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RENEWABLE ENERGY, EMERGING ENERGY TECHNOLOGIES AND SUSTAINABLE DEVELOPMENT: INNOVATION IN POWER, CONTROL AND OPTIMISATION

Abdeen Mustafa Omer
Forest Road West, Nottingham NG7 4EU, United Kingdom

Abstract

The increased availability of reliable and efficient energy services stimulates new development alternatives. This article discusses the potential for such integrated systems in the stationary and portable power market in response to the critical need for a cleaner energy technology. Anticipated patterns of future energy use and consequent environmental impacts (acid precipitation, ozone depletion and the greenhouse effect or global warming) are comprehensively discussed in this chapter. Throughout the theme several issues relating to renewable energies, environment, and sustainable development are examined from both current and future perspectives. It is concluded that green energies like wind, solar, ground-source heat pumps, and biomass must be promoted, implemented, and demonstrated from the economic and/or environmental point view.

Keywords: Built environment, energy efficiency, and environment impacts.

1. INTRODUCTION

Natural resources may be renewable, non-renewable or abstract. Non-renewable resources include fossil fuels, minerals, clear-felled tropical hardwoods that are not replaced and rare animals or plants that are hunted or collected in an uncontrolled way. Renewable resources include energy from the sun and the biological and biogeochemical cycles (such as the water and energy hydrological and carbon cycle). At a more immediate level, renewable resources include forests that have been selectively felled and replanted, animal and plant populations that have been properly managed through controlled hunting, fishing and collecting, and waters with controlled inputs that can be readily recycled and reused. Abstract resources include animals, plants and the natural landscape as part of 'the countryside' used for recreation and tourism activities such as bird watching, fishing, hiking, sight-seeing, etc. non-renewable resources are of course finite, while the other two categories are effectively infinite. Our descendants will not thank us for exhausting finite resources, nor for destroying the renewable ones.

In many countries, global warming considerations have led to efforts to reduce fossil energy use and to promote renewable energies in the building sector. Energy use reductions can be achieved by minimising the energy demand, by rational energy use, by recovering heat and cold and by using energy from the ambient air and from the ground. To keep the environmental impact of the building at sustainable levels (e.g., by greenhouse gas neutral emissions), the residual energy demand must be covered with renewable energy. In this thesis integral concepts for buildings with both excellent indoor environment control and sustainable environmental impact are presented. Special emphasis is put on ventilation concepts utilising ambient energy from air ground and other renewable energy sources, and on the interaction with heating and cooling. It is essential to avoid the need for

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mechanical cooling, e.g., by peak load cutting, load shifting and use of ambient heat or cold from air or ground. Techniques considered are hybrid (controlled natural and mechanical) ventilation including night ventilation, thermo-active building mass systems with free cooling in a cooling tower, and air intake via ground heat exchangers. For both residential and office buildings, the electricity demand remains one of the crucial elements to meet sustainability requirements. The electricity demand of ventilation systems is related to the overall demand of the building and the potential of photovoltaic systems and advanced co-generation units.

The heating or cooling of a space to maintain thermal comfort is a highly energy intensive process accounting for as much as 60-70% of total energy use in non-industrial buildings. Of this, approximately 30-50% is lost through ventilation and air infiltration. However, estimation of energy impact of ventilation relies on detailed knowledge about air change rate and the difference in enthalpy between the incoming and outgoing air streams. In practice, this is a difficult exercise to undertake since there is much uncertainty about the value of these parameters [1]. As a result, a suitable datum from which strategic planning for improving the energy efficiency of ventilation can be developed has proved difficult to establish [1]. Efforts to overcome these difficulties are progressing in the following two ways:

- Identifying ventilation rates in a representative cross section of buildings.
- The energy impact of air change in both commercial and domestic buildings.

In addition to conditioning energy, the fan energy needed to provide mechanical ventilation can make a significant further contribution to energy demand. Much depends on the efficiency of design, both in relation to the performance of fans themselves and to the resistance to flow arising from the associated ductwork.

The building sector is an important part of the energy picture. Note that the major function of buildings is to provide an acceptable indoor environment, which allows occupants to carry out various activities. Hence, the purpose behind this energy consumption is to provide a variety of building services, which include weather protection, storage, communications, thermal comfort, facilities of daily living, aesthetics, work environment, etc. However, the three main energy-related building services are space conditioning (for thermal comfort), lighting (for visual comfort), and ventilation (for indoor air quality). Pollution-free environments are a practical impossibility. Therefore, it is often useful to differentiate between unavoidable pollutants over which little source control is possible, and avoidable pollutants for which control is possible. Unavoidable pollutants are primarily those emitted by metabolism and those arising from the essential activities of occupants. 'Whole building' ventilation usually provides an effective measure to deal with the unavoidable emissions, whereas 'source control' is the preferred, and sometimes only practical, method to address avoidable pollutant sources [2]. Hence, achieving optimum indoor air quality relies on an integrated approach to the removal and control of pollutants using engineering judgment based on source control, filtration, and ventilation. Regardless of the kind of building involved, good indoor air quality requires attention to both source control and ventilation. While there are sources common to many kinds of buildings, buildings focusing on renewable energy may have some unique sources and, therefore, may require special attention [3]. In smaller (i.e., house size) buildings, renewable sources are already the primary mechanism for providing ventilation. Infiltration

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and natural ventilation are the predominant mechanisms for providing residential ventilation for these smaller buildings.

Ventilation is the building service most associated with controlling the indoor air quality to provide a healthy and comfortable environment. In large buildings ventilation is normally supplied through mechanical systems, but in smaller ones, such as single-family homes, it is principally supplied by leakage through the building envelope, i.e., infiltration, which is a renewable resource, albeit unintendedly so. Ventilation can be defined as the process by which clean air is provided to a space. It is needed to meet the metabolic requirements of occupants and to dilute and remove pollutants emitted within a space. Usually, ventilation air must be conditioned by heating or cooling in order to maintain thermal comfort and, hence, becomes an energy liability. Indeed, ventilation energy requirements can exceed 50% of the conditioning load in some spaces [3]. Thus, excessive or uncontrolled ventilation can be a major contributor to energy costs and global pollution. Therefore, in terms of cost, energy, and pollution, efficient ventilation is essential. On the other hand, inadequate ventilation can cause comfort or health problems for the occupants. Good indoor air quality may be defined as air, which is free of pollutants that cause irritation, discomfort or ill health to occupants [4]. Since long time is spent inside buildings, considerable effort has focused on developing methods to achieve an optimum indoor environment. Achieving energy efficiency and optimum Indoor Air Quality (IAQ) depends on minimizing the emission of avoidable pollutants. Pollutants inside buildings are derived from both indoor and outdoor contaminant sources.

2. ENERGY-EFFICIENTCOMFORT

In warm humid condition, airflow can be an energy-efficient means to achieve indoor thermal comfort. Airflow does not create sensible cooling of air that can be measured on a thermometer; it conducts heat from our skin. This results in a cooling sensation ASHRAE [5]. This cooling sensation becomes noticeable with uniform airflow above 0.2 m/s. airflow greater than 1.0 m/s begins to disturb loose papers. This discourages utilisation of airflow greater than 1.0 m/s in office type spaces. Airflow up to 2.0 m/s is frequently provided in industrial and storage buildings as well as living areas and bedrooms in houses in hot humid climates. Many studies, ASHRAE [5] have modelled the cooling sensation of uniform airflow on human thermal response. In steady airflow, the cooling sensation (CS), of airflow can be estimated in degrees Celsius using equation:

$$CS = 3.67(V-0.2)-(V-0.2)^2 \ {}^oC \qquad (1)$$

When average airflow, V, is in m/s.

Natural ventilation from breezes or difference in air temperature generated by solar chimneys can induce passive indoor airflow. The problem with a passive approach is that breezes are not always present when needed and solar chimneys rarely produce enough airflow for comfort. Fans, particularly ceiling fans, can provide a reliable source for airflow for indoor thermal comfort in warm humid environments. Unsteady airflow, with an appropriate gust frequency, can enhance the cooling sensation of airflow. Airflow provides a cooling sensation for occupants of buildings in warm humid climates. The enhanced benefits of turbulent airflow, with gust velocities within the range of 0.3 Hz to 0.5 Hz (with a peak preference at 0.47 Hz), present further opportunities to utilise large, high-volume, low-

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speed ceiling fans for energy efficient cooling [6]. This effect appears to be due to a peak response of human cold cutaneous thermoreceptors just beneath the skin.

As an alternative and new design philosophy, hybrid ventilation and cooling technologies (HVAC) combine the advantages of mechanical HVAC systems and natural ventilation. It has the potential to reduce energy consumption in many buildings, improve the satisfaction level of the occupants' comfort and minimise the sick building syndromes (SBS). Hybrid ventilation and cooling provides opportunities for innovative solutions to the problems of energy-consuming environment control in buildings. Because hybrid systems combine natural and mechanical ventilation, they present several complex challenges to design and analysis tools, requiring a global approach that takes into account the outdoor environment, the indoor environment, control strategy and the mechanical system [7].

3. BIOCLIMATIC DESIGN

Bioclimatic design cannot continue being a side issue of a technical nature to main architectural design. In recent years, started to alter course and to become much more holistic in its approach while trying to address itself to:

- The achievement of a sustainable development
- The depletion of non-renewable sources and materials
- The life cycle analysis of buildings
- The total polluting effects of buildings on the environment
- The reduction of energy consumption and
- Human health and comfort

Hidden dimensions of architectural creation are vital to the notion of bioclimatic design. The most fundamental ones are:

TIME, which has been called the fourth dimension of architectural space, is of importance because every object cannot exist but in time. The notion of time gives life to an object and releases it to periodic (predictable) or unperiodic repetition. Times relates to seasonal and diurnal patterns and thus to climate and the way that a building behaves or should be designed to couple with and not antagonise nature. It further releases to the dynamic nature of a building in contrast to the static image that we have created for it.

AIR, is a second invisible but important element. We create space and pretend that it is empty, oblivious of the fact that it is both surrounded by and filled with air. Air in its turn, due to air-movement, which is generated by either temperature or pressure differences, is very much there and alive. And related to the movement of air should be building shapes, sections, heights, orientations and the size and positioning of openings.

LIGHT, and in particular daylight, is a third important element. Architecture cannot exist but with light and from the time we have been able to substitute natural light with artificial lighting, many a building and a lot of architecture has become poorer so. It is not an exaggeration to say that the real form giver to architecture is not the architect himself but light and that the architect is but the form moulders.

Vernacular architecture is beautiful to look at as well as a significant to contemplate on. It is particularly interesting to realise the nature of traditional architecture where various devices to attain thermal comfort without resorting to fossil fuels can be seen. Sun shading and cross ventilation are two major concerns

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in house design and south-facing façade is mandatory to harness the sun in winter as much as possible. Natural ventilation required higher ceiling to bring cooling effect for occupants in the buildings built fifty years ago. Whereas in modern high technology buildings have lower ceiling heights, thus making air conditioning mandatory. Admitting the human right of enjoying modern lives with a certain level of comfort and convenience, it is necessary to consider how people can live and work in an ideal environment with a least amount of energy consumption in the age of global environment problems. People in the modern age could not put up with such a poor indoor environment that people in the old age used to live. In fact in those days people had to live with the least amount fuels readily available and to devise various means in constructing their houses so that they would be compatible with the local climate. It is important, therefore, for designing passive and low energy architecture for the future to learn their spirit to overcome difficulties by having their creative designs adapted to respective regional climatic conditions and try to devise the ecotechniques in combination with a high grade of modern science.

4. RELATIONSHIP BETWEEN CLIMATE, BIULDING AND OCCUPANTS

In climate-sensitive architecture, strategies are adopted to meet occupants' needs, taking into account local solar radiation, temperature, wind and other climatic conditions. Different strategies are required for the various seasons. These strategies can themselves be subdivided into a certain number of concepts, which represent actions.

The heating strategy includes four concepts (Fig. 1):

- Solar collection: collection of the sun's heat through the building envelope
- Heat storage: storage of the heat in the mass of the walls and floors
- Heat distribution: distribution of collected heat to the different spaces, which require heating
- Heat conservation: retention of heat within the building

The cooling strategy include five concepts (Fig. 2):

- Solar control: protection of the building from direct solar radiation
- Ventilation: expelling and replacing unwanted hot air
- Internal gains minimisation: reducing heat from occupants, equipments and artificial lighting
- External gains avoidance: protection from unwanted heat by infiltration or conduction through the envelope (hot climates)
- Natural cooling: improving natural ventilation by acting on the external air (hot climates)

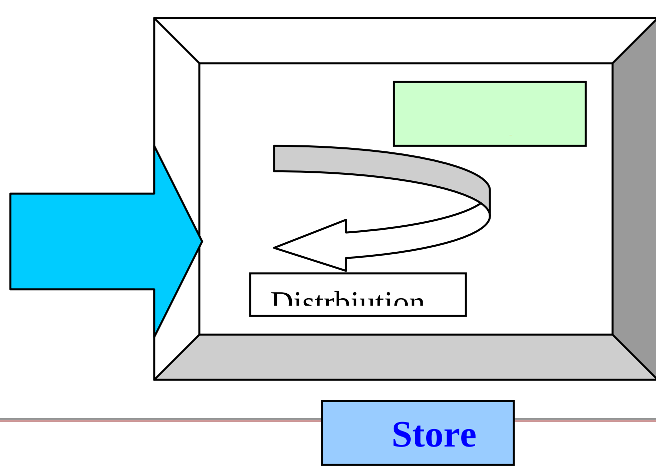

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Fig. 1. Heating strategy

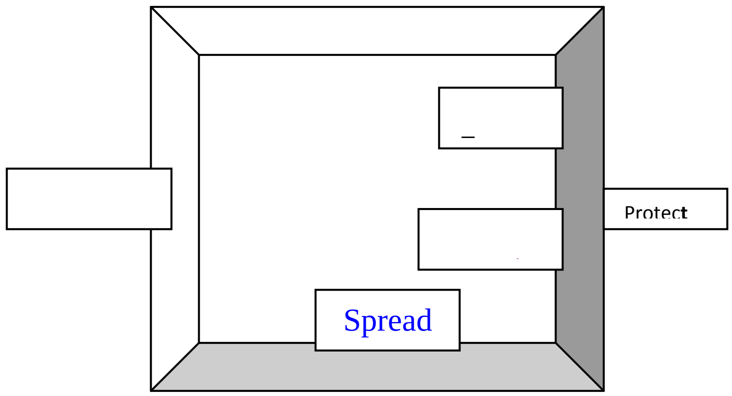

Fig. 2.Cooling strategies

The daylighting strategy includes four concepts (Fig. 3):

- Penetration: collection of natural light inside the building
- Distribution: homogeneous spreading of light into the spaces or focusing
- Protect: reducing by external shading devices the sun's rays penetration into the building
- Control: control light penetration by movable screens to avoid discomfort

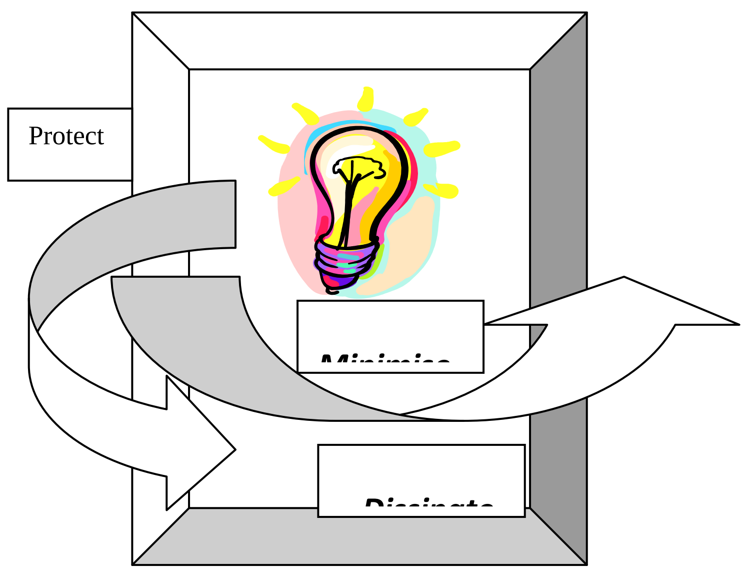

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Fig. 3. Daylighting strategies

Buildings are important consumers of energy and thus important contributors to emissions of greenhouse gases into the global atmosphere. The development and adoption of suitable renewable energy technologies has an important role.

Ventilation is essential for securing a good indoor air quality, but, as explained earlier, can have a dominating influence on energy consumption in buildings. Air quality problems are more likely to occur if air supply is restricted. Probably a ventilation rate averaging 7 l/s.p represents a minimum acceptable rate for normal odour and comfort requirements in office type buildings [8]. Diminishing returns are likely to be experienced at rates significantly above 10 l/s.p [8]. If air quality problems still persist, the cause is likely to be poor outdoor air quality (e.g., the entrainment of outdoor traffic fumes), poor air distribution or the excessive release of avoidable pollutants into space. However, the energy efficiency of ventilation can be improved by introducing exhaust air heat recovery, ground pre-heating, demand controlled ventilation, displacement ventilation and passive cooling [9]. In each case, a very careful analysis is necessary to ensure that the anticipated savings are actually achievable. Also, it is essential to differentiate between avoidable and unavoidable pollutant emissions. Achieving energy efficiency and optimum Indoor Air Quality (IAQ) depends on minimizing the emission of avoidable pollutants. Pollutants inside buildings are derived from both indoor and outdoor contaminant sources. Each of these tends to impose different requirements on the control strategies needed to secure good health and comfort conditions. Climate-sensitive and energy-conscious architecture, integrating these strategies, is not only a way of saving money, it primarily provides the occupants with a more humane, valuable environment and insure their well-being by the dynamic and harmonious interaction between man, building and climate.

5. HEALTH AND THE BUILT ENVIRONMENT

Two opposing trends threaten the engineers. The first is concern for global pollution. Not only energy use but also energy sources will be defined in terms of atmospheric contamination. The second is a demand for a performance specification for a more satisfy indoor climate. The engineers of today are facing two kinds of environmental forces.

- The first is a respect for the global external environment, which knows no natural boundaries and is now near saturation with pollution and may be affecting our climate in a harmful way. The second is a rising expectation of better indoor conditions, which in the past has meant a more energy intensive building through air conditioning. Safety issues and avoidance of exposure to toxic materials are being reinforced by concern for long-term health and welfare.
- The second trend is the continued increase in energy use as our population rises and our productivity increases. Rising standards of living require more fuel to keep us cleaner and warmer and enable us to travel long distances for recreation. More effective use of energy is now essential.

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The four more important types of harm from man's activities are global warming gases, ozone destroying gases, gaseous pollutants and microbiological hazards (Table 1). The earth is some 30^{o}C warmer due to the presence of gases but the global temperature is rising. This could lead to the sea level rising at the rate of 60 mm each decade with the growing risk of flooding in low-lying areas. At the United Nations Earth Summit at Rio in June 1992 some 153 countries agreed to pursue sustainable development [10]. A main aim was to reduce emission of carbon dioxide and other greenhouse gases. Reduction of energy use in buildings is a major role in achieving this. Carbon dioxide targets are proposed to encourage designers to look at low energy designs and energy sources.

Table 1. The external environment

Damage	*Manifestation*	*Design*
NO_x, SO_x	*Irritant*	*Low NO_x burners*
	Acid rain land damage	Low sulphur fuel
	Acid rain fish damage	Sulphur removal
	Global warming	Thermal insulation
CO_2	Rising sea level	Heat recovery
	Drought, storms	Heat pumps
O_3 destruction	Increased ultra violet	No CFC's or HCFC's
		Minimum air conditioning
	Skin cancer	Refrigerant collection
		Careful maintenance
Legionnellosis	Crop damage	
		Dry cooling towers
	Pontiac fever	
	Legionnaires	

As our knowledge of satisfactory conditions develops so we can control the physical environment to provide satisfaction. Performance based design will specify how many shall be satisfied. Target figures suggest satisfaction for 90% of the occupants is high quality, down to 70% for poor quality designs [11]. Such performance values are being applied to a whole range of indoor factors such as air quality (Fig. 4), thermal comfort, and noise levels.

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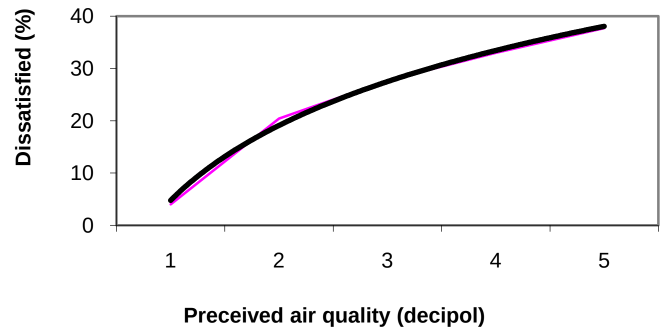

Fig. 4. Designing to a satisfaction level

6. ENERGY SAVINGS

The admission of daylight in buildings alone does not guarantee that the design will be energy efficient in terms of lighting [12-14]. In fact, the design for increased daylight can often raise concerns relating to visual comfort (glare) and thermal comfort (increased solar gain in the summer and heat losses in the winter from larger apertures). Such issues will clearly need to addressed in the design of the window openings, blinds, shading devices, heating systems, etc. Simple techniques can be implemented to increase the probability that lights are switched off [15]. These include: (1) making switches conspicuous (2) locating switches appropriately in relation to the lights (3) switching banks of lights independently, and (4) switching banks of lights parallel to the main window wall.

Large energy savings cover a wide range of issues including:

- Guidelines on low energy design
- Natural and artificial lighting
- Solar gain and solar shading
- Fenestration design
- Energy efficient plant and controls
- Examining the need for air conditioning

The strategy:

- Integration of shading and daylighting: an integral strategy is essential and feasible where daylighting and shading can be improved simultaneously
- Effect of shading on summer comfort conditions: solar shading plays a central role in reducing overheating risks and gives the potential for individual control, but should be complimented with other passive design strategies

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- Effect of devices on daylighting conditions: devices can be designed to provide shading whist improving the daylight conditions, notably glare and the distribution of light in a space, thus improving the visual quality
- Energy savings: energy savings from the avoidance of air conditioning can be very substantial, whilst daylighting strategies need to integrated with artificial lighting systems to be beneficial in terms of energy use.

The energy potential of daylighting is thus inextricably linked with the energy use of the associated artificial lighting systems and their controls. The economics of daylighting are not only related to energy use but also to productivity. Good daylighting of workspaces helps to promote efficient productive work, and simultaneously increases the sense of well-being. However, energy and economics should not become the sole concern of daylighting design to the exclusion of perceptual considerations.

The following initial requirements for the air quality in the archives were established by the consultant in conservation and international recommendations (BSI 5454: 2007) [16]:

- Air temperature between 17^{o}K and 19^{o}K
- Relative humidity between 50 and 60%, with lower values in the photographic archives
- Low levels of natural light and total exclusions of direct sunlight in archives, reading-rooms and complementary spaces
- Exclusion of ultra-violet radiation from natural and artificial lighting
- Air filters to exclude particles larger than 0.01 microns (this requirement was relaxed, considering the high cost, additional energy requirements and problems of maintenance)
- Filters of active carbon to reduce the content of ozone, sulphur dioxide and oxides of nitrogen

The activities and operations of the occupants, their patterns of use and misuse, can have a significant effect on the energy performance of the intermediate and internal environments. The management and control of three interfaces: external to internal, external to intermediate, and internal to intermediate can also have significant effect particularly in response to seasonal, daily and hourly variations in solar energy availability, its regulation and distribution. Other facilities management function can also have major energy implications, particularly maintenance, cleaning, replacement, refurbishment and adaptation.

The benefits of passive solar environments include:

- Reductions in non-renewable energy consumption and CO_2 emission
- Savings in the cost of purchased energy generally
- Savings in space and water heating costs
- Amenity and social benefits to occupants
- Prestige benefits to organisations
- Natural environment benefits for individual users
- Improved human comfort, well-being, and performance.

The potential risks that are commonly associated with passive solar environments include:

- Increased purchased energy consumption through inappropriate use
- Seasonal overheating

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- Unacceptable temperature fluctuations
- Poor air quality and condensation
- Unacceptable lighting variation and glare
- Temperature stratification
- Thermal fatigue and fracture of materials
- Winter survival of plants

In practice, low energy environments are achieved through a combination of measures that include:

- The application of environmental regulation and policy
- The application of environmental science and best practice
- Mathematical modelling and simulation
- Environmental design and engineering
- Construction and commissioning
- Management and modifications of environments in use

The storage concept is based on a modular design that will facilitate active control and optimisation of thermal input/output, and it can be adapted for simultaneous heating and cooling often needed in large service and institutional buildings. Such a system can be illustrated as shown in Fig. 5 conceptual integration of various warm/cold energy sources combined with thermal energy storage.

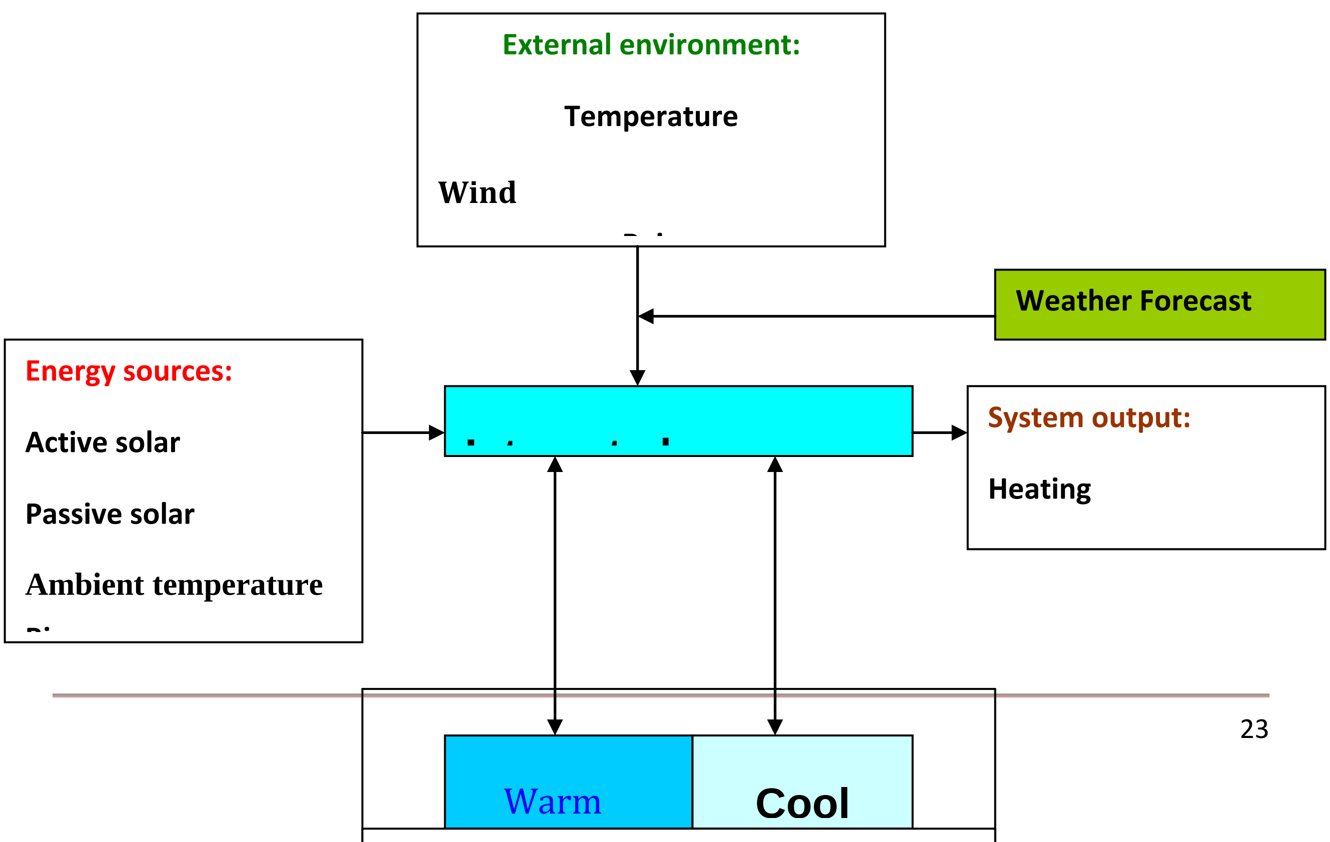

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Fig. 5. Conceptual illustration of an integrated energy system with thermal storage

Integrated energy systems need to be implemented at two levels:

1. Integration of various thermal energy sources into concurrent systems for heating, cooling and production of hot water.
2. Physical integration of such systems into the building structure

However, integrated energy systems for buildings face a number of barriers, of which the most significant are:

- Lack of expertise, information and demonstration systems
- Immature products and service delivery chains
- Utilities that still favour central generation and the market power created by such infrastructure
- Electricity markets that do not yet account for environmental externalities

A building inevitably consumes materials and energy resources. The technology is available to use methods and materials that reduce the environmental impacts, increase operating efficiency, and increase durability of buildings (Table 2). The objectives of the sustainable building practices aim to:

- Develop a comprehensive definition of sustainability that includes socio-cultural, bio-climate, and technological aspects.
- Establish guidelines for future sustainable architecture.
- Predict the CO_2 emissions in buildings.
- The proper architectural measure for sustainability is efficient, energy use, waste control, population growth, carrying capacity, and resource efficiency.
- Establish methods of design that conserve energy and natural resources.

Table 2. Design, construction and environmental control description of traditional and new houses

Design characteristics	Traditional houses	New houses

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Form	Courtyard (height twice its width)-open to sky	Rectangle-closed
Construction	Brick walls 50 cm thick, brick roof with no insulation in either	Brick walls 25 cm thick, concrete roof-no insulation
Environmental control	Evaporative air coolers	Evaporative air coolers
Ease of climatic control	Difficult-rooms open into the climatically uncontrolled open courtyard	Moderate-rooms open into the enclosed internal corridor
Maintenance	Well conserved and maintained	New construction
Windows	Vertical and single glazing	Horizontal-single glazing
Urban morphology	Each house attached from 3 sides	Row houses attached from 2 sides
Orientation	Varies-irregular shapes and winding alleyways	North-south (row houses)
Orientation and solar gain	Solar gains less affected by orientation due to shading provided by the deep courtyard	Solar gain determined by orientation-no obstruction (shading)
Sharing solar gain	Significant - due to long-wave exchange or convective exchange between the 4 vertical walls surrounding the courtyard	Minimal- S-wall receives much more solar radiation than the N-wall due to the absence of any interreflection and long-wave exchange
Occupant’s social status	Low income families	Low and middle income families

7. Results

The move towards a low-carbon world, driven partly by climate science and partly by the business opportunities it offers, requires the promotion of environmentally friendly energy sources and alternatives in order to achieve an acceptable stabilisation level of atmospheric carbon dioxide. This requires the harnessing and use of natural resources that produce no air pollution or GHGs and provide comfortable coexistence of humans, livestock, and plants. Exploitation of renewable energy sources, and particularly ground heat in buildings, can

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significantly contribute towards reducing dependency on fossil fuels and hence achieving this goal. Due to the urgent need to mitigate greenhouse gas emissions, new and more efficient ways of utilising energy in space heating and cooling applications have been actively explored. Although fossil fuel installations and central air-conditioning systems constitute a dominant technology for the buildings sector, geothermal heat pumps establish an attractive alternative.

Utilised renewable resources currently account for about 9%-10% of the energy consumed in the world; most of this is from hydropower and traditional biomass sources [16]. Wind, solar, biomass and geothermal technologies are already cost-effective today in an increasing number of markets and are making important steps to broaden commercialisation. The present situation is best characterised as one of very rapid growth for wind and solar technologies and of significant promise for biomass and geothermal technologies. Each of the renewable energy technologies is in a different stage of research, development and commercialisation and all have differences in current and future expected costs, current industrial base, resource availability and potential impact on energy supply chain.

Some emphasis has recently been put on the utilisation of the ambient energy from ground source and other renewable energy sources in order to stimulate alternative energy sources for heating and cooling of buildings. Exploitation of renewable energy sources and particularly ground heat in buildings can significantly contribute towards reducing dependency on fossil fuels.

The focus of the world's attention on environmental issues in recent years has stimulated response in many countries, which have led to a closer examination of energy conservation strategies for conventional fossil fuels. One way of reducing building energy consumption is to design buildings, which are more economical in their use of energy for heating, lighting, cooling, ventilation and hot water supply. Passive measures, particularly natural or hybrid ventilation rather than air-conditioning, can dramatically reduce primary energy consumption. However, exploitation of renewable energy in buildings and agricultural greenhouses can, also, significantly contribute towards reducing dependency on fossil fuels. Therefore, promoting innovative renewable applications and reinforcing the renewable energy market will contribute to preservation of the ecosystem by reducing emissions at local and global levels. This will also contribute to the amelioration of environmental conditions by replacing conventional fuels with renewable energies that produce no air pollution or greenhouse gases.

Globally, buildings are responsible for approximately 40% of the total world annual energy consumption. Most of this energy is for the provision of lighting, heating, cooling, and air conditioning. Increasing awareness of the environmental impact of CO_2, NO_x and CFCs emissions triggered a renewed interest in environmentally friendly cooling, and heating technologies. Under the 1997 Montreal Protocol, governments agreed to phase out chemicals used as refrigerants that have the potential to destroy stratospheric ozone. It was therefore considered desirable to reduce energy consumption and decrease the rate of depletion of world energy reserves and pollution of the environment. One way of reducing building energy consumption is to design buildings, which are more economical in their use of energy for heating, lighting, cooling, ventilation and hot water supply. Passive measures, particularly natural or hybrid ventilation rather than air-conditioning, can

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dramatically reduce primary energy consumption. However, exploitation of renewable energy in buildings and agricultural greenhouses can, also, significantly contribute towards reducing dependency on fossil fuels. Therefore, promoting innovative renewable applications and reinforcing the renewable energy market will contribute to preservation of the ecosystem by reducing emissions at local and global levels. This will also contribute to the amelioration of environmental conditions by replacing conventional fuels with renewable energies that produce no air pollution or greenhouse gases (during their use). The provision of good indoor environmental quality while achieving energy and cost efficient operation of the heating, ventilating and air-conditioning (HVAC) plants (devices) in buildings represents a multi variant problem. The comfort of building occupants is dependent on many environmental parameters including air speed, temperature, relative humidity and air quality in addition to lighting and noise. The overall objective is to provide a high level of building performance (BP), which can be defined as indoor environmental quality (IEQ), energy efficiency (EE) cost efficiency (CE), and environmental performance (EP).

- Indoor environmental quality is the perceived condition of comfort that building occupants experience due to the physical and psychological conditions to which they are exposed by their surroundings. The main physical parameters affecting IEQ are air speed, temperature, relative humidity and air quality.
- Energy efficiency is related to the provision of the desired environmental conditions while consuming the minimal quantity of energy.
- Cost efficiency is the financial expenditure on energy relative to the level of environmental comfort and productivity that the building occupants attained. The overall cost efficiency can be improved by improving the indoor environmental quality and the energy efficiency of a building.

Several definitions of sustainable development have been put forth, including the following common one: development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The World Energy Council (WEC) study found that without any change in our current practice, the world energy demand in 2020 would be 50-80% higher than 1990 levels. According to the USA Department of Energy (DoE) report, annual energy demand will increase from a current capacity of 363 million kilowatts to 750 million kilowatts by 2020. The world's energy consumption today is estimated to 22 billion kWh per year, 53 billion kWh by 202. Such ever-increasing demand could place significant strain on the current energy infrastructure and potentially damage world environmental health by CO, CO_2, SO_2, NO_x effluent gas emissions and global warming. Achieving solutions to environmental problems that we face today requires long-term potential actions for sustainable development. In this regards, renewable energy resources appear to be the one of the most efficient and effective solutions since the intimate relationship between renewable energy and sustainable development. More rational use of energy is an important bridge to help transition from today's fossil fuel dominated world to a world powered by non-polluting fuels and advanced technologies such as photovoltaics (PVs) and fuel cells (FCs). An approach is needed to integrate renewable energies in a way to meet high building performance. However, because renewable energy sources are stochastic and geographically diffuse, their ability to match demand is determined by adoption of one of the

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following two approaches: the utilisation of a capture area greater than that occupied by the community to be supplied, or the reduction of the community's energy demands to a level commensurate with the locally available renewable resources.

Energy constitutes the motive force of the civilization and it determines, in a high degree, the level of economy development as a whole. Despite the increase use of different type of energy, particularly, renewable energy sources, fossil fuels will continue dominating the energy combinations in the world near future. However, oil reserves are declining and this situation would have a negative impact in the future economic development of many countries all over the world. Climate change issues, the reduced world reserves of fossils, and higher and higher fuel prices play an important role in the development of clean technologies, such as biohydrogen, biodiesel and bioethanol, for producing renewable energy. This research gathers and presents current research from across the globe in the study of clean energy resources, their production and developments.

In Asia, the import energy dependency is rising. Unless Europe can make domestic energy more competitive in the next 20 to 30 years, around 70% of the Asian's energy requirements, compared to 50% today, will be met by imported products some of them from regions threatened by insecurity. Now, the energy requirements of the different countries are so high that, for the first time in the humanity's history, there is a need to consider different types of available energy sources and their reserves to plan the economic development of the countries. At the same time, there is also a need to use these sources in the most efficient possible manner in order to sustain that development.

There is strong scientific evidence that the average temperature of the earth's surface is rising. This is a result of the increased concentration of carbon dioxide and other GHGs in the atmosphere as released by burning fossil fuels. This global warming will eventually lead to substantial changes in the world's climate, which will, in turn, have a major impact on human life and the built environment. Therefore, effort has to be made to reduce fossil energy use and to promote green energies, particularly in the building sector. Energy use reductions can be achieved by minimising the energy demand, by rational energy use, by recovering heat and the use of more green energies. This article was a step towards achieving that goal. The adoption of green or sustainable approaches to the way in which society is run is seen as an important strategy in finding a solution to the energy problem. The key factors to reducing and controlling CO_2, which is the major contributor to global warming, are the use of alternative approaches to energy generation and the exploration of how these alternatives are used today and may be used in the future as green energy sources. Even with modest assumptions about the availability of land, comprehensive fuel-wood farming programmes offer significant energy, economic and environmental benefits. These benefits would be dispersed in rural areas where they are greatly needed and can serve as linkages for further rural economic development. The nations as a whole would benefit from savings in foreign exchange, improved energy security, and socio-economic improvements. With a nine-fold increase in forest – plantation cover, a nation's resource base would be greatly improved.

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8. Conclusions

There are clear benefits, which may accrue from the wider adoption of renewable energy technologies in building design. There are two key-elements to the fulfilling of renewable energy technology potential within the field of building design. Firstly, the instilling of appropriate skills and attitudes in building design professionals, and secondly, the provision of the opportunity for such people to demonstrate their skills. The higher education of building designers must include sustained development of attitudes and skills encompassing the use of renewable energy technologies. With the environmental protection posing as the number one global problem, man has no choice but reducing his energy consumption, one way to accomplish this is to resort to passive and low-energy systems to maintain thermal comfort in buildings. The conventional and modern designs of wind towers can successfully be used in the hot arid regions to maintain thermal comfort (with or without the use of ceiling fans) during all hours of the cooling season, or a fraction of it. Climatic design is one of the best approaches to reduce the energy cost in buildings. Proper design is the first step of defence against stress of climate. Buildings should be designed according to climate of the site for reducing the need of mechanical heating or cooling hence maximum natural energy can be used for creating pleasant environment inside the built envelope. Technology and industry progress of the last decade diffused electronic and informatics' devices in many human activities, and now appears also in building construction. The utilisation and operating opportunities components, increase the reduction of heat losses by varying the thermal insulation, optimise the lighting distribution with louver screens and operate mechanical ventilation for coolness in indoor spaces. In addiction to these parameters the intelligent envelope can act for security control and became an important part of the building domotic revolution. Application of simple passive cooling measure is effective in reducing the cooling load of buildings in hot and humid climates. 43% reductions can be achieved using a combination of well-established technologies such as glazing, shading, insulation, and natural ventilation. More advanced passive cooling techniques such as roof pond, dynamic insulation, and evaporative water jacket need to be considered more closely. The building sector is a major consumer of both energy and materials worldwide, and the consumption is increasing. Most industrialised countries are in addition becoming more and more dependent on external supplies of conventional energy carriers i.e., fossil fuels. Energy for heating and cooling can be replaced by new renewable energy sources. New renewable energy sources, however, are usually not economically feasible compared with the traditional carriers. In order to achieve the major changes needed to alleviate the environmental impacts of the building sector, it is necessary to change and develop both the processes in the industry itself, and to build a favourable framework to overcome the present economic, regulatory and institutional barriers.

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