Final Report

(May 1997)

" INSTALLATION AND TESTING OF A

SOLAR STEAM GENERATOR FOR COOKING

IN INDIA"

GTZ / GATE
Small scale project fund

Content

1. Responsibilities

2. Summary

3. Goals

4. Project Progress

5. Technical description

6. Results and Evaluation

    a. Technical

    b. Demonstration and Distribution

7. Appendix

    Data
    Drawings
    Photos

1. Responsibilities

The body responsible for the project is the World Renewal Spiritual Trust (WRST) .

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and others . . . .

2.Summary

Solar cooking is one of the most interesting applications in the field of renewable energies. Within the last twenty years many designs and concepts have been developed and tested. Especially in the field of family cooking the solar cooking box and small concentrators are available in most of the developing countries to reduce the consumption of costly kerosene, gas or firewood. Unfortunately the problem of heat storage has yet not been solved satisfactory. This is one of the reasons that solar cookers are yet not commonly in use.

In 1995 the World Renewal Spiritual Trust (WRST) and the Brahma Kumaris World Spiritual University (BKWSU) where testing on behalf of the GTZ, Germany two parabolic concentrators for institutional cooking in the “Academy for a better World” in Mt. Abu, Rajasthan , India.

The concentrator was designed by Wolfgang Scheffler a pioneer in solar cooking and were manufactured already in India. As a result of the positive tests in the end of 1995 a proposal for a solar steam cooking system for 1000 people was forwarded to the GTZ. The proposal was approved in the beginning of 1996 and successfully installed in 1997 in the Academy in Mt. Abu.

The solar steam cooking system is using 24 concentrators to focus the sunlight on twelve receivers. By means of a primary water circulation line the collected energy is transferred into a solar steam generator. From there, the steam is transferred by pipes to the kitchen, for cooking and preparation of tea.

In case of low solar radiation or extra demand, a high efficient back up steam generator based on kerosene is providing steam.

The system was operating from the beginning without any major problem and is already providing 80 % of the theoretically calculated maximum steam output of 600 Kg steam per day. After the rainy season in September 1997 the receivers, the tracking system, the focus and the load management will be improved to reach the maximum output.

The daily availability of the system is good. The whole solar cooking system is meanwhile operated and maintained by two local WRST staff members.

The combination of the solar steam cooker with a conventional back up system (generating steam with kerosene) is providing 24 hours steam on demand. This has created a wide acceptance of the system by the kitchen crew.

As the Academy has nearly 60000 visitors per year from all over India and abroad the demonstration and distribution of information is excellent. As the system is modular in size and application, already several companies and institutions have shown interest in the technology.

3. Goals

The main goal of the project " Solar cooking for institutions " is the transfer of technology, the demonstration of such system in India and the evaluation of a solar cooking system of this size under practical conditions.

Another important aspect of the project is the adaptation of all the components like receivers, steam generators, control unit, tracking system and parabolic concentrators, so that there are good chances for the distribution and acceptance of this modular technology in India. Especially institutions, companies and the media will be informed and should play a vital role in the dissemination of the system.

4. Project Progress

In between December 1995 and August 1996, several meetings and discussions were held between Dr. Baz and Mr. Rudolph of GTZ, Mr.Schmitt and Dr. Hunold of HTT, Mr.Jaspers of Certuss, Dr. Schott of Iset, Dipl. Ing. Deepak Gadhia of the Eco centre, Wolfgang Scheffler, Ramesh Shah of WRST, Prof. Bansal of IIT and Joachim Pilz of the Charitable Trust.

The aim of these meetings was to gather information's and to finalise the design of the cooker and the back up system. After approval of the project through GTZ in April 1996 the components were ordered as follows:

HTT - Solar steam generator and 12 receivers
Certuss - Back up system and water demineralisation plant
Eco centre- 24 parabolic concentrators

In September 1996 the components were shipped to India. Civil works for the 24 concentrators and the receivers started in April 1996.

In between October 1996 to February 97 the installation of the parabolic concentrators took place. Simultaneously the production of nearly 4000 small mirrors for the concentrators began in the Academy with the help of local staff.
From January to March 97 the circulation pipeline/steam pipeline were welded together by a certified welder and the back up system and water treatment plant was installed.
In April 97 the tracking system was fitted and tested. In April 97 all the electrical connections, the control unit and the insulation were completed. From Mai onwards, the flushing of the all pipes, pressure tests and electrical tests took place. Finally the system was successful inaugurated on 31. April 1997.

5. Technical Description

Wolfgang Scheffler of Switzerland has developed the parabolic concentrators originally. At present Deepak Ghadia, Manager of the Eco centre in Valsad, Gujarat, manufactures the concentrators. Around 40 of the concentrators are installed all over the Indian subcontinent and working satisfactory in community kitchens.

The parabolic concentrator is of a disk type and has a total reflective area of 7,5 sq.m. The frame and support structure is made in a rigid steel design. The parabolic disk is reflecting the sunlight by means of a PET foil which is resistant to the UV light.
The sunlight is concentrated in a receiver of 40 x 40 cm in a distance of 3 meters from the centre of the disk. A single disk is having a maximum out put of 3.0 kW at 1050 W/sq.m. solar radiation and reaches temperatures up to 550 C in the focus. In the solar cooking system in Mt. Abu a total number of 24 parabolic concentrators is installed and reflects the sunlight on totally 12 receivers.

The design is such that one mirror reflects from a higher position to the front side of the receiver and another mirror reflects from a lower position to the backside of the receiver. The mirrors are arranged in an accurate east - west alignment and tracking is done by a central system by means of a winch and an electronic regulator. At evening time the system has to be reset into morning position manually.

The system generates at present around 500kg low pressure steam per day under an average insulation of 6,0 kWh per sq.m and day in Mt. Abu. The cooker is able to cook for 800-1000 people 1-2 meals per day. The steam is used for cooking, water sterilisation and the milk/tea kitchen.
To avoid any scaling in the 12 solar receivers a separate circulation line is transferring the collected energy by means of a circulation pump and a heat exchanger into a steam

pressure tank. The medium in the receiver line is pressurised water at maximum 200 C at 16 bar. The water in the pressure tank will be heated up to 170 C at 8bar pressure.
Insulated pipes transfer the generated steam to the already existing steam cooking pots. Steam traps and a pressure reduction station ensures a good steam. In case of low solar insulation a new and high efficient kerosene based steam generator is functioning automatically as a back up system. The system is protected against over pressure by safety valves and an automatic shut down mechanism. The status of the whole plant is monitored by temperature and pressure meters and a computerised 6 channel data logger.

6.Results and Evaluation

a. Technical

The solar cooker was in operation only for two month until the monsoon started. In the monsoon, usually a period of 10 weeks, it is not practical to run the solar cooker because of continuously cloudy condition. In this period the steam is totally provided by the back up system. The rest of the year is fine and Mt. Abu reaches a maximum of 2000 kWh/m2 per year (see appendix).
The system has already passed without any damage through several storms with extreme heavy winds and rains. The mechanical stability of the foundation and the parabolic concentrators is excellent. The live span of the reflective PET foil is around 3-4 years and the replacement cost per mirror is 30 US$.
The optical /electronic tracking system is running at present satisfactory. Only in the early morning (8-9h) and the evening (17-18h) the tracking is not 100% accurate and readjustment by hand is necessary. We are planning to improve the system by adding one timer for the morning and evening times (see appendix).

The overall handling of the system is easy and operation and maintenance is already in the hands of two trained staff members of WRST.
The theoretical maximum output of the solar cooker should be 600 kg steam per day. The maximum out put in full sunshine was 500kg steam. It is expected to increase the output by removing the centre plate in the receivers and by fine-tuning of the tracking system and the focus.

It is already visible that there is no problem to use the Scheffler parabolic concentrator in modular systems for different applications like steam cooking or thermic oil for the industry.

b. Demonstration and Distribution

As the Academy attracts around 60.000 visitors per year from India and abroad, many people with different back ground like industrialist and administrators showed already interest into the system. There are regular guided tours of the cooker and information material is available on site. There have been radio interviews (All India Radio) and press articles (see Appendix).
In addition the WRST and the Bkwsu are distributing the informations of solar cooking technology through seminars and lectures (see Appendix)

Joachim Pilz
Technical Coordinator

8. Appendix

Data
Drawings
Photos