PROCEEDINGS OF THE FIRST SEDE BOQER WORKSHOP ON SOLAR ELECTRICITY PRODUCTION 23-24 FEBRUARY 1986

Editor

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Organized by:

The Applied Solar Calculations Unit
The Jacob Blaustein Institute for Desert Research
Ben-Gurion University of the Negev

Under the Patronage of

* The Israel Ministry of Energy and Infrastructure
* Ben-Gurion University of the Negev
* The Blaustein International Center for Desert Studies

INTRODUCTION

On 19th November 1985, The Israel Ministry of Energy and Infrastructure laid the corner stone, at Sede Boqer, for a national test site which will explore the potentiality of solar electricity generation for this country. This event, honoring the vision of the late David Ben Gurion and coming at a period when the country faces no particular energy crisis (that it has not always faced!), presents the Israeli solar science community with a remarkable opportunity and, at the same time, a grave obligation.

The opportunity is the chance to build on more than a decade of accumulated international knowledge. Many expensive errors and short-cuts were made in various parts of the world in a mistaken attempt to arrive at a quick alternative to oil energy. Those errors, accompanied by a lavish budget, have led to an over-reaction against solar energy and a consequent slow-down in the rate at which solar research is now being conducted. We all obviously rejoice at the new opportunities that such a Solar Center will provide for exploring new ideas.

But accompanying the promise is a grave responsibility we bear to our colleagues of the future. For we neither have the "excuse" of an oil crisis, nor can we claim to be ignorant of the wealth of published results that fill the libraries of all of us. By establishing such a facility at a time like this, the government is providing us with the opportunity to work systematically towards the goal of solar electricity generation. If, at Sede Boqer, we will merely repeat mistakes that have been made before, solar research in Israel could well be set back for generations.

This is the background to the first workshop in a series ASCU plans to hold regularly, in order to bring together all people who are active in the field. It is hoped that the result of these workshops will be continuous, up to date information on <u>all</u> relevant aspects of the problems associated with solar electric power generation. In this way the new Center will stand the maximum chance of succeeding in its appointed task.

The first workshop was devoted to three aims:

A thorough review of the subject,
An in-depth discussion on what is to be done at the Center,
The formation of working groups on the various technologies.

The present volume of proceedings contains the full texts of Dr. Dickstern's presentation on the overall energy picture in Israel, and the editor's review of solar power stations in various parts of the world. In addition, extended abstracts (supplied by most of the speakers) are reproduced in order to provide an indication of the breadth covered in this first workshop.

Three of the lectures presented first hand information about the performance of the largest solar power stations of their respective

technologies. These were the contributions by Mr. Benny Doron on the 5MW solar pond at Bet Haarava, by Mr. Micky Margalit on the 14.7MW solar thermal facility "SEGS-1" at Dagget, and by Dr. Elliot Berman on the 6.5MW photovoltaic facility at Carissa Plains. These particular presentations evoked such keen interest that an edited version of the tape recorded discussion that followed has been appended to each of the abstracts.

To the abstracts of delivered papers the editor has appended two further contributions kindly supplied by Professors Rina Reisfeld and Aharon Roy, who were unable to attend the workshop in person. Lastly, a contribution on the relative economics of the various technologies as they stand today, provided by Dr. Harry Tabor, is also included.

In the discussion session it became clear that the new Solar Center will have two tasks. The immediate one is to be an independent test site for supplying up-to-date information on the actual capabilities of the various forms of solar electricity-generating technology under Negev conditions .

The second task is to coordinate a national research program which will stimulate progress in this important area. To this end, three working groups were established as follows:

* Low temperature solar thermal: Hon. Chairman - Dr. H. Tabor.
* Higher temperature solar thermal: Hon. Chairman - Prof. A. Roy.
* Photovoltaics: Hon. Chairman: Prof. Y. Applebaum.

In addition, ASCU is to coordinate and supervise the test program at the Center. The purpose of the working groups is to prepare recommendations for the long-term research program of the Center. Those interested in participating in working group activities, including the design of the test program, are invited to contact the respective honorary chairmen.

Finally it is our pleasant duty to acknowledge the help that ASCU received in the organization of this workshop: To Prof. Jaim Wishniak for suggesting that we hold a workshop; To the Israel Ministry of Energy and Infrastructure and to the Blaustein International Center for Desert Studies, for their financial support; To Mr. Artur Isenberg for donating 50 copies of KIDMA "hot off the press"; To Dr. Yair Etzion for some last-minute art work; To Prof. Ilan Troen for the use of the Ben Gurion Research Institute's auditorium, and to Ofra Faiman, June Hare and Carol Troen for their voluntary hostess work.

The Applied Solar Calculations Unit,
Sede Boqer,
June 1986.

Note to the reader: For your convenience, all English language contributions have been grouped together in the left half of this volume and Hebrew language contributions have been placed on the right.

PROGRAM

February 23
19:00-22:00 Evening Session:

Greetings in the name of Ben Gurion University of the Negev (Prof. Arnon Shani, Deputy Rector, Ben Gurion University of the Negev)

Greetings in the name of the Sede Boqer Campus for Science and Education (Dr.Shabtai Dover, Deputy Director, The Jacob Blaustein Inst. for Desert Research and Deputy Manager, Taagid Midreshet Sede Boqer)

KEYNOTE REVIEWS:

Development of local energy sources in Israel (Dr. Pinchas Glickstern, Chief Scientist, The Ministry of Energy and Infrastructure, Jerusalem) [In Hebrew]

Solar electric power stations - a review (Prof.David Faiman, Applied Solar Calculations Unit, Jacob Blaustein Inst. for Desert Research, Sede Boqer)

February 24
08:15-10:00 Session 1: SOLAR SYSTEMS WITH STORAGE

Chairman: Dr. Harry Tabor,
Scientific Research Foundation,
Jerusalem.

Summary of one year's performance at the Bet Haaravah power station (Mr. Benny Doron, Ormat, Yavne) [In Hebrew]

Photoelectrochemical cells: Review (Prof.Gary Hodes, Dept. of Materials Research, Weizmann Inst, Rehovot)

Storage systems for solar cells (Prof.Jost Manassen, Dept. of Materials Research, Weizmann Inst, Rehovot)

Influence of insolation fluctuations on electricity storage (Prof. Yair Zarmi, Applied Solar Calculations Unit, Jacob Blaustein Inst. for Desert Research, Sede Boqer) [In Hebrew]

Effect of large scale electrical storage on the development of alternative energies (solar electric, wind, etc) (Prof. Aharon Nir, Applied Solar Calculations Unit, Jacob Blaustein Inst.for Desert Research, Sede Boqer)

10:30-12:00 Session 2: HIGH TEMPERATURE SOLAR THERMAL

Chairman: Prof. Israel Dostrovsky,
Dept. of Isotopes,
Weizmann Institute, Rehovot.

Performance of the system SEGS1 during its first year (Mr. Micky Margalit, Luz, Jerusalem) [In Hebrew]

Combination of concentrating collectors and alternate energy sources, for electricity production (Dr. Eytan Yanir, Paz, Haifa) [In Hebrew]

Fixed mirror, spherical, concentrating collector for intermediate temperatures (Prof. Gershon Grossman, Solar Energy Lab, The Technion, Haifa) [In Hebrew]

Potential of collectors of the central receiver type for electricity production (Mr. Michael Epstein, Center for Energy Research, Weizmann Inst, Rehovot) [In Hebrew]

Availability of solar radiation (global and beam) in the Beer Sheva region (Dr. Avraham Kudish, Dept. of Chemical Eng, Ben Gurion Univ, Beer Sheva)

Measurement of solar radiation at Sede Boqer and comparison with Beer Sheva data (Dr. Avraham Zangvil, Desert Meteorology Unit, Jacob Blaustein Inst. for Desert Research, Sede Boqer) [In Hebrew]

Study of different MHD systems with liquid metals utilizing solar energy (Dr.Yishajahu Unger, Center for MHD Studies, Ben Gurion Univ, Beer Sheva)

13:30-15:00 Session 3: PHOTOVOLTAIC SYSTEMS

Chairman: Prof Arie Braunstein,
Faculty of Engineering,
University of Tel Aviv.

High efficiency via multi-layer single-crystal solar cells (Prof. Enrique Greenbaum, School of Physics and Astronomy, Univ. of Tel Aviv)

Photovoltaic cells: Review (Prof. David Cahan, Dept. of Structural Chemistry, Weizmann Institute, Rehovot)

Canonical model of dc motor to P-V array tracking (Dr Sigmund Singer, Engineering Faculty, Univ. of Tel Aviv

Methods for connecting photovoltaic systems to the AC grid network (Prof. Michael Slonim, Electrical Eng. Dept, Ben Gurion Univ, Beer Sheva) [In Hebrew]

The degree of load mismatch with photovoltaic systems (Prof.Joseph Applebaum, Eng. Faculty, Univ of Tel Aviv) [In Hebrew]

The potential of photovoltaic systems for Israeli domestic use (Dr.Michael Schaal,Israel Elec.Co,Haifa)

Photovoltaic power generation on the megawatt scale (Dr. Elliot Berman, Arcosolar, USA, and Sonarco, Haifa)

15:30-17:00 Session 4: PANEL DISCUSSION

Chairman: Dr. Pinchas Glickstern,
Ministry of Energy and Infrastructure,
Jerusalem.

a. The systems that should be investigated.

b. Short-term goals for the Test Center.

c. Long-range experimental aims.

d. Establishment of informal working groups.

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