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THE ESTABLISHMENT OF REGIONAL ENERGY CENTERS FOR RURAL DEVELOPMENT IN THAILAND

Submitted to the
National Energy Administration
Ministry of Science, Technology and Energy

Under the
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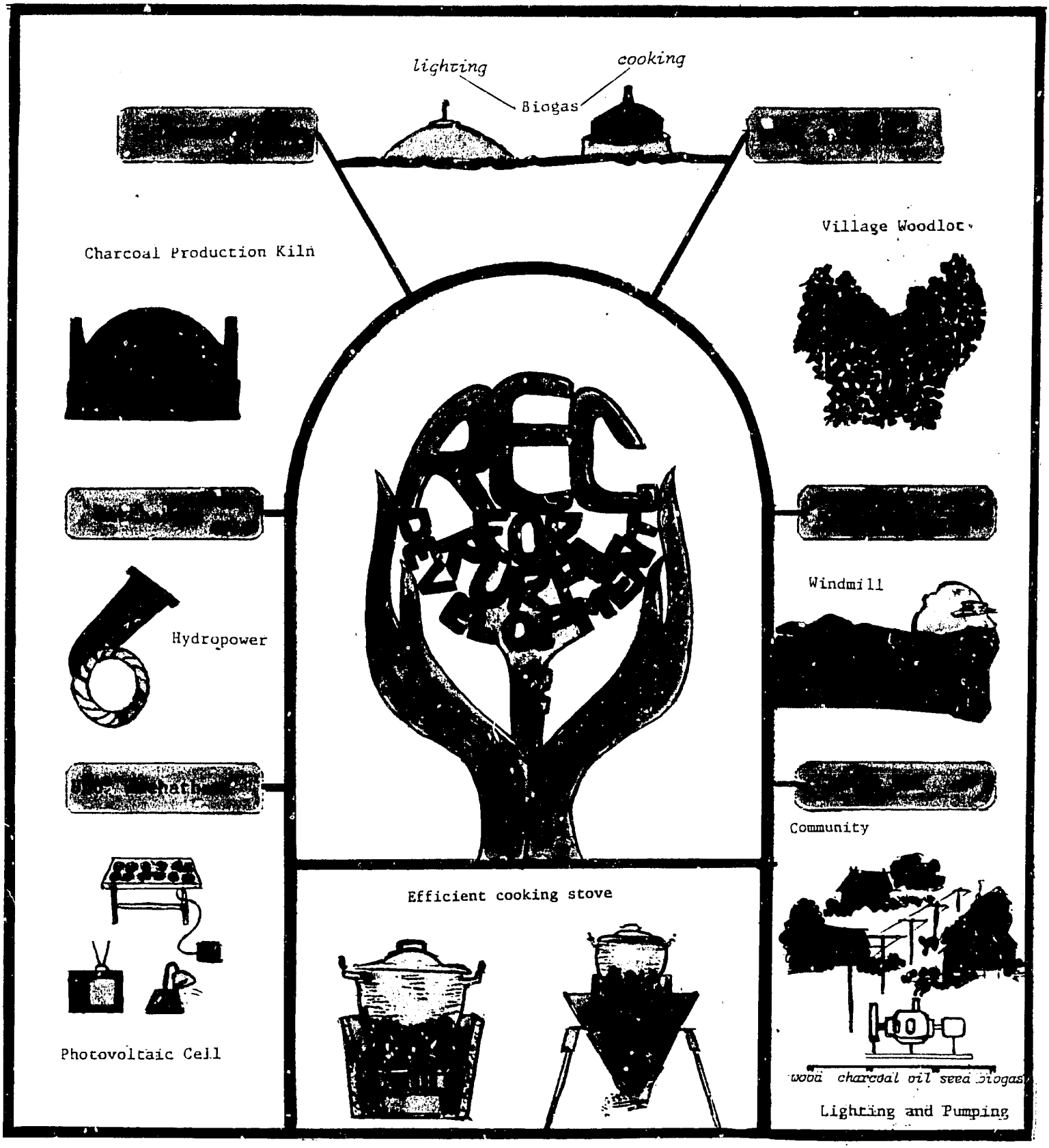
Regional Energy Centers



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EXECUTIVE SUMMARY

The Regional Energy Center is a component part of the Renewable Non-Conventional Energy Program which received financial assistance from the United States Agency for International Development (USAID) and was administered by the National Energy Administration. The operation covered a three-year time span, 1982 - 1984, and focused on providing rural communities in Thailand with the established and developed energy technologies capable of meeting basic energy needs in areas such as cooking and household lighting. In addition, energy which could help raise the standard of living and add more income to families, such as water pumping for irrigation and electricity production for rural industries, needed to be disseminated into rural areas of Thailand. This effort required demonstrations, assistance, selection of the relevant rural technology, installation, training and maintenance. The program strove to spread these technologies throughout rural areas as an assistance to the Royal Thai Government's rural development program.

Regional Energy Centers (RECs), to be effective, need the following items: one workshop, one warehouse, one training hall, an electrical system and a water supply. In terms of equipment, each center requires workshop tools, field tools, laboratory and monitoring instruments and dissemination or visual aid training equipment. For demonstrations, prototypes of energy technologies are needed for solar energy, wind energy and biomass energy. In terms of vehicles, one 2-ton truck, two 1-ton trucks, two motorcycles and two bicycles are required. The staff requires engineers or scientists, technicians of various levels and areas of specialty, guards, a labor force and drivers.

REC operations initially faced obstacles in areas such as methods, procedures, laws and communication which slowed the project down, but eventually the problems were solved and objectives were met on time. Funds for the implementation of the RECs came from the Royal Thai Government budget and from USAID assistance. The United States contributed US $458,620 (or 10,545,260 Baht) for the construction of buildings and for the purchase of tools, equipment and instruments. Total fund usage was 8,888,853 Baht. A total of 1,656,407 Baht was saved by purchasing articles at the lowest available price.

Operational and personnel responsibilities began even before the RECs were completely established. These areas included baseline village surveys, coordination, promotion and public relations. In 1984, the Maha Sarakharm REC and the Phitsanulok REC were fully established and were operating as planned. The Ratchaburi and Nakhon Sithammarat RECs still face a severe shortage of full-time officials. This problem was circumvented with the use of NEA staff consultants who are available to travel to various centers as needed to solve difficulties on a contingency basis.

CONCLUSIONS

The operational processes of the REC from its conception until the end of the 1984 project can be summarized as follows:

1. Four Regional Energy Centers (RECs) have been installed in Maha Sarakharn Phitsanulok, Ratchaburi and Nakhon Sithammarat Provinces.

2. Each center consists of an administrative office, chief's house, assistan chief's house, rowhouse (for four families), workshop, warehouse and training hall.

3. Public utilities supply the water, electrical systems and roads.

4. Tools and equipment have been procured and include workshop tools, field tools, laboratory and monitoring equipment, communications equipment, training and visual aid equipment.

5. Vehicles have been purchased and consist of a 2-ton truck, two 1-ton trucks (pick-ups), two motorcycles and two bicycles.

6. Sixteen staff members are working at the Maha Sarakharm and Phitsanulok RECs. There are five staff members at the Nakhon Sithammarat REC and four staff members at the Ratchaburi REC.

7. Energy technologies (prototypes) to be used for demonstrations of and as examples of available energy technologies have been installed. These consist of solar hot water and solar distillation techniques, solar dryers, windmills, photovoltaic cells, biogas digesters, biomass gasifiers, efficient cooking stoves and efficient charcoal production kilns.

8. 100 rai of *Eucalyptus camaldulensis* and oil seed trees have been planted at the centers and 70,000 plants of *Eucalyptus camaldulensis* were introduced to village plantations as a renewable village fuel source.

9. 368 demonstrations and promotional activities on the utilization of energy technologies were conducted: 92 on biogas plants, 200 on efficient cooking stoves and 76 on charcoal production kilns.

10. Village surveys were conducted in 56 villages within the center's areas of responsibility. Data were collected on the basic and increased income of people in each village, energy needs, indigenous resources and their potential

11. There were 225 villagers, local government officials, village leaders, public school teachers, etc. trained at the RECs on the subjects of biogas digesters, windmills, efficient charcoal production kilns, efficient cooking stoves, the construction/fabrication, uses and maintenance of each technology, etc. Also, additional training was given to those people who had already been trained but needed more assistance and who were interested in installing

the equipment for their personal usage. The results from twenty-one training sessions were highly satisfactory and the RECs were requested to continue training. Those who had been trained at the centers became important energy promoters who helped to disseminate energy technologies to rural areas of the country.

12. Training results were monitored and assessed for their effectiveness and in order to solve obstacles and problems.

13. The energy demonstration and promotional programs resulted in the continued dissemination of energy technologies. These were the family biogas plants, community biogas plants for electricity generating, photovoltaic cells for water pumping, windmills for water pumping, charcoal production kilns, etc.

14. There were 1,575 visitors to the RECs.

15. 4,550 printed materials on energy technology were distributed.

16. REC activities were advertised 62 times.

17. The RECs conducted 12 joint exhibitions with other government agencies for public relations and the dissemination of REC activities.

18. 34 coordination sessions and lectures were conducted with other energy components and government agencies interested in installing comparable or related technologies.

19. An analysis of the RECs in the closing stages of the project showed that despite unanticipated obstacles during the establishment stages, the RECs achieved their objectives and obtained the results listed in the conclusions.

RECOMMENDATIONS

1. Provisions need to be made to provide full staffs at all centers. An understaffed REC results in a limitation of operational potential.

2. The RECs have field tested numerous training/information dissemination/ public relations methods and activities. Those various methods which have proven successful in advertising and promoting the RECs and the various technologies should be made a part of the promotional activity plans for newly established RECs.

3. The monitored results of twenty-one training sessions showed that they were highly successful. The REC should definitely continue this activity as those personnel who received the training have become important energy promoters who are helping to disseminate the information on these renewable energy technologies throughout the rural areas of Thailand.

4. Training must be continued because it is the only method to disseminate energy technologies in rural areas of Thailand with highly efficient results.

5. Coordination sessions with other government offices and energy components should continue so that there are no overlapping efforts and so that related activities and projects can begin simultaneously.

6. An analysis of problems which were encountered in the early phases of the project will help in the establishment of future RECs and will encourage efficiency and mission accomplishment.

7. Additional Regional Energy Centers should be set up to cover a wider area of Thailand.

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CHAPTER 1

INTRODUCTION

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INTRODUCTION

A. BACKGROUND

Energy has developed into a human necessity and has also become an important factor in our country's economic development. In Thailand, energy is used for development and public welfare. The economic aspects of energy have been rapidly expanded to include all sectors of society: industry, transportation, agriculture, domestic, commercial, services and many other fringe areas. These economic development activities have, in turn, created a rapidly increasing energy demand.

Energy usage has become most prevalent among the following sectors: transportation 23.44%, industry 29.35%, residential commercial service and others 27.24%, agriculture 7.09% and construction 0.88% (Thailand Energy Situation, 1983). It has been found that the use of energy in the rural areas has remained at a level which is significantly lower than is used in the large urban areas, particularly in Bangkok.

From past records we find that in 1982 energy consumption was supplied from the following sources: petroleum products 58.27% charcoal 10.41%, natural gas 6.91%, hydro 6.91%, biogas 6.59%, coal and lignite 4.17%, fuel wood 3.43% and paddy husk 3.31%. Thailand has been using fuel oil for its primary supply of energy. The second most consumed energy resources are firewood and charcoal that come from natural forests. Since the oil shortages of the 1970's, Thailand has been affected by dwindling energy resources for development. Because crude oil has become more expensive to import, Thailand has been drained of a large portion of her export earnings. This creates large payment deficits, inflation and income distribution problems.

These increased energy demands have also resulted in an increase in deforestation. All these factors affect Thailand socially, economically and environmentally. They also contribute to delays in the development of the country.

Being fully aware of the situation, the Royal Thai Government has placed greater emphasis on the diversification of dependence on fuel oil to other alternative energy sources. According to Thailand's 5th Five Year Economic and Social Development Plan, which started in 1981, the objective, particularly in the energy sector, was to reduce Thailand's dependence on imported fuel oil from 68.37 percent of total energy consumption in 1981 to 46 percent by 1986. This was to be accomplished by utilizing available indigenous natural gas and lignite, and by increasing the use of hydropower, biomass, charcoal and fuel wood, solar, wind,

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oil shale, geothermal, and draught wind power, which were identified as new renewable energy resources. It was the policy, as stated in the 5th Five Year Economic and Social Development Plan, that the renewable nonconventional energy utilization was to be initiated for rural area development.

The National Energy Administration (NEA), under the Ministry of Science, Technology and Energy, started the renewable energy program in 1975. This project was to help Thailand reduce its dependence on imported energy sources and its environmental degradation due to deforestation caused by the demand for wood as a fuel, by developing and introducing other renewable energy resources. It was also aimed at promoting a better living standard for rural people through the utilization of new renewable energy resources, namely, biomass energy, solar energy and wind energy etc., that were already available in the rural areas. This should reduce both the rate of deforestation as a fuel source for cooking, and the demand for fuel oils for electricity generating. The emphasis was on substituting materials or other energy resources that were locally available for fuel oil. (For example, biogas from animal residues could be used for cooking, lighting, electricity generating, and water pumping in the rural villages). Solar energy, wind power, hydro power, agricultural residues, woodlots and charcoal depend only on the availability of the raw materials or energy resources in those rural areas. For people who live in large urban areas, such as cities or towns, energy conservation, solar energy and highly efficient cooking stoves which the population are usually familiar with are more suitable. People who live in rural areas and those who live in urban areas have many noticable differences in energy resources, methods and conditions of livings, and in incomes.

The long term goal is to substitute these renewable nonconventional energy sources in the urban and rural areas for the fuel oil which is imported from foreign countries or for other non-renewable energy sources available in Thailand. This will reinforce the frustrated natural energy resources and will also aid in tolerating any energy crises in the future.

In developing energy technologies, the tasks are divided into six main categories as follows:

Resource Assessment

This task includes the evaluation of both new renewable energy resources and the uses and availability of existing energy resources. This includes collection and compilation, a determination of other resources that can be developed and be of benefit to the rural area, site specifics and an overall evaluation of needs, attitudes, etc.

Need Identification

This task includes the determination of energy requirements for basic needs and developmental needs together with the requirements for the development of locally available resources other than energy resources.

Research and Development (R&D) of Relevant Energy Technologies

This task includes the setting up of priority research and development areas for each new renewable energy source, performing the R&D in the areas selected and linking the R&D accomplishment to development and demonstration tasks.

Development and Demonstration (D&D) of Proven Energy Technologies

The prime focus of this task is to set up a proven technology testing site in which it is possible to check the technical performance and reliability of new renewable nonconventional energy projects. If the technology is technically viable, information obtained will be fed to the development and extension promotion group as well as to interested consumers and/or enterpreneurs. The facts and figures would be fed back to the R&D group for any necessary modifications.

Demonstration and Extension/Promotion (D&E/P)

Demonstrations of the proven, reliable technology will be carried out at several selected sites. The costs of procuring locally available skills and materials will be determined. If it is accepted by the people, extension/promotion will be continued for some time through limited government subsidies by providing component hardware or equivalent reimbursement for paid materials.

Extension/Promotion and Popularization (E/P&P)

The promotion of the proven and reliable technology will be amplified on a large scale as the technology is satisfactorily accepted. Popularization through various means will be performed and training sessions will be arranged and supported.

The tasks outlined above would provide information including facts and figures for the wind scale development and/or utilization of new renewable sources in order to benefit the masses.

Since 1977 the NEA has been conducting the Renewable Nonconventional Energy Project. Since 1981 the U.S. Government has provided US$ 5 million (extended over a 5 year period) in financial assistance. This has also received the support of other Thai government agencies such as the Thailand Institute of Scientific and Technological Research (TISTR), the Royal Forest Department (RFD), the Meteorological Department (MET), Chulalongkorn University (CU) and King Mongkut's Institute of Technology, Thonburi (KMITT). This project was composed of 14 components. It had two main targets as follows:

1. To enforce the capabilities of domestic institutions that are concerned with energy by improving their personnel's abilities in conducting research, developing, planning, data collecting, and conducting an analysis and evaluation of energy resources within the country including the follow-up of energy technology advancements.

2. To research and develop energy technologies suitable for rural areas of the country. It has to serve the basic energy demand, increase the standard of living, increase incomes for rural people, and also disseminate the results of new technologies which are to be applied in rural development.

The Regional Energy Centers (RECs) is a component of the Renewable Nonconventional Energy Project. It has been financially supported by the U.S. Government to establish six Regional Energy Centers which will be operated by the NEA to disseminate and promote appropriate energy technologies. These Centers are set up to demonstrate, train, disseminate, promote, and extend appropriate new technologies throughout the rural areas in Thailand.

B. OBJECTIVES

The Renewable Nonconventional Energy Project under U.S. Government assistance was to create 6 Regional Energy Centers. The NEA, with the support of USAID and DTEC, planned for the following 6 REC's:

- Maha Sarakharm Regional Energy Center
- Phitsanulok Regional Energy Center
- Ratchaburi Regional Energy Center
- Nakhon Sithammarat Regional Energy Center
- Ubol Rachathani Regional Energy Center
- Nakhon Ratchasima Regional Energy Center

C. SCOPE

The Regional Energy Centers (RECs) is an essential component for assisting the appropriate rural oriented energy technologies to take root in the rural areas of Thailand. The function and services of RECs are as follows:

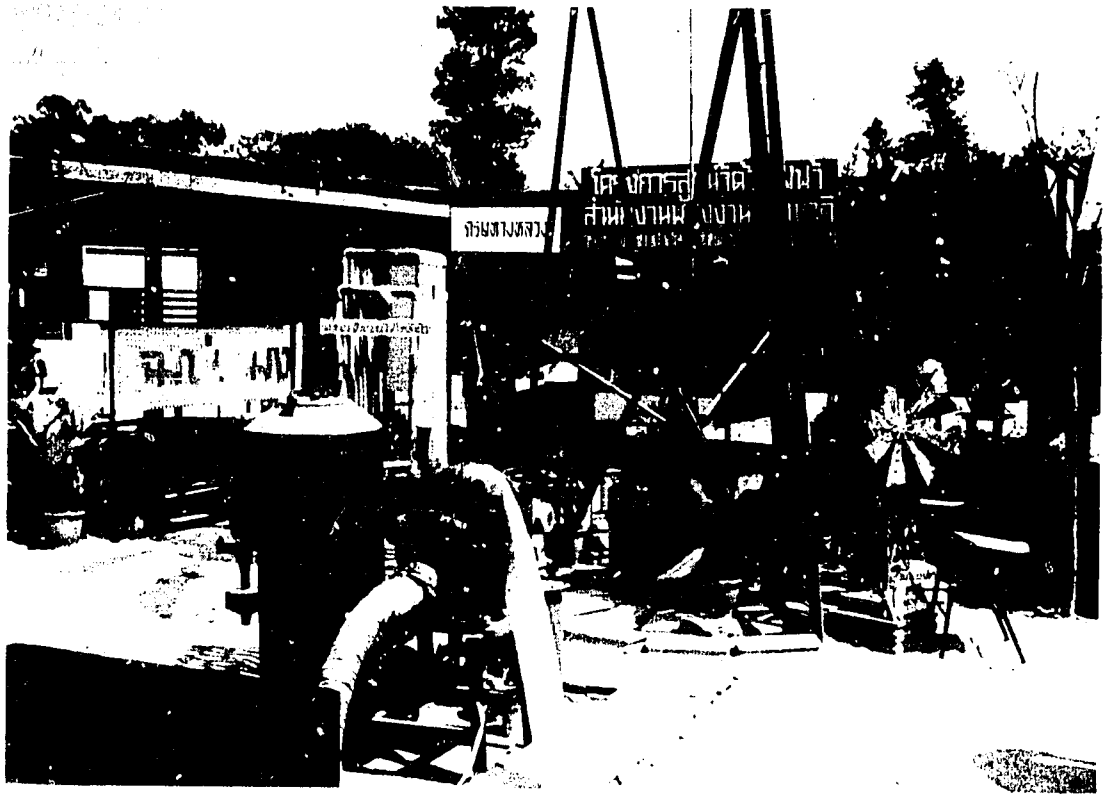
- To demonstrate the utilization of renewable energy resources for rural dwellers which meet basic energy needs, e.g., energy for cooking and lighting within the household, energy for upgrading standards of living and increasing income, energy for reducing the utilization of fuel oils or local forest resources, etc.

- To help rural people work or create energy technology systems that are suitable for the energy sources which exist in the localities according to the existing economic information, potentiality and energy technologies or to stage demonstrations in a small unit or a community system.

- To train operating personnel or those involved in rural development so that they can acquire knowledge and an understanding of energy sources, suitable energy technologies, conservation of energy sources, rural village energy sources improvement, energy generation, utilization and maintenance, etc., by collaborating with government and private organizations and people in the localities.

- To work in collaboration with government, private organizations and people in related localities in order to be able to disseminate and accelerate the utilization of energy technologies suitable for rural energy sources and to operate according to the plan.

- To collect relevant information concerning the potentiality of energy sources, energy needs, outcomes of demonstrations or field tests and socio-economic acceptability.

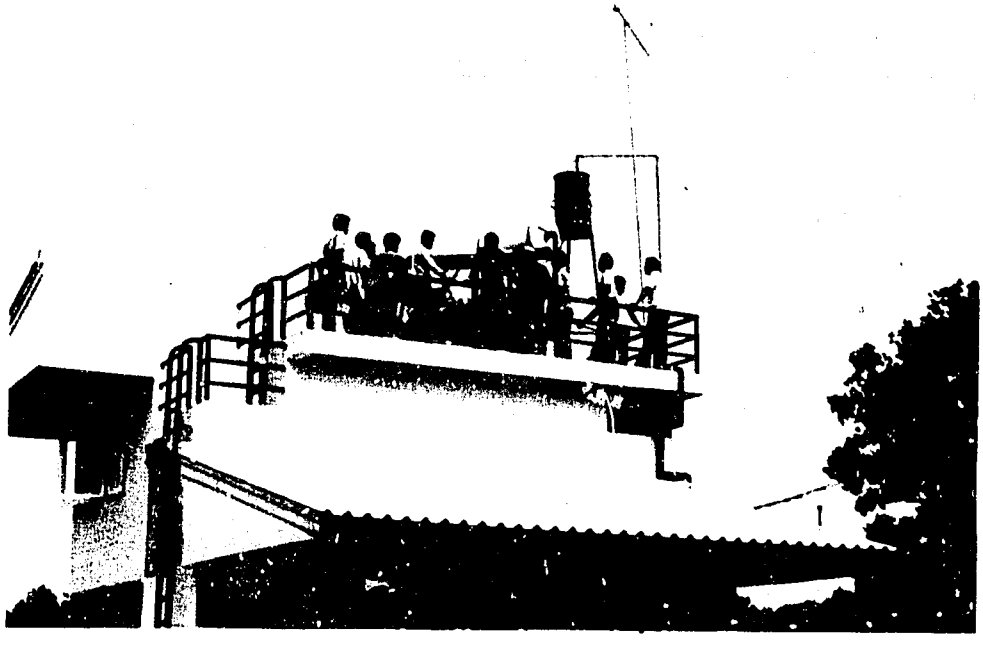


Exhibition of energy technologies in Roi-et Province.

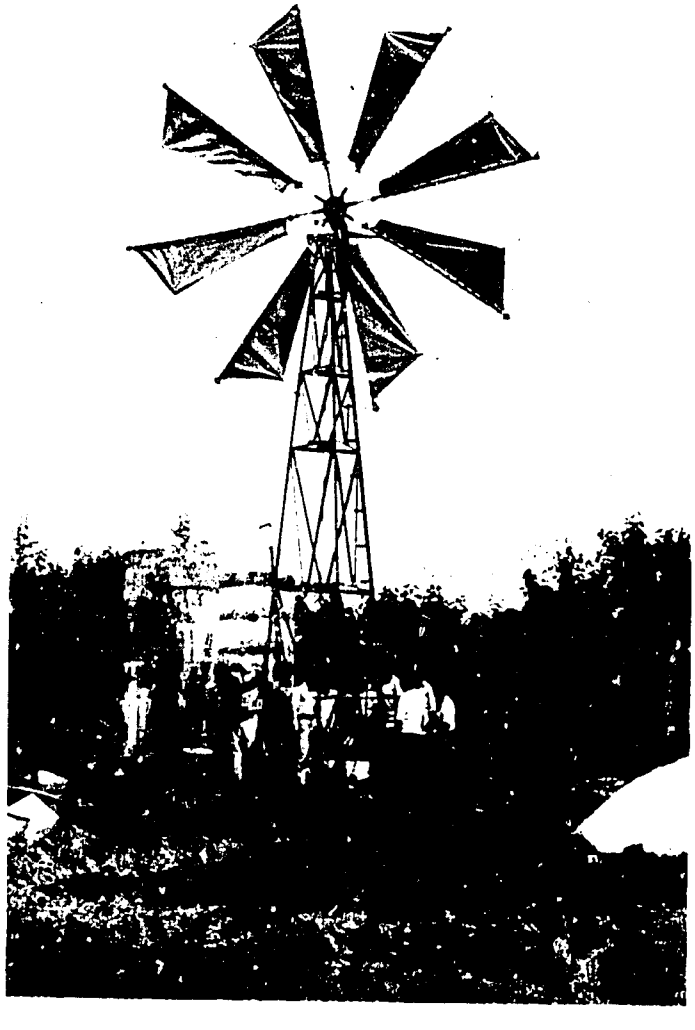
Visitors being shown the energy technology prototypes.

Loading the stove into the bucket.

Demonstrating the correct proceedures for comparing the relative efficiency of a commercial stove with the new efficient cooking stove during an REC training session.



A demonstration of the solar water heating system.



Viewing a windmill used for water pumping.

CHAPTER 2

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

A. ENERGY RESOURCE, POTENTIAL AND EXPLOITATION

Energy resources in Thailand which can be exploited can be classified into 2 types as follows:

Nonrenewable Resources

Lignite

Lignite deposites are found in many parts of Thailand. The potential reserves are estimated to be 750 million metric tons and are located at only three sites. These sources have been developed for power generation, industrial, and commercial uses. Production in 1982 was:

a)	Mae Moh, Lampang Province	1.2×10^6 ton
b)	Ban Pu Dam, Krabi Province	0.3×10^6 ton
c)	Li, Lamphun Province	0.1×10^6 ton

Other sources are under exploration.

Oil and natural gas

Petroleum crude and natural gas deposits in Thailand are located both on-shore and off-shore. The Thailand government awarded concessions for the exploration and production of petroleum and natural gas. The deposites investigated were not only inland but were also in the Gulf of Thailand and in the Andaman sea. The potential reserves are estimated to be 200×10^6 barrels and 21.1×10^{12} set of petroleum crude and natural gas (off-shore), respectively. Deposits found in 1982 have been developed. Crude oil produced and supplied to the refinery plant had an out-put of 12,000 barrels per day and natural gas for power generation, 200×10^6 cf. per day from Lan Krabue, Kampangpet Province and the Gulf of Thailand. Additional deposits have been found and developed commercially.

Oil shale

A huge deposit of oil shale was found at Mae Sot Basin, Tak Province. Its deposit covered an area of 550 square kilometers with an estimated reserve of 18,500 million metric tons. The average oil yield was 5% by weight.

Nuclear Mineral

Presently, there are no nuclear power plants in Thailand. A plan for the construction of a nuclear power plant has been postponed for political and economic reasons. In the meantime, investigations and explorations for radioactive mineral resources have been carried out. Reports on uranium bearing rocks in northeastern Thailand and monazites in southern Thailand have been made. No quantitative figures are available.

Fuelwood and charcoal

Based on Langsat 3, the forest area in Thailand in 1982 was estimated to be 156,608 square kilometers or 30.52% of the total area of Thailand. It was reduced by 18,624 square kilometers or 10.62% between 1978-1982. Fuel wood and charcoal still play an important role as the primary cooking fuel in the rural and urban areas. From the report of the Domestic Energy Utilization Survey of the National Energy Administration (NEA) in 1981, the annual consumption of fuel wood and charcoal was 6,109,525 billion kcal and 17,500,782 billion kcal respectively. It is expected that the demand will increase 2-2.5% a year. Therefore, wide-spread applications of improved practices and technologies of conservation and more effective usage of the natural forest resources, acceleration of programmes for the establishment of large scale reforestation and afforestation with selected and test species as well as small scale woodlots and plantations of energy crops are therefore necessary.

Renewable Resources

Hydro power

The average annual rainfall in Thailand is 1,500-2,000 millimeters and the period of highest frequency of rainfall (the rainy season) occurs for 4-6 months a year. The mountainous areas of Thailand are suitable for hydro-electric power. The potential reserve is 10,120 MW for in-country projects and 16,895 MW in international projects. The total potential reserves are 24,165 MW. In 1982, 1,537.9 MW of hydro-electric power plants had been installed.

Large-hydro

There are 106 large-hydro projects in Thailand with an estimated installed capacity and generation of 10,084.4 MW and 10 projects with a 1,379.2 MW capacity. Four projects with 561.0 MW capacity are presently under commission and construction.

Small-hydro

There are many sites for small-hydro power plants. The potential capacity is estimated at 472.185 MW of firm power based on dry season flow. 25 mini-hydro projects having a capacity of 100-6,000 KW and 75 micro-hydro projects having a capacity of 5-100 KW will be developed by 1985.

Biomass

CROP RESIDUES

- Bagasse: 10-15 mton was produced and mostly used by the sugar industries as a heat source. In 1982, the consumption of bagasse as a fuel for producing the steam used in sugar factories represented 6.59% of the total energy consumption. Some was also used as a raw material in the paper industry.

- Paddy husk: 3-4 mton was produced and mostly used in rice mills, where it originated, as a heat source. In 1982, paddy husk was used as a fuel for producing steam in rice mills. This represented 3.31% of the total energy consumption. It was also used for cooking, for making charcoal and in other cottage industries i.e., brick making, pottery, and food.

- Straw: 30-40 mton was produced and often burnt or ploughed into the soil as part of land preparation. Straw piles in fields and around the home for animal feeding is a common sight.

- Maize straw: 5-10 mton was produced and often burnt or ploughed into the soil as part of land preparation. It is also used for cooking and as an organic fertilizer when mixed with cow manure as a compost.

- Cassava: 10-15 mton of cassava and 0.5 mton of kenaf stick was produced. Their use is not known. The above potentials are estimated from the agricultural statistics of Thailand through the use of several conversion factors based on the yields in experimental stations. No attempt has been made to estimate yields under actual field conditions.

As the utilization of the agricultural residues is still low, it is appropriate to promote its use as a fuel for cooking food, making steam, and running an engine. Regarding this point, technologies relating to the following are under development in Thailand. Several are under the RTG-USAID Renewable Nonconventional Energy Project.

- Solid fuel production through densification and improved distillation;
- Agricultural residue cooking stoves;
- Producer gas production through controlled combustion;
- Pyrolitic oil and medium calorific value gas production through pyrolysis; and
- Boiler system design improvement for enhanced conversion efficiency in such industries as sugar refineries, and rice mills.

ANIMAL RESIDUE

The total availability of manure in Thailand is approximately 57 mton (ignoring collectability problems) and 30 mton with collectable cattle manure being set at 50%, and pig manure and fowl droplets, 75%. Potential biogas production is 1,633 million cubic meters. In 1982 there were about 4,000 family size digesters, each generating 1-2 cu m/day of biogas for household cooking throughout various parts of Thailand and 6 community size digesters, each generating 20-30 cu m/day of biogas - four being used for crop irrigation and two for village electricity generation. These figures are very insignificant when compared with its potential.

City garbage

Approximately 1 mton of garbage is collectable in Bangkok, a city of 4.5 million people. In preliminary analysis, 1 kilogram of garbage is 1,200-1,300 kcal. Collectable waste in the city of Bangkok alone is equivalent to 120 million litres of crude oil equivalent.

Sanitary and health problems due to waste pose great concern in the municipal city of Bangkok. As the city expands, the problem becomes more complicated. The cost of garbage collection and elimination by the present method, fermentation and burning, is considerable. The preliminary study of using garbage to produce electricity through a garbage-fire steam power plant at an annual production of 250 kwh using half a million tons of garbage has been completed. It could not be implemented because of a lack of awareness and understanding by some city administrators that garbage can be used not only as a raw material for fertilizer production but also as a source of heat for power generation. Up until now it has not been utilized as an energy sources.

Alcohol

Like many other agricultural countries, Thailand recognized the importance of developing the alcohol industry in order to create a renewable energy source in the country. The Thai government encourages research work on the utilization of alcohol as a fuel for motor vehicles and other purposes. Alcohol could be produced in Thailand using sugar cane, broken rice, cassava, molasses and sweet sorghum as feedstock. In the present circumstances a large scale fuel alcohol production plant could not be establish because of the recovery program of crude oil and natural gas in Thailand. A pilot plant with a production capacity of 1,500 litres/day using cassava as a feedstock is being built.

Oil seed

Nonedible oil seeds like the seeds from the jatropha curcus linn fruit are seperated from the pericap and put out to dry. They are then roasted and ground. The ground seeds are boiled with water and the oil floats to the surface. The floating oil, 25-30% by weight can be collected and used as a substitute for diesel fuel without any engine adjustment or modification. It has a very encouraging prospect in Thailand, especially for the rural people, to run their agricultural machinery because it can be propagated easily either from seeds or cuttings, and it grows well even in poor soil.

Other biomass

Forest wastes from logging operations (1.5 cu m left cut or damaged in the forest for every cu m logged); forest waste from land clearing for agriculture and rubber tree plantations; bark, sawdust, mill slab, offcut, trimmings, degraded wood, planer shavings, sander dust from wood processing industries; aquatic plants such as water hyancinth, and algae have a high potential. Their use as an energy source is not known and should be researched.

Solar energy

Thailand is situated at 6°-20°N Longitude and 97°-106°E Latitude where the average daily solar radiation is resonably high (about 17 MJ/M^2d). Solar energy has high potential and needs to be developed. Efforts are being made by a number of educational and research institutions and government agencies to carry out studies on the utilization of solar energy for various purposes e.g., refrigeration, air-conditioning, distillation, cooking, drying, water heating, pumping and electricity generation. At present solar energy is at the commercial stage in Thailand. More than 11,000 square meters of flat plate collectors have been installed in hotels, hospitals, apartments, barber shops, and private houses. It is expected that many more installations will occur as the private sector has currently shown a greater interest in solar energy. In addition, the government plans to install more and more solar collectors as an example

and to provide more incentives. There are presently more than 70 kw of solar photovoltaic cells in Thailand. Solar photovoltaic cells for communications systems, village electric generation, water pumping, educational T.V., navigational aids and high tower warning lights are being installed and tested in the country.

Wind energy

In Thailand, the average wind velocity is rather low (about 7-14 kilometers per hour) in most areas. Areas which are considered suitable for windmill applications are along the coastal areas, the Central Flain, the Northern intermountain basins, and the Korat plateau. More than 5,000 windmills have been installed, most for water pumping. Windmills are frequently seen in the salt farms along the coasts. Windmills were popular in the ancient days and later become an essential means for saving gasoline for pumping. The technology has been known for centuries and recently, several types of windmills for pumping water have been developed and are being used. Steel multiblade types, Bamboo mat and cloth sail types, and 204-wood-blade types are all manufactured in Bangkok and made in local shops. Other types i.e. the cycle wheel type, and the Bamboo sheet multiblade type are being developed. Small scale windmills for generating electricity are also being developed and tested in the country.

Geothermal

Although Thailand is not located along the active volcanic zone, 65 hot springs have been found associated with granitic batholith in the northern, western and southern parts of the country. Investigations into 5 promising hot springs with reservoir temperatures ranging from 175-200 degree celcius, have been completed. A feasibility study is being undertaken by EGAT in two selective areas in northern Thailand. Geothermal can possibly be used as a process heat to dry crops or tobacco leaves or as a heat source for electricity generation depending on the findings in the EGAT study.

Draught animal power

In 1979, Thailand had 7.205 million working cattle out of 8.461 million cattle over three years of age. Draught animal power has been used for ploughing, carting and water lifting. Each head of cattle with drawn implement should be able to plough 0.15-0.25 Ha of land in preparation for growing rice each day. It is estimated that each head of cattle has a capacity of .3 kw. 7.205 million working cattle could therefore provide a capacity of 2.1615 million kw. However, harnessing devices: yoke connected through a pulley-beam to the plough (cattle drawn implement) and cart with wooden/rubber tires with the wide varities of axles being used at present have low transmission and mechanical efficiency.

B. AGENCIES CONCERNED WITH ENERGY RESEARCH AND DEVELOPMENT

Energy Technology	Agencies Concerned
Biogas technology	- King Mongkut's Institute of Technology, Thonburi - Thailand Institute of Scientific and Technological Research - National Energy Administration - Department of Health - Department of Agricultural Extension - Department of Agriculture - Department of Public Welfare - Agricultural Land Reform Office - Chulalongkorn University
Biomass technology	- Prince of Songkhla University - Chulalongkorn University - King Mongkut's Institute of Technology - Department of Agriculture - Thailand Institute of Scientific and Technological Research - Department of Public Work - National Security Command Headquarters - Industrial Service Institute - Srimaharacha Ltd. - Mr. Prasit Jiamsamai, Karnchanaburi

Energy Technology	Agencies Concerned
Efficient stove technology	- Department of Forestry in Coordination with the National Energy Administration
Charcoal Production Kiln	- Department of Forestry in Coordination with the National Energy Administration
Village Woodlot	- Department of Forestry - The Forest Industry Organization - Ply-Wood Company Ltd. - The National Energy Administration - Thailand Institute of Scientific and Technological Research - Department of Agriculture
Oil Seed Technology	- Department of Agriculture - The National Energy Administration
Alcohol Production at the Village level	- King Mongkut's Institute of Technology - Thailand Institute of Scientific and Technological Research
Solar Energy	- Chiang Mai University - Prince of Songkhla University - Kasetsart University - King Mongkut's Institute of Technology

Energy Technology	Agencies Concerned
	- The National Energy Administration - Chulalongkorn University - Office of Basic Industry Development - Department of Science Service - The Telephone Organization of Thailand - The Electricity Generating Authority of Thailand
Wind Energy	- Kasetsart University - The National Energy Administration - Chachoengsao College of Education - Usa Economic Development Company Ltd. - King Mongkut's Institute of Technology - Volunteer in Technical Assistance - Prince of Songkhla University - Chachoengsao Teachers' College
Micro-hydro	- The National Energy Administration - Provincial Electricity Authority

CHAPTER 3

PLANNING THE ESTABLISHMENT OF REC

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PLANNING THE ESTABLISHMENT OF REC

A. PRELIMINARY PLANNING OF REGIONAL ENERGY CENTERS

Project Description and Objectives

The Regional Energy Centers (RECs) were established to be an essential component in the process of transferring relevant rural-oriented energy technologies into the rural areas of Thailand. The function of the REC's are:

- To demonstrate a means of utilizing renewable energy in order for rural people to both up-grade their standard of living and also to conserve important fossil fuels and indigenous wood resources;
- To assist rural people in procuring or fabricating suitable energy systems using renewable energy resources, by giving them techno-economic information, available incentives, or even prototype/community demonstration units (systems);
- To train local community development personnel, related local government officers, and villagers on available renewable energy technologies, their advantages/disadvantages, their implementation, operation and maintenance;
- To coordinate with local government agencies involved in similar or related projects in order to integrate various implementation plans; and
- To collect relevent information on energy needs, performance data from systems under field test conditions, socio-economic acceptance of new technologies, etc.

Site Selection

Six regional energy centers will be established. In 1982, two centers were to be ready to function- one each in the North and Northeast, respectively, at Phitsanulok and Maha Sarakharm. The others

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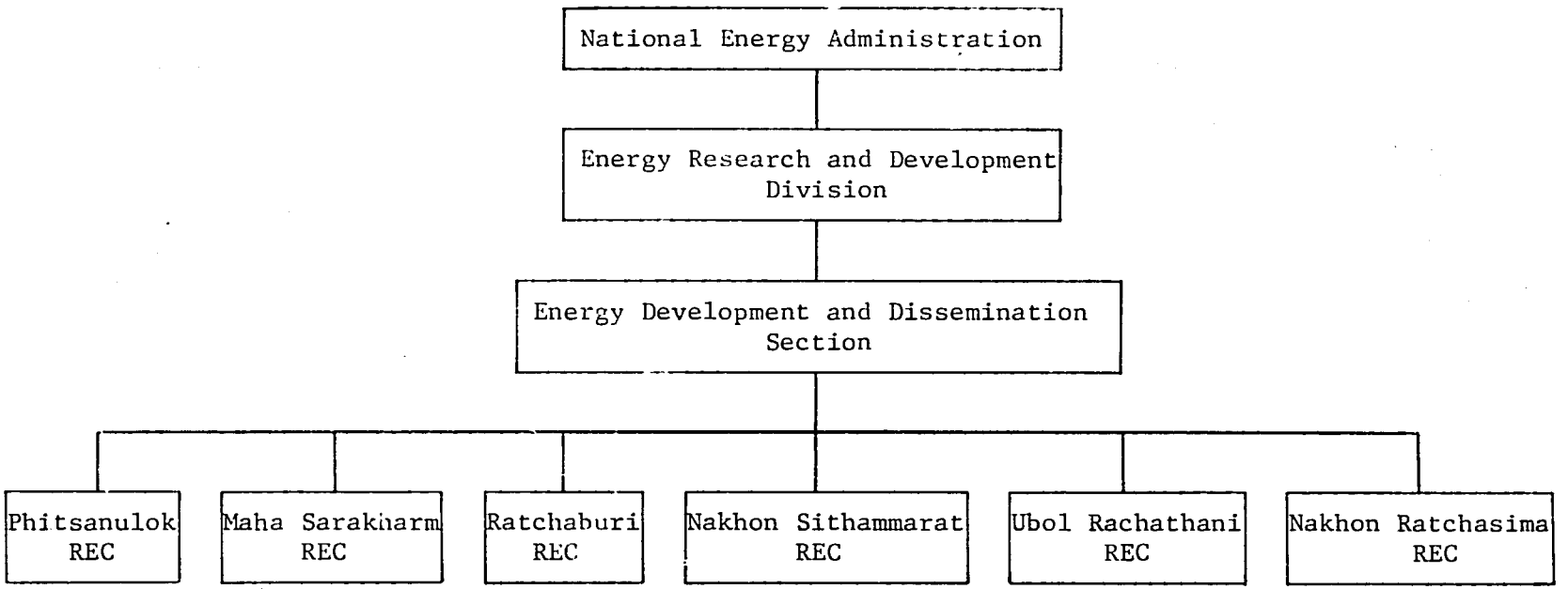


Figure 3.1 Organizational Structure of RECs

were tentatively located in Surat Thani and Ratchaburi and were to be ready to function in 1984; Chacheongsao or Prachin Buri and Ubol Rachathani are to be opened in 1986. The centers are to be located on approximately 20 rais of land (or larger) and are to be easily accessible to the public.

Land Development & Housing Construction

Office and housing facilities for each center will include a 189 m^2 office, one house for the chief of the center, two houses for the energy technologists, one four-family housing unit for energy development personnel and promotionists, one workshop, one storage area in which to keep materials & appliances, and one garage. It is further required that the remainder of the available land will be allocated for the installation of renewable energy prototypes of demonstration and technical-testing purposes, and also for the future establishment of a village woodlot, an oil plant plot and an integrated farming system.

Staffing

Staffing of the center will be by both NEA officials with rural energy technology development experience and from local personnel. There are 13 personnel (seven officials and six temporary staff) allocated for each center, i.e.,

Officials staff

- One engineer who will serve as chief of the center: The chief should have broad general experience in both management and the substance of energy questions;
- Two energy technologists: These will normally be engineers with rural experience and energy technology backgrounds;
- Two energy development personnel: These staff members will function as energy technology development personnel; and
- Two energy promotionists: These personnel should be generalists with experience in community development.

Temporary Staff

- One secretary
- One typist

- Two drivers
- Two workers

Staff members will be recruited as each center commences operation.

operation

Equipment Procurement

Procurement of the equipment needed for each center will be scheduled within one year prior to the initial operation of the center. Each center will be furnished with the following equipment:

- Workshop tools
- Field & installation tools
- Vehicles
- Demonstration equipment/system
- Laboratory equipment/monitoring equipment
- Dissemination equipment
- Office supplies

(For more details, see Annex I)

Operation

As soon as the above mentioned activities are completed, the center will be ready to operate according to the listed objectives with guidance from the NEA office in Bangkok.

Technologies introduction

The principal function of the centers will be the introduction of proven energy technologies appropriate to the villages in the region. It is planned that technological introduction and related activities will be relatively intense within a 50 kilometer radius of the center. The initial technologies to be established at the center and introduced into the villages will be biogas, rice husk pyrolysis, biomass gasifier, water lifting, efficient stoves and charcoal making. Also, the development of other project components will be included at the center when suitable; i.e., a village woodlot, an oilseeds plot, an integrated farm system, etc.

The fabrication of renewable energy related equipment will be performed at the center whenever possible. On-site construction will be encouraged whenever local people can provide labor and locally available materials, while the center staff will provide the technical assistance.

Data collection

The data collection activities of the center are planned to be related solely to the specific villages and technologies involved. These activities will include survey of village needs, available resources and the participation of villagers in the establishment of the new technologies; monitoring information on performance of technologies under actual use and socio-economic acceptance.

Training

Training for community development personnel, related RTG officials, volunteers, and villagers will be conducted at the center and at a demonstration development site. It is intended that this activity will be conducted in cooperation with other RTG departments and local institutions.

Observation tours are planned for chief of the centers to other Asian countries i.e., India, Australia or Korea (to be selected later, as needed) in order to familiarize them with current developments in the rural energy program.

B. REC PHYSICAL FACILITIES/ACTIVITIES

The process of setting up the Regional Energy Centers (REC) was in the planning for many years. It began in 1982 and required the coordination of many offices. The project completion date was set for June 30, 1984.

The component plans described the functional purposes in setting up the REC, its responsibilities and also the responsibilities of those offices who coordinate the REC. After the basic construction process of REC building was completed and approved by the NEA, the REC was able to start operations. The REC was not required to be fully equipped or have all facilities completed in order to start operations.

The plans for setting up the REC are as follows:

- The Operation and Financial Plans of REC are written to include its objectives, tasks/activities, time schedule, responsible agencies, time length, responsible person for each task/activity and procurement budget;

Table 3.1 Implementation Schedule

Activity	FY 1981	FY 1982	FY 1983	FY 1984
Land Acquisition				
Maha Sarakharm				
Phitsanulok				
Surat Thani				
Ratchaburi				
Ubol Rachathani				
Chacheongsao				
Detail Survey				
Site survey				
Site planning				
Detail survey & Planning				
Land Development & Office-Housing Construction				
Land Development				
Specification				
Bidding				
Construction				

Table 3.1 (continued)

Activity	FY 1981	FY 1982	FY 1983	FY 1984
Equipment Procurement				
Specification				
Bidding				
Shipping				
Staffing				
Officials				
Temporary personnel				
Operation: Demonstration, Dissemination, Data Collection, Evaluation, and Training				

Table 3.2 Budget - U.S. (USAID) Contribution for 4 Centers

Item	FY 1982	FY 1983-4	Total US $
Tools for Workshop	80,000	80,000	160,000
Tools for field Installation	27,000	27,000	54,000
Dissemination Equipment	48,600	-	48,600
Prototypes for Demonstrations	9,610	9,610	19,220
Lab and Monitoring Instruments	5,400	7,400	12,800
Buildings	100,000	64,000	164,000
Total	270,610	188,010	458,620

Table 3.3 Budget - RTG (NEA) Contribution for 6 Centers

Item	FY 1981	FY 1982	FY 1983-5	Total US $
Prototypes for Demonstrations and Laboratory & Monitoring Instruments	-	-	58,400	58,400
Land, Offices and Buildings	49,000	31,000	707,000	787,000
Vehicles	-	100,000	94,400	194,400
Materials for Prototype Installation	-	-	47,520	47,520
Staff and Staff Related Expenses	-	43,200	684,000	727,200
Office Equipment	-	5,450	10,900	16,350
Other Expenses	-	11,240	56,200	67,440
Total	49,000	190,890	1,658,420	1,898,310

- REC (NEA) will give the proposed plan to DTEC and USAID for further investigation and approval. After it is approved, the plan must be carried out by all three parties, USAID, DTEC and the NEA;

- Procurement Budget: For the grant fund budget, DTEC is the responsible agent. This was agreed by the U.S. and the Thai governments. The process is carried out following U.S. regulations but will also observe all Thai laws. The budget funds received from the Thai government will only follow Thai regulations.

- Follow Up/Checking Up on the REC Process: DTEC, USAID and NEA will meet twice a year to review reports on REC's progress, its obstacles, and how to solve the existing problems. The meetings are to be held at mid-year and at the end of the year. The end of the year meeting includes the approval of the next year's plan. (The plans are shown in Tables 3.4 and 3.5).

Land Acquisition

In searching for land, it has been targeted to create 6 regional energy centers: Two centers at Phitsanulok and Maha Sarakharm in 1982, at Nakhon Sithammarat and Ratchaburi in 1983, and at Ubol Ratchathani and Nakhon Ratchasima in 1984 (or other suitable places).

Designation of site

The designation of a site is based on general criteria as follows:

- The site must be in a province having potential energy resources that can be demonstrated. It is to serve as the center to disseminate and accelerate propagation and as an extension of those renewable energy applications;

- The site must be Crown Property land or public land or deteriorated land from the National Reserved Forest;

- The area of the site required is approximately 20 rai or larger which can be divided into 3 major parts: an administrative, service and residential area, an energy technical and technological demonstration and testing area, and an experimental area for planting fuel trees, e.g., fast-growing trees, oil trees, etc. This is to study how to develop energy sources and utilize them as a substitute for fuel oils as much as possible; and

Table 3.4 Regional Energy Centers - Operational Plans

REGIONAL ENERGY CENTERS COMPONENT
OPERATIONAL PLAN

FY 82 (October 1981 - September 1982)

Tasks/Activities	Oct 81	Nov 81	Dec 81	Jan 82	Feb 82	Mar 82	Apr 82	May 82	Jun 82	Jul 82	Aug 82	Sep 82	Responsible Agency
I. OBJECTIVES AND TARGET (Year 82)													National Energy Administration, (Pairach Woravech)
A. To establish regional centers at Maha Sarakharm and Phitsanulok (50% completed).													
B. To acquire land at Chachoengsao and Ratchaburi (100% completed).													
C. To procure equipment necessary for the 1st two centers.													
II. TASKS													NEA, (Pairach Woravech)
A. Land acquisition at Phitsanulok and Maha Sarakharm (completed in FY 81)													
• Land survey													
• Report													
• Location approved													
• Official requested													
• Site approved													

Table 3.4 (continued)

REGIONAL ENERGY CENTERS COMPONENT
OPERATIONAL PLAN

FY 82 (October 1981 - September 1982)

Tasks/Activities	Oct 81	Nov 81	Dec 81	Jan 82	Feb 82	Mar 82	Apr 82	May 82	Jun 82	Jul 82	Aug 82	Sep 82	Responsible Agency
B. Land development, office building and housing construction													NEA (Pairach Woravech)
Maha Sarakharm													
• Detailed site survey													NEA
• Site planing			Completed										NEA
• Contracted signed for office building													NEA
- Construction													Under NEA Supervision
- Acception													NEA
• Blue print estimated for 1 house for one 3rd-4th grade official, 1 row house for four 1st-2nd grade, officials, and 1 work-shop submitted.													NEA
• Approval													DTEC/USAID/NEA

Table 3.4 (continued)

REGIONAL ENERGY CENTERS COMPONENT
OPERATIONAL PLAN

FY 82 (October 1981 - September 1982)

Tasks/Activities	Oct 81	Nov 81	Dec 81	Jan 82	Feb 82	Mar 82	Apr 82	May 82	Jun 82	Jul 82	Aug 82	Sep 82	Responsible Agency
• Bidding													DTEC
• Tender selected													DTEC/DTEC Procurement Committee
• Contract Signed													DTEC
• Construction													NEA Supervision
• Acceptance													DTEC/DTEC Procurement Committee
Pitsanuloke													NEA (Pairach Woravech)
• Detailed site survey													NEA
• Site planning			Completed										NEA
• Contract signed for office building													
- Construction													Under NEA Supervision
- Acceptance													NEA
• Blue print estimate for 1 house for one 3rd-4th grade official, 1 row house for for 1st-2nd grade officials. and 1 workshop submitted													NEA

Table 3.4 (continued)

REGIONAL ENERGY CENTERS COMPONENT
OPERATIONAL PLAN

FY 82 (October 1981 - September 1982)

Tasks/Activities	Oct 81	Nov 81	Dec 81	Jan 82	Feb 82	Mar 82	Apr 82	May 82	Jun 82	Jul 82	Aug 82	Sep 82	Responsible Agency
• Approved		—											DTEC/USAID/NEA
• Bidding		—	—										DTEC
• Tender selected			—										DTEC/DTEC Procurement Committee
• Contract signed				—									DTEC
• Construction				—	—	—	—	—					Under NEA Supervision
• Acceptance								—					DTEC/DTEC Procurement Committee
C. NEA procurement													NEA (Pairach Woravech)
• Vehicles - 2 two-ton trucks - 6 pick-up cars - 8 Motorcycles - 8 Bicycles													
• Supplies													
- Specification	—	—											NEA
- Approval		—	—										NEA

——— Vehicles

------ Supplies

Table 3.4 (continued)

REGIONAL ENERGY CENTERS COMPONENT
OPERATIONAL PLAN

FY 82 (October 1981 - September 1982)

Tasks/Activities	Oct 81	Nov 81	Dec 81	Jan 82	Feb 82	Mar 82	Apr 82	May 82	Jun 82	Jul 82	Aug 82	Sep 82	Responsible Agency
- Bidding													NEA
- Tender selection													NEA
- Contract agreement													NEA
- Shipping													-
- Equipment acceptance													NEA
C. DTEC Procurement													NEA (Pairach)/DTEC
• Workshop & Field tools													
• Camera, Projector, Video tape													
• Phototype equipment													
• Performance monitoring instruments													
- Specification													NEA/USAID
- Approval													DTEC/USAID/NEA
- Bidding, tender selection, and contract agreement													DTEC/DTEC Procurement Committee
- Shipping													
- Equipment acceptance													DTEC/DTEC Acceptance Committee

——— Vehicles

------ Supplies

Table 3.4 (continued)

REGIONAL ENERGY CENTERS COMPONENT
OPERATIONAL PLAN

FY 82 (October 1981 - September 1982)

Tasks/Activities	Oct 81	Nov 81	Dec 81	Jan 82	Feb 82	Mar 82	Apr 82	May 82	Jun 82	Jul 82	Aug 82	Sep 82	Responsible Agency
E. Land Acquisition at Chachoengsao and Ratchaburi													NEA (Pairach Woravech)
• Land survey													NEA
• Report													NEA
• Location approval													NEA
• Official request													NEA
• Site approval													NEA
F. Training (2 persons, 1½ months each)													
• Training preparation													NEA
• Submit training requirement													NEA/USAID
• Propose candidate for approval/testing and final approval													NEA/DTEC/USAID
• Training													NEA

——— Vehicles

------- Supplies

Table 3.5 Regional Energy Centers - Financial Plan

REGIONAL ENERGY CENTERS COMPONENT
FINANCIAL PLAN
FY 82 (October-September 1982)

(Unit: 1,000 US $)

ITEMS	QUARTER I (October-December 1981)					QUARTER II (January-March 1982)					QUARTER III (April-June 1982)					QUARTER IV (July-September 1982)					TOTAL For Each Agency				
	GRANT		DTEC	NEA	OTHER	GRANT		DTEC	NEA	OTHER	GRANT		DETC	NEA	OTHER	GRANT		DTEC	NEA	OTHER	GRANT		DTEC	NEA	OTHER
	HETA	AID				HETA	AID				HETA	AID				HETA	AID				HETA	AID			
A. Construction																									
• Maha Sarakharm																									
- 1 Housing for engineer																	10	-	-	-	-	10			
- 1 Housing for technicians																	22	-	-	-	-	22			
- 1 Workshop																	18	-	-	-	-	18			
• Phitsanulok																									
- 1 Housing for engineer																	10	-	-	-	-	10			
- 1 Housing for technicians																	22	-	-	-	-	22			
- 1 Workshop																	18	-	-	-	-	18			
B. Procurement																									
• NEA Procurement									5.62					81										86.62	
• DTEC Procurement																	164.31					164.31			
C. Land Acquisition																									
• Chachoengsao				0.5																				0.5	
• Ratchaburi				0.5																				0.5	
D. Training (2 persons, 1½ months each)																									
• Observation tour/per diem, lodging																	9.0					9.0			
• International travel																		3.0					3.0		
Total				1.0					5.62					81			273.31	3.0				273.31	3.0	87.62	

- The site must be accessible, be adjacent to a road or not far from a road and be clearly visible or it must be in a municipal area with utilities in order to facilitate and expedite transportation services for visitors and for the dissemination and extension of energy technologies.

Steps in finding suitable land sites for building an REC

- The NEA will contact the provincial government, notify it of the purpose, reasons, and necessity for setting up an REC and the amount of land needed. The specifications of the land site will be described to meet the above mentioned criteria;

- The provincial government will send the request to its land office for investigation. The provincial government will give its answer to NEA;

- The NEA will send their personnel to determine the suitability of the proposed land site. If it is suitable for use and is accepted, the NEA will notify the provincial government;

- The NEA will then follow the Land Law regulations to utilize the desired land site. Each land location will have different land laws and regulations to be followed for real estate development; and

- When officially approved, the NEA will administer the construction of the REC.

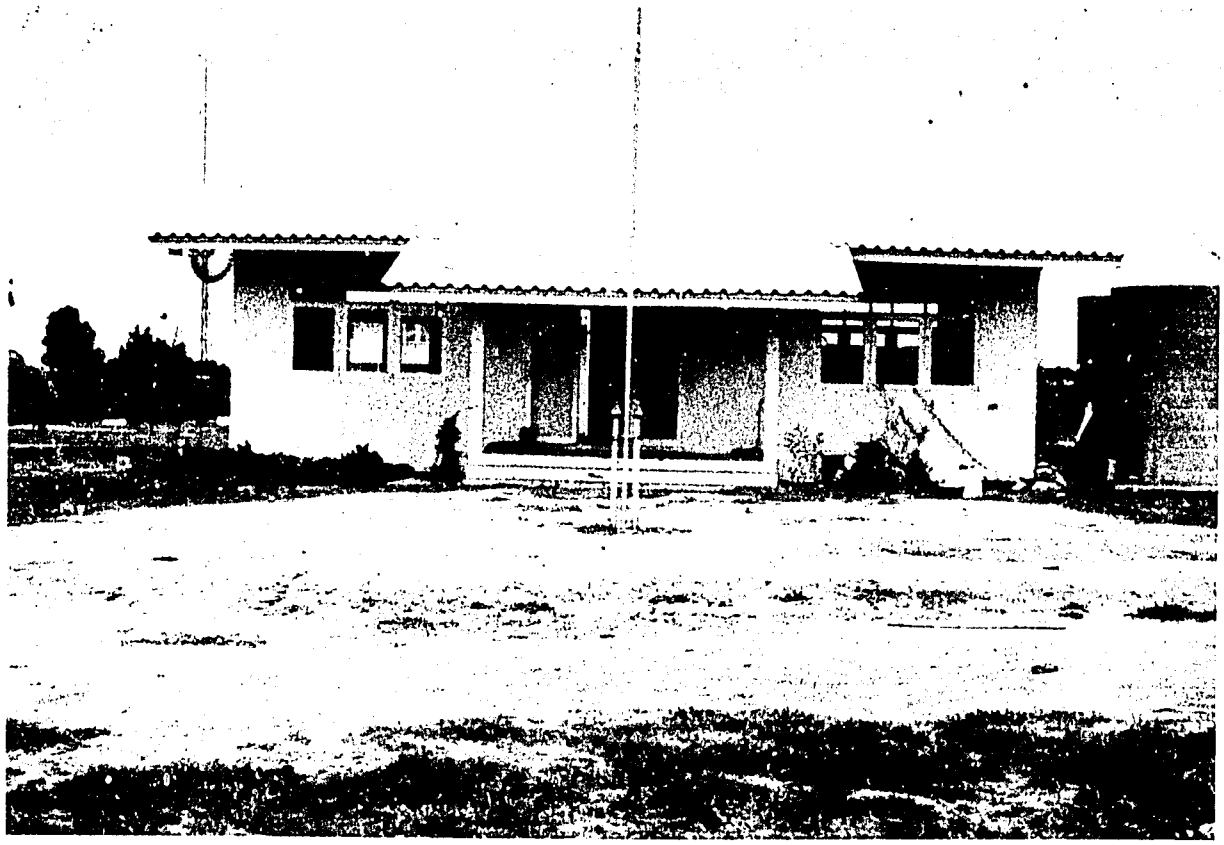
Survey and design

- The NEA will survey the surrounding areas and design a layout plan of the site. The layout plan is divided into three major parts: 1. An energy technology demonstration and testing area suitable for installing any energy technology prototypes; 2. An administrative, service and residential area for buildings, and 3. An area for energy source development experiments to determine their potential use as a renewable energy to be used as a substitute energy for oil: and

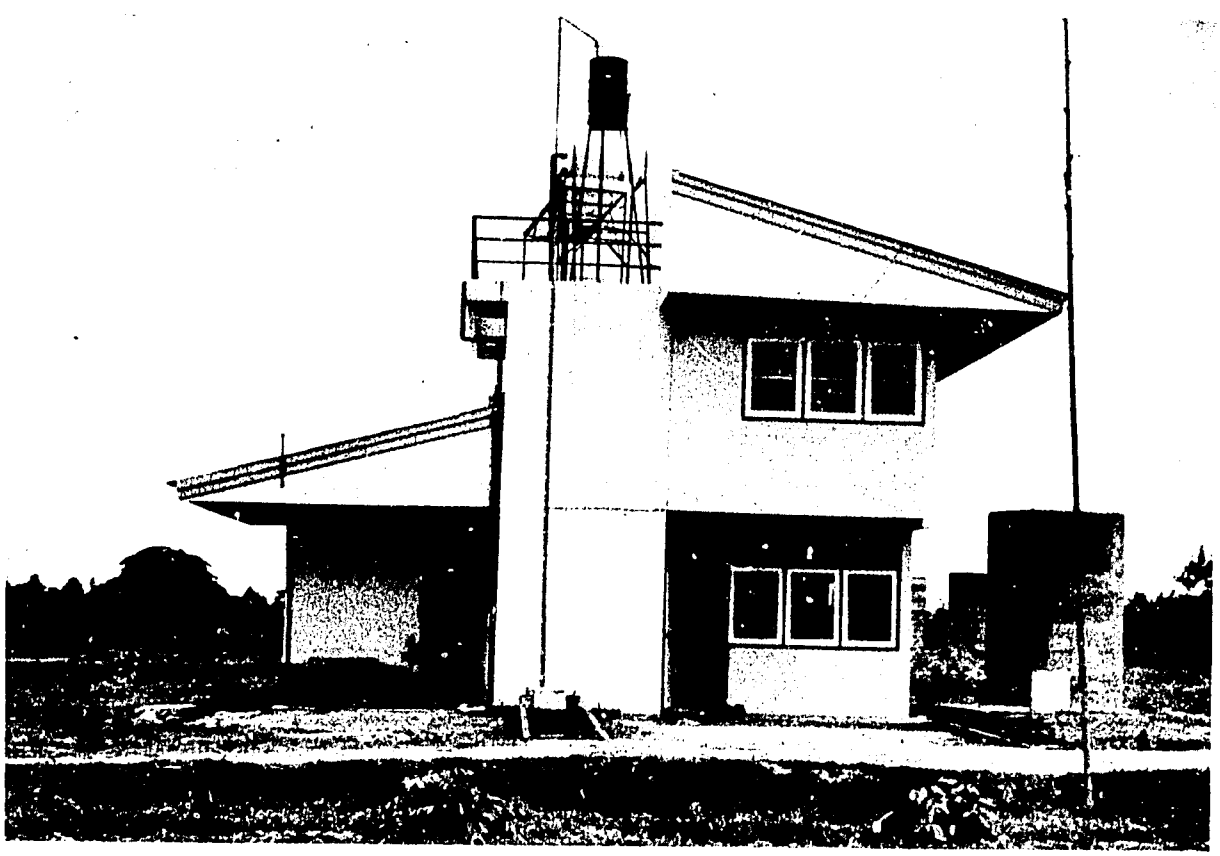
- A layout map will be drawn for a road, electrical system, water supply system, etc.

Land Development and Building Construction

Because most of the land used to establish the REC has been vacant for a long time, it needs to be cleared and improved before it is suitable for constructing buildings, roads, water pond, and drainage and before it is suitable for demonstrating the energy application in different forms (See blueprints No. 1-4 in Annex II).



Administration office at the Regional Energy Center



Residence of the REC Director.

Residence of the Assistant Director of the REC.

A four-family residence for REC officials.

Vehicles assigned to each REC include one 2-ton truck, two 1-ton trucks, two motorcycles and two bicycles.

The warehouse and workshop constructed at each center.

Public supply

Each center will consist of:

- Electrical system, 100 KVA capacity;
- Water supply system; and
- Road and land development

STEPS FOR SETTING UP THE ELECTRICAL SYSTEM

- Official request to NEA;
- System design, cost estimate;
- Approval and 50% payment;
- Construction; and
- Acceptance.

STEPS FOR WATER SUPPLY, ROAD AND LAND DEVELOPMENT

- Design system, blueprint estimate;
- Bidding;
- Tender selection;
- Contract signed;
- Construction; and
- Acceptance.

Buildings

Each center will consist of the following buildings:

- One house for chief engineer, grade 5-6;
- One house for chief engineer, grade 3-4;
- One row house (4 families) for technicians, grade 1-2;
- One administration office;
- One workshop;

- One warehouse;
- One garage; and
- One training hall.

STEPS FOR BUILDINGS PLAN

- Building design and blueprint estimate;
- Submit for approval;
- Bidding;
- Tender selection;
- Contract signed;
- Construction; and
- Acceptance.

Tool and Equipment Procurement

Tool and equipment

Each center will have the following tools and equipment:

- Workshop tools;
- Field tools;
- Energy technology prototypes;
- Laboratory equipment;
- Dissemination equipment (training and visual aid equipment); and
- Office equipment.

STEPS FOR TOOL AND EQUIPMENT PROCUREMENT

- Specification submitted for approval;
- Bidding;
- Tender selection;

- Contract signed;
- Shipping; and
- Acceptance.

Vehicles

To enable each center to work quickly, comfortably, and efficiently, there will be some vehicles made available to use for official duties, to deliver items needed to conduct village surveys and for the promotion, demonstration, dissemination and training of energy technologies in the rural area under its responsibility. Each center will have the following vehicles:

	No. of Units
• 2-ton truck	1
• 1-ton truck	2
• Motorcycle	2
• Bicycle	2

STEPS IN VEHICLE ACQUISITION

- Specifications submitted for approval;
- Bidding;
- Tender selection;
- Contract signed; and
- Acceptance.

Office facilities

Each center will have the following:

	No. of Units
• Desk and chair	6
• Bookcases	3
• Blackboards	2

Staff

Each center will have a full staff as follows:

Official staff

	No. of Persons
• Engineer/Scientist, designated as chief-of-center	1
• Engineer/Scientist, Assistant chief-of-center	1
• Technicians	2
Temporary staff	
• Secretary	1
• Typist	1
• Energy experiment personnel	1
• Energy development personnel	1
• Energy promotional personnel	1
• Welding technician	1
• Latheman	1
• Sheet metal work technician	1
• Guards	4
• Workers	4
• Drivers	2
Total	22

REC Responsibilities

Data gathering

The REC will survey and gather all data concerning the basic energy needs of the rural areas and their inhabitants, such as the energy needs for cooking, and lighting; how they can help the villagers to raise their

standard of living; and how they can help add more income to the families. Also, the REC will gather energy resources data and determine its potential for further development to serve the rural area and its people. The gathered data will be very useful for considering appropriate energy technologies in the area. In addition, the data will be used to set up the demonstration plan, promotion plan or plans for the rural development process.

Development and demonstration

The REC will conduct field tests of the component energy technologies and on their developed equipment. They will record and assess equipment performance by using local labor resources and skilled personnel. The field tests should give preliminary results in areas of technology, economy, existing problems, obstacles and acceptance to the final improvement of proven equipment.

Demonstration/Promotion Activities

The REC will demonstrate and promote the utilization of the proven energy technology derived from solar, wind and bio-organic resources. It will demonstrate and prove that energies derived from the mentioned resources are practical in use, technologically proven, economical, and are acceptable to meet basic energy needs for rural areas and their inhabitants for cooking, lighting, raising the standard of living and helping to add more income to the family. In addition, the mentioned energy can help decrease the consumption of other fossil fuels and also decrease the deforestation of local forests. Various scales of demonstrations, large or small, should be set up to publicize and promote the supporters who understand the usefulness of energy and encourage all households to use renewable energy.

Service Activities/Dissemination

The REC will serve and promote the local government officers, private enterprises and villagers who are helping to develop the rural areas and their inhabitants. The activities include the training of personnel in energy education, energy acquisition, the development of energy technologies, the selection of suitable equipment to be used in the appropriate energy technology of that area and its need. In addition, the REC will disseminate the information through the use of demonstrations, advertisements, and good public relations to the rural areas and their people on the knowledge of solar, wind, and bio-organic sources.

Training

The REC will provide practical field training to local government officials, private enterprises and villagers concerning their activities in developing rural areas and their people. The REC should be designated for this training. Training includes: understanding the usefulness of

energy sources and its potential as well as the selection, fabrication, construction and maintenance of various rural energy technologies. In addition, it includes the promotion of renewable energy sources in the villages (such as village woodlots) or of energy conservation methods in that area.

Coordination

The REC will coordinate the government officers and private enterprises which are involved in the development of rural areas and their inhabitants. The REC will set up demonstration and promotional activities to promote the energy technology used to develop that rural area and its people, since good planning can speed up the rural development project and can effectively help disseminate the objectives of the energy technology itself.

C. AREAS OF RESPONSIBILITY

As was initially planned, each REC had responsibility for 50 square kilometers of area; but this has limited the future dissemination program of the energy technology or energy production system program. Therefore, the plan was revised to cover each REC's responsibility:

Phitsanulok Regional Energy Center

The Phitsanulok REC covers land in these provinces: Phitsanulok, Sakothai, Uttaradit, Loei, Petchaburi, Pijit, Kampangphet, Tak, and Nakorn Sawan.

Maha Sarakharm Regional Energy Center

The Maha Sarakharm REC covers areas in Maha Sarakharm, Roi-et, Karasin, Khon Kaen, Chaiya Poom, Sakhon Nakorn, Udorn Thani, and Nong Khai.

Ratchaburi Regional Energy Center

The Ratchaburi REC covers areas in Ratchaburi, Kanchanaburi, Supanburi, Singhaburi, Chainart, Nakhon Pratom, Samut Songkarm, Petchaburi, Prachuab Kiri Kan, and Chumporn.

Nakhon Sithammarat Regional Energy Center

The Nakhon Sithammarat REC covers areas in Chumporn, Nakhon Srithammarat, Ranong, Suratthani, Pang-gna, Phuket, Krabi, Trang, Pattalung, Satool, Songkhla, Patani, Yala and Narathivat.

Ubol Rachathani Regional Energy Center

The Ubol Rachathani REC covers areas in Ubol Rachathani, Ya Sothorn, Sri Saket, Surin, Nakhon Phanom, and Burirum.

Chiang Mai Regional Energy Center

The Chiang Mai REC covers areas in the northern part of Thailand, including Chiang Mai, Mae Hongsorn, Chiang Rai, Nan, Lampang, and Lampoon.

D. METHODS OF ENERGY TECHNOLOGY DISSEMINATION IN RURAL AREAS IMPLEMENTED BY THE REC

The objective of the rural area development program is to improve living conditions in rural areas, to eliminate poverty, and to promote self-sufficiency. This plan is clearly stated in the Thai government's 5th 5-year National Economic and Social Development Plan. Four ministries, the Minister of the Interior, the Ministry of Public Health, the Ministry of Education and the Ministry of Agriculture share responsibility for this plan. The National Energy Administration thought that the application of energy technology would help speed rural development (since energy is essential to human life, not only city life but also rural life). Presently, energy usage in the country is less than that used in the city because outside energy sources such as electricity and fuel were utilized in urban areas prior to being utilized in rural areas. This was because it was thought that if urban areas were developed first, the rest of the country would follow. Energy resources development in rural areas was only superficially considered and the development of rural areas was slower and less extensive than the development of urban areas. Thus, there still exists poverty in the rural areas everywhere.

Any type of energy technology development activity is regarded as a technological advancement. However, if an energy technology cannot be disseminated to the public or if it does not meet with public acceptance, then the energy technology development program is incomplete and unsuitable. The following factors must be considered before implementing or transferring energy technologies for use in rural area development.

Energy Needs

Rural communities need two kinds of energy. The first type is for everyday living such as energy for cooking or energy for household electricity. The second type of energy is that type used to raise the standard of living or increase family income such as energy to run water pumps used in agriculture and domestic industry.

Accurate energy-needs data required cooperative efforts from many groups such as the local community, the district council, and the village development program committee. The data were used to prioritize energy needs in that community. Additionally, the data were used in the planning of demonstrations, promotions and implementation of the plan in order to utilize energy technology to develop the rural areas of the country.

As previously mentioned, energy is essential to human activity. Communities which have achieved high levels of economic development use more energy than communities still in the initial stages of economic development such as rural communities. Thus, the data of energy technology usage (energy equipment of the energy producing system) in rural communities were useful in determining if the technology was suitable to provide for local needs. Also the data were used in planning further energy development based on the following goals: achieving bette. quality, finding methods for most efficient energy use, and providing for maintenance of the current energy equipment and systems. Attention was also given to the problem of instilling in the users a fuller understanding of energy technology. Consideration was also given to plans for installing new highly efficient energy technologies in place of former systems.

Rural Sources of Energy

Energy implementation into rural communities must be agreeable with the available energy resources existing in these areas; such as water, sun, wind, biogas, excess agriculture materials, heat, earth, animal labor, and human labor resources. In addition, local manmade energy sources should be considered, for example, fast-growing trees, oil-producing plants, etc. Energy source assessments were conducted to determine energy sources that were sufficiently available in the area and then to match these sources to a corresponding energy technology available for installation.

Energy Technology

Energy technology is a result of technology development. Energy technology intended for use in rural areas must be economically, technologically and socially feasible. Some types are suitable for only one location. Other types are suitable for many functions or for a combination of uses in one community. Those personnel responsible for the introduction and implementation of energy technologies must be able to find reliable data and choose appropriate energy sources along with the corresponding energy technology which will be able to provide for the needs of the community.

Dissemination of Energy Technology

To be effective, the use of energy technology for rural development must meet the following criteria. It must meet the needs and satisfy the desires of the rural communities. At the same time it must experience a minimal amount of difficulties. The dissemination of energy technology is largely concerned with the following:

Resources and budget

Available resources and budget are necessary to install and effectively support new technologies.

The chosen technology

The energy technology chosen must be appropriate and capable of satisfying consumer needs. In other words, it must be technologically, socially and economically feasible:

- This technology must not require substantial training for construction, installation,use and maintenance;
- It must not be overly complex and it must not require excessive time to construct or install because this can cause discouragement;
- It must be capable of satisfying basic needs and providing for local development;
- It must not cause local conflicts and must not violate local customs;
- It must utilize local resources and labor to the highest degree possible;
- It must minimize installation costs; and
- It must be capable of using local sources of energy.

Personnel responsible for technology dissemination

This should consist of technological experts or personnel who have been specially trained and who are capable of disseminating correct information concerning energy technology.

- They must have an intimate knowledge of each facet of energy technology;
- They must be effective advertisers;

- They must be more concerned with community needs than with personal advantage. They must be truly responsible and dedicated;

- They must have effective human relations skills and be able to operate in all levels of society; and

- They must be energetic in acquiring knowledge and experience in order to improve existing activities or to solve problems which occur.

Personnel who receive an energy technology

These are the personnel who use the technology to meet their personnel needs or the needs of their communities. This group also consists of personnel who disseminate the technology to other interested parties.

- This group must be capable of receiving the new technology. This ability requires sufficient knowledge in the areas of energy needs, sources of energy, pertinent technologies, construction, assembly and maintenance;

- They must be resourceful and intelligent; and

- They must have sufficient time available for the project(s). This would include time for training, construction, installation and maintenance.

Environmental influences

Environmental factors can cause public interest or public dissatisfaction. This depends upon societal factors, the readiness of each factor previously mentioned and advantages to be accrued.

The public information stage

Dissemination of information is one important factor which enables the installation of energy technology in the development of rural areas to achieve success. This stage has the following operational steps:

THE PREPARATION STAGE

A meeting will be conducted. Included in this meeting will be the village council and advisors who will present data concerning energy needs, local sources of energy, social and economic aspects of the construction project et al. This data will be in addition to that which had been initially surveyed. Energy technology experts will present data concerning energy technology with reference to suitability, choice, principles of use, possible effects, constructions, installation,

maintenance, and efficiency compared with existing systems, plus the organization of the training phase, etc. Public relations personnel will gave information concerning the media to be used in disseminating information. This would include printed materials, leaflets, radio, television and video. The use of a suitable media influences good public relations and reflects a positive influence on the dissemination of technology. Only information concerning the technology intended for implementation will be disseminated.

THE TECHNICAL EDUCATIONAL PHASES

After the plan or project had been established, it will be necessary to educate local communities about the rural development program using the chosen technology.

Since this technology is new it will be necessary, on a daily basis, to gradually educate the community in order to stimulate public interest in the new technology. This program can also consist of efforts in areas not previously mentioned, including songs and local Thai operas, to speed the learning process. The total public relations effort must give encompassing information ranging from energy demand, current energy use, sources of energy, and rural problems to appropriate technologies which will effectively address these problems. In short, a good public relations effort must utilize a multi-media approach.

METHOD 1: Media Dissemination

Media which easily disseminate information include written materials, leaflets, radio, television, and video. Public relations presentations which are suitable to rural areas include programs such as articles, bulletins, discussions and interviews. These presentations must include things to induce people to watch and support the program, for example: local dramas or presentations that rural communities can easily understand.

A group consisting of the following personnel could be formed: personnel to control the PR effort in the information dissemination program, i.e. those people who would actually conduct the public relations effort; the rural development committee; and a group of advisors. This group would have the following goal: to study and ensure that utilization of the media mentioned above was efficient. In those cases where it failed to meet with public acceptance it would be necessary to consider alternate media or to improve the programs in the existing media.

- METHOD 2: Mobile Advertising

This method consists of bringing equipment to disseminate information concerning energy technology to schools in rural areas. This equipment can include still photos, slides, video and movies concerned with energy technology -- especially that technology which had been chosen for rural development. Another facet of this effort would be the establishment of joint seminars with local officials such as district or provincial officials. The seminars would consider local social conditions and the people's readiness to accept the new technology, since the implementations of excess technology would not receive public acceptance. Apart from utilizing media such as movies and video in the same manner as commercial advertising it would also be necessary to bring examples of the actual equipment to be installed in order to stimulate public interest. Without this the effort would achieve less success than commercial advertising.

- METHOD 3: Open House

This method consists of bringing the village headman, the committee for village development and advisors to view the energy technology which has already been installed in other similar villages. At the same time information concerning this technology can be given. Written materials can be distributed and oral explanations can be given. This method uses the actual equipment as an inducement in winning acceptance for the new technology.

- METHOD 4: Practices and Demonstrations

This is a method of energy technology dissemination which is effective in rural areas. This method entails sending instructors well versed in both the practical and theoretical aspects of the subject to rural areas. This advisor is the advisor to rural communities.

The demonstration method has proven quite effective because the community can see, touch and practice on the energy equipment and systems.

ASSESSING THE RESULTS OF THE ENERGY TECHNOLOGY

From an analysis of the previous stage we see that the publications effort using the "hand on" experience of operating the actual equipment is an effective inducement. The final results of this activity should be the inducement of the

community to support the project and the gradual elimination of all doubts. The communities will be able to estimate the value of the project for themselves. They are capable of deciding whether or not they are ready to implement the technology. The desire for the technology increases gradually with an eventual acceptance of the technology. The program must be closely and continually monitored as described above.

THE TECHNOLOGY ACQUISITION PHASE

When the community targeted for the project shows a desire to receive the equipment, additional practical training will depend upon the type of energy technology desired. Some technologies are suitable for only one location, other types are suitable for many functions or for a combination of uses in one community. NEA personnel must immediately set up plans for the demonstration, practical training and promotion of the technology once the request is made. When rural communities are satisfied with the received energy technology, they will automatically disseminate the project to others. The first group who accepts the program will be followed by a second group and so on. However, the project must be continually monitored for operational results, problems and other possible obstacles during its implementation. This is necessary for project completion and to win favorable public opinion.

Practical training for building a brick charcoal production kiln at the Maha Sarakharm Regional Energy Center. This picture shows the bricks which form the base of the kiln.

Trainees attend a lecture at the Phitsanulok Regional Energy Center.

A lecture and demonstration during a training session at the Maha Sarakharm Regional Energy Center.

CHAPTER 4

REPORT OF THE ESTABLISHMENT OF THE REC

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REPORT OF THE ESTABLISHMENT OF THE REC

A. MAHA SARAKHARM REGIONAL ENERGY CENTER (REC)

Location

No. 151 Ban Non Tae, Group 4, Ta Song Kon Township, District Capitol, Maha Sarakharm Province, Maha Sarakharm-Kosumpisai Road, 77 kilometres from the Provincial Capitol.

Land Acquisition

This government property covers an area of 17 square rai (27,514 square metres).

Land Development

Land arrangement

The total land area encompasses 27,514 m^2 (17.2 rai), which is divided into 3 major parts as follows:

- Administrative, service and residential area 7,840 m^2 for buildings already constructed, as detailed below;
- Energy technical and technological demonstration and testing area of 11,642 m^2 for installed prototypes, or as detailed below; and
- Experimental area for planting fuel trees, 8,032 m^2.

Building construction

	No. of Units
• Administrative Office, 84 m^2, (RTG contribution)	1
• House for the Chief Engineer, 90 m^2, (RTG contribution)	1
• House for the Assistant Engineer, 84 m^2, (USAID contribution)	1

	No. of Units
• Rowhouse (for 4 families), 251 m^2, (USAID contribution)	1
• Warehouse, 32 m^2, (RTG contribution)	1
• Workshop, 157 m^2, (USAID contribution)	1
• Training Hall, 150 m^2, (RTG contribution)	1

Public supply

- Water Supply System (RTG contribution)
- Electrical System (RTG contribution)

Land improvement

There are 2 compressed gravel-dirt roads within the REC area. One is 6 meters wide and 175 meters long. The other one is 4 meters wide and 319 meters long (RTG contribution).

Prototype installation

The prototypes have been installed as follows:

	No. of Units
• Solar hot water (USAID contribution)	1
• Solar distillation, fixed and portable types (RTG contribution)	2
• Solar dryers, 2 types (USAID contribution)	2
• Solar photovoltaic cell (USAID contribution)	1
• Windmill for water pumping (RTG contribution)	3
• Biomass (charcoal) gasifier (USAID contribution)	1
• Biogas digester (RTG contribution)	2
• Efficient cooking stoves, 3 types (RTG contribution)	3
• Efficient charcoal production kilns, 2 types (RTG contribution)	2

Plantation

Five rai of *Eucalyptus camaldulensis*, and one rai of oil seed trees have been planted.

Tool and Equipment Procurement USAID Contribution

Prototypes for demonstration

	No. of Units
• Gasifier engine with pump	1
• Solar photovoltaic cell	1
• Solar hot water	1
Communication equipment	
• Single side band	1
Laboratory and monitoring equipment	
• pH meter	1
• Stopwatch	1
• Balance	1
• Gas analyzer	1
• Pressure gauge	1
• Oven	1
• Hydrometer	1
• Thermometer set	1
Dissemination (training and visual aid) equipment	
• TV Receiver/monitor 20"	1
• Video player	1
• Slide projector	1
• Overhead projector	1
• Screen	1
• Amplifier	1
• Loud speaker	1
• Microphone with stand	2
• Public address microphone	1

Workshop and field tools

The workshop and field tools are an USAID contribution. They are divided into hand tools and power tools as shown in Table 4.1.

Table 4.1 Workshop and Field Tools

Description	Quantity
Hand Tools	
1. Hydraulic 4-ton Service Jacks	1
2. Pullers: Capacity 3,000 lbs.	2
3. Manual Hand Hoists: Capacity 3,000 lbs.	2
4. Grease Guns	2
5. Exterior Frame Tent with Floor	1
6. Spray & Roller Outfits: Spray Outfit	1
7. Safety Belts with Nylon Rope Lanyard	2
8. Jaw-Type Pullers:	
No. 6340K22 Two Jaw Pullers	1
No. 6340K52 Reversible Combination 2 and 3 Jaw Pullers	1
9. Bearing Pulling Attachments	1
10. Wire Stripper Kits	1
11. Testing Equipment: Volt-Ohm-Milliammeter-U.L.	1
12. Hydraulic Benders: One-Shot Benders, ½"-2" capacity	1
13. 45° Tube Flaring, Cutting & Bending Kits	1
14. Pipe Cutters:	
No. 2679A2 capacity 1/8"-2"	2
No. 2679A3 capacity 2"-4"	1
15. Complete Threader Sets: Capacity 1/8" to 1¼" pipe	2

Table 4.1 (continued)

Description	Quantity
16. Jam-Proof Ratchet Treaders: Complete Threader w/Dies 1" to 2"	1
17. No-Jam Geared Pipe Threaders: Complete Threader w/Dies 2½" to 4"	1
18. Combination Tap & Die Sets: Coarse & Fine Threads	1
19. Mechanic's Punch and Chisel Sets: 14 Piece Set	2
20. Heavy Duty Hollow Punch Sets: Gasket Cutting Punch Set	1
21. Foot Operated Floor Squaring Shears	1
22. Bolt & Metal Cutters: Center General Purpose Metal Cutters	2
23. Premium Quality Straight Pattern Snips	2
24. Solid Steel Straight & Circular Cutting Snips:	
Circular Cutting	2
Straight Pattern	2
25. Compound Action Aviation Snips: Cuts straight or wide curves left or right in light stock	2
26. Nippers & Cutters: Standard Quality Enamel Finish	1
27. Electricians Bolt and Wire Cutters: Heavy Duty	1
28. Hand Glass Cutters: Carbide Wheel Cutters	1
29. Standard Wood Chisels & Sets: With Plastic Handles, 6-piece set	1
30. Economy Carving Tool Sets	1
31. Hack Saws	2

Table 4.1 (continued)

Description	Quantity
32. Malleable Iron C-Clamps: Regular Pattern	1
33. Woodworker's Vises: Quick Action Vises	1
34. Yoke or Chain Vises with Tripod Stands	1
35. Heavy Duty Yoke Pipe Vises	1
36. Machinist's Bench Vises: Stationary Base Vises	2
37. Tongue & Groove Pliers: Large Capacity	2
38. General Purpose and Electronic Pliers: Long Nose Extra Fine Point	1
39. Plumber's Plier Kits 5 pieces	2
40. Convertible Retaining Pliers	2
41. Internal/External Retaining Ring Tools: 10" Size	1
42. Miniature Screwdrivers: Combination Driver and Hex Wrench Sets	1
43. Screwdriver Sets:	
5 piece Phillips Blade	2
5 piece Slotted Blade	2
44. Metric Hex Key Sets & Assortments: Short Arm Sets, 15 Pieces	1
45. Heavy Duty Pipe Wrenches:	
8" 1" Straight	4
24" 3" Straight	2
46. Posi-Grip Chain Wrenches:	
Capacity 7/8" to 4"	1
Capacity 3" to 6¾"	1
47. Vise-Grip Locking Wrenches:	
Straight Jaw w/o Wire Cutters	4
Curved Jaw w/o Wire Cutters	4

Table 4.1 (continued)

Description	Quantity
48. Crescent Black Adjustable Wrenches:	
4"	2
6"	2
8"	2
10"	2
12"	2
49. Metric Budget 15° Angle Open End Wrench Sets: 10-piece set in Plastic Roll	2
50. Budget 15° Angle Open End Wrench Sets	2
51. 12 Point Metric Offset Box Wrenches & Sets: 8-piece set	2
52. 12 Point Utility Offset Box Wrench Sets: 6-piece set	2
53. 17-piece ¼" Drive Metric Socket Sets	2
54. 51-piece 3/8" Drive Metric Socket Sets	2
55. 23-piece ½" Drive Metric Socket Sets	2
56. Woodworker's Tool Kits	1
57. Direct Read Memory/Sensory Torque Wrenches	1
58. Fiberglass Handled Nail Hammers	2
59. Fiberglass Handled Ball Peen Hammers, Complete Hammer	2
60. Rivet Guns: Extended Blind Rivet Gun	1
Power Tools	
1. Engine Driven Portable Pumps	1
2. Single Stage Tank Mount Compressors: Horizontal Mount, Splash Lubricated - One Cylinder	1
3. 3/8 Inch Electric Drill: Super Duty	1

Table 4.1 (continued)

Description	Quantity
4. ½ Inch Heavy Duty Electric Drill	2
5. Heavy Duty Variable, Five or Ten Speed 20" Drill Presses: 220V, 3 ph	1
6. Heavy Duty Production Electric Planes: No. 3680A1 Complete Plane	2
7. Power Hack Saws	1
8. Heavy Duty Worm-Drive Power Saws	1
9. Heavy Duty 7" Electric Grinder/Sander	1
10. Heavy Duty Utility Bench Grinder	1
11. Oxy-Acetylene Welding and Cutting Outfits: With Single Stage Regulator	2
12. Universal Cutting Fixture	1
13. Portable Alternators	1
14. Non-Breakable Torch Tip Fixture	1
15. AC Arc Welder	1
16. 250 Amp Combination AC/DC Welder	1
17. Fast Heat Soldering Gun Kits: 220V Ki	1
18. 11" Metal Working Lathe and Accessories	
Lathe	1
Cabinet Stand	1
4-Jaw Universal Chuck	1
Morse Taper Arbor-MT 2	1
Quick Change Tool Post	1
Fixed Steady Rest	1
6-Piece Turning Tool Set	1

Vehicles (RTG contribution)

	No. of Units
• 2-ton truck	1
• 1-ton truck	2
• Motorcycle	2
• Bicycle	2

Office facility (RTG contribution)

• Desk and chair	6
• Bookcase	3
• Board	2
• Typewriter (English and Thai)	2

Staff (RTG contribution)

• Chief Engineer	1
• Technician/Assistant Engineer	1
• Secretary	1
• Energy Experimentation Personnel	1
• Energy Promotional Personnel	1
• Energy Development Personnel	1
• Lathe Technician	1
• Sheet Metal Work Technician	1
• Welding Technician	1
• Guard	3
• Worker	3
• Driver	1
Total	16

Operation

1. The 1984 baseline survey conducted in 20 villages around the REC collected data on basic energy needs, energy for upgrading the quality of life, income improvement, village energy resources and its potential source, growth and current energy use;

2. 20,000 *Eucalyptus camaldulensis* plants were introduced to village plantation;

3. 42 family type biogas digesters for cooking and lighting have been distributed to villages, one-third of which were subsidized;

4. Training on assembly and production methods for charcoal production kilns (mud and brick type) was conducted;

5. Efficient cooking stoves (charcoal, wood and rice-husk cooking stoves) were introduced during meetings held at the REC and twice in villages. There were 70 trainees;

6. Training on the assembling of Biogas digesters was conducted 7 times during the promotion stage. There were 35 participants;

7. After training, demonstration and promotion classes were conducted;

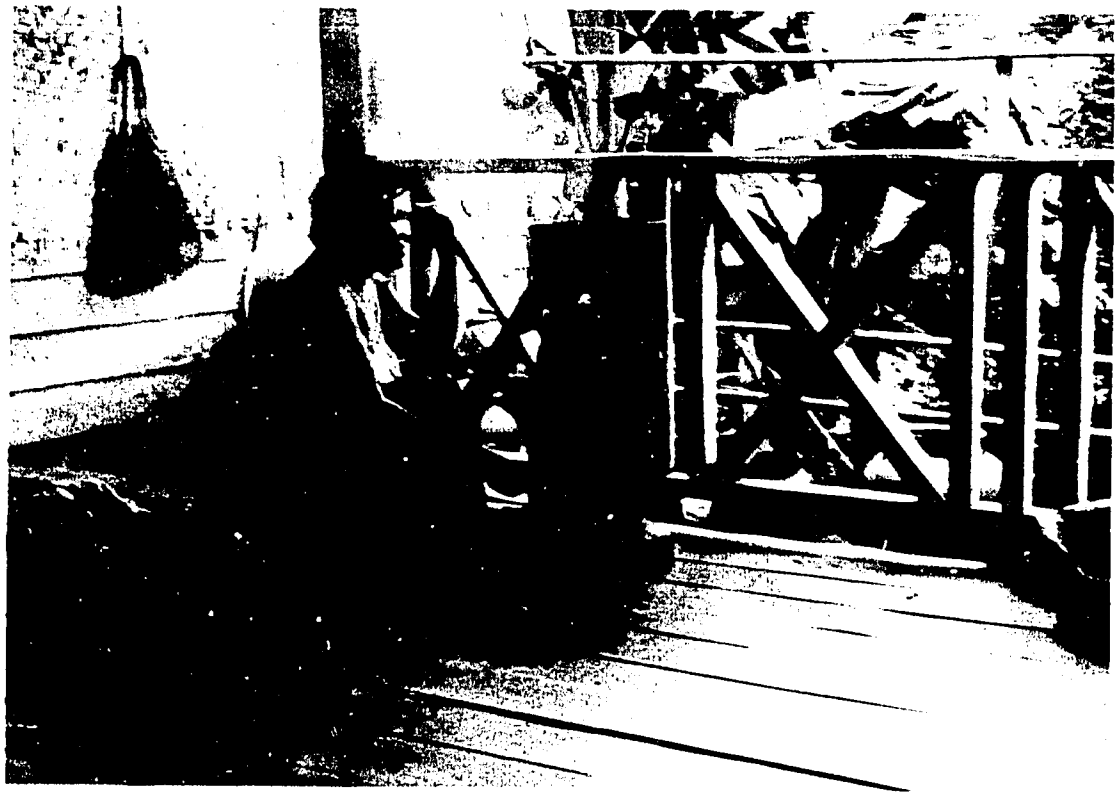
8. Follow-up and monitoring activities were conducted by REC personnel by visiting the users and by mailing questionnaires. The activities were conducted: 20 times for the Family Biogas Plant Project; 8 times for the Efficient Charcoal Production Kiln Project (for kilns currently installed in the village and for those recently introduced). These monitoring activities were also conducted once a month on two Community Biogas plants producing electricity in order to correct problems, to find obstacles, and to assist in the continuing efficient production of electricity;

9. A total of 675 people including villagers, students from educational institutes and government personnel from Maha Sarakharm Province and adjacent areas came to view the REC activities;

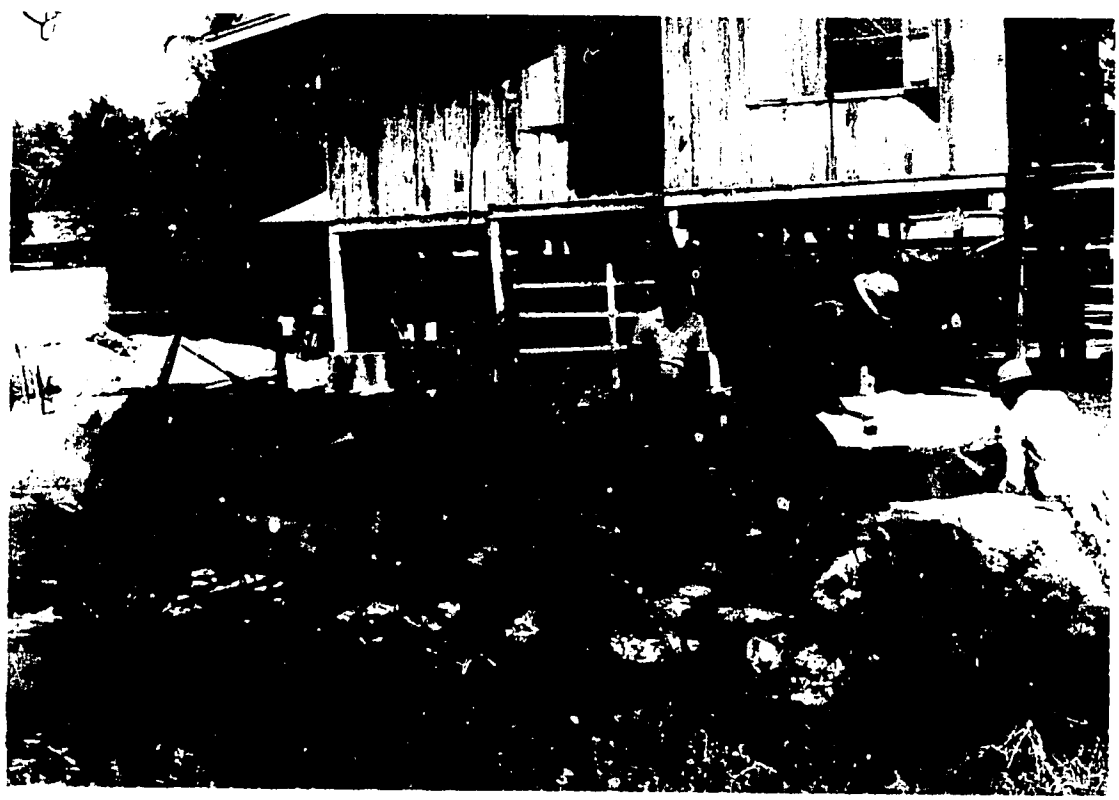
10. 2,000 sets of printed material concerning energy technology were distributed and mailed;

11. Six exhibitions were held with the cooperation of the REC and government offices; and

12. 18 lectures on energy technology dissemination were coordinated and given to district councils, provincial councils, educational institutes and various government branches within the province.



Demonstrating the use of an efficient cooking stove in Maha Sarakharm Province.



The demonstration and promotion of a biogas digester in a village in Maha Sarakharm Province.

The demonstration and promotion of an efficient charcoal production kiln in a village in Maha Sarakharm Province.

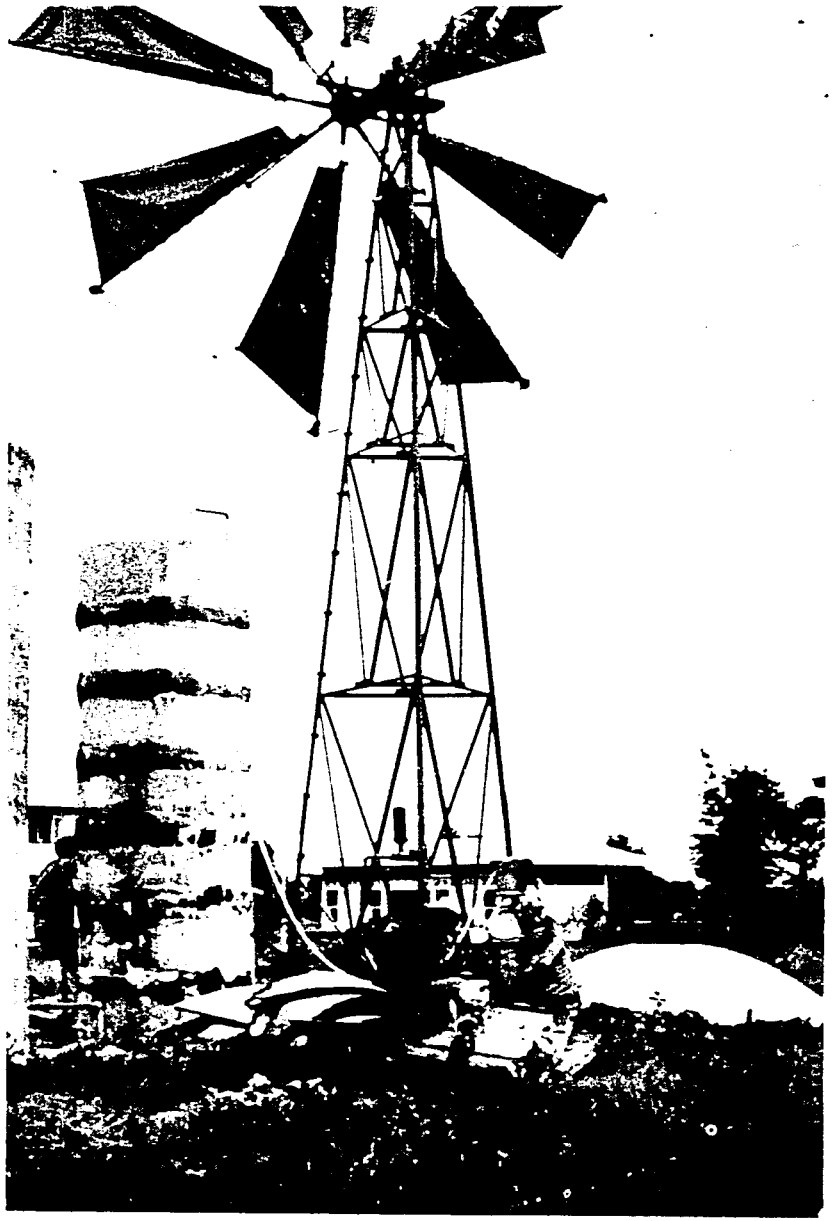
Assembling a windmill to promote water pumping for domestic consumption in Maha Sarakharm Province.

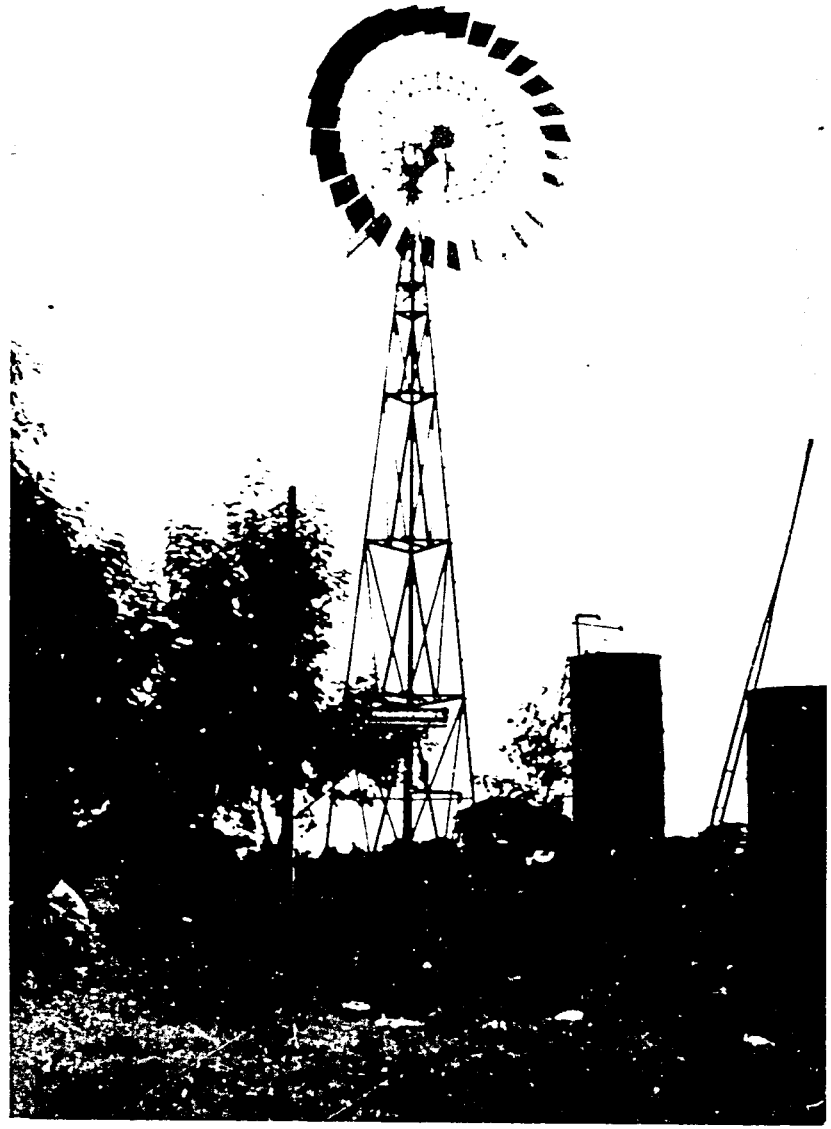
Visitors being shown the family type biogas digester.

Villagers watch a demonstration of the community type biogas digester in Maha Sarakharm Province

Efficient cooking stoves -- charcoal, wood, rice husks.

A photovoltaic cell demonstration.





Windmills used for pumping water at the Maha Sarakharm Regional Energy Center.

B. PHITSANULOK REGIONAL ENERGY CENTER (REC)

Location

No. 73, Group 3, Ban Wang Rae, Makhamsoong Township, District Capitol, Phitsanulok Province, Phitsanulok-Watboat Road, 12 kilometers from the Provincial Capitol.

Land Acquisition

This property covers an area of 20 rai (32,020 square meters).

Land Development

Land arrangement

The total land area encompasses 32,020 m^2 (20 rai), which is divided into 3 major parts as follows:

- Administrative, service and residential area of 12,000 m^2 housing the buildings listed below;
- Energy technical and technological demonstration and testing area of 4,800 m^2 for installing the prototypes listed below; and
- Experimental area of 15,220 m^2 for planting fuel trees.

Building and construction

	No. of Units
• Administrative Office, 84 m^2, (RTG contribution)	1
• House for the Chief Engineer, 90 m^2, (RTG contribution)	1
• House for the Assistant Engineer, 84 m^2, (USAID contribution)	1
• Rowhouse (for 4 families), 251 m^2, (USAID contribution)	1
• Warehouse, 32 m^2, (RTG contribution)	1
• Workshop, 157 m^2, (USAID contribution)	1
• Training Hall, 150 m^2, (RTG contribution)	1

Public supply

- Water Supply System (RTG contribution)
- Electrical System (RTG contribution)

Land improvement

There is a compressed gravel-dirt road and a compressed dirt road within the REC. The compressed gravel-dirt road is 6 meters wide and 130 meters long. The compressed dirt road is 4 meters wide and 500 meters long.

Prototype installation

The prototypes have been installed identically as the Maha Sarakharm REC except for the windmill for water pumping, because the statistical wind velocity is rather low in this area.

Plantation

Five rai of *Eucalyptus camaldulensis* and one rai of oil seed trees have been planted.

Tool and Equipment Procurement

Prototypes for demonstrations, communications equipment, laboratory and monitoring equipment, dissemination (training and visual aid) equipment, vehicles, office facilities and workshops and field tools are all the same as at the Maha Sarakharm REC.

Staff

Staffing is the same as at the Maha Sarakharm REC and consists of:

• Chief Engineer	1
• Technician/Assistan Engineer	1
• Secretary	1
• Energy Experimentation Personnel	1
• Energy Promotional Personnel	1
• Energy Development Personnel	1
• Lathe Technician	1

•	Sheet Metal Work Technician	1
•	Welding Technician	1
•	Guard	3
•	Worker	3
•	Driver	1
	Total	16

Operation (1984)

1. The data for the 1984 baseline survey were collected in 20 villages located around the REC. Information was collected on basic energy needs, energy for upgrading the standard of living, income improvement, village energy resources, potential energy sources, growth and current energy use;

2. 50,000 *Eucalyptus camaldulensis* plants were introduced to village plantation;

3. 50 family type biogas digesters were promoted;

4. Practical training on assembly and production methods of charcoal production kilns (mud and brick type) was conducted;

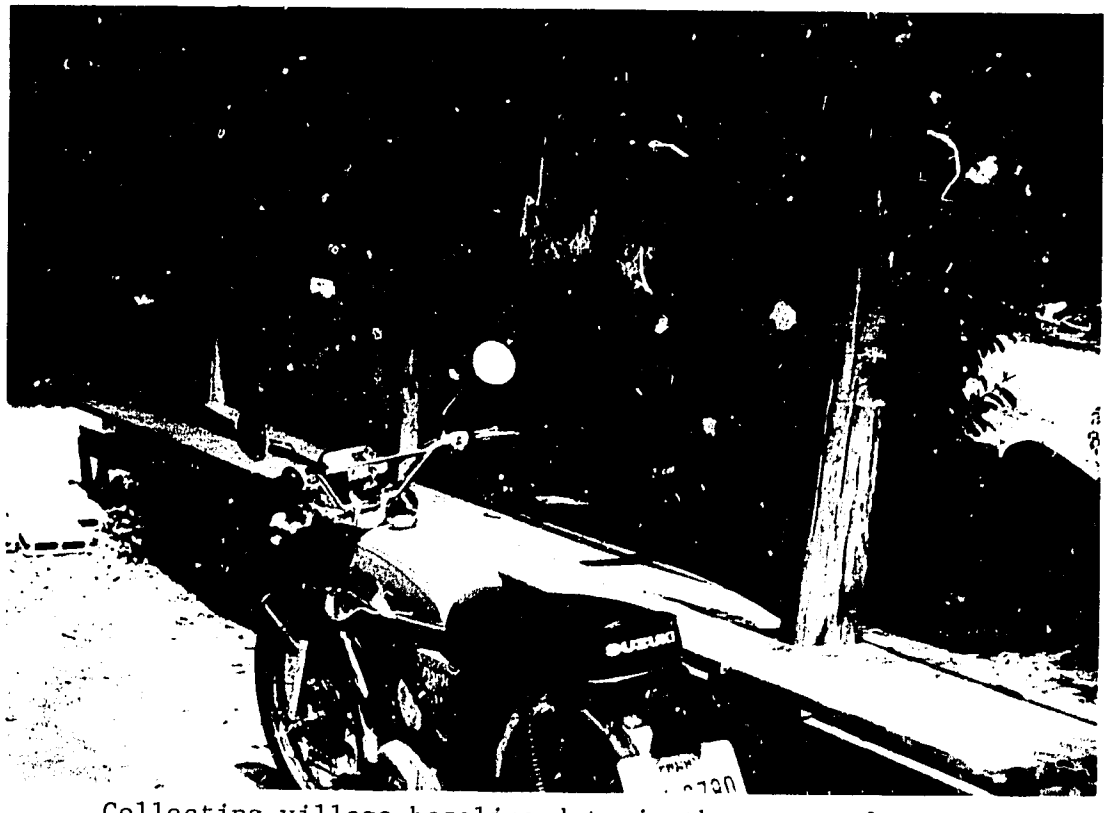
5. Twice efficient cooking stoves (charcoal, wood and rice-husk cooking stoves) were introduced. There were 70 trainees;

6. Training on the assembling of biogas digesters was conducted during 10 demonstration and promotional activities in the villages. There were 50 participants;

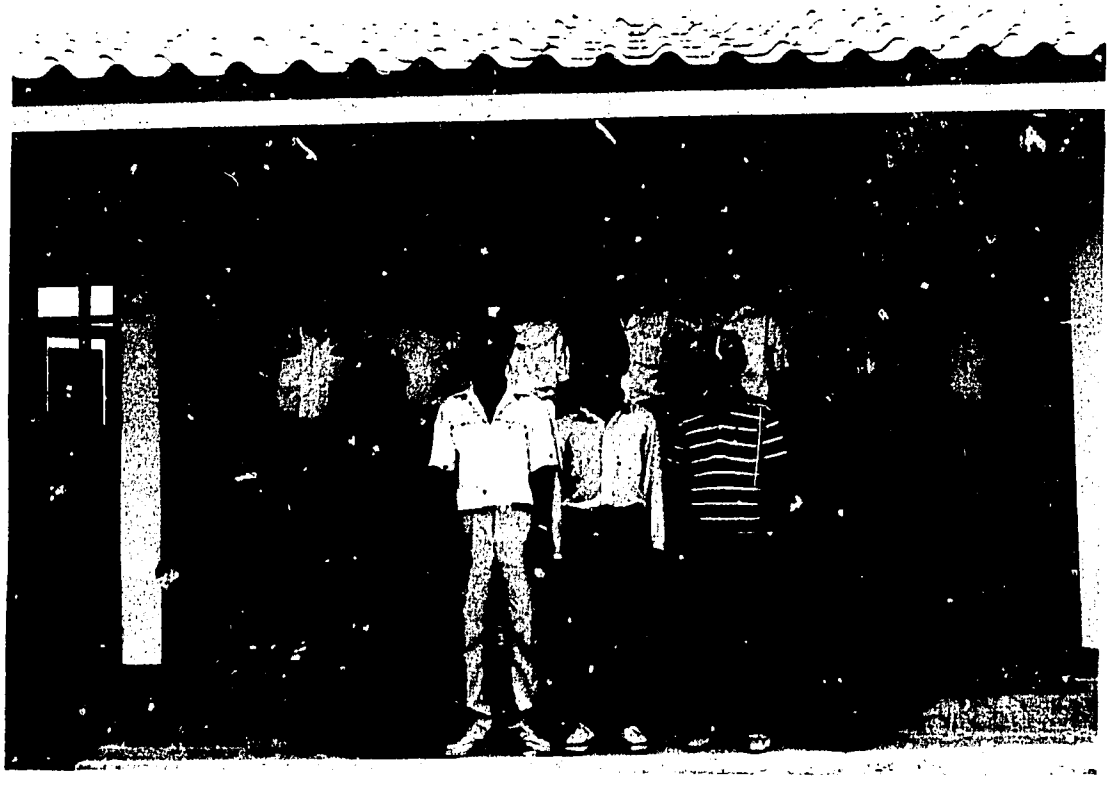
7. Follow-up and monitoring activities were conducted by REC personnel by visiting the users and by mailing questionnaires: 25 times for the Family Biogas Plant Project and 5 times for the Efficient Charcoal Production Kiln Project;

8. A total of 620 people, including villagers, students from educational institutes and government personnel came to observe the activities of the Phitsanulok REC;

9. 2,000 sets of printed material concerning energy technology were distributed and mailed;



Collecting village baseline data in the areas of energy demand, sources of potential energy, quantity of rescurces available in the village and current energy usage. (Phitsanulok Province)



Personnel at the Phitsanulok Regional Energy Center.

REC test plot of *Leucaena leucocephala* used in demonstrations for cooking and charcoal production.

Cultivating *Eucalyptus camaldulensis* for use in cooking and charcoal production demonstrations.

Test plot for castor oil plants. Their seeds are used for producing oil used as a diesel substitute.

Test plot of oil seed plants which are used for producing a diesel substitute.

10. Five public exhibitions were held with the cooperation of the REC and government offices; and

11. 16 lectures concerning energy technology dissemination were coordinated and given to district councils, provincial councils, educational institutes and various government branches within the province.

C. RATCHABURI REGIONAL ENERGY CENTER (REC)

Location

Hin Kong Township, District Capitol, Ratchaburi Province, Ratchaburi-Jombueng Road, 12 kilometers from the Provincial Capitol.

Land Acquisition

This is an old ruined woodland within the National Forest area encompassing approximately 55 square rai.

Land Development

Land arrangement

- Administrative, service and residential area of 16,000 m^2.
- Energy technical and technological demonstration and testing area of 12,800 m^2.
- Plantation area of 59,200 m^2.

Building construction and public supply

- The office, the assistance engineer's house and the rowhouse (4 families) has been constructed and the electrical system installed;
- The chief engineer's house, workshop, warehouse, training hall and the electrical system for these buildings should be completed by November 1984.

Land improvement

There are 2 compressed gravel-dirt roads within the REC area. One is 6 meters wide and 340 meters long. The other one is 4 meters wide and 260 meters long.

Prototype installation

One photovoltic cell, one biogas digester, and three efficient cooking stoves (3 types) have been installed. The remaining technologies should be completely installed by December 1984.

Plantation

88 rai of *Eucalyptus camaldulensis* have been planted: 37 rai in the REC plantation area and 57 rai on lands around the REC.

Tool and Equipment Procurement

The tools and equipment procured are the same as at the Phitsanulok REC. The workshop and field tools will be acquired by November 1984.

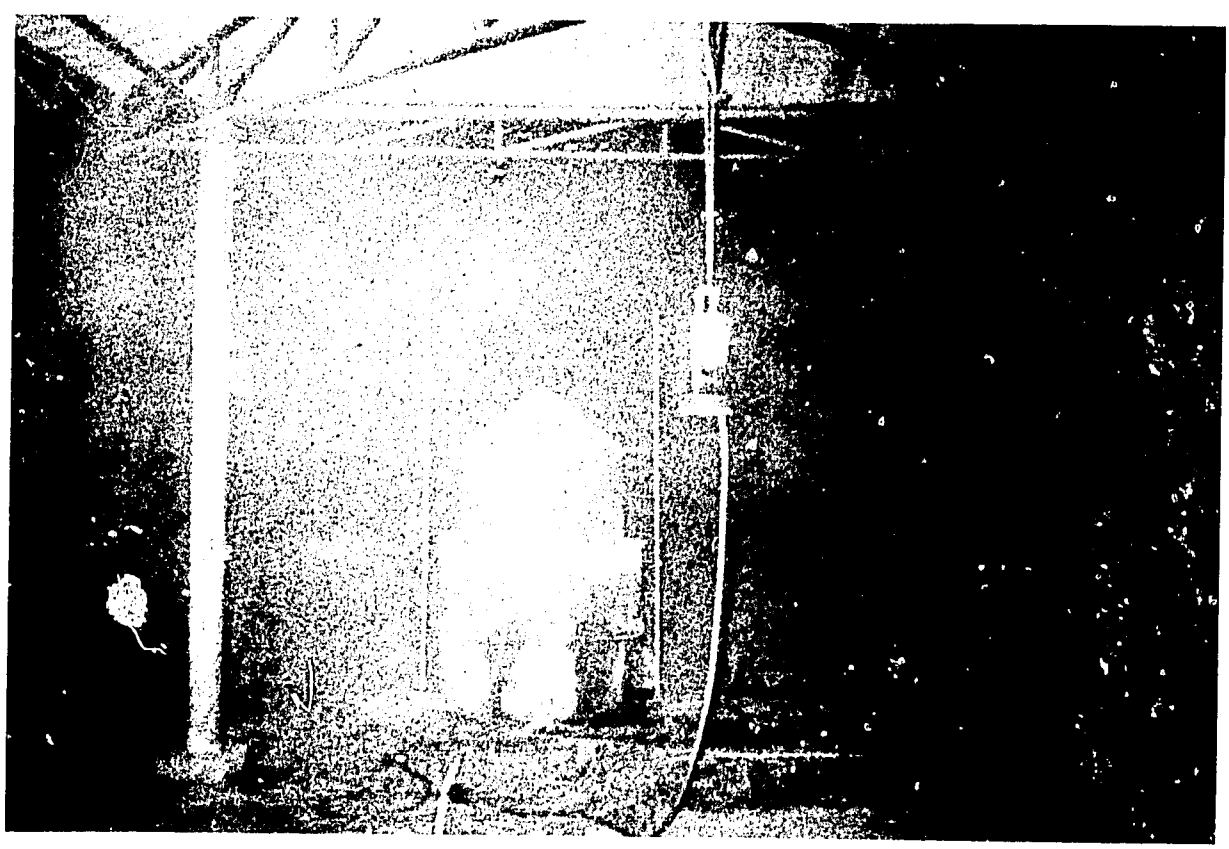
Staff

- Chief Engineer 1
- Administrative Personnel 1
- Guards 2

Operation

- Data baseline surveys of six villages were conducted;
- There were 100 visitors who came to view the REC; and
- 250 sets of printed materials were distributed.

Checking wind data at Ratchaburi Regional Energy Center.



Experimenting with a biogas lamp for lighting.

D. NAKHON SITHAMMARAT
REGIONAL ENERGY CENTER (REC)

Location

Nong Hong Township, Toong Song District, Nakhon Sithammarat Province, Asia Road #41, 7 kilometers from the Toong Song District.

Land Acquisition

This is an old and ruined land located within the National Forest area encompassing approximately 20.7 square rai.

Land Development

Land arrangement

- Administrative, service and residential area consists of 8,000 m^2.
- Energy technical and technological demonstration and testing area consists of 4,320 m^2, 2 rai.
- Plantation area covers 20,800 m^2.

Building construction and public supply

The building specifications and the water and electrical systems are the same as at the Ratchaburi REC.

Land improvement

There are 2 compressed gravel-dirt roads within the REC area. One is 6 meters wide and 180 meters long. The other one is 4 meters wide and 155 meters long.

Prototype installation

One photovoltaic cell, one biogas digester, one solar distillation, one solar dryer, one solar hot water, two efficient charcoal production kilns and three efficient cooking stoves have been installed.

Tools and Equipment

The tools and equipment furnished at the Nakhon Sithammarat REC are the same as at the Ratchaburi REC. Refer to Table 4.1 for a detailed list of tools and electrical equipment.

Staff

- Chief Scientist 1
- Technician/Assistance Engineer 1
- Guards 2
- Drivers 3

Operation

- Village-level data for the baseline survey was collected in 10 villages;
- One public viewing of the REC activities was conducted;
- There were 120 visitors; and
- 300 sets of printed materials were distributed.

E. ADDITIONAL REGIONAL ENERGY CENTERS

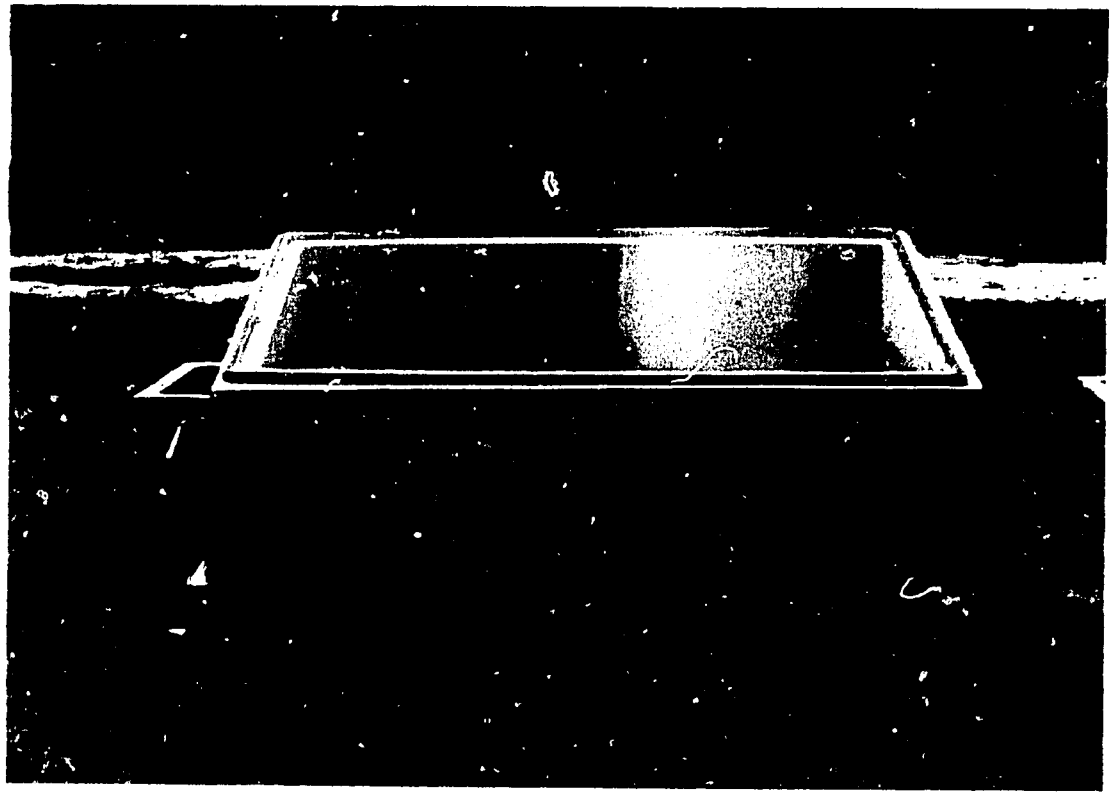
Ubol Ratchathani Regional Energy Center (REC)

The Regional Energy Center in Ubol Ratchathani will be established in 1985-1986.

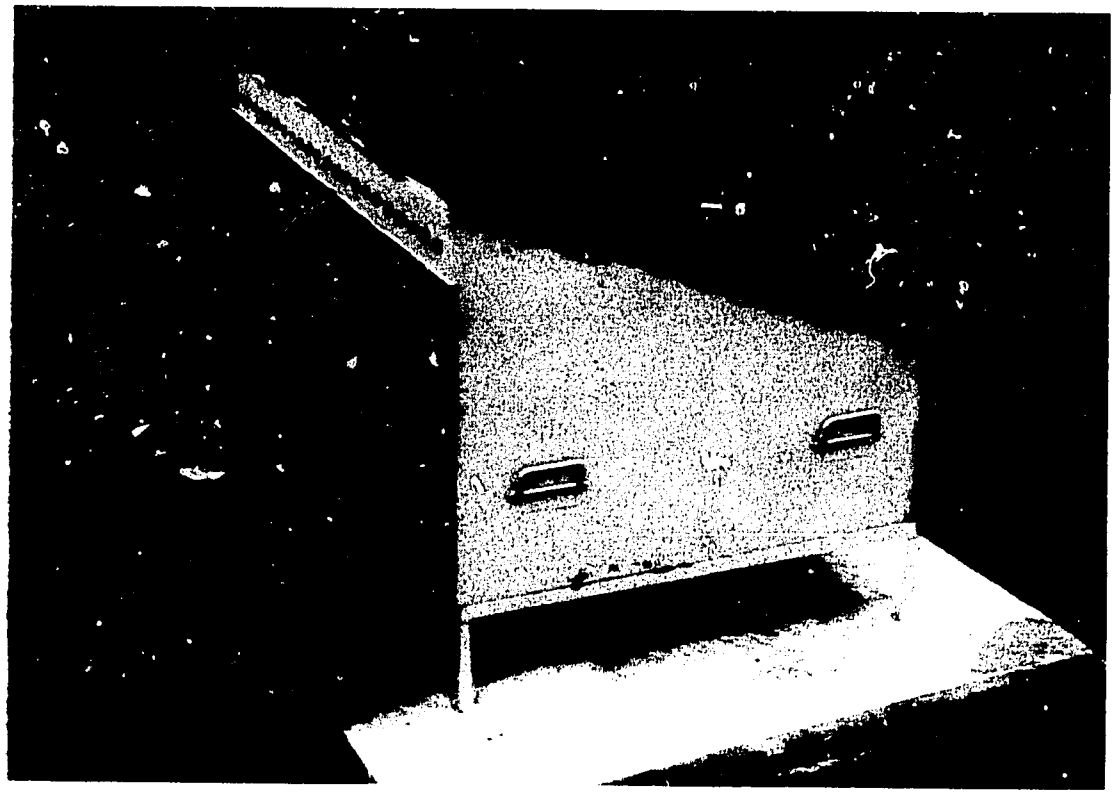
Chiang Mai Regional Energy Center (REC)

The Regional Energy Center in Chiang Mai Province will be established in 1986-1987.

PROTOTYPE INSTALLATION AND TESTING ACTIVITIES AT THE REGIONAL ENERGY CENTERS



Solar Distillation



Solar Dryer

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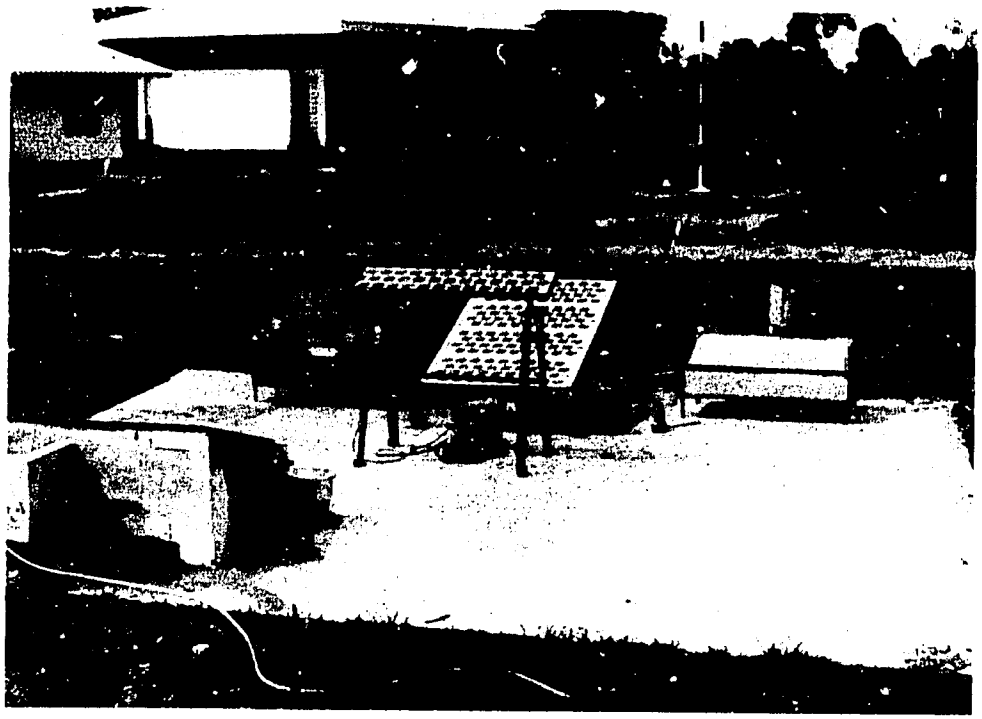
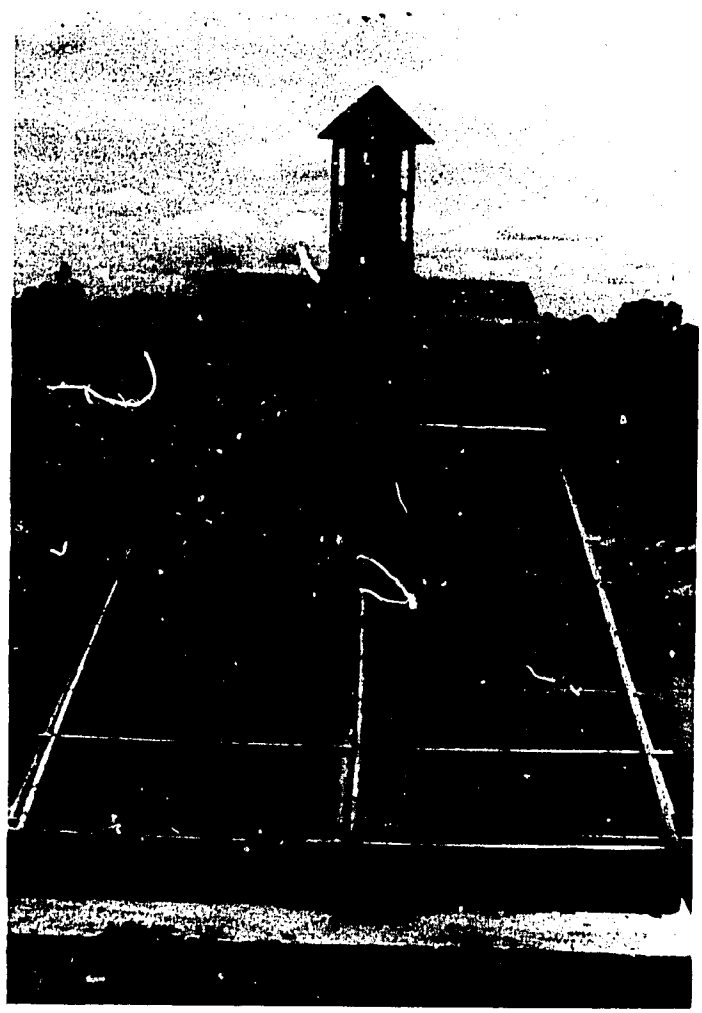
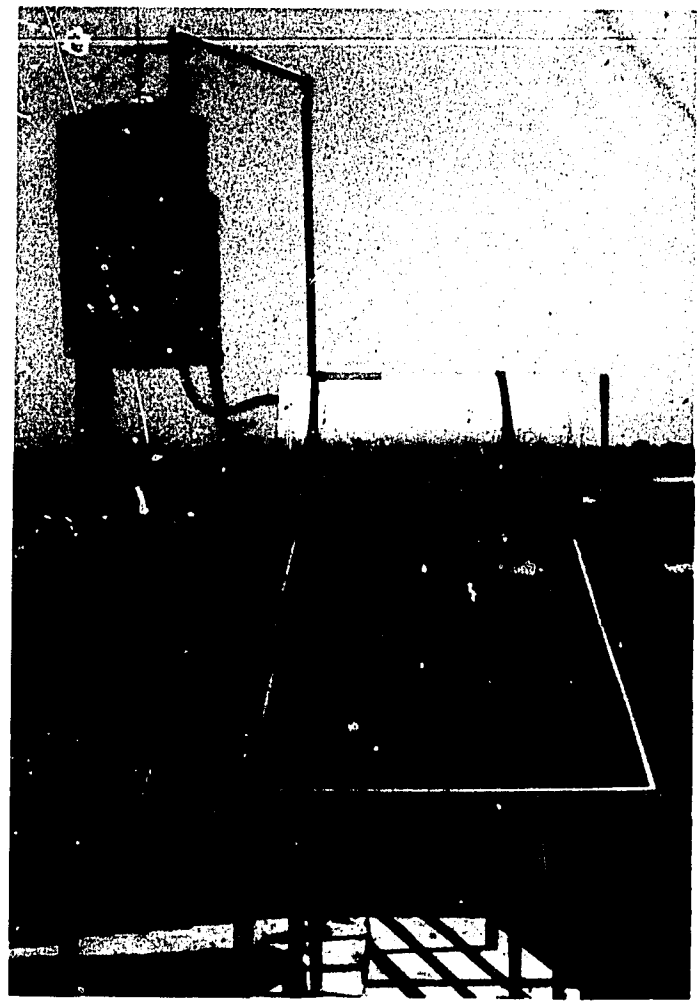


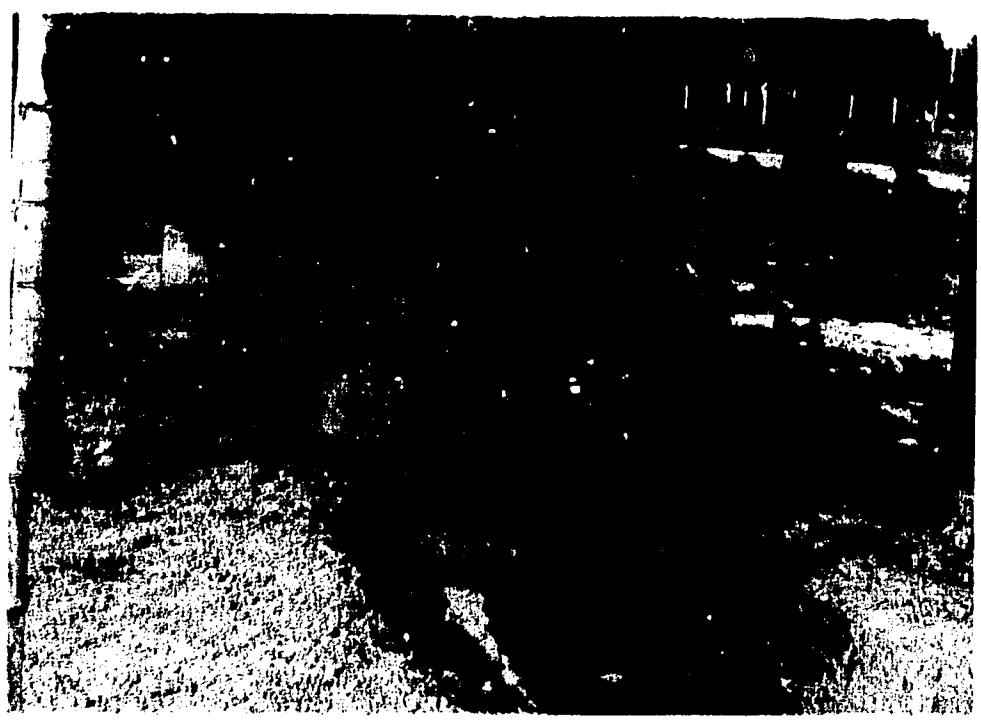
Photovoltaic Cell



Solar Dryer



Solar Hot Water Heater



Efficient Charcoal Production Kilns

CHAPTER 5

DISCUSSION AND EVALUATION

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DISCUSSION AND EVALUATION

A. LAND ACQUISITIONS

The acquisition of land at each location took 8-14 months. The process started when the NEA made a land request to the provincial government. The provincial government office sent the request to all offices concerned, such as the Provincial Land Division, the Royal Property Division, and the Provincial Forestry Department. These offices notified the district government at which the land was located. The district government committee administered and kept all request documents and sent its answer to the provincial government. The provincial government then notified the NEA of its approval. NEA sent their officials to conduct the land survey to find the most suitable sites. The land procurement process took a great deal of time since it depended on many factors such as the type of land, bureaucratic approval and real estate laws. In addition, all legal steps were followed to make the acquisition process a success.

Close coordination with all concerned agencies and continuous monitoring of the request activities resulted in receiving good cooperation from the many offices concerned. We were thus able to solve some problems and were able to reduce bureaucratic steps. The NEA has established 4 REC sites and has met its objectives.

B. CONSTRUCTION

In construction projects using the grants budget, DTEC was responsible for the procurement, the NEA was responsible for the design of the blueprints, specifications, cost estimations, the construction supervision, and joint inspection with DTEC. Construction using the RTG budget was the total responsibility of NEA.

Problems in constructing buildings at each REC also caused delays in RECs establishment. Some of these problems included:

- Land acquisition was slow. There was not sufficient time to design the center's layout which in turn caused construction to lag behind schedule;

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- There were delays in construction bidding when companies who had joined in the bidding didn't own properties as stated in government rules. This resulted in the cancellation of the initial construction bidding and required time to set up new bidding;

- The company which got the bid was not able to follow their construction schedule since they had many other jobs to do;

- The rainy season caused difficulties in construction; and

- The quality of construction did not meet the stated standards. This resulted in necessary repair and/or rebuilding.

C. PROCUREMENT

The procurement of the tools and equipment of REC took longer then scheduled due to:

- A lack of data for issuing specifications for the equipment;

- Cancellation of the equipment bids because prices were higher than the budget appropriations or because the wrong specifications were submitted;

- Reconsideration of equipment specifications since the specialized items requested were not available from supplies;

- Delays were experienced when desired equipment was only available in sets and needed to be reordered with companion pieces; and

- Some equipment was purchased aboard. This delivery time took longer then usual.

D. STAFF

There was not sufficient manpower to run all REC operations. This problem limited the capability of the REC's operation. However, in 1984, 2 RECs at Phitsanulok and Maha Sarakharm provinces had a full staff, were fully functional, and had met the REC objectives totally. But, the other 2 RECs at Ratchaburi and Nakhon Sithammart Provinces still lacked staff and their operations were limited.

E. OPERATION

The operation of the REC to fulfill its objectives has many stages. During the building construction stage, it did not require many personnel. They were able to accomplish foundation work such conducting the village baseline data surveys to include data collection and to produce energy technology advertisements to rural communities to give them a basic inducement to the energy technology implementation program in their communities. This work included the installation of various prototypes of energy technologies at regional energy centers as mentioned above. However, REC's operation in the areas of data collection, development and demonstration, demonstration and promotion/extension, service and dissemination, training and coordination was faced with many problems and obstacles. These were:

- A lack of REC manpower resources;
- A lack of efficient energy technology training;
- A lack of coordination;
- Social structure differences among communities;
- Most people could not afford the expensive energy technologies;
- Some technologies were too complex in construction, fabrication, operation and maintenance;
- Technologies which can not utilize local materials and labor are expensive;
- The technologies which rely on groups must have group cooperation so that monitoring can be accomplished better;
- Potential energy resources are insufficient. In other words, demand for the energy is more than its potential;
- Consumers feel too easy and comfortable using other types of energy such as fuel oil or electricity that can response to the demand immediately and not cause any sundries;
- A lack of personnel with knowledge and capabilities in energy technology who can implement the technology in the rural areas;
- Lack of villager leaders who are developers;

- People who use the technology change their objectives. This causes a lack of concentration in operation and maintenance;

- No motivation provided, such as budget support, wages and other benefits;

- Not ready to search for the energy technology needed by the people;

- People dare not invest in technologies they have neither seen nor heard of before;

- The technology needs skill and plenty of time to fabricate;

- Uncertainty about the form causes some difficulties in choosing which technology is better and which one can best respond to the demand. The people become confused and delay deciding which to accept;

- People were not ready at the same time as the officer promoting the technology because it was a planting or harvesting period or it otherwise interrupted their particular profession;

- Most of the officers who promoted the technology have their own specific current work in their office. They do not have enough time to continuously advice the rural people. This causes other clients to hesitate;

- A failure to provide basic knowledge about the energy technology before implementing it in the rural areas;

- Lack of personnel who have the knowledge, experiences and intention to research and develop energy technologies in each field;

- A lack of coordination between agencies, researchers, contractors and users;

- Limited budget support means the research, development, demonstration and promotion of the technology cannot be done effectively or that project coordinators will have to choose specific fields for funding to the detriment of others;

- Some government development programs had made rural communities less independent or less self-reliant. Villagers have taken the government aid for granted;

- Some rural communities faced socio-economic problems which forced many residents to travel to other communities to earn family income. The situation made it difficult to implement the energy system project in those communities in a continuing basis. The project had to be postponed until the communities were back in the normal job season again;

- Some energy technologies could only be implemented during certain seasons of the year; therefore, when not in use the equipment and system components were not maintained. Thus they wore out more quickly than normal;

- Some people in rural communities were not interested in the newly introduced technology and did not want to participate in the REC's project. Their participation was required in several areas, such as providing labor. This played a part in the partial failure of the energy technology program; and

- A lack of efficient advertising and public relations caused by not using all media available.

CHAPTER 6

CONCLUSIONS

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CONCLUSIONS

The operational processes of the REC from its conception until the end of the 1984 project can be summarized as follows:

1. Four Regional Energy Centers (RECs) have been installed in Maha Sarakharm, Phitsanulok, Ratchaburi and Nakhon Sithammarat Provinces.

2. Each center consists of an administrative office, chief's house, assistant chief's house, rowhouse (for four families), workshop, warehouse and training hall.

3. Public utilities supply the water, electrical systems and roads.

4. Tools and equipment have been procured and include workshop tools, field tools, laboratory and monitoring equipment, communications equipment, training and visual aid equipment.

5. Vehicles have been purchased and consist of a 2-ton truck, two 1-ton trucks (pick-ups), two motorcycles and two bicycles.

6. Sixteen staff members are working at the Maha Sarakharm and Phitsanulok RECs. There are five staff members at the Nakhon Sithammarat REC and four staff members at the Ratchaburi REC.

7. Energy technologies (prototypes) to be used for demonstrations of and as examples of available energy technologies have been installed. These consist of solar hot water and solar distillation techniques, solar dryers, windmills, photovoltaic cells, biogas digesters, biomass gasifiers, efficient cooking stoves and efficient charcoal production kilns.

8. 100 rai of *Eucalyptus camaldulensis* and oil seed trees have been planted at the centers and 70,000 plants of *Eucalyptus camaldulensis* were introduced to village plantations as a renewable village fuel source.

9. 368 demonstrations and promotional activities on the utilization of energy technologies were conducted: 92 on biogas plants, 200 on efficient cooking stoves and 76 on charcoal production kilns.

10. Village surveys were conducted in 56 villages within the center's areas of responsibility. Data were collected on the basic and increased income of people in each village, energy needs, indigenous resources and their potential

11. There were 225 villagers, local government officials, village leaders, public school teachers, etc. trained at the RECs on the subjects of biogas digesters, windmills, efficient charcoal production kilns, efficient cooking stoves, the construction/fabrication, uses and maintenance of each technology, etc. Also, additional training was given to those people who had already been trained but needed more assistance and who were interested in installing

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the equipment for their personal usage. The results from twenty-one training sessions were highly satisfactory and the RECs were requested to continue training. Those who had been trained at the centers became important energy promoters who helped to disseminate energy technologies to rural areas of the country.

12. Training results were monitored and assessed for their effectiveness and in order to solve obstacles and problems.

13. The energy demonstration and promotional programs resulted in the continued dissemination of energy technologies. These were the family biogas plants, community biogas plants for electricity generating, photovoltaic cells for water pumping, windmills for water pumping, charcoal production kilns, etc.

14. There were 1,575 visitors to the RECs.

15. 4,550 printed materials on energy technology were distributed.

16. REC activities were advertised 62 times.

17. The RECs conducted 12 joint exhibitions with other government agencies for public relations and the dissemination of REC activities.

18. 34 coordination sessions and lectures were conducted with other energy components and government agencies interested in installing comparable or related technologies.

19. An analysis of the RECs in the closing stages of the project showed that despite unanticipated obstacles during the establishment stages, the RECs achieved their objectives and obtained the results listed in the conclusions.

CHAPTER 7

RECOMMENDATIONS

RECOMMENDATIONS

1. Provisions need to be made to provide full staffs at all centers. An understaffed REC results in a limitation of operational potential.

2. The RECs have field tested numerous training/information dissemination/ public relations methods and activities. Those various methods which have proven successful in advertising and promoting the RECs and the various technologies should be made a part of the promotional activity plans for newly established RECs.

3. The monitored results of twenty-one training sessions showed that they were highly successful. The REC should definitely continue this activity as those personnel who received the training have become important energy promoters who are helping to disseminate the information on these renewable energy technologies throughout the rural areas of Thailand.

4. Training must be continued because it is the only method to disseminate energy technologies in rural areas of Thailand with highly efficient results.

5. Coordination sessions with other government offices and energy components should continue so that there are no overlapping efforts and so that related activities and projects can begin simultaneously.

6. An analysis of problems which were encountered in the early phases of the project will help in the establishment of future RECs and will encourage efficiency and mission accomplishment.

7. Additional Regional Energy Centers should be set up to cover a wider area of Thailand.

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ANNEX I

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ANNEX I

A. TOOLS AND EQUIPMENT

Table I:1 Tools for Workshop

Item	No.	Cost (10^3 US$)
Shop hand tools	1	0.812
Portable drilling machine	1	0.109
Portable grinder machine	1	0.145
Bench electric grinder	1	0.109
Circular saw	1	0.145
Electric planer	1	0.145
Gas welding set	1	0.435
AC-DC arc welder	1	1.051
Saw machine	1	0.725
Bench vice	1	0.507
Pipe threader	1	2.355
Spray gun with compressor	1	1.341
Drilling machine (stationary)	1	1.449
Lathe	1	13.078
Chain	1	0.290
Carpenter's tools set	1	0.181
V-O-M meter	1	0.254
Slip bending roller	1	5.688
Treader shear	1	7.246
Single side band	1	2.935
Sub-total (each center)		40.0
Total (four centers)		160.0

Note: U.S. Contribution US$ 160,000

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Table I.2 Tools for field installation (four sets, one for each center)

Item	No. for One Set	Cost (10^3 U.S. $)
Hand tools	1	
Portable drilling machine	1	
Portable grinding machine	1	
Oxyacetylene welder	1	
Carpenter's tools	1	
Chain	1	
Kamalong	1	
Planer	1	
Bench vice	1	
Pump	1	
Portable arc welder	1	
Electric welder	1	
Bent	1	
Electric generator set	1	
Total (4 sets)		54.0

Note: U.S. Contribution U.S. $ 54,000

Table I.3 Dissemination Equipment

Item	No.	Cost (10^3 US $)
Video camera	1	2.593
Stationary video tape recorder	1	2.040
Portable video tape recorder	1	2.593
T.V. receiver/Monitor 18"	1	0.974
Battery pack	1	0.048
Battery charger	1	0.131
Portable light kit	1	0.870
Intercom - head set	2	0.145
Cassette tape 20 min.	10	0.153
Overhead projector	1	0.217
Tripod screen	1	0.054
Slide projector	1	0.435
Slide synchro sound recorder	1	0.357
Microphone	2	0.109
Amplifier	1	0.806
Sound speaker set	2	0.625
Sub-total (each Center)		12.15
Total (4 Centers)		48.6

Note: U.S. Contribution = U.S. $ 48,600

Table I.4 Prototype for Demonstration (four sets, one for each center)

Item	No. for one set	Cost (10^3 U.S. $)
Bio-gas digester	1	
Engine pump	1	
Efficient stove	20	
Windmill for water pumping	1	
Solar hot water heating set	1	
Solar distillation set	1	
Solar drying system	1	
Solar photovoltaic pumping set	1	
Gasification engine with pump	1	
Total (4 sets)		39.22

Note: U.S. Contribution = U.S. $ 19,220
RTG (NEA) Contribution U.S. $ 20,000

Table I.5 Laboratory and Monitoring Instruments (four sets, one for each center)

Item	No. for one set	Cost (10^3 U.S. $)
*p*H measuring instrument	1	
Thermometer set	1	
Pressure gauge set	1	
Gases analysis instrument	1	
Weighing instrument	1	
Stove with temperature control	1	
Laboratory glass-tube set	1	
Measuring tape	1	
Timer	1	
Wind anemometer	1	
Compass	1	
Solarimeter	1	
Total (4 sets)		51,200

Note: U.S. Contribution U.S. $ 12,800
RTG (NEA) Contribution U.S. $ 38,400

Table I.6 Office Equipment

Item	1982	1983	1984	1985	Total (10^3 U.S. $)
Table & Drawer	3.55	3.55	3.55	-	10.65
Typewrite.	1.9	1.9	1.9	-	5.7
Total	5.45	5.45	5.45	-	16.35

Note: RTG (NEA) Contribution = U.S. $ 16,350

Table I.7 Materials

Item	FY. 1982	FY. 1983	FY. 1984	FY. 1985	Total (10^3 U.S. $)
Materials for Installation	-	7.92	15.84	23.76	47.52

Note: RTG (NEA) Contribution = U.S. $ 47,520

Table I.8 Other Expenses

Item	1982	1983	1984	1985	Total (10^3 U.S. $)
Expenses for O & M training and miscellaneous	-	11.24	22.48	33.72	67.44

Note: RTG (NEA) Contribution = U.S. 67,440

Table I.9 Land, Offices and Buildings

Item	No.	Cost (10^3 U.S. $)
Land acquisition		12.000
Land improvement		25.000
Staff housing		
- Chief engineer 5 - 6 grade	1	13.000
- Asst. engineer 3 - 4 grade	2	20.000
- Technician 1 - 2 grade	1	22.000
Workshop	1	18.000
Storage	1	5.000
Garage	1	3.500
Office & Training Extension	1	40.000
Total		158.500
Grand Total (4 Centers) through 1984		634.000
Grand Total (6 Centers) through 1986		951.000

Note: U.S. Contribution (up to 4 centers) U.S. $ 164,000
RTG (NEA) Contribution (up to 6 centers) U.S. $ 787,000

Table I.10 Vehicles

Item	FY. 1982	FY. 1983	FY. 1984	FY. 1985	Total (10^3 U.S. $)
A 2-ton truck	25.0	25.0	25.0	-	75.0
Pick-up car	30.0	30.0	30.0	-	90.0
Motorcycle	8.0	8.0	8.0	-	24.0
Bicycle	1.8	1.8	1.8	-	5.4
Total (6 Centers)	64.8	64.8	64.8	-	194.4

Note: RTG (NEA) Contribution = U.S. $ 194,400

Table I.11 Staff and Related Expenses

Item	FY. 1982	FY. 1983	FY. 1984	FY. 1985	Total (10^3 U.S. $)
Chief	6.0	18.0	30.0	36.0	90.0
Assistant	9.6	28.8	18.0	57.6	144.0
Personnel	8.4	25.2	42.0	50.4	126.0
Promotionist	7.2	21.6	36.0	43.2	108.0
Secretaries	-	7.2	14.4	21.6	43.2
Typist	-	6.0	12.0	18.0	36.0
Drivers	6.0	18.0	30.0	36.0	90.0
Workers	6.0	18.0	30.0	36.0	90.0
Total	43.2	142.8	242.4	298.8	727.2

Note: RTG (NEA) Contribution U.S. $ 727,200

ANNEX II

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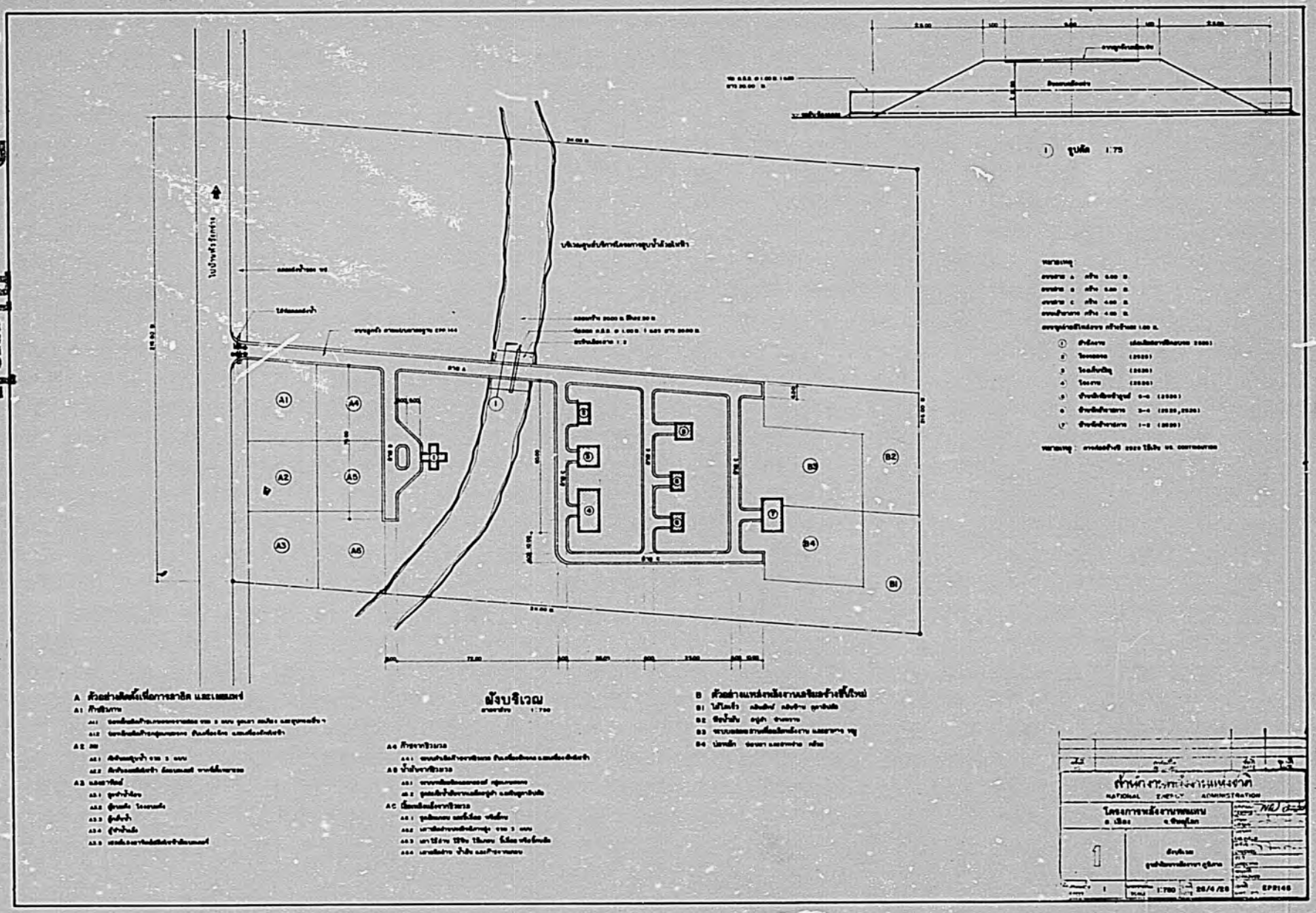

Figure II.1 Site Layout at the Regional Energy Center

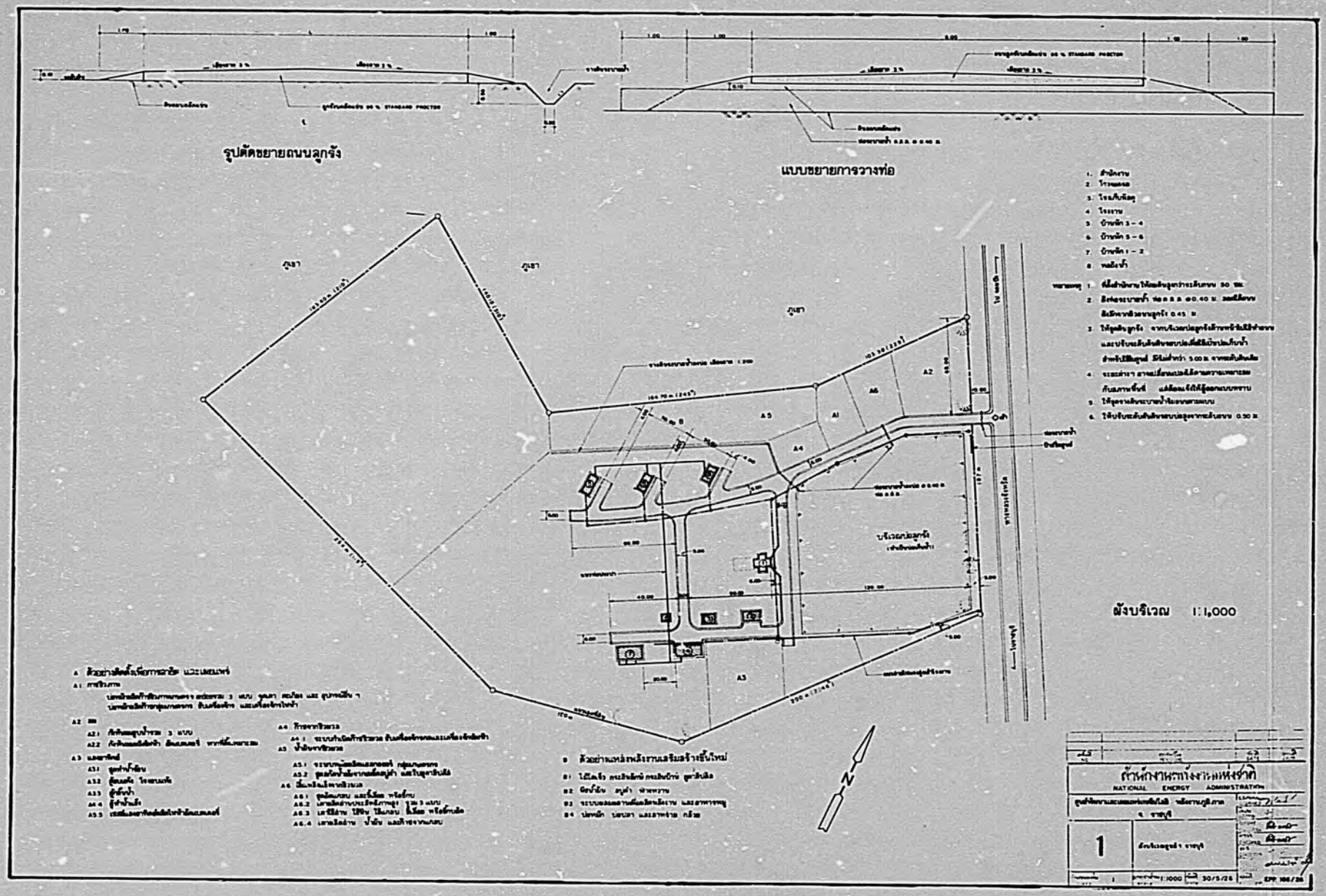

Figure II.2 Landscape at the Regional Energy Centers

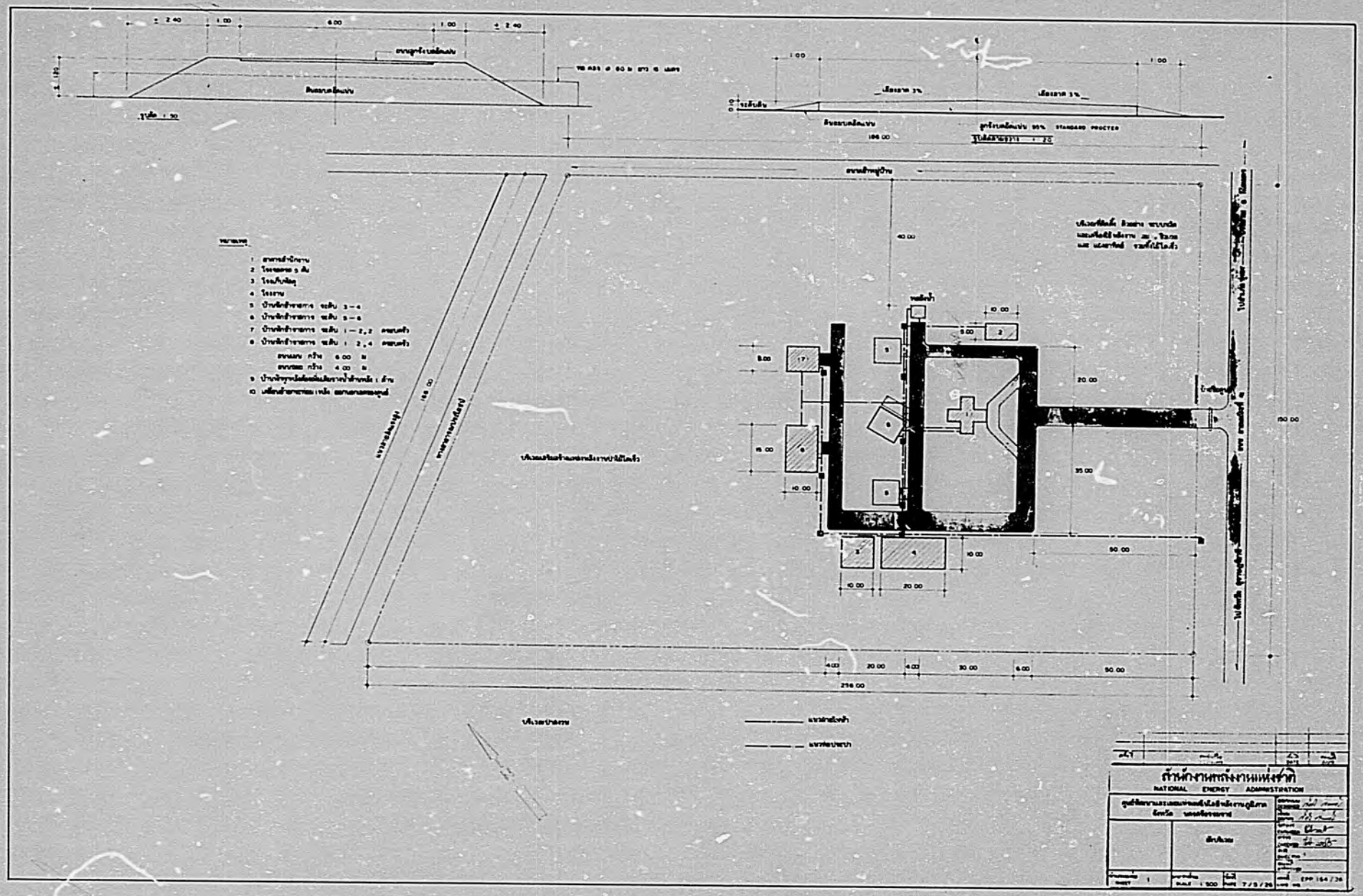

Figure II.3 Location of Transmission Lines and Plumbing Systems at the Regional Energy Centers.

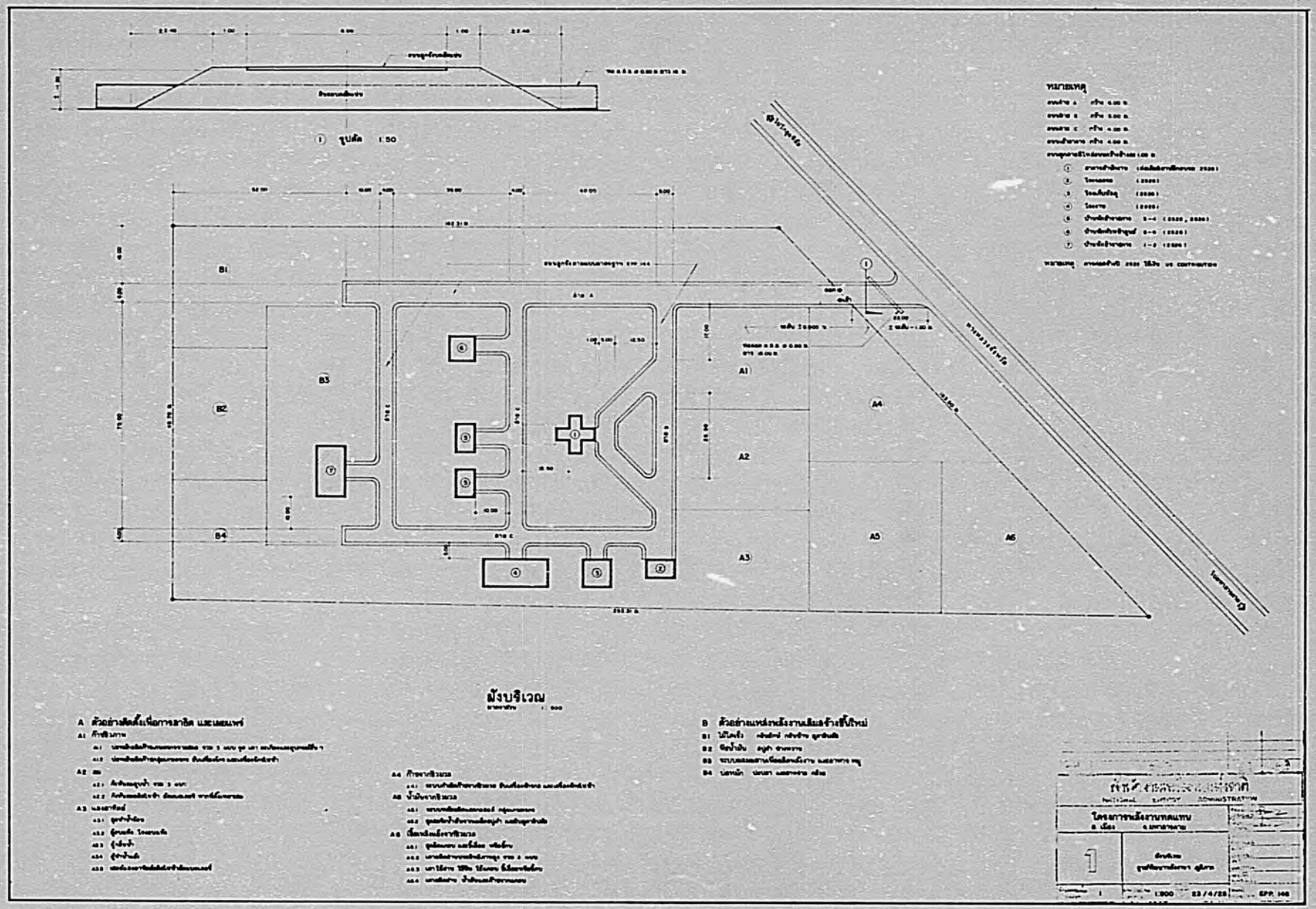

Figure II.4 Location of Energy Technology Prototypes Used for Demonstration and Testing Purposes at the Regional Energy Centers.

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