



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

C7455

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

Distr.
LIMITED
UNIDO/IOD.73
23 February 1977
ORIGINAL: ENGLISH

Expert Group Meeting on the Existing
Solar Technology and the Possibilities
of Manufacturing Solar Equipment
in Developing Countries

Vienna, Austria, 14 - 18 February 1977

CONCLUSIONS AND RECOMMENDATIONS ^{1/}

Organized by

United Nations Industrial Development Organization (UNIDO)
in co-operation with Austrian Solar and Space Agency (ASSA)

^{1/} This document has been reproduced without formal editing.
The Final Report of the meeting will be released at a later date.

INDEX

Section 1	Introduction	1
Section 2	Solar Energy: The potential and possibilities	5
Section 3	A brief analysis of Solar Technology	3
	(I) Solar flat plate collectors and Solar water heaters.	3
	(II) Solar distillation	9
	(III) Solar cooking and drying	11
	(IV) Solar refrigeration and Air-conditioning	13
	(V) Transformation of Solar Energy into Mechanical Energy.	14
Section 4	Recommendations: A plan of action by UNIDO.	17
Annex A	List of participants	23

Section 1

INTRODUCTION

1. "The Expert Group Meeting on the Existing Solar Technology and the possibilities of manufacturing Solar Equipment in Developing Countries" organized by the United Nations Industrial Development Organization (UNIDO) in co-operation with Austrian Solar and Space Agency (ASSA) met at Vienna, Austria from 14 - 18 February 1977.
2. The Expert Group Meeting was inaugurated through welcome addresses by a UNIDO representative on behalf of Dr. Abd-El Rahman Khane, Executive Director, UNIDO, by Dr. Schreiber on behalf of Dr. Wilhelm Grimburg, Director General of Austrian Federal Ministry of Science and Research, and by Dr. Gerhard Faninger of Austrian Solar and Space Agency. These welcome statements expressed a deep concern about the need to conserve energy and the need to explore possibilities of utilization of non-conventional sources of energy. The hope of a possible application of Solar Energy to the needs of developing countries both in the industrial field and for the uplifting of living standards with special reference to rural population, was expressed. The Executive Director, UNIDO, in his Welcome Address, specially thanked the Government of Austria and also the Federal Ministry of Science and Research and the Austrian Solar and Space Agency for their continued interest, co-operation and financial contribution in the organization of this Expert Group Meeting. The Executive Director referred to the directives of the Round Table Ministerial Meeting on Industrial and Technological co-operation among Developing Countries held at New Delhi (4 - 8 January 1977) that UNIDO should initiate an action programme in the field of energy. He also stated that this Expert Group Meeting on Solar Technology is UNIDO's first step towards crystallization of UNIDO's activities in the field of Energy and for launching a meaningful programme of action which will be most beneficial to the needs of the developing countries. He expressed

his confidence that the deliberations of the Expert Group Meeting will result in practical recommendations which will guide UNIDO in formulating an effective programme of action in the field of Solar Technology.

3. The Expert Group unanimously elected Dr. Gerhard Faninger, Austrian Solar and Space Agency as the chairman, Dr. E.A. Farber of Solar Energy and Energy Conservation Laboratory, University of Florida, U.S.A. and Dr. V.G. Bhide, National Physical Laboratory, India as Vice-Chairmen, and Dr. A.A.M. Sayigh of College of Engineering, Riyadh, Saudi Arabia as the Rapporteur.

4. The Expert Group Meeting was attended by a total of 33 members. From the eleven international invited experts, nine had experience in applied Research and Development and two had experience in manufacturing technology. In addition, there were eleven participants from the Austrian Solar and Space Agency, Vienna; one from the Food and Agricultural Organization of the United Nations, Rome; one from the Industrial Development Centre of the Arab States, Cairo; one from the International Institute for Applied System Analysis, Austria; seven from the United Nations Industrial Development Organization, Vienna and three observers in attendance at the meeting. The experts and observers' participation was on the basis of their individual capacity and not as representatives of their countries or commercial interests.

5. The objectives of the Expert Group Meeting were as follows:

- Evaluation of the existing technology in the field of solar energy in order to define the appropriate technology for the developing countries;
- Elaboration of a programme of technical assistance aiming to develop the utilization of solar energy, to intensify R and D, to initiate the manufacture of equipment and to strengthen the transfer of technology among developing countries.

6. The Agenda of the meeting concentrated on the needs of the Developing Countries and on the elaboration of an action programme with major emphasis on:

- Identification of institutions in developing and developed countries;
- Practical R and D programmes;
- Development of prototypes, specifications and standards;

- Manufacturing promotion;
- Technology transfer from developed countries to developing countries;
- and Co-operation among developing countries.

7. The technical discussions during the meeting covered the various aspects such as:

- solar water distillation
- water heating
- drying
- cooking
- refrigeration
- and conversion of solar energy into mechanical energy and solar pumping.

Relevant Technical papers were presented by some of the experts and participants. The summary of overall analysis of the possibilities and the possibilities of Solar Energy is presented in Section 2. A brief analysis of Solar Technology is presented in Section 3.

8. The deliberations at the Expert Group Meeting were directed towards formulating recommendations which will guide UNIDO in development of an effective programme of action towards:

- Development of specific individual projects in co-operation with participating organizations;
- Development of an integrated solar energy technology utilization programme/project either on regional or inter-regional basis with specific reference to the needs of the developing countries;
- Co-operation among developing countries;
- and Technology transfer from industrialized countries.

9. Based on the discussions, the Expert Group has analysed the Solar Technology field with the following highlights in their analysis:

- State of the Art
- Applicability
- Availability : Commercially
- The relevance to the needs of developing countries

- Transfer of Technology: Commercial and Institutional
- Research and Development
- Co-operation among Developing Countries

The Expert Group's recommendations, especially a plan of action for UNIDO, is detailed in Section 4.

10. The Expert Group also had the benefit of exchange of views with Dr. Abd-El Rahman Khane, the Executive Director, UNIDO, who is personally interested in this subject. Dr. Khane expressed his great concern on the need for conservation of conventional sources of energy with special reference to fossil fuels and the urgent need for development of other non-exhaustible sources of energy of which Solar Energy holds a great future and promise.

11. The Expert Group also had an opportunity of elaborating their views with the Austrian Press during a specially arranged Press Conference. The Press showed a great interest in the subject of Solar Energy and has given a significant coverage for this meeting in the Austrian press and allied mass media.

12. The Expert Group concluded its work with the adaptation of this document "Conclusion and Recommendations". The Representative of the Executive Director, UNIDO and of the Austrian Solar and Space Agency during the concluding session thanked the experts for participating in this meeting with UNIDO and ASSA and for promoting a common endeavour for establishing an international platform for appreciation, technological information extension, applied R and D encouragement, technological assessment and manufacturing promotion in the field of Solar technology with special reference to the needs of the developing countries. The experts and other participants thanked UNIDO, the Government of Austria, the Federal Ministry of Science and Technology and ASSA for organizing this Expert Group Meeting, for inviting them to participate and for the extended hospitality.

Section 2

SOLAR ENERGY: THE POTENTIAL AND POSSIBILITIES

1. The Expert Group recognized that energy is an integral problem of industrialization. Therefore, within the context of the aspirations of the developing countries to achieve the target of having a 25% share in the world's industrial production by the year 2000, the Expert Group recognized the importance of effective and accelerated development of solar technology and promotion of eventual local manufacture and appreciates the initiative of UNIDO in this subject with the primary objective of promoting the accelerated process of industrialization of the developing countries, with due consideration to their needs, level of institutional infrastructure and technological capabilities. In this connection, the Expert Group Meeting has noted that the "Round Table Ministerial Meeting on Industrial and Technological Co-operation among Developing Countries" held at New Delhi from 4 - 5 January 1977, has requested UNIDO to launch the "creation of programmes of co-operation concerning applied research and development activities in specific sectors, drawing upon machinery and capabilities already available in the developing countries", and energy is one of the major areas recommended by the Round Table Ministerial Meeting. Therefore, this Expert Group is happy to note that this Expert Group Meeting is UNIDO's first step towards crystallization of UNIDO's activities in the field of Energy and for launching a meaningful programme of action which will be most beneficial to the needs of the developing countries.

2. The Expert Group shares the concern of the developing and industrialized countries on the need for conservation of conventional sources of energy, with special reference to fossil fuels, and recognized the importance of development of non-conventional sources of energy. Although the sources of such energy are wind, Bio-gas, Solar, Geo-thermal, tidal, etc., the Expert Group recognized the potential of solar energy which is non-exhaustible and abundant in developing countries. The need for utilization of fossil fuels for other important product manufacture such as fertilizer, drugs and pharmaceuticals, chemicals, pesticides, plastics, etc. rather than as a source of energy is well recognized. In the developing countries there is also a need to prevent deforestation through non-judicious utilization of wood as a fuel. Need to use animal dung as a manure rather than as a fuel is also well recognized.

3. Therefore, the need for the development of a programme for applied R and D and eventual manufacturing activity with emphasis in Technology transfer from industrialized countries, domestic promotion of R and D capabilities as well as co-operation among Developing Countries in the field of solar technology is very essential. Although the basic concepts in Solar Technology are centuries old, the industrial/commercial application of these techniques has received a great deal of interest both by industrialized and developing countries and also including oil producing countries.

4. The concept of economic analysis on Solar technology and equipment requires a different philosophy and approach. As commercial manufacture is still in the early stages and not too wide spread, the analysis on optimum economic level of production can not be established at the present time. It is to be recognized that the initial cost of Solar equipment is higher than similar normal conventional products. However, the operating costs for Solar equipment is far less in comparison.

5. It is also to be noted that the major problems in Solar technology development and product design and product manufacture are a) the technology is new and in general there is a lack of knowledge on what can be done and how it can be used, b) the relevant products and equipment are not yet readily available on a commercial basis on an extensive scale and c) the equipment initial cost is high probably due to limited production scale.

6. In general, it is to be recognized that a limited number of solar products are commercially manufactured in a few industrialized countries and a couple of developing countries. There is a need for information extension and evaluation of performance on site in interested developing countries and eventual investment promotion. In addition, there are a number of Institutions in both developing and industrialized countries which have engaged in applied research and have come up with relatively technologically sound prototypes. There is a need for intensive evaluation of prototypes, testing and transformation into manufacturing prototypes, with significant emphasis on the needs of developing countries. It should also be added that there is a need for twinning of such research and development institutions in selected industrial and developing countries in the field of Solar technology. Thirdly, there is a need to

develop integrated programmes of action within the framework of co-operation among Developing Countries. In this connexion, there is a need for strengthening existing selected institutions in selected developing countries and transforming the same into "centres of Excellence" with a view towards assisting other developing countries.

7. In addition, there is also a need to develop a programme of information extension and popularization of Solar technology in the developing countries. In this connexion, the Governments of the developing countries should also take the necessary steps to initiate a modest programme in Solar technology and assign such a programme to a local institution (together with the necessary finances and technical manpower) with directives towards launching an effective R and D programme with co-operation from other institutions and manufacturers. Assistance from industrialized countries, UNIDO and other appropriate developing countries is necessary for development of such activities in interested developing countries.

8. Thus there is a need to develop programmes to suit the needs of individual developing countries and also to promote regional/inter-regional co-operation in the field of Solar technology. This will include information extension, information collection and analysis, applied R and D, evaluation and manufacturing promotion.

- - -

Section 3

A BRIEF ANALYSIS OF SOLAR TECHNOLOGY

1. SOLAR FLAT PLATE COLLECTORS AND SOLAR WATER HEATERS

i) **State of the Art:** Solar collectors are essential components of most Solar Energy devices. Indeed, quite a substantial fraction of the cost of Solar devices is covered by the cost of the collectors. Collectors should have high performance and economics. Flat plate solar collectors have been developed in several countries over the last several years. Design parameters of flat plate collectors are fairly well established. However, research and development to improve the efficiency and reduce the costs of the collectors will have to be pursued with vigour. The guidelines for the design of solar collectors are available in standard texts. These have been adequately presented in a paper in this Expert Group Meeting.

Solar water heaters are an extension of solar collectors and are the simplest of the solar energy devices. Several commercial concerns both in developed and developing countries are manufacturing solar water heaters. These are extensively available in many countries. The Expert Group feels that the technology for the fabrication of solar water heaters is well established and can be translated into commercial production both in developing and developed countries.

ii) **Assessment of Applicability:** Solar collectors form an essential component of most solar energy devices and therefore need highest consideration. It is essential for any country desirous of utilizing solar energy to set up commercial production of flat plate solar collectors. The solar water heaters have utility both for household consumption of hot water as well as in industrial heating. The technology for fabricating solar water heaters both industrial and household has relevance both to the needs of the developing and developed countries.

iii) **Commercial Availability:** Flat plate solar collectors are commercially available in a number of countries. The technology for making flat plate

- - -

collectors and solar water heaters can be easily transferred to those countries which do not have the know-how. It is desirable to promote commercial production of both solar collectors and solar water heaters.

iv) Relevance for Developing Countries: As stated earlier, flat plate collectors form an essential component of most solar energy devices and consequently need to be given highest priority. The Expert Group feels that solar energy itself has great relevance to the needs of the developing countries and therefore strongly recommends that the flat plate collector industry should be promoted.

v) Transfer of Technology - Commercial and Institutional: As stated earlier, the technology for making flat plate collectors is extensively available in a number of developed countries and in a few developing countries. Commercial transfer of technology is feasible and has indeed taken place in a few cases. It is possible to develop flat plate collector industry in a developing country as a joint venture. The Expert Group recommends that institutional collaboration between the developing countries themselves and between the developing and the developed countries be promoted vigorously. Every help should be given to the country in which technological know-how is available to put flat plate collectors and solar water heaters into commercial production.

vi) Research and Development: It is of utmost importance that research and development be vigorously pursued with the view towards increasing the efficiency and to reduce the cost of solar collectors and solar water heaters. There is a need for institutional collaboration among the developing countries for research and development on flat plate and other types of collectors.

vii) Co-operation among Developing Countries: Commercial and institutional transfer of technology for making solar collectors and solar water heaters should be encouraged among the developing countries.

II. SOLAR DISTILLATION

i) State of the Art: Solar distillation can be subdivided into two major approaches: a) simple basin-type solar stills and b) solar-assisted distillation. The first approach is a proven technology and many installations

exist around the world. Solar-assisted distillation is a combination of solar collectors and distillation equipment. This combination of both has not been tested, even though the two main components have been sufficiently tested.

ii) Applicability: Technology of simple solar stills is developed sufficiently to be used anywhere it may be needed. The unit surface cost is relatively independent of size. The capacity of the largest still in the world is under 30 m^3 freshwater production per day. Labour and most of the materials required for the implementation are available locally in the developing countries. Technology of solar-assisted distillation has a favourable economy of scale. The capacity should be of the order of 200 m^3 /day or more on the basis of existing technology. Further development and scale-up of existing evaporators could fill the gap between 30 m^3 and 200 m^3 /day. Construction of plants based upon technology envisaged in solar-assisted distillation could be carried out in most developing countries with the assistance of the appropriate expertise. However, some sophisticated components can be obtained from the world market.

iii) Availability: Some designs of simple basin-type stills are available commercially, however, durability is not proven. The components in solar-assisted distillation are available commercially, but economic consideration for each separate application must be given.

iv) The relevance to developing countries: The arid zones of the world, where insolation levels are high, are mostly in the developing countries. Consequently, solar distillation seems to be specifically relevant to these countries now and even more so in the future.

v) Transfer of technology - Commercial and Institutional: Technology of simple solar stills can be immediately implemented. The technology for the components of the solar-assisted distiller exists in some developing countries and can be easily transferred to most.

vi) Research and Development: Action programmes must be undertaken by developing countries as soon as possible. The programme should include the

following:

- in particular the testing of materials of construction for solar stills, collectors, etc. obtainable locally and quantifying the effect of different levels of maintenance
- investigating the effect of coupling of solar collectors to sea water distillation equipment already installed in their countries
- investigate both theoretically and experimentally possible methods of improving the performance of existing large scale plants
- investigating solutions to problems of heat storage and transient behaviour of distillation plants

III. SOLAR COOKING AND DRYING

i) State of the Art: Small scale Solar drying technology is relatively well established with a considerable amount of R and D activities having been undertaken for a considerable number of years. Larger scale Solar drying techniques and systems, using equipment to facilitate and enhance the drying process, as opposed to using natural sun drying, is used in some industrialized countries in particular.

As to Solar cooking, technologies have been developed in the past which operate to a greater or lesser degree of effectiveness. The sociological and cultural factors dominate this field, as well as the availability of Solar radiation at the time when the preparation of food is required. As approximately 80% of the basic energy needs of many of the communities in developing areas is the provision of cooking energy, the serious implications of the deforestation, and subsequent soil erosion, pollution, and the lack of recycling of natural fertilizers has a significant effect on the overall productivities of these areas. Technologies exist today which can alleviate the demand for cooking fuel using solar energy.

ii) Assessment of applicability: The Solar cooking and drying technologies, as discussed above, are not only applicable but necessary. As these technologies, in small scale application must be integrated into the community life, it will not prove successful to parachute alien systems without an appropriate methodology of introduction, compatible with local food traditions.

Hybrid systems combining conventional fuel supplies, such as wood, oil, etc. with solar technology, should be implemented as appropriate options.

iii) Availability - Commercially: Small scale drying and cooking technologies exist today - very few, however, are commercially available in developing countries. In larger scale solar drying technology there is obviously the possibility for more investigation and development of systems. Solar systems are available in a number of developed areas. Large scale solar cooking technology, however, has hardly been touched and would require an adequate local research effort.

iv) Relevance to developing countries: The relevance is tremendous and there do not appear to be inexpensive alternatives to conventional fuels systems available in the rural areas of developing countries, which could replace solar drying and cooking. Other non-conventional energy source, such as bio-gas, would be best used to increase the productivity of rural areas, while allowing solar cooking to provide the bulk of the cooking energy requirements.

v) Transfer of Technology - Commercial and Institutional: There certainly is a role for the exchange of commercial information on the availability of materials and processes, though in small scale applications, it would appear that local fabrication will no doubt be taking precedence.

vi) Research and Development: In the field of solar drying there is a considerable scope to investigate total systems including solar energy collection, storage, and drying chamber heat and mass transfer conditions. The systems approach should be given precedence as these technologies exist to a large extent.

In the field of solar cooking there is considerable scope in both large and small scale systems development. In both solar cooking and drying technology the introduction of local materials is critical. This should not be done to the exclusion, however, of materials which might enhance considerably the performance and facilitate the introduction. This might require a structural change in foreign aid or scarce material allocation, such as

the case of copper pipes or other technological systems which have already proven themselves in the application of these techniques.

vii) Co-operation among developing countries: It is essential that the international organizations promote the exchange of experiences between developing countries to a far greater extent. The provision of research funding as well as the sponsoring of written exchange on techniques using these systems is highly recommended.

IV. SOLAR REFRIGERATION AND AIR-CONDITIONING

i) State of the Art: Among the refrigeration processes available, an intermittent low temperature absorption refrigeration system would appear to be the most suitable for Solar Refrigeration. To date, liquid systems have been more extensively tested than other configurations. Basic modifications of well established technology, which in their solar version have been brought to prototype stage, have been tested and adequately described. Other refrigeration technologies seem to lend themselves less to solar modification based on available information. However, the solid absorption cycle systems applicability could be assessed after field test programme analysis is completed.

ii) Applicability: The plant should be constructed and operated at community level, rather than at private household level. The community could be a rural community, which supposedly possesses no electricity, or it could alternatively be a town with electricity. The plant could be used either as a cold storage plant or as a block ice production plant. It could also be used for establishing a chain of cooling centres. There is also a demand for thermally powered refrigeration plants utilizing gas, waste-wood, coal, or geothermical energy as a heat source. The abovementioned process lends itself to these alternatives.

iii) Availability - Commercially: None

iv) Relevance to developing countries: It is a recognized fact that there is a great demand for such refrigeration equipment in all developing countries.

Household air-conditioning may be regarded as a lower priority as compared to industrial air-conditioning and refrigeration plants.

v Transfer of Technology - Commercial and institutional: The liquid plant should be preferably produced in a modular capacity and sizes which can easily be adapted to the local demand. The advantage of using the modular system is the possibility of interchanging components, spare parts, etc. In addition, other systems such as the solid absorption plants are currently under tests or merit further investigation, especially under prevailing conditions of developing countries and performance characteristics and reliability assessed.

It is recommended that an appropriate number of units of the refrigeration plant should be built in a factory in one of the developing countries. Thereafter, these units should be sent out to a number of selected institutions of a few developing countries for through testing and then testing under actual use in a few rural communities.

V. TRANSFORMATION OF SOLAR ENERGY INTO MECHANICAL ENERGY

i. State of the Art: A number of systems as per the information available are either working, or under test or in the design stage. Around 50 units of 1 kw organic vapour, rankine cycle systems are working and the technology is being improved upon. 2 - 10 kw units with organic vapour rankine cycle systems with rotary machine or screw expander or reciprocating engine or spiral expanders have been designed, prototypes fabricated and limited testing is underway by selected institutions/organizations in a few industrialized countries and developing countries. Techno-economic assessment of such designs could be made only after sufficient prototypes are tested under field conditions for sufficient duration.

ii. Assessment of Applicability: As of today, no system is fully proven and can be put into mass production. However, these devices are technically feasible and some pumping units are operating under field conditions. Technological development is still continuing. Systems in the range of 2 - 15 kw are required in the developing countries. These should be efficient, simple to operate and should need very little or no maintenance.

iii) Commercial Availability: Most of the systems have been developed in the laboratory. A number of prototypes have been constructed. Then they should be further tested in the field where they are supposed to be used before any recommendations regarding commercial availability of a reliable system can be made.

iv) Relevance to the developing countries: These systems are extremely relevant to the needs of the developing countries. If systems are made in modular form, they can be used for a variety of purposes such as for pumping - irrigation and drinking water, for driving small machinery and for generation of electrical power. In a large number of developing countries these systems have high priority.

v) Recommendations: It is suggested that UNIDO should, with the help of three - four experts, undertake objective evaluation of the systems available. Based on this evaluation, few prospective systems may be chosen for field trial in two developing countries where infrastructure and testing facilities are available. UNIDO may take further steps, based on these field trials, to promote manufacture of the proven systems in those countries which are willing to put up modeling effort. The technology thus generated should be freely available to the developing countries.

In view of the great importance the developing countries attach to these systems, the Expert Group feels that R and D efforts in both developing and the developed countries be stepped up. The group also feels strongly that these prototypes should be designed and engineered properly so that they would not need any or better maintenance. Some field trials should be encouraged.

Collaboration between developing countries themselves and between developed and developing countries for Research and Development and extension should be encouraged.

vi) Co-operation between developing countries: Co-operation between developing countries in this field may take any of the following forms. All of these should be promoted:

- Co-operation between developing countries for Research and Development.
- Field testing of systems developed in developing countries in other developing countries.
- Horizontal transfer of technology and training between the developing countries.

Section 4

RECOMMENDATIONS: A PLAN OF ACTION BY UNIDO

I. Preamble: The Expert Group recognized that Solar Technology is a multi-disciplinary area of activity with continued potential for successful economic applications in both industrialized and developing countries. Therefore, with due regard to the activities of UNIDO in the encouragement of applied R and D, manufacturing promotion and technology transfer in the field of Solar technology as applicable to the needs of the developing countries, the Expert Group also recognized the fast growing technological advances in this field in industrialized countries and some developing countries, and the Expert Group places a great importance on UNIDO's capabilities of assisting developing countries through continued up-to-date sources of knowledge and effective assessment of fast growing technology.

RECOMMENDATION 1: Therefore, the Expert Group recommends that UNIDO establish an "Advisory Group on Solar Technology" on an honorary basis. Such an Honorary Advisory Group shall consist of selected eminent technical personnel in Solar Technology, both from industrialized and developing countries, and shall act as the "focal point of reference and technical contact" for UNIDO. Each member of the Advisory Group will be requested to advise UNIDO in his individual and honorary capacity in technological information dissemination system. The Advisory Group at the request of UNIDO, will meet on an adhoc basis to discuss specific technical problems, assist UNIDO Secretariat and also be available to render short term Expert Consultancy Services in the field when requested by UNIDO. Such field Services shall be based on a non-conventional financial basis, with a token recognition fee only.

II. Preamble: The Expert Group is of the strong opinion that the Solar technology in terms of scientific and theoretical principles is well established. However, it is the transformation of scientific principles into technological hardware which is still under intensive work in industrialized and a few developing countries. For example, a) only collectors (flat plate and small concentrated type) and water heaters are commercially available, b) the simple water distiller stills, simple dryers and cookers have been

successfully manufactured but have not yet been taken up on industrial production basis primarily due to need for market development and extension, c) the pump system, space heaters (household, industrial, recreational, etc.) dryers compact cookers, solar generators, multi-stage distillers and intermittent low temperature absorption refrigeration systems have been successfully designed and fabricated by a few manufacturers and Institutions, (Any judgement on large scale manufacturing possibilities/investment promotion could be given only after field trials with emphasis on reliability and performance analysis.) d) the refrigeration system (solid absorbers: calcium-chloride and others) and air-conditioners are still in the prototype stage and require further R and D work and field testing of prototypes, e) the central power station system is in conceptual stage and has a great future potential, f) solar cells for space application have been successfully designed, manufactured and used in selected industrialized countries. However, transformation of the same to large scale terrestrial usage requires further technological work to reduce costs. Solar cells, however, hold a great promise to all countries.

Therefore the work of UNIDO in the promotion of Solar technology and eventual manufacturing programmes should be geared up to different levels of "State of the Art" and future potential.

RECOMMENDATION 2: In order to promote the concept of Solar technology and its potential to the developing countries, UNIDO should collect available information and make it available to all developing countries and Institutions in industrialized countries. In addition, UNIDO should launch a programme for preparation of the specific technical manuals (sources of information, State of the Art, etc.) and also organize workshops and initiate fellowships (training) for the benefit of developing countries.

RECOMMENDATION 3: UNIDO should assist developing countries, at their request, in negotiating with foreign manufacturing firms for local manufacture of well-established commercial products, with emphasis on assessment of technology, suitability for local application, performance evaluation through local testing and commercial/techno-economic negotiations in manufacturing. It is recommended that at the request of the developing country, UNIDO become

the active adviser in all such negotiations with a view towards achieving a most satisfactory agreement with due consideration to the interests of the developing countries.

RECOMMENDATION 4: UNIDO should actively associate with the programmes of development of selected R and D Institutions of industrialized countries and also of selected developing countries, with reference to products that have been fabricated but require further testing. In this connexion, UNIDO shall act as an active partner in twining of institutions in industrialized and developing countries and assist in installation of such prototypes in developing countries through testing and techno-economical evaluation. Assistance in transformation of the test prototypes to "commercial manufacturing prototypes" is also necessary. UNIDO shall also assist the Institutions of developing countries in securing such a technology and in manufacturing promotion. In this connexion, UNIDO at the request of developing countries, should depute appropriate experts to assist the governments in formulating such an integrated programme and also assist in the effective realization of the same.

RECOMMENDATION 5: UNIDO, through active association with Selected R and D Institutions of industrialized countries shall assist R and D Institutions of developing countries in keeping informed about the activities in the conceptual stage and of activities which have a great potential future.

III. Preamble: The Expert Group - taking into account the required level of technological infrastructure, the continuous technological changes that are taking place and the need for adaptation of technologies and prototypes through field testing, as well as laboratory analysis, adaptation, negotiation for local manufacture and local entrepreneurship development - attaches a great importance on technology transfer from industrialized countries as well as co-operation among developing countries.

RECOMMENDATION 6: The Expert Group recommends that UNIDO assist all interested developing countries at their request to establish or strengthen appropriate national Institutions with emphasis on applied R and D, evaluation of technologies, negotiations on manufacture and local entrepreneurship development.

The work programmes should take into consideration the local needs, level of technology, product priority and potential, and operate on the basis of technology transfer from Institutions of industrialized countries, with emphasis on co operation among developing countries, with a view towards developing local capabilities. In this connexion, UNIDO shall assist the developing countries in making judicious decisions with respect to programmes on Solar Technology development, both R and D institutional, investment promotion and manufacturing promotion.

RECOMMENDATION 7: In order to a) promote co-operation among developing countries, b) to mobilize technological and financial resources, c) to promote the concept of self-reliance and d) to effectively utilize the technological accomplishments and capabilities of selected developing countries for the benefit of other developing countries, it is recommended that UNIDO strengthen appropriate existing Institutions in selected developing countries (which have technological, industrial and infrastructural capabilities) and transform the same into "Solar Energy Centres of Excellence" with the objective of developing an applied R and D programme for the benefit of other interested developing countries. Therefore, the Expert Group recommends that UNIDO ascertain the interest of selected potential developing countries in being associated in this programme, to become one in the nucleus of the activities within the framework of co-operation among developing countries and assist the local Institutions to develop an integrated work programme of applied R and D, assessment of technologies, evaluation of prototypes and products, disseminate technological information and techniques, train technical personnel from other developing countries and promote entrepreneurship development. Such "Centres of Excellence" should also make available prototypes and designs and technologies to other developing countries, engage in co-operative evaluation and develop a programme for eventual local manufacture of appropriate products with due emphasis on relevant technology. In this connexion, UNIDO should also develop a co-operative programme between two such "Centres of Excellence". It is also strongly recommended that UNIDO activities promote co-operation and transfer of technology to such "Centres of Excellence" by Institutions and manufacturers from industrialized countries.

IV. Preamble: The Expert Group is of the strong opinion that practical use of Solar energy has become a reality and that the world today has entered this threshold. It is a technology with great potential and it is of great benefit to the needs of developing countries. The work will require applied R and D, technology assessment, prototype field analysis, assessment of reliability of products, including techno-economic and cost analysis, development of manufacturing technology, entrepreneurship promotion and eventual local manufacture. Therefore, the Expert Group is of the opinion that UNIDO should take leadership and initiative and develop an integrated programme of action.

RECOMMENDATION 8: It is recommended that UNIDO develop an integrated short term and medium term action programme for the benefit of developing countries. In this connexion, it is recommended that UNIDO develop a co-operative programme with Institutions and manufacturers in industrialized countries as well as in developing countries. Special emphasis is to be paid to co-operation from other U. organizations and agencies, as well as appropriate inter-governmental and non-governmental organizations.

RECOMMENDATION 9: It is recommended that the governments of developing countries give sufficient priority on initiation of a programme of action in the field of Solar technology. This may require allocation of a Solar technology programme to an existing appropriate institution and provision of relevant finances and technical manpower and development of a practical work plan. In addition, it is also recommended that the governments, through existing meteorological Institutions, initiate the necessary steps for collection of appropriate data, with a view towards assisting and guiding a Solar technology programme.

RECOMMENDATION 10: It is recommended that UNIDO take an active role with the governments of industrialized countries on the concept of initiation of appropriate integrated activities through UNIDO for the benefit of developing countries. In this connexion, the Expert Group strongly urges that UNIDO initiate a programme to secure financial contributions from industrialized countries for integrated Solar Energy projects and initiate meaningful and effective plans of action.

RECOMMENDATION 11: As finances are most important for initiation of any Solar technology programme, it is recommended that governments of developing countries earmark appropriate finances for such an activity. In addition, it is also recommended that UNIDO initiate a programme to secure appropriate contributors (finances and in kind: physical facilities, technology, etc.) within the framework of co-operation among developing countries.

Expert Group Meeting on the
Existing Solar Technology and
the Possibilities of Manufacturing
Solar Equipment in Developing
Countries

(Organized by UNIDO in co-operation
with the Austrian Solar and Space
Agency (ASSA))

14 - 18 February 1977
Vienna, Austria

ANNEX A

LIST OF PARTICIPANTS

1. Mr. B. Tleitmat
Principal Development Engineer
Sea Water Conversion Laboratory
47th and Hoffman Blvd.
Richmond, California 94804
USA
2. Mr. A. Eggert-Lura
A/S International Solar Power Co. Ltd.
22B Rosenkaeret
2860 Søborg
Denmark
3. Prof. Ing. Carlo Mustacchi
19 Via Trinita dei Pellegrini
00186 Rome
Italy
4. Dr. A.A.M. Sayigh
College of Engineering
P.O. Box 800
Riyad
Saudi Arabia
5. Mr. T. A. Lawand
Brace Research Institute
MacDonald College of MacGill University
Ste. Anne de Bellevue HOA 1CO
Quebec
Canada
6. Dr. E.A. Farber
Professor and Research Professor
Solar Energy and Energy Conversion Laboratory
Department of Mechanical Engineering
University of Florida
Cainesville, Florida 32611
USA

7. Dr. V.G. Bhide
Deputy Director
National Physical Laboratory
New Delhi
India
8. Mr. M. Posnansky
POLISOLA LTD.
Guterstrasse 24
CH-3000 Bern
Switzerland
9. Mr. Jean Paul Durand
Sofretes et Mengin
Zone Industrielle d'Amilly
85203 Amilly - Montargis
France
10. Dr. H.S. Wagner
Ministry of Research and Technology
Streschmannstrasse 2
P.O. Box 1 0370
53 Bonn/Bad Godesberg
Federal Republic of Germany
11. Dr. Kamaledin Hassan
Arab Development Institute
Tripoli
Libyan Arab Republic

Other UN Agencies

12. Mr. W. Van Gilst
Agricultural Engineer
Agricultural Services Division
FAO
Rome
Italy

Other Organizations

13. Ms. Joyti Parikh
International Institute for Applied System Analysis (IIASA)
2361 Laxenburg
Austria
14. Mr. El-Missiri
Industrial Development Centre of the Arab States (IDCAS)
Cairo
Arab Republic of Egypt

Austrian Solar and Space Agency (ASSA)

15. Dr. Wilhelm Grimburg
Director General
Federal Ministry of Science and Research
Währinger Strasse 28
1090 Vienna
Austria (Note: Dr. Schreiber on his behalf)
16. Prof. Gerhard Faninger
Austrian Solar and Space Agency
Garnisongasse 7
1090 Vienna
Austria
17. Dipl. Ing. Manfred Bruck
Austrian Solar and Space Agency
18. Prof. Paul Victor Gilli
Technical University
Kopernikusgasse 26
8010 Graz
Austria
19. Dr. Gangolf Bräunlich
Institut für Umweltschutz
Hilmteichstrasse 75A
8010 Graz
Austria
20. Prof. Franz Viehböck
Institut für allgemeine Physik
Technische Universität
Karlsplatz 13
1040 Vienna
Austria
21. Prof. Erich Panzhauser
Institut für Hochbau und Entwerfen I
Technische Universität Wien
Karlsplatz 13
1040 Vienna
Austria
22. Prof. Hans Kleinrath
Technische Universität
Institut für Elektrische Maschinen
Gusshausstrasse 26
1040 Vienna
Austria

Observers

23. Dipl. Ing. Alois Rechberger
Shell Austria
Rennweg No. 12
1030 Vienna
Austria
24. Prof. Friedrich Pass
Director
Österreichische Mineralöl - Verwaltungs AG
Industriestrasse 15
2320 Schwechat
Austria
25. Mr. D.R. O'Neill
Mattiellistrasse 2 - 4 III
1040 Vienna
Austria
26. Dr. Dreyer
Dornier Systems GmbH.
7990 Friedrichshafen
P.O. Box 640
Federal Republic of Germany

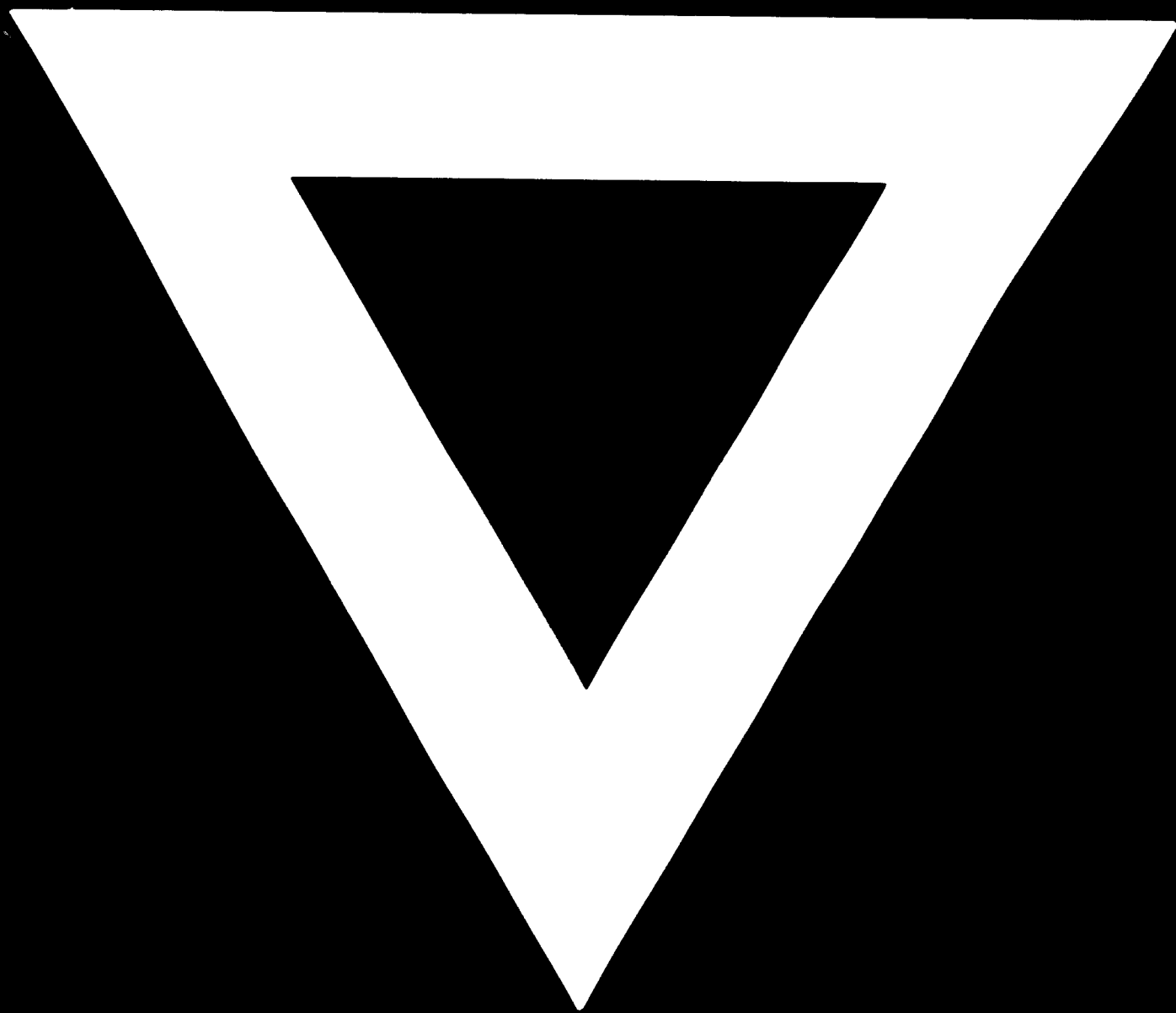
UNIDO Consultant

27. Dr. Ing. A. Takla
Afamia Consulting Engineers
P.O. Box 5107
Abu Dhabi
United Arab Emirates

United Nations Industrial Development Organization (UNIDO) Vienna

28. Mr. G.S. Gouri
Deputy Director
Industrial Operations Division
29. Mr. Swamy Rao A.A.
Senior Inter-regional Adviser
on Engineering Industries
Industrial Operations Division
30. Dr. Milan Delos
Industrial Development Officer
Engineering Industries Section
Industrial Operations Division
31. Mr. V. Akimov
Industrial Development Officer
Engineering Industries Section
Industrial Operations Division
32. Mr. I. Kourochkin
Industrial Development Officer
International Centre for Industrial Studies

C-345



77. 10. 06