Climate Change and Renewable Energy

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Abstract

The present world energy supply system is facing three basic problems: limitation of fossil fuel resources, climate change by carbon dioxide emission, and insecurity by nuclear weapon competence and radioactive materials. The strategic goal therefore should be: transition to unlimited resources, zero-emission fuels and no options for abuse. Renewable energies, in particular solar energy as the most abundant form, are an alternative for a global energy supply.

Solar energy cannot be depleted by using it: it comes to earth at day as light, and leaves to outer space as heat radiation at day and night – whether we "use" it or not. Being non-material solar energy does not create pollution, and the biotope earth is in natural balance with it. The most efficient places to harvest solar energy in large amounts are the deserts. This paper studies the change in the climate and the related progress in using renewable energy also, the effect of climate change on the future of solar energy, moreover the future of solar energy in Oman.

1.Introduction

Climate change has long-since ceased to be a scientific curiosity, and is no longer just one of many environmental and regulatory concerns. It is a growing crisis with economic, health and safety, food production, security, and other dimensions.

Renewable energy, is energy generated from natural resources—such as sunlight, wind, rain, tides and geothermal heat-which are renewable (naturally replenished), must play a major role in the global energy supply to meet the increasingly serious environmental and economic threats of climate change. The greatest priority for Earth at this time is not to handle our monetary system, the corrupt politicians, drugs, the news media or even the atomic bomb. The problem is the continuous and expanding by products from burning fossil fuels i.e. pollution, as example figure 1, shows the emissions of co_2 from Oman [1].

Since 1850 there has been a mean rise in global temperature of approximately 1° C (approximately 1.8° F). It was thought that this rise could just be part of a natural fluctuation; such fluctuations have been recorded for tens of thousands of years and operate in short-term as well as long-term cycles [2]. However, 1995 was the warmest year on record, according to the British Meteorological Office. A United Nations panel of scientists attributed the warming to human influence and predicted that if greenhouse-gas emissions [carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons] are not reduced, the average global temperature will rise by 1.0° to 3.5° C (1.8° to 6.3° F), with a best estimate of 2.0° C (3.5° F), by 2100, causing sea level to rise by 20 inches; further warming an sea-level rise would follow [2].

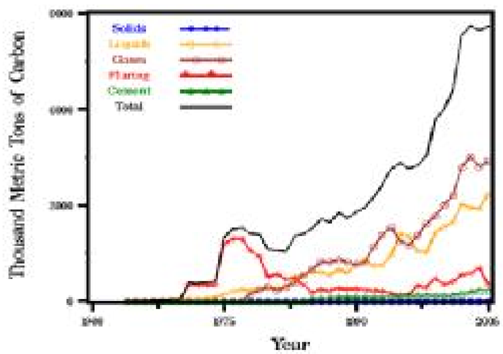

Figure 1: Emission CO_2 from Oman from 1960 to 2005 (the amount of CO_2 in increasing)

The potential consequences of global warming are so great that many of the world's top scientists have urged immediate action and have called for international cooperation on the problem.

How bad is Global Warming - and what is Global Warming? The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP). The IPCC conference in Rome 1995 concludes that there are now clear signs of man-made climate changes, and that pollution from our cars, trucks, factories and power plants is a cause of it. This paper try to focus the light on the change in the climate and the related progress in using renewable energy also, the effect of climate change on the future of solar energy, moreover, the future of renewable energy and specially the solar energy in Oman.

2.Understanding and Predicting Climate Change for Adaptation

It is very likely that most of the observed increase in global average temperatures since the mid-twentieth century is due to the observed increase in anthropogenic greenhouse gas concentrations and it is likely that there has been significant anthropogenic warming over the past 50 years averaged over every continent except the Antarctic [3]. Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes, wind patterns, and sea level rise during the latter half of the twentieth century [3]. There is also evidence that biophysical systems have been affected [4]. However, our ability to interpret change in most other impact-relevant variables, such as changes in circulation, precipitation and extremes of various types, remains more limited.

Global average surface temperatures are projected to continue to increase over the next two decades at a rate of ~0.2°C/decade [5], with accompanying changes in climate patterns that impact human and economic systems [6]. Climate science therefore must aim specifically to assist adaptation decisions around both the adverse and beneficial impacts of climate change. The main focus of the IPCC assessments has been on century and longer predictions of climate changes. These remain essential, but a parallel effort to decipher likely changes on a decadal time scale would be instrumental to support policy making. Such a concerted effort was proposed by Hibbard et al. [7] and is complementary to recommendations made by the Climate Prediction Project.

3.Climate Change and Renewable Energy

Energy plays a vital role in economic growth and poverty reduction. The Asia and Pacific region is seeing energy demand increasing rapidly due to its unprecedented economic growth. This growth is not sustainable if most of this energy will have to be met by fossil fuels.

Barack Obama President of USA said on 22 April 2009 that United States must lead the world on renewable energy and pressed Congress to set greenhouse gas limits deemed crucial for the success of global talks on climate change [8].

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Being non-material solar energy does not create pollution, and the biotope earth is in natural balance with it. So far, no military applications of solar energy are known or planned – otherwise solar energy technologies would have received support since long. The most efficient places to harvest solar energy in large amounts are the deserts. To be considered as a worldwide substitute for the fossil fuels there are 5 questions to be answered:

1. How much solar energy is coming to the Earth's deserts?

The solar energy potential of the sun-belt deserts and desert-like regions can be estimated [9] to be as **desert space = 36 Million km²,** and from the energy they receive annually from the sun. A reasonable average value for the energy of direct normal solar radiation is **2.2 TeraWatt-hour (TWh) /km²/year**. This is as if a layer of oil of 24 cm depth is put onto the deserts, each year again. Slightly other values can be considered, but the conclusions do not change with such choices. The energy received each year by 1 km² of desert is equivalent to the (thermal) energy contained in:

• 300 000 ton hard coal
• 1.5 Million barrel oil

The solar energy arriving annually at the 36 Million km² of desert areas is equivalent to

• 80 Million (Mega) TWh (thermal)
• 10,000 Billion (Giga) ton coal
• 50,000 Billion barrel oil
• 300,000 Exajoule

Since we do have the technologies to convert solar radiation into electricity, we can generate in deserts more than what we need from electricity.

2. Comparison to global demands

How the terrestrial fossil reserves, resources and their annual depletion/consumption compare to the annual solar yields is summarized in the table. According to site selection studies by the German Aerospace Center (DLR) using satellite data the deserts in the Middle East and North Africa (MENA) region would allow for production of electricity of 630,000 TWh/year, about 40 times the present world electricity demand. Collectors for the German total power consumption would require a square of 45km side length, i.e. the area of Berlin and Hamburg. In fact, deserts can be made to sustainable power houses for the world.

3. Can solar energy be supplied as demands occur in time?

Fossil fuels are available as materials that can be stored, and be employed when demand occurs. Solar energy is delivered when the sun is shining. Sun shine itself cannot be stored, but it can readily be converted into high temperature heat which can be stored in thermal storage devices for hours and even for days, with insignificant losses.

This brings the technology of solar thermal power plants into a particularly attractive position: Equipped with simple and cheap thermal storage tanks they can produce solar power by demand, also at night. Large scale thermal energy storage is technically solved and commercially available.

Longer periods without direct sunshine can be coped with by a supplementary fossil fuel heater. The solar power plant contains its own reserve capacity. Solar thermal power plants provide secured capacity.

4. Can solar energy from deserts be transmitted to the high demand regions of the world?

Once solar energy has been converted into electricity, it can be transmitted as direct current at very high voltage (500 kV and higher) over thousands of kilometers with low losses of about 3% per 1000 kilometer. The HVDC (High Voltage Direct Current) transmission is a well established technology. Since large deserts are available in North-and South America, North and South Africa, Western Asia, India, China and Australia, clean power from the deserts can be delivered to more than 90% of world population.

5. Is solar power from deserts economically viable?

In a first step, concentrating solar collectors convert concentrated solar radiation into heat of about 300° Celsius and higher, up to about 1000°C. Steam from solar collectors for thermal power plants, as from 1 barrel of oil, costs between 50 and 70 $. This cost value can be brought down to below 30$ within 10 to 15 years by mass production of such collectors.

These costs vary with the available annual solar radiation and with capital costs. The bulk materials for solar steam generating collectors are glass and iron for which there will be no shortages. According to studies by DLR one can be achieve [10] within 2 to 3 decades:

- *Power production costs of 4-6 c$/kWh*
- *Power transmission costs of 1-2 c$/kWh.*

Coal and nuclear power plants can be phased out simultaneously. With an EU-MENA grid as infrastructure for energy and climate security, solar power from deserts can become the least cost option for Europe.

4.Solar Radiation and Energy in Oman

The following bar chart for Muscat, Oman shows the year average weather condition readings covering rain, average maximum daily temperature and average minimum temperature at 15 January [11].

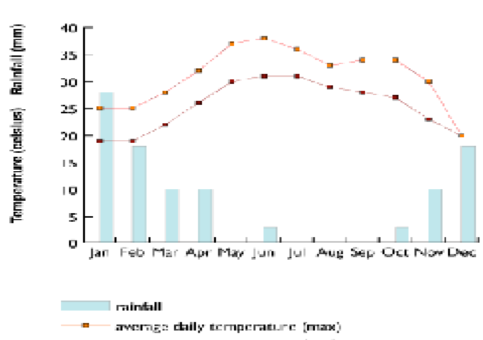

Figure 2: illustrate the temperature in Oman per year

Figure 3 displays the temperature per day- the degree of temperature has start increase at 7:10 to 13:00, and after that became deceasing [12].

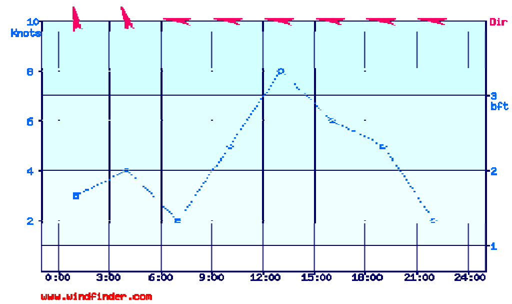

Figure 3: Muscat. Oman-Temperature per day

Also, from figure 4 we could see that the highest solar annual radiation in Oman. The solar radiation is larger than 2200 KWh/m^2, which represent one of the highest solar radiations in the world. This feature represent important conclusion based on which we can say that generation of electricity from solar energy is worthily, useful and success in Oman comparing with other countries in the world. Two short comes should be mentioned here due to the desert and sea: the effects of humidity and dust. Little information has been done regarding these two factors in Oman.

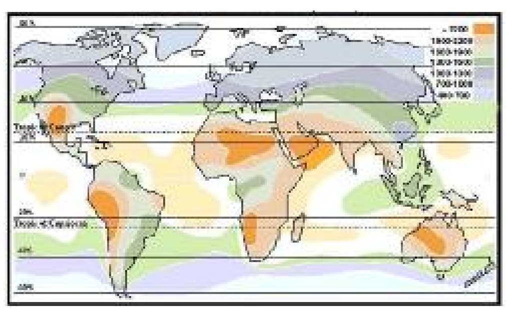

Figure 4: World Wide Solar Annual Radiation (kWh/m^2)

Oman has plans in the works to install a solar plant that will create between 50 and 200 MW of electricity [13]. Also, Oman's government plans to review six start-up wind and solar projects and take bids in 2010. The government will also recruit international advisers to perform a new feasibility study for a large-scale solar plant [14-15].

5. Conclusions

1. Global average surface temperatures are projected to continue to increase over the next two decades with accompanying changes in climate patterns that impact human and economic systems.
2. The solar energy available in deserts is more than 700 times the present global primary energy consumption. This is far more than needed to replace fossil fuels.
3. Solar thermal power plants can store solar heat and generate solar power according to demand, also at night.

4. Technologies for power production and long-distance transmission to over 90% of world population are at hand.
5. Investments into mining technologies for fossil fuels will accelerate their depletion and boost climate change, while better solar technology will be beneficial for all future.
6. Solar energy from deserts can give energy security to the world, and it can stop the ongoing devastation of the Earth by fossil fuels.
7. Oman has one of the highest solar energy concentrations in the world and would be able to produce enough power for all their domestic needs and have power left to export.

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