THE WORLD BANK AND SOLAR ENERGY

Introduction

1. As part of its general efforts to assist developing countries in preparing energy policies to meet their future needs, especially in the rural energy sectors, the World Bank has carefully monitored progress in technologies relating to so-called "non-conventional" energy sources, among which is solar energy.

2. The Bank intervenes in such fields as solar energy development only if it becomes apparent that developments which might be of value to developing countries are being overlooked or ignored, or if financing for their development and adaptation to the needs of developing countries is not forthcoming from other sources.

3. Widespread utilization of solar energy will depend on the development of improved technology and materials, and even more on a reduction in price of solar devices. This latter is critically important for the use of solar energy in developing countries. The present state of solar technology gives reason to think that the necessary advances in technology may be forthcoming in the not-too-distant future, and that it is now appropriate for the Bank to fund a modest field programme to demonstrate the feasibility of using solar energy in developing countries and to enable the inhabitants of those countries to gain operational experience in their use.

I. World Bank Projects Involving Solar Energy

4. (i) Over 60% of Bolivia's 5.6 million people live in the difficult rural conditions of the Altiplano, (high semi-arid plains over 12,000 feet above sea-level) where, despite average daily temperatures below 50° Fahrenheit, there is a very low rate of energy consumption and the majority of the people depend on non-commercial energy sources. Fuels used in the home are those locally available, usually consisting of dried animal dung, grass knots, scrub twigs and roots. Currently, animal dung is the single most important sources of fuel for household consumption in these areas, but non-commercial energy resources in the rural areas are inadequate to meet household requirements, being sufficient only for limited cooking, but no heating, during the harsh winter months. Also, the use of dried animal dung as fuel eliminates its use as fertilizer. Alternative sources of energy for use on the Bolivian Altiplano are thus of critical importance. The Altiplano receives high levels of solar energy, ranging from about 400 calories per square centimeter per day in the winter months to more than 600 calories per square centimeter per day in summer; this is well above the minimum limits for operation of solar energy devices. The physical conditions of the Altiplano, with an average of 2,500 sunhours per annum, thus make the region especially suitable for the use of solar energy as one of the substitutes for conventional energy, and the Government places a high priority on solar energy development. A Bank-sponsored rural development project approved in

in December 1977 will spend US$165,000 over a four-year period in helping a local institution to adapt and develop low-cost energy devices for heating, cooking, pumping, food drying and greenhouse agriculture. First practical applications are expected to be operating by 1980.

5. (ii) Research on Solar Ponds and Rankine Cycle Turbines in Israel. An industrial development project in Israel supports a US$1.7 million program of applied research into non-convective solar ponds as a means of collecting and storing solar energy in the form of low-temperature heat. A solar pond is an artificial shallow pool of water which absorbs the sun's heat and transport it to a dense bottom layer of brine, which often reaches a temperature of 90°C (194°F). First results are promising and a commercial prototype of a solar heating and cooling system using solar ponds is being built in a hotel near the Dead Sea. The project also includes support for the development of solar powered engines, including construction of prototypes and market studies. The engines are being designed to require little maintenance and it is hoped could replace the small diesel engine in various village applications. The total Bank contribution to the overall cost of the whole project is US$5 million.

6. (iii) Solar Water Heaters in Education Projects. The Bank is increasingly involved in the construction of education facilities. The Bank promotes the use of decentralized energy systems, including solar energy, for such projects especially those in rural areas where they most are cost-effective. An education project in Liberia includes a component for financing the installation of solar water heaters in the houses of teaching staff in rural schools.

7. (iv) Demonstration of Solar Powered Pumping Equipment. (For small scale irrigation purposes in developing countries). The project will probably be funded by the UNDP with the World Bank as Executing Agency. Four demonstration areas are proposed in India, Sudan, Upper Volta, and the Philippines. The estimated cost is around US$1.25 millions. Since the details of the project are still under negotiation it is not possible to be more precise, but the overall objectives of the project will be to gain field operating experience and to act as a demonstration of the feasibility of utilizing solar energy for water pumping.

II. Studies Concerning the Global Applicability of Solar Energy in Developing Countries

8. (i) Study entitle "Energy and Development" by Dr. Jyoti Parikh of the International Institute for Applied Systems Analysis, Laxenburg, Austria. This is a study of overall energy needs in the developing countries with special emphasis on the needs of rural areas. While dealing with overall energy requirements, it contains a fairly extensive section on solar energy utilization and potential.

9. (ii) "Solar Energy Subsystems": Summary of International Program of Solar Energy Research and Development. Dr. Anwer Makh, Director of the Solar Energy Program of the Kuwait Institute of Scientific Research, acting as consultant to the Bank, summarized the status of the solar energy research programs in some 80 countries around the world. The report gives an account of the existing state of currently available solar technology.

10. (iii) Two studies by Bank Staff

- "Developing Country Applications of Photovoltaic Cells" 1/
- "Solar Photovoltaic Cells in Developing Countries" 2/

describe the potential applicability of photovoltaic technology to rural education, health, forestry and other applications in developing countries. These papers were originally presented to international symposia of solar energy manufacturers and researchers, and were intended to bring to the attention of these experts the importance of the developing country market to the commercial future of photovoltaic technology. A third study of Bank staff "Critical Factors in Economic Evaluation of Small Decentralized Energy Projects"3/, points out a number of pitfalls that face a researcher who seeks to justify the application of a small scale energy technology to a particular development need. It points out, for example, the necessity for careful pricing of inputs and outputs and realistic estimates of the physical quantity of useful output.

III. Studies of the Applicability of Solar Energy to Situations in Particular Countries

11. (i) Khumbu Valley Tourism Study (Nepal)

With funds provided under an IDA Credit for the first tourism project in Nepal (291-NEP), a study was carried out by Nepalese consultants on the development of trekking tourism in the Khumbu Valley, which leads to Mount Everest. The Khumbu development plan proposed solar energy as a substitute for firewood, the demand for which is leading to progressive deforestation of the steep slopes of the Himalayan region and the irreversible loss of the thin top soil in these areas. Trekking tourists represent a major source of income and employment for the inhabitants, and a source of foreign exchange earnings for Nepal. The tourists add substantially to the use of firewood, which is already excessive, and ecological damage will continue unless alternative energy sources are developed for cooking and heating. The development plan proposed the use of solar energy to produce heat and hot water for the tourist trekking lodges and camp sites.

12. (ii) "Potential Use of Solar Water Heaters in India" by Dr. P.K. Rohatgi, Director, Council of Scientific and Industrial Research Complex, Cochin, Kerala, India.

13. This was a study of the possibility for local manufacture and use of solar

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1/ Weiss, C., and Pak S., "Developing Country Apllications of Photovoltaic Cells", World Bank S&T Report No.7, Jan. 19.

2/ Weiss, C., "Solar Photovoltaic Cells in Developing Countries", World Bank S&T Report No.26, Nov.1.

3/ Pak, S. and Taylor C.R., "Critical Factors in Economic Evaluation of Small Decentralized Energy Projects", World Bank S&T Report No.25, Nov. 1976.

water heaters in India for domestic and industrial purposes. The survey involved some field investigations and an analysis of production costs and material requirements under Indian conditions, and of the potential market for solar water heaters in India.

14. (iii) Rural Energy Study in Colombia.

In cooperation with Colombian organizations the Bank is assisting a Rural Energy Study in Colombia which includes, among other objectives, the development and use of solar energy devices in rural areas. The main objective of the program however, is to set up the appropriate national institutions to plan and implement rural energy projects in a comprehensive manner. A first 180 page report dealing with one rural region (Antioquia) presents an in-depth analysis of the situation and proposes recommendation for tackling with it.

Note on Biomass

The above list does not include Bank activities to increase the production of biomass fuels (principally firewood) which some would also include under the general umbrella of "solar energy".1/ The Bank has or is financing 16 fuelwood components of Rural Development Projects and is planning to finance 15 others in the next few years (A list is attached on Annex 1).

1/ In effect there is no precise definition of solar energy. Broadly taking it could include hydroelectricity and even fossil fuels. The energy of the sun, of course, is derived from nuclear sources.

ANNEX

Bank-financed Projects with Fuelwood Components

1973	Mauritius Rural Development (Cr. 419-MAF) Niger Drought Relief (Cr. 441-NIR)
1975	Mali Livestock (Cr. 538-MLI) Niger Rural Development, Maradi I (Cr. 608-NIR)
1976	Korea Rural Infrastructure (Ln. 1216-KOR) Senegal Sine-Saloum Rural Development (Ln. 1113-SE) Nepal Rural Development I (Cr. 617-NEP) Colombia Rural Development I (Ln. 1352-CO)
1977	Tanzania Tobacco Processing (Cr. 658-TA) Sudan Savannah (Cr. 718-SU) Nigeria - Lafia and Ayangba Agriculture Development { Lafia (Ln. 1454-UNI) / Ayangba (Ln. 1455-UNI) Brazil Minas Gerais Rural Development (Ln. 1362-BR) Chad Sahelian Zone Rural Development (Cr. 739-CD) Philippines Rural Development III (Cr. 1010-PH) Pakistan Hill Farming Tech. Development (Cr. 751-PAK) Kenya Bura Irrigation (Ln. 1449-KE)

Projects Under Identification, Preparation and Appraisal, January 1978, with Fuelwood Components

Tanzania Mwanza/Shinyanga Rural Development
Rwanda - Village Afforestation
Burundi Village Afforestation
Somalia Rural Forestry Component
Malawi Rural Forestry Component
Nigeria Ilorin and Bida Agriculture Development
Niger Forestry I
Mali Forestry I
Upper Volta Forestry I
Indonesia Yogyakarta Rural Development
Philippines Forestry II
Thailand Forestry I
India Forestry II
Bangladesh Forestry I
Jamaica Forestry I