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Futuristic and Intelligent Housing in Developing Countries

Ramandeep Sharma, Tanya Taneja and Er. Manpreet Singh Saini
DAV University Jalandhar

(Corresponding author: Ramandeep Sharma)
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ABSTRACT: India is one of the vast bio-diverse countries of the world. Its journey on the path of sustainability is flourishing and has become gradually more important. To meet the challenges of continuing growth without destroying the environment, self-sufficient housing would play a crucial role. As along with growing population and advancement of the era the demand is increasing, due to which the resources are depleting and are not exploited efficiently. A small initiative towards it can quickly lessen our negative impact on the environment into a positive revolution.

In 1990's the renowned architects Mcdonough and Ken Yeang applied environmental responsible building to large commercial buildings, making them self-sufficient in energy production. However, their approach can be taken to a larger scale in the form of Self-Sufficient Housing (SSH). The key approach towards it would comprise energy application, architectural design, sustainable environment and income generation.

The premise of the paper is to construct a home that goes beyond green building standards of energy efficiency and self-sufficiency and takes into account the waste production and proper resource use. A self-sufficient house is identified and explored as the solution: a house that has no connections to water supply, electricity, and waste produced by the occupants given by municipal systems. It entails whether this structure is possible in India? And is it possible for an individual to self-build or self-design by avoiding the financial constraints?

I. INTRODUCTION

The most successful, long-term and low-income housing projects are those that use sustainable design and address the social, cultural, and economic needs of residents. Sustainable design offers many solutions to the problems in housing projects present today, including healthier living environments, high-efficiency utility systems that result in lower bills for residents, safe dalliance areas for common use, a sense of community within the project as well as with the greater community, and aesthetically pleasing environments to live in. Building with sustainable materials alone will not reduce the problems traditional housing has but must combine components of sustainable design with residents want. By implementing sustainable housing projects with residents need in mind, the developers, nature, and the community as a whole will benefit.

Today, it is widely accepted that human activities are contributing to climate change. Most experts agree that over the next few decades, the world will undergo potentially dangerous changes in climate, which will have a significant impact on almost every aspect of our environment, economies, and societies.

Buildings are responsible for 40% of the energy used globally as well as emit as much as one-third of greenhouse gas emissions and at the same time demand outstrips supply. There is a clear need to reduce the impact that buildings have on the environment and society and that the built environment should be a major focus for sustainable development. The motive of this paper is to promote the need for houses, or any buildings built in the modern era, to be built with their lifecycle in mind regarding construction materials and energy efficiency.

With the change in time and technology whole world is now concentrating on environment preservation/factors depleting the resources and methods for sustainable development. People are used to the same kind of housing and constructing the same kind of houses. This research paper is about giving an idea to people how building house in some different way can make a huge difference in standards of living and can contribute to the environment as well.

"Sustainability is ALWAYS local. The minute we start importing designs, technologies, products or materials, the environmental impact increases multi-fold, defeating the very purpose of designing a green building".

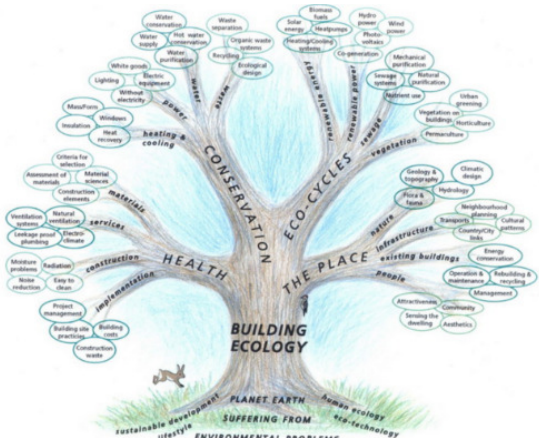

Fig. 1. Building ecology.

II. ENVIRONMENTAL

Building as Pollution: As more and more structures are designed and constructed to meet the demand of a rising population to fulfill the basic human needs, the environmental impact of buildings has increased. The building sector pitch in up to 30% of global annual greenhouse gas emissions and consumes up to 40% of all energy. Given the massive growth in new construction in economies in transition, and the disability of existing building stock worldwide, if nothing is done, greenhouse gas emissions from buildings will more than double in the next 20 years. Therefore, if targets for greenhouse gas emissions reduction are to be met, it is clear that conclusion-makers must tackle emissions from the building sector.

Policy Options for Reducing Emissions from Buildings -

- Target 1: Improve the Energy Efficiency of Buildings
- Target 2: Improve the Energy Efficiency of Household and Business Appliances
- Target 3: Encourage Energy Generation and Distribution Companies to Support Emission Reductions in the Building Sector
- Target 4: Changes in Attitudes and Behaviour
- Target 5: Substituting Fossil Fuels with Renewable Energies in Buildings

Technology

Building Materials and Sustainable Housing Provision

The course of housing development should be based on sustainability principles, which could be applied in the generalization, construction and use of the buildings. The goals of the process are to lower the environmental costs incurred by inadequate constructive systems and solutions, minimizing the impacts on natural resources, and enhance users' comfort. Gilkinson & Sexton (2007) defined sustainable housing as a form of affordable housing that assimilates environmentally friendly and community-based practices. Sustainable housing provision requires theft definition of housing needs, and the participation of the end users to guarantee their satisfaction. The general goal of sustainable development is to meet the integral needs of the world's population while ensuring that future generations have an adequate resources base to meet their demands.

They should also satisfy the following benchmark: reasonable use of natural resources; energy efficiency; elimination or reduction of generated waste; low toxicity; water conservation. Sustainable building materials can offer a set of specific benefits to the owner of a building such as reduced maintenance and replacement costs, energy preservation, improved occupants health and productivity, lower costs associated with changing space configurations, and greater flexibility in design (*www.GreenBuilding.com, 2009*).

Attaining sustainability in housing provision requires major societal changes, restructuring of institutions and management approaches. It requires the appropriate political will based on the assurance of the responsibility of government to its citizens, and the need to create a humane and decent environment for dignified living. In order to realize sustainable housing provision, the housing needs of the population have to be put into proper focus and a coordinated program to achieve this should be thoroughly worked out. It can also facilitate the acquisition of building materials, the cost of which comprises about 60% of the entire cost of a building. Production of building materials of native origin by private investors should be given logistic and material support by government.

It is a known fact that building materials are largely responsible for the menace of global warming. Therefore, the building materials and technology should be selected on the basis of their present cost, as well as from the point of view of environmental sustainability and life cycle costs.

The following points may be kept in mind while deciding on these aspects:

(i) Use materials available locally as far as possible.

(ii) Select the materials on the basis of their life cycle costs rather than the present cost.

(iii) Opt for the 41/2" staggered brick walling system instead of solid 9"brickwalls.

Clubbing of wet core areas-W.C, Bath &Kitchen Use of 4 1/2 inch staggered common wall

(iv) Choose Rat Trap bond walling systems. The benefits of the system are as follows:

It helps reduce material consumption by 25 to 30 percent.

Low material consumption leads to a significant reduction in cost.

It provides better thermal insulation.

(v) Wherever possible, Jalies should be used in place of windows. The benefits are as follows:

They reduce costs.

They enhance building aesthetics.

(vi) Easy-to-handle prefabricated components should be used as far as possible. The benefits are as follows:

This helps the standardization process.

These maintain the quality of construction.

These reduce the construction time.

(vii) Encourage the use of Ferro-cement. The benefits are as follows:

It is light –weight.

It is cost efficient.

It is energy efficient.

It is a green material.

Renewable Energy sources or Energy alternatives

The essential challenge is to fulfil the energy requirements in a sustainable way and one of the best available options in the current scenario is renewable energy sources, so it is required to enhance Carbon dioxide emissions can be reduced by an average 3.3million tons in a year by adding 1 GW energy of renewable origin so it will help to minimize the inimical effects of climate change in India.

Solar Energy: In Solar energy production photovoltaic (PV) cells are placed on the rooftop of houses or commercial buildings, and collectors such as mirrors or parabolic dishes that can move and track the sun throughout the day are also used. This mechanism is being used for concentrated lighting in buildings. Photovoltaic (PV) cells have a low-efficiency factor, yet power generation systems using photovoltaic materials have the advantage of having no moving parts.

PV cells find applications in individual home rooftop systems, community street lights, community water pumping, and areas where the terrain makes it difficult to access the power grid. The efficiency of solar photovoltaic cells with single crystal silicon is about 13 % - 17%. High-efficiency cells with concentrators are being manufactured which can operate with low sunlight intensities.

Fig. 2. Solar power plants in India.

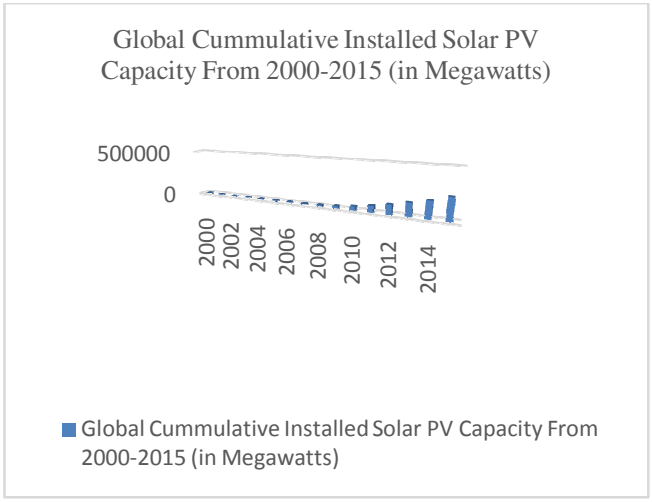

Fig. 3. Solar capacities from 2000-2015 in M.W.

Wind energy: Wind energy can come up as a solution of most of the problems because it is cost-effective in nature, clean energy resource, reduce fossil fuel demand and more over could be a fighting tool against climate change. As of the end of 2015, the worldwide total cumulative installed electricity generation capacity from wind power amounted to 432,883 MW, an increase of 17% compared to the previous year. Global wind power installations increased by 63,330 MW, 51,447 MW and 35,467 MW in 2015, 2014 and 2013 respectively.

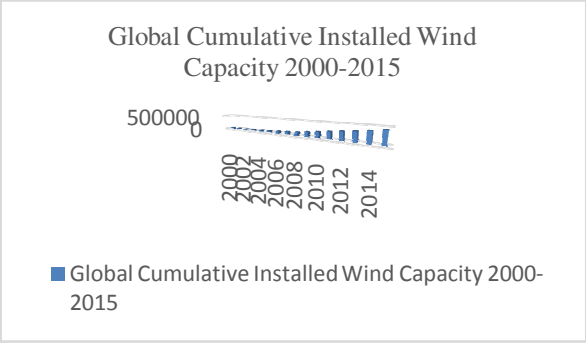

Fig. 4. Wind capacity from 2000-2015 in M.W.

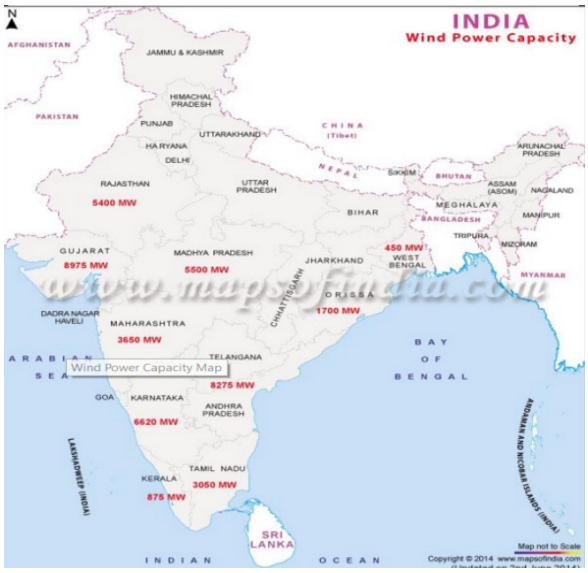

Fig. 5. Solar power plants in India.

Finance: Housing projects require a lot of finance. Finance is not easy to arrange and can be rather expensive. Therefore, a proper financing mechanism is the backbone of any affordable and sustainable housing. Without developing adequate financing mechanisms or making available special financial packages to both the developers as well as to the house purchasers, housing projects cannot aim to succeed. To curb the cost of finances, the period of construction should be reduced to the bare minimum, with the help of modern technology. For people working in the informal sector, loan repayment should be facilitated on a daily basis instead of monthly installments.

II. INTRODUCTION TO JALANDHAR

A. Before Renewable think Energy Efficiency.

Self Sufficient House System Design and Integration: Geographical -Geographically Jalandhar is Situated at 31°33'00 North latitude and 75°56'99 East Longitude, with an average elevation of 230 meters about 754.5 feet. Jalandhar is situated between the intensively irrigated and very fertile agricultural land of river Beas and Sutlej. Climatic Conditions – Jalandhar has a humid subtropical characterized by cool winters and hot summers.

Water Supply and requirements: DWSS is the Department which provides water in Jalandhar. The supply of water provided no incentive to limit water; creating reservoirs and inter-basin transfers have provided solutions to increased demand but, in turn, this has led to excessive abstraction from ground water, rivers, and lakes. The Self Sufficient house aims at cutting off municipal ties to water collection and treatment systems.

Rainwater Collection and Filtration: Rainwater is also seen as a good supply of water for purposes that don't require drinking quality water also known as potable water. However, with a series of filters to remove fine particles and UV filters to remove bacterial particles, rainwater can be used for drinking and can be stored for a longer period of time. Although it has been found that the measured inorganic compounds in the rainwater harvested from most rooftop catchment systems generally matched the WHO standards for drinking water, rainwater is rarely fit for human consumption over urban areas.

Water Storage: Water tanks are the main source of storing rainwater. Tank size should be 5% of the total annual rain fall.

Electrical: The point of a Self Sufficient house is to be independent from non-renewable resources, particularly those produced in supplying electricity. As the Jalandhar gets enough solar light throughout year, So photo-voltaic Solar panels can be installed for fulfilling the electricity requirement. The technology of photo-voltaic (PV) is improving every year; solar panels are becoming more efficient at converting the suns radiation to usable electricity.

Solar PV System: Solar PV cell is the basic building block of a PV system. It consists of semiconductor material that absorbs sunlight to generate electricity; this phenomenon of generating electricity is known as Photoelectric Effect. Only sunlight of a certain wavelength can effectively generate electricity.

Although a solar PV can generate electricity on a cloudy day, but it is not as effective as it is on a sunny day. A basic PV cell produces a very small amount of electricity and multiple of them are connected with each other to form a Solar PV module that can generate 10W to 300W output.

Table 1: Average monthly Temperature and Precipitation in Jalandhar.

		Temperature		Precipitation
Month	**Normal**	**Warmest**	**Coldest**	**Normal**
January	12.8°C	18.9°C	6.7°C	2
February	14.8°C	21.0°C	8.5°C	3
March	19.4°C	26.0°C	12.8°C	4
April	26.7°C	34.6°C	18.8°C	1
May	31.1°C	38.8°C	23.3°C	2
June	33.0°C	39.6°C	26.2°C	4
July	30.5°C	34.9°C	26.1°C	11
August	28.8°C	32.9°C	24.8°C	9
September	28.5°C	33.4°C	23.4°C	4
October	24.9°C	32.0°C	17.7°C	0
November	19.0°C	26.4°C	11.6°C	1
December	14.1°C	20.7°C	7.4°C	2

If more electricity is required, then multiple no. such PV modules have to be installed in an array.

Multiple kinds of materials are used to create a solar cell and the efficiency of solar cell depends on the same. The efficiency of a solar cell is measured as its capability to convert a certain amount of sunlight into electricity. Solar cells with different efficiencies are available in the market which are: 4%, 8%, 12%, 14% and 16%. The size of a Solar PV module required will depend on output and efficiencies. To generate 2000 watts from a 12% efficient system, we need a 200 sq.ft of roof area. Solar home lighting systems approved under NSM (National Solar Mission) are required to have a certain level of efficiency.

Sizing of Solar System: It is very important to size solar system properly. Sizing will depend on the load requirements in the setup. It is important to note that a Solar system is good for operating low wattage appliances like lights, fans, TV, etc. High wattage appliances like Air Conditioners and Water Heaters cannot be operated using solar PV system. It is very important to make sure that system is energy efficient. Please read our previous article:

Solar Panel Orientation: Solar PV system can generate electricity through direct or scattered sunlight but it's important to provide proper expose of sunlight to the Solar PV system. To collect the maximum amount of sunlight the perfect orientation of solar panel is towards south. The system should be placed in such a place so that there is no obstruction of trees or adjoining building. The load carrying capacity must be checked before installation of solar panel system as the weight of each solar panel system can be 15kg per square metre.

System Output or electricity generated from a Solar system:

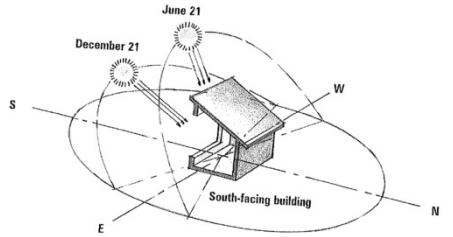

Fig 21: In the northern hemisphere a building should be angled towards the south (north in the southern hemisphere), with the building running east to west. The south side should contain enough glass to allow the sun to reach the materials of the walls and floors – the mass that will soak up the solar radiation and slowly release the absorbed energy in cooler temperatures. Care must be taken in the design with the right amount of south facing glass to avoid over heating and the correct shading in the summer months (Snell & Callahan, 2005, pp 52–56).

Fig. 2. Solar house topography.

The KWH capacity of the solar panel will depend on panel efficiency and availability of sunlight in that location. For India, it is typically taken as 19%.

Units Generated Annually (in KWH) = System size in KW*CUF*365*24

PV module (just the panel) costs anywhere between Rs30 to Rs50 per watt of power generated. A good imported module will cost around Rs40 per watt. Good ones manufactured in India would come as low as Rs30-32 per watt. A good 5 kW system for a home would cost around Rs3-4 lakhs to setup, which can provide electricity for 25 years.

Passive Solar. Removing the requirement of heating or cooling the space altogether is one way to significantly reduce the energy consumption of a building. This approach is promoted by the Passive House Institute which has set building design standards that, once applied, create buildings that use below one tenth the 'standard buildings'.

In their strict standards they promote high insulation values and air-tightness in the design of the building that eliminates the need for traditional heating or cooling systems (Passive House Institute, 2012). Other key principles of passive solar are to orient the building towards the optimal angle to take advantage of the sun's warming energy and using large quantities of dense materials (such as clay or concrete) to absorb the solar radiation. The idea is that the sun's energy will be stored within the mass of the building and will be slowly released when internal temperatures fall, thus maintaining a comfortable level of air temperature throughout the day and throughout the year with little or no additional heating.

Solar Water Heaters Solar water heaters harness the warmth of sun to heat water. In Jalandhar, India Solar water heaters can be used as their use is common and also Government is providing Subsidies on installation of solar water heaters. In case of Cold places Antifreeze liquid is used to transfer the heat to storage tanks. Solar Water Heaters can be used either to warm up water to be used within the home or to supply a heat exchanger, similar to a radiator, to transfer the heat from the water to the air in the living spaces. Solar heaters could function as both the heat source and source of hot water however different water systems should be in place.

III. CONCLUSION

In the present paper we have studied about the two components of the Self Sufficient house with which house will be self Sufficient in meeting its electricity demand and water demands, Further Study in this context is on how to manage the waste water and other wastes produced by this house and how to make the house thermally insulated and also achieving zero carbon emission to meet the exact motive of Self Sufficient housing.

It will be great to think smartly and make homes enough smart so that they can contribute to sustainable development as well as to environment at larger part.

As with the time non-renewable resources are depleting, we must have to shift our dependence from non-renewable resources to renewable resources. This small change will lead to biggest revolution in conserving the resources. House is the place where most of the resources are consumed and life time of earth is also long enough that they can play vital role in achieving this change by making the house Self Sufficient in which all the needs of residents are fulfilled by the house and all problems regarding comfortable living are resolved within the house by making use of renewable resources and proper waste management.

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