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DP/ID/SER.B/598
26 February 1988
English

16622

STRENGTHENING THE TECHNOLOGICAL BASE OF MONGOLIAN PEOPLE'S REPUBLIC (MPR) STATE COMMITTEE FOR SCIENCE AND TECHNOLOGY FOR DESIGNING, PRODUCTION AND TESTING OF PROTOTYPES BASED ON SCIENTIFIC RESEARCH

ST/MON/82/T01

MONGOLIA

Terminal report*

Prepared for the Government of Mongolia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the Final Project Review of P. Prijapratama

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INTRODUCTORY WORD

As a logical follow-up of the project DP/MONG/75/006 "Demonstration of new sources of energy in the rural development", a project proposal was formulated in 1981 by the Mongolian State Committee for Science and Technology and submitted to the United Nations Interim Fund for Science and Technology for Development under the title "Strengthening of the technological base of MPR State Committee for Science and Technology for Designing, Production and Testing of Prototypes based on Scientific Research", as priority request.

After thorough substantive review by UNIDO, the draft project document was reformulated and resubmitted to the UNFSSTD for approval. The final project document was endorsed by the UNFSSTD on the 23 November 1982, whereas UNIDO, as the appointed executing agency countersigned the document on the 26 January 1983 and then issued the project allotment document (PAD) on the 8 March 1983 for implementation. This document represents the Agency's final report containing its final assessment, findings and recommendations.

I. BACKGROUND

A. Objectives

The purpose of this project was to back-up the country's effort to make full use of its potential to strengthen and widen its scientific and technological research aiming at the appropriate application of acquired research results for the construction and testing of prototypes and at the development and upgrading of the knowledge of the scientific and technological staff in the field of applied scientific research. This will help to accelerate the development of applied science and technology in the country which will become an important catalyst in the development of the national economy and to facilitate the introduction of the latest development of science and technology into the MPR, to prepare Mongolian scientists to move with the times. The project was intended to help strengthen the newly established Technology Development and Application Department in the MPR State Committee on Science and Technology. This Department is linked to the existing Centre for Scientific and Technological Information in terms of providing necessary applied scientific and technological inputs for research and application of the results for the development of prototypes.

Specifically, the aim of the project was:

- to strengthen the technological base of the MPR State Committee on Science and Technology in connection with its design, development and testing of mechanical and electronic equipment prototypes;

- To train national engineers in the design analysis of non-conventional energy generating equipment and in the construction and testing of prototypes;

- To create a Scientific and Technological information system (scientific and technological data collection and retrieval) co-ordinating all researches and activities related to the design, development, construction and testing of prototypes;

- To prepare a comprehensive programme for application and introduction of up-to-date design into manufacturing industry.

B. Logic of the project

Although agriculture including animal husbandry only contributes to 25% of the gross national product, around 40% (150.000 farmers) of the available labour in the country is working in the agricultural sector. Due to the geographical aspects of this mid Asian country which experiences sharp changes in its continental climate and to the ethnic traditions, animal husbandry plays the most important role in the agricultural context. It contributes to almost 80% of the value of the gross national product in the agricultural branch. This makes Mongolia dependent on its animal husbandry. Nota bene: Mongolia is the third biggest exporter of sheep/lamb products in the world and the largest exporter of cashmere wool and camel hair. Many people are engaged in livestock breeding and they are living in yurt (round camel/sheep hair hut) in suuries (small society consisting of one or two families). Suuries are then joined into sommon (community). There are 299 sommons in the country. Every suury keeps 500-1000 sheeps/goats or 150-200 cows, horses and camels. Altogether, there are nearly 25 million animals. The water supply for the animals in the mountainous field comes from a variety of sources. There are 2100 watersprings; 14.000 concrete ringed wells; 10.000 tubewells; 9000 bore wells; 1000 ponds and 2000 water reservoirs.

The farmers at present use human or animal power to lift up water from the wells with an average depth of 10 meters. To provide 500 sheeps with drinking water, one should work 4-5 hours continuously. Cows, horses and camels need certainly more water to drink. Lack of water can cause a loss of the meat production by 3-4 kg per sheep and 1-2 kg wool annually. To try to alleviate this livestockbreeders' problem, the Government of the Mongolian People's Republic has decided to make use of the abundant non-conventional wind and solar energy resources in the country.

Traditional, non-renewable energy resource of MPR is coal, which supplies energy to industry, agriculture and Central State Power Station. Coal is also used to heat houses in town and rural areas during the winter. The annual coal production is nearly 5.0 billion tons, of which nearly 50% is used to supply the Central State Power Station.

Oil is also playing a partial role in the energy supply to the country. Farmers and livestockbreeders in remote areas are provided with small diesel power plants. There are around 850 units mini power plants producing 27.000 kw. Annual consumption of liquid fuel for this purpose is 60.000 tons. That amount has to be imported.

Wood and animal waste also provide energy for cooking and heating of thousands of yurts. The annual consumption of these energy resources is around 400.000 tons.

The above analysis in non-renewable energy resources' consumption has given rise to the Government's wish to make the utmost effort in using available non-conventional energy resources (wind and solar) of the country to help curb the consumption of non-renewable resources and thus save the outflow of foreign currency.

The forerunner to this project was DP/MON/75/006 which was executed by DTCD. This project demonstrated various mobile electrical, wind and solar power equipment imported from Europe and tested them to define their suitability to the four different zones of Mongolia (forest, steppe, mountain and Gobi desert).

Findings and recommendations of that project clearly stated that the use of abundant solar and wind energy resources in Mongolia would turn out to be more appropriate, cheaper and more profitable for the country. In addition to that. it would effectively help to alleviate the hard life experienced by the farmers and livestockbreeders in remote areas.

Therefore, as a logical follow-up of the previous project, the development of the national capabilities in the design, construction and testing techniques of solar and wind aggregate should be pursued; a technological base for research and experimental development of prototypes having a link with industry in general and workshops in particular, should be established to house and co-ordinate these activities.

In 1981, the MPR Government submitted a project document prepared by a UNESCO consultant to UNFSSTD. The project was intended to set up a multi-disciplinary research and scientific centre. Preliminary Headquarters' appraisal indicated that such a multi-disciplinary research and scientific centre would not be able to be established due to lack of scientific personnel and laboratory facilities. Events have shown that research and scientific institutes need many years experience and a great deal of investment before being able to bring about scientifically acceptable results. Upon advice of UNFSSTD, the MPR Government redesigned the project document to focus the objectives on the applied research and scientific activities which have a direct link with the production and application technology.

A technology development and application Department in the State Committee on Science and Technology which has a link with the existing Centre of Scientific and Technological Information was set up.

On the 23 December 1982, the project ST/MON/82/T01 was approved by the UNFSSTD with a grand total of US$206,000. On 26 January 1983, the project document was countersigned by U IDO as executing agency and the implementation started on the 8 March 1983, the date when the project allotment document was issued.

II. PROJECT ACTIVITIES

The subject of the project is quite innovative for Mongolia, therefore it has required a very long, patient and repeated research and development before a prototype could be constructed and tested at the appropriate project sites.

If the previous project DP/MON/75/006 has managed to demonstrate, the possible application of renewable energy resources technology for the remote rural areas in Mongolia, the recent project ST/MON/82/T01 has shown the possible realization of the transfer of technology in this field to Mongolia.

Four expatriate experts have worked hand in hand with their national counterparts in Ulan Bator to carry out the following activities:

- To analyse the wind and solar cadastar graphics; to design the wind and solar maps;

- To carry out inventory of water resources;

- To analyse the energy requirement and utilization in the country;

- To provide guidance in the design, development, construction and testing of prototypes;

- To organize special technical workshops, seminars and consultations in the field of renewable energy resources;

- To co-ordinate research activities carried out by the Institute for Physics and Technology (IPT), the Ministry of Water Economy (MWE), the Ministry of Agriculture (MA), the Ministry of Fuel and Electric Industry (MFEI) and Livestock Research Institute (LRI);

- To provide guidance in the applied research activities in the field of solar batteries, wind pump and thermo-electricity;

- To evaluate the rentability of the utilization of renewable energy resources;

- To introduce the application of computer in the scientific and technical information;

- To select national counterparts to be trained abroad in the related field of the project;

- To prepare a list of the necessary equipment to be purchased abroad;

- To install and commission the equipment;

- To train national counterparts in the utilization of imported equipment;

- To elaborate proposals for the second phase of the project.

III. ACHIEVEMENT OF IMMEDIATE OBJECTIVES

All four immediate objectives of the project have been satisfactorily achieved:

- Application of research results in the design, development, construction and testing of the first Mongolian wind water pump of types TWN-C40-0.5-2.0 and)+(CA-0.5 and wind energy aggregate Xy4-1; solar batteries Navan-1, Navan-2 and Navan-3 and solar collector system. Three prototypes of water pump TWN-C-40-0.5-2.0 were tested at the test site of soumon Bajandelger, South Gobi aimak and at the workshop area of the Ministry of Water Economy. One prototype of water pump)+(CA-0.5 was installed at the test site of the State Committee for Science and Technology in Ulan Bator. the wind rotor has a diameter of 2 m and has 12 rotor-blades. Water elevation capacity amounts to 2 m^3/hour for well of 10 m depth. The total weight of the aggregate is 400 kg.
  The wind energy aggregate prototypes Xy4-1 were installed at the test site of SCST Ulan Bator and at the All Republic Exhibition of the MPR Invention and Rationalization.
  The solar batteries with the capacity of 0.2 to 0.5 volt were tested in the laboratory of IPT, to supply power to electrical consumer products such as portable radio, TV-set, lighting bulps, etc... Solar collector panel to be used for water heating, glasshouses and jurt heating were demonstrated at the solid physics laboratory of IPT.

- Training of Mongolian engineers in the above field of activities. Technical seminars, workshops and consultations were organized to familiarize the engineers with the application of renewable energy resources technology. Eight Mongolian engineers were trained abroad in the field of design analysis, solar cells and photovoltaic production technology, thermo-electricity and application of computer in the technical information.

- Creation of an information system co-ordinating all activities related to the design, development, construction and testing of prototypes. This system has been set up under the auspices of the Centre of Scientific and Technological Information. Hardware and software for that purpose were delivered. Experts services have been given to the system. National staff has been given sufficient training and guidance.

- Comprehensive programme for strengthening the national capabilities in modern design and technological analysis has been prepared on paper by the expatriate expert but the realization of the plan still lags behind due to lack of necessary tools and instruments.

IV. PROJECT RESULTS UTILIZATION

The project under final review has clearly shown four different results which are now being utilized by the Mongolian authorities and the State Committee for Science and Technology as inputs to the available modest manufacturing industries and other institutions:

- Two different wind pump prototypes TWN-C40-05-2 and)+(CA-0.5 which have undergone summer, fall, winter and spring tests at the project sites in South Gobi aimak, Bajandelger aimak and Ulan Bator Central Workshop were accepted by the Government authorities as useful tools to help the farmers and livestock breeders in the remote somons and aimaks. The MPR State Committee for Planning has decided to have the improved prototype)+(CA-05 manufactured 150 serial pieces and 50 serial pieces of prototype TWN-C40-05-2 accompanied with accessory in form of Mongolian made 3 m^3 steeltanks with heating stove. The prototype of wind energy aggregate Xy-4-1 still needs a lot of improvements before reaching the stage of feasibility in serial production to meet the remote areas' requirement for energy generating equipment.

- Three different research results of the Institute of Physics and Technology Ulan Bator have been attained. Prototypes of solar devices

- consisting of collector subsystem, heat accumulating and dubbing subsystem for heating water for jurts, houses and greenhouses, have been developed and tested in the test sites. Prototypes of solar elements made of monocristal and polycristal silicon with efficiency of 6-9% were developed and thoroughly tested. Prototypes of solar batteries with a capacity of 0.2 to 0.5 volt were also developed and tested to supply energy for portable radio, TV-set and lighting.

- The first two prototypes i.e. solar devices for heating purposes, which will certainly be very useful for the country, as in winter the temperature drops to minus 40°C, and the cristal silicon solar elements, continue to need thorough research to obtain maximum efficiency for a serial production.
  The result of research activities on solar batteries, its development and test of the prototype is very promising. After a feasibility study on possible requirements of solar batteries, Mongolia would need 28.000 solar batteries with a total capacity of 160 Kw annually. A serial production of solar batteries has been planned by the State Committee for Planning, pending the availability of manufacturing, equipment and skilled national manpower.

- Due to the limited foreign currency funds, the Electronics Laboratory of the State University of Mongolia has made use of a microprocessor and some components delivered for this programme to develop its own training kit prototypes for students in electronics and automation techniques. They call this kit, which will be used for training in the field of computer and automation techniques, "PC/TC Training Pioneer". Hundreds of students will be using the kit, which was developed and assembled by Mongolian scientists and researchers under the guidance of expatriate experts in this field.

- Technical Information Unit, established during this project period under the Centre of Scientific and Technological Information (CSTI) has started its operation under the guidance of an expatriate expert, to collect and store all information related to all activities in the field of design, development, construction and testing of prototypes for future manufacturing in industry. A few users have made use of the data collected by the Technical Information Unit.

V. ASSESSMENT

1. The subject of the project is quite unique and innovative for Mongolia, therefore a large portion of research and a high grade of patience in development have been required before prototypes could be properly constructed and accurately tested. In addition, the lengthy procedure of recruitment of Government nominated experts, and difficult mail and telex communication from Europe to Mongolia should be taken into consideration when assessing the delay in the project's implementation.

2. The national counterparts, scientists, engineers and technicians dealing with the activities of the projects are a serious and enthusiastic younger generation. They are very keen on adopting updated, appropriate and applied technology. They eagerly co-operate with expatriate experts. They readily make use of project equipment delivered for the programme and properly maintain them.

3. Considering the vast (1.5 mill km^2) and mountainous area of Mongolia, which is inhabited by only 1.8 million people, whose main products are from their cattle breeding, a programme which directly supports and alleviates the herd daily life is very welcome.

4. The current results achieved in the implementation of the project will certainly upgrade living conditions and, to a certain extent, give social impact to the scattered nomadic cattle breeders and small farmers.

5. Based on the availability of water resources throughout the country, on the annual average of wind speed which is 3 to 4 m/s, on the thorough tests of wind pump prototypes in different project sites, on the price comparison of well water lifted by wind pump and by diesel pump, which costs 1 to 1.5 tughriks/m^3 and 3.70 tughriks/m^3 respectively and on the accurate analysis of demand, it is expedient that the State Committee for Planning has decided to manufacture 200 pieces wind pumps type TWN-C40-0.5-2.0 and)+(CA-0.5 to be delivered together with heatable steeltank to the cattle breeders and farmers. However, in order to manufacture wind pumps of better quality and higher efficiency, an improvement of current design is essential. To meet this urgent need, an

appropriate project proposal for emergency technical assistance in improving the design of wind pumps was designed by the UNIDO staff on mission.

6. The prototype of wind energy aggregate Xy4-1, which was displayed in the All Republic Exhibition still needs further elaboration a l development to reach an acceptable standard of reliability.

7. The high intensity of solar radiation in Mongolia has led the scientists to carry out research and development of solar devices. The solar water heater and solar devices for dwelling-and greenhouse heating, however, still need a little improvement to attain efficient performance.

8. The development of solar batteries with capacity of 0.2 to 10 voltage is very promising. Pending the availability of proper manufacturing equipment and skilled manpower in Mongolia, the production of solar batteries to meet the domestic demand can start.

9. Survey on the utilization of thermo-electric generator on the thermal energy of a domestic stove in the jurts was carried out by an expatriate specialist in this field. But, as there were no research and development facilities available, the expert's valuable conclusions and recommendations contained in his technical report are worth considering in the follow-up programme for this country.

10. The Technical Information Unit which has been established under the aegies of the Centre of Scientific and Technological Information still requires the follow-up guidance of an expatriate specialist to enable it to stand on its own feet and operate properly.

VI. CONCLUSION AND RECOMMENDATIONS

1. As the wind pump models TWN-C40-0.5-2.0 and)+(CA-0.5 functioned reasonably well and serial production of both types is in process, an information campaign to the possible endusers should be started, to provide them with solid and attractive information on the technical data and economical factor aiming at the creation of the market.

2. Since the main purpose of this project was to expand applied scientific and technological research to create a sound basis for the application of research results to the manufacturing processes, it is expedient that an Engineering Design Unit with a link to manufacturing workshop/industry should be established under the auspices of the Science Committee for Science and Technology.

This Engineering Design Unit will carry out further development and adaptation of scientific and technological research results to give applied inputs to manufacturing industry and to continuously update the design to improve the products. A participation in the establishment of the Engineering Unit should be a subject of new UNIDO technical assistance to MPR.

3. Intensive training of manpower for industry in general and solar elements/solar batteries manufacturing workshop in particular should be undertaken to provide a skilled manufacturing team when production work starts. The key to such development, however, is an accurate analysis of market demand. A proper study should also be undertaken, prior to any development involving the establishment of a manufacturing industry, to determine who will really use solar batteries.

4. The different alternative energy sources for use by small rural communities (cattle breeders and farmers) in Mongolia should be integrated into one complex. And in this complex it is necessary to include thermo-electric generator, which according to the expatriate expert's findings could be manufactured in the country.