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Feasibility Study Report

Mauritius Alternative Energy

Project No. 698-0135

Program Office: AID, Bureau for Africa

Office of Development Resources

Special Problems Division

Director: John Blumgart

Project Officer: Robert Mac Alister

Administered by: AID/Washington

Contract No: AID/Afr-C-1572

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by

Dr. M.T. Raiford

Contract Consultant

submitted

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Summary

A fact-finding mission concerning the alternative energy development potential for Mauritius and possible US A.I.D. funding was carried out during August 1979. In connection with this the status of the Wright proposal made earlier by ITDG-U.K. was ascertained.

The potential for alternative energy development in Mauritius appears to be quite good in all respects - in terms of the climatic, economic, social, and political environment found there. Being a 100% importer and highly-dependent on oil for its major energy systems makes Mauritius ripe for alternative energy development. The government, university, industrial/commercial, and private sectors are eager to implement solar, wind, and related energy forms. However, the Wright proposal, which would attempt to accomplish this, appears to have died due to organizational and financial reasons. Thus an alternative proposal has been developed by the author and is outlined herein.

Recommendations are given for US A.I.D. funding to Mauritius as soon as possible, at the level of approximately $300,000 over a 3-year period.

I. INTRODUCTION

During my three-week visit to Mauritius in August, 1979, I had the opportunity of meeting with officials and representatives from the government, the university, and the commercial/industrial sector, and others who have an interest in solar energy development, during a full and well-rounded program. My visit was under the auspices of the Minister of Power, Fuels, and Energy - Dr. K. Busawon - who assigned Dr. S. Hurry, Head of the Electrical Engineering Division of the University of Mauritius, to work out the details of my program and serve as my escort, along with a car and driver. As such, I was able to cover practically the entire island and thus observe first hand the land, the climate, and the people, in addition to those on my official program (copy attached)

One develops an intuitive feeling rather quickly, both from personal observation and talking to people, that there is an abundance of solar energy in all its forms and that there is great interest and optimism in the feasibility of its use there. This is borne out at least preliminarily by a look at (1) solar and wind data taken by the Meteorological Service (copy attached of percentage sunshine figures, which are similar to North Carolina's, e.g.), (2) direct measurements taken by myself with solar meter while there (showing solar intensities approaching as high as 300 Btu/ft^2/hr during this winter month of August), (3) the successful installation and operation of several solar hot water heaters on homes and hotels, and (4) the rapid growth of sugar cane all over the island.

Concerning this latter point, it might be noted that Mauritius

already is utilizing solar energy on a vast scale as biomass conversion to sugar, with sugar cane covering most of its land, and dominating its life in all respects, especially economically. Currently, as has been the case for over a century, it may be said that: as goes sugar, so goes Mauritius. The question, then, is: how does this relate to Mauritius energy cost and supply situation, should some of this biomass be converted to energy forms other than sugar (such as alcohol for motor fuels), and can additional unutilized amounts of solar energy be tapped in various forms and in significant quantities in such a way that it is not at the expense of the sugar crop?

(Note: I will generally use the term "solar energy" in the broad sense which is included not only direct solar radiation but also wind, biomass, ocean thermal and wave energy; also terms such as "significant" or "vast" scale refer to Mauritius' scale).

Mauritius currently imports 100% of its petroleum, which is its main energy source (80% of its electricity is diese-fuel generated). It has no indigenous oil or other fossil fuels, and no refineries. Despite this, the dramatic rise in OPEC prices since 1973 has not yet had the impact on Mauritius that other countries have experienced. The answer to this seemingly curious situation lies, as you might expect, in sugar: (1) the 21 sugar factories are energy self-sufficient, generating all their steam and electricity from their own sugar cane waste (bagasse), and (2) the world price for sugar exports also rose dramatically during this period. However, sugar prices fluctuate and are now down somewhat, while the oil crunch will inevitably worsen as time goes on, both in supply and price, so that officials knowledgeable about the situation and its trends are worried. The development of the indigenous renewable energy resources of Mauritius

seems the only answer, certainly in the long terms and probably immediately.

Fortunately, Mauritius has not only the renewable energy resources needed but also the technical resources and government interest necessary to develop and apply them. At the University of Mauritius there exists already a capable group of young scientists and engineers who are anxious to develop alternate energy technologies, and who are now, along with their laboratories, shops, and library, under - utilized. Their efforts, as well as those of government and the commercial/industrial sector, are now somewhat "extra-curricular" and fragmentized. There is thus strong and urgent need to tap and channel these energies and abilities, and to coordinate these efforts. This was not only observed by me but was also expressed to me many times by both University and government officials, as well as the private sector.

Thus, the creation of an alternate energy R&D institute at the University of Mauritius is needed right away. However, even more immediately needed is a national energy-policy board at the government level which would include the commercial/industrial and university/technical sectors, and which would survey national energy needs/sources/uses, develop national energy policy and goals, coordinate energy development efforts, and under which the institute would operate and serve.

On the other side of the institute would be needed an extension service much like or a part of the agricultural extension service, in order to disseminate the knowledge, plans, and technologies developed at the institute to the people who need them. It is important that such an institute not operate in an

isolated situation, but that it does largely adaptive, applied research and be closely tied to all sectors - government, industry, rural people, etc. - in order to fulfill needs.

In connection with the above should be mentioned a proposal put forward by David Wright of the Intermediate Technology Development Group in 1977 to establish a technology development and consultancy center at the University of Mauritius. While the basic approach and philosophy of that proposal is sound and similar to the above, its organizational setup and relatively high level of funding have kept it from being approved and implemented. The University Senate, the Ministry of Energy and the Ministry of Economic Planning and Development still have taken no action on it and show no intention of doing so. Thus, the Wright proposal itself seems to be a dead issue in Mauritius, while it is generally agreed that many of the needs it attempted to address are pressing, and that a modified, initially less-costly and less-ambitious approach would be desirable and acceptable.

Therefore, I have come up with an alternative proposal, based on discussions and suggestions from all parties concerned, which I believe will remove the roadblocks that have kept the Wright proposal from being enacted and still satisfy the expressed needs, thus being acceptable and implementable at least in its general form. This involves setting up first a National Energy Board (NEB), under which an Alternate Energy Research Institute (AERI) would operate. AERI would initially utilize currently under-utilized faculty and facilities at the University of Mauritius, with a small staff and budget, and be closely tied to the government and other sectors, and to national energy needs, through the NEB. The Minister of Energy would thus receive much-needed support in developing national energy policy and indigenous renewable energy resources.

Details of the above plan are included in the following section, in which are listed observations, needs, and recommendations given to Dr. Busawon, Minister of Energy, at his request, before my departure from Mauritius. Some of these can be enacted by the government on its own without delay, while others would need funding from A.I.D. or elsewhere in order to be implemented.

II. Observations, Needs, and Recommendations - Mauritius

A. Observations:

1. Sugar is the overwhelmingly dominant factor in Mauritius' well-being.

2. Sugar factories are self-sufficient in energy, but the industry as a whole relies heavily on motor transport, as does the rest of the economy.

3. The country has a well-developed electrical system, such that the majority of the energy used is in this convenient but inefficient form, and is over 80% generated from diesel fuel (20% hydro).

4. The combination of the above items means that the country is heavily dependent on petroleum as its input energy, all of which must be imported from OPEC.

5. There is growing recognition that Mauritius is blessed with local, renewable energy resources, such as those from the sun, wind, earth, and sea in addition to the hydro-power already being tapped.

6. Various efforts have begun to start tapping these local, renewable resources, but they are rather un-coordinated and fragmentized.

7. Details of energy source and energy usage

patterns are not generally available.

8. A national energy plan has not yet been developed.

9. Government incentives to encourage more efficient energy use and transitions to new forms of energy have not yet been developed.

10. The University and private sector are eager to help implement the transition but need help and ways to channel their efforts.

11. Mauritius is somewhat isolated from developments occuring elsewhere - i.e. information input is slow and fragmented.

12. Rodrigues and other dependencies are in more urgent circumstances than Mauritius.

13. The growing tourist industry is vulnerable to the availability of jet fuel, electricity for operation, and the sagging world-wide economy.

14. The current links of Mauritius with Africa do not seem as natural as would be links with India, Southeast Asia, and the Pacific Islands, at least culturally and environmentally (e.g. Fiji Islands).

15. The sugar industry, the Central Electricity Board (CEB), Central Water Authority (CWA) - indeed the entire country as currently set up - is highly vulnerable to strikes.

16. The sea-wave scheme of Bott has been extensively developed for about 20 years and could put Mauritius in the forefront as a model for this form of energy development.

17. Cyclones visit the island periodically, with winds clocked up to 175 mph.

18. Southeast trade winds strike the island rather consistently and strongly year 'round.

19. Despite the island's relatively small size (720 sq. mi.), there exists rather wide variation in topography and climate.

20. A good bit of solar energy data, as well as wind and related climatological data, exists. Campbell-Stokes sunshine recorders have been in use on the sugar estates for years, from which percentage of possible sunshine figures have been obtained. Pyranometers have recorded intensities directly at three sites for three years, with three more soon to be added.

21. Two firms are already offering solar water heating panels for sale and have made several large installations, especially on hotels, with attractive payback periods projected (5 years) despite heavy import duty (70%).

22. At least one firm would like to manufacture panels locally and has asked the University of Mauritius for a locally suited design using local materials.

23. It has recently been realized that there may be significant geothermal energy to be tapped from a dormant volcanic crater.

24. The last hydropower site is under development.

25. The country is highly electrical (400 million kwhr generated in 1978) with the domestic sector using almost twice as much electricity as the industrial or commercial sectors.

26. Electricity prices are high with a decreasing scale starting at 65 cents (rupees), and a large increase on the way due to recent 40% OPEC price hike. ($ 1 US = 5.867 Rps. current rate).

27. The people generally increase their standard of living by increasing their electricity use, with more appliances, etc.

28. In-line water heating elements are rapidly increasing in use, which will use large amounts of electricity at peak hours

B. Needs.

1. A transition away from dependence on imported oil towards indigenous renewable energy sources.

2. A thorough survey of the current energy source - energy usage patterns in the country, both in absolute and relative terms, and by sectors.

3. A thorough study of, and assessment of, the renewable energy resource base in its various forms, expressed in common energy units for comparison to conventional energies.

4. An immediate program to encourage energy conservation (i.e more efficient energy usage) in buildings, transport, etc.

5. Development of a national energy plan setting goals and methods of implementation.

6. Cut electricity usage or generate it with renewable energies rather than oil.

7. A means of coordinating the currently fragmented efforts and projects underway to develop indigenous renewable energy sources.

8. A means of better utilizing university scientists and engineers, and facilities, in the development of renewable energy sources for Mauritius.

9. A means of gathering information world-wide to provide

input to this effort, and a means of disseminating the plans, knowledge, and technologies generated therefrom to the commercial and private sector in Mauritius.

10. Financial support for the above-mentioned activities for development of renewable energy sources.

11. Financial incentives to the commercial, industrial, and domestic consumers to use less conventional energy and more renewable energy technologies.

12. Energy systems which are not vulnerable to cyclones, strikes, embargoes, import price hikes, etc.

13. Construction of a pilot-project sea-wave unit.

14. Immediate solar and wind power for dependencies.

15. Careful study of sugar and tourist industries.

C. Recommendations to Minister of Energy

1. Make it a stated government policy that development and use of indigenous renewable energy sources will be implemented as rapidly as possible, with energy conservation the most immediate step, in order to reduce dependency on import of foreign oil.

2. Make a thorough and comprehensive survey of current energy source-energy usage patterns, of all energy forms, not just electricity.

3. Develop a national energy plan which details how the nation will make the transition towards renewable energy sources, starting with the current energy situation, and setting goals in both time and energy units and the means for getting there.

4. The above goals should be done in 3 stages - short (5 year), mid (10 yr), long (20 yr) range goals - with percentage of total energy supply that new renewable sources are projected to represent stated.

The short-term national energy plan should be completed right away so as to be included in the upcoming 5-year plan of the government (1980-85).

5. Set up a national energy board to carry out the above tasks and to plan and coordinate development of new energy sources for Mauritius.

6. Set up a research institute at the University through which its scientists and engineers can perform the necessary resource studies and adaptive research to provide the technical support needed by the above-mentioned board to develop appropriate energy technologies for Mauritius.

7. Set up an energy extension service, perhaps through existing agricultural extension service, to disseminate results and technologies developed at the institute to the commerce and industry sector, rural sector and domestic sector.

8. To promote use of currently available technologies, implement at least a 25% tax credit (up to some limit) for all energy conservation and renewable energy equipment installed by homeowners or commerce and industry. This should include both active and passive means for saving energy or using solar, wind, biomass, geothermal, etc.

Remove duty on such equipment that is imported.

9. Set up a solar loan bank which would provide low-interest loans to customers desiring to purchase a renewable-energy system, with long periods of payments available to them.

10. The government should lead the way by implementing a program of energy conservation and solar energy use on its own buildings and installations in all cases where life-cycle costs show that money will be saved over the lifetime of the equipment.

11. The government should finance the installations of several types of solar and wind systems on homes, office and institutional buildings (e.g. hospitals), in farms and industry, to serve as demonstration projects for others to see.

12. A solar energy data handbook should be developed immediately which would provide the necessary solar data, as well as wind and related climatological data, needed by designers and installers, as well as researchers, of solar energy systems. Computer generated insolation values on surfaces of any orientation should be produced from data provided by the Mauritius Meteorological Service.

13. The CEB should:

a. begin a transition away from diesel-generated electricity to renewable energy sources.

b. explore seriously the installation of wind turbines of large size (100 Kw - 2 Mw) connected to the grid in the near term.

c. explore and experiment with photovoltaic calls for use in the mid and long-term, especially for isolated spots.

d. institute a uniform price, to replace the decreasing price schedule as presently used, since present system encourages larger use of electricity.

e. continue off-peak pricing, i.e. lower prices during off-peak hours, to level-off demand and cut peak generating capacity required, and advertise its potential for savings to customers.

14. Encourage the production of alcohol for motor fuels from sugar cane.

15. Proceed with construction of the sea-wave 20 MW plant, or at least the first 2 MW unit, as soon as funding can be obtained. The time to stop studying and start building seems to be at hand.

Suggested Set-up of the National Energy Board: (Item 5)

Chairman: Minister of Power, Fuels, and Energy (or person to be nominated by him, and to serve as his advisor).

Members: Head of
- Central Electricity Board
- Central Water Authority
- Planning Unit (EPD)
- Natural Resources and Environment Unit (Agriculture)
- Joint Economic Committee
- School of Industrial Technology
- Council of Institution of Engineers
- Sugar Institute or Industry
- Rodrigues Administration

- Alternate Engery Research Institute (to be formed).

(shorten name of Ministry to simply Ministry of Energy)

Function: to develop national energy policies and specific programs for the Minister of Energy.

This will be based on a complete survey of the current national energy situation and an assessment of the indigenous renewable energy resource base by the research institute.

Suggested Set-up of the Alternate Energy Research Institute (Item 6)

This would come under the National Energy Board which is under the Ministry of Energy, and be located at, and operated by, the University of Mauritius, initially using existing faculty and facilities, and would provide the technical support needed by the NEB and Ministry of Energy, as well as develop appropriate energy technologies for Mauritius based on renewable energy sources. It would contain a library and info. center, and provide consulting services.

Functions:- Develop a data base on Mauritius' energy sources (i.e., indigenous renewable energy sources).

- Perform an assessment of these energy resources from the data base.
- Develop design handbooks and manuals for utilizing these renewable energy sources.
- Do research and development (largely adaptive) on renewable energy technologies and appropriate technologies in general for Mauritius.

- Collect a good library resource on these subjects, including subscriptions to journals and newsletters.
- provide information to those requesting it.
- provide design services on an individual fee basis to those requesting it.

Staffing:

Director (at least half-time, initially a University person)

Advisor: (From outside)

Secretary: (half-time initially)

Technical Staff: From School of Industrial Technology and Divisions of - Physics and Electronics - Mechanical Engr.
- Electrical Engr.
- Civil Engr.
- Sugar Technology

From School of Agriculture

Related Staff:

An Economist)
) From School of Administration
Sociologist)

Librarian and Information Officer - (half-time initially)

Shop technicians (part-time as needed)

All the above will be current University personnel as far as possible, with the secretary and librarian possibly added, plus an outside advisor. . . These personnel will have an appropriate part of their pay shifted from current channels to a channel through the Institute, corresponding to their division of work-load between the two.

III. Comments Concerning Renewable Energy Development for Mauritius

There seems to be no problem with cultural acceptance of alternative energy devices in Mauritius; indeed a rather positive attitude towards them seems to exist. However, such devices as solar cook which require radical alteration of daily routine will probably not be accepted here any more than they have been elsewhere. Solar hot water heaters work well and seem to be accepted; this is the first solar technology that should be, and is being, used, and it has a good potential for national savings. Most hot water is produced electrically and is thus expensive. The head of the Joint Economic Committee estimates that there is currently a potential annual market in Mauritius for 2,500 domestic water heaters alone, which over five years time would save on the order of 30 million kw-hr. This represents 10% of current electricity usage. Further, hotels and hospitals with their large hot water demands offer potential for significant savings. For example, an impressive solar hot water system at Touessrok Hotel, employing 64 imported (South Africa) panels, is expected to pay off within five years; and the SSR National Hospital currently heats well over 100,000 gal/mo. to 140°F from fuel oil, which could well be done with solar. Local manufacture of panels, which Rogers Group would like to do, would lower costs further and make payoffs even better and within reach of homeowners in general.

Generally, the people raise their standard of living by tapping onto the widespread electrical grid, or by adding appliances such as hot water heaters, cookers, irons, TV sets, etc. to their existing electrical use. Thus, aside from hot water heaters, probably the

best way to help the people, expecially rural poor, is to generate electricity more cheaply from renewable resources if possible, so that it becomes accessible to them in price. For those not near the grid, small wind or photo voltaic generators would be desirable (e.g. around Chemarel) to make electrical supply available at all. To supply significant quantities to the grid, the possibilities include large solar concentrator systems for steam electric generation, large photovoltaic arrays, and large-scale wind turbines. It seems that with the availability of the Southeast trade winds and the scarcity of land, the use of large wind turbines would be the most appropriate. Current hydro-plants are of the megawatt size, and newer plants, including a propose coal-fired plant or the sea-wave plant, are of the 20 MW size. (Total capacity in Mauritius is 100 MW). Thus, wind generators could supply the same magnitudes of electricity now that they have reached the 2 Mw size (such as in the U.S. at Boone, NC). For example, a row of ten 2 Mw wind turbines along the Southeast coast would give the 20 MW capacity now bieng contemplated for the next plant. The one important requirement is that they must be designed to withstand 175 mph gusts at a minimum, and preferably 200 mph gusts.

Wind power for Rodrigues Island and other dependencies is urgently needed for water pumping and electricity generation (to replace diesels). This could be implemented immediately. The French and Australians have expressed interest in aid here but so far have not done anything. UNDP has funded a small project recently which will involve data-taking and installation of a 5 kw windmill. Water pumping windmills are probably more urgently needed. Simple sail windmills such as those on the island of Crete in the Mediterranean, where 10,000 of them constantly pump water, should be explored for use here. It might

be good for the Commissioner for Rodrigues to go there to see them. Solar driers and refrigerators for fish and crops should also be introduced. I showed a description of a solar rice drier to the experimenters at Chinese rice project in Mauritius, which could prove useful. Biogas digesters could also be used to produce methane. Alcohol from sugar cane juice or molasses has already been extensively studied and should be pursued (see attachment).

Most of these technologies have been well researched and developed elsewhere and are ready to be used. Thus, the equipment could be imported in the near term, while local adaptive research and local manufacturing capability is being developed. The adaptive research using basic designs but adapted to Mauritius climate and other conditions, would be carried out by AERI where needed, plus any new or basic R&D where needed. Outside consultants in solar and wind energy should be brought in as needed, for site selection, equipment recommendation, etc. There should also be a faculty exchange between the University of Mauritius and an American university .

Two other organizations which are being considered by Mauritius are a National Research Council and a National Appropriate Technology Center. Thus, the Alternate Energy Research Institute, and the National Energy Board, may have to be set up with these in mind. I would suggest that AERI include appropriate technologies in general in its Mission and not limit itself to strict energy categories. (E.g. development of a heavy-duty personal-sized motorized cane cutter similar to our weed cutters might be a very useful technology intermediate to knives and huge mechanized cutters - the latter hampered by the uneven terrain and rocks). Further,

this should be a part of a National Research Council as well as the NEB specifically.

Mauritius seems to be a country that is well enough organized, manageable-enough in size, and keen-enough in interest to achieve real accomplishments in implementing renewable energy usage in a fairly short time and in relatively significant amounts. It could thus not only benefit the country itself but also serve as a good example or model for other countries in Africa and elsewhere, which I think is badly needed to put a lot of the alternative energy talk into practice. In fact, the AERI of Mauritius might eventually become a regional center, thus avoiding duplication in each country which would be costly in both time and money.

IV. Recommendations to US A.I.D.

I recommended that US A.I.D. provide funding to the Government of Mauritius as soon as possible, for a 3-year period initially, to get their alternative energy development moving. These funds would be channeled through the Ministry of Energy to support the specific recommendations in section II that require funding, such as the development of a solar data base and handbook, the installation of test and demonstration equipment for the various existing technologies, the creation and operation of a Mauritius Alternative Energy Research Institute, and provision of consultants and faculty exchange. These activities should all begin as soon as possible.

The National Energy Board, on the other hand, can be set up immediately by the Government of Mauritius and begin its planning and policy-making functions, without need of any funds - except those

which would be channeled through AERI for services required from it.

AERI would be operated by the University of Mauritius under contract to the Ministry of Energy with A.I.D. funds. As proposed, AERI initially would operate largely using existing University faculty and facilities to the extent available, with modest addition of staff and funds. Then, after the initial 3-year period, the whole set-up should reviewed. If it has grown as hoped, a more full-time staff and larger, permanent quarters and facilities could be considered at that time for the next phase. AERI may begin attracting some of its own research funds, and the Government of Mauritius may be able to allocate funding to it, by that time. However, A.I.D. should be prepared to continue funding of the Institute if needed, so that it is not just dropped at the end of the initial period or possibly become a difficult burden on the Government's limited resources if dropped in its lap.

I would recommend that the Director of AERI be a Mauritian, chosen perhaps from the University itself, by the Minister of Energy, the NEB, and the Vice-Chancellor of the University. It would probably be a good idea for me to serve as his advisor, feeding him necessary information and advice by mail from my home-base during the year, and making a short visit each year to Mauritius. There should also be a faculty exchange set up between the University of Mauritius and a suitable American university, preferably North Carolina A&T State University where I am located, with a Mauritian coming over the first summer for, say, a 2-month's stay, and then an American going there for a similar stay the following year, etc.

Meanwhile, this first year the solar data base and handbook could

be compiled and generated by the computer program already operational at NC A&T State (it has already been used to generate such a handbook for the State of North Carolina). I would recommend that this be done immediately by myself and my computer colleague, so that the solar workers in Mauritius have the basic data necessary for their solar and related research and design work. (Note: the use of myself and my University as suggested above is based on availability, capability, and interest, and I believe appropriateness, realizing that the actual choice is entirely at A.I.D.'s discretion, however).

Concerning the large-scale schemes for sea-wave, geothermal, and wind energy, I would not recommend US A.I.D. funding at this time, despite their merit, since they are costly and Mauritius is currently under negotiation with the U.K., Russia, and France for finance of these projects, respectively. AERI should support this work.

Production of alcohol from sugar juice or Molasses should be financed locally by the sugar industry and possibly the government. A lot of background study has already gone into it.

Attached (as the last attachment) is outlined a general budget for A.I.D. funding for the 3-year period. Total funding recommended for AERI, demonstration units, and all, comes to $328,500, or a little over $100,000 per year.

General Budget Outline

Per Year

I. AERI:

A. Staff:

Director ($\frac{1}{2}$ time)

Consultant (external, part time)

Secretary (half time)

Total

B. Facilities:

Overhead:	Office	$ 5,000
	Laboratory	$ 5,000
	Workshop	$ 5,000
Equipment:	Office	$ 2,000
	Laboratory	$ 4,000
	Workshop	$ 1,000
Supplies:	Office	$ 500
	laboratory	$ 1,000
	Workshop	$ 2,000

Library & Information Center

Book purchases	$ 1,000
Subpscriptions	$ 1,000
Operations Services	$ 1,000
Overhead	$ 1,000
	$29,500

C.	Consultants	$10,000
	Faculty Exchange	5,000
	Travel (internal)	2,000
	(external)	4,000
	Extension service	2,000
	Miscellaneous	2,000
	Total	25,000

AERI total: $71,500 for 3 years = $214,500

II. Data Handbook: $ 5,000

III. Equipment (Demonstration, test):

Water-pumping windmills	20,000
4 KW wind turbines (2)	15,000
Solar call generators (2)	10,000
DHW Systems, Rural Hospitals	40,000
Solar crop driers (2)	2,000
Biogas digesters (2)	2,000
Test and Monitoring Equipment	15,000
Equipment Total:	$114,000

IV. Total 3-year budget: $328,500

Programme for Dr. Maurice Raiford, USAID

Consultant on Solar Energy (August 2 - August 24, 1979)

Thursday, August 2

5.30 p.m. Arrival at Paisance - Flight KA 443

Friday, August 3

10.00 a.m. American Embassy

Monday, August 6

10.00 am. Ministry of Power, Fuel & Energy

2.30 pm. Economic Planning Unit

Tuesday, August 7

10.00 am. Central Electricity Board

2.00 pm. Meteorological Department

Wednesday, August 8

2.30 pm. SSR National Hospital

Thursday, August 9

10.00 am. Joint Economic Committee

11.00 am. School of Industrial Technology
University of Mauritius

1.30 pm. Visit to Riambel (Sea-wave project)

Friday, August 10

10.00 am. University of Mauritius

11.00 am Central Water Authority, Port Louis

2.00 pm. Ministry of Employment

Monday, August 13

10.00 am. Rogers Commercial Centre (Visit to workshop
assemblying Solar Water Heaters)

1.30 pm. Visit of Solar Installations at Trou-aux-Biches
and Pamplemousses

Tuesday, August 14

11.00 am. Meeting with the Council of the Institution of Engineers (Mauritius)

3.30 am. Talk on "Solar Energy: The State of the Art" at Boname Hall, Reduit

Wednesday, August 15

10.20 am. Departure for Rodrigues (unable to get on flight)

Saturday, August 18

3.15 pm. Arrival from Rodrigues

Monday, August 20

10.00 am. Visit to the Bulk Sugar Terminal

1.30 pm. visit to the Albion Rice Project

Tuesday, August 21

9.30 am. Visit to FUEL and Riviere Champagne Hydro-Electric Scheme

12.30 pm. Mecalec Solar Water Heaters, Touesserok

Wednesday, August 22

10.00 am. Ministry of Power, Fuel & Energy

Thursday, August 23

Free

Friday, August 24

6.00 pm. Departure for Nairobi.

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PRICE EQUIVALENCE LINE FOR ALCOHOL AND GASOLINE

FIGURE 4

April 1979
Mr. Patakau
J.E.C.

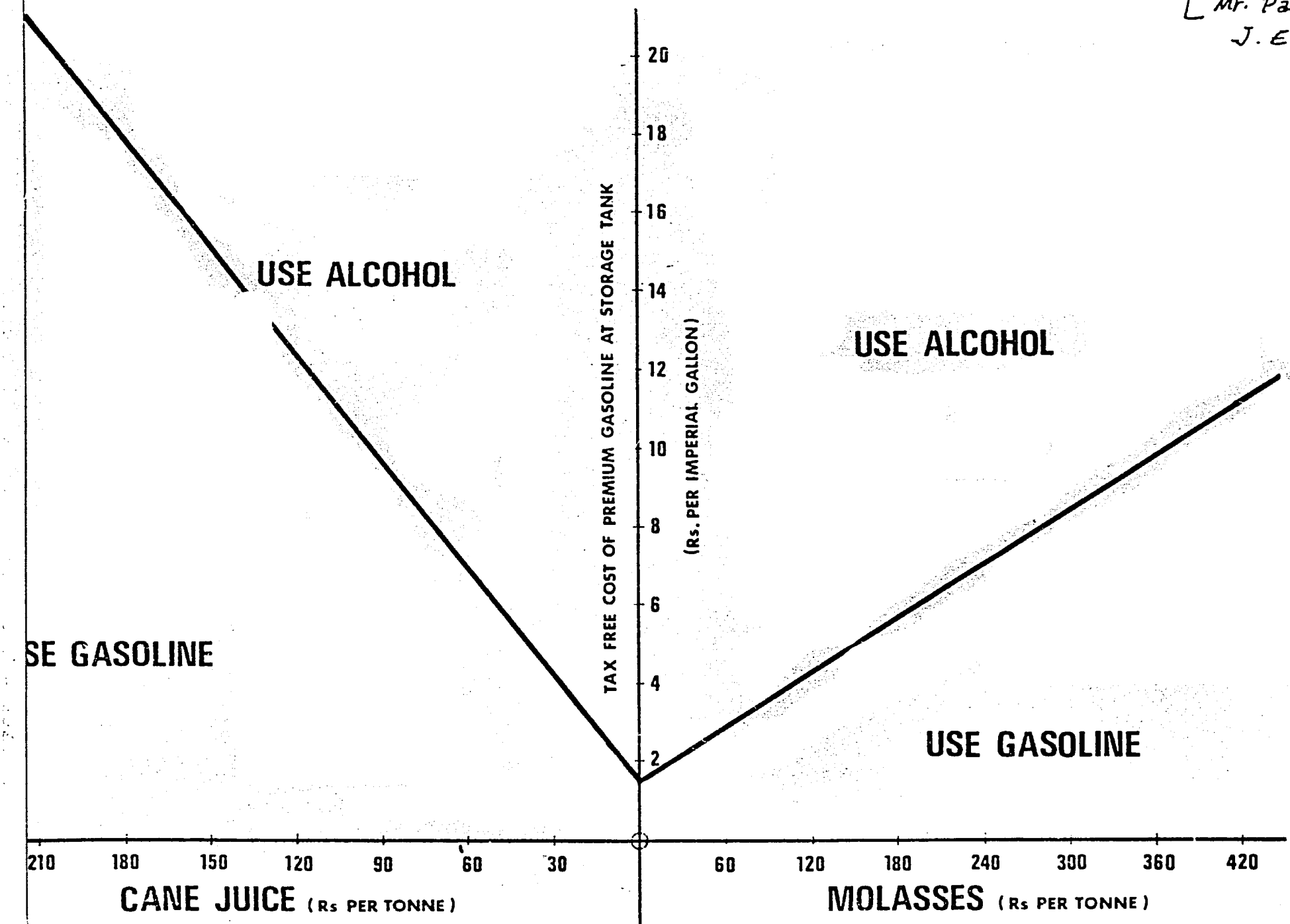

TABLE VI.2

MEAN SUNSHINE (1961-70) EXPRESSED IN HOURS PER DAY & AS FRACTIONS OF THE MAXIMUM POSSIBLE

Month	PAMPLEMOUSSES		REDUIT		TAMARIN		VACOAS		UNION PARK		BELLE RIVE		UNION FLACQ		PLAISANCE	
	hrs/day	S	hrs/day	S	hrs/day	S	hrs/day	S	hrs/day	S	hrs/day	S	hrs/day	S	hrs/day	S
Jan.	8.5	65	8.5	65	7.5	58	7.7	59	6.2	48	7.0	53	7.4	57	8.1	62
Feb.	8.5	66	8.1	63	7.7	60	7.5	58	6.4	50	6.9	54	7.6	60	8.2	64
Mar.	7.1	59	7.2	59	6.8	56	6.9	57	5.1	42	6.0	49	6.3	52	6.5	54
Apr.	7.7	67	6.9	60	6.6	57	7.0	60	5.1	44	6.3	54	6.4	55	6.0	52
May	7.7	69	7.3	66	7.1	64	7.5	67	5.2	47	6.7	60	6.3	57	6.1	55
June	7.3	67	7.1	65	6.6	60	6.9	63	4.7	44	6.3	58	6.1	56	6.0	55
July	7.5	68	7.3	66	7.1	65	7.1	64	4.4	40	6.2	57	5.8	53	5.7	52
Aug.	7.8	69	7.3	65	7.1	62	7.1	63	4.3	38	6.1	54	5.7	51	5.9	52
Sept.	7.3	61	7.1	60	6.7	57	7.1	60	4.9	41	6.3	53	6.3	53	6.5	55
Oct.	8.1	65	7.8	62	7.5	60	7.5	61	5.4	44	6.8	54	6.8	55	7.3	58
Nov.	8.5	66	7.9	61	7.0	54	7.2	56	6.0	46	6.8	52	7.0	54	7.7	60
Dec.	7.9	59	7.3	55	6.8	51	6.8	52	5.2	39	6.6	50	6.9	52	7.6	58
YEAR	7.8	65	7.5	62	7.0	58	7.2	60	5.2	43	6.5	54	6.6	54	6.8	56