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Green Building Design and Construction Using Concept of Sustainability

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Abstract **-** The history of green architecture is basically the history of mankind. Green building, or sustainable design, is the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and of reducing impacts on human health and the environment for the entire lifecycle of a building. Green-building concepts extend beyond the walls of buildings and include site planning, community and land-use planning issues as well. The growth and development of our communities has a large impact on our natural environment. The manufacturing, design, construction and operation of the buildings in which we live and work are responsible for the consumption of many of our natural resources.
To design, construct, operate and maintain buildings energy, water and new materials are utilized as well as amounts of waste causing negative effects to health and environment is generated. In order to limit these effects and design environmentally sound and resource efficient buildings; "green building systems" must be introduced, clarified, understood and practiced**.** Due to the apparent shape and materials used to build homes in the Middle East, this paper attempts to provide a new and different design with similar but environmentally friendly materials. Due to the use of traditional materials in the construction of the buildings in Middle East and also the lack of use of environmentally friendly materials and lack of energy management in countries such as Iran-Iraq-Syria and … The article's innovation is in three parts, which is fully discussed in the introduction section:
1) Simultaneous use of the Sustainable material and energy management system mentioned in the paper in a design
2) The author's effort to design a comfortable space for work, which is called the second house
3) Use of environmentally friendly materials and clean energy and using the (BEMS) energy management system to reduce energy dissipation and comparing the energy consumption of this model with the similar traditional models.

Keywords*:* Sustainable Building, Green Architecture, Reusable Materials, Environmental Design, Natural Architecture.

1. Introduction

The beginning of the twenty-first century has ushered in the era of green buildings. Most of buildings use energy inefficiently, generate large amounts of waste in their construction and operation, and emit large quantities of pollutants and greenhouse gases. In contrast to conventional buildings, green buildings seek to use land and energy efficiently, conserve water and other resources, improve indoor and outdoor air quality, and increase the use of recycled and renewable materials. Green architecture, or green design, is an approach to building that minimizes harmful effects on human health and the environment. The "green" architect or designer attempts to safeguard air, water, and earth by choosing eco-friendly building materials and construction practices. Building a greener home is a choice — at least it is in most communities. "Typically, buildings are designed to meet building code requirements," the American Institute of Architects (AIA) has reminded us, "whereas green building design challenges designers to go beyond the codes to improve overall building performance and minimize life-cycle environmental impact and cost." Until local, state, and federal public officials are persuaded to legislate green processes and standards — just like building and fire prevention practices have been codified — much of what we call "green building practices" is up to the individual property owner.

Green architecture, or green design, is an approach to building that minimizes harmful effects on human health and the environment. The "green" architect or designer attempts to safeguard air, water, and earth by choosing eco-friendly building materials and construction practices [1].

Green architecture has several characteristics that make it unique. It has features such as water saving, specially designed ventilation systems for cooling and heating, non toxic and non synthetic materials, recycle and reuse of older buildings etc. drainage is also an important factor to consider. Proper drainage facility prevents water from blocking and also prevents surface runoff. Space that is left over should be efficiently used. Green trees and plants can be planted so that fresh oxygen is available. Solar energy should also be harnessed. With the help of green architecture electricity consumption is reduced and natural resources are instead used. Natural and eco friendly materials such as bamboo and woods should be used. Steel, aluminum should be avoided as it has many bad effects on the environment as well as on people's health. Rooms should be free from any obstruction so that air can flow freely through the rooms [2].

The single most important green design decision is size. Smaller houses automatically consume fewer resources both during construction and after occupation. Houses should be sized to work for you every day. Simpler forms lose less energy because the ratio of exterior surface area to volume is smaller. Every projection from a house is like a cooling fin.

Solar orientation is the most important design element. Heating and cooling loads in a home could be cut significantly by orienting the long walls of houses east-west, exposing south facing windows in winter, and shading them in summer, and avoiding expanses of glass on west-facing walls that get the full brunt of the flat afternoon sun.

Even in lots where the street dictates layout of the home, there are still steps you can take. You can reverse plans to place the garage on the west side of a house. Porches and broad roof overhangs can shade south and west facing windows. Plant, or don't cut down in the first place, trees that shade the west side of a house."

What's the key to durability? Water is probably public enemy one, two, three, and four. Uncontrolled water rots homes, peels paint, and causes mold. Moisture control is a huge focus of building science–inspired components like generous overhangs, proper window and door flashings, and rain-screen walls that allow siding to dry, improve paint durability, and avoid water wicking. Normal construction details assume greater importance.

Controlling air and moisture leakage from inside to out not only saves energy, but also can prevent damaging condensation from forming in framing cavities. The use of vapor barriers in cold climates is an important moisture control element.

Attention to detail is another key. We must follow a careful step-by-step flashing, sealing, and installation sequence to ensure proper performance over the life of the building.

Other details can be as basic as properly installing house wrap or builder's felt as a secondary weather barrier, so that water that gets in behind the siding was directed out again.

Insulation is a job that needs careful detailing. From a green perspective, this is very important. And air sealing—filling the holes where inside air can leak out or outside air can leak in—is at least as important as insulation, because no insulation can achieve its potential if air can leak through it. Air infiltration must be kept as low as possible.

It's vital to eliminate areas that allow inside air access to the thermal envelope, including areas behind bathtubs, showers, and kitchen soffits. These areas should be closed off from the wall behind them with an air and moisture barrier. Recessed ceiling lights are another source of leakage. New models are available that are air sealed to help control infiltration.

While you're thinking about HVAC equipment, don't neglect the ducts. Don't run any ducts in unconditioned spaces. Normal air conditioning duct leakage can be 20 percent.

Fluorescent lighting gives you more light for your energy dollar, (compared to incandescent or halogen), and they also produce less heat than incandescents and halogens and can save significantly on cooling loads. Fluorescent lights don't necessarily give off a sickly green light anymore, either. Commonly available lamps with a color temperature of 2,600 to 2,800 kelvin give off light that's nearly indistinguishable from a cool white incandescent bulb.

Supplying Energy Star–rated appliances is another simple way to cut down energy use. Similar Energy Star–rated appliances can vary in actual consumption, so go one step further and compare annual energy use printed on each appliance's label.

If ever there was a green building strategy that's a no-brainer, waste reduction is it. A simple expedient is to design in 2-foot modules to use materials most efficiently. Optimum Value Engineering is an approach to framing that questions the use of every stick of lumber to optimize materials use. For example, most openings don't require double 2x12 headers for

structural purposes. If a double 2x12 can be replaced with a single member, it will save lumber and create space to add insulation.

Recycling is another simple approach. Cardboard and metal are easy to recycle. Not only does this keep material out of the landfill, but recycling saves some of the cost of buying new, and saves the cost of a Dumpster.

If there's a downside to air sealing, it's the potential to trap pollutants inside. Typical indoor pollutants include formaldehyde (off-gassing from OSB, most forms of particle board, and some carpet and their glues), volatile organic compounds (VOCs) (solvents from paints, finishes, automotive products, etc.), combustion by-products such as carbon monoxide (from gas stoves and any improperly vented fuel-burning appliance), and excessive moisture.

There are two approaches to improving indoor air quality (IAQ). The first is reducing the use of products that off-gas. Use plywood floor sheathing, which off-gasses less formaldehyde than OSB. Detached garages separate exhausts, fuel, and pesticide storage from living spaces. Providing dedicated combustion air for furnaces, boilers, and water heaters can prevent back-drafting stack gasses into the house.

Proper ventilation, the second approach, is as important as reducing sources. Using heat recovery ventilators (HRVs) in northern climates, brings fresh outside air in, while exhausting stale inside air. The two air streams pass each other in the ventilator's heat exchanger, with the outgoing indoor air tempering the incoming outdoor air. An added benefit is that in the winter an HRV ventilates the house and retains some indoor humidity. It exhausts air from bathrooms, and laundry and kitchen areas, and directs the tempered incoming fresh air into the living areas and bedrooms.

Many of us remember the inadequate flushing and frequent clogs from the federally mandated change to 1.6-gallons-per-flush toilets in the 1980s. But that has changed, and low-consumption toilets perform very well today.

Water issues also include managing storm water runoff to maintain natural ground percolation that recharges aquifers, as well as preventing siltation of waterways. It's often possible to reduce the storm sewer infrastructure by increasing the ability of individual home sites to absorb storm flows. Techniques include draining roof runoff to absorption fields and the use of pervious concrete pavers on driveways. This approach may even ease the path through local land-use boards by showing that you're doing the right thing.

Simply choosing one product over another is the easiest, yet the least important path to going green. Look for swaps that take something not as green and replace it with something greener that requires no changes in worker skills. Examples include specifying concrete that incorporates fly ash (a waste product from coal-burning power plants) as a partial substitute for Portland cement. Another example is using bamboo flooring, which regenerates quickly, instead of wood species that are not as sustainable.

Look for Forest Stewardship Council certified lumber and low-VOC paints. Although low-VOC paints cost a little more, the major brands all include a mildewcide, which makes them an easy sell.

Prefab foundation panels are one possible swap. Not only does a Superior Wall foundation go up in a day, it's waterproof, it requires no concrete footer, and it's insulated. Elk's reflective roof shingles are another, which use a 3M mineral coating that reflects about 25 percent of unwanted solar radiation versus other shingles.

As global populations increase, so too will the need for accommodation. However, current mainstream building methods are unsustainable, producing large amounts of CO2 both during construction and throughout a building's life. Thankfully, sustainability is becoming a priority for developers, and with many exciting innovations happening in the construction industry, sustainably addressing global accommodation needs seems possible. Here's five materials that could help:

1. Developed by Spanish and Scottish researchers with an aim to 'obtain a composite that was more sustainable, non-toxic, using abundant local materials that would mechanically improve the bricks' strength', these wool bricks are exactly what the name suggests. Simply by adding wool and a natural polymer found in seaweed to the clay of the brick, the brick is 37% stronger than other bricks, and more resistant to the cold wet climate often found in Britain. They also dry hard, reducing the embodied energy as they don't need to be fired like traditional bricks.

2. Traditional roof tiles are either mined from the ground or set from concrete or clay - all energy intensive methods. Once installed, they exist to simply protect a building from the elements despite the fact that they spend a large portion of the day absorbing energy from the sun. With this in mind, many companies are now developing solar tiles. Unlike most solar units which are fixed on top of existing roofing, solar tiles are fully integrated into the building, protecting it from the weather and generating power for its inhabitants.

3. Whilst 95% of a building's CO2 emissions are a result of the energy consumed during its life, there is much that can be done to reduce that 5% associated with construction. Concrete is an ideal place to start, partly because almost every

building uses it, but mostly due to the fact that concrete is responsible for a staggering 7-10% of global CO2 emissions. More sustainable forms of concrete exist that use recycled materials in the mix. Crushed glass can be added, as can wood chips or slag - a byproduct of steel manufacturing. Whilst these changes aren't radically transforming concrete, by simply using a material that would have otherwise gone to waste, the CO2 emissions associated with concrete are reduced.

4. Made from recycled newspapers and cardboard, paper-based insulation is a superior alternative to chemical foams. Both insect resistant and fire-retardant thanks to the inclusion of borax, boric acid, and calcium carbonate (all completely natural materials that have no associations with health problems), paper insulation can be blown into cavity walls, filling every crack and creating an almost draft-free space.

5. In fact, super-efficient windows would better describe this particular building material. The three layers of glass do a better job of stopping heat from leaving the building, with fully insulated window frames further contributing. In most double-glazed windows, the gas argon is injected between each layer of glass to aid insulation, but in these super-efficient windows, krypton - a better, but more expensive insulator - is used. In addition to this, low-emissivity coatings are applied to the glass, further preventing heat from escaping.

A building that combined all five of these methods would be an admirably sustainable option for housing. Whilst the construction industry tends to progress at a slow pace, the importance of sustainability is a high profile issue, and one which is only likely to increase. With sustainable building materials already fully developed, it is now up to consumers to actively demand their use and building developers to respond promptly. When it comes to building sustainably, the savings generated in energy, water, maintenance, operations, and healthcare can offer you short and long-term investment returns. By applying sustainable building strategies, you can maximize both your project’s economic and environmental performance. Here are some of the ways you can benefit from green building:

Energy Efficiency & Water Conservation
Improved Indoor Air Quality
Reduced Carbon Footprint
Increased Property Values
Increased Employee Productivity
Improved Employee Attendance
Promote Your Company’s Values
Government & Utility Incentives

Recycling construction materials is one of the problems facing countries such as Iran-Iraq-Syria and so on. Also, energy consumption due to the lack of proper management of consumption in such countries has caused problems. Therefore, in this paper, we are trying to solve these problems. The Novelty of this paper is to solve these problems by using the Sustainable Concrete and Wool Bricks, as well as the use of an energy management system simultaneously. Then, we will briefly comparing the energy consumption of this model with the similar traditional models.

2. Case Study

The study area has a typical mild climate. It is characterized by a fairly warm season and a slightly rainy temperature winter. Precipitation falls mainly during the colder season from autumn to spring. The prototype is therefore designed for the mild humid climate of middle east.

Sustainable energy in buildings refers to efforts to reduce or eliminate the need to burn fossil fuels for space heating and cooling. buildings use one-third of our total energy, two thirds of electrical energy and one eighth of water.[3] Garden roofs, which can be installed on both conventional and protected-membrane roofing, require additional components, such as a root-resistant layer, a drainage layer, a filter membrane and a growing medium, to support the growth of vegetation. Garden roofs are generally considered to be "intensive" or "extensive," based on the weight of the system.[4] Water use generally refers to municipal potable water use on the site. It includes the use from fixtures (faucets, toilets, sinks, etc.), the use from equipment (dishwashers, etc.), and the exterior use for landscaping.[5]

Good system design and good specification of products can easily reduce water use by 50% or more. At least one green building certification system requires buildings to be net zero water use.

There are several ways to get the most out of every drop: water-efficient fixtures and equipment, water-efficient irrigation and landscaping, recycling water so it can be used more than once, and capturing rainwater. You can also purify the water on-site with living machines or advanced septic systems.

2.1. Building Prototype Suggestions

The BEMS technology is a broad concept of building control, and can have a variety of characteristics. However, the term BEMS is limited to use for sophisticated and advanced control systems [6]. Therefore, while all buildings require and have some form of control system, BEMS technology is substantially different from previous control systems. The main point in which a BEMS differs from other control systems is the characteristic of communication: information of the processes and functions of the building can be received and controlles at a central, single operating unit. Therefore, decisions can be made based upon the received information [6]. This is a critical aspect of a BEMS as it allows for optimization of the system.

Fig. 1: prototype suggestion designed by ClimateTechWiki [7].

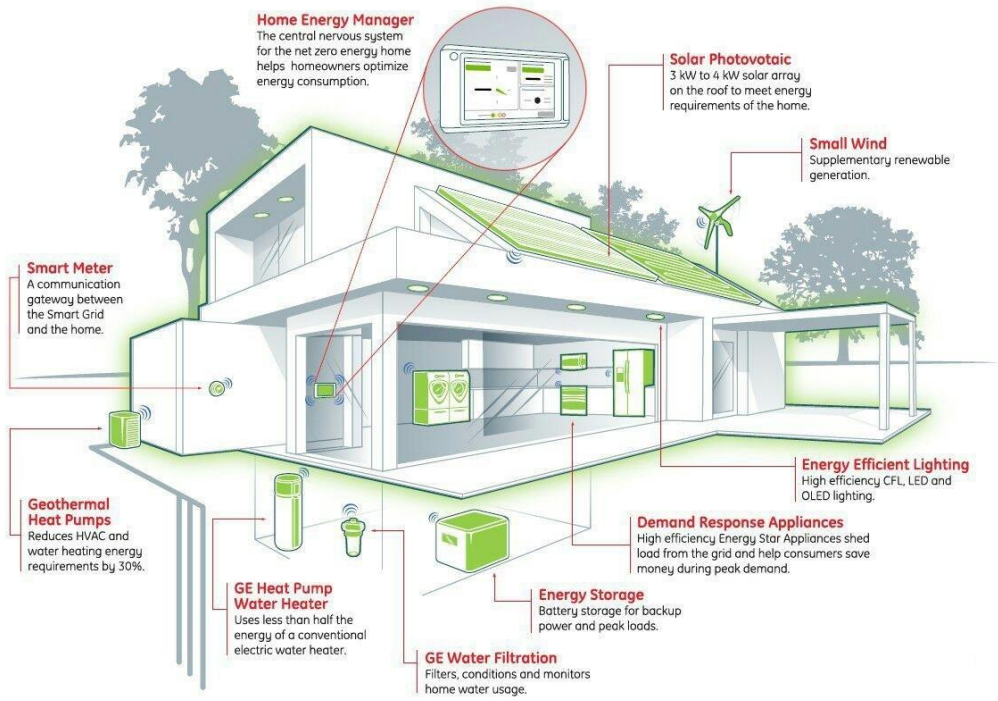

Fig. 2: Energy Systems details designed by ClimateTechWiki [7].

Fig. 3: Second House prototype plan by Author (Eghbali,2018).

The walls of the house are thick and massive. The high-mass walls are cooled from the cool night time temperatures. In turn, the walls then cool the occupants during the day by accepting the heat radiating from their bodies.

The walls are made of Sustainable Concrete and Wool Bricks and also covered by Paper Insulation.

Floor covered by carpet or casework.

Well pumps are built to be used for extracting water from an underground source.(As designed by ClimateTechWiki)

Solar hot water systems are used to collect energy from the sun in panels or tubes to produce domestic hot water used in the house. (As mentioned by ClimateTechWiki)

Photovoltaic panels are installed on south-facing roof which is inclined with an angle to maximize the amount of electricity produced.

Light pipe or light tube was used to transmit and use optimal sunlight.

Light tubes or light pipes are physical structures used for transporting or distributing natural or artificial light for the purpose of illumination, and are examples of optical waveguides.

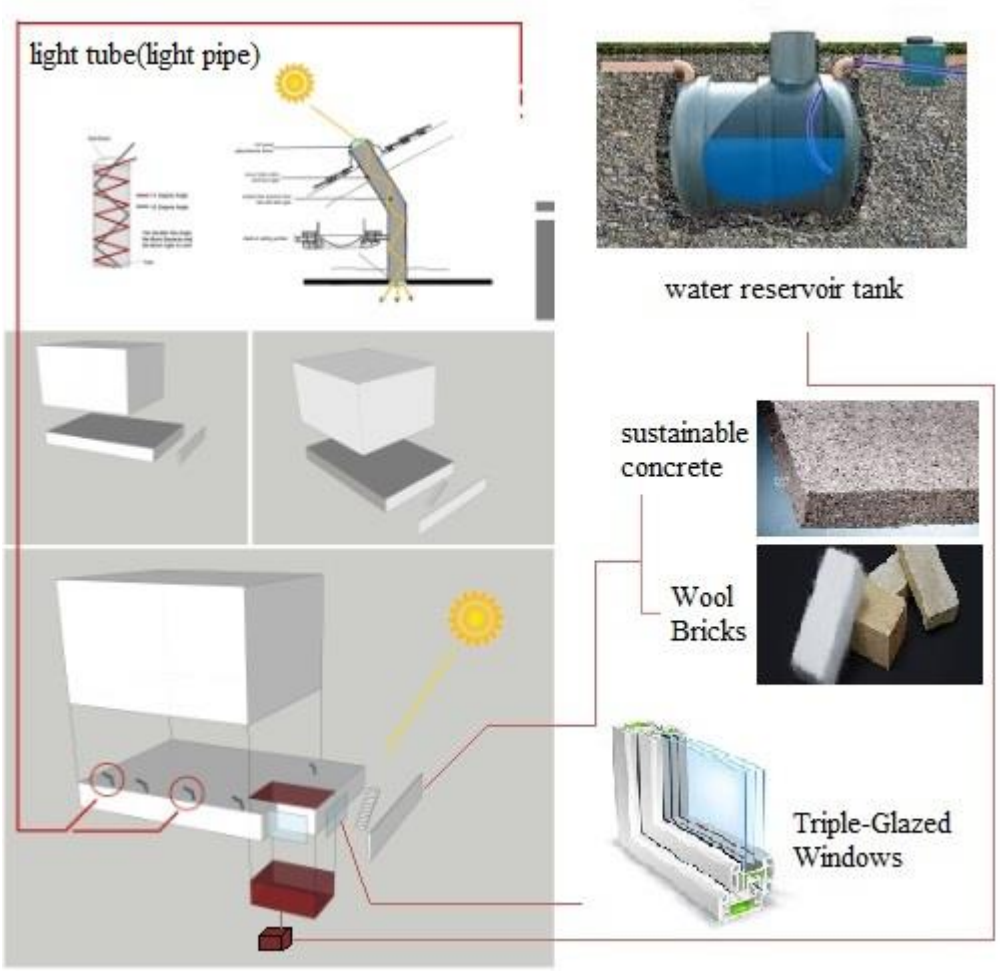

Fig. 3: Second House suggested materials by Author (Eghbali,2018).

3. Conclusion

Green and sustainable buildings are naturally different from conventional buildings. They require special materials and building practices as well as management commitment to sustainability [8]. Due to the barriers reported, the unique characteristics of sustainable building project required adjustments to conventional project management practices to minimise risks and improve the chances of delivering the project within acceptable costs and schedule. Realistic financial and time constraints, superior planning, design and construction processes are needed to deliver a green and sustainable building project [9].

Sustainable and Green buildings will only results from building professionals working together to achieve this common objective. It is important to explore the strategies for containing cost during the planning phase of a project to reduce developers first cost in delivering the green and sustainable building project [9]. Sustainable and green building requires a client who is sympathetic to this ideal, user who understands and values the concepts and designers and contractors who as a team evolve the design with a sustainable outlook. passive solar construction doesn't have to cost more than conventional construction, and it can save money on fuel bills [10] Because a well-designed passive solar home or building is highly energy efficient, it is free of drafts. Extra sunlight from the south windows makes it more cheerful and pleasant in the winter than a conventional house [11].

Table 1: Energy consumption measured by Author.

Power consumption(during August)		
Power	Green building	traditional building
Water	35 (m^3)	77(m^3)
Electricity	133(kwh)	262(kwh)
Gas	59(m^3)	95(m^3)

Table 2: Energy consumption measured by Author.

Power consumption(during November)		
Power	Green building	traditional building
Water	27(m^3)	62(m^3)
Electricity	112(kwh)	213(kwh)
Gas	110(m^3)	304(m^3)

In order to check energy consumption, we reviewed the amount of electricity, water and gas consumed. After reviewing the power consumption of the proposed design and comparing it to traditional ones, the Average electricity consumption dropped by 51%, water use reduced by 63% and Gas consumed dropped by 38% . This means that in green buildings energy consumption can be reduced more than 50% compared to conventional ones.

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