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THAILAND

New and Renewable Energy Development

I. Introduction

Situation

1. Energy demand has been rising rapidly since the commencement of the 1<sup>st</sup> - 5 year economic development plan. In 1961, the energy consumption was 1765 million litres of crude oil equivalent. The share of crude oil sources of energy was 78 per cent. In 1971, the end of the 2<sup>nd</sup>- 5 year economic development plan, the energy consumption was 7,695 million litres of crude oil equivalent. The share of crude oil sources of energy was 83 percent.

2. Almost all crude oil sources of energy had to be imported. Its amount was increased by five folds, but its cost by only three folds during 1961 - 1971. The import of crude oil sources of energy was 16 per cent of the total export earning in 1971.

3. In 1981, the end of the 4<sup>th</sup>- 5 year social and economic development plan, the demand of energy is estimated at 18,724 million litres of crude oil equivalent. The share of crude oil sources of energy will be 76 per cent. The import of crude oil sources of energy will increase from 16 per cent in 1971 to 37 per cent of the total export earnings in 1981. This is severely affecting the economic and social system of the country causing large payment deficits, inflation and income distribution problems. It will be much more severe during the 5<sup>th</sup> - 5 year social and economic development plan starting in 1982.

/ Problem

### Problem

4. The problem the country is facing in the energy fields are not only dependent on crude oil and its products but also the lack of foreign exchange to procure them. The country spent more than one-third of its foreign exchange earnings to procure crude oil and its products in 1980. Moreover the government has set a high priority policy to develop the rural areas where the fruit of the development has not yet reached. The energy demand for agricultural production and small scale industries in the rural will be in addition to the need for cooking, lighting and other amenities. This will exert an increasing demand for energy and much of the demand will have to come from crude oil sources of energy unless positive steps are taken to introduce alternatives. The traditional use of fuel wood and charcoal for cooking in particular is already seriously affecting forestation. It is estimated <sup>that</sup> less than 25 percent of land is left as forest land.

### Policies

5. The Government of Thailand has realised the situation and has put more emphasis on the development of new and renewable energy sources. The general policies pertaining to these can be summarized as follows:

(a) The development of new and renewable energy sources is a key to national survival and no efforts should be spared to reduce dependence on imported energy.

/ (b)

(b) The development of new and renewable energy sources should serve people throughout the country.

(c) The investigation and planning, research and development on the utilization of new and renewable energy sources are fully encouraged and supported as far as possible.

(d) Private sectors and state enterprises are urged to commercially fabricate proven and acceptable energy producing facilities using local skills and materials.

(e) Promotion of cooperation with other nations, subregional, regional, international organizations are encouraged for the exchange of information, personnel and technologies.

#### Energy Strategies

6. The strategies for harnessing conventional sources where technologies are sources commercially available are divided into 6 main tasks as follows:

a. Investigation including exploration and interpretation of energy resource.

b. Planning starting from project identification, formulation and approval.

c. Preconstruction design specification and estimate

d. Construction, installation and test run

e. Operation and maintenance

f. Evaluation

7. In the case of nonconventional energy sources, noncommercially available technologies and/or socially unaccepted and/or low efficiency and/or rural oriented, small scale, individual or community owned decentralized system, the tasks are divided into 6 main categories

/ as follows:

as follows:

a. Resource assessment: This task includes evaluation of new and renewable energy resources and existing status of each energy resource use and availability of energy resource data on the continual basis, collection and compilation, determination of other resources that can be developed and benefit the rural area, site specific and overall.

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

c. Research and development (R&D) of Relevant Energy Technologies: This task includes setting up of priority research and development areas in each new and renewable energy sources, performing the R & D in the areas selected and linking the R & D accomplishment to development and demonstration tasks.

d. Development and Demonstration (D & D) of Proven Energy Technologies: The prime focus of the task would be to set up a proven technology testing site to check its technical performance and reliability. If it is technically viable, it will feed the development and extension/promotion group and its number will be increased and demonstration given<sup>at</sup> selected sites. The fact and figure would be fed back to the R & D group for any need of modification.

/ e.

e. Demonstration and Extension/Promotion (D & E/P):

Demonstration of the proven, reliable technology will be carried out at several selected sites. Cost of procurement by use of locally available skills and materials will be determined. In case it is accepted by the people, extension/promotion will continue for some time through government limited subsidies by providing component hardware or equivalent reimbursable cash of paid materials.

f. Extension/Promotion and Popularization (E/P&P): The

promotion of the proven and reliable technology will be amplified to the large scale as the technology is satisfactorily accepted, popularization through various means will be performed, training to do-how will be arranged and supported.

The tasks outlined above would provide information including fact and figure for the wide scale development and/or utilization of new and renewable sources in order to benefit the mass.

II. Potential of New and Renewable Sources of Energy

8. Hydro: Hydro power in the country has a potential to generate energy as much as 17,304 gigawatt hours(Gwh.) The current developed capacity is 1,270 MW, generating electricity at an average of 1,751 Gwh in 1980. Micro-hydro potential capacity in Thailand is estimated at 1,066 MW of firm, dry season unregulated power.

The term "micro-hydro" refers to a hydro-power unit which is less than 100 KW. in capacity. Development of the full potential of such a dispersed resources is questionable and if 5% or 50 MW of the potential is considered as practical for development then more than 500 micro-hydro projects can be expected to be developed in this country.

The National Energy Administration, a governmental organization responsible for this development has found that <sup>the cross</sup> flow turbines and impulse turbines are most appropriate for rural development projects. At present, these kinds of turbines are being manufactured locally while the sophisticated and high cost governors are still ordered from abroad.

9. Charcoal and Fuel Wood: Fuel wood still plays an important role in the life of community as the principal cooking fuel in rural and urban areas. The demand of fuel wood in 1979 was 30 - 40 million cubic meters (mcm). Recently estimates based on land satellite imagery put the total forest area close to 25% of the total land area and it is estimated that should the trend continue the supply from natural forest will decrease to the level of 14 mcm in 1985.

10. Biomass: Bagasse is produced and mostly used (85 - 90%) by sugar industries as a heat source which shares in an aggregated energy consumption of about 8.2% in 1979.

: Paddy husk is used (55 - 60%) in rice mill where it originates as a heat source and also for cooking and making charcoal (10 - 15%) and in other cottage industries i.e., brick making, pottery, and food. Its share in the aggregated energy consumption was less than 1% in 1979.

: Garbage has not yet been used as an energy source.

: Agricultural residue like forest and crop are available as an energy source.

/ : Animal

: Animal residue has a quite high potential for energy production-biogás. Presently, there are a few thousand biogás digesters and this would increase to about 60,000 within the next decade.

: Other crops like sugar cane and its molasse, cassava chip can be converted to liquid fuel-ethanol, apart from being used as food and feed stocks.

: Aquatic plants like water hyacinth, algae have a high potential as an energy source.

11. Wind Energy : Wind speed in Thailand, except in some selected areas such as coastal mountainous range, is low. Average annual wind speed varies from 7 to 14 kilometres per hour in the West, Northeast, North, and Central. Nevertheless, wind energy is of significant importance in water pumping for agriculture. The best locations for development of large scale wind energy are along the coastal area, specifically, at Songkhla province in the South and Si Chang island in the East which have consistent and high wind speed.

#### 12. Natural Gas

The investigation of the three discovered gas wells in the Gulf of Thailand revealed the reserve of 10 trillion cubic feet. The reserve of liquid natural gas in the three gas wells is estimated at 12,720 billion litres.

13. Solar Energy: The annual average daily solar radiation in Thailand is about  $17 \text{ MJ/m}^2$  - day which is classified as fairly high with variation of  $\pm 15\%$ . The climate of Thailand is of strong seasonal nature with a rainy period from May to November and a dry season, from December to April. Even during the rainy season, long

unbroken period of cloudiness is rare, with rain clouds often building up in the near afternoon after a bright sunny morning. Thus, there is usually adequate radiation over most part of the country to run solar energy applications effectively.

In spite of moderate publicization by solar equipment distributors, solar energy utilization is not widespread. Solar water heaters using flat plate collectors and auxiliary heaters are now manufactured in Thailand, but they are suitable for commercial purposes such as hotels, factories, hospitals, public services etc and for some domestic uses especially in the northern part.

14. Oil shale: The quantity of oil shale in the North of Thailand is still not high enough for commercial production. As one ton of oil shale is estimated to yield an average of 52 litres of oil or about 5% of the total weight of oil shale, the expense in extracting oil from oil shale is higher than the price of imported oil. Other possibility of utilization of oil shale is to use as a direct fuel for power plant but again it is still not economical. Moreover, the available information is not enough to decide the trend of the development.

15. Geothermal: Preliminary investigations indicated that there are at least 65 hot springs distributed all over Thailand. Only 5 promising hot springs, with reservoir temperature ranging from 175 - 200 degree celcius, have been investigated. The five geothermal systems could offer a possible development for electricity generation and 11 more hot springs with reservoir temperature between 100 - 175 degree celcius have been located and could be developed for industrial or agricultural applications.

### III. Plan for New and Renewable Energy Resources Development

#### 16. Purposes of the Plan

(a) To accelerate the indigenous energy resources development to substitute oil in order to reduce the share of oil consumption from 75 per cent of aggregated energy demand to 45 per cent by 1989 and enable Thailand to extenuate its oil dependence on foreign countries.

(b) To supply energy for rural people in types, quantity and quality appropriate to their needs and living condition.

(c) To accelerate the energy resources investigation, need identification, research development, demonstration, and extension/popularization of energy technologies.

#### 17. Plan for Development

With high reliable technologies entrusted in the plan, conventional energy has been developed to substitute crude oil to a certain extent. It is also suitable to be utilized in centralized system. Still, there is necessity to set the nonconventional energy development plan apart from the conventional one owing to the differences of their development objectives. The nonconventional energy development objective aims at an accelerated rural development policy.

#### Conventional Energy Plans

18. Major and Mini Hydro-power Development is to substitute fuel oil and diesel oil in power generation and simultaneously, electricity might replace kerosene in giving light. The plan calls for the development of <sup>/large</sup> scale hydro-power projects on a normal basis but to accelerate development of mini-hydro projects (having a

/ capacity

capacity 100 KW to 6 MW) to 5 projects a year.

19. Garbage Energy Development Plan

To get rid of garbage by incineration and make use of the heat to generate same electricity as that of conventional thermal power plants.

The investment of about 60 million U.S. dollar is required in order to get rid of 1 million tons of garbage per year and generate energy from 40 MW. installed capacity at 250 Gwh. a year.

20. Fuel Wood and Charcoal Development Plan

The project subjected to this plan is the reforestation project with the rapid growth trees in the areas of 4.6 million rais (2.5 rais = 1 acre) which, from 1989, is expected to produce about 12.9 mcm. per year together with the natural wood of about 9.5 mcm. will be able to serve the wood demand for 22.4 mcm. The investment during the plan period is estimated at 310 million U.S. dollar.

21. Natural Gas

The programme to extract natural gas has already commenced. The construction of the pipeline and other facilities are near completion. It is expected that the gas will be available in late 1981 at the amount of 225 million litres of crude oil equivalent and will increase to 6147 million litres of oil equivalent in 1986

It is also anticipated that liquid natural gas will be available in 1982 in the amount of 516 million litres of crude oil equivalent.

/Nonconventional

## Nonconventional Energy Plans

### 22. Micro Hydropower Development Plan

The project of a capacity about 20 - 100 KW. is selected because at this size use of locally made turbine with lower costs than that of foreign could be made.

Within the first three of the ten-year period, 5 micro hydropower units will be installed annually and the projects will be shared by the government fund, foreign aid and community effort. For the next seven years, thirty units of micro hydropower plants are expected to be installed by the government with more community contribution.

### 23. Biogas Development Plan

The project proposed in the plan will be the construction of 106 digesters of community size and 60,000 of household size. The estimated expenditure to be paid by the government is about 5 million U.S. dollars.

Currently, biogas plant design programmes consist of development of suitable digester using cheap material for construction. Three adaptive designs plus one new model made of cement jars and design and development of suitable gas holders using non-corrosive materials and drumless digesters are being considered.

### 24. Oil Shale Development Plan

The project proposed in the plan is a pilot power plant project of 10 - 20 MW. capacity by using low quality oil shale. A feasibility study of oil extraction project of 50,000 barrels a year by using high quality oil shale and a feasibility study of a

large power plant construction to enable the construction at the end of the plan if feasible are being planned. The pre-investment for the whole plan is about 30 million U.S. dollar.

25. Ethanol Production Development Plan

The plan to mix ethanol with benzine in order to use it as fuel will start in 1981 after feasibility study for establishing an alcohol factory is completed. The government shares in the plan will be about 250 million U.S. dollar in addition to the private shares in the investment should the project prove feasible.

26. Solar Energy Development Plan

The formulated projects fixed for development and demonstration stage include application of solar energy e.g. solar drying, solar water pumping, solar water distillation and process heat, small scale solar electricity generation, solar refrigeration and air-conditioning.

27. Wind Energy Development Plan

It comprises of demonstration on the utilization of wind energy in water pumping for consumption in villages and farming in small areas including the small scale electricity generation from wind power for villages in the rural areas where wind velocity is consistent. Several projects will be implemented during this decade with the proposed budget of 7 million U.S. dollars.

28. Geothermal Energy Development Plan

It consists of demonstration on the utilization of geothermal energy in tobacco leaves and crops drying so as to supply farmers with cheap heat, and development of hot springs for electricity

generation. Within the above scope of work, the preliminary budget is tentatively estimated at 3 million U.S. dollars.

29. Rural Oriented Energy Technologies Development Plan

It includes several components such as

- Village Energy Survey
- Improvement of Cooking Stove
- Improvement of Charcoal Production
- Watergasification
- Biogasification
- Liquid Fuel Production i.e. ethanol, vegetable oil
- Solid Fuel Production i.e. pyrolysis of ricehull, densification of charcoal dust and other fine residue.
- improvement of Furnace and Boiler
- Water Lifting Technologies
- Village Woodlots
- Establishment of Rural Energy Centers

With the view to improve the existing use and supply more energy to rural area the budget for the above components implementation is estimated at 18 million U.S. dollars

IV Realization of Major Constraints in Implementation of the Plan and Means to Overcome Them

30. Major and Mini Hydro-Power Development Plan requires hydrological, topographical, geological, economic and other data for feasibility studies arriving at optimum implementation plan. Such

/ data

data are under intensive investigation and technical support to prepare feasibility studies of the identified projects is requested.

31. Garbage Energy Development Plan has an institutional constraint. It requires an awareness and understanding of local administration that garbage can be used not only as raw material for fertilizer production but also as fuel derived refuse.

32. Fuel Wood and Charcoal Development Plan requires the public and government level awareness of the fuel wood situation and that situation will lead to rural energy crisis soon. Allocation to the public of deforested plot to establish fast growing fuelwood plantations in the village near the population center and distribution system is the prerequisite and the government commitment to include such plantation as a top activity in the rural job creation project would facilitate its implementation.

33. Micro Hydro Development Plan needs an active involvement of local community and a proper institution to deal with their participation is required. Standardization of a micro set and fabrication of such set locally is desirable.

34. Biogas Development Plan requires an intensive effort to popularize the techniques and to train selected villagers to do how. Trained villagers will introduce the technologies paid by the government as a demonstration set and help select an interested and suitable individuals to supervise installation, operation and maintenance of a promotional set in a village. Mass production design to produce cooking gas for a family would help promote biogas utilization faster than a built in-place one.

35. Oil Shale Development Plan requires standardization of resource evaluation procedure to determine the extent of a deposit. It also requires exploitation technologies to determine potential development methods to best accommodate the resource. This information would enable Thailand to prepare comprehensive development plan faster.

36. Ethanol Production Development Plan requires willingness of the private sector to invest. Such willingness can be derived from the fund allocated by the government for preinvestment studies and the favourable loan provided by the international financing institutions for procurement of overseas capitals and services.

37. Solar Energy Development Plan requires standardization of ready sets to suit local climatic conditions. Utilization of locally available skill and material in the production process would reduce a high initial cost and foreign exchange component to be competitive with familiar ones.

38. Wind Energy Development Plan requires site specific investigation and performance standard for wind equipment to be produced locally and introduced to the selected site.

39. Geothermal Energy Development Plan requires high capital cost needed for the exploration work and production drilling. Provision of the technical service and drilling rig for the exploration are desirable.

#### V Scope for International Cooperation

40. Thailand like most other developing countries is highly endowed with biomass but its existing use as an energy

source is more or less traditional. It is timely necessary to pay more attention to it. Flow of information on the methodologies and technologies on the assessment and improvement of its use among developing countries and interested industrialized countries and an establishment of coordinated R & D programme on biomass energy production, transportation, storage, utilization would benefit the majority of people especially in the developing countries.

41. Technologies for the development of oil shale and the utilization of biomass solar and wind are not yet fully developed. Rate of their advancement, extent and rate of their utilization is not known. A periodical report on a comparative study and recommended design of system to serve an identified end use, technical fact and economic figure, technical improvement and cost reduction trend is desirable. It is recommended that a well prepared demonstration and installation programme aiming at information generation and dissemination covering liquid, gas and solid fuel production from biomass to use as an alternative to an exhaustable fuel in an engine of various range, process heat generation from direct combustion of biomass and oil shale, collection and storage of solar in manufacturing and agro-based industries, electric and shaft power/ generation from biomass gasification and biomethanation, and from solar pond with rankine cycle engine be established in all regions wherever appropriate to determine performance under condition of use and to generate information for the developing countries.

42. Strengthening the capacity of Thailand and other developing countries on all energy matter related to new and renewable energy resource development would help them exploit limited resource much more beneficial and accelerate the development of new and renewable sources of energy. It is recommended that intensive training of their citizens at all level be encouraged and supported. Special category of fellowships and energy careers be established for training of specialists in new and renewable sources of energy. Similarly vocational training schools, centers, and college could be a subject of assistance to develop a cadre of skilled technical manpower to maintain renewable energy systems and to monitor experiment/demonstration projects. Organization of technology tours of on-going commercial venture, demonstration projects, pilot plant experiments and R & D facilities could help stimulate the interest of the developing countries to undertake the similar project in their countries.

43. It was recognized that substantial financial resources would be required to undertake the above recommendations. It is proposed that new funds for new and renewable energy development and cooperation be established and specialized agencies in the UN system be strengthened.