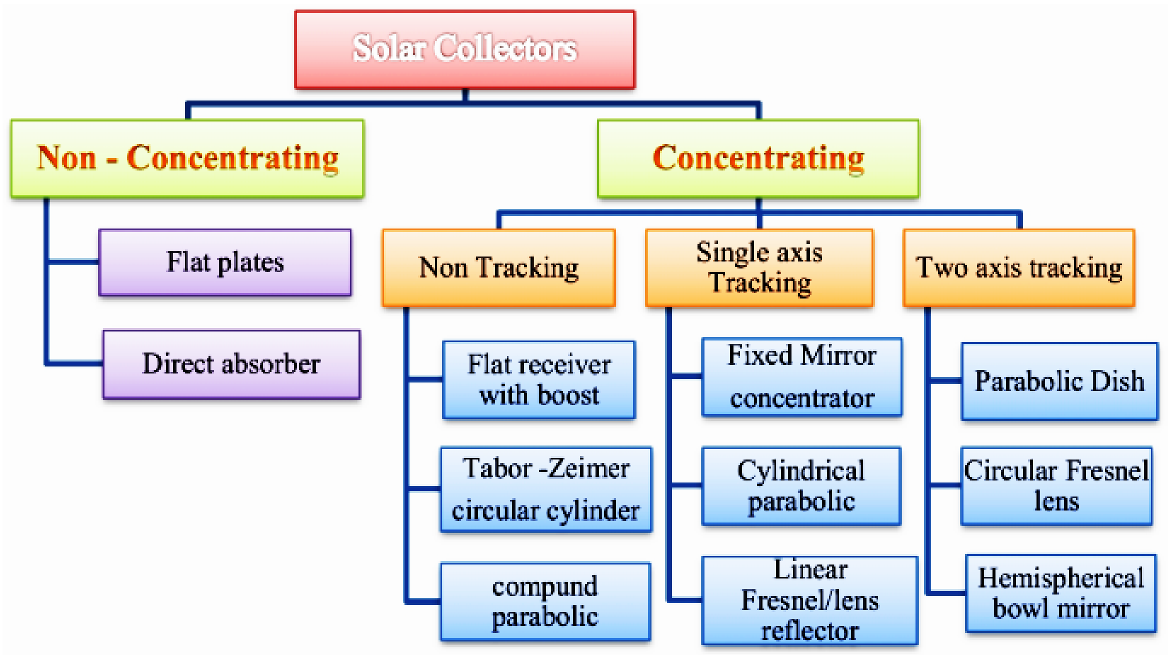
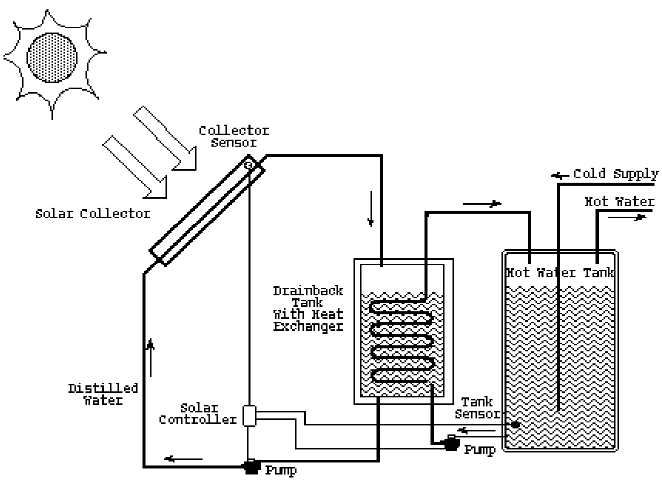


Figure 5 Shows The types of Solar collectors. [13]

Longer wavelength infrared radiation is emitted from the absorber, but most of it cannot pass back through the glass. This produces what is known as the greenhouse effect. (It commonly occurs in automobiles on a hot summer afternoon. [5]
A solar collector system is at first glance tremendously attractive because it offers virtually free heat. In reality the first costs are huge, because your roof is covered with plumbing and plumbing is the most expensive part of any building [6]. This is in addition to the cost of the storage system, the distribution system, the pumps, and installation. (Figure 6)



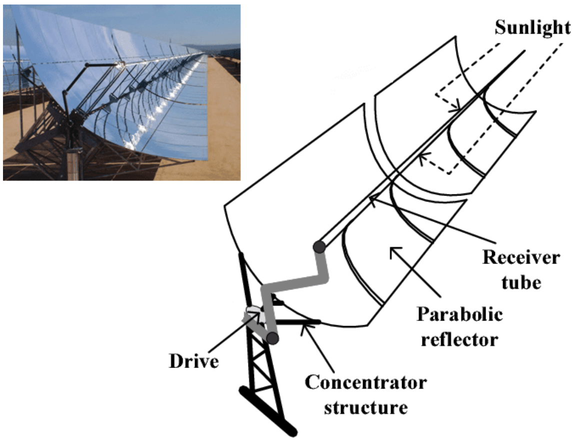


Figure 6 Shows Solar collectors [7]

Sun Dish:
The Sun Dish produces power from solar energy. The sunlight concentrated at the receiver of the Solar Power Unit provides sufficient heat to generate electricity. This system can operate on your choice of fuel when sunlight is not available.
The 'Sun Dish' is composed of dish-shaped solar concentrators, which focus and intensify the reflected solar energy on a heater attached to the Stirling engine. Electronic controls and tracking motors keep the sun focused on the receiver. Before sunrise, the dish is in a stored downward or "stow" position to protect the mirrors from soiling and potential hail damage. [9]
When the sunrises tracking motors precisely move the dish to follow the sun. Heat from the sun is converted to power in the Stirling engine/generator and fed to the electrical grid. The system continues to track the sun throughout the day until sunset when the controls put the dish again in the downward facing position. [10]

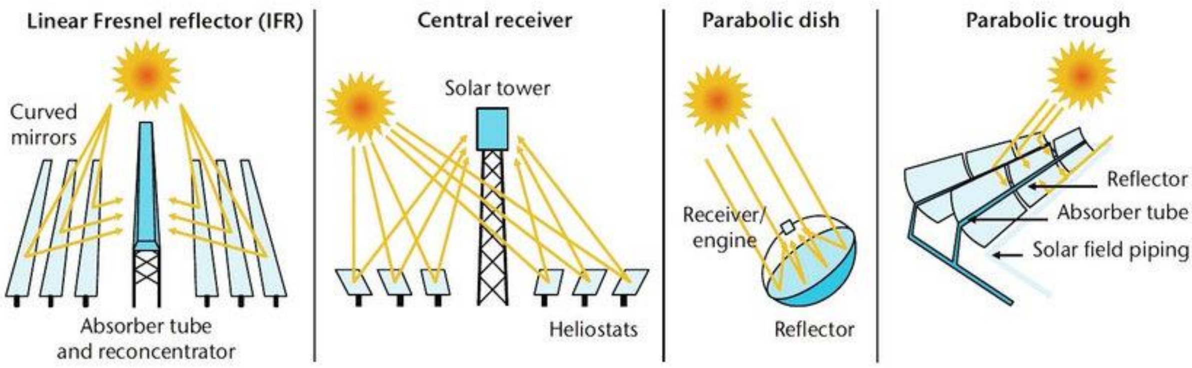


Figure 5 Shows Form of the sun dish [10]

4.2 Wind Energy:
While it is certainly practical to use old existing windmills for pumping and thus saving power, wind generated electricity would be unreliable in New England. In most cases the cost of the wind generator cannot be recovered in a reasonable time from the output of electricity [12]. The most popular available type plugs into the home circuit, generating when the wind blows, and cutting it off when it is calm.
a. The law states that any excess power generated by an individual mill must be purchased by the electric company.
b. Must have storage batteries to keep a relatively constant supply. [14]

Types of wind turbine:
The horizontal axis wind turbines are installed at the wind farms in many countries for small and large power projects, while vertical axis wind turbines are used in urban areas on top of tall buildings, roadside dividers, railway lines, and other locations because they operate at low wind speeds. Table 1

Wind is an indirect form of solar energy. The wind is driven mainly by temperature differences on the surface of the earth that are caused by sunshine. [14]

- An advantage of wind turbines over some forms of renewable energy is that they can produce electricity whenever the wind blows (at night and also during the day).
- Wind turbines usually have just two or three blades (up to 25 meters long) that turn when the wind blows. Figure 6 &7
- The blades drive a generator that produces electricity, much like steam turbines. [12]

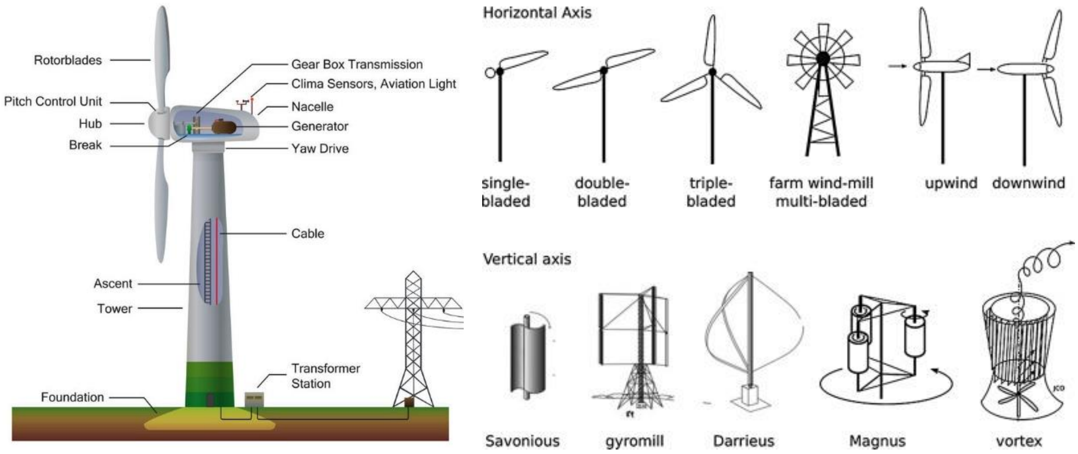


Figure 6 The main Types of wind turbine (Horizontal Axis & Vertical Axis)

(a) (b) (c)

Figure 7 Details of wind turbine

(a) Domestic (small scale) HAWTs, (b)Domestic (small scale) VAWT (Savonius type),
(**c**) Domestic (small scale) VAWT (Darrius type) [14]

- We can combine multiple sources to deliver intermittent electric power and this system called “Hybrid power system.” [15] Figure 8
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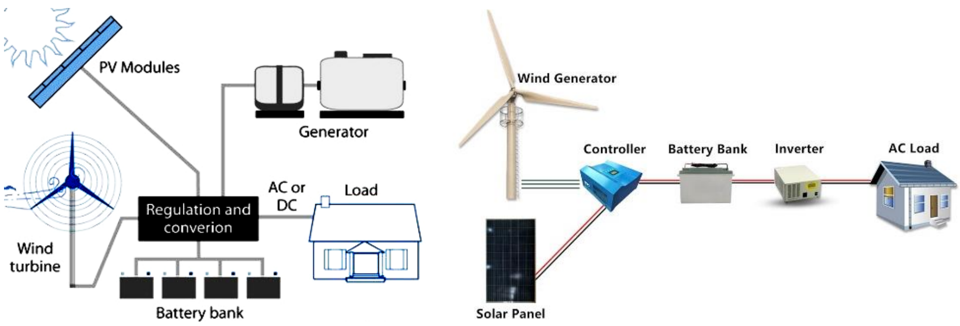

Figure 8 Hybrid power system

Table 1 Difference between Horizontal Axis and Vertical Axis Wind Turbines

Basis of Difference	Horizontal Axis Wind Turbine	Vertical Axis Wind Turbine
function	A horizontal axis wind turbine is the one whose axis of rotation is horizontal.	A wind turbine is called a vertical axis wind turbine if its axis of rotation is vertical.
viated name	HAWT is the abbreviation used for horizontal axis wind turbine.	VAWT is the abbreviation used to denote the vertical axis wind turbine.
Axis of rotation with respect to wind stream	For the horizontal axis wind turbine, the axis of rotation of turbine is parallel to the wind stream.	For the vertical axis wind turbine, the axis of rotation of the turbine is perpendicular to the wind stream.
Location of electric generator	In the horizontal axis wind turbine, the electric generator is installed at the top of the tower.	In the vertical axis wind turbine, the generator is installed on the ground.
Location of gearbox	In HAWT, the gearbox is installed at the top of the turbine tower.	In VAWT, the gearbox is installed at the bottom of the turbine.
Need of yaw mechanism	In the horizontal axis wind turbine, the yaw mechanism is required to orient the turbine in the direction of wind.	The vertical axis wind turbine does not require yaw mechanism because it receives wind from all directions.
Self-starting	Horizontal axis wind turbine is self-starting.	Vertical axis wind turbine is not self-starting, hence a starting mechanism is required to start it from stationary position.
Design and installation	The design and installation of a horizontal axis wind turbine is complex.	The design and installation of a vertical axis wind turbine is comparatively simple.
Operation space of blades	Horizontal axis wind turbine requires large space for blade’s operation.	Vertical axis wind turbine requires small space for blade’s operation.
Dependency on wind direction	The operation of horizontal axis wind turbine is dependent on wind direction.	The operation of vertical axis wind turbine is independent of the wind direction because it receives wind from all directions.
Height from ground	The height of the horizontal axis wind turbine from ground is large.	The vertical axis wind turbine is installed at comparatively smaller distance from the ground.
Need of nacelle	In case of horizontal axis wind turbines, a heavy nacelle is installed at the top of the tower.	There is no need of nacelle in case of vertical axis wind turbines.
Power coefficient	Horizontal axis wind turbine has a high power coefficient.	Vertical axis wind turbine has a low power coefficient.
Tip speed ratio (TSR)	Horizontal axis wind turbine has high tip speed ratio.	Vertical axis wind turbine has considerably low tip speed ratio.
Noise produced	The operation of horizontal axis wind turbine is noisy.	Vertical axis wind turbines produce comparatively less noise.
Efficiency	The ideal efficiency of horizontal axis wind turbine is around 50% to 60 %.	The ideal efficiency of vertical axis wind turbine is usually more than 70%.
Hindrance for birds	Horizontal axis wind turbines cause high obstruction for birds.	Vertical axis wind turbines cause less hindrance for birds.
Cost	Horizontal axis wind turbines are more expensive due their complex design and installation.	Vertical axis wind turbines are less expensive because their design and installation is quite simple.

4.3 Water Energy:

4.3.1 Hydroelectric Power and the Rivers: Figure 9

Hydroelectric power is an important source of energy of Dam on Rivers. [16]

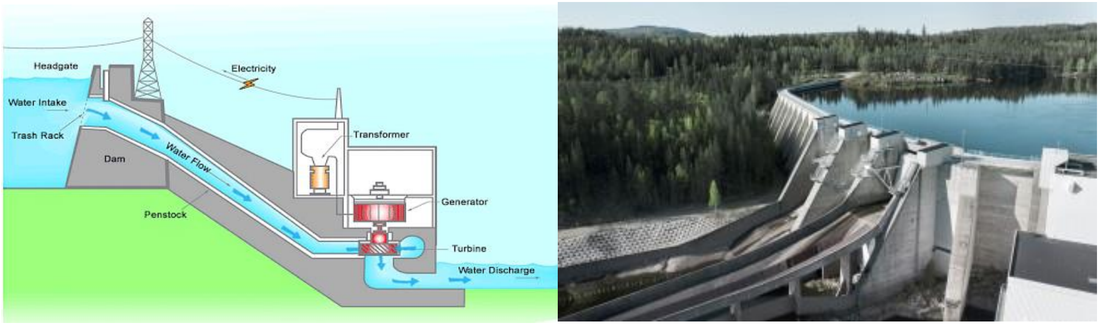

Figure 9 Hydroelectric power

4.3.2 Tidal power: Figure 10

The Earth's tides are not directly related to solar energy but are another force of nature, the moon travels around the earth , the gravitation force between the two acts on the ocean and the earth revolving on its axis produces high and low tides on the earth's surface, the motion of this water represents a tremendous amount of power. [5]

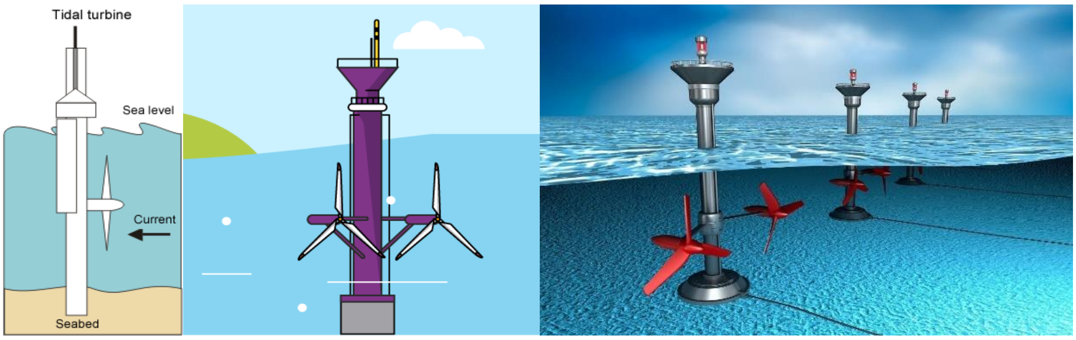

Figure 10 Tidal power

4.3.3 Water Wheels:

The two common types of water wheels are:

A) The undershot wheel: It can be installed adjacent to or over an existing stream.

B) Overshot wheel: It needed a cliff, dam, or sluice to raise the level of the water behind it to the top of the wheel. [16]

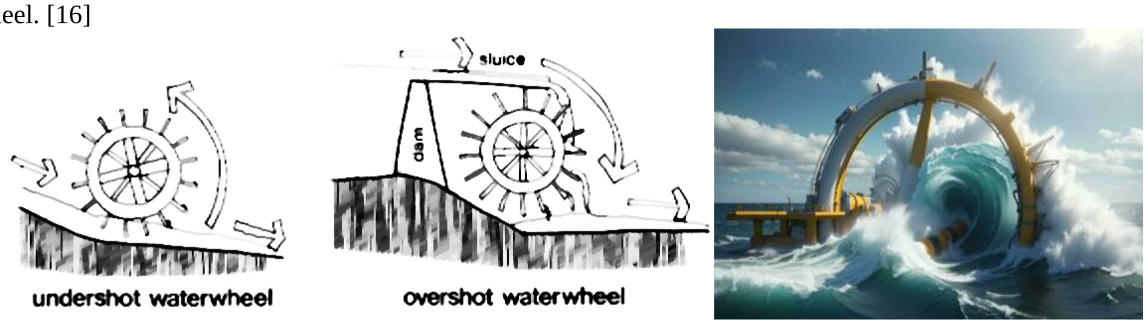

Figure 11 The undershot and Overshot wheel

4.3.4 Thermal gradients: Figure 12

Large-scale electrical generating plants could utilize the temperature differentials with power generators located just below the ocean's surface. [15]

4.3.5 Ocean Waves: Figure 13

The Scottish Island of Islay is the site of the world's first commercial wave power station, which began to feed electricity into. The system in use at the plant is an oscillating water column, sited on the shoreline in a specially excavated hole behind a natural rock bund an unusual but successful variation on conventional installation. [16] Inside, waves create air movements that drive a pair of self-rectifying, contra-rotating wells turbines, which turned to provide power to the grid.

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The simplicity of the turbines and the installation process leads to high reliability.[7]

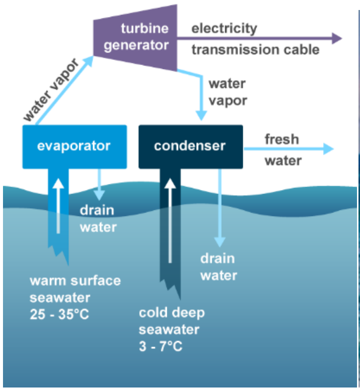


Figure 12 Thermal gradients

Figure 13 Ocean Waves power

4.4 Earth Energy:

4.4.1 Geothermal energy: Figure 14

Geothermal power is obtained by heating water with the hot rocks beneath the surface of the earth. This is not suitable in the northeast because the hot interior of the earth is far beneath the surface here. There are three major types of geothermal power: dry steam, hot water/wet steam, and hot dry rocks. Each has different characteristics of depth, access, and economic feasibility. [17]

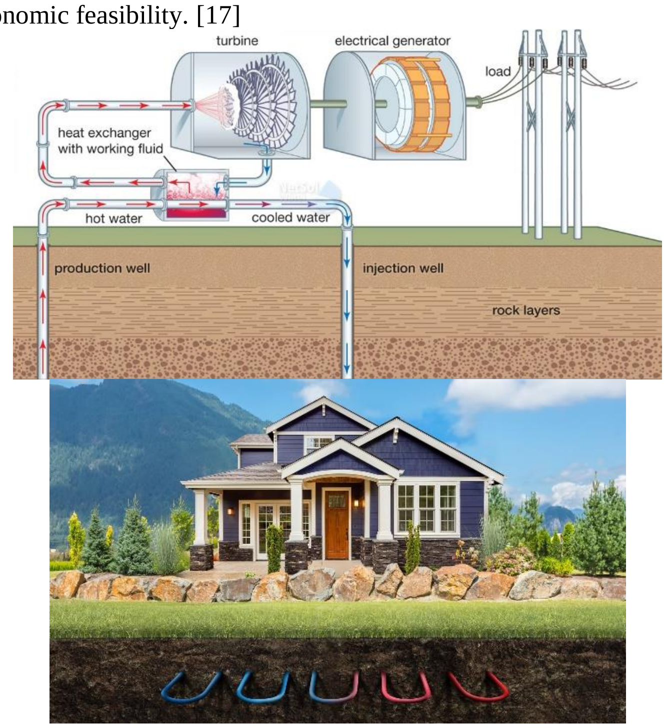


Figure 14 Geothermal energy

4.5 Solid Wastes: Figure 15

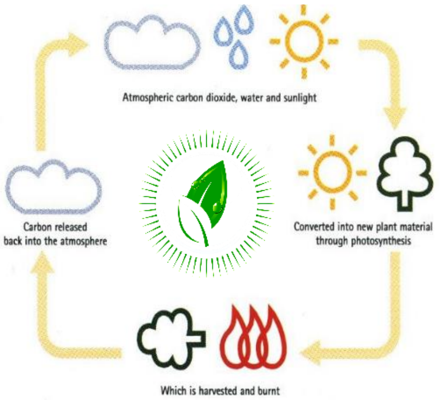
The Biosphere process offers boundless and unlimited benefits by solving the global waste problem while major push for generating electricity from alternative sources continues to be the topic due to shortage and massive power failures.

Many communities are experimenting with converting solid Waste to fuel. [17]

This refuse is now generating methane, and one contractor hopes to be able to recover 28.32 cubic meters (1000 cubic feet) of gas per minute from it. If this project is a success, there are numerous other landfills around the country to which the same techniques could be applied.

Bio-fuels are made from renewable biomass resources such as grasses, trees, trash, and waste from the agricultural and forestry industries. Bio-fuels include ethanol, methanol, bio-diesel and additives for reformulated gasoline.

Ethanol, the most widely used bio-fuel, is added to 9 percent of the nation's gasoline to improve vehicle performance and reduce air pollution. Figure 16
These power plants use waste from paper mills, sawmills, wood products manufacturing, orchard pruning and agricultural by-products. Scientists are developing dedicated energy crops (fast growing trees and plants) grown specifically for use in biomass power plants. [19]



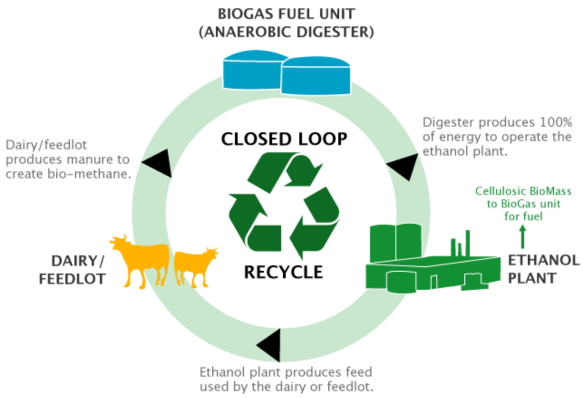


Figure 15 Biomass Energy

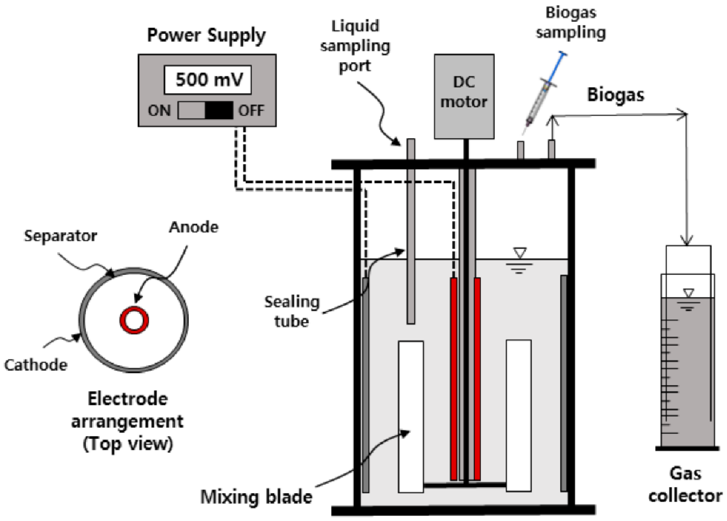


Figure 16 Biomass Energy (Methane Generation)

5. Case study: Timber and Sustainable Building Published: Lighthouse Zero Energy Home

5.1 Introduction: The project won the inaugural achievement in engineered timber award at the TTJ Awards in September. It is certainly an eye-catching design and one with which Potton sales and marketing director Joe Martoccia knew he wanted to be involved. “I was completely blown away by it as a piece of architecture first and foremost,” he said. “We have a range of traditional designs and it had been searching for a couple of years to develop a contemporary range. [18]

The prototype building was unveiled at BRE's OFFSITE 2007 exhibition and conference in June
A self-build package with cutting-edge green credentials that looks good, too! David Castle reports on the award-winning Lighthouse net-zero carbon home that closes the lid on soul-less boxes.
When Kingspan Off-Site revealed its innovative Lighthouse net-zero carbon home earlier this year, a few eyebrows must have been raised.
With its curved roof design and futuristic aesthetics, the prototype building pushed the boundaries of modern house design, while, at the same time, offering a blend of cutting-edge green technologies. Now, less than four months later that prototype is a fully-fledged self-build package thanks to Kingspan subsidiary Potton, which has

worked with the project's architects Sheppard Robson to develop what is claimed to be the most advanced house produced for the self-build market. Figure 17

Figure 17 Lighthouse Zero Energy Home

"It had been engaged with a couple of designers, but it just wasn't meeting the mark. They were coming up with soul-less boxes, whereas Potton is all about design, style, quality and lifestyle. Thanks to efficiencies in construction, energy use, CO2 emissions and carbon footprint, Lighthouse by Potton is the first self-build home to achieve the government's Code for Sustainable Homes Level 6, the standard to which all new homes will be designed and constructed from 2016.

The Lighthouse range offered intelligent contemporary design. Based on a simple timber frame barn-like form, some designs feature a sweeping roof that envelopes the central space providing an open-plan, top-lit, double-height living space, with the sleeping accommodation at ground level. However, the living space uses a glulam portal structure so floors can be slotted between the frames or left open as required.

5.2 Timber and Sustainable Building treatments:

5.2.1 Passive System:

The Lighthouse seeks to address the challenges of future climate change and summer overheating. The Lighthouse is testing examples of thermal heavyweight' room ceiling surfaces within a lightweight structural system. [18]
Two different surfaces are demonstrated as a passive system: Figure 18
- BASF PCM (Phase Change Material) plasterboard
- Dense cement fiber board
-These surfaces help absorb daytime heat and then give it up to cooler night time purge ventilation.

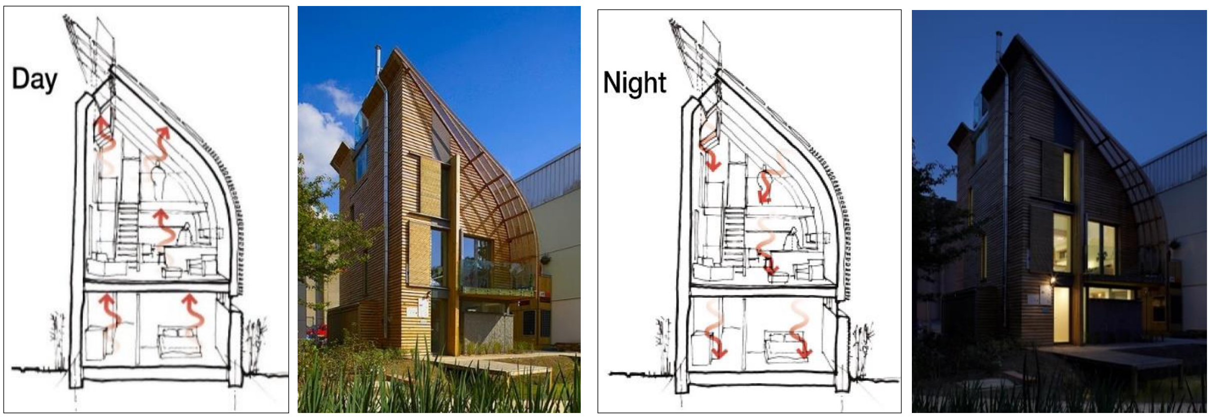


Figure 18 Passive system in Lighthouse as a Zero Energy Home

a. Passive Ventilation:

Located on the roof, above the central void over the staircase, the windcatcher provides passive cooling and ventilation. When open these catches the cold air forcing it down into the heart of the houses, living space and the ground floor sleeping accommodation, dispersing the hot air, allowing it to escape. The windcatcher also

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brings daylight deep into the plan of the house and provides the ground floor with sleeping accommodation with secure nighttime ventilation.

As shown Figure 19

Figure 19 Passive system (Ventilation using wind catcher)

b. Heating:
The building envelope specification will deliver high levels of thermal insulation and airtightness so that the home will only need to be heated for a couple of months in mid-winter.

c. Airtightness:
Lobby areas design to the front and back of the house to maintain the high level of the airtightness in the build.

5.2.2 Active System: Figure 20

a. Solar thermal panels:
The panels generate all the hot water in summer and some in the spring and autumn, reducing the demand on the biomass boiler and the amount of wood used. [18]

b. Photovoltaic (PV) array:
PV panels capture energy from the sun to supply electricity for the whole house.

c. Reduced glazing:
Complying with the U-values of the Code, the glazing is 5-10% less than that in the traditional home. The living space of the Lighthouse is adapted to accommodate this with a large double height volume on the upper levels with sleeping accommodation below.

d.Water:
Increased awareness about what water to use where - rainwater for the garden and washing machine, shower and bath water for the WC.

e.Smart Metering and monitoring systems:
A Smart Meter records energy consumption, to help occupants identify any wastage and to promote more environmentally aware lifestyles. [18]

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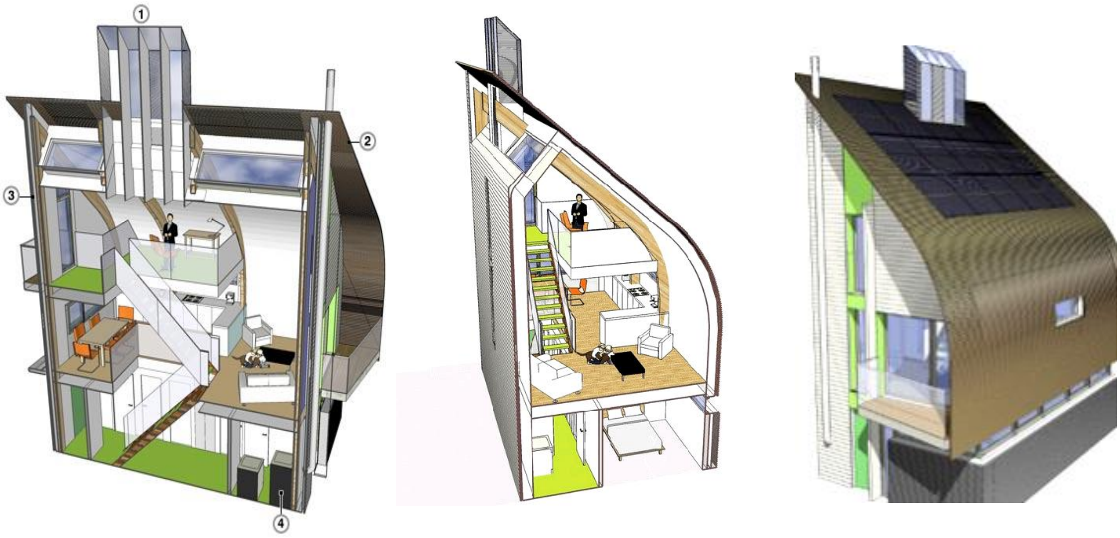

1. Wind catcher, for summer ventilation
2. Solar array at back of house for hot water and electricity
3. High-level of wall insulation
4. Waste management (Biomass boiler) (news.bbc.co.uk2011)

Figure 20 Passive and Active Systems

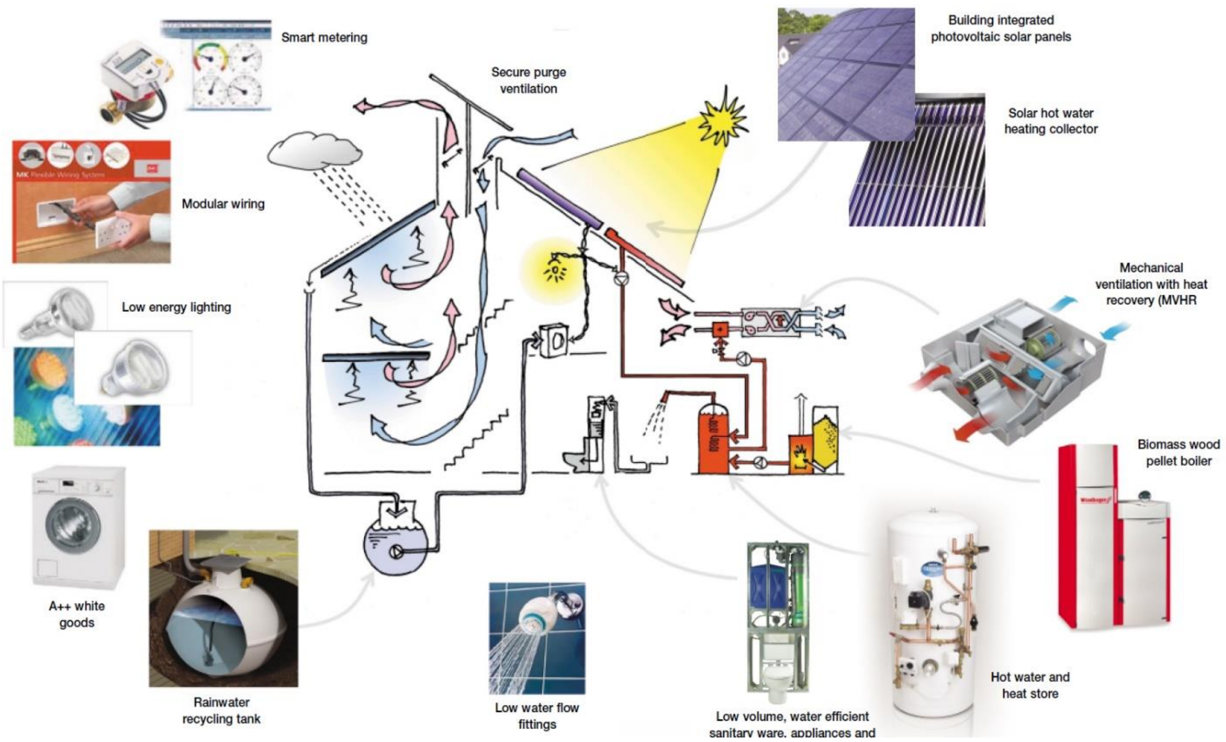

Figure 21 Accommodating for Climate Changes by Using Renewable Energy [18]

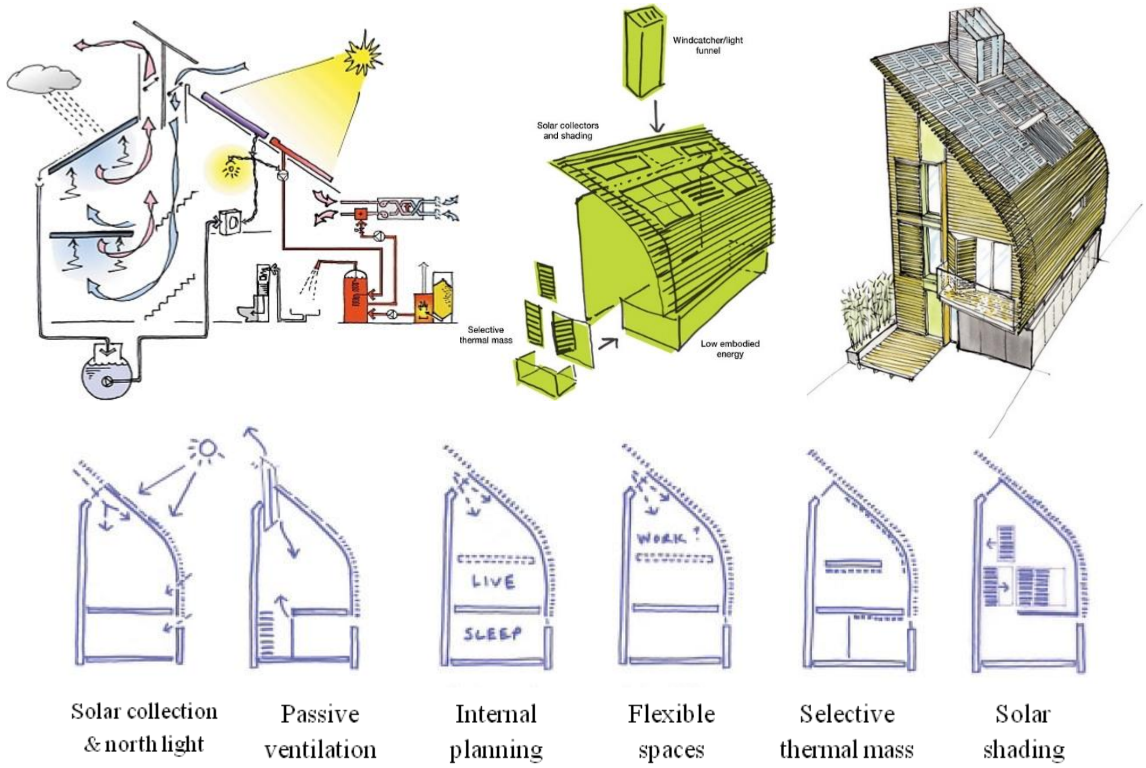

Figure 22 The Treatments and In Door Environmental Design

6. Results:

Renewable energy, at its most basic level, can be thought of as energy that occurs naturally and repeatedly in the environment. Worldwide energy demand continues to increase (currently at a rate of 2% per annum), while the availability of fossil fuel expected to decline in the longer term and concerns over the potential impact of global warming continue to grow. The sustainability of energy supply can therefore be expected to continue rising up the social, economic and political agenda in the years to come.
Renewable sources have a key role to play in the Governments wider Climate Change program: these sources generally produce lower (or even negligible) levels of pollutants (e.g. greenhouse gases) than the conventional sources of energy they displace and thus also help the UK to meet its climate change targets.
Concentrated solar power technologies are gaining more attention in the last two decades in order to replace the conventional power technologies and reduce their environmental impact. Among the developed concentrating technologies, parabolic trough solar collector and solar tower are the most mature and dominant technologies. As part of the continuous development of these technologies, significant efforts have been deployed to predict and improve their performance, and therefore reduce their cost and make them more competitive.

Energy Efficiency & Renewable energy:
– Building orientation to take advantage of solar access, shading, and natural lighting
– Effects of microclimate on building.
– Thermal efficiency of building envelope and fenestration.
– Properly sized and efficient heating, ventilating, and air-conditioning (HVAC) system.
– Alternative energy sources.
– Minimization of electric loads from lighting, appliances, and equipment.
– Utility incentives to offset costs. [19]

The most significant difference that you should note here is that a Horizontal Axis Wind Turbine has its axis of rotation parallel to the wind stream, whereas a Vertical Axis Wind Turbine has its axis of rotation perpendicular to the wind stream. Both these types of turbines use the kinetic energy of blowing wind to drive an electric generator to produce electricity.

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