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Full Length Research Paper

Energy use and improvement in industry, buildings development and environment

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The use of renewable energy sources is a fundamental factor for a possible energy policy in the future. The move towards a de-carbonised world, driven partly by climate science and partly by the business opportunities it offers, will need the promotion of environmentally friendly alternatives, if an acceptable stabilisation level of atmospheric carbon dioxide is to be achieved. 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. 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 paper. Throughout the theme several issues relating to renewable energies, environment and sustainable development are examined from both current and future perspectives.

Keywords: Energy, environment, sustainable development, global warming

INTRODUCTION

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. 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. A recent 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 (Omer, 2008). According to a recent 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 (Omer, 2008).

The world's energy consumption today is estimated to 22 billion kWh per year, 53 billion kWh by 2020 (Omer, 2008). 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 photovoltaic (PV) and fuel cells (FC) (Omer, 2008).

Background

For a northern European climate, which is characterised by an average annual solar irradiance of 150 Wm^{-2}, the mean power production from a photovoltaic component of 13% conversion efficiency is approximately 20 Wm^{-2}. For an average wind speed of 5 ms^{-1}, the power produced by a micro wind turbine will be of a similar order of magnitude, though with a different profile shape. In the UK, for example, a typical office building will have a demand in the order of 300 $kWhm^{-2}yr^{-1}$. This translates into approximately 50 Wm^{-2} of façade, which is twice as much as the available renewable energies (Omer, 2008). Thus, the aim is to utilise energy efficiency measures in order to reduce the overall energy consumption and adjust the demand profiles to be met by renewable energies. For instance, this approach can be applied to greenhouses, which use solar energy to provide indoor environmental quality.

The greenhouse effect is one result of the differing properties of heat radiation when it is generated at different temperatures. Objects inside the greenhouse, or any other building, such as plants, re-radiate the heat or absorb it. Because the objects inside the greenhouse are at a lower temperature than the sun, the re-radiated heat is of longer wavelengths, and cannot penetrate the glass. This re-radiated heat is trapped and causes the temperature inside the greenhouse to rise. Note that the atmosphere surrounding the earth, also, behaves as a large greenhouse around the world. Changes to the gases in the atmosphere, such as increased carbon dioxide content from the burning of fossil fuels, can act like a layer of glass and reduce the quantity of heat that the planet earth would otherwise radiate back into space. This particular greenhouse effect, therefore, contributes to global warming. The application of greenhouses for plants growth can be considered one of the measures in the success of solving this problem. Maximising the efficiency gained from a greenhouse can be achieved using various approaches, employing different techniques that could be applied at the design, construction and operational stages. The development of greenhouses could be a solution to farming industry and food security.

Energy security, economic growth and environment protection are the national energy policy drivers of any country of the world. Figure 1 shows the world populations grow, much faster than the average 2%, the need for more and more energy is exacerbated. Enhanced lifestyle and energy demand rise together and the wealthy industrialised economics, which contain 25% of the world's population, consume 75% of the world's energy supply. The world's energy consumption today is estimated to 22 billion kWh per year (*IEA, 2007)*. About 6.6 billion metric tons carbon equivalent of greenhouse gas (GHG) emission are released in the atmosphere to meet this energy demand (*IEA, 2007)*. Approximately 80% is due to carbon emissions from the combustion of energy fuels. At the current rate of usage, taking into consideration population increases and higher consumption of energy by developing countries, oil resources, natural gas and uranium will be depleted within a few decades. As for coal, it may take two centuries or so. Technological progress has dramatically changed the world in a variety of ways. It has, however, also led to developments e.g., environmental problems, which threaten man and nature. In Figures 2 summaries the world oil production in the next 10-20 years (*IEA, 2007)*. At the current rate of usage, taking into consideration population increases and higher consumption of energy by developing countries, oil resources, natural gas and uranium will be depleted within a few decades, as shown in Figure 3 volume of oil discovered worldwide (*IEA, 2007)*. As for coal, it may take two centuries or so. One must therefore endeavour to take precautions today for a viable world for coming generations.

OBJECTIVES

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 following two approaches (*IEA, 2007)*: 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.

METHODOLOGY

The provision of good indoor environmental quality while achieving energy and cost efficient operation of the heating, ventilating and air-conditioning (HVAC) plants 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 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) and cost efficiency (CE).

- Indoor environmental quality is the perceived condition of comfort that building occupants

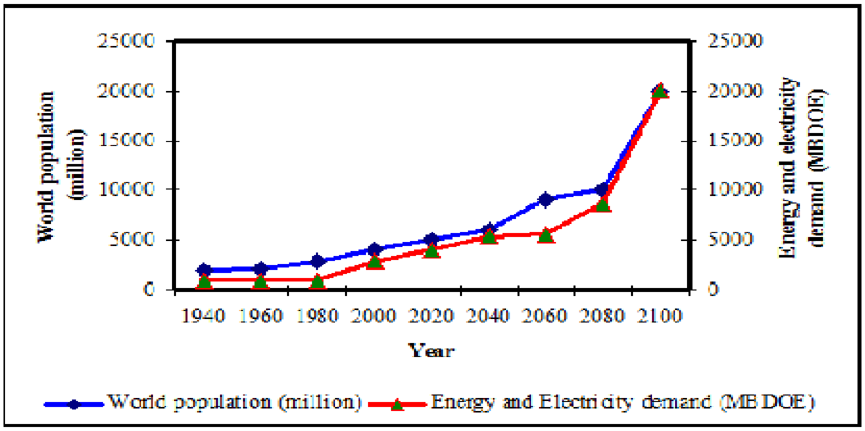

Figure 1: Annual and estimated world population and energy demand Million of barrels per day of oil equivalent (MBDOE) (*IEA, 2007*).

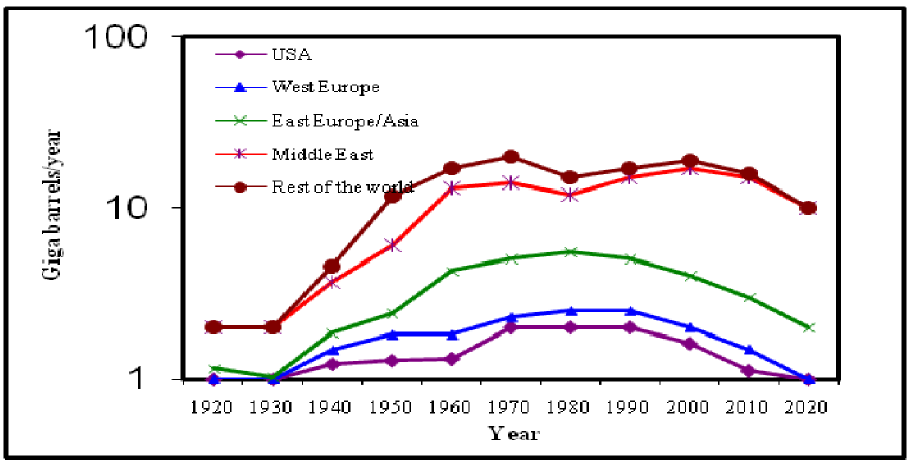

Figure 2: World oil productions in the next 10-20 years (*IEA, 2007*).

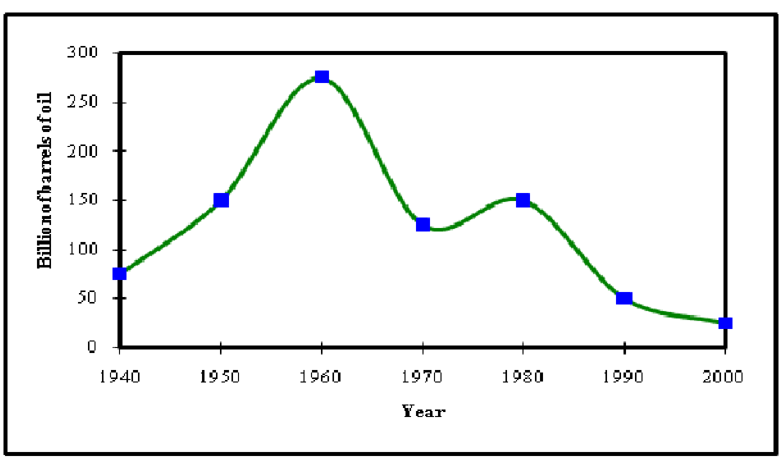

Figure 3: Volume of oil discovered worldwide (*IEA, 2007*).

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 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. Research into future alternatives has been and still being conducted aiming to solve the complex problems of this recent time e.g., rising energy requirements of a rapidly and constantly growing world population and global environmental pollution. Therefore, options for a long-term and environmentally friendly energy supply have to be developed leading to the use of renewable sources (water, sun, wind, biomass, geothermal, hydrogen) and fuel cells. Renewables could shield a nation from the negative effect in the energy supply, price and related environment concerns. Hydrogen for fuel cells and the sun for PV have been considered for many years as a likely and eventual substitute for oil, gas, coal and uranium (*IEA, 2007)*.

DISCUSSIONS

Over millions of years ago plants covered the earth, converting the energy of sunlight into living tissue, some of which was buried in the depths of the earth to produce deposits of coal, oil and natural gas. The past few decades, however, have experienced many valuable uses for these complex chemical substances, manufacturing from them plastics, textiles, fertiliser and the various end products of the petrochemical industry. Indeed, each decade sees increasing uses for these products. Renewable energy is the term used to describe a wide range of naturally occurring, replenishing energy sources. Coal, oil and gas, which will certainly be of great value to future generations, as they are to ours, are non-renewable natural resources.

The rapid depletion of non-renewable fossil resources need not continue. This is particularly true now as it is, or soon will be, technically and economically feasible to supply all of man's needs from the most abundant energy source of all, the sun. The sunlight is not only inexhaustible, but, moreover, it is the only energy source, which is completely non-polluting.

Industry's use of fossil fuels has been blamed for warming the climate. When coal, gas and oil are burnt, they release harmful gases, which trap heat in the atmosphere and cause global warming. However, there has been an ongoing debate on this subject, as scientists have struggled to distinguish between changes, which are human induced, and those, which could be put down to natural climate variability. Nevertheless, industrialised countries have the highest emission levels, and must shoulder the greatest responsibility for global warming. However, action must also be taken by developing countries to avoid future increases in emission levels as their economies develop and populations grows, as clearly captured by the Kyoto Protocol (*IEA, 2007)*. Notably, human activities that emit carbon dioxide (CO_2), the most significant contributor to potential climate change, occur primarily from fossil fuel production and consumption. Consequently, efforts to control CO_2 emissions could have serious, negative consequences for economic growth, employment, investment, trade and the standard of living of individuals everywhere. Scientifically, it is difficult to predict the relationship between global temperature and GHG concentrations. The climate system contains many processes that will change if warming occurs. Critical processes include heat transfer by winds and tides, the hydrological cycle involving evaporation, precipitation, runoff and groundwater and the formation of clouds, snow, and ice, all of which display enormous natural variability.

The equipment and infrastructure for energy supply and use are designed with long lifetimes, and the premature turnover of capital stock involves significant costs. Economic benefits occur if capital stock is replaced with more efficient equipment in step with its normal replacement cycle. Likewise, if opportunities to reduce future emissions are taken in a timely manner, they should be less costly. Such a flexible approach would allow society to take account of evolving scientific and technological knowledge, while gaining experience in designing policies to address climate change (*IEA, 2007).*

The World Summit on Sustainable Development in Johannesburg in 2002 committed itself to "encourage and promote the development of renewable energy sources to accelerate the shift towards sustainable consumption and production". Accordingly, it aimed at breaking the link between resource use and productivity. This can be achieved by the following:

- Trying to ensure economic growth does not cause environmental pollution.
- Improving resource efficiency.
- Examining the whole life-cycle of a product.
- Enabling consumers to receive more information on products and services.
- Examining how taxes, voluntary agreements, subsidies, regulation and information campaigns, can best stimulate innovation and investment to provide cleaner technology.

The energy conservation scenarios include rational use of energy policies in all economy sectors and the use of combined heat and power systems, which are able to add to energy savings from the autonomous power plants. Electricity from renewable energy sources is by definition the environmental green product. Hence, a renewable energy certificate system, as recommended by the World Summit, is an essential basis for all policy systems, independent of the renewable energy support scheme. It is, therefore, important that all parties involved support the renewable energy certificate system in place if it is to work as planned. Moreover, existing renewable energy technologies (RETs) could play a significant mitigating role, but the economic and political climate will have to change first. Climate change is real. It is happening now, and GHGs produced by human activities are significantly contributing to it.

The predicted global temperature increase of between 1.5 and 4.5°C could lead to potentially catastrophic environmental impacts (DEFRA 2002). These include sea level rise, increased frequency of extreme weather events, floods, droughts, disease migration from various places and possible stalling of the Gulf Stream. This has led scientists to argue that climate change issues are not ones that politicians can afford to ignore, and policy makers tend to agree (DEFRA 2002). However, reaching international agreements on climate change policies is no trivial task as the difficulty in ratifying the Kyoto Protocol has proved.

Therefore, the use of renewable energy sources and the rational use of energy, in general, are the fundamental inputs for any responsible energy policy. However, the energy sector is encountering difficulties because increased production and consumption levels entail higher levels of pollution and eventually climate change, with possibly disastrous consequences.

At the same time, it is important to secure energy at an acceptable cost in order to avoid negative impacts on economic growth. To date, renewable energy contributes as much as 20% of the global energy supplies worldwide (DEFRA 2002). Over two thirds of this comes from biomass use, mostly in developing countries, some of it unsustainable. Yet, the potential for energy from sustainable technologies is huge. On the technological side, renewables have an obvious role to play. In general, there is no problem in terms of the technical potential of renewables to deliver energy. Moreover, there are very good opportunities for RETs to play an important role in reducing emissions of GHGs into the atmosphere, certainly far more than have been exploited so far.

However, there are still some technical issues to address in order to cope with the intermittency of some renewables, particularly wind and solar. Yet, the biggest problem with relying on renewables to deliver the necessary cuts in GHG emissions is more to do with politics and policy issues than with technical ones (DEFRA 2002). For example, the single most important step governments could take to promote and increase the use of renewables is to improve access for renewables to the energy market. This access to the market needs to be under favourable conditions and, possibly, under favourable economic rates as well. One move that could help, or at least justify, better market access would be to acknowledge that there are environmental costs associated with other energy supply options and that these costs are not currently internalised within the market price of electricity or fuels. This could make a significant difference, particularly if appropriate subsidies were applied to renewable energy in recognition of the environmental benefits it offers. Similarly, cutting energy consumption through end-use efficiency is absolutely essential. This suggests that issues of end-use consumption of energy will have to come into the discussion in the foreseeable future (Robinson, 2007).

However, RETs have the benefit of being environmentally benign when developed in a sensitive and appropriate way with the full involvement of local communities. In addition, they are diverse, secure, locally based and abundant. In spite of the enormous potential and the multiple benefits, the contribution from renewable energy still lags behind the ambitious claims for it due to the initially high development costs, concerns about local impacts, lack of research funding and poor institutional and economic arrangements (IPCC, 2001).

Hence, an approach is needed to integrate renewable energies in a way that meets high building performance requirements. However, because renewable energy sources are stochastic and geographically diffuse, their ability to match demand is determined by adoption of one of the following two approaches (Parikn et al, 1999): 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 and population growth

Urban areas throughout the world have increased in size during recent decades. About 50% of the world's population and approximately 7.6% in more developed countries are urban dwellers (UNIDO, 1997).

Even though there is evidence to suggest that in many 'advanced' industrialised countries there has been a reversal in the rural-to-urban shift of populations, virtually all population growth expected between 2000 and 2030 will be concentrated in urban areas of the world. With an expected annual growth of 1.8%, the world's urban population will double in 38 years (UNIDO, 1997). With increasing urbanisation in the world, cities are growing in number, population and complexity. At present, 2% of the world's land surface is covered by cities, yet the people living in them consume 75% of the resources consumed by mankind (Kothari et al., 2011). Indeed, the ecological footprint of cities is many times larger than the areas they physically occupy. Economic and social imperatives often dictate that cities must become more concentrated, making it necessary to increase the density to accommodate the people, to reduce the cost of public

Table 1: EU criteria pollutant standards in the ambient air environment

Pollutant	EU limit
CO	30 mg/m^2; 1h
NO_2	200 µg/m^2; 1h
O_3	235 µg/m^2; 1h
SO_2	250-350 µg/m^2; 24 h
	80-120 µg/m^2; annual
PM_{10}	250 µg/m^2; 24 h
	80 µg/m^2; annual
SO_2 + PM_{10}	100-150 µg/m^2; 24 h
	40-60 µg/m^2; annual
Pb	2 µg/m^2; annual
Total suspended particulate (TSP)	260 µg/m^2; 24 h
HC	160 µg/m^2; 3 h

services, and to achieve required social cohesiveness. The reality of modern urbanisation inevitably leads to higher densities than in traditional settlements and this trend is particularly notable in developing countries.

Generally, the world population is rising rapidly, notably in the developing countries. Historical trends suggest that increased annual energy use per capita, which promotes a decrease in population growth rate, is a good surrogate for the standard of living factors. If these trends continue, the stabilisation of the world's population will require the increased use of all sources of energy, particularly as cheap oil and gas are depleted.

The improved efficiency of energy use and renewable energy sources will, therefore, be essential in stabilising population, while providing a decent standard of living all over the world (Kothari et al., 2011). Moreover, energy is the vital input for economic and social development of any country. With an increase in industrial and agricultural activities the demand for energy is also rising. It is, however, a well-accepted fact that commercial energy use has to be minimised. This is because of the environmental effects and the availability problems. Consequently, the focus has now shifted to non-commercial energy resources, which are renewable in nature. This is bound to have less environmental effects and also the availability is guaranteed. However, even though the ideal situation will be to enthuse people to use renewable energy resources, there are many practical difficulties, which need to be tackled. The people groups who are using the non-commercial energy resources, like urban communities, are now becoming more demanding and wish to have commercial energy resources made available for their use. This is attributed to the increased awareness, improved literacy level and changing culture (Kothari et al., 2011).

The quality of life practiced by people is usually represented as being proportional to the per capita energy use of that particular country. It is not surprising that people want to improve their quality of life. Consequently, it is expected that the demand for commercial energy resources will increase at a greater rate in the years to come (Kothari et al., 2011). Because of this emerging situation, the policy makers are left with two options: either to concentrate on renewable energy resources and have them as substitutes for commercial energy resources or to have a dual approach in which renewable energy resources will contribute to meet a significant portion of the demand whereas the conventional commercial energy resources would be used with caution whenever necessary. Even though the first option is the ideal one, the second approach will be more appropriate for a smooth transition (Kothari et al., 2011).

Energy and environmental problems

Technological progress has dramatically changed the world in a variety of ways. It has, however, also led to developments of environmental problems, which threaten man and nature. During the past two decades the risk and reality of environmental degradation have become more apparent. Growing evidence of environmental problems is due to a combination of several factors since the environmental impact of human activities has grown dramatically because of the sheer increase of world population, consumption, industrial activity, etc. throughout the 1970s most environmental analysis and legal control instruments concentrated on conventional effluent gas pollutants such as SO_2, NO_x, CO_2, particulates, and CO (Table 1). Recently, environmental concerns has extended to the control of micro or hazardous air pollutants, which are usually toxic chemical substances and harmful in small doses, as well to that of globally significant pollutants such as CO_2. Aside from advances in environmental science, developments in industrial processes and structures have led to new environmental problems. For example, in the energy sector, major shifts to the road transport of industrial goods and to individual travel by cars has led to an increase in road traffic and hence a shift in attention paid to the effects and sources of NO_x and volatile organic

Table 2: Significant EU environmental directives in water, air and land environments (Kothari, 2011).

Environment	Directive name
Water	Surface water for drinking
	Sampling surface water for drinking
	Drinking water quality
	Quality of freshwater supporting fish
	Shellfish waters
	Bathing waters
	Dangerous substances in water
	Groundwater
	Urban wastewater
	Nitrates from agricultural sources
Air	Smokes in air
	Sulphur dioxide in air
	Lead in air
	Large combustion plants
	Existing municipal incineration plants
	New municipal incineration plants
	Asbestos in air
	Sulphur content of gas oil
	Lead in petrol
	Emissions from petrol engines
	Air quality standards for NO_2
	Emissions from diesel engines
Land	Protection of soil when sludge is applied

Table 3: 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
	Increased ultra violet	No CFC's or HCFC's
O_3 destruction	Skin cancer	Minimum air conditioning
	Crop damage	Refrigerant collection
	Pontiac fever	Careful maintenance
Legionnellosis	Legionnaires	Dry cooling towers

compound (VOC) emissions. Environmental problems span a continuously growing range of pollutants, hazards and ecosystem degradation over wider areas. The main areas of environmental problems are: major environmental accidents, water pollution, maritime pollution, land use and sitting impact, radiation and radioactivity, solid waste disposal, hazardous air pollutants, ambient air quality, acid rain, stratospheric ozone depletion and global warming (greenhouse effect, global climatic change) (Table 2).

The four more important types of harm from man's activities are global warming gases, ozone destroying gases, gaseous pollutants and microbiological hazards (Table 3). The earth is some 30°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 (Figure 4). At the United Nations Earth Summit at Rio in June 1992 some 153 countries agreed to pursue sustainable development (Boulet, 1987). A main aim was to reduce emission of carbon dioxide and other GHGs.

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. Problems with energy supply and use are related not only to global warming that is taking place, due to effluent gas emission mainly CO_2, but also to such environmental concerns as air pollution, acid precipitation, ozone depletion, forest destruction and

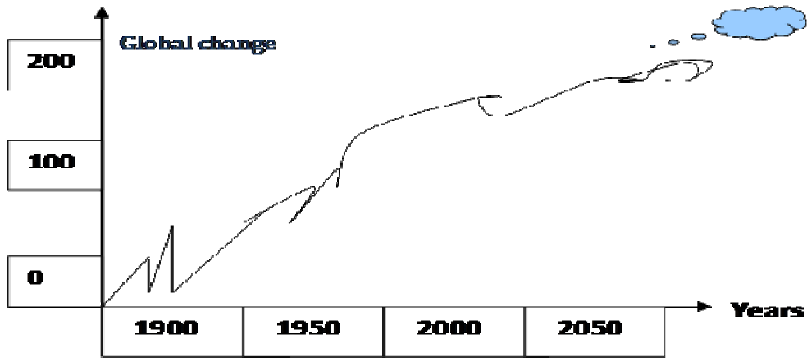

Figure 4: Change in global sea level (Boulet, 1987).

Table 4: Global emissions of the top fourteen nations by total CO_2 volume (billion of tons) (Boulet, 1987).

Rank	Nation	CO_2	Rank	Nation	CO_2	Rank	Nation	CO_2
1	USA	1.36	6	India	0.19	11	Mexico	0.09
2	Russia	0.98	7	UK	0.16	12	Poland	0.08
3	China	0.69	8	Canada	0.11	13	S. Africa	0.08
4	Japan	0.30	9	Italy	0.11	14	S. Korea	0.07

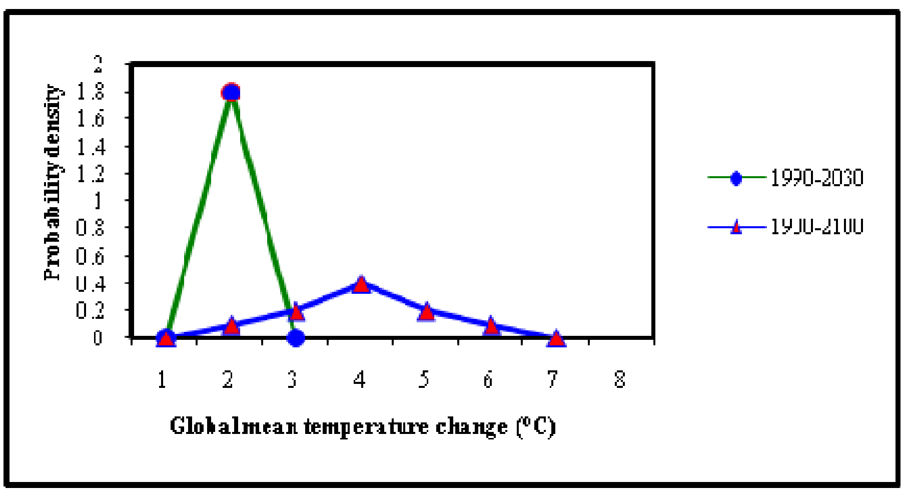

Figure 5: Global mean temperature changes over the period of 1990-2100 and 1990-2030 (Boulet, 1987).

emission of radioactive substances. These issues must be taken into consideration simultaneously if humanity is to achieve a bright energy future with minimal environmental impacts. Much evidence exists, which suggests that the future will be negatively impacted if humans keep degrading the environment (Table 4).

During the past century, global surface temperatures have increased at a rate near 0.6°C/century and the average temperature of the Atlantic, Pacific and Indian oceans (covering 72% of the earth surface) have risen by 0.06°C since 1995. Global temperatures in 2001 were 0.52°C above the long-term 1880-2000 average (the 1880-2000 annually averaged combined land and ocean temperature is 13.9°C). Also, according to the USA Department of Energy, world emissions of carbon are expected to increase by 54% above 1990 levels by 2015 making the earth likely to warm 1.7-4.9°C over the period 1990-2100, as shown in Figure 5. Such observation and others demonstrate that interests will likely increase regarding energy related environment concerns and that energy is one of the main factors that must be considered in discussions of sustainable development.

Environmental transformations

In recent years a number of countries have adopted policies aimed at giving a greater role to private ownership in the natural resource sector. For example, in the UK the regional water companies have been privatised and have been given a considerable degree of control over the exploitation of the nation's regional water resources. Similar policies have been followed in France and other European countries.

Typically, a whole range of new regulatory instruments such as technological standards accompanies such privatisation on water treatment plants, minimum standards on drinking water quality, price controls and maximum withdrawal quotas. While some of these instruments address problems of monopolistic behaviour and other forms of imperfect competition, the bulk of regulatory measures is concerned with establishing 'good practices' aimed at maintaining the quality of the newly privatised resources as a shorthand. Society has to meet the freshwater demands of its population and its industry by extracting water from the regional water resources that are provided by the natural environment (lakes, rivers, aquifers, etc.).

These water resources are renewable but potentially destructible resources. While moderate amounts of human water extractions from a given regional water system can be sustained for indefinite periods. Excessive extractions will change the geographical and climatic conditions supporting the water cycle and will diminish the regenerative capacity of the regional water system, thereby reducing the potential for future withdrawals. Typically, recovery from any such resource degradation will be very slow and difficult, if not impossible; resource degradation is partially irreversible (Erreygers et al., 1996).

To make sustainable water extraction economically viable, the sustainable policy has to break even (all costs are covered by revenues) while unsustainable policy has to be unprofitable (costs exceed revenues):

$(1+r)vt_{-1}=5y_t+v_t$ (1)

Where: r is the interest rate, t=year, y is the revenue.

$(1+r)vt_{-1}>105y_t$ (2)

$(1+r)vt_{-1}<[105/(105-5)]v_t$ (3)

The term [105/(105-5)] is to define the natural productivity factor of the water resource as (1+g) = [105/(105-5)]; g is the natural productivity rate.

Rate g will be close to zero if the sustainable extraction level is much smaller than the unsustainable level. Using g, the equation can be as follows:

$v_t(1+r)/(1+g)v_{t-1}$ (4)

Regulatory measures that prevent resource owners from adopting certain unsustainable extraction policies are a necessary pre-condition for the effective operation of a privatised natural resource sector. Unregulated water privatisation would result in an inflationary dynamics whose distributional effects would threaten the long-term viability of the economy. This inflationary dynamics is not due to any form of market imperfection but is a natural consequence of the competitive arbitrage behaviour of unregulated private resource owners (Meffe et al., 1996).

Sustainability concept

Absolute sustainability of electricity supply is a simple concept: no depletion of world resources and no ongoing accumulation of residues. Relative sustainability is a useful concept in comparing the sustainability of two or more generation technologies. Therefore, only renewables are absolutely sustainable, and nuclear is more sustainable than fossil. However, any discussion about sustainability must not neglect the ability or otherwise of the new technologies to support the satisfactory operation of the electricity supply infrastructure.

The electricity supply system has been developed to have a high degree of resilience against the loss of transmission circuits and major generators, as well as unusually large and rapid load changes. It is unlikely that consumers would tolerate any reduction in the quality of the service, even if this were the result of the adoption of otherwise benign generation technologies.

Renewables are generally weather-dependent and as such their likely output can be predicted but not controlled. The only control possible is to reduce the output below that available from the resource at any given time. Therefore, to safeguard system stability and security, renewables must be used in conjunction with other, controllable, generation and with large-scale energy storage. There is a substantial cost associated with this provision.

Environmental aspects

Environmental pollution is a major problem facing all nations of the world. People have caused air pollution since they learned to how to use fire, but man-made air pollution (anthropogenic air pollution) has rapidly increased since industrialisation began. Many volatile organic compounds and trace metals are emitted into the atmosphere by human activities. The pollutants emitted

Table 5: Classifications of data requirements (Trevor 2007).

Item	Plant data	System data
Existing data	Size	Peak load
	Life	Load shape
	Cost (fixed and var. O&M)	Capital costs
	Forced outage	Fuel costs
	Maintenance	Depreciation
	Efficiency	Rate of return
	Fuel	Taxes
	Emissions	
Future data	All of above, plus	System lead growth
	Capital costs	Fuel price growth
	Construction trajectory	Fuel import limits
	Date in service	Inflation

Table 6: Classification of key variables defining facility sustainability (Trevor 2007).

Criteria	Intra-system impacts	Extra-system impacts
Stakeholder satisfaction	Standard expectations met Relative importance of standard expectations	Covered by attending to extra-system resource base and ecosystem impacts
Resource base impacts	Change in intra-system resource bases Significance of change	Resource flow into/out of facility system Unit impact exerted by flow on source/sink system Significance of unit impact
Ecosystem impacts	Change in intra-system ecosystems Significance of change	Resource flows into/out of facility system Unit impact exerted by how on source/sink system Significance of unit impact

Table 7: Energy and sustainable environment (Abdeen 2008).

Technological criteria	Energy and environment criteria	Social and economic criteria
Primary energy saving in regional scale	Sustainability according to greenhouse gas pollutant emissions	Labour impact
Technical maturity, reliability	Sustainable according to other pollutant emissions	Market maturity
Consistence of installation and maintenance requirements with local technical known-how	Land requirement	Compatibility with political, legislative and administrative situation
Continuity and predictability of performance	Sustainability according to other environmental impacts	Cost of saved primary energy

into the atmosphere do not remain confined to the area near the source of emission or to the local environment, and can be transported over long distances, and create regional and global environmental problems. The privatisation and price liberalisation in energy fields has to some secured (but not fully). Availability and adequate energy supplies to the major productive sectors. The result is that, the present situation of energy supplies is for better than ten years ago (Table 5).

Action areas for producersp:

- Management and measurement tools- adopting environmental management systems appropriate for the business.
- Performance assessment tools- making use of benchmarking to identify scope for impact reduction and greater eco-efficiency in all aspects of the business.
- Best practice tools- making use of free help and advice from government best practice programmes (energy efficiency, environmental technology, and resource savings).
- Innovation and ecodesign- rethinking the delivery of ‘value added’ by the business, so that impact reduction and resource efficiency are firmly built in at the design stage.
- Cleaner, leaner production processes- pursuing improvements and savings in waste minimisation, energy and water consumption, transport and distribution, as well as reduced emissions. Tables (6-8) indicate energy conservation, sustainable development and environment.
- Supply chain management- specifying more

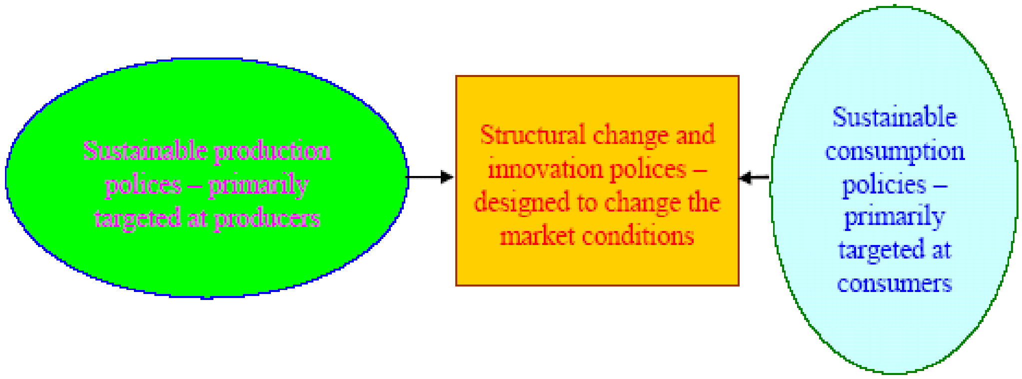

Figure 6: Link between resources and productivity (Omer 2009).

demanding standards of sustainability from 'upstream' suppliers, while supporting smaller firms to meet those higher standards.

- Product stewardship- taking the broadest view of 'producer responsibility' and working to reduce all the 'downstream' effects of products after they have been sold on to customers.
- Openness and transparency- publicly reporting on environmental performance against meaningful targets; actively using clear labels and declarations so that customers are fully informed; building stakeholder confidence by communicating sustainability aims to the workforce, the shareholders and the local community (Figure 6).

With the debate on climate change, the preference for real measured data has been changed. The analyses of climate scenarios need an hourly weather data series that allows for realistic changes in various weather parameters. By adapting parameters in a proper way, data series can be generated for the site. Weather generators should be useful for:

- Calculation of energy consumption (no extreme conditions are required
- Design purposes (extremes are essential), and
- Predicting the effect of climate change such as increasing annually average of temperature.

This results in the following requirements:

- Relevant climate variables should be generated (solar radiation: global, diffuse, direct solar direction, temperature, humidity, wind speed and direction) according to the statistics of the real climate.
- The average behaviour should be in accordance with the real climate.
- Extremes should occur in the generated series in the way it will happen in a real warm period. This means that the generated series should be long enough to assure these extremes, and series based on average values from nearby stations.

Growing concerns about social and environmental sustainability have led to increased interest in planning for the energy utility sector because of its large resource requirements and production of emissions. A number of conflicting trends combine to make the energy sector a major concern, even though a clear definition of how to measure progress toward sustainability is lacking. These trends include imminent competition in the electricity industry, global climate change, expected long-term growth in population and pressure to balance living standards (including per capital energy consumption).

Designing and implementing a sustainable energy sector will be a key element of defining and creating a sustainable society. In the electricity industry, the question of strategic planning for sustainability seems to conflict with the shorter time horizons associated with market forces as deregulation replaces vertical integration. Sustainable low-carbon energy scenarios for the new century emphasise the untapped potential of renewable resources. Rural areas can benefit from this transition. The increased availability of reliable and efficient energy services stimulates new development alternatives. It is concluded that renewable environmentally friendly energy must be encouraged, promoted, implemented, and demonstrated by full-scale plant especially for use in remote rural areas.

This is the step in a long journey to encourage a progressive economy, which continues to provide us with high living standards, but at the same time helps reduce pollution, waste mountains, other environmental degradation, and environmental rationale for future policy-making and intervention to improve market mechanisms. This vision will be accomplished by:

- 'Decoupling' economic growth and environmental degradation. The basket of indicators illustrated shows the progress being made (Table 9). Decoupling air and water pollution from growth, making good headway with CO_2 emissions from energy, and transport. The environmental impact of our own individual behaviour is more closely

Table 9: The basket of indicators for sustainable consumption and production (Omer 2009).

Economy-wide decoupling indicators
1. Greenhouse gas emissions
2. Air pollution
3. Water pollution (river water quality)
4. Commercial and industrial waste arisings and household waste not cycled
Resource use indicators
5. Material use
6. Water abstraction
7. Homes built on land not previously developed, and number of households
Decoupling indicators for specific sectors
8. Emissions from electricity generation
9. Motor vehicle kilometres and related emissions
10. Agricultural output, fertiliser use, methane emissions and farmland bird populations
11. Manufacturing output, energy consumption and related emissions
12. Household consumption, expenditure energy, water consumption and waste generated

linked to consumption expenditure than the economy as a whole.

- Focusing policy on the most important environmental impacts associated with the use of particular resources, rather than on the total level of all resource use.
- Increasing the productivity of material and energy use that are economically efficient by encouraging patterns of supply and demand, which are more efficient in the use of natural resources. The aim is to promote innovation and competitiveness. Investment in areas like energy efficiency, water efficiency and waste minimisation.

Encouraging and enabling active and informed individual and corporate consumers.

Most scientists predict that rising global temperatures will raise the sea level and increase the frequency of intense rain or snowstorms. Climate change scenarios sources of uncertainty and factors influencing the future climate are:

- The future emission rates of the GHGs.
- The effect of this increase in concentration on the energy balance of the atmosphere.
- The effect of these emissions on GHGs concentrations in the atmosphere, and
- The effect of this change in energy balance on global and regional climate.

Wastes

Waste is defined as an unwanted material that is being discarded. Waste includes items being taken for further use, recycling or reclamation. Waste produced at household, commercial and industrial premises are control waste and come under the waste regulations. Waste Incineration Directive (WID) emissions limit values will favour efficient, inherently cleaner technologies that do not rely heavily on abatement. For existing plant, the requirements are likely to lead to improved control of:

- NO_x emissions, by the adoption of infurnace combustion control and abatement techniques.
- Acid gases, by the adoption of abatement techniques and optimisation of their control.
- Particulate control techniques, and their optimisation, e.g., of bag filters and electrostatic precipitators.

The waste and resources action programme has been working hard to reduce demand for virgin aggregates and market uptake of recycled and secondary alternatives (Figure 7). The programme targets are:

- To deliver training and information on the role of recycling and secondary aggregates in sustainable construction for influences in the supply chain, and
- To develop a promotional programme to highlight the new information on websites.

Lifecycle analysis of several ethanol feedstocks shows the emission displacement per ton of feedstock is highest for corn stover and switchgrass (about 0.65 tons of CO_2 per ton of feedstock) and lowest for corn (about 0.5 ton). Emissions due to cultivation and harvesting of corn and wheat are higher than those for lignocellulosics, and although the latter have a far higher process energy requirement (Figure 7). GHG emissions are lower because this energy is produced from biomass residue, which is carbon neutral.

- Large steam power (LSP)
- Small steam power (SSP)
- Brayton cycle power (BCP)
- Bio-oil conversion power (B-CP)
- Gasification power (GP)
- Small steam CHP (SSCHP)
- Turboden cycle CHP (TCCHP)
- Entropic cycle CHP (ECCHP)

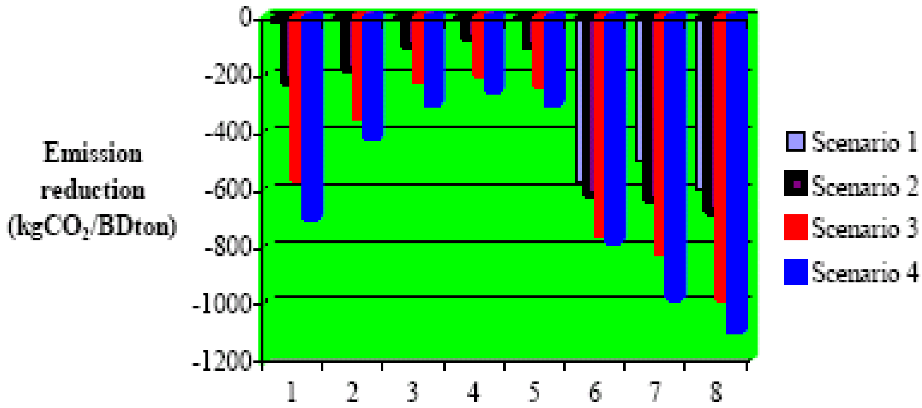

Figure 7: Comparison of thermal biomass usage options, CHP displacing natural gas as a heat source (Omer 2009).

Green heat

The ground is as universal as air and solar radiation. Over the past twenty years, as the hunt for natural low-carbon energy sources has intensified, there has been an increased endeavour to investigate and develop both earth and ground water thermal energy storage and usage. Geothermal energy solutions, although well known, are another in our armoury of renewable energy sources that are within our immediate grasp to use and integrate with an overall energy policy. For high temperature heat storage with temperatures in excess of 50°C the particular concerns were:

- Clogging of wells and heat exchangers due to fines and precipitation of minerals.
- Water treatment to avoid operational problems resulting from the precipitation of minerals.
- Corrosion of components in the groundwater system.
- Automatic control of the ground water system.

As consumers in less-developed countries increase their capacity of electricity and green power, developed nations are starting to realise the benefits of using low-grade thermal energy for green heat applications that do not require high-grade electricity. This shift will not only benefit renewable energies that are designed for space conditioning, but also will contribute to the global mix of green power and green heat capacity. Earth energy (also called geothermal or ground source heat pumps or GeoExchange), which transfers absorbed solar heat from the ground into a building for space heating or water heating. The same system can be reversed to reject heat from the interior into the ground, in order to provide cooling. A typical configuration buries polyethylene pipe below the frost line to serve as the head source (or sink), or it can use lake water and aquifers as the heat medium. An advantage is gained from the necessity to provide filtered fresh air for ventilation purposes by providing every dwelling with a heat recovery mechanical ventilation system. Incorporation of a heating/cooling coil within the air-handling unit for each of the five blocks allows for active summertime cooling (i.e., collecting heat in summer), which along with the use of roof mounted solar panels to provide domestic hot water produces as well tempered and well engineered hybrid low energy scheme at very low carbon emissions.

Effects of urban density

Compact development patterns can reduce infrastructure demands and the need to travel by car. As population density increases, transportation options multiply and dependence areas, per capita fuel consumption is much lower in densely populated areas because people drive so much less. Few roads and commercially viable public transport are the major merits. On the other hand, urban density is a major factor that determines the urban ventilation conditions, as well as the urban temperature. Under given circumstances, an urban area with a high density of buildings can experience poor ventilation and strong heat island effect. In warm-humid regions these features would lead to a high level of thermal stress of the inhabitants and increased use of energy in air-conditioned buildings.

However, it is also possible that a high-density urban area, obtained by a mixture of high and low buildings, could have better ventilation conditions than an area with lower density but with buildings of the same height. Closely spaced or high-rise buildings are also affected by the use of natural lighting, natural ventilation and solar energy. If not properly planned, energy for electric lighting and mechanical cooling/ventilation may be increased and application of solar energy systems will be greatly limited.

Table 10: Effects of urban density on city's energy demand (Omer 2008).

Positive effects	Negative effects
Transport: Promote public transport and reduce the need for, and length of, trips by private cars. **Infrastructure**: Reduce street length needed to accommodate a given number of inhabitants. Shorten the length of infrastructure facilities such as water supply and sewage lines, reducing the energy needed for pumping. **Thermal performance:** Multi-story, multiunit buildings could reduce the overall area of the building's envelope and heat loss from the buildings. Shading among buildings could reduce solar exposure of buildings during the summer period. **Energy systems:** District cooling and heating system, which is usually more energy efficiency, is more feasible as density is higher. **Ventilation:** A desirable flow pattern around buildings may be obtained by proper arrangement of high-rise building blocks.	**Transport**: Congestion in urban areas reduces fuel efficiency of vehicles. **Vertical transportation:** High-rise buildings involve lifts, thus increasing the need for electricity for the vertical transportation. **Ventilation**: A concentration of high-rise and large buildings may impede the urban ventilation conditions. **Urban heat island:** Heat released and trapped in the urban areas may increase the need for air conditioning. The potential for natural lighting is generally reduced in high-density areas, increasing the need for electric lighting and the load on air conditioning to remove the heat resulting from the electric lighting. **Use of solar energy:** Roof and exposed areas for collection of solar energy are limited.

Table 10 gives a summary of the positive and negative effects of urban density. All in all, denser city models require more careful design in order to maximise energy efficiency and satisfy other social and development requirements. Low energy design should not be considered in isolation, and in fact, it is a measure, which should work in harmony with other environmental objectives. Hence, building energy study provides opportunities not only for identifying energy and cost savings, but also for examining the indoor and outdoor environment.

Energy efficiency and architectural expression

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. 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 technology in buildings has an important role to play. A review of options indicates benefits and some problems (Singh, 2008). There are two key elements to the fulfilling of renewable energy technology potential within the field of building design; first the installation of appropriate skills and attitudes in building design professionals and second the provision of the opportunity for such people to demonstrate their skills. This second element may only be created when the population at large and clients commissioning building design in particular, become more aware of what can be achieved and what resources are required.

Terms like passive cooling or passive solar use mean that the cooling of a building or the exploitation of the energy of the sun is achieved not by machines but by the building's particular morphological organisation. Hence, the passive approach to themes of energy savings is essentially based on the morphological articulations of the constructions. Passive solar design, in particular, can realize significant energy and cost savings. For a design to be successful, it is crucial for the designer to have a good understanding of the use of the building. Few of the buildings had performed as expected by their designers. To be more precise, their performance had been compromised by a variety of influences related to their design, construction and operation.

However, there is no doubt that the passive energy approach is certainly the one that, being supported by the material shape of the buildings has a direct influence on architectural language and most greatly influences architectural expressiveness (Lazzarin, 2002). Furthermore, form is a main tool in architectural expression. To give form to the material things that one produces is an ineluctable necessity. In architecture, form, in fact, summarises and gives concreteness to its every value in terms of economy, aesthetics, functionality and, consequently, energy efficiency (David 2003).

The target is to enrich the expressive message with forms producing an advantage energy-wise. Hence, form, in its geometric and material sense, conditions the energy efficiency of a building in its interaction with the environment. It is, then, very hard to extract and separate the parameters and the elements relative to this efficiency from the expressive unit to which they belong. By analysing energy issues and strategies by means of the designs, of which they are an integral part, one will, more easily, focus the attention on the relationship between these themes, their specific context and their architectural expressiveness. Many concrete examples and a whole literature have recently grown up around these subjects and the wisdom of forms and expedients that belong to millennia-old traditions has been rediscovered. Such a revisiting, however, is only, or most especially, conceptual, since it must be filtered through today's technology and needs; both being almost irreconcilable with those of the past.

Two among the historical concepts are of special importance. One is rooted in the effort to establish rational and friendly strategic relations with the physical environment, while the other recognises the interactions between the psyche and physical perceptions in the creation of the feeling of comfort. The former, which may be defined as an alliance with the environment deals with the physical parameters involving a mixture of natural and artificial ingredients such as soil and vegetation, urban fabrics and pollution (Zuatori, 2005). The most dominant outside parameter is, of course, the sun's irradiation, our planet's primary energy source. All these elements can be measured in physical terms and are therefore the subject of science. Within the second concept, however, one considers the emotional and intellectual energies, which are the prime inexhaustible source of renewable power (Anne and Michael, 2005).

In this case, cultural parameters, which are not exactly measurable, are involved. However, they represent the very essence of the architectural quality. Objective scientific measurement parameters tell us very little about the emotional way of perceiving, which influences the messages of human are physical sensorial organs. The perceptual reality arises from a multitude of sensorial components; visual, thermal, acoustic, olfactory and kinaesthetics. It can, also, arise from the organisational quality of the space in which different parameters come together, like the sense of order or of serenity. Likewise, practical evaluations, such as usefulness, can be involved too. The evaluation is a wholly subjective matter, but can be shared by a set of experiencing persons (Randal and Goyal, 1998)

Therefore, these cultural parameters could be different in different contexts in spite of the inexorable levelling on a planet- wide scale. However, the parameters change in the anthropological sense, not only with the cultural environment, but also in relation to function. The scientifically measurable parameters can, thus, have their meanings very profoundly altered by the non-measurable, but describable, cultural parameters.

However, the low energy target also means to eliminate any excess in the quantities of material and in the manufacturing process necessary for the construction of our built environment. This claims for a more sober, elegant and essential expression, which is not jeopardising at all, but instead enhancing, the richness and preciousness of architecture, while contributing to a better environment from an aesthetic viewpoint (Yadav, 1997). Arguably, the most successful designs were in fact the simplest. Paying attention to orientation, plan and form can have far greater impact on energy performance than opting for elaborate solutions (Brain and Mark, 2007) . However, a design strategy can fail when those responsible for specifying materials for example, do not implement the passive solar strategy correctly. Similarly, cost-cutting exercises can seriously upset the effectiveness of a design strategy. Therefore, it is imperative that a designer fully informs key personnel, such as the quantity surveyor and client, about their design and be prepared to defend it. Therefore, the designer should have an adequate understanding of how the occupants or processes, such as ventilation, would function within the building.

Thinking through such processes in isolation without reference to others can lead to conflicting strategies, which can have a detrimental impact upon performance. Likewise, if the design intent of the building is not communicated to its occupants, there is a risk that they will use it inappropriately, thus, compromising its performance. Hence, the designer should communicate in simple terms the actions expected of the occupant to control the building. For example, occupants should be well informed about how to guard against summer overheating. If the designer opted for a simple, seasonally adjusted control; say, insulated sliding doors were to be used between the mass wall and the internal space. The lesson here is that designers must be prepared to defend their design such that others appreciate the importance and interrelationship of each component. A strategy will only work if each individual component is considered as part of the bigger picture. Failure to implement a component or incorrect installation, for example, can lead to failure of the strategy and consequently, in some instances, the building may not liked by its occupants due to its poor performance.

Energy efficiency

Energy efficiency is the most cost-effective way of cutting carbon dioxide emissions and improvements to households and businesses. It can also have many other additional social, economic and health benefits, such as warmer and healthier homes, lower fuel bills and company running costs and, indirectly, jobs. Britain wastes 20 per cent of its fossil fuel and electricity use.

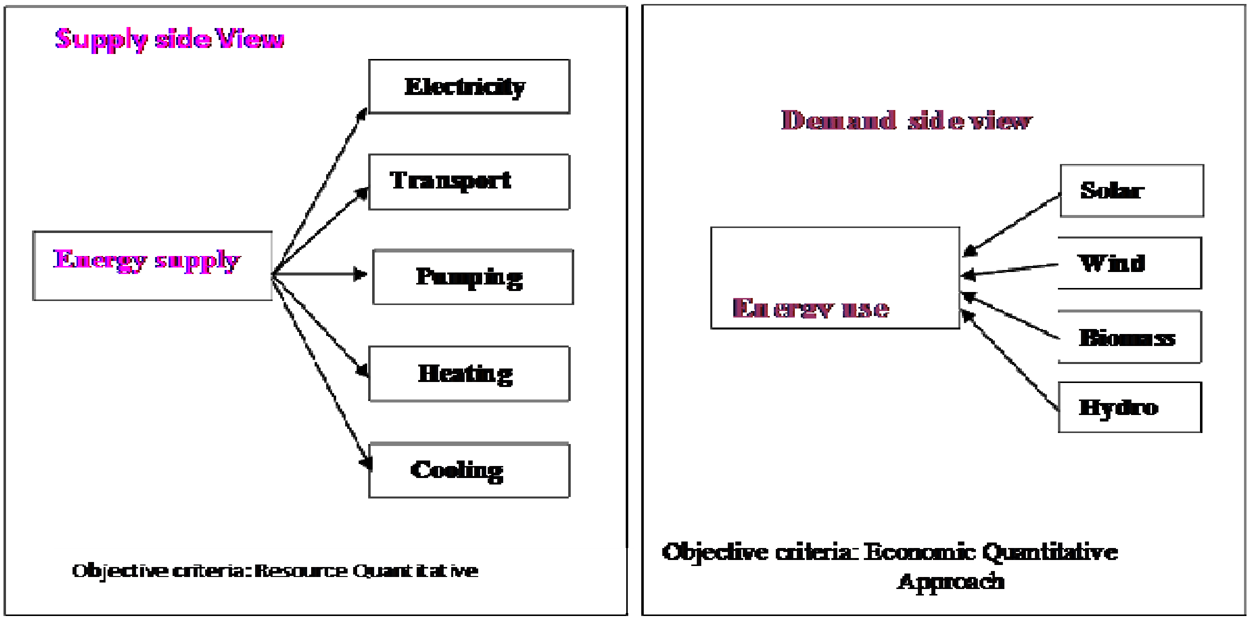

Figure 8: Supply side and demand side management approach for energy (Omer 2008).

This implies that it would be cost-effective to cut £10 billion a year off the collective fuel bill and reduce CO_2 emissions by some 120 million tones. Yet, due to lack of good information and advice on energy saving, along with the capital to finance energy efficiency improvements, this huge potential for reducing energy demand is not being realised.

Traditionally, energy utilities have been essentially fuel providers and the industry has pursued profits from increased volume of sales. Institutional and market arrangements have favoured energy consumption rather than conservation. However, energy is at the centre of the sustainable development paradigm as few activities affect the environment as much as the continually increasing use of energy. Most of the used energy depends on finite resources, such as coal, oil, gas and uranium. In addition, more than three quarters of the world's consumption of these fuels is used, often inefficiently, by only one quarter of the world's population. Without even addressing these inequities or the precious, finite nature of these resources, the scale of environmental damage will force the reduction of the usage of these fuels long before they run out.

Policy recommendations for a sustainable energy future

Sustainability is regarded as a major consideration for both urban and rural development. People have been exploiting the natural resources with no consideration to the effects, both short-term (environmental) and long-term (resources crunch). It is also felt that knowledge and technology have not been used effectively in utilising energy resources. Energy is the vital input for economic and social development of any country. Its sustainability is an important factor to be considered. The urban areas depend, to a large extent, on commercial energy sources.

The rural areas use non-commercial sources like firewood and agricultural wastes. With the present day trends for improving the quality of life and sustenance of mankind, environmental issues are considered highly important. In this context, the term energy loss has no significant technical meaning. Instead, the exergy loss has to be considered, as destruction of exergy is possible. Hence, exergy loss minimisation will help in sustainability. In the process of developing, there are two options to manage energy resources: (1) End use matching/demand side management, which focuses on the utilities. The mode of obtaining this is decided based on economic terms. It is, therefore, a quantitative approach. (2) Supply side management, which focuses on the renewable energy resource and methods of utilizing it. This is decided based on thermodynamic consideration having the resource-user temperature or exergy destruction as the objective criteria. It is, therefore, a qualitative approach. The two options are explained schematically in Figure 8. The exergy-based energy, developed with supply side perspective is shown in Figure 9.

The following policy measures had been identified:

- Clear environmental and social objectives for energy market liberalisation, including a commitment to energy efficiency and renewables.

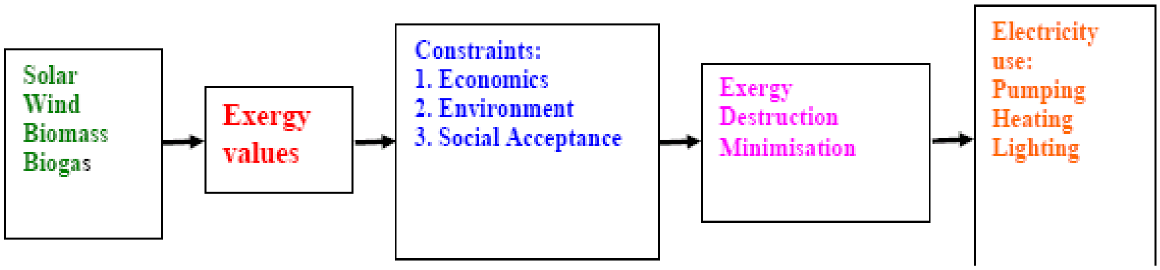

Figure 9: Exergy based optimal energy model (Omer, 2008)

- Economic, institutional and regulatory frameworks, which encourage the transition to total energy services.
- Economic measures to encourage utility investment in energy efficiency (e.g., levies on fuel bills).
- Incentives for demand side management, including grants for low-income households, expert advice and training, standards for appliances and buildings and tax incentives.
- Research and development funding for renewable energy technologies not yet commercially viable.
- Continued institutional support for new renewables (such as standard cost-reflective payments and obligation on utilities to buy).
- Ecological tax reform to internalise external environmental and social costs within energy prices.
- Planning for sensitive development and public acceptability for renewable energy.

Energy resources are needed for societal development. Their sustainable development requires a supply of energy resources that are sustainably available at a reasonable cost and can cause no negative societal impacts. Energy resources such as fossil fuels are finite and lack sustainability, while renewable energy sources are sustainable over a relatively longer term. Environmental concerns are also a major factor in sustainable development, as activities, which degrade the environment, are not sustainable. Hence, as much as environmental impact is associated with energy, sustainable development requires the use of energy resources, which cause as little environmental impact as possible. One way to reduce the resource depletion associated with cycling is to reduce the losses that accompany the transfer of exergy to consume resources by increasing the efficiency of exergy transfer between resources i.e. increasing the fraction of exergy removed from one resource that is transferred to another (Trevor 2007).

As explained above, exergy efficiency may be thought of as a more accurate measure of energy efficiency that accounts for quantity and quality aspects of energy flows. Improved exergy efficiency leads to reduced exergy losses. Most efficiency improvements produce direct environmental benefits in two ways. First, operating energy input requirements are reduced per unit output, and pollutants generated are correspondingly reduced. Second, consideration of the entire life cycle for energy resources and technologies suggests that improved efficiency reduces environmental impact during most stages of the life cycle. Quite often, the main concept of sustainability, which often inspires local and national authorities to incorporate environmental consideration into setting up energy programmes have different meanings in different contexts though it usually embodies a long-term perspective. Future energy systems will largely be shaped by broad and powerful trends that have their roots in basic human needs. Combined with increasing world population, the need will become more apparent for successful implementation of sustainable development. Heat has a lower exergy, or quality of energy, compared with work. Therefore, heat cannot be converted into work by 100% efficiency. Some examples of the difference between energy and exergy are shown in Table 11.

The terms used in Table 11 have the following meanings:

Carnot Quality Factor (CQF) = $(1-T_o/T_s)$ (5)

Exergy=Energy(transferred)xCQF (6)

Where T_o is the environment temperature (K) and T_s is the temperature of the stream (K).

Various parameters are essential to achieving sustainable development in a society. Some of them are as follows:

- Public awareness
- Information
- Environmental education and training
- Innovative energy strategies
- Renewable energy sources and cleaner technologies
- Financing
- Monitoring and evaluation tools

Table 11: Qualities of various energy sources (Omer, 2008).

Source	Energy (J)	Exergy (J)	CQF
Water at 8o °C	100	16	0.16
Steam at 120 °C	100	24	0.24
Natural gas	100	99	0.99
Electricity/work	100	100	1.00

Improving access for rural and urban low-income areas in developing countries through energy efficiency and renewable energies will be needed. Sustainable energy is a prerequisite for development. Energy-based living standards in developing countries, however, are clearly below standards in developed countries. Low levels of access to affordable and environmentally sound energy in both rural and urban low-income areas are therefore a predominant issue in developing countries.

In recent years many programmes for development aid or technical assistance have been focusing on improving access to sustainable energy, many of them with impressive results. Apart from success stories, however, experience also shows that positive appraisals of many projects evaporate after completion and vanishing of the implementation expert team. Altogether, the diffusion of sustainable technologies such as energy efficiency and renewable energies for cooking, heating, lighting, electrical appliances and building insulation in developing countries has been slow.

CONCLUSIONS

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 study 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. The international community would benefit from pollution reduction, climate mitigation, and the increased trading opportunities that arise from new income sources. The non-technical issues, which have recently gained attention, include:

- Environmental and ecological factors, e.g., carbon sequestration, reforestation and revegetation.
- Renewables as a CO_2 neutral replacement for fossil fuels.
- Greater recognition of the importance of renewable energy, particularly modern biomass energy carriers, at the policy and planning levels.
- Greater recognition of the difficulties of gathering good and reliable renewable energy data, and efforts to improve it.
- Studies on the detrimental health efforts of biomass energy particularly from traditional energy users.

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