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Solar Energy for Buildings: Clean Energies Utilisation and Environment

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ABSTRACT: The move towards a low-carbon, 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. This requires the harnessing and use of natural resources that produce no air pollution or greenhouse gases (GHGs) and provides comfortable coexistence of human, livestock, and plants. This communication presents a comprehensive review of energy sources, and the development of sustainable technologies to explore these energy sources. It also includes potential renewable energy technologies, efficient energy systems, energy savings techniques and other mitigation measures necessary to reduce climate changes.

Keywords: renewable energy resources, technologies, sustainable development, environment

1 INTRODUCTION

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 photovoltaic (PV) have been considered for many years as a likely and eventual substitute for oil, gas, coal and uranium. They are the most abundant elements in the universe. The use of solar energy or PVs for the everyday electricity needs has distinct advantages: avoid consuming resources and degrading the environment through polluting emissions, oil spills and toxic by-

products. A one-kilowatt PV system producing (150 kWh) each month prevents 75 kg of fossil fuel from being mined. 150 kg of carbon dioxide (CO_2) from entering the atmosphere and keeps (473) litres of water from being consumed. Electricity from fuel cells can be used in the same way as grid power: to run appliances and light bulbs and even to power cars since each gallon of gasoline produced and used in an internal combustion engine releases roughly 12 kg of CO_2, a greenhouse gases (GHGs) that contributes to global warming.

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.

2 SOLAR ENERGY

Conventional hydrocarbon resources are finite and will run out one day. Table 3 shows proven reserves of various types of fossil fuels worldwide. The growth of the world economy needs energy and if oil is depleting then the energy to grow no longer come from oil. After years of surpluses in the production capacity of virtually every energy commodity, surging demand in Asia and North America, and political and technical difficulties that reduced production capacity, the oil market has tightened. Historically, crude oil prices witnessed sharp jump; some researchers called it as oil crises as shown in Figure 1. The integration of PVs within both domestic and commercial roof offers the largest potential market for PV especially in the developed world.

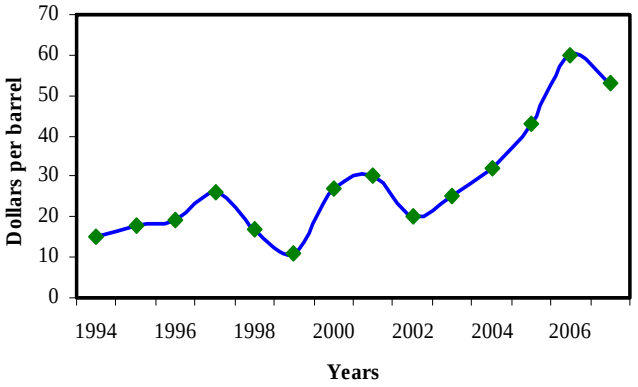

Figure 1: Oil prices trend from 1994-2007.

Numerous national programmes are attempting to stimulate this market using standard PV modules as a roof element. However, roofs are not static, uniform structures and so are not ideally suited to modules which require precise, planar mounting structures. To date, attempts at producing a PV roof tile which accommodates current roof practice, in terms of both installation and aesthetics. The market for PV has historically

been based on off-grid application where the relatively high cost of PV could be economically justified. In 2001 about 330 MWp of PV were produced and installed around the world and the growth rate of the industry is over 30% per year-100% per year in some countries with aggressive implementation schemes. There have now been a number of successful large-scale programmes of systems deployed for basic power needs in rural households in developing and less developed countries. Remote applications servicing other applications such as telecommunications, cathodic protection, water pumping, etc., continue to grow as well. The PV market will continue to grow strongly for the next several years at least, driven by incentive programmes, cost reductions and greater market awareness.

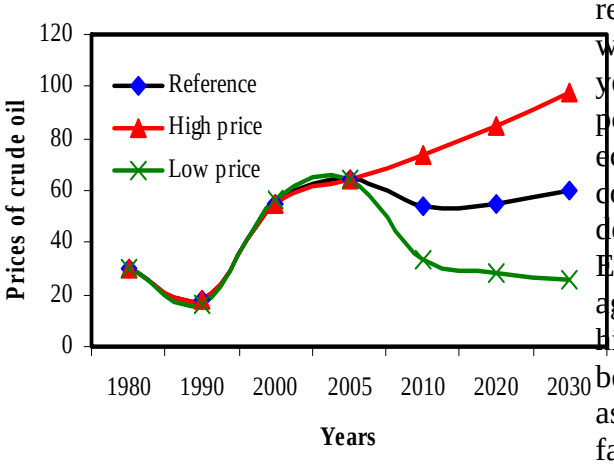

Figure 2: Forecast prices of crude oil for low-sulphur light crude oil.

Consequently, all commodities and services that depend, directly or indirectly, on oil, as source of energy or a raw material, went up in price. In the longer term with the foreseeable exhaustion of world's crude oil reserves and higher oil prices (Figure 2). The eventual exploitation of fuel resource to produce liquid fuels and/or electricity, together with chemicals and building materials, would be favoured by four factors, these are:

- High organic matter content of oil shale
- Suitability of the deposits for surface mining
- The location-away from centres of population but having good transport links to potential consumers (i.e., phosphate mines, potash and cement works) and most importantly and
- The unit price of crude oil.

3 DISCUSSIONS

Sustainable energy is energy that, in its production or consumption, has minimal negative impacts on human health and the healthy functioning of vital ecological systems, including the global environment. It is an accepted fact that renewable energy is a sustainable form of energy, which has attracted more attention during recent years. A great amount of renewable energy potential, environmental interest, as well as economic consideration of fossil fuel consumption and high emphasis of sustainable development for the future will be needed. Explanations for the use of inefficient agricultural-environmental polices include the high cost of information required to measure benefits on a site-specific basis, information asymmetries between government agencies and farm decision makers that result in high implementation costs, distribution effects and political considerations [1]. Achieving the aim of agric-environment schemes through:

- Sustain the beauty and diversity of the landscape.
- Improve and extend wildlife habitats.
- Conserve archaeological sites and historic features.

- Improve opportunities for countryside enjoyment.
- Restore neglected land or features, and create new habitats and landscapes.

Furthermore, investigating the potential is needed to make use of more and more of its waste. Household waste, vegetable market waste, and waste from the cotton stalks, leather, and pulp; and paper industries can be used to produce useful energy either by direct incineration, gasification, digestion (biogas production), fermentation, or cogeneration. 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.

Two of the most essential natural resources for all life on the earth and for man's survival are sunlight and water. Sunlight is the driving force behind many of the renewable energy technologies. The worldwide potential for utilising this resource, both directly by means of the solar technologies and indirectly by means of biofuels, wind and hydro technologies is vast. During the last decade interest has been refocused on renewable energy sources due to the increasing prices and fore-seeable exhaustion of presently used commercial energy sources. In Sudan great attention is given to the utilisation of renewable energy potential of the country. Solar energy constitutes the main renewable energy resource in Sudan [2]. This study is an attempt to explore the potentialities of solar energy technologies with particular reference to application of solar energy technologies in remote rural areas of the Sudan. The main objectives of this theme are reviewing and assessing the current and future share of various solar energy applications in the over all mix of energy in Sudan, as well as identifying potential areas for utilising future technologies and recommending future courses of action to encourage the commercial utilisation of solar energy technologies.

The utilisation of solar energy in Sudan pertains to be the use of:

(1) Solar cookers:

The solar cookers are made from wood and glass. Different types of solar cookers (locally manufactured) have been designed, and disseminated in Sudan. Now solar cookers are commercially available in local markets [3].

(2) Industrial solar water heaters (SWHs):

Different systems designs have been developed, tested and evaluated in the country. The best one is the solar water heaters on the roofs of the buildings [4]. A typical family size SWH unit consists of 1-1.44 m^2 of solar collectors' areas and a 1 m^3 hot storage tank. Due to high and reliable solar irradiance of about 5.5 kWh/m^2 day a typical Sudanese SWH with 1.44 m^2 net area and 25% average system efficiency over the life time has the potential to produce around 150 l of hot water at 45^oC per day for about 340 sunny days per year. Several technical and non-technical factors influenced as the following: (i) Selection and treatment of materials used in the manufacturing of the SWH. This situation drastically reduces the economic viability and performance of the SWH systems over their lifetime. (ii) Space availability on roofs especially in high-rise buildings. (iii) Lack of public awareness of the benefits of using SWH systems, and of the maintenance and monitoring procedures, and (iv) The unavailability of credit schemes, especially for the low-income groups, in order to have a SWH system with soft payments.

Currently the Energy Research Institute (ERI) has a SWH laboratory for simulation of solar radiation, quality control, calibration and determination of performance behaviour of the SWH. This will assure the quality and reliability of the SWH and protect both the consumer and manufacturer.

Such development brings the following challenges:

- The need to provide farmers with ready access to these individual technologies, repair services and technical assistance.
- Access to markets with worthwhile commodity prices, so that sufficient profitability is realised.
- This type of technology could be a solution to food security problems. For example, in greenhouses, advances in biotechnology like the genetic engineering, tissue culture and market-aided selection have the potential to be applied for raising yields, reducing pesticide excesses and increasing the nutrient value of basic foods.

(3) Solar stills:

Various versions have been constructed. Solar stills are suitable for use in laboratories, medical purposes, charging and topping batteries, and supplying drinking water to small communities in isolated sunny areas as well as local markets. Solar stills for charging and topping batteries is the best economically [5].

(4) Solar dryers for peanut crops:

Solar dryers have been developed, tested and proved good.

(5) PV solar lighting systems:

This application mainly used for schools for night classes, mosques, Khawas, and household nearly 1000 units (40 W-1.5 kW) [5].

(6) PV solar water pumps:

While Sudan has a high potential in terms of solar radiation, the utilisation of the PVs does not depend only on solar radiation, but also on many factors, especially the PV price development. Solar pumps are most cost effective for low power requirement (up to 5 kW) in remote places. Applications include domestic and livestock drinking water supplies, for which the demand is constant throughout the year, and irrigation. The suitability of solar pumping for irrigation is uncertain because the demand may vary greatly with seasons. Solar systems may be able to provide trickle irrigation for fruit farming, but not usually the large volumes of water needed for wheat growing. Table 16 shows some of the PV systems installed in Sudan. More than 100 pilot stations employed PV generators for pumping

water for drinking purposes, and irrigation of small-scale farms. The PV water pumping has been promoted successfully in Kordofan state in Sudan.

(7) PV solar refrigerators:

Solar powered refrigerators are usually used for storing medicines in rural remote areas. More than 200 units are installed in Sudan.

(8) PV communication systems:

More than 20 pilot stations employed PV generators for communication purposes, e.g., radios and trains signals (at main stations, e.g., Khartoum, Atbara, Port Sudan etc.) (50 W-250 W) [5].

4 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 energy, particularly in the building sector. Energy use reductions can be achieved by minimising the energy demand, rational energy use, recovering heat and the use of more green energy. This study was a step towards achieving this 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. However, by adopting coherent strategy for alternative clean sustainable energy sources, the world 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, every nation's resource base would be greatly improved while 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 related to clean energy, which have recently gained attention, include: (1) Environmental and ecological factors, e.g., carbon sequestration, reforestation and revegetation. (2) Renewables as a CO_2 neutral replacement for fossil fuels. (3) Greater recognition of the importance of renewable energy, particularly modern biomass energy carriers, at the policy and planning levels. (4) Greater recognition of the difficulties of gathering good and reliable renewable energy data, and efforts to improve it. (5) Studies on the detrimental health efforts of biomass energy particularly from traditional energy users.

The present study is one effort in touching all these aspects.

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