INFLUENCE OF ENVIRONMENTAL CONDITIONS ON PHOTOVOLTAIC POWER GENERATORS IN EAST OWEINAT

BY

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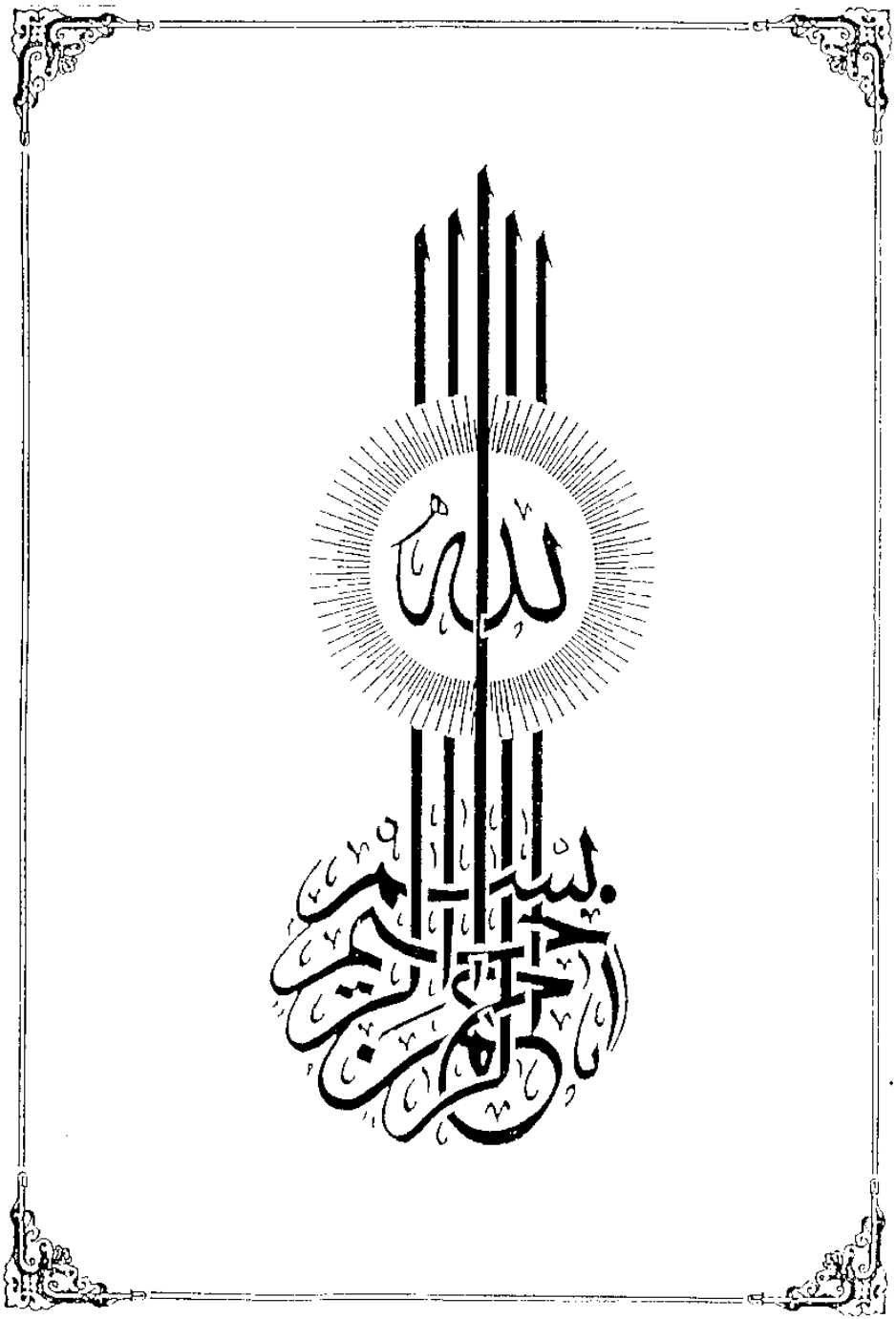

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ABSTRACT

This thesis comprises a study of the influence of environmental conditions on photovoltaic power generators at East Oweinat.

Generally Egypt is one of the most suitable countries for utilizing the new and renewable type of energy, specially solar energy. East Oweinat is a remote desert area which is characterized by an immense aquifer of under ground water which is suitable for domestic and irrigation use.

The solar energy resources at East Oweinat are greatly exceeding the conceivable energy demands for irrigation. The solar insolation in the area amounts to about 2570 kwh/m^2 per year, while the irrigation energy requirements are about 1800-2400 kwh/feddan per year. Engineering, environmental studies and agricultural experiments during the past six years (1982-1987) show that East Oweinat will be a good supply for agriculture products for Egypt.

The thesis starts by describing the theory of solar radiation and insolation as it is the basis for electric power generation using solar cells. The solar insolation per meter square for a certain location of known latitude and longitude are discussed in details. The variation of insolation at East Oweinat were measured monthly for one year.

The following chapter includes a study about photovoltaic conversion system and its applications. The operation of the

solar cell, equivalent circuit of solar cell and solar cell array are discussed. The controller required to obtain maximum power in the range of rated voltage, the batteries storage system to feed the night loads and the inverter to convert the D.C energy to A.C current are discussed.

Stand-by units of diesel generator system which may be used when the sun is dull for several days and the batteries cannot supply the load are described.

The thesis include also a chapter which is devoted to discuss the environmental effects on photovoltaic power generation at East Oweinat. As East Oweinat is a stratigic area, some of these environmental effects such as temperature, solar insolation, wind speed and humidity were measured in the field for the last six years, starting 1982.

These environmental measurements are presented into figures that show the relevant side effects on power generation at East Oweinat.

The last chapter manifests the photovoltaic projects in Egypt since 1978 and till present. It includes a full describtion for the solar village of 200 feddans at East Oweinat which is an Egyptain-Italian project utilizing renewable energy.

The thesis is concluded with recommendation obtained from field experiments done in East Oweinat using equirelant photovoltaic equipment designed for the solar village project. The different enveironmental conditions were considered.

CHAPTER I

INTRODUCTION

1.1 SOLAR ENERGY AND ENVIRONMENT :

Solar energy is one of the new and renewable energy resources in the world.

Solar energy is one of the important components of the enviornment-development interrelationship. The oil prices escalations helped to increase the research to find out new and alternative resources for energy [1].

The most serious research efforts were made in the industrialized nations, in which the solar research was concentrated on the process of collecting solar energy, transforming it into heat or directly into electricity and storing it by the best means [2].

Renewable energies as solar and wind, are more convinient than convential energy resource oil, since it is less polluting and safe for environment. The increasing demand for convential energy as firewood, coal and fuel oil for rural industries and agriclture products giving high pollution and generating have all generated a rural "crisis".

This crisis can be understood only as an interaction of natural technological and social factors [1].

Solar energy can be converted directly to electricity by means of solar cell as photovoltaic system.

The conversion of solar energy to electricity will be effected by many environmental factors as : solar intensity, temperature, wind speed, humidity,.....etc.

Solar energy has the disadvantages of being intermittent, in time and space, thus the need for its storage is the only way.

The negative environmental impact of solar energy is less than that of any other source of energy.

Solar energy compared with nuclear energy has the advantage of being pollution free and safe. However it is diluted energy source while nuclear energy is a concentrated one.

Solar energy cannot be addressed as an isolated physical problem but should be considered as an integrated problem for development with its socio-cultural, economical, environmental and geopolitical dimensions.

1.2 SOLAR ENERGY AND EGYPT :

Egypt is a country among the arab world which falls within the "solar belt" which is characterized by 3000 hour of sunshine a year. The average insolation of the arab world could be estimated at about 520 $cal/cm^2/day$ or about 250 w/m^2. Thus the solar energy reaching the arab world is equivalent to about six times the estimated theoritical oil reserves.

Although solar energy has been used since ancient times in simple applications for drying systems. The recent applications have exceeded the premitive methods, to generate electrical power. Fast development steps have been

made after 1973, as a result of sudden rise of oil prices. Producers have hence realized that there will be good market for renwable energy sources.

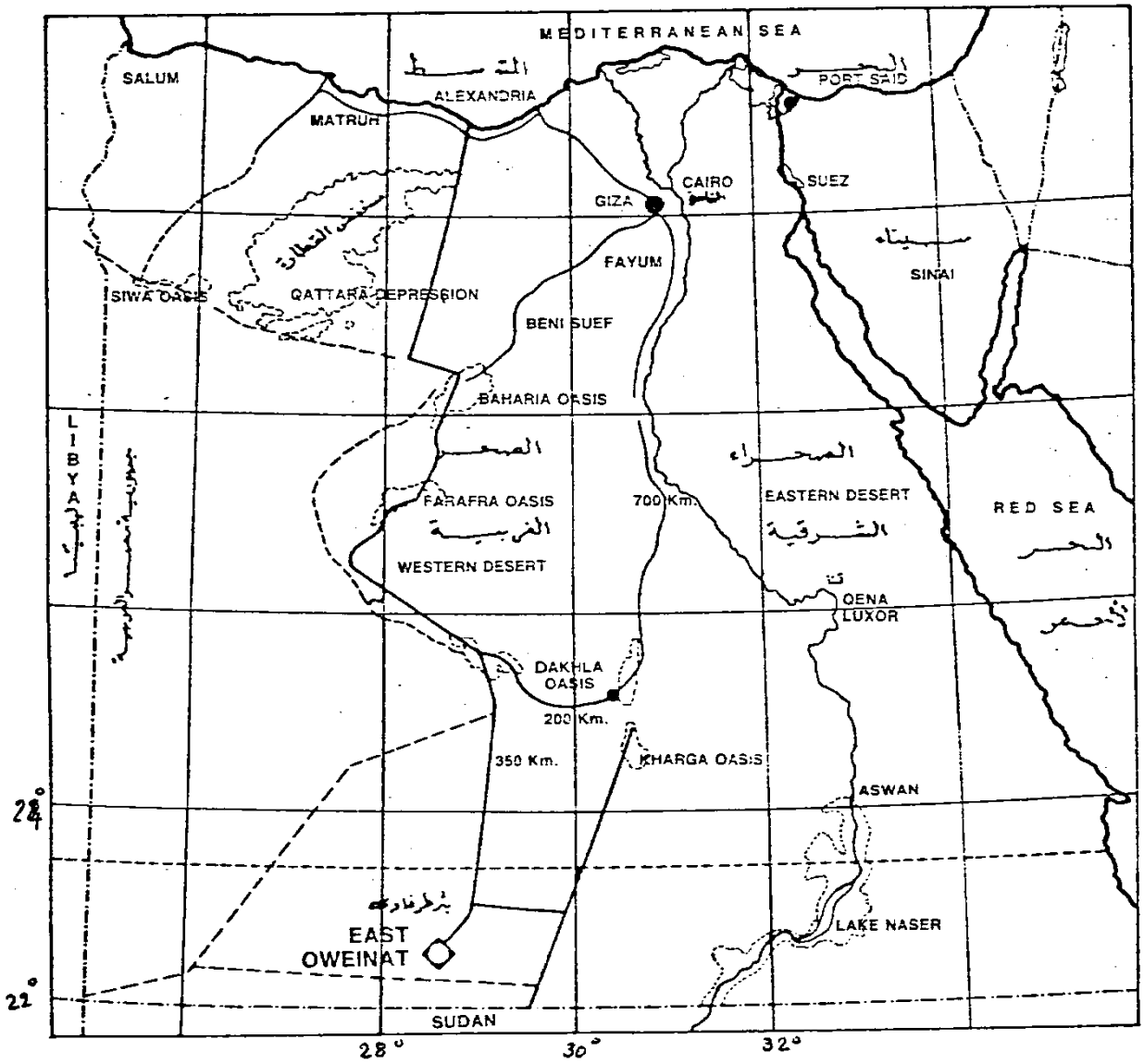
Solar energy in Egypt still present supplies only a fraction of its proven potential with 3000 hours of sunshine a year, Egypt has considrable natural resource of energy. Also it possesses vast area in desert where large solar power generating facilities could be constructed.

Currently demand for electricity in Egypt continuous to grow at 13% to 15% annually. As a result, Egypt will probably consumes its oil reserves withn the next 10 years, resulting in the necessity to import oil at prices which may be then have again risen. For these reasons Egypt must make use of the renewable energy potential [3].

renewable energy in Egypt can be used to supply the remote areas with energy as a local source to avoid transportation of the convential energy.

1.3 EAST OWEINAT AND RENEWABLE ENERGY :

The East oweinat area is located about 1300 Km south to Cairo in the south-western part of Egypt and about 400 Km to the south of the new valley area. It lies between latitude 22 00'N and 24 00'N and longitudes 28 00'E and 30 00'E. It is considered to be a flat arid area about 6 million feddans. The only available topographic maps for this area are on the scales 1 : 500,000 and 1 : 1,000,000 as shown in (Fig 1.1). The results of the study of soil resources illustrate the various land tracts of the arable land which have been classified according to the F.A.O. standards



(Fig.1.1) Map of East Oweinat

(1976). Soil classification and land capability maps produced as a result of this study show the existance of about 3.3 million feddans of promising sand soils. About 1.5 million of this acreage is considered to be of first priority with a deep soil section of over 90 cms.

Several production and observation wells have been drilled in this area. The results of the ground water resources evaluation were that the aquifer saturated thickness ranges from 100 m to 700 mts. The average optimum rate of pumping per well was found to be 300 m^3/hr. With an anticipated drawdown ranging from 6 m to 27 m. The T.D.S. of water ranges from 220 to 700 ppm.

The model developed to evaluate the ground water resources concluded that a long term extraction of 4.7 x 10^6 m^3/day is certainly available. This is sufficient to irrigate 189,000 feddan.

About 900 kms of cold mix asphaltic roads constructed to link this area to the existing asphaltic road at Kharga and Dakhla. An experimental Pilot farm (10 feddans) near one of the water production wells was chosen to test several kinds of plants using solar energy (Photovoltaic system) to pump water.

There is no doupt that such results indicate the potential of this area for future rehabitation and development in Egypt, so an important part of the total area was selected to construct topographical maps on the scale 1 : 100,000 using landsat images.

The General Petroleum Company has discovered under ground water aquifer in East Oweinat, which is suitable for domestic and irrigation use. Since the aquifer is of water table type, thus we need power for pumping such water .
Since Renewable energy represented in solar and wind is more available as localized sources at East Oweinat. A hybrid system of solar-wind energy could be applied in such a remote area. The photovoltaic system is composed of photovoltaic panels, the controller to maximize power, the stroge batteries to feed the night loads and the inverter to convert the D.C energy generated to A.C for consumers.
The system provides energy at a suitable cost and gives a continuous power supply with minimum maintenance, cheap spare parts, durable energy system, safe and pollution free.

1.4 SOCIAL EFFECT FOR PHOTOVOLTAIC SYSTEM :

The impact of the utilization of solar energy as photovoltaic system for example on society is due to both its impact on the behaviour and the habits of the individuals, both interrelated. The use of solar energy will improve the quality of the environment, will help to increase the cultivated area, hence will have positive effect on the quality of life of the community .
The use of solar energy at East Oweinat will influnce greatly the planing of the new settlement, the infra structure such as : bioclamatic buildings, streets, sewers, electric mains and water lines.