PD-AAX-[redacted]
670

January 1982

DEMONSTRATION PROJECTS

The Development and Application of Biogas Technology in Rural Areas of Egypt

I. Background Information

Problems of food supply, energy availability, and pollution abatement are among the most important faced by this and future generations in Egypt. Attention to these priorities figure prominently in the programs of the National Research Center (NRC) as it endeavors to serve the Egyptian people in both rural and urban sectors. The project for "The Development and Application of Biogas Technology in Rural Areas of Egypt" fits perfectly into that framework of applied scientific and technological problem solving. It looks at ways for using vegetable, animal, and human wastes to produce energy (the "biogas" generator), and natural fertilizers under environmentally safe conditions.

Efforts to develop rural (one-family) and village-scale biogas generators in different countries of the world exhibit various degrees of success. Chinese and Indian programs, both of which have been studied in detail by the Egyptian group, have extensive and very practical operating experience in areas such as digester design, operation, maintenance, and--most importantly--in techniques to win user participation and acceptance. But success in any one program is not easily translated into comparable success in another program. The technology must be field-tested and made compatible with existing socio-economic conditions. Thus, the biogas technology project at the NRC has been specifically designed to explore and test the variables that determine success--and success is defined in terms of rural acceptance, voluntary use, and economic viability rather than mere technical feasibility.

Succinctly stated, the goal of the NRC project is to demonstrate that the application of biogas technology on the village level is technically, socially, and economically feasible. In addition to the generation of the gas itself, major considerations include applying the technology to improving the village environment, producing useable fertilizer, enhancing waste treatment, and improving public health and sanitation.

The NRC program's major elements are as follows:

1. Fact finding. Gathering of data and evaluation of experiences to provide a basic picture of the technology involved, the factors in Egyptian village customs and daily life that affect either positively or negatively the acceptance of biogas systems, and the factors relevant to project implementation.

2. Supportive work. Interdisciplinary efforts in preparing village (field) testing, providing services needed for the work, and analyzing the results. These efforts include laboratory and

bench-scale research, engineering design and development, fundamental microbiological work, fertilizer testing and evaluation, and sociological and feasibility studies.

3. Village demonstration. Demonstration of the practicality, usefulness, and cost effectiveness to the village users is the most important element in this project. Two villages were selected to test (demonstrate) the technical economic and village acceptance of biogas energy systems in rural application.

II. Project Status, end of December 1981

A. Fact Finding.

An initial step was a review of the literature and relevant experience gained by other groups that have been engaged in biogas technology at the village level. A fact finding trip to China, Thailand, and India gave particular impetus to the Egyptian project because of the opportunity provided to observe various biogas digester designs, their operating characteristics, and ways in which on-the-scene problems were solved. Especially important were the discussions on social acceptability, village-level training for maintenance and normal operation of various systems.

Team members also participated in international technical meetings in India and the United States for purposes of interaction with a wide cross-section of people, many from developing countries, on local approaches to biogas system design and rural applications.

B. Supportive Work

1. Village selection. Preliminary surveys were conducted in four villages, using criteria such as interest of villagers in a biogas technology experiment; representation of traditional vs new-planned village models; availability of data from government and other sources on village services, population, family statistics, and energy use; and relative proximity to the NRC. Two villages -- Al Manawat (very near Cairo and undergoing a transition from rural to rural-urban status) and Omar Makram (160 km from Cairo and a new-village on the western fringe of the Delta) -- were selected as sites for testing biogas systems.

2. Laboratory and bench-scale research. This comprises all the digestibility research aimed mainly at achieving greatest efficiency and highest pathogen destruction rates. The biogas team investigated mixtures of cow dung, sewage, and agricultural wastes (weeds, water hyacinth and maize/cotton stalks). Following their investigation, they decided to focus on such operational characteristics as solids concentration in digester loading, temperature effects on gas volumes and on generation rates, time-length of digestion process under various conditions,

and destruction of bacteria under operating conditions. The presence of pesticides in agricultural wastes was found to have a marked effect upon the volume of gas produced.

3. Engineering and development work. This comprises all work for developing simple, reliable and low cost village-type biogas plants and appropriate gas-use devices. Three prototype digester units were designed, built, and operated at the NRC by the engineering group. They considered the entire range of construction, digester start-up, maintenance, and long term operational parameters in order to arrive at a design that could be transferred to a village and would perform reliably. The same group evaluated prototype gas-use devices and designed for local fabrication in Egypt a test burner with replaceable parts for final testing in village situations.

4. Fertilizer development work. This aspect includes all work relating to the assessment of digested products such as fertilizer and soil conditioners and necessarily must cover laboratory, greenhouse, and field testing. Based upon the work to date, digested materials show good fertilizer value (particularly with respect to available nitrogen and phosphorus) as well as favorable microbial population.

5. Fundamental microbial work. This work has concentrated in two areas: (a) suppression of hydrogen sulfide formation during digestion because that material adversely affects gas formation, and (b) conditions for the destruction of harmful microbial agents in the digestion process.

C. Village Demonstration Work

Implementation of the village demonstration project began at Al-Manawat in March 1981. Two family-size digestors -- each of about 10 cubic meters volume -- were built. One of a modified Indian type was attached to a local farmer's house, and the other of the Chinese model was installed in the village collective unit. Both units have operated satisfactorily since May 1981. Actual operational experience on the local farmer's digester showed that gas use was much less, particularly in summer, than was originally estimated. This has the advantage of lengthening the retention period of the charge and gives the investigation team a new opportunity to optimize cost/benefits in future digester designs.

During the coming months of Phase II, the NRC group working with Omar Makram villagers will begin the program there, continue the social and technical economic evaluations in both villages, review the possibility of adding other test-sites, and inaugurate a central biogas services laboratory within the NRC.

III. Major Problems and their Resolution

No major technical problems have arisen that adversely affected the work or seriously delayed the schedule as projected in 1979. The interdisciplinary team has worked well together and various opportunities for observation/study trips abroad have proved very beneficial to the project, not only from the technical and data-gathering aspects but in reinforcing working relationships and team rapport.

Mention should also be made of the good working interaction between the Egyptian team and the U.S. advisory panel. The U.S. panel consists of two engineers with specific R&D experience in biogas systems and a rural sociologist with field experience in technology transfer methodologies.

Procurement of equipment for the central biogas services laboratory has been a time consuming process and the lack of that equipment has held back the work at several critical junctures. As of December 1981, approximately 63% of the equipment had been shipped to NRC. It is expected that new procedures will reduce the steps in the procurement approval chain in Phase II.

The biogas project necessarily requires locally purchased materials and supplies to construct prototype generators at the NRC site and test generators in Al-Manawat village. Several times when these funds were delayed, alternative arrangements -- including personal loans by the researchers themselves -- had to be made. Similarly, the transition from Phase I to Phase II has been hampered by a lack of funding for materials, supplies, and salary incentives. Although the problems are on their way to resolution, time has been lost which necessarily lengthens the total time needed to accomplish project goals.

IV. Immediate Next Steps

- Continuation of multidisciplinary followup work on the operating prototype in Al-Manawat and demonstration units at the NRC in Cairo.
- Continuation of social-technical-economic analysis and appraisal in the context of the village demonstration projects.
- Building one or more additional demonstration digesters at the NRC site.
- Inauguration of a Central Biogas Services Laboratory, using the analytical equipment purchased during Phase I.
- Selection of one or more additional villages for construction and operation of biogas digesters and initiation of social-technical economic analyses of the impact these biogas generators will have in those village locations.