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The State of the Art and Development Strategies of Renewable Energy in Arab Countries of Masherek

High-level Expert Meeting
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The State of the Art and Development Strategies of Renewable Energy in Arab Countries of Masherek

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ABSTRACT:

With the increasing concern of environmental issues. The solar energy can respond to the delima of development and environment. The Arab countries of the Mashrek , Egypt, Jordan, Syria and Lebanon possess high solar energy potential. it is worth to mention that the term solar is used symbolically here to present all renewable energy sources and technologies, solar electricity, biomass, geothermal, wind energy conservation, ... etc.

Strong effort has been undertaken in order to put in practice the application of solar energy. Certainly the know-how and the technological issues limit some sophisticated applications. The economical feasibility put a stationary and rigid boundary for the extension of some other applications as solar refrigeration and electricity generation.

The necessity of keeping the running research requires important funding. Fortunately the growing interest of preserving the environment has served in renewing the interest in maintaining certain research areas, which has been considered some times as non - economical application of solar energy specially thermal and photovoltaic

The present report based on the countries reports namely Egyptian and Jordanian and the data collected from Lebanon, Syria and Iraq. Based on the available data a conclusion is reached regarding the future strategies for developing the use of solar energy and the avenue of cooperation between these countries. In general there are large funds which has been devoted to the development of solar energy

1-INTRODUCTION:

With the increasing concern of environmental issues the solar energy as clean and renewable source of energy can reduce the consumption of fossil energy. the related problem of burning the fuel presents a real threat to the mankind. Nowadays the solar energy is promising and show positive aspects both technical and economical.

A solar energy exploitation in Arab masherek countries as a natural resource of major importance has to be based on the development of local expertise and technologies. In this field the creation of know-how requires extensive research work and certainly a strong cooperation between the involved countries. Beside the technological issues, the related issues as manufacturing, training and maintenance are also of great importance.

A global strategy of developing the solar energy utilisation must put into consideration the social and economical impact. In fact the nature of Masherek countries is similar, they have arid areas with high solar intensity and strong wind. Most of these countries possess natural fossil resources (petrol oil). These countries relay on fossil resources for their energy supply. Their dependence on oil varies from 70 % in Egypt to more than 90 % in Lebanon, for all this countries the energy consumption per capita is increasing at a rate of 5 to 6 % annually.

the involved countries share the necessity of implementing a strong programs for the exploitation of renewable energy resources. A target of 5 % as a the contribution of renewable energy in total energy consumption is fixed in Egypt. Jordan is about to reach this percentage. Iraq possesses also development programs for the use of solar energy. Lebanon, Syria and Jordan import the majority of their energy demand represented in petrol oil. On the other hand these countries possess good solar resources, Wind energy resources and acceptable hydropower resources.

In general these countries posses an important research potential, and technological institutions, beside their are several governmental energy agencies dealing with, coordination and research in the field of new energies, as NREA in Egypt and RSC in Jordan.

It is noticeable that the international cooperation has significant contribution to the enhancement of solar energy research programs.

The applied research and development in new energies covers the following applications:

1- Electricity generation by wind energy and photovoltaic for the development of rural areas.

2- Solar desalination

3- Solar water heating for domestic and industrial use.

4- Solar space heating.

5- Water pumping utilizing photovoltaic, mechanical wind pump.

6- Energy storage devices.

7- Solar refrigeration

8- Passive solar utilization in ventilation.

9- Industrial energy conservation.

10-Agricultural application in greenhouse, corp drying..

Through the present report, the activities concerning the above mentioned solar energy applications will be presented according to the availability of data.

The objective of the present report is to present beside the statistical data a global view of the development strategies in t he field solar energy.

2-ABOUT THE ARAB COUNTRIES OF MASHEREK:

Following are some informations regarding the Masherek COUNTRIES. This informations based COUNTRIES reports and some other publications mentioned at the end of this report:

-EGYPT :

Egypt,as one of the developing countries, has maintained high growth rate of energy consumption during the last decades. The average annual growth rate of petroleum products consumption is estimated to be about 5.7 %,that for natural gas consumption is about 15.1 %, that for total petroleum energy consumption (both natural gas and petroleum products)is about 7.4 % , while that for electricity sales or electric energy consumed is about 8.5 % .

The total final energy demand for Egypt is expected to range between 39 MTOE and 48 MTOE at the end of this century (Table 1,2)

The total energy requirements in the year 2002 are expected to be 46 MTOE according to the low Gross Domestic Product (GDP) growth rate scenario and about 59 MTOE according to the high GDP growth rate scenario.

In the near future, the rate of energy consumption in Egypt will increase more and more . If no additional new crude oil reserves are discovered, Egypt's crude oil available will not be enough to meet the increasing demand requirements, and this of course will have a negative effect on the whole economy development programs.

So,electricity generation using other energy forms (coal,natural gas or nuclear) rather than petroleum energy becomes a necessity.

The enhancement of successful programs for the exploitation of renewable energy resources becomes a necessity to release pressure of the expanding demands on the limited conventional energy resources.

Egypt has good prospects with regard to several renewable energy sources. The most promising of these are SolarThermal,PV , Wind, and biomass applications .

TABLE (1) DOMESTIC CONSUMPTION oF COMMERCIAL ENERGY
(1960- 1990 / 91)
(Unit : Million TOE)

Year	Petroleum Productes	NaturalGas	Electric Power Hydro	Total
1960	4.7	---	0.07	4.8
1970	5.9	---	1.34	7.2
1975	7.5	0.04	1.95	9.5
1980	11.7	1.80	2.80	16.3
1982/83	15.6	2.42	2.55	20.6
1986/87	19.0	4.96	2.55	26.2
1990/91	20.3	7.33	2.43	30.1

Table(2) ENERGY PRODUCTION And Fuel Consumption

(1960-1990/91)

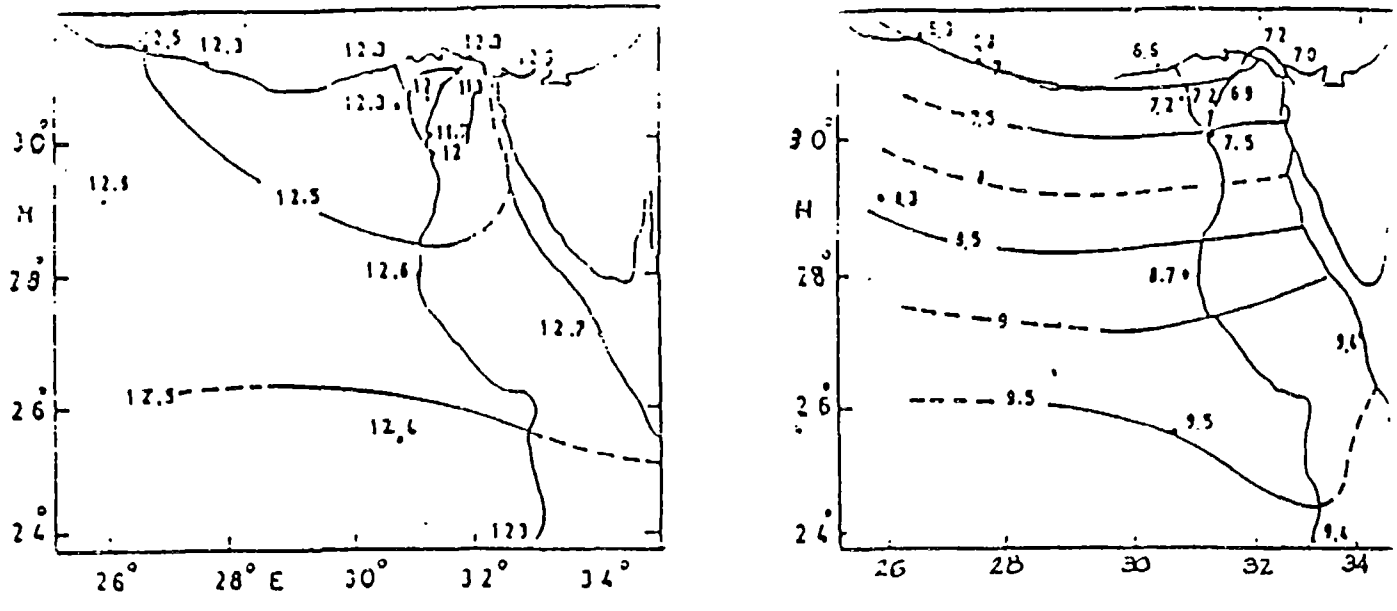
Year	Petroleum Products (1000 MT)	Natural Gas (1000 MT)	Electric Power (Million KWH)
1960	4113	---	1898
1970	3251	---	6915
1975	8714	33	9799
1980	13132	1624	18430
1982/83	16779	2604	24591
1986/87	20826	2450	35201
1990/91	23652	8140	43478

Source : Egyptian Electric Authority (EEA)
Fuel Consumption in 1000 Ton Mazout Eq.

The need for energy planning in Egypt started with the establishment of the" Supreme Council of Energy " (SCE) 1979, followed by the establishment of the "Organization of Energy Planning" (OEP) in 1983 to submit the technical supports to SCE through energy planning, conservation and energy economy.

The many advantages of renewable energy in comparison to conventional energy - such as sustained supply, minimum transportation, etc.... - have become increasingly enterhenced within the planning thoughts. However , such perceptual acceptance has been transferred to specific action plans in most developing countries. The gap between calls of the academic and pioneering research organizations,on one side,and actual investment decisions, on the other, is still wide.

The lagging role of renewable energy in development plans may be attributed to many factors such as technological limitations and subsequent diseconomics of application systems, distorted energy price structure due to subsidy policies, deeply rooted tradition, among others. However, it is evident that overcoming such lag depends mainly on establishing of an efficient institutional structure for information and data based policy formulation.



a- July

b- January

Figure (1) Sunshine hours

-LEBANON:

The energy consumption in Lebanon is higher than that of developing COUNTRIES, and is about half of the world average. This energy demand is divided approximately into: 32% domestic, 41% transportation, 27% industrial and agricultural.

At present the two main energy resources used are hydroelectricity and petroleum products either in primary form or after conversion to electricity. Fuel imports represent almost the totality of the energy demand (more than 95%). Local resources in the form of hydroelectricity represent 3-5% of the total (a total potential of about 520 MW of which only 240 MW are presently installed, so it is very important and urgent to think about alternative energy sources to diminish the dependence on imported energy. The solar energy is planed to be used in domestic and agriculture sectors (heat water, heating and air-conditioning, cooking, solar power generation photovoltaic conversion, green houses, biomass. In the present time there is no available informations on the state of the art of the use of solar energy in Lebanon.

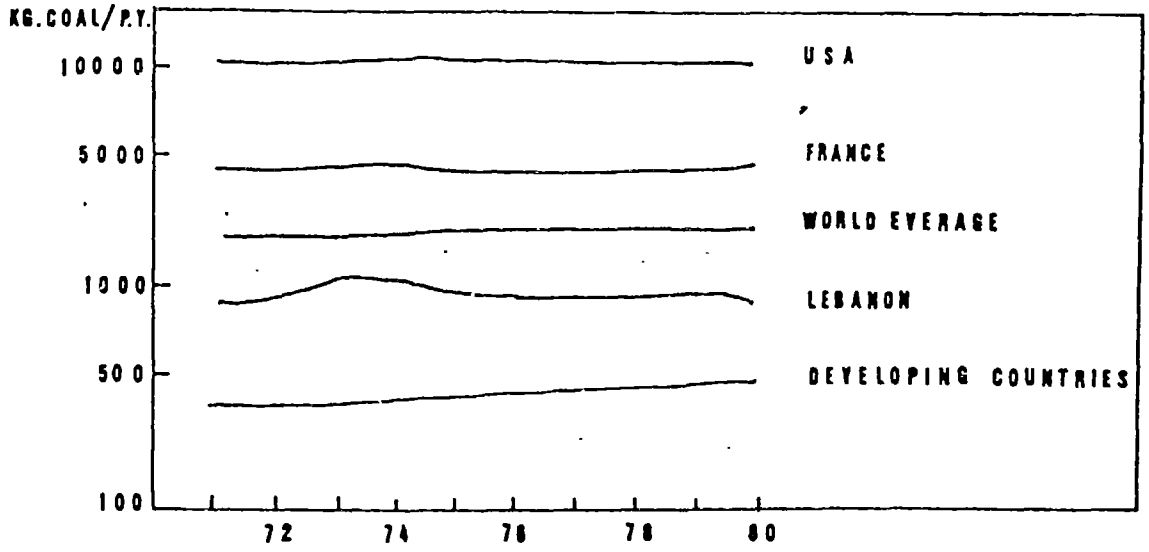


Fig. 1. Yearly per capita energy consumptions for some countries.
Source: United Nations statistics year books.

JORDAN:

The solar and wind energy activities in Jordan are carried out by the Renewable Energy Research Center (RERC) at the Royal Scientific Society (RSS). Basically one might recognize that policy and to some extent promotion related activities are implemented at the Ministry of Energy and Mineral Resources (MEMR). the basic research in this field is carried out by the four Jordanian universities. The Jordan electricity authority (JEA) and MEMR installed, and tested the first Jordanian wind farm connecting to the grid and made the primary contacts with European companies to erect the largest solar thermal power plant (30) MW PHEBOS Project). The Meteorological Department had started a program to measure solar radiation. The higher council for science and technology (HCST) was established to take the lead in simulating and coordinating science and technology within the research and development centres.

The RERC concentrated its work, until now, on conducting applied research in the field of solar thermal, wind energy and photovoltaic application. Furthermore, solar thermal, wind energy technology commercialisation and the transfer of the Jordanian gained knowledge to other developing countries are also considered.

Jordan imports approximately all of its energy needs in oil. on the other hand, Jordan possesses good solar resources, good oil shale resources, small hydropower resources and acceptable wind energy resources. Thus it was important that research and development activities concentrate on these resources. The four Jordanian universities concentrate activities in this field on basic research. The ministry of energy and mineral resources (MEMR) deals with energy planning and policy actions. This Ministry is giving renewable energy and conservation of energy high consideration, MEMR and Jordan Electricity Authority had acquired, installed and operated the first Jordanian wind farm in the northern part of the country. The JEA had made the primary contacts with an European consortium to establishes a 30 MW solar thermal power plant in Jordan. The new established Higher Council for Science and Technology (HCST) aims at coordination of research activities within research and development centres (universities, Ministries, Royal Scientific Society ....,etc)

The Meteorological Department started cooperation program with German Ministry for Economic Cooperation (BMZ) through German Agency for Technical Cooperation (GTZ), to measure the global and diffused solar radiation in Amman, Irbed, Shoubak, Dhulail, Deir Ala, Ghor Safi and aqaba.

The applied Research and development (R&D) in this field is being carried out by the RERC of RSS. Until now the R&D work was concentrated on :

i) Solar desalination.
ii) Solar water heating for domestic use and industrial applications.
iii) Solar space heating.
iv) Water pumping utilizing photovoltaic, mechanical wind pumps.
v) Delivery of electrical power for a remote village utilizing hybrid system of wind energy, photovoltaic and storage batteries.

Table (3) : Wind energy water pumping stations in Jordan

No.	Location	Daily output m^3/d	Total Head (m)	Rated Power (kW) or Rotor Diameter (m)	Installed since
1	Jurf El-Daraweesh*	50	65	ϕ 7 m	1988
2	Jurf El-Daraweesh**	00	65	14 kW	1985
3	Kharana***	140	110	2 x 20 kW	1987-1989
4	Mudawara*	40	14	ϕ 4.26 m	1983
5	Twaneh*	70	29	ϕ 7.3 m	1986
6	Tal Hassan*	40	80	ϕ 7.5 m	1990

* Multiblade mechanical windpump.
** Electrical wind converters with a cluster of 3 pumps.
*** Small wind farm with a cluster of 4 pumps.

IRAQ :

The Iraqi government has established since 1980 the Solar Energy Research center (SERC) under the National Scientific Research Council. The tasks and objectives of the SERC are to enhance the utilization of solar energy on a large scale in space and water heating. corp drying, electrical generation, desalination, pumping, cooling.

There are large activities undertaken in the area of renewable the major efforts have been carried out in the following fields:

- Solar heating and cooling of space and water heating.
- Solar greenhouses and food industry.
- Photovoltaic shallow water pumping.
- Water desalination.
- Photochemical and storage of solar energy.
- Solar collectors evaluation and development.
- Solar refrigeration.
- Solar electricity generation.

3-RENEWABLE ENERGY ACTIVITIES :

Following are the a brief description of the activities in each area of application of solar energy . The presented statistical data and projects data are based on the informations from countrires reports.

1-WATER DESALINATION

The activities in this field is concentrated mainly in Jordan and Egypt. In jardan their are two systems in Aqoba with total capacity of 2 cupic meters /day. In egypt there are several small domestic units for the individual use of maximum capacity of 4 fit/day. Besides their are research project under taken by the NRC (national Research Center) in order to construct a large desalination plants of capacities larger than one cupic meters/day several technologies are in investigation as flush evaporation and reverse osmosis. In Egypt and Jordan their are large efforts devoted to research in this area, due to its importance for the development of rural and isolated areas .

TABLE (4)

Specification of two desalination systems in Jordan (Ref. 2)

	System (1)	System (2)
Collector type	Aluminum pipes	Solar still
Area	375 sq meters	20 sq meters
Cooling	Sea water operated cooling system	Passive
Maximum daily Output	5.25 Lit/sq m	4 lit/sq m

2- SPACE HEATING & COOLING

There are serval research in the area of solar ventilation of building in EGYPT. In fact there is no large scale or practical use despite the successful and promising research results in universities. The solar house is still also in the laboratory research phase due its elevated cost. The passive use in architectural design is used and their are some designs uses solar passive ventilation. (research centre of American university in Sadat city.

Jordan`s experience in space heating includes the design and building the first Jordanian solar heated house (1982) and the design and the erection of a house within the frame work of the Jordanian/Iraqi project (1990). Also another solar house was constructed in cooperation with Kuwait Institute for Scientific Research. In this house passive and active design criteria are considered. Flat Plate collectors, storage tank and water tank underfloor heating device will be utilized for space heating, while desert cooler operated by PV generator will be used for space cooling.

In fact the solar house technology will be costly for this region but the passive solar which has been used since thousands of years is adequat for this region.

3-WATER HEATING :

A-DOMESTIC

The use of solar heaters in Egypt has became now a common practice specially in building of the new communities as well as the touristics villages. Over 40,000 units are in operation, while the demand is considerably increasing in parallel to the gradual removal of the subsidy of energy prices. More than 8 private and public companies now manufacture and install solar water heaters in Egypt either following Egyptian designs or under license but after developing and modifying them to be adapted to local prevailing conditions.

In Jordan, due to the effort undertaken from different organizations, the number of solar water heaters (SWH) installed had rapidly increased. The total number f installed SWHs amounted to 110,000 units. This represents 26% penetration rate. A recent study shows that the number of manufactures are 25, RSS worked on the development of domestic solar water heaters according to the criteria that guarantees low cost of the unit, ease of the installation and maintenance and the utilization of materials available in the Jordanian market. RSS had agreements with local; manufacturers for mass production for the local market and exports, RSS contributes significantly for the compilation of the Jordanian and Arab standards. For the determination of the thermal performance of solar collectors, an out door testing facility allows the testing of solar collectors according to international and national standards in small time span and speeding up their development.

b-INDUSTRIAL APPLICATIONS:

Solar heating systems in Egypt for industrial processes, combined with both waste heat recovery and energy conservation have been implemented and are running successfully. NREA is requested to replicate the application to serve other industrial establishments. Following some examples of industrial energy conservations

(1) THE POULTRY PROCESSING PLANT PROJECT

Objectives

The project basic objectives are to demonstrate and field test Solar Industrial Processes Heat and Waste Heat Recovery System in Food Industries..It incorporated the design , construction, operation, training and testing of the system shown in the attached schematic.

A- SOLAR WASTE HEATING SYSTEM PRODUCING:

26 m^3 day of hot water at 50-60 ^oC to be fed to two chicken scalders, using flat plat collectors with total surface area of 350 m^2.

B- WASTE HEAT RECOVERY SYSTEM PRODUCING:

A flash steam to produce steam from the high pressure condensate, produced from the rendering cookers. Such steam is fed for heat loss compensation in the scalding . A condensate return system to combine the discharge from the lower pressure condensate streams from each scalder and the flash steam system back to the boiler.

PROJECT ENERGY SAVINGS

- The project saves about 2245 (BBL/yr) of fuel oil.
- Treated water is also saved as a result of reuse of condensate steam.

(2) - HELWAN TEXTILE PROJECT

Objectives

The project's basic objectives are to demonstrate and field Solar Industries Processes Heat And Waste Heat Recovery System Textile Industries.. It incorporated the design , construction, operation, training and testing of the system shown in the attached schematic.

A - SOLAR WASTE HEATING SYSTEM PRODUCING:

26 m^3 / day of heat water at 50-60 ^oC , to be fed to two washers using flat plate collectors with total surface area of 350 m^2

In Jordan the RSS had designed, erected and tested heating systems. two of these systems were acquired in cooperation with the United Nations Industrial Development Organisation (UNIDO). These systems were manufactured in RSS workshop and installed at one of the leading diary companies and a hotel in Aqaba respectively Other large systems utilizing vacuum tube collectors are used in RSS cafeteria for hot water delivery and space heating.

4- PHOTOVOLTAIC APPLICATIONS:

In Egypt most of the known photovoltaic applications were demonstrated and tested, while photovoltaiç use in some applications such as communication systems have been commercialized. The use of solar photovoltaic power for water pumping in remote areas has been demonstrated and running successfully. The use of photovoltaic desalination for producing potable water have been implemented and demonstrated in remote areas particularly along the Red sea coast. A photovoltaic Diesel hybrid ice making plant of 36 kwp for fish preservation is now running and producing 6 tons /day of flake ice at Wadi El- Rayan lake, some 45 KM south west of El- Fayoam town. Several photovoltaic powered communication and vaccine refrigeration systems have been demonstrated in remote areas as Sinai, the Northern Coast and Oases.

The phtovoltaic yearly PV electric energy production according to NREA plan amounts to 35
MW bby the year 2005 for different applications ranging from pumping village electrification, telecommunication, desalination, refrigeration, to grid connection. All these applications have good potential for repairabilitry particularly pumping and village electrification as several villages that need to. be electrified have low demand and are far from the grid. The planned cumulative conventional saved through utilizing PV technology over the years 1995 till 2005 amounts to 120 thousands tons of oil equivalent.

The utilisation of the phtovoltaic in Jordan includes:
- Supply of remote stations by PV systems to power telecommunication equipment located in remote and isolated stations belong to the civil defence and the police.

Table (2) : Solar Water Large Installation in Jordan

	System (1)	System (2)	System (3)	System (4)	System (5)
Location	Dairy Company Rusaifa	Coral Beach Aqaba	Swedish Org. f. Ind. Relief Amman	RSS cafeteria* Jubiha - Amman	Ibn Nafees Hospital Irbed
Type of Collectors	Flat plate	Flat plate	Vaccum tube	Vaccum tube	Vaccum tube
Area of Collector (m^2)	120	180	27	96	60
Storage tank volume (m^3)	5	12	1	6	5
Installed since	1985	1986	1989	1990	1990

* Integrated with a 10 kW wind converters / used also for space heating.

Table (4) : PV water pumping stations in Jordan

No.	Location	Daily output m^3/d	Total Head (m)	Rated Power (kW)	Installed since
1	Umari	40	26	1.613	1985
2	Jafr	40	19	1.344	1985
3	Hazeem	120	18	2 x 1.76	1986
4	Rahmeh	40	35	2.12	1987
5	Shomari	200	12	2 x 2.15	1989
6	Tal Hassan	40	80	5.5	1990
7	Wadi El Buttom*	50	50	4.4	1990/1991
8	Wadi El Ritem*	43	55	4.2	1990/1991
9	Wad Rajil*	50	45	4.0	1990/1991
10	Jafr PV1*	50	30	2.7	1990/1991
11	Breekah S-115*	100	20	3.5	1990/1991
12	Umrug 2*	50	50	4.4	1990/1991
13	Fidan 6*	36	60	3.8	1990/1991
14	Sharq El Hasa*	100	40	2 x 3.6	1990/1991
15	Hazeem El Dhahek**	100	20	2 x 2.2	1990/1991

* Will be equipped with PV pumping system through the world wide photovoltaic pumping program supported by German Ministry for Science and Technology (BMFT) and GTZ.

** Screw pump project.

- Supply of the remote and isolated areas with their minimum electricity requirements for selected purposes such as clinic refrigerator, electric lighting, educational television and emergency telephone.

-- To provide electricity to the transmitter/receiver equipment, which control train traffic.

- To provide electricity to radio equipments, which control the motion direction of the Potash harvesting engines, which belong to the Arab Potash company.

- To provide power needed for the operation of civil aviation station near Aqaba..

5- WIND ENERGY:

Egypt has a high wind potential. The western coast of the Red Sea, Particularly the Gulf of Suez, is characterized as one of the best wind locations world-wide. There is a potential of producing about 20000 mw of electric power NREA started its first demonstration wind farm consisting of 4 units, 100 KW each, connected to local distribution grid serving one of our oil companies in Ras Ghareb. The farm is running successfully since 1990. Anther similar wind farm of the same capacity has been installed at Hurghada, connected to the local network 45% of the components of the windmills were locally manufactured in Egypt. An expansion project is now under implementation at Hurgada, the first stage of it consists of 30 units, 100 kw each. 10 units of advanced design with movable blades (pith controlled), while 20 units from the partially locally manufactured units. This will be expanded by a second stage of 2 MW capacity, using larger units in the range of capacity of 250-300 KW.

The total potential of wind energy in Jordan is in the order of 50 MW which can connected to the grid without major change The highest wind energy potential is in the northern and southern parts of the country. The annual energy output from 50 MW wind turbine capacity installed in these areas will correspond to approximately 3-4% of the total electrical demand in Jordan.

Table (4) Estimated Avaliable wind Energy for Res Sea Coast

Regio No	Area Km Sq.	Area Fac	Net Area Km Sq.	No of Turbines /Sq. Km	No of Turbines	Net annual output in MWh/turbine	installed Capacity in MW	Net annual Power output in GWh
1	594	0.8	475	32	1500	680	3040	10336
2	781	0.8	625	32	19994	570	4000	11396
3	931	0.8	745	32	23834	470	4768	11202
4	937	0.8	750	32	24000	585	7800	14040
5	750	0.8	600	32	19200	431	3840	8275
Total	3993	4	3195	32	102228		20448	55249

1 ABO EL - DARAG - ZAFARANA
2 SOUTH OF ZAFARANA - NORTH OF RAS GHAREB
3 RAS GHAREB - RAS SHOKER
4 RAS BEHEAR ZIET BAY
5 NORTH OF HURGHADA

B: LOCAL MANUFCTURING OF WIND TURBINES UNITS

Local manufacturing of wind turbine compnents could reach 78 % during two years and this will reduce the unit cost by about 21 % compared to the case with zero local manufacture , as shown in table 5

Table (5) Capital Costs , 41 MW Wind Farm
(prices in Thoisands of US $ as of 1992)

Year	No. of units		Costs according to % local manufacture			
	100 KW	200 KW	0 %	38 %	59 %	78 %
92 / 93						
93 / 94	60		9351	8364	7824	7320
94 / 95	60		9351	8364	7824	7320
95 / 96	30	45	15097	13587	12710	11895
96 / 97		85	18704	16720	15640	14895
subtotal	150	130	52603	47035	43998	41175
Know -how transfer , 200 KW units				2500	2500	2500
maint. workshop, vehicles stores , ect. (5 % of W.T. costs)			2630	2352	2200	2059
Total			57733	51887	48698	45734

The Jordan Electricity Authority and Ministry of Energy and Mineral Renounces had installed four horizontal axis wind turbine of 80 KW rated power each. The turbine were delivered by Danish Wind Technology. The total production of the wind farm during the first year of operation was 650 MWh. A project for the generation of electric energy for remote vilage sponsored by the united Nations Development Program and the Arab Fund is running. The project consists of 2 wind energy converters of the AEROMAN type with a rotor diameter of 14 meters and rated capacity of 20 KW. In addition to Photovltaic generator of 10 kw and storage batteries which have a capacity of 1500 Ah. The system supply the necessary energy to the remote village of the JURF of 600 people on a 24 hours basis

SOUTH -SOUTH AND SOUTH NORTH COOPERATION:

It appears from the available informations that there are strong cooperation between the international development agencies and the mashrek countries, particularly Egypt and Jordan.

There are also several projects of cooperations between Egypt and Jordan in the field of water pumping. Also several cooperation agreements exists between Jordan and Iraq. Recently a new agreement of cooperation between Egypt and Syria has been reached.

- CONCLUSIONS :

Based on the available information the following conclusions are offered:

- The utilisation of solar energy in masherek countries is in progress it appears from the available information that Egypt and Jordan has the lead in this field. Iraq has been very active in this area but since 1990 there is no available informations on the research activities in this area. There is no available information from Lebanon and Syria.

- This countries are eager to acquire its own local technology in this field several experiences in Egypt and Jordan prove this attitude.

- Some other application of renewable are still in the primary phase of evaluation as Geothermal, Wave energy.

-In order to enhance the research activities it appears that these countries which possess a high research potential must reach an agreement for the interstate cooperation and coordination. In fact the high cost of R&D in this field requires to avoid any unnecessarily duplication in research work. Beside the gained experience in the application field in one country can be fruitful to other country

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