Architecture of buildings using renewable energies in harmony with sustainable development

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Abstract
Harmony with sustainable development and energy efficiency and using renewable energy sources are some issues that should be considered by designers and architects in designing and architecture of the building. In this paper factors such as designing buildings with free natural energies and the creation of a modern architecture in harmony with sustainable development are discussed. This study is based on library studies according to a descriptive approach. In this paper, the role of renewable energies such as solar energy, biomass and wind energy in sustainable architecture will be explained. Based on the material presented in this study, the use of renewable and clean energy resources can bring us closer to sustainable architecture. Then, an outstanding example of the sustainable architecture is presented (council house 2) where renewable and clean energies have been used very well in this architecture.

Keywords: Sustainable Architecture, Renewable Energy, design, buildings, council house 2

Introduction
Buildings compared to other artifacts, have a relatively long life. During all stages of planning, construction, equipping, and demolition or reusing it, they will affect sustainable development. In addition, the building has a considerable impact on human health. For example, 90% of people living in Europe spend their time at the building and architectural spaces. Norberg-Schulz in his book "Architecture: Meaning and place," writes: "In my career, the modern world has undergone a very complex crisis. Our historic environment has quickly been destroyed; our natural environment has been the victim of pollution and uncontrolled exploitation and we has been treated just as a human material. In general, people do not form a part of significant Integrity and is a stranger for his world" (Schultz, 2003). On the other hand, due to increasing urbanization and technology, each day we see the creation of a new wave of architectural styles that pose as different and strange forms and buildings But the question is what type of Architectural works can be introduced as a Sustainable work. Since no building can be considered absolutely Sustainable, Spaces should be created in a way to be relatively close to the principles and an environment, based on effective utilization of natural resources and ecological principles, to be created.

The continuous increase in population, face more and more countries with the problem of energy shortages and threaten human life. By integrating the principles of sustainable and optimal use of renewable energies Perhaps it was hoped that the problem such as energy shortage, Multiplicity of environmental pollution, and etc. be partially overcome. Due to the increasing use of renewable energies and the development of advanced technology systems, in order to diversify energy resources and reduce the consumption of fossil fuels, some activities should be done in the production of such energies so that in case of energy crisis in the world, they can be used to provide a part of the energy. In this regard, this paper is seeking to explain the importance of using renewable energies for Sustainable building design based on modern architecture.
2. Previous research
According to Lauring (2010), Sustainability forces architects to reintegrate techniques and urban and building utility as crucial parts of design considerations, while architects contextual approach needs to be widened. Architecture has traditionally been a practice rather than a science, a practice relying very much on visual images as inspiration or more directly as forms to repeat. He concluded that Sustainable urban development will depend on political action: On a national level traffic infrastructure will have to support dense urban settlement and municipalities will have to provide local traffic conditions, building sites and municipality plans supportive of new types of housing and city building. Guy and Moore (2007) in their article believe that pluralism is a means to contest technological and scientific certainty. At the same time, they reject epistemological and moral relativism. These twin points of departure lead them to propose a research agenda for architecture of reflective engagement that is sympathetic to the pragmatist tradition. According to Kharrazi Sanat Shotorban (2007), Supply and use of energy in human life has always been vital And access to new energy resources play an essential role in civilizations rise and change, As the Industrial Revolution and the use of fossil energy created a new civilization and changed human life immediately and boosted. Although using renewable energies caused change and development, but also created problems as well. To establish the ecological balance in the planet, there was a new attitude in development which today called sustainable development. Gorji Mahlabani (2010) in his article suggest that view of human about nature, is his worldview or perspective which is reflected in his approach and methods. Thus, there are the theoretical shortcomings and ambiguities in concept of sustainable architecture which can be a significant barrier to their environmental protection. His goal is to seek environmental theories of sustainable development and sustainable architecture. He first discusses about the goals of sustainable development and sustainable architecture and provides its solutions to realize its shortcomings and to suggest further policy.

3. Sustainable architecture
This type of development, resulting from growing awareness of the global links between the growing environmental problems, social issues, the economy, poverty, inequality and concerns about a healthy future for mankind. Sustainable development, strongly ties environmental social and economic issues together (Hopwood et al. 2005). Some scholars such as Alan Fricker believe that sustainability is an outlook to the future which is actually a route map that focuses on a set of moral and ethical values and principles and controls human behaviors (Munier, 2005). In Richard Rogers’s view, sustainable design is going to be faced with future needs without destroying the remaining natural resources for future generations. About buildings, sustainable design gives indications on resource efficiency, minimum energy, flexibility, and long life (Rogers, 2007). Edwards and Hyatt argue that a large part of sustainable design is what we do via saving energy, but you know, designing is a creating spaces that are safe, durable, economical, and sensitive to local needs and requirements. They also point to the definition of sustainable development as the establishment and management of safe buildings that are based on environmental criteria and efficient resources (Edwards and Hyatt. 2001). The concept of sustainability in architecture is not this that we create buildings to have just a long life, because the life of a centuries-old building does not match the needs of the present. Sustainable Architecture is that can respond to the needs of the present. According to the lives and needs of today’s architecture and limitations on energy resources, a series of general indicators can be defined as the principles of sustainable architecture which we will discuss about them.

3.1. Effects of cultural, environmental and climatic conditions
Every person who lives in the community has its own culture and Conditions and these cultures and traditions as affect people’s lives, should also be effective in type of architecture because architecture also is an integral part of human life. In fact, we should create a Building that is not "stranger" to its surrounding and designers of sustainable architecture should, after
adoption of building with climate and surrounding conditions and taking advantages of environmental energies, should pay attention to culture, religion and ethnicity of people whom they want to design for.

3.2. Harmony with nature and the environment
If we are aware of the resources of environment in which we live, we can prevent them from damaging. Understanding of the environment will determine designing stages such as solar orientation and buildings orientation. In this regard, several attempts were made in organic and ecotech architecture. In organic architecture, Buildings should be designed in such a way that has minimal Damage to nature. In ecotech architecture, the environment, fuel use, biodegradable energy, and renewable energy are considered that have minimal damage to nature and the environment.

3.3. Saving energy (Energy efficiency and conservation)
Energy crisis, environmental pollution, global warming and the urban heat island in big cities are problems of this century around the world. All this causes a lot of energy to be spent on heating and cooling spaces. By rational use of limited natural resources and construction management, we should help to conserve natural resources and reduce energy consumption. One of these strategies is sustainable or green building design

3.4. The correct answer to the functional needs
Strengths and weaknesses of a building impact on global ecosystems because Proper functional relationships between spaces, ratio of filled spaces to empty spaces, and Designing spaces appropriate to function in itself lead to less wasted energy and efficient use of spaces. In fact, we should divide functions within architectural spaces according to the culture and lifestyle.

3.5. Readability and unambiguous
Building that is created, should not be seen strange for the people of the area and should be designed in such a way to be compatible with culture of the people. Aesthetic principles in them should be adhered and odd combinations and forms that have no background in architecture of the area should not be applied.

3.6. Emulation of vernacular architecture in a modern way
Given the technological development and urbanization, by traditional method, no longer we afford to create architectural monuments, Because our needs of the architectural space has been changed and the traditional construction methods are not responsive any more But according to new technologies, Vernacular architecture can be transformed into a modern form.

3.7. Appropriate use of materials
The role of materials used in the creation of sustainable architecture cannot be ignored. Materials that are used should be impressive visually and mentally, including colors, textures and type of materials. According to the ecotech architects, the building shell should react against environmental changes like body skin. Materials should be used that can minimize damage to nature and even the colour that is used must be of material that is not harmful to the environment.

4. Renewable Energies
Renewable energies (new energies) are types of energies that, unlike the nonrenewable energies, have the ability to return to nature like wind, solar, hydropower and biomass energies. In recent years, due to the fact that renewable energy sources are running out, these resources are considered. In 2006, about 18% of world energy consumption was obtained from renewable energies. Traditionally, the share of biomass was about 13% which is used for heating, and 3% was the share of hydropower. 2.4% of the remaining include small hydro power plants, modern biomass, wind energy, solar energy, geothermal and biofuels which are rapidly expanding. The use of wind energy, with an annual growth of around 30% and with an installed capacity of 157,900 MW in 2009, is seen largely in Europe, Asia and the United States. At the end of 2009 a total of more than 21,000 MW of energy was produced by the photovoltaic power. Thermal - Solar power stations are working in U.S. and Spain.
Concerns about environmental changes and increases in oil prices and peak oil production, cause the increasing growth of legislation that encourage utilization and commercialization of renewable resources. The world tries to replace clean energy with fossil energy and in the near future, solar, wind and tidal energy will be used extensively, so the technology of using this energy must be developed and developing countries to achieve these technologies should increase their industrial and practical powers (Mashk, 2003). In the following, we discuss three of the most renewable energies.

4.1. Solar energy
In each second two quarters of a million solar mass is converted into energy. Considering sun weighs about 333 thousand times the weight of the earth. Considering the fact that sun's weight is about 333 thousand times more the weight of the earth, this luminous sphere can be as energy bonanza to 5 billion years. Like other energies, solar power, directly or indirectly, can be converted into other forms of energy such as heat, electricity, and etc. Recently, the vast resources of solar energy are used to produce electrical energy, dynamic use, heating of buildings and sites, drying agricultural products, chemical changes and so on.

4.2. Biomass Energy
Another renewable energy is biomass energy. Biomass resources in nature are plant resources and agricultural waste, municipal waste and food and livestock waste. These are the resources that their pouring on nature, in addition to health problems, will cause greenhouse gas emissions and damaging the environment. The continuation of this trend causes numerous and sometimes irreparable damages to the environment. Managing these resources, in addition to control of environmental contamination, lead to a lot of energy. U.S. and European countries are now using sources of biomass for energy production in power plants.

4.3. Wind Energy
The use of wind energy in many countries, compared to other energy sources currently being used, has increased. Using wind turbine technology due to not polluting the environment and also for low price of wind power turbines can be a good idea. The advantages of this energy will be as follows: Wind turbines require no fuel, supply a part of electricity demand, the relative lower price of wind energy compared to fossil energy in the long term and creating sustainable energy system, no need to water, do not need much space and do not pollute environment. Many designers are seeking to use more natural energy in designing buildings. One of these works is Wind Tower in Vienna. This light tower, while surrounded by the extrusion force of the wind, is Able to move in the direction of the hardest oscillations in wind flow. The generators that are activated by dynamic system of the tower, change it into a massive power station to produce more energy and wind power. (Vagliasso, 2006)

5. Melbourne Council house 2, a new eco-friendly building, and an outstanding example of sustainable architecture
Council House 2 (also known as CH2), is an office building located in Melbourne, Australia. It is occupied by the City of Melbourne council, and in April 2005, became the first purpose-built office building in Australia to achieve a maximum Six Green Star rating, certified by the Green Building Council of Australia. CH2 officially opened in August 2006. CH2 is meant to be a 'lighthouse project' for new building developments, aiming to influence future design to be more sustainable and efficient. Some objectives when designing the building were to be greenhouse neutral and improve the overall employee wellbeing.
It is a multi-award winning and inspirational building that has reduced CO2 emissions by 87%, electricity consumption by 82%, gas by 87% and water by 72%. The building purges stale air at night and pulls in 100% fresh air during the day. The building exterior moves with the sun to reflect and collect heat, and turns sewage into usable water. The building has improved staff effectiveness by 4.9% and will pay for its sustainable features in a little over a decade.

5.1. Strategies
Different strategies were used when doing this but all were focused around a sustainability
aspect. Biomimicry was a large component in designing the building. The building’s principal design architect, Mick Pearce, incorporated a system previously and successfully used in the Eastgate Centre in Harare. The heating, ventilating, and cooling system (hvac) is designed with strategies taken from a termite mound. In the termite mound, the cool wind is drawn into the base of the mound, via channels and the 'coolth' is stored using we soil. As the air warms, it flows upwards and out of the mound via vents. This gives the mound the ability to keep a stable temperature. CH₂ uses similar strategies with its system by effectively using natural convection, ventilation stacks, thermal mass, phase change material, and water for cooling.

Another strategy used taken from nature is the skin system. The façade is composed of an epidermis (outer skin) and dermis (inner skin). The 'dermis' of the building consists of the outside zone to house the stairs, lifts, ducts, balconies, sunscreens and foliage with the inner line defining the extent of the 'fire compartment'. The dermis was designed with lightweight constructing using a steel frame. The epidermis provides the micro-environment including the primary sun and glare control for the building while creating a semi enclosed micro-environment. Ventilation stacks are implemented on the north and south façades of the building. These stacks are used to channel air. The north stacks receive more sun so they are black to absorb heat, which in turn encourages the warm air from the building to rise up out of the stacks. The south stacks are used to channel down cold air through the vents. These stacks also offer shading for office windows.

![Figure 1: CH₂ Building](image)

The ceilings are made from pre-cast concrete, with a 'wavy' shape, to optimise surface area, which allows for an increase in thermal mass capacity. The thermal mass in the concrete is flushed at night, through a night purge, absorbing 'coolth' form the night air and allowing it to absorb heat from the space during the day. With the 'wavy' design, heated air is collected at ceiling height, and then channelled out of the building and into the ventilation stacks. Radiant cooling is also a strategy used by running chilled water through beams and ceiling panels. Chilled panels cool the rising warm air, which then drops, creating a natural convection current. Phase change material is used to cool the water for the chilled beams and panels. It efficiently helps to keep the water circulating through the beams and panels at a desired temperature. The phase change material is often referred to as the 'battery' of the building because of its purpose of storing the 'coolth'. Natural day lighting was a difficult task for the CH₂ team due to the building’s orientation and position in relation to surrounding buildings, and the requirement for a deep open plan office space. The best design techniques for CH₂ to allow the most natural light included a synergy between windows size and air ducts, light shelves to reflect light into the office area, vaulted ceilings to allow further light penetration, shading on north, west, and east façades, and finally timber louvres to control light penetration from the afternoon western sun. The light shelves were place on the north façade which in turn will create a soft indirect light on the roof space. These light shelves are placed externally and
made of fabric in a steel frame. The vaulted ceilings allow for more natural light filtering to the deeper parts of the office space. Locating the windows at the highest point of the curve improved this technique. The east facing façade uses a perforated metal system for shading that also acts like a thermal chimney. Heat rises pulling air through the eastern part of the building allowing it to be naturally ventilated. The north facing façade is composed of steel trellises and balconies supporting vertical gardens nine stories high. The foliage protects the building from the sun and also filters sunlight for a reduction of indoor glares. Light shelves are used to provide shading as well as reflect natural light into the building. These light shelves are placed externally and made of fabric in a steel frame. The west facing façade is covered with a system of timber louvres that pivot to optimise the penetration of natural light and views. These louvres also protect the façade from the harsh western sun. The louvres open and close depending on the amount of sun that is hitting the western façade. The louvres are made from untreated recycled timber and are moved by a computer-controlled hydraulic system. The building also uses artificial lighting throughout to provide a sufficient amount of light when natural light is not available. These lights use the low-energy T5 luminaries which achieve a lighting power density of less than 2.5 watts/m² per 100 lux. Shower towers are used on the southern façade. These towers draw outside air from above street level and cool the air by evaporation to form the shower of water. The cool air is then supplied to the retail spaces and the cool water is used to pre-cool the water coming from the chilled water panels. The towers are made from tubes of lightweight fabric 1.4 meters in diameter. Testing from these towers has shown a temperature reduction of 4 to 13 degrees Celsius from the top of the tower to the bottom of the tower.

The designers also used an innovative concept of design by using the same amount of foliage on the building as would have been present if the site was still in its original natural vegetated state. This is accomplished by using a roof garden, which also serves as a break-out and recreation space for staff. The northern façade also incorporates planter boxes situated east and west of each northern balcony.

5.2. Indoor Environment Quality

A main concern when designing CH₂ was the Indoor Environment Quality (IEQ), and many steps were made to optimise this in particular. With an improvement in the overall IEQ designers believed this could lead to fewer sick days of occupants, less headaches and better well being while staffs are at work. The City of Melbourne’s aim was to create a healthy, comfortable, adaptable and stimulating work environment for the staff. Strategies used to improve the IEQ include a well-designed working environment, fresh air, natural light, greenery, and use of materials that emit low amounts of Volatile Organic Compound (VOCs). Not only do these strategies improve the work place, but also can save the city money based on productivity gains.

Displacement ventilation was used as the primary ventilation in CH₂. The advantages of using a displacement ventilation system include, increased cost effectiveness in operation, improved air quality within occupied zone, greater operational efficiency, ability to conceal, quiet, and finally flexibility. The minimum fresh air requirement at CH₂ is 22.5 litres/second/person. This is much higher than the Australian Standard of 10 litres/second/person. The higher turnover rate was chosen because research has show that low fresh air requirements can be directly linked to low productivity and sickness, including colds and flu.

Natural light was optimised in the design of CH₂ by creating a wavy ceiling, use of light shelves, larger window at the bottom of building and smaller windows at the top, use of colours to accentuate the natural light, and the concepts that windowed areas were shared by all not owned individuals. The interior of the building is also decorated with a variety of plant life with aesthetic purposes, as well as research that show that plans reduce the amount of VOCs in the air. In addition to controlling VOCs with plants CH₂ planners chose materials to keep the indoor pollutants at a minimum. Low VOC paints, low VOC carpets, low VOC adhesives and
sealants, and low emission formaldehyde composite wood products are all used in the interiors of the building.

Conclusion
Many theorists are looking for a view to the nature that can lead to respectful behavior towards nature. In the view of Alexander, Ecology is the knowledge of togetherness of objects, environment and elements. Norberg-Schulz is seeking to make sense of built environment through nature. Also according to Nasr, The only solution to the present crisis in human societies is to restore divine nature of the nature (Gorji Mahlabani, 2010). In this paper factors such as designing buildings with free natural energies and the creation of a modern architecture in harmony with sustainable development were discussed. Sustainable architecture in new issues is to try to reduce the negative impacts the new architecture on the environment and instead, by using renewable energies, to save energy consumption. All the principles of sustainable architecture should be embodied in a complete process leading to the construction of a healthy environment both visually and psychologically appropriate. Sustainable architecture is different in each region or country. In this article, the role of renewable energies such as solar energy, biomass and wind energy in sustainable architecture were explained. Based on material presented in this study, the use of renewable and clean energy resources can bring us closer to sustainable architecture. Melbourne Council house 2, a 10-storey office building for about 540 City of Melbourne staff, is an outstanding example of the sustainable architecture, where renewable and clean energies have been used very well in this architecture. It has been designed to copy the planet’s ecology using the natural 24-hour cycle of solar energy, natural light, air and rainwater, to power, heat, cool, and water the building. The building consumes 373,012 kWh of electricity and 65,963 kWh of gas annually. Compared to the previous Council building (c1970), this equals savings of: 82% electricity consumption, 87% gas consumption, 72% mains water supply, and 4.9% improvement in staff effectiveness as a result of the healthier building (clean fresh air and non-toxic finishes).

CH2 has been successful because it has taken a ‘ground up’ green design approach. Designers considered the best environmental options and solutions, recycled products such as concrete, cement, steel and timber were used in construction, sustainable and energy savings products were used at every point a formal accreditation system was set up requiring all contractors, service providers and companies supplying products, to meet strict standards of sustainability in their products and services.

References