

PROGRESS REPORT AND EVALUATION (FINAL)

PILOT PROJECT TO DEMONSTRATE RURAL APPLICATIONS
OF SOLAR ENERGY - C.I.D.E.R.A. (CRS project MA-9D-003B)

Funding Received: \$ 30,000 - part of USAID OPG No. 608-79G-001.
All funds fully accounted for in Final Report
covering total grant prepared in March 1982.

**Other funding -
from C.R.S.:** \$ 19,000 - to cover living travel and
administrative expenses of technicians -
fully accounted for.

Progress of Project Activity since last report (28 February 1983)
and Project Overview

The construction of the solar oven installation at CIDERA, Temara, was completed at the end of April 1983. It comprises a mirror-mounted heliostat with electronic control system, powered by hydraulics, a mirror-mounted concentrator, a twin-chambered bread-baking oven on rails and a tripod-mounted oven for the baking of ceramics. The creation of this installation was made possible by the collaboration of a number of agencies. The USAID OPG funded the purchase of materials; C.R.S. obtained funding from the Geneva Travel Loan and Development Fund for the project's running costs up until June 1982. Qualified solar engineers and technicians have been assigned to the project by GEPOSAT, France (Groupement pour Etude de Fours et Outils Solaires et l'Assistance en Technologies Appropriées); since June 1982 the running costs have been covered by a grant made by the French Ministry of Foreign Relations for use by GEPOSAT; costs of personnel assigned to the project have been borne by the CDER (Centre pour le Développement des Energies Renouvelables), since that organization's participation in the project from mid 1982.

During 1982, and following a series of meetings between the interested parties, ownership of the project site - originally that of the Jesuit Fathers responsible for the Temara Agricultural School - passed, with the management of the school, to the Ministry of Agriculture. However, since the solar installation itself was naturally of greater interest to the Ministry of Energy and Mines, an agreement was drawn up between those Ministries allowing the second full and free use of the installation for an initial period of 2 years, which may be extended indefinitely. A translation of that agreement is attached to this report.

The agency within the Ministry of Energy and Mines responsible for the solar oven is the Centre pour le Développement des Energies Renouvelables, set up in 1981 and based at Marrakech, where its work is at present chiefly in the development of

photovoltaic cells. Moroccan engineers and technicians from the CDER have been assigned to the Temara project since April 1982. The addition of the solar installation (or rather the use of it) to the CDER's facilities is considered of great value in providing wider experience for its technical personnel and in the development of the possible applications of the solar oven in Morocco (see below). In fact, the "acquisition" of such a major facility has been instrumental in giving the CDER a new sense of momentum and purpose, helped not least by the publicity surrounding the Temara solar installation, which has served, at the same time, to make the CDER better known.

An important element in the publicity given to the solar energy installation was that of its official inauguration in the presence of two Government Ministers: Mr. Mousma SAAFI, Minister of Energy and Mines and Mr. Othman DEMNATI, Minister of Agriculture and Agrarian Reform. The ceremony was held at the site on the morning of Saturday, July 23rd and special invitations were extended to members of all participating organizations. Those who represented USAID were Mr. Gary Bricker, Head of Projects, and Mr. Andres del Acedo, Supply Officer. Representing Catholic Relief Services were Mr. Michael SHEEHAN, Director and Mrs. Gigi HRDLICKA, Program Assistant. Mr. Marcel FLICHY, President of GEFOSAT, came from France to attend. Also present were the Director-General of the CDER, Mr. Abdelhaq FAKIHANI, the Director of the Department of Agricultural Education and Research, Mr. Abderrahmane KASSA, and Mr. REGHAE ex-Minister of Finances, as well as the Governor and Caid of the Province of Temara and Skhirat. Not long after this event, one of Morocco's daily newspapers, "Le Matin", published an article on the solar oven - a copy of which is attached to this report.

Present Status of Project

The responsibility for the management of this project now lies with the CDER - the most appropriate Moroccan authority. A budget for the purchase of materials and tools has been made available to the project, along with 3 other CDER projects, by a grant of 23,000 Fr. from the French government organization "Agence de la France pour la Maitrise de l'Energie". Since these funds are in francs, all purchases of materials will be made in France where materials are considerably cheaper (not as at the commencement of the project where the emphasis was laid on local purchasing). Whether funding from Moroccan sources for 1984, for the continuation of the project, will be forthcoming is as yet unknown. Management of present funds is in the hands of the CDER and permission for their disbursement, as well as the authority for any actions to be taken concerning the solar installation, has to come from that organization (in Marrakech) instead of from GEFOSAT (in France) as before. A French "military" volunteer engineer is assigned to the CDER and heads the on-site team, assisted by a Moroccan solar engineer and/or technician assigned to the project by CDER. The contract of the present French engineer, Christophe Cordell, ends in December, but he will be replaced by another volunteer, Jerome Foch, who arrives in December. Also starting work on the project then will be a well qualified Moroccan engineer who is at present receiving special training at GEFOSAT's solar oven site at Montpellier. Immediate plans include the construction of a wind shelter for the Concentrator and the finer tuning of the electronic control system.

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Practical Applications of the Solar Oven

- Bread-baking

As in other sectors in Morocco, the Summer has not been a time of great activity or achievement at Temara. However, since the completion of the solar installation, a first series of experimentation has been successfully completed: that of the baking of bread. These experiments were undertaken in conjunction with a student from the Hassan II Agronomical Institute, who presented a paper on "Bread-making with solar energy" for his end-of-studies thesis, for which he obtained a very good grade. His research had 2 parts, the first consisting of enquiries amongst the city, commercial bakers as to their baking costs (ovens are normally fired by wood or fuel oil) and the second consisting of modifying the baking in the solar oven of a baker's dough to achieve the same quality of finished bread. A jury of tasters were used to judge the results which finally were very successful. It was calculated that the oven as it is now could cook a maximum of 160 loaves (weighing 450 grams/1 lb.) per day, costing at present 1 DH. each. At this rate, and assuming a minimum of 250 days of sunshine a year, the cost of the installation would be amortized in 10 years. Naturally the cost of construction of any future installations should be greatly reduced by virtue of the experience gained on this prototype - and particularly if several were built at the same time. It was also calculated that a modification in the design of the bread-making oven itself - a larger door - would permit the baking of a greater number of loaves at one time and increase the possible number of loaves baked per day to 400. It is possible that another student from the Agronomical Institute will carry out similar work next year with a modified oven.

- Ceramics

The experimental work in hand at present concerns the baking of ceramics. The max. temperature so far gained with the specially-adapted oven is 850°C. Modifications to the shape of the "Pre-heating" chamber are underway to increase the temperature to 1,000°C. This will allow the baking of ceramics in 1 to 2 hours. Artisanal baking methods in use in Morocco - for example at the Sale potteries outside Rabat - are still very primitive, taking 8 - 10 hours, which does not permit of high quality finished products. The team working at Temara hope that their work in this area will be taken notice of by Morocco's potters. A seminar is planned for end November/beginning December which potters from many parts of the country will be invited to attend to make them aware of the benefits of rapid baking methods. (Baking times can be reduced by a number of factors, chiefly that of oven shape and construction, quite apart from the use of alternative energy sources). Contact has been made with the "Centre d'Apprentissage" in the Medina - a training center for young potters where there is a very go-ahead instructor. He is extremely interested in what can be learnt from the Temara experimentation, and it is hoped that this will lead to a modification in the Training Center's teaching methods, and thus have a real impact on Morocco's future potters.

A recent development within Morocco's mining industry has been research into the possibilities of the exploitation of large good-quality clay deposits in the Anti-Atlas area. Were the Government to decide to go ahead with large-scale commercial exploitation of these, in the production of ceramics, the provision of solar-powered ovens could be a vital factor in making any project viable. In Morocco's South conventional energy supplies are at a premium (a problem faced by any plans for the area's development); sunshine is the most plentiful resource.

- Metals and Minerals

Morocco is rich in a variety of minerals and particularly in Phosphate of which it is the world's chief exporter. The prices for these exports, in their raw state, are very much lower than those the same minerals obtain in the industrial world once processed. It is naturally to the country's advantage to develop its own processing industry, and the CDER hope that solar energy could be part of this. In this context, and taking advantage of the recent publicity, the CDER has recently circularised all of Morocco's mineral companies and faculties of Science, informing them of the solar installation and its potential, and asking them to propose programs of experimentation of interest to their particular branch. An open meeting is to be held in October. A specific example of a possible application is that of the drying (up to 100°C) and pyrolysis (up to 800°C) of Phosphate to produce Phosphoric Acid. (Morocco does have facilities for producing Phosphoric Acid by applying Sulphuric Acid - the primary method - but since it has to import the Sulphur for this process, much of its profitability is lost.) To make use of solar energy, it would be necessary to develop a special heat receiver and rotating oven for this process. A similar receptacle could be used for the treatment of gypsum for plaster and cement.

- Other

A special visit by Thierry Salomon, senior GEFOSAT engineer, is planned in October, under the auspices of G.E.R.S., a French economic organization, for the purpose of identifying Morocco's needs in high temperature processes. An important benefit of this survey will be an assessment of the potential market for the Temara technology and recommendations for its future development.

Final Evaluation

The present perspectives of the solar installation at Temara are in fact incalculably greater than those originally envisaged for the solar element of the major C.I.D.E.R.A. project, funded by OIG No. 608-79G-001. In this the benefits of the installation were to be confined to the Agricultural School, then administered by the Jesuits, and its pupils. With the taking over of the school by the Moroccan authorities, the use of the solar site has passed to the Moroccan organization most likely to make the fullest use of it. Now under management by the CDER, this innovative technology can be made available on a national scale, wherever its application is practical. The preceding section

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TRANSLATION

AGREEMENT BETWEEN
THE MINISTRY OF AGRICULTURE AND AGRARIAN REFORM
AND
THE MINISTRY OF ENERGY AND MINES
CONCERNING THE SETTING UP AND USE OF THE SOLAR
OVEN TO BE INSTALLED AT THE TEMARA SCHOOL OF
AGRICULTURE

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This agreement is between, on the one hand,

- the Ministry of Agriculture and Agrarian Reform, Kingdom of Morocco, represented by Mr. Abderrahmane KASSA, Director of the Department of Agricultural Education and Research, (DEAR)

and on the other hand,

- the Ministry of Energy and Mines, Kingdom of Morocco, represented by Mr. Abdelhaq FAKIHANI, Director-General of the Center for the Development of Renewable Energies (CDER).

The following is set forth and agreed upon for the purpose of making explicit the conditions under which a solar oven (hereafter referred to as "the Installation") will be installed and utilized at the Temara School of Agriculture.

PREAMBLE

The word "partners" is used to designate the Department of Agricultural Education and Research (DEAR) and the Center for the Development of Renewable Energies (CDER).

The partners wish to complete the installation of, make functional, and fully exploit, within the grounds of the Temara School of Agriculture, an installation for the concentration of solar energy of the solar oven type with a capacity of 11 Kw.

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The functioning of this installation will make available equipment with the potential for research and development of the artisanal and semi-industrial applications of concentrated solar energy for the following uses:

- baking, sterilization, canning;
- treatment of minerals (dehydration, decarbonization of phosphates, preheating of shale oils, etc.);

- fusion of metals;
- baking of ceramics
- steam production

and, in general, all possible end-uses of concentrated solar energy.

This installation is at present under construction in the context of a program of aid of USAID and C.R.S. The design and construction of the equipment is being carried out with the scientific and technical support of G.E.F.O.S.A.T. association (Groupement pour l'Etude de Fours et Outils Solaires et l'Assistance en Technologie Approprie).

Since this installation may be used for a wide range of applications, it will be possible for the partners to set up pluri-disciplinary teams for its utilization.

Finally, the partners wish to promote the direct, practical applications of solar energy to the benefit of rural development and they will give priority to agricultural and mining applications.

ARTICLE 1: Nature of the Installation

The following are the specifications of the installation:

An optical system of solar energy concentration, made up of:

a) a heliostat of 30 m², including:

- a metallic support frame
- 60 mirrors
- a control mechanism permitting the structure to follow the sun's movement.

b) a concentrator of 20 m², including:

- a metallic support frame
- 208 mirrors.

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This optical system, as defined above, is designated "the installation".

The various receivers, pieces of equipment and specially designed implements, already acquired or fabricated, or those which could be acquired or fabricated, within the context of utilization of the installation are not part of it.

ARTICLE 2: Ownership of the Installation

The installation described under Article 1 will be the property of the Ministry of Agriculture unless the signatories decide otherwise. However, the ownership of the accessories described in the last paragraph of Article 1 will devolve upon the owner of the installation unless they are acquired by the use

A transfer of the installation to a CDER site might be envisaged, allowing experimentation to be carried out under optimal conditions. This transfer would be the subject of a special agreement between the 2 parties.

ARTICLE 3: Rights of Utilization of the Installation

Full and entire rights to the use of the installation are hereby granted to the Center for the Development of Renewable Energies by the DEAR.

At the same time, so as to facilitate the setting up and carrying out of experimentation, the DEAR places at CDER's disposal a terrain of 600 m² surrounding the installation, as well as the building adjacent to the installation from which the installation is operated. This terrain will be marked out by a fence or some other means of demarkation.

On this site, CDER is installing a local team responsible for the management concerning the installation.

In return for this full and entire use of the installation, CDER undertakes to maintain the installation in good functional order. CDER alone will be responsible for technical modifications or additions of any kind which may be carried out on the installation during its later utilization.

ARTICLE 4: Exploitation of the Installation-Creation of a Scientific Committee

The CDER, having full rights to the use of the installation and being the appropriate body for the coordination, promotion and encouragement of programs concerning the development of renewable energy sources, is hereby made responsible for the management of the installation.

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So as to allow use of the solar oven by all interested organizations, the CDER will be responsible for the coordination of different programs of research and experimentation which could be carried out with the use of the installation.

An advisory Scientific Committee could be set up by later agreement.

ARTICLE 5: Team of the functioning and utilization of the Installation

The CDER will delegate a technical team for the completion and utilization of the installation. This team will be composed of a sufficient number of persons.

ARTICLE 6: Functioning and Utilization of the Installation

So as to facilitate the work of the team responsible for the functioning and utilization of the Installation, the DEAR will make available to this team a place of work situated within the Temara School of Agriculture.

As far as is possible, the DEAR will give assistance as required by the CDER for the completion and utilization of the installation.

ARTICLE 7: Length, reconduction, revision and termination of the Agreement

The present agreement has been concluded for a period of 2 years from the date of signature by the 2 parties.

It may be tacitly renewed in its present form by 2-year period unless one of the parties wishes otherwise, in which case notice must be given to the other party of this intention at least 2 months prior to the expiry date of the current period.

ARTICLE 8: Arbitration in case of disagreement

In the case of disagreement, and before any recourse is made to a superior authority, both parties will nominate an authorized representative. These representatives will meet with the aim of reaching a friendly settlement of the dispute. If this is not possible, appeal will be made to the arbitration of a person designated by both parties.

ARTICLE 9: Renunciation of rights of ownership

In the event that DEAR wishes to give up its rights of ownership of the oven, or desires to regain the terrain defined under Article 3 for its own use, DEAR will make a free gift of the ownership of the installation to CDER.

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ARTICLE 10: Modifications to this Agreement

Changes to this agreement may be made by additional clauses or by an exchange of letters.

for: C.D.E.R.

(Signature illegible)

Date: 23rd November 1982

for: D.E.A.R.

Signed: Abderrahmane KASSA
Director of the Department
of Agricultural Education
and Research

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Developpement des energies renouvelables

LE FOUR SOLAIRE DE TEMARA

Dans le cadre d'un programme d'aide de l'USAID de l'AFME et du Catholic Relief Services (CRS), le centre de Développement des Energies Renouvelables (CDER) a pu réaliser à l'Ecole d'Agriculture de Temara, une installation de concentration de l'énergie solaire (four solaire) de 11 kw thermiques pouvant atteindre une température de 1100 degrés centigrades et ce en collaboration étroite avec la Direction de l'Enseignement Agricole et de la Recherche (DEAR). La conception et la mise en œuvre de cet équipement ont été effectuées avec l'appui scientifique et technique de l'Association Française OXFORD (Groupement pour l'Etude de l'Energie et l'Outillage Solaires et l'Assistance en

Technologie Appropriée).

Cette unité permettra la réalisation de divers processus artisanaux et industriels comme la cuisson et l'émaillage de terre, la fusion des métaux, le traitement des produits agricoles et miniers etc..

DESCRIPTION DU PROJET

Les principales caractéristiques de l'installation sont les suivantes :

Système optique de concentration de l'énergie solaire comprenant :

— Un héliostat de 30 m2 composé :

- d'une structure métallique support
- de 60 miroirs réfléchissants,
- d'un mécanisme d'asservissement au mouvement du soleil.

— Un concentrateur, de 20 m2 composé :

d'une structure métallique support

de 208 miroirs réfléchissants

Le captage de l'énergie solaire est assuré par l'héliostat : miroirs plans orientés vers le soleil et suivant automatiquement son mouvement.

L'héliostat réfléchit les rayons solaires sur le concentrateur qui concentre les rayons sur une surface de 12 cm de rayon constituant l'entrée du four ou foyer.

Ce foyer est situé à 8 m 30 du concentrateur et 1 m du sol.

Un contre-poids ou panier accumulateur que l'on remonte manuellement deux fois par jour assure le mouvement de l'héliostat.

Ces mouvements sont réglés par un système électronique permettant d'accrocher deux voiles hydrauliques, un pour la rotation horaire et l'autre pour la station de déclinaison.

L'héliostat est composé :

— d'un pylône ;

— d'un MAT de levage pylné qui permet de lever l'héliostat ;

— d'une partie mobile qui assure le réglage de l'axe par rapport au

solaire au montage de ce projet ont été acquis localement, à l'exception des miroirs et des composants électroniques.

OBJECTIFS DE L'INSTALLATION :

Cette installation permettra de disposer d'un équipement de recherches et développement en matière d'application de l'énergie solaire concentrée pour des opérations de type :

— cuisson, stérilisation, conservation agro-alimentaire,

— traitement de produits miniers (déshydratation, décarbonatation)

— fusion de métaux et alliages

— cuisson de céramique et de différents produits de l'artisanat ;

— production de vapeur et d'une multitude générale toutes les utilisations possibles de l'énergie solaire concentrée.

FINANCEMENT :

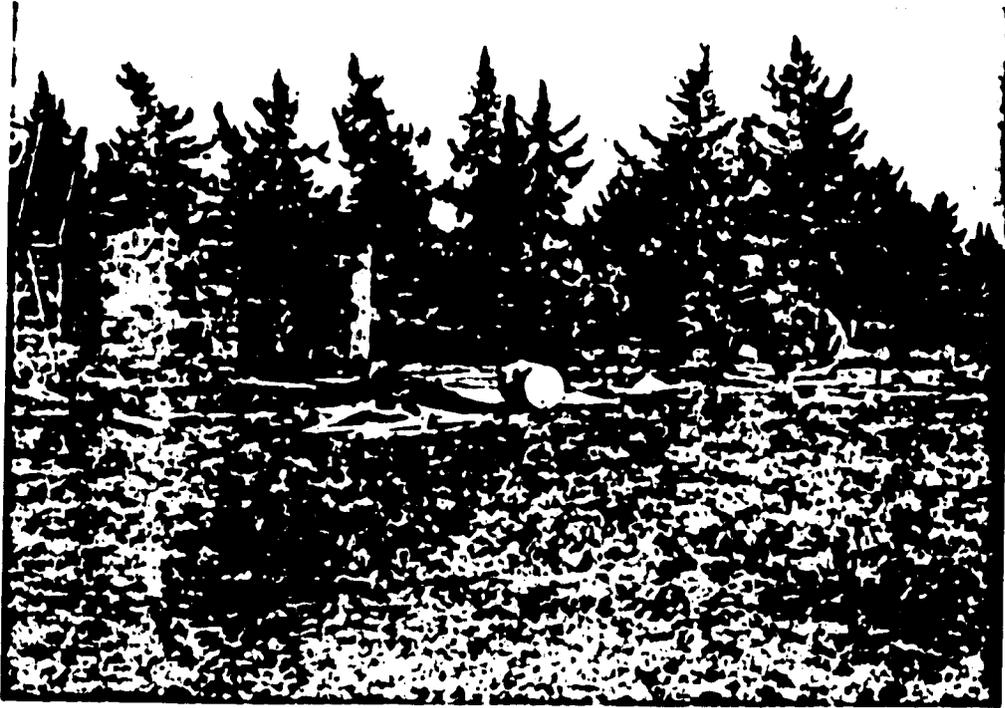
Le financement du projet a été effectué comme suit :

— USAID : 2000 \$ pour l'équipement

— CRS Maroc : 1000 \$ pour les frais de fonctionnement au Maroc et la partie en charge du personnel local.

— Fondation de France : 1500 FF pour couvrir en partie les missions courtes et les frais de fon-

SOLAR ENERGY PROJECT - AT TEMARA, RABAT, MORCCOO



In the beginning ...



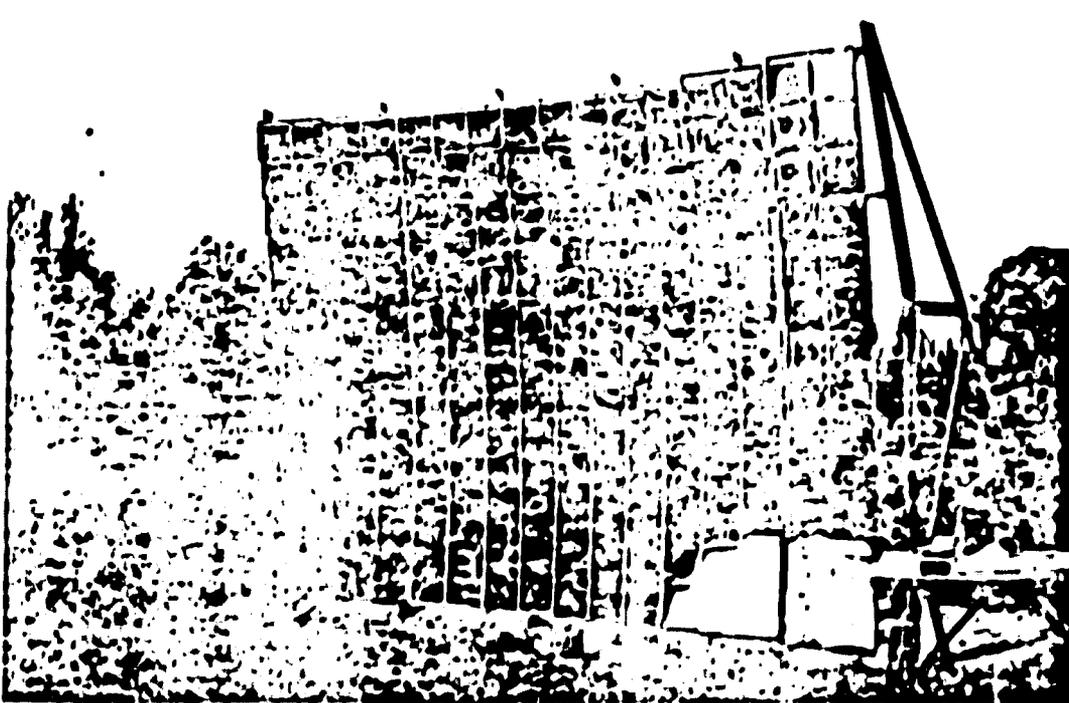
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SOLAR ENERGY PROJECT - AT TEMARA, RABAT, MOROCCO



General view of completed installation:

Concentrator (seen also below); heliostat; twin-chambered bread oven



SOLAR ENERGY PROJECT - AT TEMARA, RABAT, MOROCCO



View of heliostat behind lowered weight-bucket, pumped up by compressed air, which powers hydraulic directional control system of heliostat.



The end product: freshly sun-baked loaves, taken from the oven.

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