ALTERNATIVE ENERGY SOURCES

FOR

RURAL DEVELOPMENT

SUB ACTIVITY 2

of

SCIENCE AND TECHNOLOGY (Loan/Grant)

US.AID Project No 497 - 0266

Prepared by

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ALTERNATIVE ENERGY SOURCES

FOR

RURAL DEVELOPMENT

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ALTERNATIVE ENERGY SOURCES
FOR RURAL DEVELOPMENT

I. OBJECTIVES

The objective of this program is the utilization of the natural energy sources such as, water hyacinth, sago palm, agricultural wastes, and wind or small hydro power which are available abundantly in many Indonesian Villages.

This is considered of paramount importance for developing the rural areas in this country, since the conventional energy sources, such as electricity piped gas, gasoline or diesel fuel may not be available to them for decades due to cost, lack of power lines, geographic isolation and other distribution problems.

This program has three principal objectives :

(1). Conservation of scarce fossil fuel.

(2). Retarding the rapid consumption of firewood which is devastating forests, and causing soil errosion

(3). Providing low income people, who live in rural areas, an improvement in life quality at price they can afford.

/II. SCOPE .....

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II. SCOPE

This program will include five sub-programs, as follows :

(1). Utilization of water hyacinth.

(2). Etanol production from sago palm.

(3). Methanol production from biomass.

(4). D.C. Electricity for remote areas.

(5). Utilization of rice straw for village energy.

The activites of this program are focused on the following scientific and technological approaches :

(A). An inventory / limited survey of availability - straw and other rural waste that can be used as energy sources, sago palm and water hyacinth in specific rural areas, and the assessment of energy demand, in order to determine the village compatibility of developing alternative energy.

(B). Development of the appropriate alternative energy sources for supporting the productive activities and energy demands of a rural area.

The construction and testing of appropriate prototype units which may be duplicated for widespread utilization to relieve the demand for - fossil fuel and fire wood, at moderate cost.

/(C). Imple....

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(C). Implementation of demonstration units in a pilot village, to evaluate the public accep tance and determine the necessary dissemina tion program.

(D). Investigation of manufacturing possibilitie of the well proven units in Indonesia, by i vestigating the market, social and economic aspects, and also the available know how an facilities in the country.

The provision of assistance and training fo entrepreneurs interested in the establishme of new ventures based on the finding of the program.

III. PROJECT DESCRIPTION

1. SUB PROGRAM (1). UTILIZATION OF WATER HYACINTH.

1.1. Introduction :

Water hyacinth (eichhornia crassipes), which has luxuriant growth and rapid propagation, is a ry trouble some floating herb, since these aquati weeds frequently obstruct the drainage of farm-la cover the fishery area and block the hydro-electr installation. Moreover it provides perfect breed

/places .....

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places for some species of mosquitoes. Since appr mately 6 million hectares of water areas in I donesia are covered by these weeds, a program fo utilizing the water hyacinth with the purpose controlling and managing it, should be elaborate

1.2. Program Description :

The proposed program will consist of researc activities in order to utilize the water hyacint for producing methane as well as its by-products such as fertilizer and mushroom growing media. This program will involve four phases and will r quire 3,5 years for completion. The total esti ted budget is US $ 320,000 (Rp 200.000.000,-). In the following paragraphs brief descriptions o these four phases is presented.

Phase One-Inventory / Feasibility / definition

This program will be started by an inventory/fea bility/definition pha of six months duration which a limited survey and a brief study will be conducted to determine the availability of water hyacinth, the technique in gathering and process the water hyacinth for methane production and it by products, and the possible ecological side effects.

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Moreover a study of social & economic consequences to find out the possible cultural institutional or trade barriers that might be prevent use of methane as energy sources for supporting village activities, will be done.

The results of this phase should provide all specifications and definitions which are required in developing necessary appropriate prototypes.

The required budget of this phase is US $ 61.599 (Rp 38.499.375,-)

Phase two-Hardware Development

The major emphasis of activities in this phase are experimental works both in laboratory, workshop and in the field, in order to develop prototype units and other related components/equipments. Those technical systems should meet the definitions and specifications provided in the first phase.

This phase will be scheduled for one year period and will be budgeted at US $ 197.867 (Rp 123.666.870,-).

Phase three-Demonstration

After constructing and testing of the prototypes

/in the .....

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in the second phase, those units will be installed in a demonstration village, so the public acceptance and user opinions can be evaluated. The necessary modifications and improvements of those units to meet the village requirements will be done. Social and economic impacts caused by implementing this technology will also be studied.
This phase will need at least one year period and the required budget is US $ 43,936 (Rp 27.460.000

Phase Four-Manufacturing Possibility

As a follow up of those above phases, the investigation of possibilities of manufacturing of well proven units will be conducted. It of course should include all studies about marketing, social and economic aspects, and technological capabilities of industries in Indonesia. The guidance for small industries who are interested in producing those units will be prepared. As a result of this phase, a recommendation of possible dessimination program to widespread the application of the finding of this program as an alternative solution on energy need in the rural area, will be proposed.
This program will need a budget of US $ 16598 (Rp 10.373.750.,-) and will require one year period.

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1.3. Cost Estimate.

SUB PROGRAM : UTILIZATION OF WATE HYACINTH

ASE ONE: Inventory / Feasibility Study / Definition.

I. Training two man year	US $	32.000,-
II. Survey & meeting	US $	9.700,-
III. Digester construction	US $	16.000,-
IV. Salary	US $	1.899,-
V. Contingencies and miscellaneous	US $	2.000,-
	US $	61.599,-

ASE TWO: Hardware Development.

I. Equipment, commodities, instrument, vihi and green house	US $	151.9 ,-
II. Material & local labor for experimental prototype energy-converter construction	US $	42.1 9,-
III. Salary	US $	3.7 8,-
	US $	197. 7,-

PHASE THREE: Demonstration.

I. Technical advisors.....	US $	25. 0,-
II. Space and facilities	US $	15. 8,-
III. Salary	US $	3. 8,-
	US $	43. 6,-

ASE FOUR: Manufacturing Possibility.

I. Training course in biogas technology on water hyacinth for unskilled peop	US $	12. 0,-
II. Salary	US $	3.798,-
	US $	16.598,-

T O T A L ..... US $ 320.000,-

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2. SUB PROGRAM (2). ETHANOL PRODUCTION FROM SAGO PALM

2.1. Introduction :

Sago is a tropical plant that grows most in all areas of the Indonesian archipelago, especially in the eastern part such as in Maluku, Sulawesi and Irian Jaya.

In Maluku and Irian Jaya, sago grows well in large quantities as a wild plant spread over [illegible] 1.000.000 hectares, especially in stagnant [illegible] low-land areas. It grows in clusters and forms forests.

This plant is not well utilized yet, although in certain areas it is used as staple food. The sago tree may produce 150 - 500 kilograms of sago flour containing 80% of carbohydrate/starch.

By those figures, it seems that sago is potential source for food production as well as for ethanol production.

2.2. Program Description :

The objective of this program is to investigate the utilization of sago [illegible] as an energy material especially by fermentation and distilling its flour into alcohol.

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This program will require a budget of US $ 320.000 (Rp 200.000.000,-) and will need 3.5 years for completion it involves following phases :

Phase One-Preliminary Study

This phase will take about 2 years duration and will consist of an experimental works in laboratory to find out the appropriate processes in producing ethanol, and to select the appropriate microbial strains and enzymes that are required in those processes. A study and a field survey for determining the amount of sago palm which could be exploited per year and for investigating the harvesting technique as well as other processes that are required for raw material preparation in the field,will be conducted.

the ecological aspects will be taken into consideration. The utilization of parts of the sago tree which are unused in the processes will also be studied.

The proposed budget for this phase is US $ 277.337 (Rp 173.609.375).

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Cost Estimate

ETHANOL PRODUCTION FROM SAGO PALM.

Phase one : Pre Eliminary Study.

Salary	$ 2[illegible]
Travel & Technical Advisors	$ 41[illegible]
Survey	$ 15[illegible]
Materials & Equipment	$ 105[illegible]
Training 2 Man Year	$ 47[illegible]
Books, Publishing, Documentation	$ 1[illegible]
Contingencies	$ [illegible]
Vehicle & Administration	[illegible]
	$ 977

Phase two : Pilot Plant Design.

Salary	$ 1[illegible]
Survey	$ [illegible]
Administration	$ [illegible]
Books, Publishing, Documentation	$ [illegible]
Contingencies	$ [illegible]
Materials	$ 21[illegible]
	$ 421[illegible]

T O T A L ..... $ 32[illegible]

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Phase Two-Pilot Plant Design

The elaboration of the design of a pilot plant and other related equipment based on the basic data and specifications that are provided in phase one, is the main effort of this phase. The possibility to manufacture those systems in Indonesia should be taken into consideration.

The application of ethanol as an engine fuel that may be applied to support various productive activies in rural areas, will also be tested. As a follow up of this program a recommendation and a proposal of a program for developing the pilot plant will be proposed.

The estimated time to complete this phase is at least one and a half year, and the required budget will about US $ 42.193 (Rp 26.370.625)

3. SUB PROGRAM (3). METHANOL PRODUCTION FROM BIOMASS.

3.1 Introduction :

In Indonesia, various forms of biomass which are not utilized well, are available abundantly. The annual forest production in the form of log, saw wood plywood, etc, is about 80 million cubic meters, an

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its residue is estimated about 24 million cubic meters. Moreover there are about 200.000 hectares nipah forests, more than 1000.000 hectares sago palm forests, 4 million hectares underbrush - forests and also about 16 million hectares alang alang areas.

The amount of agricultural waste should also be considered. Those biomass can be utilized as an - energy source, although because of their bulk - and relatively low heating value they cannot be economically transported very far from the source Methods are therefore needed for converting bulk biomass into clean, efficient, energy-intensive fuels which can be used as replacements for petroleum products in providing heat and light in the rural villages, and providing fuel for engines. Mehtanol is one of such forms of synthetic fuel which has a good prospect for those purposes. Eventhough up now methanol is produced primarily from natural gas, the possibility to produce from biomass, should be investigated.

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3.2. Program Description :

The objective of this program is mainly to investigate the possibility of converting various of biomass into methanol. This program will be conducted in a three and half years period and will consist of a feasibility study and experimental works in laboratory. It will take a budget of US $ 160,000 (Rp 100.000.000,-) and consist of following phases :

Phase One-Feasibility Study

In this phase, a brief study to determine the potency of various type of biomass for producing methanol will be conducted. It should identify the following matters :

- Conditions of biomass, seasonality of production and location, and current disposition.
- The characteristics, including the value of current disposition, requirements for collection and transportation, and the energy content.
- The feasibility of using those biomass as a feed stock for producing methanol.

in parallel with that activity a study of necessary technology for producing methanol which involves

/involves a .....

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a high temperatures pyrolysis process to produce synthetic gas and a liquefaction process in which the synthetic gas is catalytically converted into methanol, will be done.

Some designs of gas producer is starting to be - evaluated.

This phase will require one year period and will budgeted at US $ 40,000 (Rp 25.000.000,-).

Phase Two-Process Development

After getting conclusions of phase one, experimental works on potential types of biomass will be - started.

The experiments will be done in two steps in the first step, experiments on gasification process - will be conducted, by using several types of gas producer and by applying various potential feed - stock. In the second step, the produced gas will be purified and will be catalytically converted - into methanol.

The results of both phases will provide the - necessary data, specifications and definitions - which are required for determining the possibility to produce methanol from biomass commercially, in this country. This phase will require two and a - half years and will be budgeted at US $ 120,000 - (Rp 75.000.000,-).

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3.3 Cost Estimate

SUB PROGRAM : METHANOL PRODUCTION FROM BIOMASS.

Phase one : Feasibility study / definition.

I . Training 1 man year	US $	17.500,-
II . Survey	US $	10.000,-
III. Books, publishing, documentation.	US $	5.000,-
IV . Contingencies and miscellaneous	US $	7.500,-
	US $	40,000,-

Phase two : Experimental.

I . Technical Advisors (2 manmonth)	US $	25.000,-
II . Space and facilities	US $	5.000,-
III. Equipment, commodities and small instrument	US $	64.000,-
IV . Material & local labor for experimental and prototype energy-converter constructions	US $	24.000,-
V . Contingencies and miscellaneous	US $	2.000,-
	US $	120.000,-

T O T A L . . . . . US $ 160.000,-

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4. SUB PROGRAM (4) D.C. ELECTRICITY FOR REMOTE AREAS.

4.1. Introduction :

It is a well known fact that for the next 10 to 20 years the resources of PLN combined with the various AID programs will be hard - pressed to keep pace with the electrification of industrial and larger rural areas.
What about the smaller remote villages which are not considering industrial growth ?
Are they to be by passed and can electricity help their economic and social growth ?
This proposal concedes that it is not practical for PLN to build power lines to remote - villages. However there is a need for limited electricity in small remote villages and there is no question but what limited lighting, radio and television will be beneficial to their - growth. If a way could be found to provide - electricity with-in the village its-self and without the expence of building power lines - plus without the need to buy fossil fuel a program of remote area electrification is feasible and should be initiated.
There is a system to meet the above requirements which basically consists of a simple water or -

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wind (depending on the compatibility of the location) generator connected to portable - battries. The battries are hand carried to - each house for electric power and later re - turned to the charging station.
Following is a description of the proposed - system.

4.2. Program description

This program will consist of a formalization and improvement of a battery power system - which is already in use on a " Grase roots " basis by the Indonesian people, plus couple- the battery power system to a village located wind or water powered charging generator.
It should be noted that the following is al - ready common throughout all of Indonesia;

A. D.C. Powered neon light fixtures are availa
Their cost is less than A.C. Fixtures.

B. Almost all radios and small televisions pro ed in Indonesia have provisions for D.C battery power.

C. Almost all cities and large villages alread have charging stations for batteries. Howev

/they use ....

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they use small diesel powered generators and for a family in a remote village to bring a battery for charging may consume one whole day, but yet they do just - exactly that, sometimes traveling more than 80 km by public transportation.

The following technology already exsits :

A. Many international AID and appropriate - technology organizations have developed self-help books and programs which out line in detail simple water wheels, mini turbine's, wind mills, etc.

B. Various mini-turbine's are operating in Indonesia.

C. There are several institutions in Indonesia who have developed wind mills for - small power applications. To mention a few, LAPAN, ITB-DTC, ITB-ECL, LIPI etc.

In terms of later impetus for this program it should be keep in mind that there is - world wide renewed interest in battery power and several countries are in the process of developing improved storage batteries. For example in the U.S.A. there are virgouris

/programs .....

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programs at general electric, energy developme
associates and P.S.E. and gas of newwark, N.J
Department of energy and EPRI are jointly
financing the battery energy storage test'
facility. There is also a new project by the
department of energy to test large scale batte
programs (SBEED).

Plans call for a facility consisting of a 30,0
kilowatt-hours lead-acid battery coupled to a
10,000 kilowatt A.C - D.C. converter.

The facility will be tied into a small electri
utility system and will be operated by its
employees.

It will be the purpose of this program to
collect all of the available data, select the
components/systems most appropriate based on
village compatibility, maintainability, cost a
simplisity.

Construct a demonstration system, install in
demonstration village and observe performance.

Calculate the overall application of this syst
of providing electricity to remote areas and r
commend what further programs should be initia

/The program ..

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The program will consist of four phases and be budgeted at U.S.A US $ 49.600 (Rp 31.000.000).

The time frame is 18 months. The research & feasibility will be conducted by BPPT personell.

The prototype systems will be built at the BPPT energy laboratorium Serpong.

Phase One-Feasibility / Definition

This phase will consist of three parts as follows

Part I : collection of all available data on current :

A. Battery and D.C electric components.

B. Mini Hydro Systems.

C. Wind mills.

Part II : calculation of practical power requirements based on part I and village surveys.

Part III : Select appropriate components/ systems which is most compatible with existing village capabilities and requirements. Also select demonstration village.

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Phase I is scheduled for 6 months and is budgeted at USD 8.500.00
(Rp 9.312.500,-)

Phase Two-Hardware Development

This phase will assemble the various components into a formal system.
Manufacture the auxillary items to support the systems and conduct the necessary compatibily - and laboratorium testing.
Phase II is scheduled for 6 months and is - budgeted at USD 24.850
(Rp 15.531.250,-)

Phase Three-Demonstration

This phase will consist of the installation and operation of the prototype units as developed in phase II. All aspects of the systems will - be observed including social acceptance.
Any modifications required will be performed.
The demonstration will consume 6 months and is budgeted at USD 10.500
(Rp 6.562.500,-).

/Phase Four .....

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4.3 Cost Estimate

SUB PROGRAM : D.C ELECTRICITY FOR REMOTE AREA

Phase One : Feasibility / Definition

I.	Survey & Data Collection	US $	4,000.00
II.	Books, Reports and Documentations	US $	1,000.00
III.	Salary	US $	500.00
IV.	Technical Advisors (20 M Days)	US $	3,000.00
		US $	8,500.00

Phase Two : Hardware Development

I.	Materials and Equipment	US $	17,500.00
II.	Technical Advisors (40 M Days)	US $	6,000.00
III.	Salary	US $	500.00
IV.	Contingencies	US $	450.00
		US $	24,450.00

Phase Three : Demonstration

I.	Local Transport & Allowance	US $	6,000.00
II.	Technical Advisors (10 M Days)	US $	1,500.00
III.	Salary	US $	500.00
IV.	Installation/Start up + Space/Facilities ..	US $	2,500.00
		US $	10,500.00

Phase Four : Training and Dissemination

I.	Local Transport & allowance	US $	3,000.00
II.	Evaluation & Consultation	US $	1,000.00
III.	Technical Advisors (5 M Days)	US $	750.00
IV.	Contingencies	US $	1,000.00
		US $	5,750.00
	T O T A L	US $	49,600.00

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Phase Four-Training and Dissemination

Phase four will be combined with phase three i that village training will be conducted during the demonstration.

In addition simple operating and maintenance m nuals will be prepaired.

Recommendations for additional programs and dissemination will be submitted.

Phase four is scheduled for four months and budgeted at USD 5,750 (Rp 3.593.750,-).

5. SUB PROGRAM (5) UTILIZATION OF RICE STRAW FOR VILLA ENERGY

5.1. Introduction :

Since rice is the predominant crop in Indo sia, and the people are distributed roughly proportionally to the production, it is natura to look toward it as a potential energy sour The quantity of straw believed available is enormous. To roughly calculate this amount; is estimated that the available dry straw rep sents three to five times the polished rice duction and that an average hectare produces

/2,5 tonnes

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2,5 tons of rice each year.

Thus the weight of straw produced on each hectare is around 7,5 tons , which has the energy equivalent of $1,125 \times 10^8$ BTU'S.

A typical individual living in most areas of the developing world uses about 5×10^6 BTU / year of energy derived from wood to supply his cooking needs.

On Jawa, a typical individual consumes about 100 kg of polished rice each year. This each hectare supports about 25 people. If all the straw were available, it is estimated that 22.5 people could use it to do their cooking, or about 90 percent of those supported. Clearly not all of the straw is available as some is plowed under for furtilized, some is used as food for water buffalo or as mulch for maize of tobacco. But very large quantities are either burned or left to rot in the fields.

Since clearly the potential energy recovery from the straw is extremely significant, a program to develop this source for domestic fuel can have a very positive effect on the development of rural Indonesia.

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5.2. Program Description :

The proposed program will involve four phases and will require 2.5 years for its completion. The attached schedule indicates the mile stones which are integrated with the other alternate energy programs under the main program task. The total estimated budget is USD 128,000 (Rp 80.000.000,-).
In the following paragraphs brief description of these four phases is presented.

Phase One-Inventory / Feasibility / Definition

A limited survey will be conducted to determine the amounts of rice straw available and its current use with in the village.
Attitudes and complications in gathering and processing the straw from the field to the village will be investigated. Ecological side effects will be considered.
Since the straw can not only be burned directly to supply heat for cooking but can be converted using simple retorting techniques, to a gas and a char that could be used both for lighting and or cooking, there is a wide range of hardware that could be developed, such as single family

/or multiple..

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or multiple family units. Perhaps from a technical point of view a multiple units is best, but socially a single family unit is desireable Phase one will address all of the above possibl conflicts and establish the best avenue to proceed for phase two.

In addition an acceptable demonstration village will be selected.

This phase will be scheduled for 5 months and will be budgeted at USD 43,350 (Rp 27.093.750,-).

Phase Two-Hardware Development

The major emphasis of the work will be experimental and the effort will involve both laborator procedures in basic disciplines such as heat transfer, thermodynamics, combustion, chemistry etc and practical shopwork in component desig and fabrication as dictitated by phase one prototype units will be built and operated on closly monitered basis.

Based on a compromise of efficient operation, ea of fabrication, social acceptability, maintainality and cost of fabrication demonstration units will be built.

/This phase.....

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This phase will extend over months and will be budgeted at USD 49.850 (Rp 31.156.250)

Phase Three-Demonstration

In this phase the components developed in phase two will be installed and operated in the environment of the demonstration village as outlined in phase one. Thus the effort will involve substantial field work with considerable emphasis on surveys of user opinion concerning experience with the hardware developed. Any retrofits required will be accomplished.
The third pahse is scheduled for months and budgeted for USD 23.800 (Rp 14.875.000,-)

Phase Four-Training and Dissemination

An evaluation of the demonstration units technical production level will be established.
Training and guidance for village craftsmen or intrepreneurs will be accomplished.
A manufacturing guide will be written at the approprate level and for the Indonesian language pamphlets regarding the use and advantages will be published and distributed. The budget for this

/phase .....

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5.3 Cost Estimate.

SUB PROGRAM : UTILIZATION OF RICE STRAW FOR VILLAGE ENERGY

Phase One : Inventory / Feasibility / Definition

I.	Survey	US $	6,000.00
II.	Training (1 man year)	US $	24,000.00
III.	Books, Publishings, Documentations	US $	2,000.00
IV.	Technical Advisors & Travel	US $	11,350.00
		US $	43,350.00

Phase Two : Hardware Development

I.	Materials and Equipment	US $	20,000.00
II.	Technical Advisors & Travel	US $	17,350.00
III.	Feed Stock & Local Labour	US $	1,000.00
IV.	Local Transport & Allowance	US $	6,500.00
V.	Contingencies	US $	5,000.00
		US $	49,850.00

Phase Three : Demonstration

I.	Installation/start up & space/facility	US $	3,025.00
II.	Local Transport & allowance	US $	8,000.00
III.	Salary	US $	500.00
IV.	Technical Advisor & Travel	US $	7,275.00
V.	Contingencies	US $	5,000.00
		US $	23,800.00

Phase Four : Training and Disseminati

I.	Local Transport & Allowance	US $	4,000.00
II.	Evaluation & Consultation	US $	2,000.00
III.	Salary	US $	1,000.00
IV.	Contingencies	US $	4,000.00
		US $	11,000.00
	T O T A L	US $	128,000.00

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phase is USD 11.000
(Rp 68.750.000,-) and will be completed
in months.

IV. PROJECT EXECUTION PLANNING

The function of the agency for the development and application of technology (B.P.P.T) which is a governmental agency, is among other the evaluation, development and application of technologies in the field of non-conventional energy. It carries out its functi among other by elaborating such research programs and also by sponsoring and coordinating such activities in the different institutes/laboratories in Indonesia.
In this case all activities in this program will be coordinated by B.P.P.T and executed together with othe institutes/laboratories which are also doing research i the related field.
Subprogram-utilization of water hyacinth, will be done together with ecological institute of Pajajaran Universi which already started a program in this field in Cilangk west-Jawa.
Subprogram-ethanol production from sago palm, will be do together with Bogor Institute of agriculture (IPB).

/B.P.P.T .....

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B.P.P.T. and IPB already have a common research progran to utilize the sago palm for food production.
Subprogram-methanol production from biomass, will be elaborated together with chemical engineering department of Bandung institute of technology (I.T.B) in the fiel of biomass gasificationprocess/technique, and Lemigas (state owned petroleum institute) in the field of liquefaction process/technique.
ITB has already started a research program on gasificati of agricultural wastes for unskilled people.
Lemigas already has both experties and facilities in th field of catalytically liquefaction process.
Subprogram-DC electricity for remote area and
Subprogram-Utilization of rice straw for village energy, will be executed by BPPT it self at PUSPIPTEK area/Serpo For this purpose such a workshop and a test facility w be built there. Those facilities may also be used for d loping the prototype units that is planned to be const ed in this program.

B.P.P.T will nominate a project leader who will do the program management and will act as a liaison officer, anc also will nominate coordinator for each subprogram who w coordinate the related research activities.

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