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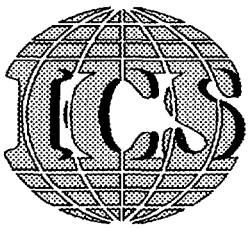

CONTRACT NO. 2000/062

Final Report on

Expert Group Meeting on "Networking of PV Systems and Applications"
Photoenergy Center, Faculty of Science, Ain Shams University,
Cairo, Egypt 26-28 April 2000

THE REPORT CONSISTS OF THREE PARTS:

PART (1) FINAL REPORT

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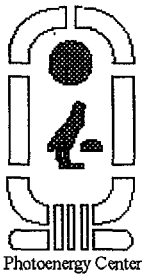
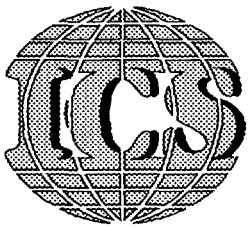
TWO PARTS IN TWO SEPARATE BOOKS
IT CONTAINS PAPERS AND MATERIALS PRESENTED.

Prepared by
Professor Dr. M. S. A. Abdel-Mottaleb
DIRECTOR, PHOTOENERGY CENTER, AIN SHAMS UNIVERSITY

CAIRO, EGYPT
MAY 2000





Final Report on

Expert Group Meeting on "Networking of PV Systems and Applications"
Photoenergy Center, Faculty of Science, Ain Shams University,
Cairo, Egypt **26-28** *April 2000*

Organized by ICS in collaboration with the Photoenergy Center

Prepared by

Professor Dr. M. S. A. Abdel-Mottaleb

Expert Group Meeting Directors

Mr. Anthony Bromley, Senior Officer, UNIDO/IEE/SES

Prof. Dr. Sabry Abdel-Mottaleb, Director, Photoenergy Center

Organizers

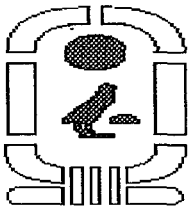
Mr. Gordon Thompson, ICS High Technology Consultant

Mr. Tatsushi Kurobuchi, ICS Programmer Officer, High Tech and New Materials area, Trieste, Italy

Prof. Dr. Sabry Abdel-Mottaleb, Director, Photoenergy Center

Cairo, Egypt

May 2000



FINAL REPORT
OF
Expert Group Meeting on "Networking of PV systems and applications" Cairo, 26-28 April 2000

Sponsored by: ICS-UNIDO
Hosted and co-organized by: Photoenergy Center, Cairo, Egypt

The Expert Group Meeting has been held in Cairo taking into account the advantage of its geographic location among Middle East and North African countries, which have good experience and strong interest in PV applications.

The meeting was hosted by the Photoenergy Centre, Ain Shams University, Cairo, Egypt from 26 to 28 April 2000. Scientific sessions were conducted at the conference facilities of Sonesta hotel Heliopolis. The program included a visit to the Photoenergy Center's facilities and Ain Shams University Campus. Detailed program is described in the book of abstracts that has been distributed among the participants upon arrival.

All participants were received at the Cairo international airport by a representative of Ain Shams University and accommodated at Sonesta Hotel Heliopolis.

Complete list of participants is also given at the end of this report. Participants are from different Arabic countries and from Egypt together with experts from *Australia, Japan and Italy.* A representative of ESCWA (Lebanon) was invited and other two representative of UNIDO local office in Cairo as well as

representatives of UNDP Cairo had also attended the Opening and General sessions of the meeting.

In the opening session *M. A. Tag El-Din (vice President of Ain Shams University), M. M. Abdel-Fattah (the Dean of the Faculty of Science), A. Bromley (UNIDO)* and *Sabry Abdel-Mottaleb* extended a warm welcome to about 70 audience. The attendees were representing the invited participants and different VIPs from many Egyptian Authorities and Institutions. Most importantly, the initiative of the ICS of holding and organizing this meeting in collaboration with the Photoenergy Center is highly appreciated from the distinguished Egyptian and International participants and all are encouraging the ICS to keep the topic of PV on the top of its activities.

The program offered 17 lectures and presentations that were delivered by a group of international experts. The participants represented a good mix of senior scientists, engineers, industry personnel and economists with some of them on the important decision-making level.

All presentations showed and emphasized the enormous importance of the PV energy for the enhancement of economic and social developments in developing countries in addition of being an infinite source of clean energy.

All presentations were accompanied by lively discussions indicating the enthusiasm and competence of the participants in the issues under consideration. Actually, these discussions went on over coffee and meals breaks and often well into the night, which was certainly facilitated by the good infrastructure provided in an excellent hotel.

In summary, it has been emphasized that the worldwide demand for solar electric power systems has increasingly gained momentum in the last decade. Energy from PV solar cells are one of the most judicious choices, particularly in the non-grid remote areas owing to its reliability, competitive cost and easy maintenance.

It must be added that the demand for environmental and longer-term fuel supply concerns by governments and electric utilities help accelerate the market for PV systems.

The participants have been pointed out that typical existing applications of PV include stand-alone power systems for cottages and remote residences, navigational aides for the Coast Guard, telecommunication sites, military sites, water pumping for farmers and emergency call boxes for highways.

Through lots of field tests all over the world, PV systems have been devised so as to adapt to the various kinds of applications and also substantive know-how has been established on the institutional aspects, pilot project characteristics, implementation process, operational and technological issues.

The cost of PV systems, which had been a long-standing question for PV applications, has decreased to a realistic level (but raised to about 15US$/Wp in the occupied Palestine) due to the improvement of energy conversion efficiency and the development of thin-film cell technology. In fact, recently the cost has remarkably dropped and it is expected to be competitive with the conventional energy sources before 2010 and share an important role of electricity generation in the near future.

As a consequence, PV applications in developing countries will become essential for our every day life not only in rural areas but also inside the newly established towns using building integrated PV.

With the new phase of PV technology - from the R&D stage to industrialization – a practical approach for technology transfer and sharing is strongly recommended.

A successful part of the Workshop was the visit of the Photoenergy Center facilities and laboratories featuring state-of-the-art PV training and demonstration systems and spectroscopic instrumentation, e. g. for time-resolved fluorescence measurements that are used for the characterization of the semiconductors used for producing solar cells. The visitors were impressed to see

the great advances achieved due to efforts of the Ain Shams University researchers to establish the Photoenergy Center as an important photophysics, photochemistry and spectroscopy research, development and training institution on an international level. Detailed information about the Photoenergy Center is available at the website: www.photoenergy.org and the brochure attached.

The social events accompanying the Workshop, which included a short sightseeing tour as well as a dinner cruise on the Nile, succeeded in creating a warm social atmosphere and good contacts among the participants.

All participants expressed their thanks to the Photoenergy Center for the outstanding hospitality extended to all and for the friendly atmosphere that created many fruitful contacts that would be last for many years to come.

Expert Group Meeting Directors

- Mr. Anthony Bromley, Senior Officer, UNIDO/IEE/SES
- Prof. Sabry Abdel-Mottaleb, Director, Photoenergy Centre

Organizers

- Mr. Gordon Thompson, ICS High Technology Consultant
- Mr. Tatsushi Kurobuchi, ICS Programs Officer, High Tech and New Materials area, Trieste, Italy
- Local Organizer: Dr. Sabry Abdel-Mottaleb and the staff members of the Photoenergy Center in collaboration with the Public Relation Department of Ain Shams University.

NOTES AND FINAL CONCLUSIONS:

The Expert Group meeting was held in Cairo, Egypt during 26-28 April 2000.

All participants strongly endorsed the initiative of the UNIDO International Centre for Science and High Technology (ICS) in sponsoring this meeting, and its foresight in conducting a program on photovoltaics.

The participants also congratulated the photo-energy centre of Ain Shams University for its excellent job in organizing the meeting, and other Egyptian Authorities for their support.

The meeting reached the following conclusions:

- **The potential markets for PV and other renewable in the Arab region, developing countries and globally is very large even if we only consider non-grid connected systems.**

- **The dual benefits of bringing elective power to remote areas through PV are poverty alleviation and reducing climate change.**

- **There is a need for programs on awareness building and training in PV systems, their assembly installation, repair and maintenance, design and calls on ICS – UNIDO and other international and regional organizations to address this.**

- **There is universal agreement on the importance of networking among group members. Sharing of experiences and know how of groups working on and promoting PV and renewable is invaluable in facilitating future development and cooperation.**

- **Increased focus is needed in the application and commercialization of PV systems. Commercial activity will have the largest impact on increasing the uptake of PV technology.**

- **There is a myth on the high cost of PV. In many cases PV is the only viable solution, particularly if life cycle costs are compared. There is an existing market and this will expand as the cost of PV continues to fall.**

- **Monitoring of PV systems to obtain performance data is very important.**

- **Electric utilities must be integrated into the renewable energy industry.**

- **Success stories need to be publicized and replicated elsewhere.**

- **Supportive National Policy and regional initiatives were necessary to achieve optimum growth of PV and renewable energy systems.**

The Expert Group made the following recommendations:

- **Encourages sharing and cooperation in national programs on PV, and inviting participants to each others training programs and participation of experts in various centers of expertise.**

- Encourage link and integration between researcher/Government and industry. This could involve commercialization and local production of technologies, policy initiatives and determining priority areas of research.

- Project development workshop by UNDP – UNIDO in countries to bring together stakeholders on renewable to develop GEF projects.

- Calls upon UNIDO to develop in cooperation with other international (eg. CASE), and regional organization regional GEF projects for capacity building on PV and renewable energy in developing countries and the region.

- Calls upon ICS to continue and expand its programme on PV and renewable energy in general as it fits both the area of high technology and new materials, and the environment.

- Establishment of an electronic information exchange and the development of a website to be managed as a project by ICS/UNIDO.

- Initiating the monitoring of PV systems to obtain performance of data as a high priority. The information is to be shared. The collection (and analysis) of data will assist resource assessment and planning, and evaluation of system.

- Developing training in the effective planning and design of PV based, and PV hybrid systems.

- Developing strategies to influence National Policy (and Regional Initiatives) and that will assist the uptake of renewable energy technologies.

- Establish and maintain international collaborative links with organizations similar to CASE

- Call upon UNIDO to work with national focal points for GEF to develop projects on renewable energy. The focal points may be suited to ESCWA.

- The presentation material from the meeting should be published.

- Members should make recommendations on potential participants for the next ICS activity – a meeting on the modeling of PV systems that were facilitated by CASE on behalf of ICS with tentative timing in September or October, and is likely to be held in Trieste.

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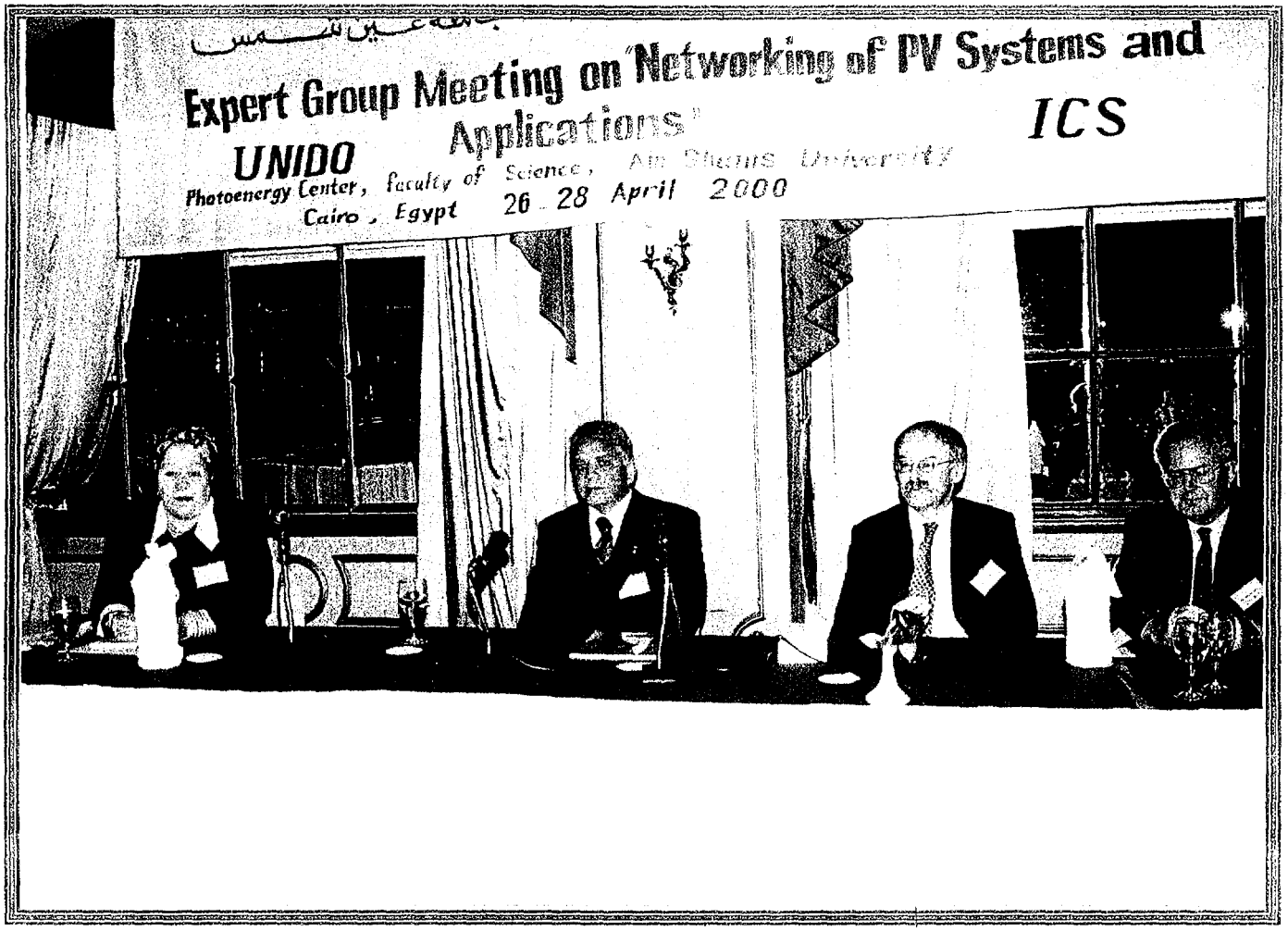
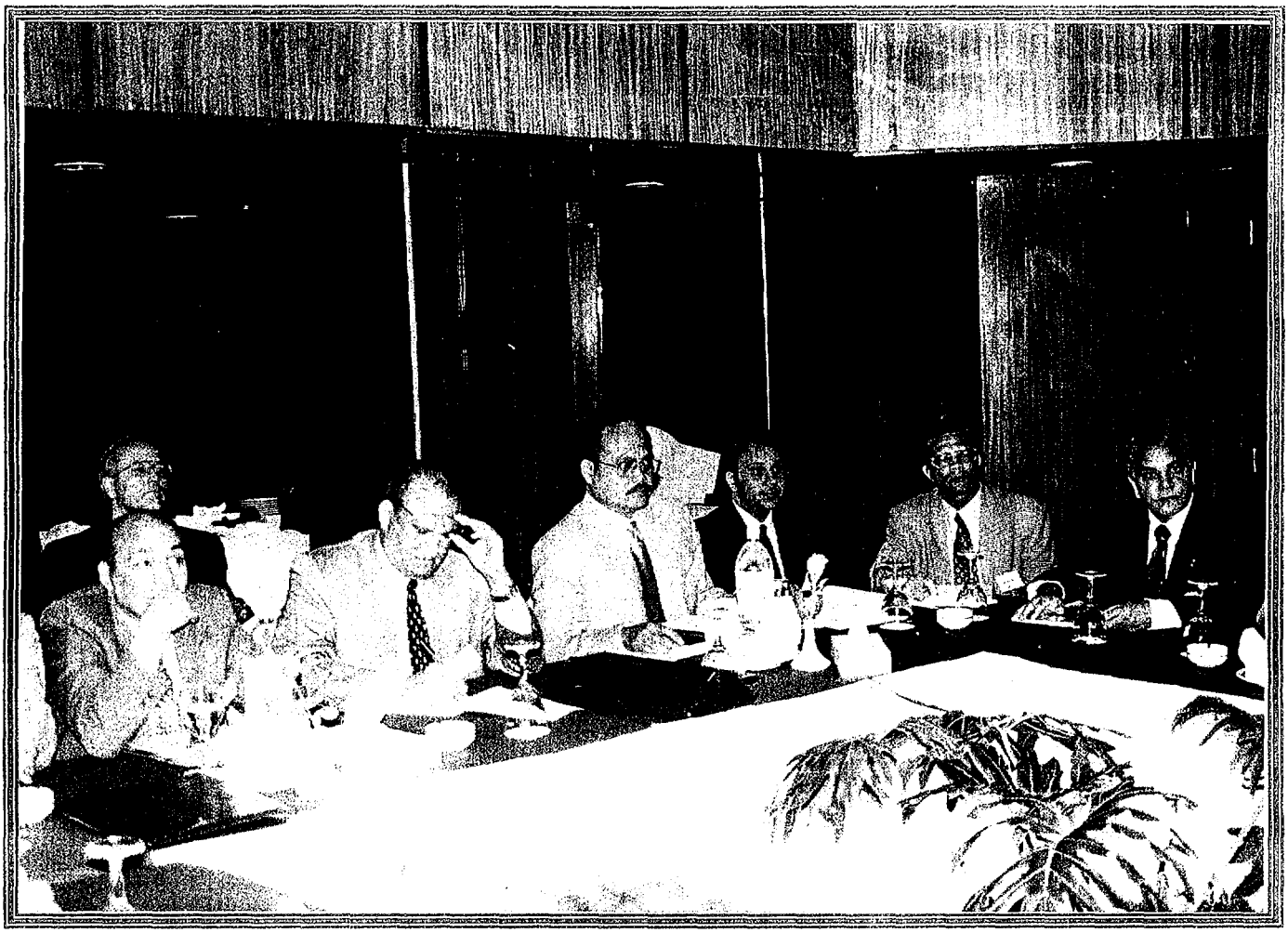
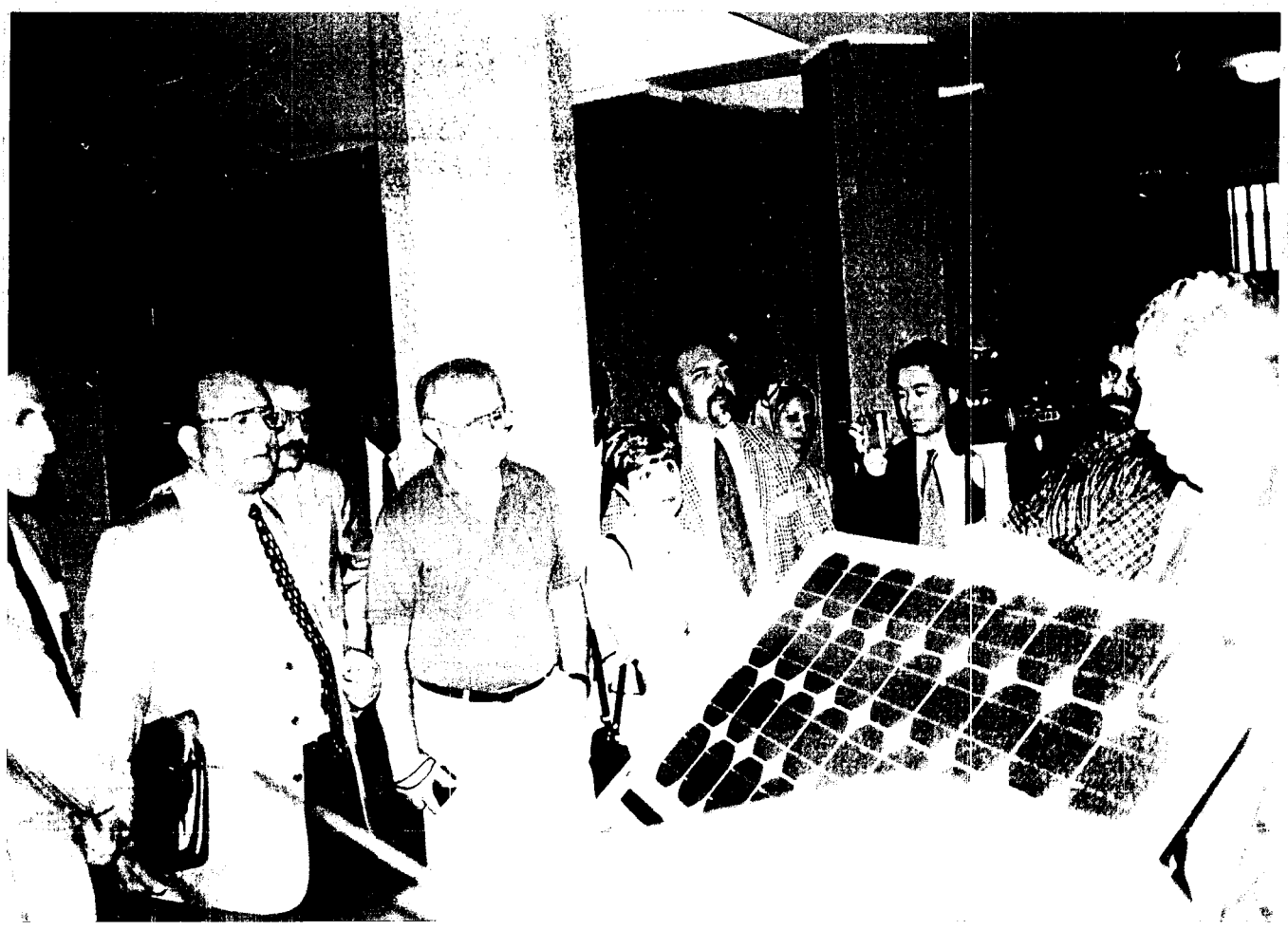
Photo Gallery

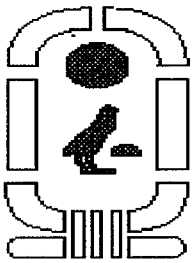
Opening of Expert Group Meeting on Networking of PV Systems and Applications

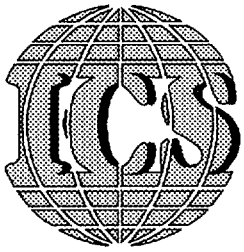


Round Table Discussion









Expert Group Meeting on "Networking of PV Systems and Applications"

Photoenergy Center, Faculty of Science, Ain Shams University, Cairo, Egypt 26-28 April 2000

Financial Statement in US$

Travel, Board/Lodging	30000.0
Per diem	3840.0
Meeting and Printed Materials	2500.0
Communications (Fax, Tel, Etc.)	1050.0
Equipment (Projector Data Show)	7376.0
Overhead, slide	250.0
Social events	2400.0
Secretarial works	1000.0
Transportation	800.0
Wages and Honorarum	500.0
Rental charges of conference rooms	600.0
Total	50316.0 $

22379
(2 of 2)

CONTRACT NO. 2000/062

PART (2) ANNEX A (BOOK OF ABSTRACTS AND THE PROGRAM)

PHOTOENERGY CENTER
Faculty of Science,
AIN SHAMS UNIVERSITY
Abbassia, CAIRO,
EGYPT

A I N S H A M S U N I V E R S I T Y

UNIDO

p ḥ r w t m i m w

Changes with rays of light

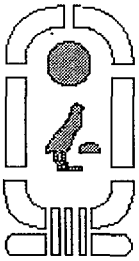
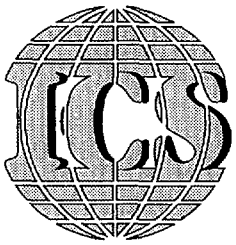
ICS

Expert Group Meeting on "Networking of PV Systems and Applications"
Photoenergy Center, Faculty of Science, Ain Shams University,
Cairo, Egypt 26-28 April 2000

Expert Group Meeting on

"Networking of PV Systems and Applications"

Photoenergy Center, Faculty of Science, Ain Shams University,
Cairo, Egypt 26-28 *April 2000*

Expert Group Meeting on "Networking of PV Systems and Applications"

Photoenergy Center, Faculty of Science, Ain Shams University, Cairo, Egypt 26-28 April 2000

Under the auspices of:

Professor Dr. Hassan Ghalab
President of ASU

Professor Dr. M. A. Tageldin
V. President of ASU

Professor Dr. M. M. Abdel-Fattah
Dean of the Faculty of Science

Directors:

M. S. A. Abdel-Mottaleb (Photoenergy Center)
A. Bromley (UNIDO)

Local Organizing Committee:

The staff of the Photoenergy Center in cooperation with the satff of the Department of Chemistry and the Department of Public Relations

Forward

The Photoenergy Center has submitted before two years, project proposals to the ICS for help in building up PV facilities for training and knowledge transfer. This Expert Group Meeting (EGM) shows that ICS responded favorably to our request.

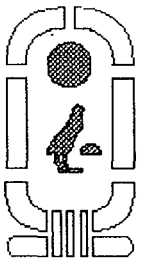
We realized that the use of photovoltaic cell and solar panels for harvesting solar energy is a technology which developing countries are starting to master and exploit with rewarding profitable results. Research, development and know-how transfer are crucial elements for the success of such an environmentally benign and promising technology. ICS is just now starting its program on PV activities focussing on systems and applications in cooperation with UNIDO SES/IEE Branch.

As I understand, ICS could provide the seed money for various training activities in order to formulate project proposals to international fundraisers. The main purpose or the expected outputs of this EGM is to make a concrete action plan for the ICS subprogram on renewable solar energy.

This EGM meeting should result in promoting the international cooperation programs and projects aiming at know-how transfer through the training, production and/or assembling of PV systems to the developing countries.
Within this framework, ICS and the Photoenergy Center are grateful for your participation.

I wish you all a stimulating meeting and a very nice stay in our sunny country Egypt.

Sabry Abdel-Mottaleb



The moral and financial support
from the following
Egyptian and International Organizations
are highly appreciated:

Ain Shams University
Ministry of High Education
and Ministry Scientific Research
Ministry of Electricity
Ministry of Transport
Ministry of International Cooperation
Ministry of Military Production
UNIDO (Vienna) and ICS (Trieste-Italy)

The local organizer
And initiator

Photoenergy Center, Faculty of Science,
Ain Shams University
Cairo, Egypt

Timetable

Expert Group Meeting on "Networking of PV Systems and Applications"
Photoenergy Center, Faculty of Science, Ain Shams University,
Cairo, Egypt 26-28 April 2000

SUMMARY TIMETABLE

1st Day: WEDNESDAY 26 April 2000

08.30 - 09.30	REGISTRATION
	GENERAL OPENING SESSION
09.30 - 10.15	O P E N I N G [Abdel-Mottaleb, Bromley] Welcome Address [OFFICIALS, ASU]
10.15 - 11.00	Opening Address [A. Bromley, UNIDO]
11.00 - 11.30	Coffee Break
	Chairman: E. Eid
11.30 - 12.15	Opening Address [G. Thompson, CASE, ICS]
12.15 - 13.00	Opening Address [A. Hegazi, ESCWA]
13.00 - 13.20	Discussions
13.20 - 15.00	Lunch Break
	EXPERT GROUP SESSION "FOR ONLY REGISTERED PARTICIPANTS"
	Chairman: H. Osawa
15.00 - 15.40	A. Al-Ashwal (Yemen)
15.40 - 16.20	N. Attili And H. Hamed (Palastine)
16.20 - 16.50	Coffee BREAK (NILE TV International INTERVIEW)
16.50 - 17.30	A. Al-Mohammad (Syria)
17.30 - 18.10	S. Zahrani and N. Eugenio (Saudi Arabia)

2nd Day: THURSDAY 27 APRIL

Chairman: H. Barakat (NRC, Egypt)

09.00 - 09.40	H. Osawa (NEDO, Japan)
09.40 - 10.30	R. Ricca (Eurosolar, Italy)
10.30 - 10.50	Coffee Break

Chairman: G. Thompson (CASE, Australia)

10.50 - 11.30	A. Hamidat (Algeria)
11.30 - 12.10	A. Benallou (Morocco)
12.10 - 12.40	E. Ahmed and H. Rakha (NREA, Egypt)
12.40 - 13.40	LUNCH BREAK
13.40 - 23.00	Visit of ASU, Photoenergy Center, City Tour and Nile Cruise

Bus will leave from the front door of Sonesta Hotel at 13.45 sharp

[summer time change: 12.00 pm change to 01.00 am]

3rd Day: FRIDAY 28 APRIL

Chairman: A. Bromley (UNIDO)

09.30 - 10.10	M. Kabariti (Jordan)
10.10 - 10.50	B. Rezig (Tunisia)
10.50 - 11.20	Coffee Break
11.20 - 12.00	S. Abdel-Mottaleb (Egypt)
12.00 - 12.40	Discussion
12.40 - 15.40	BREAK (Friday Parayer followed by Lunch)
15.40 - 17.00	Final Discussions
17.00 - 17.30	Coffee Break
17.30 - 18.00	Closing Remarks

Abstracts

Expert Group Meeting on "Networking of PV Systems and Applications"

ABOUT UNIDO

Anthony Bromley

1. ABOUT UNIDO
   - INTEGRATED PROGRAMMES AND SERVICE MODULES

2. THE UNIDO ENERGY PROGRAMME
   A) INDUSTRIAL ENERGY EFFICIENCY
   B) RENEWABLE ENERGY

3. UNIDO SERVICES ON ENERGY
   A) ADVICE ON STANDARDS, AWARENESS PROGRAMMES AND DEMONSTRATION OF TECHNOLOGY
   B) POLICY ADVICE TO GOVERNMENTS, UTILITIES AND AGENCIES

4. GENERAL UNIDO ACTIVITIES
- IDENTIFICATION OF BARRIERS TO RENEWABLE ENERGIES AND STRATEGIES FOR THEIR REMOVAL
- MARKET ASSESSMENT STUDIES AND
- FEASIBILITY STUDIES
- CAPACITY BUILDING
- INTRODUCTION OF NEW AND IMPROVED ENERGY TECHNOLOGIES
- PROMOTION OF RENEWABLE ENERGY TECHNOLOGIES
- DEMONSTRATION PROJECTS
- TRAINING
- TECHNOLOGY CENTRES
- NETWORKS

5. UNIDO AND CLIMATE CHANGE
   - UNIDO AND GLOBAL ENVIRONMENT FACILITY - GE

6. UNIDO ONGOING AND PIPELINE GEF PROJECTS

Developments in Sustainable Energy Technologies & The Role of CASE

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The presentation will provide a history of CASE, its methodology, and some CASE studies will be covered.

The presentation will also provide an overview of solar energy applications, the current policy environment, an analysis of the market, barriers to entry and concluding remarks

PRESENTATION OVERVIEW

- Introduction
- Background CASE
- Solar Energy Overview
- Policy Environment
- Catalyst for change
- Market characteristics
- Economic/Financial comparisons
- Barriers
- Conclusions
- CASE studies

*STATUS OF PHOTOVOLTAIC APPLICATIONS AND THE RENEWABLE ENERGY PROMOTION MECHANISM IN THE ESCWA REGION

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Abstract

The energy sector of the ESCWA member States (MS)* is facing two main challenges. The first is the need for a transition to a more sustainable production and use of energy. The second is building and strengthening links in the field of energy among ESCWA-MS by promoting sub-regional and regional cooperation in the field.

To achieve such challenges and in view of the fact that all countries in the region enjoy tremendous indigenous Renewable Energy (RE) resources, the member States need to: (a) promote the use of cleaner fuels and technologies; (b) promote a cost effective mix of fossil fuel and RE resources and (c) mitigate to the maximum possible the environmental impacts of the energy sector.

It is due to the above and the fact that almost 67 percent of the region's population (105 million) are living in the rural areas, that the development of RE, particularly photovoltaic applications is essential for sustainable development in the region.

This paper presents a survey of the current status of the photovoltaic development and use in the region covering areas of; (1) R&D and planning; (2) Demonstration and field testing, (3) existing industrial and marketing capabilities and (4) the commercialization status of the different photovoltaic applications. The paper will also touch on the institutional framework, strategies and policies that are relevant to the photovoltaic development in selected countries of the region as well as the constraints facing the development and widespread use of photovoltaic systems in the region.

In addition, the activities of the UN-ESCWA and its possible contribution to the development of photovoltaic applications in the region will be discussed together with the prospects for regional cooperation in the field.

The paper will put emphasis on the rational, objectives, membership and current development status of the ESCWA Renewable Energy Promotion Mechanism (REPM) established by ESCWA as an existing mechanism networking activities among countries in the region, which can have an active role in supporting the proposed photovoltaic networking process.

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* The ESCWA-MS are 13 Western Asian Arab countries, namely: Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestinian Authority, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen

PV Technologies in Yemen: Potentials, Applications, Marketing and Promotion

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Abstract

This work concerns PV Technologies Potentials, Applications, Marketing and Promotion in Yemen. At the beginning a brief description of the country background is introduced describing the developments which took place during the last decay hence the reasons behind the present economical depression are mentioned briefly. Further the energy status of the country is described. In this context the energy sources are outlined both conventional and renewables. A special emphasis is given to the availability and high potentials of renewable energy sources (RES). In addition the energy balance is demonstrated for different forms of consumption and different types of fuel used.

The institutional arrangement of energy sector is also introduced showing the different stake holders of the energy sector. Further it will be shown that PV technologies do not have an adequate room in this arrangement.

The existing electrical energy services for rural areas are examined in order to show the market potentials for PV technologies. It will be seen that a small percentage of rural house holds are using electricity for lighting. As the vast majority are still using kerosene or gas for lighting. It will be shown also that the electrical energy consumed by rural house hold is considerably low.

In order to show the reliability and remarkable success of PV technologies in Yemen the existing applications are investigated in different areas (data demonstrating the application of telecommunication, TV, water pumping, rural electrification, . . . etc. is provided). As a result of the investigations one can see that these applications can be assumed quantitatively negligible but successful in quality terms.

Although Yemen has great solar energy potentials and there is a real need to use PV Technologies in remote rural areas as a source for electrical energy the number of installed PV capacity is very low. In this work the barriers for diffusion of PV Technologies are briefly discussed. In addition the existing commercialization problem is also discussed and practical solutions to promote commercialization are proposed.

Most of International Agencies and Organizations (IAO) have shown a great interest in renewable energy technology development in general and PV Technologies in particular. An example of these agencies and organizations are: UNIDO, UNDP, WB, GTZ, EU, . . . etc. Most of IAO have contributed in some projects in this field in Yemen. However one can

notice the absence of coordination among IOA and inconsistency. This work proposes a mechanism enabling the necessary coordination of all national and international efforts.
Finally this work withdrew some recommendations and conclusions which would possibly lead to promotion of wider PV Technology applications in Yemen.

Presentation of Palestine

By H. HAMED & N. ATTILI
PEC, PALESTINE

Due to absence of fossil fuel resources and due to several years of occupation, Palestine has to import about 95% of electrical energy from the IEC. About 120 villages still suffer from either lack of electricity or insufficient services, living in rural areas, about 60% of the whole area (6000 km^2). About 45 communities (50,000 inhabitants) have no electricity and about 73 communities (210,000 inh.) have partial services through decentralized diesel generators.
The municipalities and village councils are responsible for distribution and sale of electricity. The prices vary between 12 cent for imported to 50 cent/ kWh for locally generated electricity.

Abundant of solar radiation in Palestine (5.46 kWh/ m^2.day) enables solar energy applications to fulfill larger part of energy needs.

The Palestinian Energy & Environment Research Center (PEC) has started with pilot projects for PV applications through its clinic electrification program. In spite of the system high cost (15 \$/ W_P), applications extended to electrify isolated schools, households, public establishments and publicity stations. More than 60 systems were installed with a capacity of more than 35Kw.
There is serious discussion with the Palestinian Telecommunication Co. to supply all remote stations with PV systems. Moreover, the Solar Demonstration Station is going to be established soon. Financing of these projects was by subsidies and international grants, local authority contribution, final users and combination.

The potential of PV market seems to be high. It is expected to electrify about 1000 Bedouin families, 40 publicity stations and 22 water pumping stations. Investigations indicate that PV electrification is possible for about 60 villages of 1.2 MWp total power. The estimated cost is about 18 M \$.

As PEC is the national institution responsible for renewable energies, it has the expertise, capacity and capability for promotion, design, installation and maintenance of PV systems. PEC can be considered as the center of PV activities. The role of private sector is limited to management of financial aspects (Banks) or supply of equipment (BOSS - PRO - TECH., SIEMENS & SOLNUR Co.). Non of the components of the SHS is locally manufactured, but available in the market.

Special training programs on PV applications are needed. Efficient technology like equalizing system for storage batteries, solar water pumps, technology for industry and telecommunication applications are also needed to be introduced.

Several collaborative links and joint activities have been established in order to promote and utilize PV technology:

- Palestine is a member in the World Solar Summit.
- Palestine is a partner in the EC projects for integration of PV for rural electrification (iresmed, intersudmed projects).
- Palestine is cooperating with the Government of Baden Wuerttemberg/ Germany for a PV revolving fund project.
- Palestine involves in Eldorado German Program for promotion of PV technologies in developing countries.
- Palestine cooperates with UNIDO for promotion of renewable energy applications.
- Palestine involves in the PV exhibitions held in Mediterranean region.
- Local financial establishments
- Local Ministries, ministry of education, ministry of health and ministry of local affairs.

NREA ACTIVITIES IN THE FIELD OF PHOTOVOLTAIC SOLAR ENERGY

1. The role of small and large-scale photovoltaic systems in the development of rural and isolated areas in Egypt.

Eng. Hassan Hassaballa Rakha '.
Director General
For
Environmental & Economical Studies

2. Testing and certification capabilities and achievements

Dr. Eng. Elham Mahmoud Ahmed.
Director of Studies, Research & Testing of PV.

ABSTRACT:

1. The paper presents the extensive experience of photovoltaic (PV) applications in Egypt, which are carried out in part by the New & Renewable Energy Authority (NREA). It also covers the future prospects of PV applications and the constrains limiting the spread use of such technology in Egypt.

2. One of the main NREA's achievements is the establishment of the Egyptian Renewable Energy Development Organization (EREDO), as a testing, certification and research center. It consists of a set of advanced laboratories including photovoltaic and optic labs. This paper will present a brief description of the capabilities and activities of these labs.

Tel.: 2726867
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New & Renewable Energy Authority (NREA)

Activities o f the Energy Research Institute - King Abdulaziz City for Science and Technology.

Presentors: Engr. Saleh Al - Zahrani, Engr. Nunilo N. Eugenio Time: 15 min

The King Abdulaziz City for Science and Technology (KACST) is an independent scientific organization that has several branches of research undertaking, one of which is the Energy Research Institute (ERI). The goal of the institute is to adopt and develop new energy technologies that are appropriate for the social and environmental make up of the country. The solar village, its research facility, is located 55 kms north of Riyadh. This presentation covers the organizational structure of ERI, its research facilities and the ongoing solar energy projects in general and the hydrogen production plant, solar camp and the two sun simulators of the laboratory in particular. The 6 kW PV grid connected project will be discussed.

CASE STUDIES

1. 350 kW Photovoltaic Power System.

Presentor: Engr. Nunilo N. Eugenio Time: 10 min

Saudi Arabia is geographically located to receive enormous energy from the sun. For this reason, the country penned an agreement with the Unite States of America to explore and utilize this renewable form of energy. The 350 kW Photovoltaic Power System was installed in 1980 and become operational in 1981. It was a standalone system providing electrical power to 3 villages. Its basic operation was altered as the electrical needs of the users greatly increased. To date, the system is used as the main power supply of the hydrogen production plant. This presentation presents the system configuration and hardware of the power and the 18-year experience of operating and maintaining it. It will also share the various research tasks that were conducted for 8 years.

2. PV Highway Projects.

Presentor: Engr. Nunilo N. Eugenio Time: 10 min

The Ministry of Communication (MOC) of Saudi Arabia implemented the 5 year development plan for infrastructure starting on the year 1980. The department of highways linked most of the major cities and towns of Saudi Arabia since 1985. Thousands of kilometers of highways and bridges were constructed. In 1984, MOC funded PV projects for highway use such as tunnel and sign lighting, overheight vehicle detection and traffic monitoring system. These projects ensure safety and comfort of the commuters in general and the drivers in particular, at all times of the day. This presentation discusses the system configuration of the PV projects together with the

lessons learned in the operation and maintenance and the lessons learned Emphasis will be given to the tunnel lighting project.

3. PV-Water Pumping &Desalination.

Presentor: Engr. Saleh Al-Zahrani Time: 15 min

Providing adequate potable drinking water is becoming a serious problem in remote areas. Saudi Arabia is a very suitable place to use renewable energy such as Solar Photovoltaic (PV) energy. For this reason, a PV system was designed and installed aling with water pumping and desalination systems in the village of Sadous, 72 kms northwest of Riyadh. The PV field composing of 158 panels is configured in series/parallel connection to generate 11.06 kW of peak power. The averaged pumped waer from the well is 18 m^3/day with total dissolved solids (TDS) greater than 6000 PPM. The average product water is about 5 m^3/day with TDS less than 300 PPM.

PHOTO-VOLTAIC (PV) APPLICATIONS IN SYRIA

Dr. ALI AL-MOHAMAD
ATOMIC ENERGY COMMISSION, P.O. BOX 6091, DAMASCUS, SYRIA

Expert Group Meeting on" Networking of PV Systems and Applications"

ABSTRACT:

In this presentation, a detailed information about renewable energy resources in the country is given. More emphasis on the potentiality of solar radiation resources (thermal, light) will be considered. Possible and available applications of solar applications, for the daily life of the inhabitants especially in rural areas are analyzed. In addition, the expected growth of the renewable energy demand is summarized.

Introduction:

Syrian Arab Republic is geographically situated in between 32° 3' and 37 latitude north of **Equator** line and in between the longitude lines 36 and 42° 5' east of Greenwich line. Therefor, as a Mediterranean country, Syria enjoys a large scope of renewable energy resources that include solar, biomass, wind and Geothermal. Syria is blessed with high level of solar radiation. The average rate of the solar radiation (insolation) is approximately in access of **5kWh/m^2** per day which is equivalent to **1825kWh/m^2** per year over the entire area of the Syrian land. The number of hours on which the solar radiation can actually be utilized varies from **2820-3270** hours/year. The number of cloudy days varies from **38-45** days/year.

The available climatic data are presented in a set of three tables [1], [2] and [3]. These tables represent the daily sunshine hours, daily solar irradiation on the horizontal plane and daily mean ambient temperature respectively. The reported measurements are for 15 meteorological stations in 15 different geographic locations.

KEY FIGURES OF THE SYRIAN ARAB REPUBLIC:

- Population: **17 200000**(1999).
- Urban Population: **50.57%** (1994).
- Rural Population: **49.43%**(1994).
- Total Area: **185000** sq. Km.
- Number of houses: **2578564**(1994).
- Major Energy Sources: oil, gas and hydro-power.
- Oil Consumption: **12.5** Million Tons of Oil Equivalent(1996).
- Rate of Consumption: **4.7%** per year (before 1996).
- Expected Increase in Rate Consumption: **4%** per year up to 2015.
- Total Electricity Generation: **18328 G.W.h**(1996). This includes:

1. Hydroulic Turbine: 3550 G.W.h(1996), Forms(19.48%) .
2. Steam Turbine(N.G): 1608 G.W.h(1996), Forms(8.75%).
3. Steam Turbine(F.O): 5347 G.W.h(1996), Forms(29,14%).
4. Combined Cycle: 3555 G.W.h(1996), Forms(19.5%).
5. Gas Turbine(N.G): 4230 G.W.h(1996), Forms(23%).
6. Gas Turbine(D.O): 38 G.W.h(1996), Forms(0.21%).

- Average (Solar Radiation) Insolation: **5 kWh/ m^2** per day, equivalent to **1825 kWh/ m^2** per year.
- Average Sunny Hours: **2820-3270 Hours/year.**
- Average Wind Speed: **6-12 m/s for 53.7% for7 months per year, in Area A.**
  5-10 m/s for 34.9% for 4 months per year, in Area B.

- Expected potential of Bio-gas which can be generated from the available Bio-mass is approximately: **286 Million Cubic Meters/year.**

Station	Period	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year.
Qarachoch	60-79	4.5	5.2	6.1	6.8	9.5	12.1	12.3	11.4	9.5	7.9	6.1	4.2	8.0
Jarablus	58-77	4.1	5.4	6.6	8.0	10.2	11.7	12.3	11.7	11.8	8.5	6.3	3.8	8.4
Hassakeh	58-77	4.7	5.9	6.7	7.5	9.9	12.1	12.4	11.7	10.3	8.2	6.6	4.8	8.4
Meeselmiyeh	68-79	3.9	4.9	6.1	7.8	10.3	12.2	12.5	11.9	10.3	8.1	6.2	4.0	8.2
Alleppo	58-78	4.1	5.3	6.7	7.9	10.7	12.4	12.7	12.0	10.6	8.5	6.7	4.3	8.5
Raqqa	60-73	4.9	5.9	7.1	8.5	10.2	12.1	12.3	11.8	10.6	8.6	7.1	5.0	8.7
El Jeed	66-79	3.0	4.5	5.9	7.3	10.2	11.8	12.1	11.4	10.0	7.1	5.7	3.0	7.7
EL Baida	60-79	5.1	6.0	7.1	8.4	10.3	11.6	11.0	11.0	10.1	8.5	6.7	4.9	8.4
Lattakia	69-78	5.7	5.8	6.4	7.3	9.9	10.7	10.3	10.3	9.5	7.9	6.7	4.8	7.9
Deir Ezzor	58-82	5.1	6.5	7.3	8.2	10.1	12.0	12.2	11.8	10.4	8.5	7.1	5.2	8.7
Hama	60-77	4.2	5.5	7.1	8.4	10.7	12.5	12.7	12.0	10.5	8.5	6.9	4.5	8.6
Palmyra	58-82	5.3	6.9	7.7	8.5	10.4	12.2	12.5	11.8	10.5	8.7	7.3	5.6	8.9
Kharabo	68-79	5.1	6.7	7.7	8.6	10.5	12.3	13.3	11.8	10.5	9.3	7.3	5.3	8.9
Damascus-Mezzeh	58-77	5.5	6.7	8.1	9.0	10.9	12.5	12.7	12.0	10.8	9.2	7.5	5.7	9.2
Damascus-Airport	70-82	5.4	6.8	7.7	8.4	10.7	11.9	12.0	11.8	10.4	9.0	7.2	5.3	8.9

Table 1: Daily Sunshine Hours

Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year.
Qarachoch	2.2	3.0	4.0	4.9	6.3	7.3	7.3	6.6	5.3	4.0	2.8	2.0	4.7
Jarablus	2.1	3.1	4.2	5.3	6.5	7.2	7.3	6.7	6.0	4.2	2.9	1.9	4.8
Hassakeh	2.3	3.2	4.2	5.2	6.5	7.3	7.3	6.7	5.6	4.1	2.9	2.2	4.8
Meeselmiyeh	2.2	3.0	4.1	5.4	6.7	7.5	7.5	6.9	5.7	4.2	2.9	2.0	4.8
Alleppo	2.2	3.1	4.3	5.4	6.8	7.6	7.6	6.9	5.8	4.3	3.0	2.1	4.9
Raqqa	2.4	3.3	4.4	5.5	6.6	7.4	7.3	6.8	5.7	4.3	3.1	2.3	4.9
El Jeed	2.0	2.9	4.1	5.3	6.7	7.4	7.4	6.8	5.7	4.0	2.9	1.8	4.8
EL Baida	2.5	3.3	4.3	5.5	6.6	7.1	6.9	6.5	5.6	4.2	3.0	2.3	4.8
Lattakia	2.4	3.2	4.1	5.1	6.4	6.8	6.6	6.3	5.4	4.1	3.0	2.2	4.6
Deir Ezzor	2.5	3.5	4.5	5.5	6.6	7.3	7.3	6.8	5.7	4.3	3.2	2.4	5.0
Hama	2.3	3.3	4.5	5.7	6.9	7.7	7.6	7.0	5.9	4.4	3.2	2.3	5.1
Palmyra	2.6	3.7	4.7	5.7	6.7	7.5	7.5	6.9	5.8	4.4	3.3	2.6	5.1
Kharabo	2.7	3.8	4.8	5.8	6.9	7.6	7.6	7.1	6.0	4.8	3.5	2.6	5.3
Damascus-Mezzeh	2.8	3.8	5.0	6.0	7.0	7.7	7.7	7.1	6.1	4.7	3.5	2.7	5.3
Damascus-Airport	2.8	3.8	4.8	5.7	6.9	7.5	7.4	7.0	5.9	4.6	3.4	2.6	5.2

Table 2: Daily Solar Irradiation on the Horizontal Plane(kWh m^{-2} d^{-1})

Station	Period	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year.
Qarachoch	60-79	5.7	7.5	11.1	15.7	22.5	28.9	32.7	32.4	27.5	21.1	13.6	7.6	18.9
Jarablus	57-76	5.2	6.7	11.0	15.9	21.6	27.0	30.3	29.8	25.3	19.1	12.3	7.0	17.6
Hassakeh	57-76	5.3	7.2	11.5	16.5	22.5	28.2	31.3	30.5	25.7	19.3	12.0	6.8	18.1
Meeselmiyeh	57-79	4.9	6.6	10.8	15.2	20.4	25.2	26.1	27.7	24.6	18.0	11.9	6.7	16.4
Alleppo	51-78	5.6	7.4	10.7	15.5	20.9	25.7	28.1	28.1	24.9	19.5	12.3	7.3	17.2
Raqqa	58-79	6.4	8.2	12.3	17.5	23.2	28.0	29.9	29.4	25.5	19.8	12.9	7.7	18.4
El Jeed	66-79	6.9	8.9	12.4	16.4	21.1	26.1	28.5	27.9	24.5	19.7	12.8	8.1	17.8
EL Baida	60-79	11.5	12.5	14.5	17.4	20.4	24.1	26.4	27.0	25.3	22.1	17.7	13.2	19.3
Lattakia	66-78	11.6	12.6	15.1	17.9	20.9	24.0	26.4	26.9	25.6	22.6	17.8	13.2	19.6
Deir Ezzor	51-82	6.9	9.2	13.1	18.6	24.3	29.6	32.9	31.9	27.6	21.1	13.2	8.1	19.7
Hama	56-76	7.3	8.3	11.8	16.3	21.5	26.0	28.1	28.2	25.3	20.3	13.5	8.2	17.9
Palmyra	56-82	6.8	8.9	12.8	17.7	22.9	27.3	29.3	29.1	25.9	20.6	13.2	8.1	18.5
Kharabo	56-79	6.3	7.7	11.3	15.2	19.1	23.3	25.0	24.7	22.0	17.5	11.9	7.3	15.9
Damascus-Mezzeh	51-76	7.1	8.6	11.8	16.2	21.0	25.1	26.8	26.9	24.1	20.0	13.8	8.6	17.5
Damascus-Airport	56-82	6.1	8.1	11.3	15.7	20.2	24.5	26.2	25.9	22.9	18.2	11.8	7.4	16.5
Bailaneh	66-73	5.4	7.6	11.8	16.9	22.7	27.2	29.6	29.1	25.7	19.5	12.0	6.7	17.9
El Shoghour	57-71	8.3	9.5	13.1	16.8	21.8	26.2	28.5	28.9	25.7	20.0	13.3	9.1	18.4
Joureen	65-79	7.0	9.0	12.6	16.6	21.4	26.9	29.9	29.4	25.9	20.1	13.0	8.2	18.3
Khafseh	59-71	6.3	7.5	11.5	16.4	22.4	27.4	29.7	29.6	25.6	19.2	13.0	7.9	18.0
Qattineh	57-72	6.4	7.6	11.1	14.8	19.0	22.1	23.4	24.1	22.6	18.8	13.3	8.1	15.9
Salkhad	59-72	4.6	4.9	8.1	12.4	17.0	21.1	22.1	22.8	21.1	17.3	11.6	6.1	14.1
Qamishli	52-78	6.2	7.8	11.3	16.1	22.1	28.0	32.2	31.7	27.4	21.3	13.5	8.1	18.8

Table 3: Mean Temperature (C°)

SOLAR ENERGY APPLICATIONS IN SYRIA:

Both the sun's heat and light can be utilized to generate energy, either by a thermodynamic process or by a direct conversion of light sunshine into electricity by means of photo-voltaic (PV) devices.
The most popular application, in Syria, is the households solar hot water (SHW) systems. The Syrian government had established a public company for manufacturing these systems and also encourages and facilitates the private sector to establish small companies and workshops for manufacturing such systems. At the present time, there are more than fifty private small firms and workshops officially licensed by the **Ministry of Industry**, and one state owned company.

The full annual production capacity of the solar flat plate collectors produced by the private sector is approximately 15000m^2 and about 6000m^2 by the government company. To cover the expected future demands for solar hot water systems, all factories need to double their production in the coming years.

In fact, there is no exact survey for the number of installed solar hot water systems in the count, however the estimated number is about 6000. The following table gives some of the major firms manufacturing solar hot water systems.

Company Name	Location
L AVA	Damascus
JARRAR	Damascus
QOURDAB	Damascus
Deutsch Arabische Solar Technik	Damascus
Al-FAJER	Damascus
Kossabi and Souas	Homs
Kial Company	Lattakia
M.A. Younis	Tartous

-Feasibility study of SHW systems in Syria:
At the present time, it is possible to produce high quality and high performances SHW systems with cost not exceeding similar systems in the neighboring countries. The total cost of SHW with two panels ($2x1m^2$) systems is approximately 400 $.

Let us consider a practical application:
The cost analysis study of the SHW systems is as follows;

The daily consumption of hot water is approximately 20 L/capita.
The average family consumption is 120 L/family/day.
The total energy needed to rise the water temperature about 40 C° is 120x40=4800 k.kalory.

In case of Electric heater:
The equivalent electricity is 4800/860=5.6 kWh.
The total energy needed is 365x5.6=2044kWh/year.
The real cost for one kWh is 2,5 S.P.(Syrian Pound).
The annual electricity cost is 2044x2.5=5110 S.P.
The heater cost with its connections is about 5000 S.P=100$..
Annual maintenance is approximately 300S.P.

In case of Diesel heater:
The diesel heater efficiency is about 45%, therefore, the required amount of diesel is **one liter/family/day (Approximately 10000 K.Kalory).**
The total energy needed is 365 Liter per year.
The real cost for one liter of diesel is 10S.P.
The annual diesel cost is 3650S.P.
The heater cost with its connections is 5000S.P.
Annual maintenance is approximately 300S.P.

In case of SHW:
The total cost (installation + connection) is about 25000S.P.
Annual maintenance is 300S.P.
Useful life is 20 years.
From the above figures, its clear that the pay back is approximately five years in case of electric heater and about six years in case of diesel heater if real prices for electricity and distillate oil are considered.

*-OTHER SOLAR ACTIVITIES:

- **Airport employees' buildings project:**
  The project involves more than 2000 flats in two-story building located near Damascus international airport. The project started in 1984 adopting **solar passive heating techniques** using Trombe walls and direct gain. This project is considered as a pilot project in the middle east area. Until now about 529 units were completed . In addition, all units are provided with solar hot water systems ($3\times1.4=4.2m^2$ collector area) connected to a 280 liter storage tank.
- **Student's housing building at Tishreen University (Lattakia):**
  This project supplies about 13750 liters of hot water at 50C°. The system has 750 sq. meters flat plate collectors.
- **Solar passivation heating systems for elementary school:**
  The school is situated in Jaramana near Damascus. The school consists of thirteen classrooms in two story building.

PHOTO-VOLTAIC APPLICATIONS:

The photo-voltaic programs, in Syria, are still not widely exploited. Except the recent electrification of few villages in the rural areas, the overall applications of (PV) technologies are very modest and very limited.

Existing PV applications:

* -The first demonstration project using photo-voltaic technology was started in 1992. The **UNDP** and under the technical cooperation contract (SYR/88/007) has provided financial support to the Higher Institute of Applied Science and Technology (**HIAST**) to implement the electrification of **Abou-sorra and Al-Mesherfe villages**.

* -Another electrification project using (PV) technology of four villages in the north of Syria was also executed with cooperation between the Japanese International cooperation Agency (**JICA**) and (**HIAST**).

Table [4] shows number of inhabitants, number of households and the installed capacity of PV panels in **Abou-sorra and Al-Mesherfe, Zarzeta, Fadra, Katora and Rasm Al-Shake Kalaf (water pumping) villages north of Aleppo [4].**

Village	No. of inhabitants	No. houses	Install. Capt.kW
Abou-sorra	275	13	2.1
Al-mesherfe	110	6	0.3
Zarzeta	300	40	35
Fadra + Katora	250	37	9.8
Rasm Alshake	150	15	0.8

Table [4].

* -PHOTO-VOLTAIC TEST STATION IN ADDRA:

The system has been installed since 1978. The output is 2kW peak (**Cipel France**) with twenty 48Ah batteries with an autonomy up to 10 days. The load consists of four 24V, 100W lamps and 24V radio transmitters. There is also 200W solar force water pump.

* -PHOTO -VOLTAIC PUMPING INSTALLATION:

This installation is used to lift water for irrigation in Dummar near Damascus. It adopts, AEG modules supplying 3.25 kW and 24 batteries, each 2V, 400 A.h.

Size of the PV market:

The government of Syria executed many ambitious programs to electrify most of the Syrian cities and villages. As a result of these programs, about 96% of houses were electrified. However, still a considerable number of small villages and isolated houses are not connected to the main national grid. That is mainly because these villages are either far from the national electricity grid or very costly and not feasible to be connected to the grid. Therefor, using a PV technology for electrification purposes is a good and sensible solution. In fact, the number of the off-grid small villages is approximately eight thousand. But there is no exact survey available about the number of isolated houses. To conduct a detailed survey about the market size and the places in need, a huge work by experts is still to be carried out.

PV programs, centers of expertise and organization structure:

The PV program in Syria is still very modest, and as mentioned before the program, in general, includes electrification of six small villages and few PV panels used for testing facilities.
Of course there are several reasons behind the unpopularity of PV systems will be explained later.

active centers and institutions:

In Syria there are several governmental institutions conduct researches and development on renewable energy applications. Also, in recent years, courses on renewable energy resources (solar, wind and bio-mass...) are introduced at several universities. These are:
1- University of Damascus, Aleppo, Al-Baath and Tishreen.
2-Higher Institute of Applied Science and Technology.
3-Atomic Energy Commission.
4- Ministry of Electricity.

It is useful to mention here that my commission has a good group of researchers working on the development of solar cells and its related materials. There are also, in the above mentioned centers, few groups carrying small research activities on PV.

Areas of need and existing training programs:

Since the technology of PV is still not fully established in Syria, a technology transfer and intensive training programs are urgently needed. Most of the research laboratories need to up date their old testing equipment, sample preparation systems and measuring equipment to cope with the fast development, in surrounding world, in this field. Also intensive training programs, courses and workshops for the technical staff in many areas of PVs technology (i.e. characterization, sizing, solar PV systems implementation, solar effects, ...) are needed. At the present time the activities in these areas are very limited. In conclusion:
instrumentation and intensive technical training are urgently needed to promote the PV activities in Syria.

Collaboration links:

In the past few years there was some cooperation with international organizations such as (**UNDP**) and with friendly countries through (**JICA**). The government received some experts and trained few engineers working in different sectors of government ministries.

- Training project on bio-gas technology (pilot plant) with cooperation of **ESCWA**.
- Scientific cooperation with **India** to construct two bio-gas plants 90 m^3 and family size plants.
- Electrification of two villages south of Damascus with cooperation of **UNDP.**
- Electrification of four villages north of Aleppo with cooperation of **JICA.**

At the present time, the ministry of Electricity with the cooperation of UNDP are conducting a national survey on renewable energy resources in the country.

Expected Renewable Energy Demand:

There are many reasons (i.e. expected increase in energy consumption, limitation of conventional resources, expected increase in oil prices and damage to the environment....) to justify a policy by the government to support the use of alternative energy resources. In this regard, solar energy is an excellent option to reduce the fuel oil consumption for hot water production and for electricity generation. Also, the use of available bio-mass and wind resources will help in saving oil consumption and compensating the expected future shortages. Moreover, the total emission of CO_2 and other gases to the atmosphere, as a results of conventional energy consumption, will be reduced and consequently reducing the damage to our environment.

Taking into account all these parameters, there are strong incentives to put plan and policies to develop the applications of renewable energy resources and to have their shares in the future energy balance. **It is expected to contribute, by renewable sources, more than 700 Thousand Tons of Oil Equivalent in year 2010. This is equivalent to 3.5-4% of the total energy balance**.

Conclusions:

In spite of the abundance of solar (insolation) in Syria and the efforts by the government to promote the applications of SHW systems for public use, the results of such efforts are still disappointed and very modest. The main reasons behind that are:

1-Availability and cheapness of the conventional energy resources. That is because the Syrian government subsidizes all forms of energies (electricity, oil fuel, and gas....).
2-High cost of the solar systems in comparison with the people income.
3- National electricity grid covers more than 96% of the Syrian inhabitants.
4-Limited space available, on top roofs, since more than 50% of the Syrian population live in cities and more than 90% of them are living in multi-story building.
5- The benefit of the renewable energy technology is still not fully recognized by the public.

At the end, to promote the applications of renewable in general and with more emphasis on the application of PV, vigorous work is urgently needed.

"Networking of the PV Systems and Applications"

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Abstract

The potential solar energy in Algeria is very important with an average sunshine per year is about 3000 hours. The total area of the country is more than 2 millions km2 . The respective percentage of the area and the yearly average irradiation for the three specific regions are as fellows:
- Coastline: 4%, 2650 hours/year.
- High-plateau: 10%, 3000 hours/year.
- Sahara: 86%, 3500 hours/year.

The yearly average of daily solar irradiation on optimal tilted surface is very interesting. It ranges from 5 to 7 kWh/m2/day.
The research and development in the field of solar energy have existed since fifties, the first solar furnace was built in the site of Bouzaréah (Algiers) in 1954. But the applications in situ of solar energy and especially photovoltaic were initiated only in 1985. The PV applications is particularly used for water pumping, rural electrification, telecommunication, refrigeration and cathodic protection. The installed PV power in Algeria since 1985 is estimated about 1 MWp. From 1985 to 1990 the assessment of the rate and the installed PV power of the above specific regions are respectively:
- Coastline: 15.32%, 42 kWp.
- High-plateau: 26.22%, 71.9 kWp.
- Sahara: 58.46%, 160.3kWp.

The value of the installed PV power (1MWp) is far away from a full exploitation of the solar resources and the real potential of local market.

In remote area they are many fields and sectors which needs PV power such as agriculture, telecommunication, transport cathodic protection. Example only for rural electrification the PV power needs are evaluated no less than 20 MWp without taking account the needs of the other PV applications such as water pumping, signalling of pathway, refrigeration plants.
Two nationals programs have been undertaken and funded by the government. The first program is "the solar energy great south program" with an aim to install stand alone PV systems for different applications as the water pumping and electrification. It was started in 1985 and finished in 1989.

The second program is "the south rural electrification program" for which the aim is to supply 216 000 rural houses and more than 300 agricultural sites. It started in 1995 and still in progress.

In the field of research and education they are only post-graduate studies in Algeria. The students receive theoretical courses and practical training in photovoltaic laboratories. The actual needs are the overseas training and advisors for students registered in the doctorate level.

The PV modules are not manufactured in Algeria in spite of the big efforts to setting up an industry. Only one unit of encapsulation of PV modules came into operation in 1985. Recently the new laws have been applied to incite investment of private companies.

PV Activities in Morocco

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Sunlight Power Maroc
Morocco

Abstract

Since their initial introduction in Morocco more than thirty years ago, PV systems have been used in different areas including rural electrification, water pumping and telecommunications. The initial introduction followed a defined strategy aimed at:

- Showing the ability of these systems to respond to some energy needs in remote areas not connected to the electrical grid,
- delimitate and study their limitations.

It is in this perspective that several demonstration and pilot projects were conducted between the late seventies and the late eighties the most important of which was the PPER (Pilot Rural Pre-Electrification) program. These projects have led to the maturation of a number of household and professional applications of solar PV systems, around which a general understanding developed admitting with the necessary field experience and economic post evaluation that PV is the solution to use in some areas of the country, under defined conditions. The present installed capacity is over 5 MWp.

The pilot project strategy also helped to develop a private sector in different support areas for PV systems (installation and maintenance, manufacturing, engineering and service), and to secure a steady development of the market, which his presently close to 1 MWp/year.

The size of the market is expected to grow in the next years due to the important investments being made in this sector, to the support to be granted by the PVMTI (PV Market Transformation Initiative) program (5 million $ US), to the important decentralized electrification program being launched by the utility (200,000 households in the next five years), in addition to rural health centers electrification, water pumping programs and professional telecommunication projects.

The centers of expertise in the country are within:

- The "Centre de Développement des Energies Renouvables", which is the governmental agency in charge of the sector, insuring advice, animation and training,
- The "Office Nation d'Electricit" which is the national utility,
- The Moroccan association of solar industries which groups the private sector capacities, and
- The Ministry of Energy and Mining, which is in charge of the policy and regulation development

The Moroccan solar PV industry concentrates on BOS manufacturing: controllers, lamp ballast, battery, cables, electrical accessories. There have been several attempts to start module lamination in country, but so far with success due to limited access to adapted financing. The areas of need are thus a better access to financing which is adapted to renewable energies development.

With the present trends, the collaborative links in place at the national and international levels, the different cycling training programs and the increasing involvement of the private sector, PV activities are expected to continue their development in Morocco.

ICS Expert Group Meeting on networking of PV systems and applications
Photo-energy Center, Cairo, 26-28 April 2000

Photovoltaic Activities and Applications in Jordan

National Energy Research Center
Amman – H.K. of JORDAN

1. Abstract

Rural areas in Jordan form about 80 % of the total country area, in which only about 3% of the total inhabitants are distributed through. These areas lack for basic electric and water networks. In 1980 the Renewable Energy Research Center (RERC) at the Royal Scientific Society (RSS) started research and development activities related to the use of PV in Jordan for rural electrification and water pumping. In 1985, "Solar Photovoltaic Pumping Program" has been initiated by installing the first PV water pumping pilot station. Results have shown high degree of reliability for these systems, the fact that encouraged local and international sponsors to support this program.

The yearly average solar irradiance in Jordan is 6.42 $kWh/m^2.d$ on tilted fixed surface (40^o) which makes Jordan a very attractive environment for solar applications. Moreover, after many years of intensive applied research, it is found that water pumping using PV as a power supply is the most feasible among the known pumping technologies in Jordan when the equivalent hydraulic energy needed is less than 3800 m^4/day. Results have shown that, the cost of the cubic meter produced by using PV technology is a bout half the cost that Jordan government pays by using traditional methods.

This paper briefly describes the Jordan PV program, existing applications, market, training program, collaborative links, and other information about Jordan activities related to PV applications.

As a case study, this paper presents the results of the techno-economic studies that carried out for a PV water pumping program with a total capacity of 47.52 KWP, that was executed in Jordan.

PV Technology in Tunisia in nine questions

Bahri REZIG
Laboratoire de Photovoltaique et Matériaux Semiconducteurs ENIT

Abstract

1. Existing PV Applications
1.1 Rural Electrification (*****)
1.2 PV Pumping (***)
1.3 Stand alone Telecommunication Systems(**)
1.4 Mobile Health 'Caravans'(*)
* Stars indicate qualitatively the intensity of the application

2. Size and profile of the market
2.1 Widely supported application as low cost and clean energy
2.2 Mainly Public supported 'social market'
- 100.000 to 300.000 individualized households
- Outreach education centers (Primary schools, alphabetization)
- Integrated Social Service Systems
- Handcraft based rural Micro-projects (Solidarity Funds)
2.3 Connection to conventional grid has to overcome a failed former experience.
2.4 Week marketing strategy in PV Pumping sector
2.5 Expanding market: Mobile Communication Relays
2.6 Tunisian market should be considered as a bridging market towards a wider one (Maghreb and Africa).

3. PV Program
3.1 Yet installed: 6500 systems, 650 kWp.
3.2 2010 Objective: growth of 550% in installed PV power.
- Electrification of 10.000 schools
- 70.000 to 100.000 households in remote and low density areas
- PV Pumping projects
3.3 Solidarity Funds, UNEP, UNDP Programs

4. Centers of expertise (capacity, capability)
4.1 INRST: The National Research Center hosts a Prototype Pilot Line Production: Innovative R&D task force, From Silicon based Cell processing to module encapsulation. (Few tens of kW full capacity).

4.2 University (ENIT, FST, FSS, ENIS?): Mainly alternative solar cells. New thin film materials and low cost processes. Stable and motivated teams. Some work is carried out on PV systems (1 kW training plant installed in ENIT) and related electronics blocs (conversion, storage, design, lifetime studies?). In this area, ENIT work is focused on PV lighting, pumping and freezing.

4.3 CGDR: This Center is responsible for Rural Development and showed recently some interest in technical aspects of PV dissemination. It is a very useful partner supporting the on-site test and sizing studies. PV seems to be a minor activity.

4.4 ANER: National Agency for Renewable Energy shifted recently from Ministry of Industry to Ministry of Environment. 15 years old experience in PV Program implementation. The main governmental Policy tools in the area. The Agency should be the brain of the Clean Energy Strategy of Tunisian long-term strategy. All international and national Programs are managed through the ANER.

4.5 STEG. Up today; the Main National Electric Power Supplier. An unavoidable partner in Solar Electricity Market. It is not sure that the last privatization of the production sector will decrease the involvement of the company in this alternative market.

5. Industry capacity

5.1 There is no PV industry in Tunisia. Nevertheless, a significant merging sector is arising around mechanical products (glass, aluminum, metal sets?) and electronic devices including transmission, storage and loading (cables, batteries, lamps..).

5.2 Foreign investment and joint venture PV projects had been initiated with some European companies but without success.

5.3 Some commercial suppliers of PV systems are working hard to contribute to the dissemination of this technology. Unfortunately, sometimes the unavailability of the PV related spare parts is discouraging.

6. Areas of need

6.1 Technology:

- Help to a decisive implementation of a local PV Production
- Develop advanced but appropriate technology of PV modules. Thin film technology could meet the criteria.
- Lunch incentive actions to build attractive technology-based joint ventures

6.2 Training

- Networking in Education and training task force
- Support and amplify regular regional summer schools on Clean Energy topics.
- Launch a specialized Master supported by UNIDO and tightly linked with the professionals of the PV issues. This could prepare educators and experts.

7. Collaborative links already in place:

- Tight links between teams working on PV topics from the materials to the system.
- Irregular links exist between ANER and research teams. The ANER is a partner and not a funding organization.
- International collaboration between Tunisian and European labs mainly in advanced PV materials.

8. Existing training programs if any: The training Programs in the field are neither regular nor intensive.

9. Organization structure for PV activities

- ANER: Responsible: M. DIMASSI, affiliated to the Ministry of Environment (see section 4)

Photovoltaics For Efficient Solar Energy Conversion

Draft paper (merged with a Project Proposal)

Submitted by:

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To: The PV Expert Group Meeting (***ICS - UNIDO Project, Trieste, Italy)***

Cairo, Egypt, 26 - 28 April 2000

This draft paper (merged with a project proposals) deals with supporting applied studies, technology transfer, marketing and development of PV products and systems in Egypt that could be very fast produced on industrial level for immediate application as a clean, reliable and duarable source of energy needed for sustainable and global development process in Egypt.

Background and Target Formulation.

In short, I will give here an outline of a prelimenary draft for the Project Proposal. I will try to concentrate on what I consider to be important elements for drafting a project proposal and an action plan for developing, applying and marketing PV systems in Egypt.

International Situation and Market Potential

First of all, I believe it is important to note, that there is a wide agreement (on national as well as on the international levels) on the need for developing rapidly the technology and utilization of PV especially in sunny developing country like Egypt. This realistic technology subject can be very fast transferred into industrial potential products by cooperation with small or medium enterpris industry companies in Egypt. The project aims at making a more significant progress in the transfer and development of technolgy of PV (low cost and more efficient) that should fulfil its potential in securing Egypts's long term clean energy supply and in contributing to its environmental protection.

Market situation in Egypt is still very young and of very high potential. To the best of my knowledge, no considerable amount of PVs are produced on an industrial scale.

Few private companies are working in the production of home-assembled PV arrays and systems. Almost all applications and PV systems marketing are limited to street (transportation roads) lighting systems and in some touristic villages for camping and yachting. As a first approximation, one can say that production of PV in Egypt is limited to research and testing purposes as well as the above mentioned few applications.

Moreover, another potential activity in Egypt is the successful attempts of Metallurgy Institute of the Academy of Science and the National Institute of Solar Energy Research to produce very pure silicon (99.999% Si) that is needed internationally for producing efficient silicon based PVs. This is a long term plan that needs a lot of capital investiments.

Furthermore, the Ministry of Military Production has recently announced a program for PV production. It will start production in the coming few years.

The following facts are in favor of global PV:

. PV is now being widely used in some countries to convert light to electricity.

. PV proved to be one of the most reliable clean energy source.

. Job Creation: As a result of the market penetration and utilization, too many opportunities for job creation will be opened.

However, there is still an urgent need for production and test of cost/effective consistant PV systems that based on new materials (new semiconductors, new forms of already existing semiconductors -nanoparticles, amorphous, polycrystalline forms - or like organic PV materials that mimick the nature (as in plants which use light harvesting organic molecules around us).

Action Plan (Joint Venture to be Supported) :

- Market study that aimes at increasing market potential will be one important element of this project. The need for a level playing field is important : Internalisation of external costs and benefits must be a guiding principle for future energy pricing. The creation of guarantee funds could be helpful for applied research needed for development. It is encouraging to see that international donor institutions like the ICS-UNIDO are increasingly involved in the financing of renewable energy projects such as this proposed PV one. PV have to be considered in the wider context of

energy savings and energy efficiency. It should be considered in all sectors, like fore example in the building and housing and health and environment protection sectors.

- Technology Transfer and Development:

The ultimate goal is:

- to produce (with the collaboration with small or medium industrial factories) and
- to test cost effective high quality PV solar cells (already available in the international market) based on new materials and/or new composite of semiconductos.

PV already exists in the market had very few product standards and no systems standards existed, which means that manufacutrers especially in developing countries had no guidelines to produce a reliable product, how to install them and how to serivce them. The lack of accredited testing laboratories made testing difficult for producers especially in the developing countries. However, in Egypt and within the framework of the programs of the ministry of electricity and energy for development and localization of renewable energy technologies, the Egyptian Renewable energy Development Organization (EREDO) has been established as a specialized center within the New and the Renewable Energy Authority (NREA). It has Photovoltaic laboratories:

Outdoor photovoltaic laboratory

The outdoor PV Lab. has two main sections:

1-Testing units for measurement and the evaluation of photovoltaic modules.

2-Demonstration Units for photovoltaic applications, household and pumping equipped with measuring instruments for testing their performance. The laboratory is also equipped with a data acquisition system and a meteorological station unit.

Indoor photovoltaic laboratory

The lab. can perform R&D studies on PV cells, as well as testing and certification of PV modules. It has two main separate facilities;

The PV cell testing facilities with pulsed solar simulator, monochromator and four points prob systems.

photovoltaic modules testing facility, with mounting twist tester and insulation tester.

The Role of the Photoenergy Center:

The Center has established a small PV station for training and demonstration. It consists of PV arrays, Battaries and Charge regulators for different applications. Namely, lighting, water pumping and hydrogen production are among other important applications demonstrated at the Center .

The Photoenergy Center of Ain Shams University is a package that satisfy creteria to be approved research and development organization that strives:

- to develop new PV products and systems

- to promote and maintain a set of quality standards and certification procedures for the performance of PV products and systems, to ensure high quality, reliability and durability.

Promising achievemnets would be expected by using the facilities available at the Photoenergy Center and its staff members as well as making use of National and International Cooperation with specialized laboratories in Europe (Italy, Germany, France,...., etc.), Japan, USA, Australia to be specified in the final project document). The Center is well connected with the leading research institutions all over the world. The Center shall make use of its scientific connections in realizing and complementing the research to be carried out in order to develop new low cost and more efficient PV products and systems. **[Related International Research Activities Carried out by the Photoenergy Center ? The center accomplished with other international partners a research project on n-Silicon optoelectrodes for solar applications and electronic fabrication; financed by European Community (Partners were: two labs in France (CNRS "Professors Etman and Gorochov" and Ecole Polytechnique "Ozanam and Chazalviel" - Paris), one Lab in UK "Professor L. Peter" (Bath University))].**

On the domestic level; the Center has also very good contact with national industries (Public and private sectors) that will enable finding industrial partners for close collaboration in the project. In spite of the high level of technology already achieved in Europe and other industrialized countries, it was general agreed that a continued effort on domestic levels for research and technological development will be needed also in future, if the present level is to be maintained or improved. Technological development can only be considered to be successful, if it results in a good market product, and if it has been correctly integrated and adapted to market conditions. Finding new economic applications is very important.
An example for the urgently needed new applications of crucial importance is in the field of Building integrated PV.
On January 1, 1997, IEA's (International Energy Agency) PV Power Systems Program welcomes a new task: Task VII – PV in the Built Environment.
The objective of Task VII is to enhance the architectural quality, the technical quality and the economic viability of PV systems in the built environment and to assess and remove non-technical barriers for their introduction as an energy-significant option.
Primary focus of Task VII is on the architectural design of (roofs and facades of residential, commercial and industrial) buildings and other structures in the built environment (such as noise barriers, parking area's and railway canopies), and on other market factors, both technical and non-technical, that need to be addressed and resolved before wide spread adoption of PV in the built environment will occur.

[Egyptian Market - Technological needs: Building Integrated Photovoltaics

Solar PV energy is the only renewable energy form, which can be readily integrated into the urban environment and is particularly suited to roof tops and building facades.
Some companies have developed a cost-effective production technology for the manufacture of high efficiency laser grooved buried grid (LGBG) crystalline silicon solar cells that deliver 16 - 18% photovoltaic (PV) conversion efficiency on large area substrates.

The cells and modules give high performance and are ideally suited to applications which require reduced space and balance of systems costs, in particular in the growing market for grid-connecting PV solar energy.

Furthermore, there are some companies offering coloured solar cells, thereby allowing architects greater flexibility for integration of solar cells into buildings.

Grid-connect PV systems offer the opportunity to generate significant quantities of commercially valuable electricity, operating in parallel with existing electricity grid and allowing interactive exchange of electricity to and from the grid. This is a rapidly growing market in which three main applications are evolving: residential PV for the domestic sector (1-5 kWp), centralised PV for utility generation (100 kWp – 5 MWp) and building integrated PV for the commercial and industrial sector (10 – 250 kWp).

Solar PV energy is the only renewable energy form, which can be readily integrated into the urban environment and is particularly suited to roof tops and building facades. Building facades should be attractive as well as functional and the option to offer solar cells in a range of colours is considered an asset to the market acceptance of the technology by architects and designers.

Although photovoltaic systems have been used to power building loads, particularly for remote dwellings, for around twenty years, there has been a considerable increase in interest since 1990 and many countries now have significant programmes in building integrated photovoltaic systems (BIPV). The main difference in today's systems is that the PV array forms part of the building envelope, both generating electricity and performing the job of the roofing or cladding material it replaces.

The BIPV system has many advantage for use in urban environments. Not only is the generation of the electricity more environmentally benign than conventional methods, but the use of the electricity within the building on which it is installed also reduces the environmental impact of distribution. The BIVP system uses existing façade or roof area, without requiring additional land which is very valuable in most urban centers. The fact that PV systems generate electricity without any noise or emissions means that the building inhabitants are not disturbed by the presence of the system.

An additional benefit, whilst capital costs of PV systems remain high compared to conventional generation of electricity, is that some financial offset can be allowed with respect to the building material replaced by the PV system. This reduces the effective cost of electricity produced by the system.

BIVP systems can have many designs and applications and recent systems have also demonstrated a multifunctional approach. In these cases, the PV system also acts, for example, as a shading device or is designed to assist in natural ventilation of the building. Especially for commercial buildings, each system is designed to meet the needs of the architect and user. Issues which must be considered are the performance of the PV system, how the output matches with the electrical loads of the building, the aesthetics of the design and, of course, the costs.

At present, only a few BIPV systems are cost effective in terms of electricity generation, although they also have value in terms of environmental considerations and the image of the building owner. However, as the capital costs of PV systems decreases due to increasing market size, the generation of electricity by BIPV systems is expected to become increasingly attractive in urban centres around the world.

The technical potential for BIPV is very large, even in high latitude climates, and several countries have announced large development programmes to stimulate the market and hence increase the rate at which the capital costs are reduced. If all these programmes are realised, the installed BIPV capacity will grow to around 4GW in 2010, over 40 times the current annual market for PV systems in all applications.

Furthermore, the technology of Thin Film Silicon is architecturally attractive. It looks like tinted glass and replaces prime time tariff day-time electricity with power generated by light. In older buildings and homes solar roof tiles are the ideal way to generate power. Sunslates blend visually with the roof material and are simple to install and wire by hand. For prestige corporate or public buildings thin film silicon makes a strong visual and environmental statement, whether used as an entire façade, or as architectural detail. TFS is laminated into 1sq m and 1.5sq m panels of toughened glass - each with a single electrical connection – reducing the handing and wiring needed on site. Thin film silicon laminated are more cost-effective than expensive cladding materials and can make an important energy contribution especially in a building designed for energy sustainability.
Suitable for new-build projects, as well as retro-fitting onto existing structures, TFS is ideal for the urban environmental where other renewables are inappropriate.

- Knowledge Transfer

This is another area of need. Information dissemination and awareness creation at all levels is another priority area for a faster penetration of PV. The Center through his continuous activities (and this project) is trying to put in place a comprehensive information system (data base establishment) and knowledge transfer (desingning training courses, creating fellowships program, etc.). Moreover, increased efforts in

form of consultation for example are also needed at national ,regional and local levels , if the still existing information gap is to be bridged.

Education and training, especially professional training, is occupying a prominent position in our PV Action Plan. Professional training (for scientists and researchers) in other Developing Countries (Arabic countries as well as south coast countries of the Mediterranean sea, where prospects for developing solar technologies are particularly good) is also essential, if similar PV projects investiments are to be implemented successfully in these countries. This will also create a strong domestic market that would be successful in producing and utilizing the clean technology needed for development. Specifically, the action plan will focus on the following:

- Holding Training Courses.
- Organizing scientific specialized meetings.
- Fellwoship position opening (4 - 6 qualified scientists mainly from Egypt).
- Consultancy (Experts from industries at both National and International levels).

Economic Aspects: Funding PV projects? This is one of the major problems that need to be solved to overcome the barrier for marketing PVs.

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Eurosolare

COMPANY PROFILE

EUROSOLARE S.p.A belongs to the E.N.I group, the Italian oil and gas company. It started in 1992 based on the experience in Photovoltaics gained by AGIP S.p.A. ever since 1980, and operates in Research, Development and Application of PV Energy.

PRODUCTS, CAPACITY AND MARKET
Eurosolare is at present the only Italian Company, and one of the most long-standing world-wide, to be vertically integrated in the production cycle, from the treatment of raw silicon material to the realisation of Cells, modules and Photovoltaic Systems.
The production volume is presently around 3 MW/year. Full capacity on full shift is around 7 MW/year.
The market is mostly concentrated in Europe and Africa, although it is foreseen to expand activites in China through a joint-venture established in 1999 with a chinese cmpany..

EXPERTISE
Eurosolare operates in several countries supported by the synergies of the E.N.I. group and the technical and practical experience of Agip.

At its own production plant, located in Nettuno (Rome), Eurosolare has also developed a Quality Assurance and a System Engineering skill which have contributed to the realisation of many photovoltaic products, both in Italy and abroad.

Eurosolare is supported by an extensive R&D effort for the development and optimisation of competitive technologies, particularly concerning the crystallisation of silicon and the cell fabrication sequence.

PROGRAMMES
Eurosolare is involved in European Community Research Programmes and collaborates with many Organisations, Universities, Research Institutes and operators in the sector of technological development and innovative photovoltaic products.

COLLABORATIVE LINKS ALREADY IN PLACE AND EXISTING TRAINING PROGRAMMES

Concerning system installations, collaborative projects are in place in Libya, Nigeria, Eritrea, Congo, Italy. They relate mostly to rural elecrtrification, with an increasing effort on building integration and urban applications.

In the field of training, links in place include Centres and organisations in Libya, Algeria, Congo, China,

Concerning co-operation in R&D, projects and activities are being carried out with organisations in Australia, Europe and the US.

SERVICES

1) Standard and special tailored Cells, Modules and Systems, to satisfy any need (included "architectural" photovoltaic modules to be used as construction elements, like facades, roofs, terraces, etc).

2) Feasibility studies including After-sale Assistance and Training Activities.

ORGANISATION

Eurosolare is structured in 5 branches, under the direct control of the President and CEO, Mr. Cainer, namely:

1. *– Administration & Finance: Mr. G. Santucci*
2. *– Personnel & logistics: Dr. D. Egidi*
3. *– R&D: Dr. F. Ferrazza*
4. *– Technical operations: Dr. G. Alessi*
5. *– Commercial operations: Ing. E. Fioravanti.*

The Present Status of PV Development in Japan

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In response to the agreement reached at COP3 to reduce CO_2 emissions-the Kyoto Protocol, Japan's long-term Energy Outlook was recently revised, including the upward revision of the national target of installed Photovoltaic (PV) capacity to 5GW by FY2010.

The New Energy and Industrial Technology Development Organization (NEDO) is conducting research and development (R&D) on PV power generation systems under a national plan called the "New Sunshine Program," directed by the Ministry of International Trade and Industry (MITI). The R&D program aims at the deployment and dissemination of PV applications through development of both solar cells manufacturing technologies and PV power generation systems. Besides NEDO's involvement in national projects, international undertakings involving demonstration projects, information exchange and research projects are carried out in cooperation with several countries. Demonstration projects, by way of illustration, are executed with developing countries in Asia where significant results have been obtained.

In parallel with such R&D, promotion is an essential means to enhance the PV market. Domestically, NEDO conducts field test projects, subsidy programs and advisory projects directed at the industrial sectors and local governments. Consequently, the Japanese government finances both the technological development and promotion to enhance PV deployment and dissemination.

List of Participants

Expert Group Meeting on "Networking of PV Systems and Applications"

Photoenergy Center, Faculty of Science, Ain Shams University, Cairo, Egypt 26-28 April 2000

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