# CEER-A-055

PROPOSED FIVE YEAR PLAN

ENERGY AND ENVIRONMENT PROGRAMS

FY 1982-86

DRAFT NO, 2

DECEMBER 1979

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH,

UNIVERSITY OF PUERTO RICO ~ US. DEPARTMENT OF ENERGY

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PROPOSED FIVE YEAR PLAN (FY~1982-86)

[ENERGY ON ENVIRONMENT PROGRAMS

?CEER

TABLE OF CONTENTS


PREFACE ~

PURPOSE OF DOCUMENT

UNIQUENESS AND CAPABILITY OF P.R. AND CEER FOR R & D

{IN ENERGY AND ENVIRONMENT.

CEER Organization ?-

Accomplishments, Past

Accomplishments, Present

PROPOSED FIVE YEAR PLAN (1982-86) SUMMARY ~-

PROPOSED FIVE YEAR PLAN (1982-86) PROGRAMS

1, ore

11) Blows

TIT, BIOCONVERSTON

TV, FOSSIL FUEL RESEARCH

1. SOLAR PROGRAM

VI. BcOLOGY PROGRAM

VEL! ENVIRONMENTAL HEALTH

VILE, MATERTAL DEVELOPMENT

IX, INTEGRATED TECHNOLOGICAL ASSESSMENT

X. NUCLEAR PROGRAM

XI. TRANSPORTATION AND CONSERVATION

XTT, PUBLIC AWARENESS.

XIII, INTERNATIONAL PROGRAMS

APPENDIXES.

APPENDIX A ~ ERDA Action Menorandua dated

April 11, 1976

APPENDIX B - CEER Programe

---Page Break---

PREFACE

As the result of a negotiating process begun in 1975 between the Energy Research and Development Administration and the University of Puerto Rico, the Adninistrator of ERDA (now DOE) ?and the President of

the University approved an Action Memorandum dated April 11, 1976, pro~ viding for the creation of a Center for Energy and Environment Research (CBER) to supersede the Puerto Rico Nuclear Center (PRNC) which had

been operated under contract with the Atomic Energy Comission since 1957. ?The Council on Higher Education of Puerto Rico authorized the establish? ent of CEER effective July 1, 1976. Appendix A contains a copy af the ?Action Memorandua of April 11, 1976 mentioned above.

?To help CEER achieve che transition from a nuclear Center to one focusing on ERDA's (DOE) national energy goals and Puerto Rico's ova energy needs, BRDA (DOE) established an Oversight Committee. The Committee hold its first meeting with representatives of CEER and the

University System in November, 1976, to review the transitional measuré

?taken up to that time and to refine plans for the future, There was full

agreenent that CBER's success would require continuous and close commi-ication and collaboration between the Center, ORO, ERDA (DOE) technical

program directors and the Oversight Committee, as well a continuous

interaction between the Center and the University System as a whole.

A five year plan (FY-1977-82) dated February 1977 was prepared for the second meeting of the Oversight Committee in March 1977, This plan has served as @ general guide with some modifications, for CRER's present prograas.

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?The Action Memorandum dated April 11, 1976 (Appendix A) considered the possibility of three options for changing the old Puerto Rico Nuclear Center (PRNC)~G0C0 operations to new CEER adainistrative set-ups ad

follows:

1, Continue the PRNO-COCO arrangements with UPR-making certain ?management and funding modifications.

2. Develop mixed ERDA (DOB) GOCO and non-GOCD arrangement with the UPR.

3. Discontinue the ERDA (DOB) GOCO operations, transferring the

facilities to the UPR, or others, or close them if appropriate and executing ERDA (DOE) prograns under other contractual bases

Dption number 3 above was the recomended one, This option involved

the gradual reduction of funding (until complete elimination) for support of facilities. The present inability of the UPR to financially support CHER requires a revision of funding, and previous set plans by DOF in its relations with CEER, unless the forced closure of CEER is the selected alternative. There are now several valid reasons for continuing DOE support that were mostly unknown or undefined by 1976. They have grown out of the on-going work at CEER, and are coupled to the changing ?energy situation. These reasons are Listed below.

[REASONS WHY DOE SHOULD CONTINUE CHER SUPPORT:

1, International Frograne

CEER represents a useful instrument to DOE International Relations in the Caribbean and Latin Anerica. Because of Puerto Rico's Spanish and English cultural background uniqueness and the bilingual Spanish and

English speaking population, geographical location in the Caribbean,

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as

and established scientific and technical interactions with Latin America fesents on ideal institution for DOE inter~

and the Caribbean, CEER re

national interface in energy assessment of LDC countties and technology transfer in the indicated areas, CEER is presently involved in energy related future prograns with Venezuela, Panama, and Ecuador. Doainicen Republic officials have alxeady contacted the CEER Director for possible future interactions.

During the past fow years CHER Scientists have taken an active participation in energy related mestings and symposia held in Venezuela, Coloabia, Chile, Dominican Republic, Jamaica, and Barbados. These rectings were sponsored by US-AID and other USA oF international orga~ nizations.

2, Sooner Demonstration of Economic Competitiveness

Puerto Rico Represents one of the very few areas under the US flag where econonic competitiveness of various energy alternatives could be proven sooner, which will accelerate the comercialization of these energy alternatives. Anong such energy alternatives are: a) OTB, ») Biomass, ¢) Direct Solar Conversion technologies.

Puerto Rico has one of thé best sites, if not the best, for the

ocation of an OTEC plant which can result in minimum project investment

costs. Only the aites of Punta Tuna in southern Puexto Rico and the

?site of Keyhole West of Havaii main {oland offers 1000 meters ocean water

depths close to land (6000 fe. for Kawaii and 9000 fe. for Puerto Rico),

where temperature differentials of (20-24°F) between surface and deep

waters are found. Such temperature differentials axe required for an

ove facility. The closeness of such ocean site areas to land mininiz

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costly electrical cable connections and deployment costs for first

generation faciliti

The Puerto Rico Electric Pover Authority (PREPA) has extensive experience in installing, conserving and operating transmission submarine cables. P, R. has been interconnected with two offshore islands, Vieques and Culebras, with over 20 miles of undersea (46kv, 14 MVA three phase)

transmission cables. The operating experience of PREPA for these cables

extends over 15 years. The Puerto Rico site has the added advantage over the Hawaii site in the sense that the electrical pover system of

Puerto Rico can absorb the pover of a 100-500 mW OTEC plant. The total

generating capacity of the Puerto Rico system exceeds 4000 MW and ite

2000 MW. The electric power system of Hawaii

peak generation exc

hhas a peak demand of approximately 90 Mi. A large OTEC plant ( 100 Mi) in which econonic feasibility can be achieved should be proven in a large power system with sufficient electrical stability.

In Biomass, the impressive production records of tropical grasses

?and napier grass, demonstrated under the CEER/DOE sponsored Biomass

prograns, have already indicated the possibility of biomass fuel costs of the order of $1.70 per million BTU delivered vs present $4.00 per million ?BTU off fuel costs. Biomass energy alternatives could probably be de- ?wonstrated through the CEER programs to be one of the firet comercially viable econoate energy alternatives sponsored by DOE,

In the area of direct conversion of solar energy such a photo~

voltaics and direct conversion of solar heat to steam for prime mover applications to electrically driven generators, the insolation rates are

of paranount importance in determining economic competitiveness. Recent

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data obtained at Ponce, P. R. (southcoast), at 18 degrees latitude, indi cate an average daily total isolation of approximately 1900 BTU/sq. f-day on a horizontal surface, The relatively snali change in day length (P.R. being close to the equator) from sumer to winter, enhances the utili-zation factor of solar energy throughout the entire year. The high

isolation rates of tropical Puerto Rico is a very important factor to

sooner denonstrate the economic competitiveness by DOE sooner than in seny other areas.

3. Component Testing in Tropical Environment

Puerto Rico's tropical weather offers an adequate and suitable environ nent to study the effects of tropical environment on solar technology components such as photovoltaics cells, ferroelectric converters, solar concentrators, ete, The discontinuance of CEER will impact adversely on ?such important energy-environment related programs.

4, Unique Tropical Ecological System

The only tropical forest omed by the U.S. Dept. of the Interior is in Puerto Rico - the Luguille Rain Forest. It offers the only true tropical ecological system under the US flag where the interaction between ecology ?and energy systems or components are presently being studied, CEER data acquisition laboratory and field station in addition to a 200 acre Use

Permit in El Verde Forest (which is part of the Luquillo Rain Forest)

forms an inportent part of the program. In addition Puerto Rico is wnique in that it contains six different ecological zones ranging fron desert to rain forest.

5. Affirnative Action Policy

Of approximately 43 research and development facilities including CEER,

owned and supported by DOE, CHER is the only facility located in an

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environment vhich constitutes a predominant minority group. The contin ?vous support and funding of CHER will enhance the good will and spirit

of DOE as a strong supporter of the Affiraative Action U.S. Government

Policy.

6, Baseline Data

Important energy and environment baseline information developed during

the last three years of CEER/DOE programs represent significant assets in

the time schedule and program definition of viable energy and environment

ielier comer

development and denonstration projects which might bring

cialization in the Caribbean as well as the southern part of the USA

reasons for

During the period of 1976 to present, the aforenentions

?continued DOE support, grew out of the world energy situation and research

occuring over the last few years, CEER's original objectives were somewhat modified

per the changing energy situation in relation to the

needs of both the Mainland USA and P.R. As such, in review and observa

trend

tion of the: it i felt that review and modification of the

original Action Memorandum should be carried out in accordance with the

benefits to DOE in continuing support of CER.

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PuaPOse OF DociMENT

and

?Tae main purpose of this documentation is to project progr:

budget requirements for the 3 year period (FY-1982-86) beyond the current

5 year (1977-81) contractual relationship with the Department of nersy

(008) in order to contribute in meeting the President's Nationl Plan

for Boergy Research and Development Needs and serve as the basis for a

proposed new contract with DOB.

?The principal CEER objective is to support the effort of achieving

national energy independence while contributing to Puerto Rico's ova

?effort to obtain the sane goal for itself. Puerto Rico's econoay at

present time depends entirely (99 percent) on energy derived from im

ported petroleum. Total petroleum fuel domestic consumption in Puerto

Rico io approximately 70 million barrels per year. Table 1, "Estinates

of P. R, nergy Requirenents to the year 2000", indicates rough prodic-

8 studies. Puerto Rico's total fuel

tons made by CEER energy analy:

bill for the rest of the century is predicted to exceed $155,000,000,000

if no energy alternatives are considered.

?To implement the timely development of alternative sources, CEER

efforts should be substantially increased from the level of funding

sustained during the current five year (1976-81) contractual plan with

DOE, The prograns presented herein address this

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TALE

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ESTIMATES OF PUERTO HICO'S ENERGY HEQUIREXENTS TO THE YEAR 2000

?UNDER PRESENT SOCIO-ECONOMIC STRUCTURES AND ABSENCE OF

STRONG R"AND D PROGHAY. ON ALTERNATE ENERGY ?SOURCES

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(0) Statistical Correlations between population and GNP and betveen GNP and

~ Electrical Energy Generation.

Correlation 99% :

42) Gasoline Consumption growth projected conservatively between 2.2/2 - 32

More accurate predictions to be included in

per year vs. 6.6% actual

(CeeR Energy Studs

(G) Industrial needs projected at SE per year grovth. More accurate predic

bbe included in CEER Energy Studies.

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1985-50:

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?UNIQUENESS AND CAPABILITY OF P.R. AND CEER FOR R & D

1 ENERGY AND ENVIROWOENT

GEER is the only significant research and developnent facility in

Puerto Rico and one of the fev within the U.S. that focus on both energy

and environment problens and the interrelated impact upon each other. It

1s on of the largest one in the Caribbean, Puerto Rico is also probably

the most technologically advanced region of the Caribbean. Many techni~
cally advanced projects were developed in P.R. prior to even consideration given
by other Latin American or Caribbean islands for such projects. The

result of this technological advancement has provided Puerto Rico with

local scientific and technical personnel capable of handling sophisti-
cated R & D projects in both energy and environment. A few of the
technically advanced projects are:

1, The BOWS (Boiling Nuclear Superheat) Nuclear Plant ~ Only one of
?two research boiling water reactors with integral nuclem steam
superheating built in the USA, This facility of 50,000 Heh,
16,300KWe was constructed on the west coast of Puerto Rico at
Rincéa, and operated by the local pover utility during the

riod 1960-68. Facility personnel were trained at PRNC (CEER),

Several BONUS related experfennts and measurements vere carried out at PRNC (CREE), Among one of the reasons for selecting Puerto Rico by the USAEC (now DOE) vas the technical capability of PREPA and the University (PRNC) to carry out the program.

2. Muclear Research Reactor

?A swimming pool 1 MW research reactor built in 1959 and later

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replaced (1970) by a Triga Type reactor (246i) which served as an R&D and training facility for nearly 18 years of PRIC (now EER) operations.

Controlled Flash Evaporator Desalinizatfon Pilot Plant, 10 GMP

at Palo Seco Power Plant.

This has been the only desalinization pilot plant ever built using a pover plant condenser waste heat for water deealting.

?The project was a success but water cost

Rad to compete with

other desalting schemes using §1.50/bb1 of1 at that tine (1965) .

Today the information developed in this project is an asset for

future consideration of vater desalting due to the high fuel cos:

The Arecibo Tonospheric Laboratory, owed and operated by Cornell

University, has theworldls most powerful radio tel

scope in the

field of astronomical investigations. This has added specialized

radio comunication technicians and scientists to the scientific

population of Puerto Rico.

?The 200 KW DOE-NASA/PREPA wind mill erected on the island of

Culebra, located to the east of Puerto Rico. Important operating

data is being accumulated at present. This represents another

energy alternative technological advancenent.

- Rua Pilot Plant

A special law of the Legislature of Puerto Rico established the Rum Pilot Plant in 1952. It {s owned and operated by the UPR Agricultural Experiment Station, It is located at Rio Piedras

a short distance from the min CEER-UPR facilities, Its operations

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are organized in a mmber of divisions dealing with analytical chemistry, fermentation chemistry and technology, run waste utili-

zation, and technical

A collection of superior yeast strains is also available. Labora~

tories are well equipped for investigation in all aspects of the manufacture of yigm and allied products. Information derived from

these etudi

is transmitted to the P.R. Rum Industry through publications and technical meetings. Special reports are issued periodically to the rum industry and various interested institutions.

In addition to above projects, Puerto Rico has a very sophisticated and advanced electric power aysten, It is the second Largest public utility within the USA, being second only to the city of Los Angeles Water and Power Systen, The Puerto Rico electric generating system is equipped vith fully automated remote controlled and supervised hydroelectric pover stations (approx. 80 MM in 8 automatic stations); soder high pressure (2400 psi), igh temperature 1000°F superheat, 1000°F reheat steam stations with digital computer supervision in all stations above 82.5 Mi capacity (4-82.5 MM units, 4-100 MW units, 2-225 Mi units and 4-650 i units).

Te Palo Seco Steam Station computer installation was @ pioneer in the

field being placed in operation in 1960. The generating transmission

system is economically dispatched vith an economic-d
puter which sends digital signals to generator governor for minisum fuel.
consumption systenvise, and in addition, it provides security programs

{tea operations.

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?The main transmission network is 230 KV. The distribueton system
is equipped with renote control and electrically supervised stations,
Systen planning ie performed with very sophisticated computer programs
for load flow, loss of load probability analysis, transient stability,
Joad modelling, etc. The technology involved in planning, constructing
snd operating the pover aysten requires a high caliber of engineering
expertise and provide a challenge to the educational institutions.

Taland industries are also highly sophisticated and advanced. There are many computer oriented and electronic industries, petrochemical refineries, an aircraft factory, a large electrical? industry, chemical

factories, pharaaceutical industris

+ ete.

In the education field, Ph.D degrees in Cheniatry, Physics, Marine Sefences and MS in al1 engineering prograns are offered by the University of Puerto Rico. There are three schools of medicine in addition to that

of the University of Puerto Rico, Tn addition to the University of Puerto

Rico, three large private Universities offer degrees in Sciences, Business

Administration and other professional fields.

All of these activities provide an adequate and suitable background for the development of R & D projects on energy and environment in Puerto Rico.

(CHER AND ITS ACCOMPLISHMENTS

CREB Organization

The Center for Energy and Environment Resear

+ Previoudly known as

the Puerto Rico Nuclear Center, operates as a single unit within the Uni-

versity of Puerto Rico system, reporting directly to the President of the

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University. UPR is an Seland wide university with over 60,000 students

concentrated in three large campuses, three four year university colleges, and five comunity colleges and includes an agricultural research network

and cooperative extension service. The organizational structure of CEER

is iilustrated fn Figure 1.

DOE facilities associated vith GEER have aa acquisition value of approximately $12 million and are located on four main sites: (1) Rio Piedras site, adjacent to the UPR School of Medicine, (2) Mayaguez site

(20 acres), adjacent to the UPR Campus in Mayaguez, (3) Cornelia Hil oite (20 acres) south of Mayaguer and adjacent to the ocean which houses the marine ecology program, (4) tugutlio National Forest #1 Verde Facility

in the Luguillo Rain Forest vhich houses data acquisition laboratory field se

station and has 2 200 acre Use Permit.

[A new eite has been added recently consisting of a 15 acre lot within the municipality of Toa Baja in the Ward of Palo Seco and not far froa

the north coast, This eite recently acquired by the UPR Syaten has been

assigned to CEFR for the development of a future Experimental Station for field testing and demonstration of alternative energy sources such a solar, vind, and bionass-biocoaversion.

Accomplishaents, Past

During the 19 year (1957-1976) period én vhich the CHER: predecessor, the Puerto Rico Wuclear Center (PRNC), operated a nuclear energy progean, one of its main accomplishments was the training of students?in nuclear science and technology, nuclear medicine and health physic. A total of 3560 students and scientists fron 41 different countries participated in the various

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training and research programs. The participants vere from countries ?throughout the entire globe, representing India, Great Britain, Spain,

Greece, Israel, Korea, Lebanon, Liberia, Kenya, Philippines, Germany,

Hungary, Indonesia, Thailand, United Arab Republic, Turkey, South Africa,

Malay, Foraosa and Japan. Hovever, the largest number of participants

vere from Latin Anerican countries, including Argentia, Bolivia, Brasil, Chile, Colowbia (largest representation), Costa Rica, Cubs, Dominicen Republic, Ecuador, Bl Salvador, Guatemala, Haitf, Honduras, Janaica, Moxocp. Nicaragua, Penang, Paraguay, and Venezuela, Many of the parti-cipants that were students traine in these programs, today held inportan positions in both government and private industry in their respective countries in the fields of energy and enviroanent, The good will and ambassadorship together with the intelectual and know-how accomplishments gained through these training prograns is probably the major accomplish-ment of the CEER predecessor.

Accomplishaents, Present

?The major accomplishment of CHER during the last three years of

operation has been the establishsent of a base for res

uch and development

programs for alternative energy sources and the solution of environmental Problems associated vith them. Bageline inforaation has been collected,

analyzed and reported for such important prograr as the siting of an Ocean

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includes biofouling corrosion and materials studies, measurenents of ocean-ographic envixonmental studies parameters, seawater surfactant eystens and variability relationships to an open cycle FOAM OTEG Systen and OTEC Para~meter Ocean Spatial Variability.

Due to Puerto Rico's geographical location in a high insolation region with sufficient rainfall, good agricultural land and the availabi- Mey of facilities and agricultural research scientists, bionass for energy research programs has been under development at CEER and the Agriculture Experiment Station of UPR, Baseline infornation in relation to Biomass

includes the development of agricultural technologies and optimization for

harvesting large colums of biomass and their econonic and agricultural eisniey

Bioconversion projects producing methane from vastes have been deve~ oped. Wastes biologically digested together with biomass in an optinized six, can represent an atractive project from the point of view of integrated energy and environment research in Puerto Rico as vell as other areas, including the USA mainland, A demonstration project (waste diges-

tion only) for the US Aray at Fort Buchanan has been developed by CHER

and {s in operation, portant information has been gathered for the

dosign of larger systems, Various methane generators including newly designed

tems to digest rum distilling has produced important baseline

information.

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A solar research program can not be logically developed unless a base~

line solar radiation data is developed for the area under consideration.

Solar radiation data has been under continuous monitoring by a series of

CHER measuring stations located in Mayaguez, Cabo Rojo, Lajas, Rio Piedras,

Ponce and Catafio. These data, both global and diffuse, are taken on an

hour by hour basis, stored in a computer, and have been mathematically sodeled for practical use for research and design applications. Reports hhave been issued containing this important and vital information. Additional measuring stations are planned to generate nore detailed information.

?An evacuated tube CFC concentrator for producing steam for industrial requirements has been developed by CEER vhich will form the base of future industrial solar steam programs. In addition, CEER has participated in the design phase of solar demonstration projects (photovoltaics and solar~ thermal.

?The design, testing, and evaluation of a solid dessicant air conditioning machine using silica gel has provided basic information for the further study and consideration of this important system in the tropic:

Air conditioning is a significant electrical load in Puerto Rico, especially in the comercial sector.

In the ecology area, salient accomplishments are the establishment of baseline information for future ecological stu.

15 and assessment related

to planned energy production and utilization. This has been accouplished

through El Verde Project and the Tallabos-Guayanilla Bay ecosystem studiety

research of several years duration that carries over from PRNC programs.

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In addition, the ecology section presently has a Large role in the eco-

system study for the OTEC site andi new

iting consideratiom for a coal

fired plant.

Health prograns fora an important part of CEER prograns. The main

?efforts in the past has been in controlling water quality and tropical disease transaission through aquatic eystens (schistosomiasis). Ae a result of CEER's efforts, schistosomiasis in P, R. has been nearly exradi-

jeline information required

cated. Ongoing programs are establishing b:
in connection with correlation of respiratory diseases, cancer and air quality as well as the correlation between gastrointestinal disorders and water quality are comon in Puerto Rico,

Materials progranstave developed basic information related to inprove-

termination of properties

ments and optinization of fuel cell electrodes,
of several solar selective surfaces and material degradation on solar

collectors and water heaters in the tropics, A ba aiveady exists in the

area of materials research in teras of availability of scientiste:ind

laboratories.

On integrated technological assessment, energy analysis of various

alternative energy sources has been made, providing basic economic infor-

mation and period of competitiveness for the tinely selection and develop~

?ment of alternative energy sources, The studies indicate that nuclear

energy, on @ cost basis only, is the lovest cost energy for the rest of the

century and beyorid Biomass and OTEC are strong contenders with costs

lower than coal fired pover plants. Photovoltaic economics looks highly

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promising. The engineering economic analysis of alternatives

2 a very,

important aspect in an energy environment programand CEER is not overlooking

this aspect.

Public Awareness or Training and Education Programs have received very

Little funding, However, CHER has conducted several significant programs

in this area including an International three weeks energy seminar in which

scientists from Latin Anerica participated. In addition, several sumer energy-eavironment oriented training courses for local high school teachers

?and students have been conducted. Base information has been accumulated

for future programs. CEER also sponsors and participates in many prof sional level seminars each year in the areas of energy and environment.

tn the Transportation and Conservation Sector, significant econoaie and policy studies have been and are presently being conducted, Base data has been established for important future policy and decision making considerations, Over twenty five (25)% of P.R. not petrolew imports sre

spent in the transportation

Present studies and experimentation is focused toward the feasibility of utilising electric or hybrid electric vehicles. Poth of these vehicles show promises for substantial reduction in gasoline usage due to the pre dominant high density traffic in the metropolitan areas.

?To keep abreast of the latest developments in energy and environment

reseatch, CEER has sent their scientists to visit various research Labor

tories for discussion of special projects and current research in the

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areas of prime interest to CHER, Some of these laboratories visited have

Deen: ORNL, JPL, SHRI, ANL, IMS, SRL, BNL, Sandia, and LAL, In addition,

visite to major university resi

sch laboratories have also been carried out,

?among sone of which are: MIT, U of Colo., Colo State U., U. of Fla., Cal

Tech, UCLA, U, of Cal-

jerkeley and U. of Mich.

?Additional programs and accouplishaents at CEER during the last four years include the success of the magnetic separation program (renoval of

pollutants from aqueous waste discharges); tertiary treatment of vaste

water with water hyacinths; use of sludge and hyacinth coapost to produce ethane; joint efforts with the Venezuelan Government in the research required to establish the practicability of using a microbial oil ?stimule-tion method in marginal wells producing extra heavy crudes and biodegration of heavy crudes by means of selected microorganions.

Extremely careful planning was nect

y in making periodic al1 the

above CEER accouplishnents through very Limited funding, an average total on the

order of $3 million per year for all prograns.

Figure 2 ?Institutional and Developaental Prograns FY-1980 Projections

and ¥Y-1979 Alfoéations? illustrate thé actual funding disttibution of the

various prograns.

Table 2 "Institutional and Development Funding by Project Areas FY-79

?and FY-80 indicates the present funding distribution by institutional pro-

gran classification,

Appendix B "CHER Prograns" gives a detailed Listing of "CEER Inetitu-

tional and Development Programe: F¥-77 through FY-70". The specific on

going projects funding, project location, and leaders are indicated, Also

included within Appendix B are the sponsored and Competitive Research

Programs.

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FIGURE? INSTITUTIONAL, AND DEVELOPMENTAL, ProgRANS £91980 PROJECTIONS

?AND FY-1979 ALLOCATIONS

INSTITUTIONAL FUNDING

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INSTITUTIONAL,

(GENERAL:

DEVELOPMENTAL,

(GENERAL)

TRANSPORTATION

wan

oTueR

CONSERVATION

PETROLEUM

ENVIRONMENT

BIOCONVERSION

oTec

BIOMASS

SOLAR

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THOUSANDS OF DOLLARS

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PROPOSED FIVE YEAR (1982-86) PLAN

SuMARY

?Tho proposed five year plan (1982-86) for the developeont of

alternative energy sources is subdivided into thirteen (13) main

subject areas:

1. ome

11, Biomass

HIT, Bioconversion

TV. Fossil Fuels Research

V. Solar Progran

VI, cology Programs

VIL, Environmental Health

VIII, Materials Development

TX, Integrated Technological Assesseent

X. Nuclear Program

XL, Transportation and Conservation

XIT. Public Avareness

XIIT, International Programe

Sumary Table $-1 "Total Funding Requirements for Proposed Five

Year Plan" illustrates the funding level requirements for each eub-

Ject program, Total funding requirements average out approximately $13.7

million per yearsThis is approximately 3-4 times the average level of

CEER funding existing during the last two or three years. One of the

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main reasons of the increase is that the proposed program budget reflects

costlier development and demonstration programs as cospared with previous

ess expensive programs addressed to develop baseline information data.

42% of the total budget goes tovard "Development" and only 30% to Basic

Research. This last requirement is

Waly needed for developacnt of addi-

tional baseline information, Denonstration programs account for 22% of che

Budget while training and education accounts for less than 6%. Wo meaning full energy program could be developed without a funding comparable to the indicated in Sumary Table S-1. OTEC is the largest budgeted progres (21.5%) followed by Biomass (19.42), Ecology which interfaces with several of the energy prograns ranks third in budgeting (18.62) followed by

Solar (9.12).

Summary Table $-2 "Total Program Personnel Distribution? illustrates the total manpower requireneats, by classifications for all programs. For detail information on manpower requirements, per progran see the corres ponding Table 2 under the respective program section.

The total maximum projected personnel requironents for the progr:

varies between 297-335. Prosont CEER total personnel is slightly under 200,

hence this indicates an approximate growth of 77% to handle al programs.

(ORER fools that enough physical facilities are available. After deconta~

ination of the nuclear reactor facilities in Mayaguer, that additional

available space in addition to that available at the Rio Piedras facility

should be able to accomodate the projected expansion.

Sumary Table $-3 "Total Program Budget Distribution by Type of

Research, Developsent, Denonstration and Education and Training. The

largest coaponent as previously pointed out is "Development. For details

of Budget classification of a particular progran refer to the corres

ponding Table 3 in the respective section program.

---Page Break---



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Summary Table 8-4 "Total Program Budget Distribution Classified" {lus

trates the total budget classification distribution by personnel, equipment

land materials, and services (contracts). Personnel Budget estimates of

50% of total indicates an adequate and appropriate use of the budget dollars. For details of che budget distribution for a particular program, refer to the corresponding Table 4 of the respective section program.

Pigure 3 illustrates graphically the Budget distributions. The bud

4s presented, does not reflect inflation but includes overhesd and fringe benefits. Dollars indicated are early 1980 dollars.

Not included within the budget is the program on Energy Assessnent Studies of Underdeveloped countries and Technology Transfer in the Inter~ national Program, This can contribute substantially to the U.S. efforts. However it is rather difficult to estimate Budget requirenents for this program, This will depend mainly on the role played by U.S. agencies and the degree of interaction and involveseat of CEER in each progran.,

A detailed description with budget analysis for each program follows.

---Page Break---

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FIG.3. CER 5 YEAR PLAN (1902-86)

BUDGET AND PERSONNEL DISTRIBUTIONS

Budger Diste by Budget Distr. by

Programs Type of Reseorch

1 Distr. by

Services

MAN POWER

TECHNICAL

SeTENTIFIC!

GEER abu,

vas

Teter Personnel Dist for 1966 In number

orm

---Page Break---

-25-

PROPOSED

1982-86

---Page Break---

OTEC PROGRAM

---Page Break---

rt

T, T&G PROGRAM

OTRC Studies - Integrated Engineering and Environmental Program

Puerto Rico is blessed with one of the best sites in the vorld

for desonstrating technical and econoaic feasibility of an OTEC

power plant sooner than any other USA mainland site. Efforts in

OBC Studies in Puerto Rico go as far back as 1966 when the local

electric utility performed a study for the Punta Tuna site in

South Puerto Rico and described a research program and the funding

requiresents.

Im its noreal operation an OTEC plant may be considered to be draving

up water from two depths and discharging it at a third depth as a

?mixed plune potentially containing a variety of adulterants. The

discharge may be regarded

point source subject to dispersion in

whatever the prevailing currents may be in accordance with the myriad

Intake and structural

of factors which may influence that proce

integrity questions are of greatest importance in the vicinity of the

structure and diminish in inportance with distance; whereas discharge

questions may be regarded as increasing in importance to a maximum at

sone as yet unspecifiable but ?discrete distance

jownstrean? beyond

which plant influences can no longer be differentiated from background.

The environmental information required for predicting the probable

impact of the environment upon the plant overlaps broadly with the

information needed to describe the environmental effects of? an OTEC

unit. Te is mainly the details, emphasis and applications of the data

which differ. Knowledge of currents, temperature structure, water

mass chemistry, and dominant biota ie required for different reasons

---Page Break---

both near the plant site and "Jovnstrean", The CEER research plan for

OtEC is designed to develop the above inforaation with the appropriate

ite off

eaphasis on a field study which starts at the specific OTEC

Punta Tuna and radiates broadly and with decreasing spatial resolution

to encompa:

?an area expected to intercept a plune arising at the OTEC

Aischarge. Figure I-1 shove the grid of stations lying in a 60 degree

fare having {ts main axis in a NE/SW (approximately 241° TH) direction

originating at the OTEC site where a Landing Craft Utility (LCU) vessel

will be moored for biofouling, corrosion and heat transfer studies.

Figure 1-2 locates Punta Tuna in Puerto Rico.

Periodic replicated measurenents of current velocity and direction

in relation to depth will be made at an array of stations within the

ved

grid and alvays at the LCU. Temperature, salinity, nutrients, di

?oxygen, chlorophyll and phytoplankton profiles will Likewise be

measured across the grid. Zooplankton vill be collected on the sane

synoptic cruises providing the other biological, physical and chemical data, On a schedule complenentary to planned cruises similar data will be developed at the LCU, but with more detail to resolve patterns of

vertical distribution and short term temporal variation (day-to-day and hour-to-hour), ?These data will be applied in the interpretation of the

synoptic cruise dat

4n vhich spatial and short term temporal variation Will necessarily be confounded. LCU sampling will also eaphasize entrainnent/inpingement potential, the potential for physical strese

to structures due to currents and waves and an evaluation of the theraal

Fesouree, LOU studies will further provide « backdrop of potential

---Page Break---

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Physical, cheaical and biological correlate

transfer and corrosion measurements concurrently being made there.

seu

?are planned which will define water masses in the vicinity, and by the use of drogues define a ?nost probable plune" for purposes of determining which areas and ecological comunities most need to be studied dowstrean.

Data from the first year of study will be used along with the latest design information to refine estimates of a most probable plume and of the most Likely environmental impacts for further study. ?The later studies will focus on the effects of biocides on nodel heat exchanger biofouling, corrosion and heat transfer and within the most probable pluse area on the effects of biocides, heavy

netals and working fluid on organisns residing there.

---Page Break---

PROGRAM OVERALL BUDGET

(Thous. of Dollars)

Proge ee} eB tw

one

A. Evaporator (Biofouling,

Corrosion, Materials,

Cleaning and Enhanced Heat

Transfer) 250 300350250, 150

B. Condensor (Inorganic

Fouling, Corrosion,

Materials, Cleaning and

Enhanced leat Transfer) 450 500 550450350

?Site Characteristic and

Ecological Effects (Current

Waves, Nutrients, Entrainment,

Biocides) 1,200 1,650 1,900 2,050 2,400

D. Miscellaneous (Raiser Cable,

Mariculture, Advanced

Systens) 300 350 400 450500

rorats 2,200 2,800 3,200 3,200 3,400

?approximately 400K/yr will be used through 85 for

operation of the research facility. Budget assumes

OTEC 10-100 platform will be available in FY-86, thus research facility operation is reduced to 100K/yr.

---Page Break---

TABLE 1-2

?PROGRAM PERSONNEL DISTRIBUTION

(Mian-Years)

Program Titles e838

omc

A. Bvaporator

Scientific staff Lo 12 LS. 1 3

Tech. Staff 200 2h 3

Adm. State 33a 3

B. Condensor

Scientific staff 20 23 27 20 1.6

Tech. Staff 43 49 57337

Ada. ?staff 3B Bs 3

C. Site characterization and

Ecological Effects

Scientific staff 6 7.2 8.2 9.0 125

Tech. Staff 7 9:2 10.9 12.2 16.6

?Adm. State 1 1 1 1 1

D. Miscellaneous

Scientific staff 1 L316 20s.

Tech. Staff 27 8S 4 wT 60

?Ada. Stafe ?4 oth ?4

?rorats

Scientific staff 10 2.0 ok wa

Technical staff 16 2h.

Adm. Stafe 2 2 2 2 2

?ALL STAPF w a 36 a6.

%9 man-yrs/yr will be subcontracts for research platform operation and

do not show in this table.

---Page Break---



TABLE 1-3

?PROGRAM BUDGET DISTRIBUTION BY TYPE OF RESEARCH

(hous. of Dollars)

Program Titles a 83 hOB 86

corse

A. Evaporator

Basic Research 50 50 ° 0 50

Development 200 250 250125100

Desonstrat ion ° 0 ° 0 0

Educ. & Training ° ° ° ° 0

| Condensor

Basic Research 100 10050, © 100

Development 350 400 © «400 350,250

Denonstration 0 0 © 100100. 0

Educ. & Training ° ° ° 0 °

©. Site Characterization and

Ecological Effects

Basic Research 200 200 200 «200200

Developaent 1,000 1,450 1,700 1,800 2,150

Denonstration ° 0 0 750 50

Educ. & Training ° ° ° ° 0

Miscellaneous

Basic Research 200 © 250250 50250

Development 100 = 100150200250.

Denonstration 0 0 0 ° °

Educ. & Training ° 0 ° ° °

Totals

550 600-500-450 600 ?2, 700

1,650 2,200 2,500 2,475 2,750 11,575

° 0 "200 "275 50 "525.

° ° 0 0 ° °

2,200 2,800 3,200 3,200 3,400 14,800

---Page Break---

BIOMASS PROGRAM

---Page Break---

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TT, BIOMASS PROGRAM

A. Baisting Prograns

Bionass production research studies on tropical grasses and sugarcane were initiated in 1976 the UPR Center for Energy and Environment Research (CEER). Sugarcane, tropical grasses

related to sugarcane, and other tropical grasses have large

srovth potentials on a year-round basis in Puerto Rico due to the high insolation rates and appropriate soils. This, together with the available scientific and technical personnel and agrononical laboratories makes biomass research an attractive possibility to help in the solution of energy probleas. It is estimated that the ailing sugar industry presently using over 70,000 acres of 1and could be replaced by an economically viable

biomass for energy and higher-test molasses (to supply the rum industry agricultural program. The important rum industry in

8. The basic

Puerto Rico imported last year 90% of its mol:

RGD information resulting from this program is useful to many

Caribbean Islands, Latin Anerica nation as vell as mainland USA.

---Page Break---

?The basic premise is that such plant materials can be produced as a rene-

wable, domestic source of fue!

and chemical £

stocks that will substi-

tute for {aported fossil fuels, Two annual reports dated 1977-78 and 1978~

79 to BOE presents the results of tvo years of research efforts. Fuel costs

of the order of {1.70 per million BTU have been predicted with year round production of tropical grasse:

?The Project Objectives of this Program have been (a) determination of

the agronomic and econonie feasibility of mechanized, year-round production of solar-dried biomass, through the intensive management of sugarcane and napier grass as tropical forages, and (b), exanination of alternate tropical

as potential sources for intensive bionass production. A secondary objective concerns the selection and breeding of new sugarcane progeny having superior biomass productivity as their principal attribute.

Ie is estimated that this Program needs to be continued at the present lavel of funding of approximately $400,000 per year up to the Year 1984-85.

New Prograne:

B. Hydrocarbon Producing Plants

While tropical grasses (sugar cane-S, Officinarun x 8, spontaneus) and napier grass (Peonisetun purpureus) have impressive production records in Puerto Rico they require

Larger vater denands than hydrocarbon bearing plants of the

Buphorbias, Asclepiaie and Guayale families. Fresh water

requirements for the tropical grasses require water within

---Page Break---

m3

probably Less than 500 ppm salts content while the indicated

hydrocarbon producing plants might thrive wich water as mich

?as 2000 ppm salt content. They are very rugged type plants

land might adapt hetter to the more hostile environment of

southwestern Puerto Rico and southwestern U.S. desertic areas.

They also can grow better in steep slope

?The chemical components extracted from the hydrocarbon

producing plants of the fanilies indicated abovr are nore

valuable than the heat content of the fibers. Even after the hydrocarbons, which are aainly Polymers of isoprene, a

extracted, the resultant fiber still can be used as biomass fuel with 7000-7500 BTU per dry pound. About 20% by wieght of isoprene polymers can be extracted from the indicated plants.

Puerto Rico has about 65 species of 10 fanilies of such Inydrocarbon producing plants and import can also be nade from Brasil, other South Anerican countries, and che western USA mainly California.

?The principal objectives of the project will be (a) the Sdentitication of the most promising candidates for detailed studies of selection and breeding of switable hydrocarbon bearing plants progeny having superior isoprene polymers

productivity as their principal attribut

Included within

this objectives are laboratory studies for characterizatién of the isoprene polymers and evaluation of their conversion

---Page Break---



into useful motor fuels and chemical feedstocks. (b) determina

tion of the agronomic and economic feasibility through intensive

managenent of hydrocarbon bearing plant plantation.

Sone effort is presently being performed at CEER in this

area, Samples are being collected from local hydrocarbons

producing plant and analyzed.

timated a2 follows:

?The evel of funding is

82 83 nd

150K 200k 400K SOK 500K

Te is estinated that a technical staff of seven agronomists

?and one organic (hydrocarbon) chemist will be involved in this project.

C. Seaweed, Farming and Harvesting

Although land used for uneconomical agricultural prograns

such as sugar cane could be made economically productive in a combined bionass for energy programs as previously indicated, harvesting the seas make sore sense for Puerto Rico and many

others small caribbean islands than land biomass.

?This research study will address itself also to the

possibility of developing and harvesting tropical marine alg: including sargassum. From using available data and from direct simple observation a very preliminary agsessuent will be made.

wo factors are inportant for the development of « marine farm:

Water depeh

2. Water currente

3. Available nutrients

---Page Break---

>.

ms

Water dopth above 200 ft. results unsuitable for development

of any type of marine algae. Marine kelp, a red algae con

thrive in depths up to 150 £e, ?They require relatively slow

water notion. Abrupt water current changes produce serious

obstacles to the thriving of these algaes. The study will try

to identify any appropriate marine areas vhich could be used

for detailed studies and further definition and roughly estinate

ice potential values.

It fs estinated chat a technical staff of 3-4 scientists

will be involved.

?The level of funding is estinated as follows:

82 83 84 85 86

100K «150K «200K-??«300K «400K

Dixect Firing of Biomass (Tropical Grasses and/Sugarcane

Solar dried biona:

is contemplated for direct firing in

?conventional watervall steam boilers in central electric pover

plants. The BTU content of dried (152) sordan is approximately

7500 BTU/Ib or 15 millions BTU per ton. It is estimated that

one single 450M generating unit operating at 75% capacity

factor can supply by the year 1967, 13% of the electrical

energy needs of Puerto Rico and displace approximately 5

illion barrels of Bunker ¢ ofl. This will require 55,000-60,000

acres of land. By contrast, the afling sugar cane industry

Jin Puerto Rico has over 70,00 acr

of sugar cane plantation.

Sugarcane production in Puerto Rico is uneconomical at present

---Page Break---

land was government subsidized last year to the approxinate

Figure of $500 per acre of sugar cane plantation.

Econoaie analysis indicate that direct biomass firing can be

economically more attractive than ofl, coal and OTEC plants

in the Puerto Rico Scenario. For the year 1990, CEER energy

studies analysis indicate that direct firing of biomass in

Puerto Rico in 450MW units can produce electricity with @

levelized cost of 9 cents per kwhr including 8% compounded

Anflation up to 1985 and 5 per y

sr compounded inflation

thereafter, For the same escalation assumptions and year, 450% coal fired plants can produce electricity at the lovest estinated cost of 12 cents per kwhr levelized cost, while a 250M OTEC Plant will be over 14 cents per kwhr levelized cost. An ofl fired plant is estimated to produce energy at 4 levelized cost of 46 cents per kuhr assuming 9 per year

inflation in oil costs.

Progran D Objectives:

The principal objective of the direct firing progran is to convert an existing sugar mill to handle 1000 tons of biomass oer day, and determine the logistics of production,

?arying, transportation, storing and burning of biona

+ and

technical modifications and inprovenents to boiler handling and burning equipaent and particulate and gaseous enissions characteristics. Electric pover utilities will therefore

be able to incorporate ie steam boiler bids specificatios

---Page Break---

enough techaical data for specifying steam boilers to burn bionass and design other items euch as storage and handling equipsent accordingly.

?The project vill be divided into four principal phases as follows:

(a) Instatlation and costing of a biomass dryer phase

?Tho Steara-Roger Company of Denver has previously installed rotary dehydrator in sugar mills on the US mainland and Havali. This unit will be a rotary dehydrator utilizing waste heat from the mill stacks. Te must be capable of drying large daily tonnages to 40% moisture and lesser anounts to 15-25% oisture. The atnospheric emissions produced from such plant will be compared to those from nore conventional plants.

(®) Biomass Storage Facility Phase

A biouass complex must be constructed to accomodate both solar dried and mechanically dried biomass fuels.

A structure, aluninun roofed, oper

?sided, 12 fe. deep,

?and total 120,000 oq.ft. area with bituminous-crushed

stone floor designed for bionass carrying vehicles is

envisioned storage structure, for

typical bioma

the 100 tons per day project. This will provide 60

day-storage. Construction cost is estimated at

$7.00/sq.ft. The unit mst be suitably designed so

---Page Break---

that fuel can flow to the boiler with minisum handling

costs and ease of operation

(©) Agricultural Field operations Phase

Optimization of land use (8000 acres) for full year

operation of the project:

1) already planted land for Ist. year operation

2) replantation

3) mix of different species, cane, napii

sordan.

(@) Environmental Assessment

Tramination of the impact of such harvest and culture operations upon surface and ground water quantity and quality. The extent to which culture techniques to achieve maxinun biomass require fossil fuels in terms of fertilizer and biocides applica

fons which may also have environmental costs, a

increase total operational costs, should be

(e) Mil1 Engineering Phase

Modifications to the existing mill and

performance evaluation.

---Page Break---

DIRECT FIRING OF

Project D Estimate (Thousands)

Teen 2 8

Salaries and wages 180, 160,

2qutpment 2,000, 80,

Field operations 650, 650,

Travel & Per Dien 10, 10,

Additional Direct

Costs (Waint.) and

Others 36, 150,

Total Direct costs 2876 1070

Indirect cost

45% of Salari

and Mates a

Sub-Total 2957 ust

20% Contingency = _591__ 230,

?ora, 3548 1381

5 Ye. Total = $9072

180,

80,

650,

20,

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230

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180,

80,

650,

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150,

1070

aL

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230

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180,

80,

650,

20,

a

aust

230,

1381

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11-10

?TABLE 11-1

TOTAL BIOMASS BUDGET (Thousands §)

Project a a3 86 85 86

Tropical Grasses Agrononic

Studies (Continued) 400 400 400 200 -

Hydrocarbon Bearing

Plants 150 200 400 ?500 500

Seaweed 100 150 200 300 400

Direct Firing of Biomass 3,500 1,380 1,380 1,380 1,380

rorats 4,150 2,130 2,380 2,380 2,280

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m1

?TABLE 11-2

?BIOMASS PROGRAM PERSONNEL, DISTRIBUTION

(an-Years)

Existing Tropical Grasses Bionass Program

8 83 aS

Scientific State 4 4 soa e

Technical Staft 3 3 3 se

Adsinistrative Staft 1 1 a

Hydrocarbon Bearing Plants

Sefentific Staft 2 3 os 8 4

Technical staff 1 2 3038

Administrative State a a ,oa oa

Seaweed Faraing and Harvesting

Scientific Staff 2 2 2 3003

Technical staff 1 2 2 2 4

Administrative Staff ° 1 a aoa

Direct Firing of Biomass

Scientific Staff 45 45 45 4S 4S

Technical staff 3.0 3.0 3.0 3.0 3.0

Administrative Staff 1.0 Lo 10 10 1.0

?TOTALS

Scientific Staff WS 1S SSL.

Technical Staff 80 © 10.01.0985 10,0

Adainistrative Staff 3.0 4.0 4.0 4.0. 3.0

ALL STAFF Le OWES

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m-12

?TABLE 11-3

PROGRAM BUDGET DISTRIBUTION BY TYPE OF RESEARCH

Existing Tropical Grasses Biomass Progra

2 Sho BS BH Totals

asic Research 20 200 = 20000 =

Development 200 200 © 300100 =

Demonstration ° ° oof

Biucation & Training ° ° rr

Hydrocarbon Rearing Plants

asic Research 150-200-200 300300

Development ° ° 200 © 200 200

Denonse ration ° ° oo oO

dveation & Training ° ° a)

Seaweed Farming and Harvesting

Basic Research 100 150 150150250

Development 0 o 50150150

Denonstration ° ° ° ° 0

Bdveation & Training ° ° ° oo

Direct Firing of Biomass

Basic Research - - - -

Development. :

Demonstration 3,500 1,380

Education & Training - -

TOTALS

Basic Research 450 350 550 550 550 2,650

Development. 200 200 450 450-350 1,650

Demonstration 3,500 1,380 1,380 1,380 1,380 9,020

Education & Training 0. 0 0 Q

o_o

OTALS Fo | F133 7380 280 13,30

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TABLE 11-4

BIOWASS PROGRAM BUDGET DISTRIBUTLON-CLASSTFIED

(thousands $)

Existing Tropical Grasses Biomass Program

2

Personnel, 200

Equipment and Materials 150

Services 50

Hydrocarbon Bearing Plants

Personnel ry

Equipment and Materials 50

Services 25

Seaweed Farming and Harvesting

Personnel 60

Equipment and Materials 30

Services 10

Direct Firing of Biomass

Personne 313

Equipment and Materials 2200

Services 987

?Toras

Personnel 648

Equipaent and Materials 2430

Services 1072

Torats 4150

83

200

150

30

1s

30

25

100

35

3

313

96

om

738

331

1061

2130

200

150

50

200

100

100

100

50

50

313

on

13

396

a7

2380

85

100

75

25

200

200

100

1s

100

65

a3

96

om

78

in

2st

2380

200

200

200

100

100

313

om

n3

396

a7

2280

3660

4026

5636

13,320

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BIOCONVERSION PROGRAM

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TIT, BIOGONVERSION PROGRAM

METHANE

It is rapidly becoming apparent that Biocoaversion may be one

of the Key components in the resolution of the critical energy pro~

blens facing the world at present. In addition, judicious choices

of the operational paraneters of this process can contribute to no

?snall extent to the amelioration of the a

?icultural and protein

shortfalls in many parts of the world. Although the basic elenents

of bioconversion are vell known, and in fact have been successfully

?eaployed for centuries, it is necessary to study and develop tech niques and devices which can be integrated into modern mass production methods to produce simple, low cost systens. These must be compatible with the technological and economic constraints of the Third World

and developing countries, and those sectors of the industrialized

nations where isolated appropriete technology concepts are still

apliicable.

Institution has been following as much
1a5 possible these guidelines in the design and prototype testing of

anaerobic digestion systens for a variety of substrates. After @

nent of the low

comprehensive survey of the Literature and an asse:

level decentrailized energy needs of Puerto Rico and other less developed areas of the Caribbean, designs were developed for a series

of bioconverters, sone of which have already been constructed and a

operational.

?The primary consideration vas in maximizing the conversion of

---Page Break---

mr-2

the most comonly available biomass and each bioconverter was designed for a specific substrate. The systens tested and show to produce usable methane (and other valuable by-products) used as substrates vvater hyacinths, agricultural waste, animal (poultry ans ovine)

cafeteria refuse and run slops.

At present, continuously operating bioconverters are those using water hyacinchs, run waste and cafeteria refuse, The first two units are operating at CHER and the cafeteria waste converter is in opera tion at the Fe. Buchanan Aray Base in cooperation with the Aray?

Bavironmental Research Progr:

Preliminary assessment is under vay of the potential of the

marine algae Sargassum as a bioconversion subst:

ith the coopera

tion of the Goddard Space Laboratories (Bethesda) of NASA, a series of

satellite photographs of Sargasso sea vere made available and are

currently being examined.

Another area which is currently being explored is potential of

?the municipal refuse deposits as a source of naturally generated methane

in appreciable quantities. Designs have been for an experimental

?methane tapping system and it is expected that this vill be functional

early in 1980,

{In addition co the experinental work, the staff of the Biocon version Program has been active in a nunber of conferences, locally and on the mainland, relating to Bioconversion. Presentations were nade of the Division's project and concepts. At the present nusher,

there are also a number of proposals to various agencies now under

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m3

consideration for future funding of continuing efforts in all areas of bioconversion.

Preliminary studies have been initiated in other areas of bioconversion such as biophotolysis, hydrogen production and assessaent of hydrocarbon plants as fuel producers. After copletion of 1ite~ ature studies experimental operations, as indicated in the following pages, will be initiated,

?The specific objectives of the Bioconversion Progr

Produce, use and demonstrate the technical and economic feasibility of fermentative biogas production from locally available bionass {in decentralized, lov technology operations.

2. Instrument and monitor existing or newly constructed biogas production facilities.

3. Develop alternate uses for anaerobically fermented vaste residue and effluent.

Work with local industry to help reduce environnental pollution

and petroleum derived energy dependence by biological converting

wastes into biogas and secondary products.

Design, and monitor biological? energy production systems for incor~

Poration into existing agricultural or industrial facilities in

Puerto Rico.

6. Optomize and demonstrat

hydrogen production by biophotolysis.

7. Design, construct and demonstrate the feasibility of using the marine

ecosysten as a source of biomass for biogas production.

8, Act as a contral technology data source for tropical biogas

---Page Break---

mrt

production information and expertise.

9. Develop and denonstrate the construction of a functional and useful

blological analogue of the photovoltaic cell using halophylic bac~

teria.

10, Preliminary screening of other general bioconversion processes for energy or environment conservation.

?The following is proposed as the Experimental Progra to meet Bio

conversion objectives:

A, Biogas desoastration program

Design, construct and denonstrate the biogas production potential of locally available bionass sources. Program duration 5 years, approximately 10 person years required.

3. Comercial monitoring program

Instrunentation and monitoring comercial scale biogas production facilites; program duration 4-8 years, approximately @ persons years required.

©. Alternative waste utilization program

Develop alternative uses for anaerobically fermented vaste residue and effluent. Program duration 6 years, approxinately 14 person years required.

D, Industrial energy production and waste utilization program

Work with local industry to help reduce environmental pollution and dependence upon petroleus derived energy resources. Program duration

5 years, approximately 12 person years required.

E, Bioghotolyeie program

---Page Break---

m5

Optonize and denonstrate biophotolysis potential. Program duration

4 years, approxinately 10 person years required.

Marine biomass program

Demonstrate the marine environment

1 biomas

1nd biogas produe~

tién resource. Program duration 8 years, approxinately 18 person

years required.

©. Information transfer progran

?Transfer appropiate technology information to local personnel.

Continual program, approxinately 1.5 years required yearly.

H, Light activated biologics! proton pumping progran

Investigate the feas{bility of utilizing the Light activated protein

Ponping characteristics of the purple menbrane segment from halo-

philic bacteria in the construction of a functional and useful

biological analogue of the photo-voltaic cell. Program duration

5 years, approximately 10 person years required.

I. Bioconversion screening progran

?Bioconversion screening program

Evaluate various bioconversion proce:

"8 for energy or eavironment

conservation. Program duration 6 years, approxinately 13 person

years required,

Tables IL-4 indicates the budget distribution for these above programe.

---Page Break---

mr-6

TII-b BIOCONVERSION

ETHANOL,

Puerto Rico, and particularly the University of Puerto Rico is vel suited for conducting fermentation ethanol studies with sugarcane. The Island has a long history of conventional cane production in support of the

sugar-refining and distillery industries. There is a natural capability

for year-round harvesting of sugarcane, which would provide a continual influx of raw jufce and eliminate the need to produce and store molasses for off-season feraentation.

Several divisions within the UPR franevork are ideally qualified for

specific contributions to ethanol research. The Agricultural Experiment Station can readily supply the input cane from both conventional and energy=

Plantation groth regines. The Experinent Station's Run Pilot Plant has a

range of fermentation facilities and technical personnel long acquainted

?with fermentation research, Other personnel from the UPR Department of

© available to support ethanol studies. Puerto

Chemical Engineering are a

Rico's Sugar Corporation, a unit of the local Department of Agriculture,

can also contribute to sug

production and fermentation studies

---Page Break---

un

[ETHANOL PROJECT

?The Erhanol project would evaluate ethanol production costs utilizing sugarcane juice and high-test molasses as direct sources of fermentable

solids, Baphasis vould be directed tovard minimizing producting costs by utilizing a one or two-step milling operation, reduced fermentation tine, and distillation-extraction modifications. Cost reduction studies would center on reduced milling expenditures, direct fermentation of raw juice, improved fermentation efficiency through superior yeast selection and

Process modification, and improved distillation process

The econonic ai

ssment of proc

es using crude juice as a direct
source of fermentable solids, as opposed to the more costly preparation

Of stable high-test mola:

+ ie regarded as an important phase of the

Proposed project. For this purpose the Vogelbusch approach is ideally suited since the fermentors are closed systens working with yeast recycl~ ing. This assures that alcohol losses are ntgligible and contamination is Minimized, By evaporating the clarified juice toa stable syrup, a sub- stantial cost factor is added to the process which could render the ethanol Produced too expensive for its use as a motor fuel and for most industrial applications. For run production, ?the added cost inpact may be marginal.

In the latter instance the mols

es is ordinarily transported to a run dis-

tillery site, and hence the increased shipping charges for raw juice would

offset sone oF the savings expected from direct fermentation of the juii

Por practical purpos

it will be better to perform the ethanol produc

tion operations directly at the milling site. This will minimize transpor-

tation and storage costs and the need for storage facilit:

---Page Break---

mre

Distiltilation process: The conventional distillation has as its

object the purificaton and concentration of ethyl alcohol by using a sys~

are the "b

tom comprised of three colums. The: x", purification, and

rectification columns. Waste streans, terned "slope", consist of ater or water containing solids in solution or euspension. In the usual dis~

softs"

tillation process for run, by-product streams include "fu:

(wixtures of alcohols with substances having more than two carbon atoms per

molecule), and "heads" (mixtures of aldehydes, ketones, esters, acids, and

amines). The separation of these components from ethanol isa cost factor

which probably is not necessary in a fuel-production process. An

important feature of the proposed project is the evaluation of means whereby

this step canbe minimized or eliminated.

Project objectiv

The prinary objective of this project ie to evaluate the direct pro~

duction of ethancl from surgarcane fermentable solids in an integrated eys-

ten, with emphasis on wodified technologies and econonization of the inte~

grated processes.

Brojece Approach

The necessary tasks to achieve this goal are:

4. A pre-milling preparation of cane, followed by one or two milling

steps ained at the extraction of maximm recoverable fermentable

solids.

b. An economic evaluation of the suitability of crude juice

mentation substrate, as opposed to high test-nolasses.

---Page Break---



A short time fermentation technology based on continuous fermen-

tation and the development of economical techniques to extract

the ethanol product.

to perform an economic analysis of the various steps, including

fan agcessnent of the aajor implications of the integrated proces

ses, and to wake recomendations applicable to industrial-scale

production of ethanol.

---Page Break---

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?BIOCONVERSION PROGRAM TOTAL, BUDGET

Biogas Demonstration

Comercial Monitoring

Alternative Waste

Ueilizaeion

Industrial Frergy

Production

Biophotolosys

Marine Biomass

Information Transfer

Light Activated

Biological Puaping

Bioconversion Screening

qorals

TagLE T1I-1a

(8 Thousands)

2 8

6 50

a 55

ms

9060

mo

250160

3s

6 2

so 2

ol 566

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1%

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34

36

560

& is

40

65

7

160

30

34

495

---Page Break---

nen

TABLE In1-2a

BIOCONVERSION-BUDGET BY PERSONNEL, DISTRIBUTION

Project A ~ Biogas Denonstration

Scientific State

Technical staff

Adniniotrative Staff

Project B ~ Comercial Yonitoring

Scientific staff

Technical staff

Adainistrative Staff

Project C ~ Alternative Waste

Scientific state

?Technical Staff

Administrative Staff

Project D ~ Industrial Energy.

Production

Scientific State

Technical staff

Adwinistrative Staff

Project E ~ Biophotolyeie

Scientific Staff

Technical staff

Adninistrative Staff

Project F ~ Marine Biowass Conversion

Scientific staff

Technical Seatf

Administrative Staff

Project 6 ~ information Transfer

Scientific staff

Technical staff

Administrative Stage

82

3

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3

?8

2

2

%

&

3

3

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3

3

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33

3

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3

2

3

---Page Break---

ABLE 111~2a(Continuation)

Project H - Light Activated

Biological Proton

Pomping

Scientific Staff

Technical Staff

Adainietrative Staff

Project I~ Bicconversion

Scientisic state

Technical staff

Adninistrative Staff

orans

Scientific staff

Technical staff

Administrative Staff

?Total staff

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TABLE TII-3a

?BUDGET DISTRIBUTION BY TYPE OF RESEARCH

Project A ~ Biogas Denonstration

Basic Res

Development:

Denonstration

Education & Training

Project B ~ Comercial Monitoring

Basic Research

Development

Demonstration

Bdveation & Training

ech

Ueilization

Project ¢~ Alternate Waste

Basic Research

Development.

Desonstration

Bducation & Training

Project D ~ Industrial Energy

Production

Basic Research

Development

Desonstration

Education & Training

Project E ~ Biophotolysis

Basic Research

Developaent

Desonstration

Education & Training

Project F ~ Marine Bionass

Basic Research

Developsent

Denonstration

Education & Training

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50

23

50

30

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?TABLE I1T-3a (Cont.

oly a

o 0 o o 0

6 09 9 6 06

Cr

Eveation & Training 35

Project H~ Light Activated

Biological Pumping

Basie Research 6

Development oO 0

Denonseration 2 09 o 6 06

Eiveation 6 Training o 09 o 6 26

Project 1 = Biceonversion

Screening Frogran

Baste Research sos saa

Developaent 0 7 oY iB

Demonstration 0 0 0 0 0

Education 6 Training o 09 0 oo 2

TOTALS ($ Thoveande

Basie Research ose a7 area 27867

Developaent 2 102102168 10k 572

Demonstration Bo 6 SS 120500

Bdveation & Training 3 2 8 0 tos

rorms ol 564564560485 3084

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mrs

TABLE TIT

?BIOCONVERSION PROGRAM BUDGET BY CLASSIFICATION

ry

30

Equipaent & Materials 55

Services °

Program B = Consercial Monitoring.

30

Equipaent & Materials 55

Services 0

Program ¢ - Alternative waste

Ueilization

Personne? 35

Equipment & Materials n

Services °

Program D ~ Industrial Energy.

Production

Personnel, 30

Equipment & Materials 60

Services °

Program £ - Biophotolysis

Personnel 30

Equipaont & Materials 4

Services 0

Program F ~ Marine Bionass

Personnel 40

Equipuent & Materials 210

Services 0

Program G ~ Information Transfer

v

Equipment & Materials 1B

Services °

3

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Ey

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48

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---Page Break---

TABLE 111~4 a(cont.

Program W = Light Activated

Biological Pumping

Personnel

Equipment & Materials

Services

Personnel

Equipaent & Materials

Services

TOTALS (Thousand dollars)

Personnel,

Equipment & Materials

Services,

?TOTALS

nr-16

88

25

55

259

652

ou

276

207

485

Totals

402

1675

2

3084

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nr

BIOCONVERSION

(EER 5 YEAR PLAN

?ETHANOL PROJECT

TABLE TIb-1

2B 8 ws

rorats m0 0s 40

same 111-2

Personnel Distribution

Scientific Staff M343 3s ka

Technical Staff 4d bt a ad

Administrative Staff SS

?Table I1Tb-3

Budget Distribution by Class of Research

Basic Research 2000 20s

Developnent 100 100100100.

Demonstration - - - -

Biucation 6 Training = = =

?TorALs 220 220° 2250

TABLE T1Tb~4

Budget Distriubtion - Classified

Personnel 185185 ass

Bquipment & Materiale 15 15,1920

Services 2 2 21 35.0

rorals 220 © 220023 24.0

Total

905

505

740

69

96.

905

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FOSSIL FUELS RESEARCH

---Page Break---

wa

1V. FOSSIL, FUELS RESEARCH PROGRAM

Puerto Rico is fully dependent on fossil fuels as an energy source.

?Traditionally Venezuelan crudes have been a major source of supply for

local refineries. Consequently, ve need to fully understand all the

?associated problens related to the production and consumption of petro

eum and other fossil sources in a tropical eavironnent. CEER for the

last two years has initiated a progam in fos

1 fuels oriented to

explore the biodegradation of non-conventional hydrocarbon mixtures

under aerobic and anaerobic conditions. Duly motivated scientific person

nel, laboratory facilities, base Line data, and intimate personal and

professional Links with scientists from governsent laboratories, univer

sities, and decision-makers interested in the development of non-tradi-

tional sources of hydrocarbons is available, In addition, Puerto Rico

how faces the attractive possibility of finding petroleus on the north

coast as a result of basic and detailed geophysical studies making

fossil fuels research program a venture well exploring,

The Fos

£1 Fuels Research Program mission, goal:

nd objectives

The Misoion: Improve our understanding of the environmental impacts

?and the technology associated with the production,

upgrading, and consumption of fossil fuels, knowledge

of the potentially serious risks that these fuels

Present ro the public health and the environment and

the possible technological alternatives to improve

their production upgrading and consunpt ion.

---Page Break---

The Objec

L

2

Develop-a systens perspective of the health and environmental aspects which could result from research work

sssociated with the production, upgrading end consump

tion of fossil. fuele and to take the necessary 6

required to increase the availability of hydrocarbon

sources to protect public health and the natural

?environnent.

To explore the chemical and physical nature of fo:

fuels with an orientation to inprove their production,

upgrading, and consvaption.

?Jo explore the technological aspects associated vith the

production, upgrading, processing and consumption of

?non-conventional fossil fuels.

}- To investigate the microbial biochemistry associated

with the biodegradation of hydrocarbons and their hete~

Tocompounds in nature, to improve this process under

controlled conditions, and to look for potential

applications in the areas of enhanced ofl recovery and

in the disposition of fossil fuels derivatives in @

tropical environment.

---Page Break---

wes

4, To predict and control toxic substances associated

with the production upgrading and consusption of fossil

fuels.

5. To integrate molecular, biochemical, structural and

physiologic data in order to understand the essential nature of enviromental disease as a result of the continuous and increasing use of fossil fuels.

Fractions by Microorganisns and its spplication vo Enhanced Heavy O11 Recovery,

?The production and upgrading of heavy and extracheavy crude oils today represents a tectnological problem and a strategically davaluable source

of energy. To help reduce the environmental impacts involved in the com

nercialization of auch nev energy sources and to define its full potestial én

the eahancaent of ofl recovery it Se proposed to continue exploring the

biodegradation of sulfur cospounds and heavy petroleum fractions by selected

groups of microorganisms. Microorganisms from two sites in Puerto Rico

(conco

1d Gulf Refineries) and impregnated soils from heavy petroleum pro ducing fields in Venezuela (Orinoco Petroleum Belt and Lake Guanoco) are

presently under study, with routine sampling for hydrocarbonoclastic nicroorganisas by direct plating and enrichment culture, A salts nediun supplenented with yeast extract {8 used to provide conditions for aerobic petroleum degradation and various media containing peptone or thioglycolate are in use for the anaerobic, lS producing biodegradation. The use of a

350-525°C high sulfur aromatics fraction QMorichel erude ofl) and a

---Page Break---

correspondiigly low sulfur-high paraffinic substrate (hana Anal crude) as well as bentothiophene permitsthe comparative assessuent of the isolated

microorganisas. ?The biodegradations are monitored by three different

parameters: The actual disappearance of the substrate fron bacterial. cul~ tures, ?by increase in the oxygen uptake by the bacteria in presence of the compounds and by comparisons of the chromatographic analysis of the bac

terial culture.

From that perspective, ve will study the extend and full effects of Dacteria in a petroleum reservoir. Our intentions is to establish

the basic eriteria for evaluationof

wenability of oft formations to bac~ teria treatuent. Tt is known that water-flooded ofl reservoirs of high Porosity and permeability hold the most prouise for positive results, for bacteria can effectively penetrate such deposits, and carry out their

reactions in situ. In addition, aerobic microorganiens can grow in the

earth, at the expense of petroleum, dow to depths of 7-9000 feet. We

propose to study the controlling factors in such biodegradations.

1 Objectives of this Project

4, Optimize the grovth conditions of the organisms that utilize or grow

in presence of petrosulfur compounds or components separated from

hhigh sulfur containing crude oil fractions.

44, Provide an assessnent of acrobic-anaerobic dual systens involved in

the degradation of synthetic mixtures of organo-sulfur compounds,

high sulfur crude oils or refinery wastewaters.

---Page Break---

Afi. Develop detailed mechanieus for joint efforts with the Venézvelan

covernment.

fv. Field teste on the in situ Biodegradation of heavy crudes utilising

selected microorganisas.

?vs Establish the practicality of the microbial of stimulation method

4 marginal vells and/or wells producing very heavy crudes and

selected from Venezuelan fields.

Rationale for selected Approach

From previous knovledge, several points should be taken into

4%, Laboratory and simulated field studies denonstrate that hydrocarbonoclastic bacteria ability to degrade hydrocarbons 4a related to the degree of hydrocarbon pollution of the isolation site. Evidence indicates that isolates frou the polluted sites effects greater degradation and that ofl degradation is enhanced especially ia the presence of sufficient nitrogen and phosphorus.

B.A single microorganisns will not possess the enzymatic capacity to netabolize all of the many compounds present in crude ofl.

© Compared to the saturate fraction, the eromatic fraction is less

easily biodegraded, susceptibility decreasing a8 the number of aro~

matic or alicyclic rings in the molecule increases vith sulfur containing aronatics roughly twice as recalcitrant as their non-sulfur analogues,

4. The presence at C. EE, R. of several bacterial isolates obtained from oil contaninated environzents from Puerto Rico and from different

areas of Venezuela's Orinoco Petroleum Belt and lake Guanoco.

---Page Break---

w6

?These organiss are able to grow and/or degrade benzothiophene and

crude petroleum fractions.

£. anaerobic bacteria which produces H,S from organic sulfur compounds.

as well as from crude oil, residue ofl, and asphaltenes have been

obtained fron of1 wells or bottoms of crude of] reservoirs and

refinery water treatuent gedinent

Svesific aims,

Since the b:

je analytical methodology have been developed and

lection of hydrocarbon degrading organisms is available it is pro

posed to:

4, Isolate and characterize quantitatively the petroleun degrading capacities of the more capable aerobic and anaerobic microorganisms.

, Study compositional changes originated by the anaerobic digestion

of heavy petroleus fractions and sodel sulfur compounds before and

after aerobic digestion and viceversa.

e. Study appropriatemethods for injection and recovery of cultures and

icrobe product mix respectively.

4. Stablish an inventory of failure -cavsing problens and trouble

shooting measures.

©. Monitoring and control measuresnesded to ensure the maintenance of

the desired microbial activics

{. Test the biod:

Vousual Features

4. The presence of at least 15 bacterial isolat

wradation products for mutagenicity and teratogenicity.

obtained from

heavily polluted sites and capable of growing in presence and degrad~

ing different fractions of erude ofl.

---Page Break---

we

. The convenience of having access to basic informetion regard-
ing the Venezuelan Orinoco Petroleum Belt and Lake Guanoco high sul-
fur extra heavy ofl reservoirs.

?. The long standing personal relationship existing between the key
energy officials of the Republic of Venezuela and our research group
which permits us to collect onsite Venezuelan soi nicroorganisns
?adapted to heavy oi! environments and to initiate badly needed
esearch on production and environmental aspects of heavy crudes under

ship of the Federal Department of Energy. This fact opens

the spon

?an excellent opportunity for nore anbitious cooperative agreenents

4in areas of mutual interest involving the United States, Puerto

Rico, and the principal South Averican o{1 producer (i.e., microbial

6 useful in enhanced of recovery).

4. This project represents the first and only project ever conducted

in Puerto Rico davolving research on the production and environmental

aspects of high eulfur heavy oils and petroleun couposition and is a

basic undertaking from which local scientists could start contribut~

ing to our fossii energy probleas particuarly if comercial crude

oft deposits a

Benefits of Proposed Work

Te is known that crude of1 and petroleum products discharged at the

found on the North Coast of Puerto Rico.

water surface are rapidly modified under the effect of physico-chemical

and biological transformations, themselves closely dependent on

---Page Break---



ecological factors. Advancing on that experience, this research in

progress will help:

Understand the microbial degradation of heavy crudes and/or heavy

oil fractions when discharged into the environment; particularly

the anaerobic degradation of hydrocarbon

something of great signi-

ficance to understand the formation and alteration of foseil organic

materials.

bb, Increase knowledge a8 to how o;

cific heavy of might behave sub-

sequent to a spill, before the spill takes place in order to antici~

pate the consequences.

?. Understand the behaviour of che aromatic sulfur heterocoupounds in

potroleus, substrate hard to biodegrade, when exposed to microorga-

?nisns adapted to grov in the presence of high sulfur heavy crudes,

?and/or model petrosulfur compounds

4

Improve our knowledge on the trestment and disposal of effluents

and industrial wastes

fe, Improve our knowledge in microbiological processes useful in

enhanced off recovery.

£. Bvaluate the relative toxicity of biodegradation products fron heavy

oil fractions of low and high sulfur content and explore health and safety considerations asociated with the handling of large anounts

of cultures under Field condi ions.

---Page Break---

wo

Project Bi Comparative Toxicities of Petroleus Water Soluble Fractions and

Biodegradation Products on Tropical Marine Organi:

This project will provide results on a two year laboratory study of

the effects of petroleun fractions on selected tropical marine organians.

?The fractions of intereat will also he subjected ro the action af petrntenm

degrading microorgenisas isolated by culturing in aromatic substrates. The

study will be conducted by @ multidisciplinary team of researchers fron the

Center for Energy and Environment Research in Sen Juan, Puerto Rico. Since

increasing avereness is present about the need for information on the effects

of crude ofl on tropical marine organisas and particularly the effects a

release of crude ofl will have on comercially inportant species of sarine

organisns, ve have decided to enploy well characterized fractions of crude

of1, to chemically analyze the water soluble fractions (WSF), to conduct com

parative studies on the sensitivity of different Life stages of tropical marine species exposed to different WSF, to expose the test fractions of crude ofl to the action of petroleum degrading microorganisms and compare the relative toxicities of the resulting WSF, to conduct histopathological observations,

and to determine the rate and degree of uptake and depuration of hydrocar- bons by selected species of organisas vhon they are exposed to sub-lethal concentrations of the water-soluble fractions of Venezuelan and Libian

igh boiling distillates.

Most previous bioassay studies on the effect of ofl on organisms are of

?Limited value because "the concentrations of ofl that the test specios

---Page Break---



were actually exposed to in these studies ai

alsost conpletely unrelated

to the enount of ofl used to prepare the test solutions" (Rice et al 1977).

?Therefore, well defined vater-soluble fractions will be used during expo

sure. Fractions will be characterized by modern analytical techniqu

+ and

obtained froa high sulfur-aronatic content and high paraffinic-low sulfur content crude ofls of significant comercial value. Due consideration to nixing energy, mixing duration, viscosity of the test fractions, pl, sali-

?nity and temperature will be taken. In addition, since microbial orgeniens

?and evaporation seens to be by far the main cause of the decline in oft

concentrations with tine in bios

8, ve will study the biodegration of

selected oil fractions and employ a high boiling petroleum distillate from

which

lected fractions will be studied. After biodegradation of the

Fractions of inter?

t the resulting water soluble compounds will be tested for its toxicity on marine organisns. This will help determine the contribution of biodegradation to the toxic effects on marine organisns of selected ofl fractions; of particular interest vhen prinary substances

of low solubility such as polynuclear aromatics are used as the test

fractions. Biodegradation studies on test fractions vill help establish

4£ the sane relative toxicities apply when the primary test substances are subjected to biodegradation conditions. We feel this is important since in the past the presence and toxicity of polar hydrocarbon deriva tives of polar oxidation products of oil hydrocarbons have generally been ignored. The use of sore effective analytical techniques will help us unravel the difficult problen of identification and quantitation of the water-soluble test fractions and the rate and depree of uptake and depu-

ation of hydrocarbons by tropical aarine organisas.

---Page Break---

Objectives of this Project

4. Principal Objectives

1, To compare the sensitivity of different Life stages of tropical

marine species exposed to various well defined fractions extracted

from a high boiling point cut (350-525) of two crude ofls uti~

Lizing both static and flow through techniques.

2. To determine the relative importance of individual fractions of

saturates, mono-aronatics, di-aromatics, acid, basic, nitrogen

?and sulfure concentrates in regard co the acute toxicity of the

test organisns under various conditions of tesperature and organic

substrate concentrations.

3. To conduct detailed chemical characterizations of the test solu-

tions at various times during the experiments and to test for flected species, eo that the

longer periods of time feu

relationships between oil concentrations that are toxic for short

?and long exposures can be deternined.

4, To expose selected crude ofl fractions to petroleum degrading

icroorgantons in order to study the relative toxicities of their

vvater phase soluble products.

5. To conduct histopathological observations and to determine the

and degree of uptake and depuration of hydrocarbons by

species of marine organisns when they are exposed to sub-Lethal

concentrations of the water-soluble fractions of Venezuelan and

Libian high boiling distillates.

b. Subordinate objective

?To coupare the results obtained in this study with those reported for the tenperature rone, Care must be taken since there will be

Aifferences in test ois, temperature, salinity and test procedures.

---Page Break---

wz

Bes ind/or Benefits Expected

4, Heavy and Light crude ofls like the ones to be used here are

defined in Puerto Rico and the effects of ol spills on certain

?tropical marine organisas nay be predicted. Thie will improve

?our understanding of hydrocarbon uptake and depuration by marine

oxganians.

b. The relative inportance of the major components present in two

petroleum distillates boiling between 350-525°C will be noted.

Chemical studies on the principal constituents in the water soluble

fractions will be conducted and differences between the various

petroleum oils euch

how oi concentrations change with tine

recognized. As a result, information on the fanilies of compounds

that occur in the test mixed substrates and suspected of having

deleterious properties will be gathered.

©. Toxic effects of biodegradation products will be assessed using

well defined substrates, single or mixed cultures of microorga~

nisms, and test marine specimens.

4. Better understanding of the role of microorganisas in resoving

ofls from the marine environment.

er Indic isms of a Tropical Refinery Efflvent

Bathway

Tt 4s a well known phenomenon that water quality influences the compoition of aquatic organisas in both species diversity and abundanc

---Page Break---

was

example, man's activities, which introduce excess nutrients along with

other pollutants

4into lakes, streams, rivers and estuaries are causing

significant changes in aquatic environments. Excess nutrients greatly

accelerate the process of eutrophication and putrescible organic matter such

a8 domestic sevage also reduces dissolved oxygen concentration and number of

species while a few species become exceedingly abundant. On the other hand,

?hen other contaminants containing toxic substances are introduced into a

riverwith inadequate dilution, most Life is eliminated.

Bavironsental effects of oil pollution and bioassays on the toxicity of

ofl and its couponents have been Limited mainly to the Tesperate Zone, vheress

{in the tropics vere enviromental conditions are quite different, practically

10 published work is available. It is proposed that a series of tropical oil

Pollution environmental studies be considered. The first and most obvious

study is to characterize organisns which are tolerant to continuous exposure

of oi2 and an ideal location is the Caribbean Gulf Refining Corporation

Gayanén) and its surrounding environment. Subsequent detailed studies

should include hydrocarbon concentrations accumlated in organisas, bottoa

sedinents and water, bioassays and mutagenesis.

---Page Break---

wea

Tn 1955, the Esso Refining Coupany (BayanGn) vas established and was

later acquired by the Caribbean Gulf Refining Corporation in 1962. Prom

1962 to 1977, euadorian exude ofl was comonly processed and during the

Past two years, a mixture of Santa Rosa condensate and Leona crude oft

from Venezuela is being refined. At present, sbout half of @ million galons of vastewater perday are discharged into a freshwater stream, namely, Jas Lajas Creek. This creck unites with the Malaria Control Canal (Las

Cucharitias Canal) before discharging into San Juan

xy and covers a total distance of 4 river km.

Personal observations and those by residents Living along the Malaria

Control Canal have noted that surface water off filme in the canal are comon. It should also be noted that apparently there is no other industrial discharge in the effluent pathway of Gulf Refining Corporation and sone of

the re

its of the proposed study will be compared with those of @ pre~

vious ecological survey.

Objectives of this Project:

4. To determine the levels of hydrocarbons in the tropical freshwater

effluent pathway of a petroleum oil refinery that would be tole-

rated by certain organisns so as to help set permissible level

fuldelines. Special emphasis will be placed on the concentrations

of total saturates, polars, and aromatics on bottom sediments and

?water samples and tolerant organisms associated with these com

Ponents of the ofl refinery effluent.

---Page Break---

Wels

b, To identify organiems which may be used as indicator of oil

pollution.

¢. To biomonitor sensitive species observed at control stations in

the freshwater stream exposed to the ofl refinery effluent.

Results and/or Bonefits Expected

Inplications of the proposed re

ch to of pollution originating from

Potroleu producing or refining operations, environsental inpacts associated

?with coal consuming pover plants, and the chesical characterization of botton

sedinents in heavily polluted water bodies are significant and profitable

imowledge should be gained from this experience.

?Project Di Biological Degradation of Sulfur Construction Materials and the

Effect of Microbial Inhibitors

THIOBACILLUS THIOEIDANS, a bacterium implicated in the degradation of

conerete will be added to sulfur concrete bars, sulfur-based composite coat-

ings for concrete protection, and to a Calgary "Pronk" sulfur asphalt. San

ples to be used in the work will be aupplied by local and foreign private

firms, The test bars will be imersed in a sulfur free synthetic sales

ediun at 26°C. Changes in the pk of the media, in bacterial cells numbers, and in the flexural strength of the test bars will be determined. Also, ve

will study the presence of any surface etching in the test specinens. Com

sercial biocides will be selected and incorporated in the sulfur couposites and

ite {nbibition properties studied as well as any leaching of the bactericide

into the media. Leaching effects of the inhibitor in the sulfur concrete, for

?example, will be considered as @ function of the type of composite formlation.

Finally, an Anes! Mutagenicity Test of the biocides of interes wili be made

---Page Break---



to assess any potential environmental effect associated with the biocides

in sulfur composi

?The couposites of interest are new technology materials of potential

impact in energy conservation, present unique advantages for the protection of masonry, concrete, and other surfaces exposes to the corroding effect of

sea vater, for Mining water inpoundaent ponds, ete. Sulfur coatings and concretes show great resistancets acids and salte having other physical

and structural properties of great potential

4 material for special

applications in regard to the OTEC project.

?4. Principal Objectives:

1, To delineate the extend of sulfur composites biodegradation under laboratory controlled conditions and under tropical field conditions 4n the presence of sulfur-oxidizing bacteria and/or anaerobic and reducing bacteria.

2. To establish the populations of sulfur degrading microorganiens, pil

and sulfate levels in the media at different periods during the experiments and to help define vhat significance this may have on the performance of the composites in their intended end us

3. To explore the effect of several conmercial bactericides to protect the sulfur composited? fron biodegrédation,. and ?to! gee if they Teach out of the composite or dffect tke structural strength sf ie} ese ?material.

To test any offective microbial inhibitors to be used, in thia study

4

for mutagenicity.

---Page Break---

wey

b. Subordinate Objective

?To generate badly needed information on the short and long term expo-

sure to microbial organiens of selected sulfur composites of comercial importance. These materials already have attractive potential insulating and/or constructional applications by utilizing the lov thermal conductivity of sulfur and/or the ability of eulfur to act as a bonding coment. The importance to energy conservation and to the recycling of a valuable ele~ ?ment in growing over supply as « result of the increasing consueption of high sulfur natural gas and petroleua'is obvious.

Project Ei The Characterization of Airbone Particulates and their Toxic

Properties in Selected industrial Environments

Selected hydrocarbons

and other air contaminants in particulate matter

in a heavily industrialized site in tropical Puerto Rico will?be isolated, identified, and characterized by various chromatographic and spectronetric means. Initially efforts will be dedicated to explore the peculiar toxico~ logical potential of the emissions producted in the South Coast petroleum petrochemical complex followed by sinilar studies in the Cataio industrial Park, Base Line studies associated ?vith recently proposed coal operated pover-plant will be pursued as a result of the initial work Special effort Will be dedicated to establish the size distriburfon of airbone particulates nd to identify the nitron and sulfur containing plycyclic aromatic hetero- compounds, volatile hydrocarbons and potentially toxic trace elewents. + Aassociated mutagenic and teratogenic effects of selected fractions vill be studied in an effort to define sose toxic properties of help in predicting

potential hazardé concerning hunan health. Knowledge of computer simulation

---Page Break---

wes

and modelling, composition and size distribution of particule material,

chemical transformation of pollutants and its associated toxicological

effects vill support bionedical studies in Puerto Rico dealing with a

very wide spectrum of personal disconfort and i110

Objectives of thie project

a. Principal Objectives

1, Initiate a systematic effort to characterize potentially toxic

felenents and organic constituents (especially sulfur and nitro~

gen derivatives) dovmvind and upwind the neighborhood of « petroleum

petrochemical comple:

2. Correlate the principal families of compounds (group-type analysis)

detected with their possible mutagenic and teratogenic effects.

Exeracts from particulate matter of various sizes willbe obtained end

evaluated for biological activity.

3. Improve our knowledge of sources of toxic substances by studying

airborne particulate composition with an orientation to establish

(a) Af the particulate matter in the south coast industrial complex

is responsibte for ispacting the atmosphere from neighboring cities

downwind from the cosplex and (b) if the particulates bearing these

contaminants are suall enough to be deposited efficiently in hunan

tungs.

b. Subordinate Objectives

4, Bnploy air pollution computer simulation methods to correlate the

chemical nature of the contaminants which the prevailing meterology

of the region.

---Page Break---

wei

2. Conduct research in areas remote from immediate sources of pollution

to provide background values in areas directly unaffected by point

3. Train research scientists and students Sn environsental health

research by developing an interdisciplinary research program to increase our knowledge of toxic substances in the environment.

This project attenpes to:

4, Improve our knowledge of the chemical composition of the volatile hydrocarbons and the acidic, basic, nevtral, and polar fractions iso- laced from aizborne particulates in the neighborhood of « petroleus-

petrochemical environment. This is necessary to obtain a better unde!

standing of the potential health hazards associated with the transportand penetration of particulates into the respiratory aysten fron petroleum ?oF coal consuming operations.

b, Measure both the size distributions and chemical composition of per-

ticles in anbient air, inorder to understand the sources, and the behaviour of airborne particulates in the atmosphere. Observations on size distributions of trace elenents and/or key organics in particulates, Af sufficiently distinctive, could be used as a means of source iden tification if data on size distributions of particles from specific types of sources were available.

©. Correlate toxic properties such as mitagenic and teratogente effects

with the chenical composition of selected test fractions.

---Page Break---



?The proposed research will be of significance also to:

18, Cancer epidemiology studies undervay in Puerto Rico as well as field,

clinical, toxicological or laboratory investigations to be undertaken

as a result of this effore.

, Help initiate work tovard establishing « danage function for the

Guayanilla-Peiuelas area. This will serve to stimulate Puerto Rico

researchers in planning studies oriented to characterize the nature and

?magnitude of the population at risk affected by given levels of pol durante.

©, Strengthen the infrastructure for complex compositional studies elated to the atmospheric emissions arising from coal or coal-oi! slurries combustion pover plants. These fossil fuels are alterna tives presently under the active consideration of our government energy policy makers. Studies on the nature of air enseions will affect decisions regarding control techniques or after combust ion.

4, Provide public officials with an effective data base for efficiently

allocating Limited resources anong the many conflicting demands for

pollution control and other aspects of social welfare.

©. Act as a vehicle for the training of environmental health scientist

?and for continuing mission oriented research in Puerto Rico.

Rationale for Selected Approach

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Project A

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Desonstration

Bducation & Training

Project

Basic Research

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Education & Training

Project ?

Basic Research

Developsent.

Denonstration

Education & Training

Project D

Basic Research

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?Training & Education

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Basic Research

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?Training & Education

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TABLE 1V-3

FOSSIL FUELS RESEARCH

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Program Budget Distribution Classified

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SOLAR ENERGY PROGRAM

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SOLAR ENERGY PROGRAM

Introdyetion

?The goal of the solar energy progran of CEER/UPR is to help

develop at the earliest feasible tine comercially, attractive

and environsentally acceptable applications of solar energy. The

high insolation rates in Puerto Rico is an important factor which could lead toward the demonstration of econonic conpetetivencss by DOE sooner then in any other U.S. areas. Average daily total Ansolation recently measured at Ponce, Puerto Rico at 18* latitude indicates a value of approxinately 1950 BTU per oa.ft. per day on @ horizontal surface.

Solar radiation is readily converted into thermal energy, electricity and clean fuels through conversion processes and

systens that are accepted as technically feasible. The important

ext phase is to design and prove practical, reliable, economical syatens.

?The high levels of solar energy over Puerto Rico make. it Possible to consider systeas that provide thermal and/or electri~ cal energy at the point of use, At the same tine there are two disadvantages of solar energy that pose challenges to development of economical solar energy systems and to innovators in research ?and technology. First, sunlight provides a relatively sual energy flux density coupared co that obtained in pover systems using fossil or nuclear fuelss that is, its natural intensity is

relatively low presenting a technological challenge to achieve

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economical conversion to useful foras of energy. In addition, direct application forms of solar energy are intermittent and variable due to daily, seasonal, and environmental effect. The

direct energy conversion systens mst be designed either to

utilize the energy when it is available, or in conjunction with storage and vith back up systens using other fuel sources. Solar programs supported by CEER/UPR include systematic solar

aa

acquisition throughout Puerto Rico, solar cooling of buildings {in tropical regions, generation of electricity from photovoltaic conversion of sunlight, industrial solar process heat end solar saterials research, A summary of ongoing solar energy areas and involved organizations are shown in Table V-A.

Duting the five year program emphasis will be continued and

?expanded to involve private industry and enterprise in all

Phases of the solar energy research, developsent and demonstration

Program in order to accelerate the transition of solar technology

to the comercial sector.

?As @ reoult-of research and development projects undervay

and planned it is anticipated that by 1985 solar energy syatens

ike solar hot water heating, solar cooling and agricultural

applications will start to have their comercial impact at

competitive prices for selected application:

Some technologies

Like solar photovoltaic and thermal power generation can be ready

for Large scale utilization by the late 1980's.

?The major problem in each technology area is to develop

systems that are economically acceptable to the public and

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commercial sectors. This requires innovative engineering as well

?a5 new and improved approaches to solar energy collection, energy

storage, transport and conversion; nev systes approaches; and,

perhaps most importantly, investigation of new and cheaper aterials to improve system performance, reliability and economic

attractivene:

GEER will also help to solve important problens dealing vith

environmental, social, legal, regulatory and econonic factors

sociated with widespread utilization of solar energy systens.

PROGRAMS

AL Solar

twork for Puerto Rico

Im order to properly design solar energy utilization syst ong term trends in availability of solar energy in diffuse and Sirect form should be know. The strong variations in the micro~ clinate distributions in Puerto Rico requires establishment of a

number stations to obtain accurate data for the

pecitic site of

?This progran plan has as its major goal the development of a continuing network throughout Puerto Rico, for the collection of

total and diffuse solar radiation data. Through this network,

?accurate, consistent and orderly data will be gathered and analyzed and tabulated. Four monthly insolation data reports for each site

containing relevant paraneters will be published periodically for effective dissemination of inforsition.

?According to the pattern of the microclimate distribution and

anticipated potential for solar activity, following solar data

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ves

stations will be established and operated at least one full year or

wore: 1) Rfo Piedras, 2) Mayaguez, 3) Ponce

ist the customer and

of this program is to a

the small but viable Puerto Rican solar water heater industry by

testing comercially

categories under tropical conditions to provide then ith characte~

istic data, The eaphasis wil be on determining the long term

climate/performance requirenents, methods of integration with

existing hot water systens, characteristics of existing use patterns

?and cost performance characteristics of the tested system. The

results will be sumarized in a simple handbook for dissenination

of information.

Industrial and Agricultural Process Heat

?The objectives of this program include design development, test

in and help in denonstrating solar proc

18 heat application systems

In the stat

industry accounts for about 40z of the energy

consused. If non-substitutable electricity use end feed stocks are

substracted, the fraction is about 30%. Recent data indicates that

the sane percent ratio's are also val{d for Puerto Rico. Because

of this large size this denand is a very attractive target for solar

energy use.

The highest use potential for solar heat are those industrial

Processes that require hot water and low-temperature (<350°F) steam.

?WHtations already operating

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?These uses represent about one-third of the energy required by

industry.

?The use of solar energy to provide industrial heat is in the

denonstration stage. The hardware neces:

wry for these solar uses

is mostly available and the renaining constraint to ite wide-spread

?use is economical because of the high cost of the solar collectors.

GEER progran recognizes this and has focused its efforts accordingly.

In the industrial sector, most current demonstrations focus on

providing hot vater. The hardware for these uses is essentially

tie vater heating.

the same flat plate collectors as are used for dont

Hovever, the production of industrial steam is less advanced because

the required collectors are sonevhat less developed. Yor these high

tesperatures evacuated and/or concentrating collectors are required.

?The major Rand D efforts in CEER program is the development and

testing of a high efficiency, low cost concentrator resistant to

tropical island conditions. The progran also emphasizes participation

?in ongoing denonstration projects according to DOE's National Progran

Plan for Research and Developnent in Solar Industrial Heat.

This program also contemplates extension of industrial process

heat progran to include agricultural and biomass applications as

well as to include other important temperature ranges as shown in

Figure Vol.

Solar Space Cooling

?The objectives of CEER's cooling progran is to conduct research

and development designed to assist in creating a viable solar

---Page Break---

industry for Puerto Rico. The specific objective of the directed R

. and D is to provide the energing solar industrial base the materisle,

in the tropics.

?components and information needed for cost effective cooling =)

DOE's R and D progran on cooling has been very extensive and ie

built upon the development of specific approaches, called paths.

Following paths have been identified for solar cooling:

PATHS TO SOLAR COOLING

ENERGY soURcE/ ENERGY COLLECTION/ ENERGY

SINK EJECTION [CONDTTTONTNG

un Liquid-Heating Desiccant chiller

collector

2. sua ?Air-teating Desiceant chiller

collector

3. oun ?Advanced Yon-Concen- Absorption oF

trating Collectors Rankine cycle

chiller

4. oun Concentrating Non- Absorption or

Tracking Collectors Rankine cycle

chiller

5. oun Concentrating Track- Absorption or

ing collectors Rankine eyele

chiller

6, environnent Night Effect

cooling

. ?environaent Bvaporative Cooling

APPLICATION

Space Cooling

Space Cooling

Space Cooling

Space Cooling

Space Cooling

Space Cooling

Space Cooling

Special conditions in a tropical/subtropical region as they exist

in Puerto Rico, require 2 cooling eyaten vhere most of the energy is used to remove the humidity from the ambient air. R and D at the CEER

?is concentrated on the development of  s1

fen very close to the one

---Page Break---

v3

described in path 2, (i.e., a conbination of a highly advanced evacuat-
4 air collector in conjunction with a solid/sater desiccant chiller.
The tasks involve the testing and analysis of the air collector, as
well as the development of the technology for its fabrication. The
interfacing of the collector with the desiccant systen and the overall

design is a major part of the program.

E, Photovoltaics

The overall objectives of the Photovoltaic Conversion program is

to help to develop economically viable photovoltaic electric power systens (PEPS) suitable for a variety of terrestrial applications and

requirenents

pable of providing a significant amount of Puerto Rico

by the year 2000,

To accomplish the sane objectives for U.S.A., the Department of

Energy has set up goals involving following eub-prograns:

A. Develop practical low cost solar photovoltaic arrays

2. Perform detailed PEPS analysis, cost and integration

evaluations necesarry to characterize eubsyatens and

?components in these power generating systens.

3. Develop low cost, energy efficient processes required

fo fabricate photovoltaic array

Develop technolgical and research base for further

improvenent in photovoltaic material, device and

systen capabilities.

5. Perform carefully planned experinents and demonstrations

with flat and focusing photovoltaic systems.

Jn accordance with DOE's pragran goals CEER will concentrate on

the following sub-prograne:

1. Conduct advanced photovoltaic materials and solar

cell research,

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2. Perform conceptual design studies of photovoltaic systens

for an on site residence, central power station and

intermediate pover station.

Perform assessment studies on cell manufacturing technology in Puerto Rico.

4, Market analysis assessuents for photovoltaic application

systems in Puerto Rico.

Participate in competitive DOE prograns for systens

denonstration projects,

Solar Thermal Pover Generation

?The conversion of solar energy into electricity is a problem with

4 variety of possitle solutions. One method is solar thermal

conversion. The conversion method utilizes various types of solar

collectors to generate steam which drives a turbine and generator

to produce electricity. Only the solar heating of the boiler

Aistinguiehes this cycle from that of # coal or gas fired plant.

?This use of existing pover-technology is a major reason that solar thermal pover systeas are being studied for future comercial

applications.

?Two major types of solar collecting systems are being developed

for solar thermal power systens:

a) Central Receiver (Power Tover)

b) Distributed collector systems

Central Rece!

jer syatens consist of a large tower surrounded by @

field of tracking mirrors which concentrate the sun!

rays onto a

boiler located in the top of the tover. Distributed collector

systens consist of a thermally coupled field of sasller mirrored

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vel

concentrators that focus the Light onto a focally positioned receiver.

The thernal energy in form of steam ie then fed into central power

bolic eroughe

generating equipment. Possible collector types are pai

(ine focus) or parabolic disches (point focus). For high temperatures

to be maintained at the receiver, these systess must track the sun

across the sky by moving either the concentrating mirror or the

receiver.

?The planned goals of the Solar Thermal Prograns at the CHER ar

1) Help to provide a full technology base for the production of theraal-electric power conversion in the late 1980's to meet the utility requirenents for load-folloving or intermediate load electric power generating systems,

2) Welp to provide a full technology base for total energy systens for urban complexes, rural communities ?and industrial parks.

To achieve the goals of the Solar Thernal subprogram area the following objectives have been established:

1) Design, fabrication and testing of prototype components and subsystems that are critical to

tthe success of the distributed collector system concept.

2) Bvaluation of total energy systen applications

for urban and rural communities and industrial

parks.

3) Investigation of critical interface problens

Of solar thermal electric systens and total

energy systens.

4) Research and development of materials, components,

yyateas and concepts.

5) Continued cost benefit studies to identify cost and

performance criteria for components, subsystens and

systeas.

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ECOLOGY PROGRAMS

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VE ~ ooLOGY PRocRANS

A. Ecosystem Structure and Process Studies

?Any energy developaent can be expected to have effects

?pon ecosystems. Prediction of the quality direction and

magnitude of these effects depends upon understanding of the

normal composition and functioning of the systess upon which

they impinge, The objective of CEER studies of tropical eco systens is to develop such understanding, A number of sepa~

rately funded projects contribute to this general goal. A Aarge fraction of the ecological studies for the Ocean Thermal Energy Conversion (OTEC) Program is of this nature but has been singled out for special treatment because of its Linkage to a specific developing technology. Studies for industrial ?siting (as in the case of power plants) are included here as fare the more basic backgroud studies of cycling and transport in the rainforest. Plans by the local electric utility to build « coat plant, ofl and mining exploration for copper and fckel has been factored in, Also included are the Long Tera Ecological Research studies being developed for possible NSP funds in collaboration with the U.S. Forest Service Institute

of Tropical Forestry, The National Bavironmental Research Park

will provide the organization for much of the above mentioned

terrestrial ecological work, These are expected to continue

series of basic ecological research atudies on individual

species by individual investigators. These are also included

for accounting purposes here.

---Page Break---

vee

Obviously, thie program of studies overlaps with the

wore specifically directed "Ecological Effects Studies".

Information generated in such progran will be utilized by

the others.

Projects

?ove (Progran FMnding included under OTEC Progran)

Nationa Environmental Research Park

Cycling and Transport in Tropical Forests

Long Term Geological Monitoring

Indostrial siting

Miscellaneous Basic Ecological Studies

yeling and Transport Studies in Tropical Eeosystens

studies is to understand the proc

The objective of the

ses of cycling and transport of materials in tropical terres trial ecosystens in order to be able to predict the effects of

?energy development upon these basic processes,

RESOURCES MANAGEAENT STUDIES

studies ained at the re

water, soil, biological and

industrial wastes and wildlife especially vhere man's activi~

?es impact upon these, Present prograns include bioreclanation

of water and wastewater, magnetic separation, factors influen-

ing land crab survival and sovage composting. Puture prograns

?are anticipated in land disposal of wastes, miriculture and

aquaculture,

---Page Break---

vies

Beological Effects Studies

?This program emphasized experimental or correlational studies explicitly directed tovard the investigation of

specific perturbing factors and in that senee more applied.

It As clear that the "Ecosystem Structure and Proce:

studies

will contribute to a background for effects studies and that

the study of specific perturbations will reveal important

features of structure and process simultaneously. In this

category of research will fall the following sorte of projects.

The measurenent of assinilative capacity

The aspects of intensive biomass culture on ecosystens

(12 spilt recovery studies as in Bahia Sucia (or pos

sible oil drills in northern P.R, seas).

Guayanitla Bay Hermal, mercury and hydrocarbon effects

studies

---Page Break---

vib

TABLE VI-1

9K BooLOGY PROJECTIONS

A, Heosyetem Structure and Process Study

Project

National Environmental

Research Park

ycling and Transport in Forests

Long Term Ecological Monitoring

Industrial Siting

Miscellaneous Basic Studies

rorats,

3. Resource Managenent Studies

Project

Bioreclanation of Water

Physical/Chenical Water Treatnent

Water Use and Reuse Studies

Waste Disposal Research

Aquaculture and Mariculeure

roras

C. Ecological Effects Studies

Project

Energy Pollutants ~ Marine

Biomass Culture Effects

Energy Pollutants ~ Terrestrial

rorais

GRAND TOTALS (Ecology excluding

?oTeC)

100

200

600

200

2400

150

150

300

150

850

400

150

50

600

2850

Fr dodger x

Bh S

200 200 200

300300300

200 200 200

175300500

200 200 200

10751200 1400

200 200 200

soe

200 200200

250 100 100

200 200 200

300 700700

250 200 200

os

300 50200

500 400400)

2075 23002500

200

300

200

1500

200

200

100

zB

200

250,

450

2650

---Page Break---

TABLE VI-2

PERSONNEL MAN YEARS - ECOLOGY

Hcosysten Structure and Process Studies

82

Scientific staff 4

Technical staff 4

Administrative Staff 4

Resource Managenent Studies

Scientific staff 10

Technical staff 10

Adsinistrative Staff 3.5

Beological Bffects Studies

Scientific staff 8

Technical staft 8

Administrative Staff Ls

Totals

Scientific staff 2

Technical staff 2

Administrative Staté 3

Total state a

3

10

10

10

10

35

Ls

a

7

6

2

2

Ls

6

26

61

35

4s

Ls

30

30

6

---Page Break---

TABLE VI-3

?RESEARCH TYPE ECOLOGY PROGRAMS

WSK

Kind of Regearch 2 83 a 86

A. Eeosysten Structure and Process Studies

Basic 308 236 266 308330

Development. 1036 796 88810361110

Denostration oe

Education & Training 5 4 48 56 Go.

B, Resource Managenent Studies

Basic 8 9 7% 70 70

Developaent 366 387 301 301301

Desostration 340360 280 280280

Education & Training 6 63 4949 a

©. Reological Effects studies

Basie 90 75 66] gs

Developaent 360 300 240 240270

Denonstration 150 125 100 100 le

Education & Training o 0 0 6 0

Totale

Basie 482 401 39443868,

Development 1762 14831429 15771681

Denonstration 490 485 380 380 392

Education & Training 16 106 97 105 _ 109,

2850 2475 2300 2500 2650

---Page Break---

(sxorauas x01 9 sTvrwmiva any ixanaIaba x7 ?aNNOswE

9 SV cauneraxsio) aHLaISSviO ~ NoLZART¥ISIa TI0aNe WEDOLa AOOI0OR

oa sav

---Page Break---

ENVIRONMENTAL HEALTH

---Page Break---

vm.

viet

Environmental Health and Impact Studies

Introduction -

?The major environmental health problems in the pas

for Puerto Rico were Malaria and Bilharzia, the par~

tic diseases spread by vectors. Construction of

in the south

hydroelectric and irrigation syst.

coast during the 1920's touched off a bilharzia ep

demic that vas only recently brought under control

Malaria was eradicated in the late 1940's. The Environmental Health Division has studied biological

and environmental methods for control of bilharsia

related to hydroelectric reservoirs in Puerto Rico

and the Doainican Republic. Evaluation of the in-

fection rate by means of the ekin test (indirect

hod, 1974) was performed in a representative s.

ple of fifth grade classrooms throughout the islan

to corroborate the decrease in transmission of this

@isease as compared with equivalent surveys performed in

1963, and 1968.

Since 1978 the Division has been analyzing respiratory

disease mortality to determine geographical distribu-

tion, by means of crude attack rates, and age

justed

attack rates and investigating the reliability of the

mortality data by examining the hospital records of

---Page Break---

vur-2

the deceased by means of a representative sample of

the 1976 deaths in Puerto Rico, Twenty-eight years

of respiratory cancer data is being analyzed to de.
termine the trends of this disease in the ieland.
Correlation of these data with known air pollution

vill be performed to develop more detailed

studies in euch a

?The future work of this division will be directed

towards the following Projects
A, Mortality and Morbidity Respiratory Studies

Prospective studies of mortality and morbidity in

areas with relatively high incidence and prevalence

of respiratory diseases mortality which is associated with energy producing pollution soure

2 Catazo,

Yabucoa, and Guayanillas ar

3. Mortality Studies (Water Quality related

Prospective studies of mortality on Cardiovascular,

Gastro-intestinal and Renal diseases and its relation

with water sources, geographical distribution, prev-

alence, incidence and the correlation of such factors

to perform specific studies of mortality and morbid-

ity in areas which ai

trate positive correlations

and trends, Also establish bio-monitoring with Marisa

gomnuarietis in the water bodies to

termine contan-

imants present ifchis method is fe

ible,

---Page Break---

vi-3

©. Disease Morbidity Monitoring Related to Alter~

native Energy Sources-CEER personnel

Develop disease (morbidity) monitoring of the CEER Personnel that will be working with new sources of

Energy for Puerto Rico (Solar Energy, OTEC, Bio

and others). This will be an area that will grov along vith CHER's total grovth in time. We will per: form surveillance and special studies of outbreak

as they occur. Later, if justified, more detaile monitoring vill be performed, to determine cause and effect, develop preventive measures for such dis~ orders. Establish the type of health criteria to b used in determining the capabilities of an individual to be hired to perform « task within a given project according to the risks to which he will be exposed

and the periodical determinations to be made once he

hired to monitor disorder development.

D. Schstosomiasis Studi

Develop schistosomiasis projects with the Dominican

Republic Institutions in r

arch and control of this

@isease in their country. The areas to be considered

WILL be training, surveillance, evaluation, biological

control and environmental modifications. In Puerto

Rico Irrigation Canal studies and Marisa infectivity

with S. mansoni, Rice fiel

eraneni,

fon project with

---Page Break---

caribbean countries

B, Environmental 6 Occupational Morbidity -

Energy Production Related vith Industry

Develop retro:

ctive and prospective studies with

energy producing institutions within the island to

determine high risk environmental and occupational

morbidity and recommend solution to such proble

The five proposed areas of research are to be unde

taken by the Division of Environmental Health and

Impact on its own but there are several other areas

which could be developed in cooperation with Fos

Fuels and Terrestrial Ecology.

---Page Break---

Project

Project

Project

Project

Project

roras

vrs

TABLE VII =!

[ENVIRONMENTAL HEALTH

(fotal Budget-in thousands)

20

600

265

145

760

210

no

40

us

850

86

385

205

x20

30

160,

940

---Page Break---

vis

?rapt vil-2

[ENVIRONMENTAL HEALTH

?PERSONNEL DISTRIBUTION

Project A - Mortality and Morbidity Reapiratory Studie

Scientific staff 1 a 1 1 1

Technical staff Ls ols 1s Ls Ls

?Adainistrative Staff 2 2 2 2 2

Project B ~ Mortality Studies (Hater Quality related)

Technical staff

z

Scientific staff Y

1

Mainistrative Staff 2

Project ¢ ~ Di

vase Morbidity Yonitoring related to Alternative Bnery

Sources CHEK Personnel

2 8 %

Scientific Stat aoa os .

Technical staff ns i ls is

Administrative state 1125132 20

Project D ~ Schstosontasis studies

2 86

Scientific staft 1 L

Technical staff ?5. ?s

Aiministrative Stage 125 tas

Totats 2 6

Scfencieie seaft 2.10 3.50

Technical Staff as $50

Administrative Staff 7130 8235,

?i Stat was 18.25,

---Page Break---

vu?

TABLE VEI~3

EAVIRONMENTAL HEALTH BUDGET DISTRIBUTION BY TYPE OF RESEARCH

ALL Projects ($k)

2 BS 8k

Basic Research 600 605760850 940.3755

Development a

Denonstration ce

Rdveation & Training - - - - - +

---Page Break---

ENVIRONMENTAL WEALTH BUDGET DISTRIBUTION BY: CLASSEFECATION

Al Projects

?TABLE VIT~4

«so

(Distribution made 60% personnel, 25% equipment & materials, & 15%

services)

Personnel

Equipment & Mat.

Services

gis

150

Bis

8

363

151.25

20.75

60s

84

436

190

ae

760

86

564

235

un

940

---Page Break---

MATERIAL DEVELOPMENT

---Page Break---

vonr-1

ETE ~ MATERIALS DEVELOPMENT

?The wost pressing problens in the developnent of eneray conversion, transmission and storage technologies are material probless. The involvenent of the technical and scientific dis~ ciplines of solid state physics and physical chenistry in the development of materials for energy conversion, storage and transmission is of paranount ?importance, A CEER research program on materials probleas, at a low level of funding, has been under developpent during the last three years. Tncluded within this progran vere the following research projects: a) Photo Induced Electron Transfer State: A possible source of hydrogen, b) Study of the optical and aging characteristice of various selective surfaces, ¢) Study of surface of electrodes used in fuel cells and 4) nergy conversion making use of theraal differentials by neans of ferroelectric materials.

?The above indicated efforts, at a low level of funding, has

been a basic type of research and has established a base for continuance of this program, CEER feels that basic type of re~

search on materials probleas should continue at UPR/CEER but that

rain efforts should be readdressed to research appropriate to the

local conditions and the tropical areas of the Caribbean and

certain sinilar weather regions in South USA mainland.

?The main efforts of the present proposed materiale program

will be focused, therefore, on the following projects:

Data Center

The main objective of this program will be the collection

---Page Break---

viz

of data on various types of materials. This Data Center

will be used as the base for the development of other CEER/

UPR and other government and private sectors programs in the

Caribbean and Latin America, Sone materiale of interest to be considered are metals, plastics and ceramics, Data of

interest includes thermal conductivity, electrical and ionic conductivity, pyroelectric and piezoelectric coefficients,

?wechanical properties of bulk materials, corrosion properties

?mass transport (diffusion), energy levels and spectra. Table

VIIFA "Materials Problens Related to Energy Conversion" i1- lustrates the general scope for addressing this material data

bank information center.

Material Degradation

?This program will consider studie

related t0 corrosion,

mechanical and chenical degradation in the tropics of the most

pertinent materials Listed in Table VIII-A

This program will also characterize or determine changes

in radiation/reflection spectra of pertinent solar miterials

under tropical conditions.

?An argon 7 vat laser in the blue and green spectra and a

Ramen grating spectrometer available at CEER from UPR/Mayaguez

?campus together with available expertise in the field already

existing at Mayaguez will provide the analytical toole and

"base" for the development of this part of the program, An

U.V. source will be added into the program,

---Page Break---

vires

soyasodog 1eopuryoox (7)

?sooy33e (2)

>eaen030y (@)

pyreusenea32213 (2)

suoroeza3uT uoyzerPeE (?)

?2nyeuoauy oxou zopun enor:

x0 woyaupea aM0I9q TTTA Wo}

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sits stzto's ater

s rrss0g

sevuoya,

vetec's eet ayeaqonozoug

s DEIeTE 39TOS

s?6 stve atee Teexeur 28105

s s*6 actety ett a0

Ra aay RT aT WR ?? same ??saearTeT wary

3 sozuedz0ur sx00g

Bar WLR

NOTSWAANOO JOWENG OL GRLVISY SHATGONA STVISIVR

vAnIA 21¥E

---Page Break---

vant

Tine Resolved Studie:

Atteapts are being made by CEER to obtain fends for

research on synchorotion sources for diffraction and scat

tering studies in ferroelectric and other materials to characterize crystal structures. CEER personnel has many years of experience in neutron diffraction and scattering experinental studies with the deconfssioned Triga research

?This program proposes studies on time resolved structures

of ferroelectric materials eith syncrotion sources,

D, Electrode Surfaces Studies

?This progran includes the developnent of scattering studies of electrode surface by EXAFS. A carbon electrode will be coated with @ fraction of a monomolecular layer of suitable electrode material and the surromding Liquid of

?the electrode atoms examined by EXAFS, This will character

ize or determine the radial distribution,

Electrochemical Cell. Developaent

Electrochemical cells have two interesting large scale

applications, The first i load leveling. The second, an

electric car pover source would put the transportation system

fon the utility grid, As long as oil is used for most gener

ation, this 64

1s pointless unless residual fuels becone very

much more plentiful than gasoline.

The field of solid state electrodes and solid electro-

lytes would, hovever, make excellent use of our backlog of

---Page Break---

mR

vires

crystallographic knowledge skill and information and of

such of the x-ray and electrical equipment chat ve have

available,

?One idea that cones to mind is the use of solid hydrates having high proton mobility (e.g. copper formate Cu 4H,0) as

electrolytes together with a rare earth nickel hydride anode.

?This program contenplates the possibilities of develop-

ing an electrochemical cell based on the indicated principles.

Plastic Materials Applications

Beat exchanger cleaning problems in OTEC systens represent

an important consideration in total efficiency end power out~

put of the plant, While it may not be true that ultrasonic

Will either enhance heat exchange much or reduce microfouling

4 has boon shown to eliminate macrofouling. Thus it could

replace Cly which is environmentally unacceptable as a bio~

PVDF can be manufactured

growth inhibition in heat exchange

?a5 a rather inexpensive plastic film with piezoelectric pro-

perties that permit it to be used as an ultrasonic transducer.

Tt may also be of use in water pipe screens and filters.

Te is evident that of all the materials that were exanined during the recent activity in one dimensional conductors, doped

polyacetylene is perhaps most interesting. Tt is essentially a

doped plastic with conductivity from insulator up to about

2000 mht ca??, This is 2 orders of magnitude down from copper,

but could be of interest for special application where metals

fare not wanted. It is also in the semi conductor range and

---Page Break---

vanr-6

should be looked at for photovoltaic properties. Such polymers

would conduct without the ne:

ssity of insulation i.e. they are

1 disensional, A progran to investigate the sbove possibilities

of PVDF materials is proposed.

Solar Collector Surfactant Cleaning

Kaowledge gained on surface and surfactant chemistry spreading, and contact angle phenonena could perhaps be used

to examine possible methods of cleaning solar collectors

without scrubbing. A knowledge of major airborne particulat

?would be neces

"7

?This progran proposes to assess the potentiality of this new cleaning method.

Hydcogen Production via Solar Energy

Hydrogen represents probably the best form of storing solar energy, CEER will continue efforts initiated in liydrogen production by use of solar energy. Research subjects such fas Photo Induced Electron Transfer States, photocatalytic cycles, or photoclectrocatalys:

sing pervorkite photoelec~

trodes or thersochemical cycles will be examined for the most

appropriate research development in the tropics.

---Page Break---

vant-7

TABLE VITI-1

MATERIAL PROGRAM OVERALL BUDGET DISTRIBUTION

(Thousands of Dollars)

2 ws ae

Program Titles

AL Data center 50 3 0 ©6100

3. Materials Degradation 50 80 150 150 150

©. Tine Resdlved Studies 40 36a

D. Blectrode Surfaces 60 8 100 100100

E. Electrochemical Cell

Development 7 so 70 100 100

Plastic Material

soplications - 5075 100 300

Solar Collectors

Surfactant Cleaning - 30 4) 5050

Hydrogen Production via

Solar Energy 52 100 150 200200

?TorALs 250 455° 655780790

---Page Break---

?TABLE vIaI-2

MATERIAL PROGRAM PERSONNEL DISTRIBUTION

(an-Years)

Program Titles 82 83 84 85

Data Center

Scientific stat 6 2 a a

?Technical staff ?6 5 a a

Ministrative state ?6 5 a a

Materials Degradation

Scientific seat 3 a Ls L?

?Technical seatf 7 7 10 us

Administrative staff 3 3 5 ?3

©. Time Resolved studi

Scientific state 2 3 1.0 Lat

?Technical Staff 2 2 5 15

Adninistrative Staff a a a 2

D. Blectrode surfac

Scientific seaft 6 10 Ls 1s

?Technical Staff ?6 2 s ?8

Adninistrative Staff 2 2 2 2

E. Electrochenieal cell

Development

Scientific staf - ?4 8 Lz

Technical Staff : ?3 ?3 Na

Administrative Staff : 6 3 33

F, Plastic Material Applications

Scientific state - 6 3 2

Technical staff : ?3 ?3 ?8

Administrative stage : 3 3 3

G. Solar Collector ~ Surfactant Cleaning

Scientific state - ?4 ?4 2

Technical staff = 2 2 3

Administrative : at a a

33

2

?3

a

---Page Break---

virr-9

TABLE VITI-2 (Continuation)

?Hydrogen Production via Solar Energy

Scientific staff 2 6 Ls 18 Le

Technical staff 5 ?3 10 16 Ls

Administrative Staff 2 3 3 3 ?3

?TOTALS PERSONNEL, MATERIAL PROGRAM

Scientific state 2600 aa 23 8.6 8.9

Technical staff 26 aa 3.2 71:2 12

Adninistrative Staff Vea 21 27 27

?Tora 66 10.7 16.6 tsa.

---Page Break---

vit-10

ABLE vITL-3

MATERIAL PROGRAM BUDGET DISTRIBUTION

?TYPE OF RESEARCH

(Thousand of Dollars)

2 83h

Developaent 50 30 «10 ot

Materials Degradation

Development. 50 80 150 aso 50

©, Time Resolved Studies

Basic Research 4 3 6a

Hlectrode surfaces

Basic Research 60 8 100 100-100

B, Electrochemical Celi

Davelopnent 50 70 100 100

F. Plastic Naterial Application

Development - 50-75 io 100

©. Solar collector

Surfactant Cleaning

Developnent - 3 5050

H. Hydrogen Production vie

Solar Energy.

Basic Research 50 100 150 200200

TOTALS ALL PROJECTS ($ Thousands)

Basie Research 150 250370380

Developaent too 240-4510

Denonstration 0 0 0 0 o

Education 6 Training 0 9 = 9 gg

rorats 250 455655780, 790

---Page Break---

e

viri-11

TABLE VELI~

MATERIALS PROGRAM BUDGET DISTRIBUTION

CLASSIFIED ( Thousand of Dollars)

a

Personnel 4s

Equipment & Mats.

Services 3

Material Degradation

Personnel, 35

Equipment 6 Mats. 10

Services 5

Mise Resolved Studies

Personnel 30

Equipment & Mats. 3

Services, 5

Electrodes Surfacs

Personnel, 35

Equipment & Mate. 20

Services 3

Hlectrochenical cell

Developaent

Personnel °

Equipnent & Mats. °

Services °

Plastic Material Application

Personnel -

Bquipient & Mats. -

Services -

Solar Collectors

Surfactant Cleaning

Personnel :

Equipaent & Mate. -

Services -

45

30

50

20

10

35

10

20

10

80

35

3

45

10

70

13

3

ots

obs

100

3

50

io

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70

1s

3

Boa

30

20

as

10

5

100

35

a5

35

10

1

10

15

1b

75

15

10

50

10

35

10

5

---Page Break---

TABLE VETI~4 (Cont).

H, Hydrogen Production via

Solar Energy

Personnel

Equipment & Mats.

Services

TOTALS All Material Prograns

Personnel

Equipsent & Mats.

Services

?TorAL,

vart-12

20

20

10

165

35,

250

40

40

20

275

1s

ec

455

15

50

25

00

50

50

a

a5

as

780

00

50

50

492

us

23

790

Totals

a6

10

404

2930

---Page Break---

INTEGRATED TECH, ASSESSMENT

---Page Break---

1.

1x1

Integrated Assessment Technology Program

?The technology developed for the energy alternative:

of (a) Solar Hot Water syste:

+ (>) wind driven elec~

trical generators and pumps and, (c) photovoleas arrays arrangements need to be placed as soon as prac- ticable at the disposal of local manufacturing groups, salesmen and users in order to use effectively the RGD accomplished at the laboratory

We propose to develop prograns in each of the above

Chree mentioned alternatives and with emphasis in the

order given to integrate technological know-how ¢.

ent

the local community. For the integrate.

of large energy power systens using such alternative:

as Biomass, OTEC, and central photovoltaics power

Plants, CEER proposes to continue economic evaluations

of such alternatives on a periodic basis with computer

developed programs to adequately program the needs o:

R&D funds for the development of such alternatives in

the PLR, scenario, This requires coordination or

integration with a11 government concerned agencies.

The following prograns and budget estimate are proposed:

A. Solar Wot Water Systens Progran

Offer a11 hot water system manufacturers through an

appropriate P.R. Government Agency such as Departa-

mento de Aountos del Consumidor (DACO), general

---Page Break---

x2

technical services and independent assurances:

1, economic analysis of calculated savings are

2. syetem capacity design is correct for expected
loading

3. manufacturer equipment meets required
successfully and is of proper quality

es

4. publish for the benefit of manufacturers any
late developments which might improve the
economics of his operation and promote tech-
nical conferences

5+ publish for the benefit of users general lie.
erature about solar water heating syst
do-it yourself pamphlet.

3, Mind Driven Turbines Program

Under this program CEER will establich a small community involved demonstration program of « wind driven electrical generator 1-5xv and wind driven fr. tigation pump tests, Data will be generated for local manufacturers and entrepeneurs for conmercialization. Users manuals vill be prepared and also a do-it yourself pamphlet. Wind data will be developed for the

whole island such that expected power output and

energy could be determined from turbine characteris. ties. A mechanic will be avaflable for direct help

C. Photovolt.

ice Community Program

Under this program CEER will establish @ small demon-

stration community involved program for photovoll

---Page Break---

installations for communication applications and

other snail users.

Direct technical help and advice will be provided

to manufacturers and users. Descriptive literature

WiLL be presented. This program will not become

effective until 1985.

---Page Break---

Tes

TABLE 1x1

{ENTEGRATED ASSESMENT TECINOLOGY PROGRAM BUDGET ($ Thousands

2 8 wm Bw

A. Solar Hot Water System 5055606570

B. Wind Driven Turbines 758859085

© Photovoltaics Gommity - = = = 50,60

D. Bheray Analyeis ms 0 5 ow

Torais 135 170185255285

lz

---Page Break---

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TABLE 1-2

INTEGRATED ASSESSMENT TECHNOLOGY PROGRAM

?PERSONNEL DISTRIBUTION

Project A ~ Solar Hot Water Systens

Scientific Staff - oe ee

Technical staff

Administrative Staff

Project B ~ Wind Driven Turbines

Scientific Staff

Technical stafe

Administrative Staft :

Project ¢ - Photovoltaics Comunity

Scientific stafé - ee ee

?Technical staff - ee a a

Adzinistrative Staff = ff oad

Project D - Energy Analysis

Scientific statt

Technical Staff

Administrative Staff

TOTALS ALL Projects

6 8 8 Lo

35 Lo

Scieneific Staff 36 8 Lo

Technical Staff 3310 3077

Administrative Staft 19° 250 25 318 ao

---Page Break---

16

TABLE 1-3

INTEGRATED ASSESMENT TECHNOLOGY PROGRAM BUDGET

TYPE OF RESEARCH

2 83

Bducation & Training 50 55 60670

Hind Driven Turbine,

jasic Research

Development

Denons'tration

Education § Training % 8 8 = 9095

©. Photovoltaics Comminity

Basic Research

Development

Denonstration

Education & Training 5060

D. mnergy Analysis

Basic Research

Development. 335 50g

Desonetration

Education & Training

moras

Basic Research

Developaent 3035 450 gts

Desonstration

Education & Training W5 195 4s 205 225s,

---Page Break---

?INTEGRATED ASSESMENT TECHNOLOGY PROGRAM BUDGET

A. Solar Wot Water Syaten

Personnel

Equipsent & Mats.

Services

B. Wind prives Turbines

Personnel

Equipnent & Mate.

Services

©. Photovoltaics-Conmunity

Personnel

Equipment & Mate.

Services

Boergy Analysis

Personnel

Equipaent & Mate.

Services

orALs

Persoonel

Equipment & Mats.

Services

m7

TABLE 1-4

?CLASSIFTED

a

30

20

so

25

35

20

50

25

us

50

170

35

20

35

25

125

50

10

18s

40

20

so

25

170

70

15

255

40

20

10

60

30

35

25

aes

30

20

285

180

25

10

700

0

1050

---Page Break---

NUCLEAR PROGRAM

---Page Break---

x

NUCLEAR PROGRAM

?A, Muclear Fusion Program

Nuclear fusion promises to be the ultimate and optimum solu-

tion of the energy problen for humanity. The firet nuclear fusion

Feactors will use tritium fuel. Approximately 852 of the energy in this type of reaction is Liberated in the form of L4MEV neutrons. Any

Imachine designed to harness the energy produced by this type of reac~

tion must convert the L4MEV neutronic energy into a manageable forn.

the 14,

?The most commonly considered concept to harne!

neutron energy in fusion reactors is by permitting the energy

to be deposited in a Lithium blanket designed to breed the re-

\e generated in the blanket is

quired tritium 107 and the hi

Fencved by conventional heat exchanger technology to operate

42 rankine cycle, This approach does not lend itself to the

generation of out reactor fuels.

ydrogen production from vater decomposition with L4MEV neutrons

is of particular interest in the harnessing of this fusion energy for

sies

the generation of out reactors fuels. CEER ha

Mayaguez a ISOKEV proton accelerator and facility vhich produces 14MEV

neutrons in a target reaction which could be effectively used for this

pup

Existing experimental data on the conversion efficiencies of

radiolytic water decomposition indicate values of 10%." Some

experimental data indicate higher efficiencies (30 to 402), but

ehese results are not fully understood and the researchers have

---Page Break---

x2

?not been able to duplicate experimental results such as the

CIRENE reactor experiments. More inportant, hovever, there

is no data using UMEV neutrons a8 a source, It is estinated

?that 30-40% conversion efficencies in radiolytic decomposition

of water with 16¥EV neutrons can result in acceptable hydrogen/

electricity production scenarios.

CER proposal of February 1977 entitled "Feasibility De-

sign Study Project for a 100KWE Level Pilot Plant Fueled by

ydrogen Produced by Direct Solar Heat" contains a detailed éis-

cussion of the most promising theraochenical cycles to that date.

?The use of 14MEV neutrons in a thermochemical step can result én

eliminating incovenient high temperature steps of a particular

switable thermochemical cycle.

CHER has been in contact with KMS Fusion of Ann Arbor, Michigan

in an effort to establish such a program. KMS Fusion is willing to

develop a joint effort vith CHER in this area, In addition, CEER per-

?sonnel will maint

itself abreast of the new developments in Fusion

Technology by attending seminars, symposia, reading the Literature and

holding occasional local lectur

B. Nuclear Fission Program

In the field of much

1F Figsion CEER proposes to monitor and

transfer technological infornation from the national Laboratories to

interested CEER/UPR, P. R. industry and Latin American countris

vested personnel. Distinguished investigators and professors will be invited from time to time to present findings and developments to CEER

---Page Break---

personnel. CEER personnel will attend national meetings, conferences,

TablesM-1 chrough XI-4 itlustrate the funding and effort

scheduled.

---Page Break---

xa

TABLE EL

NUCLEAR PROGRAM

BUDGET (In Thousands §)

2 Bw

Muclear Fusion Program 607575

B. Wuclear Fission Program 55

ror 65 8

[NUCLEAR PROGRAM

?TYPE OF RESEARCH

2 8

Nuclear trogras

6 755

Developaent

Desonstration

Education & Training 5s 5

coe

Tas x2

NUCLEAR PROGRAM,

BUDGET ~ PROGRAM PERSONNEL DISTRIBUTION

a 83k

Nuclear Progras

Scientific staff aoa 1

Technical staff Boss

Adninistrative Staft non oR

TABLE X-3

125,

2

L, 38

105

125

tn

ts

86

100

---Page Break---

Personnel

Equipment & Materials

Service

sorts

65

a

Ble 8

105

105

275

us

3s

435

---Page Break---

TRANSPORTATION ann CONSERVATION

---Page Break---

xt

XI TRANSPORTATION AND CONSERVATION

GEER has an ongoing program on the important transportation ?and conservation area. Approximately 25% of all energy consumption

in Puorto Rico is accounted for by the Transportation Sector. Over

17 millions barrels of distillates will be consumed in Puerto Rico during 1979 by nearly one m{llion vehicles.

GEER ongoing prograns in this area are classified under two main topics:

+ Hybrid Vehicle Test and Demonstration Program, and

Sociorteonoaic and Decision Policy Studies.

GEER has been in contact with JPL and the University of Florida in the program development for the Hybrid Vehicle Test and Dononstra~ tion Progran. A Hybrid Vehicle has already being purchased by CEER for this progres.

In the area of Socio-Bconoaic and Decision Policy Studies GEER

has already published studies on:

+ San Juan Transit: Outline of a Policy Analysis for Decision

Making (October 1977).

+ Rhergy Conservation in Transportation in P.

A Policy

Study (Septeaber 1978).

+ Policy R&D: Outline of a sethodology with reference to de

cision making in the fields of eneray, transportation and

fenvironsent (Septeuber 1979).

Description of the above two main topics on transportation follows.

---Page Break---

x2

Hybrid Vehicle Development, Test and Denonstration Program

Wt is believed that due to the unique driving conditions in

Puerto Rico (60% of sll driving is done in the urban areas) conside~

Table energy savings can be acconplished by utilizing transportation

?modes matched to a particular driving cycle. One of this modes is

the hybrid vehicle, This vehicle utilizes an electric motor in its

with a modest bank of batters:

45 a power source.

joline or diesel driven electric generator is used to recharge

the batteries while the vehicle is in notion, vhile driving at slow

speeds in urban traffic or while stopped avaiting a traffic Light

change. hen properly matched (electric motor-gas driven generator)

the hybrid vehicle's range is essentially dictated by the capacity of the internal cosbustion engine fuel tank.

The CEER's Hybrid Vehicle Development, Test and Denonstration Progran seeks to denonstrate the technical feasibility, and greater feel econony of this node of transportation. It also seeks to create Public avareness and acceptance of the hybrid vehicle in Puerto Rico a 4 viable transportation alternative through information dissenina~ tion and vehicle denonstrations,

To accomplish these goals the Hybrid Vehicle Development Test and Denonstrations Progran proposes the felloving projects:

A. Development of a Driving Cycle for Urban P. R.

B. ybrid Vehicle Pover Train optinization

©. Hybrid Vehicle Denonstration

D. Motor-Cenerator Engine Developaent for liybrid Vehicle Applications

---Page Break---

Project A seeks to characterize the unique driving conditions in Puerto Rico. Due to the fact that 80% of all personal driving in the island is performed in the urban areas substantial fuel econo~ nies can be achieved by utilizing electric propulsion where motor ef ficiency 1s essentially independent of apeed and load, In order to

make valid testing and comparisons 2 driving cycle characteristic of
the urban driving conditions in Puerto Rico must be developed and
confirmed.

Project B is expected to optine the hybrid vehicle pover train.
?The interrelationships between speed, range, vehicle and battery pack
Weight, electric motor horsepower and generator set capacity a8 ap-
plied to a particular driving cycle have a marked impact on the energy
consuaption, This subprogran seeks to model the systen and to test
one or more actual power train arrangements.

Project G will be directed tovards the denonstration of the fe:

sibility of utilizing hybrid vehicles in fleet operation. The progran
Will be tailored to @ particular driving application stressing fuel

economy, personnel training, public avareness and overall vehicle evs

uation.
A fleet of at least ten vehicles is to be purchased and operated

by the University of Puerto Rico, Mayaguez Caapus Buildings and Grounds

Departaent. Funds from DOE and the P. R. Energy Office are expected

to be obtains

Project D is directed towards the development of motor generators

specifically applied to hybrid vehicle use. Such parameters as type of

Senerator winding, sotor controls and weight will be optimized, build

and tested.

---Page Break---

xs

fvel-efficiont mix of transportation/aobility modes:

(@) Wore sensible uses of private automobiles (total mil

Leage; increased occupancy)

(i) Bus-and-publico system (integrated)

(iti) Realistic rail concepts for San Juan and the Island

(iv) Mobility alternative to Private Vehicle Transportation

System PUTS)

bycyeles

+ valking:

(Synthesis and development of existing plans)

() Water-based transportation

(vi) Incentives/disincentives, positive restraints on PVIS

Ge

©. and D. below)

3. Non-construction methods of improving TSM.

4, Managenent/infornation syste

Socio-environmental aspects of TSM; e.g. traffic flou/density

studies related to institutional location, operations, work

hours, residences of enployees--as input into the development

fof short-term, quick-fix measures, as well as of longer-term

planning.

6. Analysis and anticipation of new parameters (technology, fuels,

supply, cost, ete.).

---Page Break---

ion Eeonoaics

2, Analysis of the extent to which PVIS is publicly subsidized

(fuel cost, parking, highvey use, violations, low inepectfon/

Seintenance standards with resulting accident cost and air

?quality inpact, use of general funds for highvay maintenance,

etc. ~ see "Energy Conservation in Transportation..., pages

56-60, for a more detailed inventory of apparent categories

of aubsidies).

2. tmalyais of the real C/B of public transportation ve. non

subsidized PVIS.

3. The elasticity of donand for private transportation ia function

of the Puerto Rican socioeconomic structure.

4. The resulting policy directives.

Transportation Policy RED

1, Feasibility of active restraints on PVIS through

() controlled availability of feel

(Gi) cost (removal of subsidies)

(ii) Physical restraints (access, parking, etc.)

(iv) taxing and other disincentives

(w) regulatory and enforcenent

2. Analysis of the elements and causes of the previous failures

to adopt and inplenent a rapid transit in San Juan ("Motro?

?and on the Island ("Tusca").

---Page Break---

x7

Elaborate for concrete application the concept of transpor-

tation

function of human and environmental resources and opportunities vs. the Limited technoeconomic conception and planning. (This "econanagenent" concept of transportation

was outlined in "San Juan Transit...

Develop this study

40 it would also contribute to national EDP in transportation.

Improvenent of the degree of certainty in transportation decision making through better methodology, systen analysis and synthesis, increased quantification of the socio-environsental data, and other techniques or policy R6D.

Progressive inprovenent through conerete applications of technology end environmental impact assessment in transportation,

liso with the aim of contributing to EDP on the national level.

Institutional and Legal Elenents

L

Foster through specific programs and proposals the integration

of transportation research and operations in Puerto Rico:

GEER, HIM Transportation Institute, TOP, CSP, Office of Eneray,

Planning Board, Forts Authority, ete.

Mave input in

() Revision of the P. R. Traffic Code

(6) Reorganization of the Executive Branch, 80 as to foster

?TSC and TSM policies. (B.G., the Traffic Code is

energy "blind"; the present organization of the govern=

?ment promotes fragnentation in policy development end

---Page Break---

implenentation).

3. Provide policy and drafting support in the development and

revision of evs and regulations pertaining to:

(@® ? eensing

(i) enforcenent.

(ii) tax structure and other incentives/éisincentives f

voring TEC and TSH.

4. Monitor reaction of agencies to GEER studies and provide ac~

tive support enhaneing favorable measures and actions.

+ Bdueation

1, Publication and dissemination of CEER studies:

() Puerto Rican government

Gi) National circulation where indicated

(4ii) Adaptation and translation into Spanish (where neces:

sary) of research results judged potentially useful

in the context of Latin Anerican transportation/enerey

problens.

2. Development of more effective techiques and programs ained

?at TEC, based on public opinion and related studies.

3. Sectoral contribution to GEER public information and avareness

programs.

---Page Break---

TABLE xl-1a,

TRANSPORTATION AND CONSERVATION ~ HYBRID VEHICLE

Overall Budget Distribution

(Thousands of Dollars)

ao 2 8 w B&B

ybrid Vehicle

A. Driving cycle urs

3B. Power Train

Optimization 152.5 202.5

. Mybrid Demonstration 272.5 202.5 202.5 202.05

D. M6 Dev. for Hybrid

Veniele 242.5 167.5 160.5

?Toras 300 475 02.5 us 370 167.5

---Page Break---

xr-10

TABLE xI-2a,

?PROGRAM PERSONNEL DISTRIBUTION HYBRID VEHICLE

Program Titi:

a

(Qlan-Years)

Driving cycle

Scieneitic State

Tech. State

Admin. Staft

= Power Train Optinization

Scientific staff

Tech. State

?Adan. Staff

Hybrid Vehicle Desonstration

Scientific Stafé

?Tech. Staff

Admin. State

- MG Dev. for Hybrid Vehicle

Scientific seafe

Tech. Staff

Adnin. Staff

Total

Scientific stasf

Techical staff

Administrative Seagt

?Torals

a2

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---Page Break---

xr

TABLE 2-30

?PROGRAM BUDGET DISTRIBUTION - HYBRID VERTCLE

?TYPE OF RESEARCH (Thousands of)

Program Titles

A, Driving Cycle

Development 147.5

B. Power Train

Optimization

Development 152.5. 202.5

©. Hybrid Vehicle

Denonstration

Denonst ration 272.5 202.5 202.5 202.5

D. thG Development for

Hybrid Vehicle

Development. 242.5 167.

roraLs 300 475 202.5 445370867.

---Page Break---

TABLE X1-ba

PROGRAM BUDGET DISTRIBUTION ~ HYBRID vexTCLE

aw

Progean Titles

A. Driving Cycle

Personnel 122.5

Bquigment & Materials '20

Services 5

3. Power Train Opts.

Personnel 87.5 157.5

Equipment & Materials 6040

services 53

©. Hybrid Vehicle Demons.

Personnel 137.5

Equipment 6 Materia 110

Service 3

D. %6 Developsent for

ybeid Vehicle

Personnel

Byulpaent 6 wateriale

Services

ALL Progeane

Pereomel 210 ais

Bquipment & Materials ?80 150

Services 0 ?to

xriz

?TOTALS 300 475

157.5

40

157.5

40

202.5

157.5

40

157.5

80

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120

10

44s

157.5

40

122.5

40

280

80

10

370

122.5

40

12.5

40)

167.5

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---Page Break---

xr

?PROGRAM PERSONNEL, DISTRIBUTION - TRANSPORTATION POLICY STUDIES

(lan-Years)

2 8 6

6 a 6

9 908 oat

©. mnergy/teonomice wk 3 a

». Policy 6 eo 7 7

BE. Legal/Inst tutional

?oral Se (A-E) 3 3 3 3

Pera. Tech. (A-E) 3 5 10 ko 0

Pers. Adm. (A-8) ss 5 15

F. Educational

se - - - - -

tech 3 5 10 oo

Ate ass as

ALL Programs (A-8)

se 3 3 3 3 3

Tech 1 1 2 2 3

Atm 1 1 1 1 1

---Page Break---

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---Page Break---

PUBLIC AWARENESS

---Page Break---



XII THE PUBLIC AWARENESS PROGRAM

Puerto Rico is a self contained community with energy problene

which stem from a worldvide scenario superimposed by unique societal

and geopolitical circunstanc

Mach of the Department of Energy efforts addressed to inprove

Public avarenes

in the energy plight are not, in general, effective

in Puerto Rico, the Caribbean and other South American countries.

Prograns effective to a local community such es Puerto Rico should

consider the following set of unique conditions:

+ The mose effective means of promotion and communication

?anong people is through the Spanish Language.

Deity experience is geared to a tropical climate, with

hardly any seasonal change. AL references to winter rigor

Preparation and avareness are totally meaningl

overnnent and public services are all centralized. wealth,

education, justice, public order, and utilities, all of these are regulated by the state goverment. Puerto Rico

for all purposes, could be vieved as a big county vith little,

if any municipal government independence. Puerto Rico is

densely populated ~ as dense as if all the population of the

world were Living in the U.S.

Puerto Rico has a very den:

?automobile population,. about

five times as dense as the U.S. That is comparable to @

billion cars in continental U. S.A.

---Page Break---

xur-2

Puerto Rico is little known by the majority of the Averican

people. ven at the cultural level represented by the pro~

Ject evaluators, mexpected and serious gape of inforaation becone evident from their coments with disastrous effect

for the fairness of the competition.

Puerto Rico has a total lack of geological energy resources.

P. R, institutions buy energy at the price imposed by OPEC.

Further large increases on oil prices could paralize P. R.

econoay and make Puerto Rico largely dependent on energy

sources from the U. S., posting an additional burden to an

already taxed energy situation, Public avareness of this

fragil scenario is imperative anong both local and continen~

eal citizenry.

There is, therefore, a strong rational to include a Public

?Awareness Program as an institutional component in a proposed Five

Year Plan.

CBER's Public Avareness Program is subdivided into four are

Bducational Program, Source Information Program, Active Information

Program, Comunity Participation Program.

A Educational Program

?The main goal of this Progran is to develop a state of ava~

reness, interest, and enthusiasm agong primary, secondary and community

college teachers for the energy predicament both global and national

---Page Break---

xm-3

and its effect and implication to the peculiar situation of Puerto

Rico. It is expected that the avarene:

stirred by this program be

translated into positive and meaningful educational achievenents which the program in tur will support and promote.

A List of activities, by no weane inclusive, is the following

Visits, informal talks and demonstrations to teachers by

scientists, educators, and adzinistrators

+ Chautauqua type sessions with teachers where educators,

scientiat

+ engineers, technicians and other specialists

present different aspects of the energy situation.

Actual visit to the classroom by educators for teaching

desonstrations, field trips, experinents, etc.

Linited student and teacher research participation in colla-

boration vith C2ER staff and/or professors from sponsoring

universities. Although these studies may range from simple

short range projects to more complex involvements they mst

seek solutions to clearly identified probleas of local in

portance.

+ Production and/or adaptation of curricular saterials and/or

nethodologies directed to enhance the student and community

avareness to the energy plight. CEER will sponsor this ac~

tivity as single teachers projects but preferably as @ colla~

borative effort anong teachers, re

wrchers, and other

?educational specialists.

Organization and/or support of teachers and students sumer

vorkshops.

---Page Break---

x4

A, Educational Program Budget

Activity F823 YB FYB F486

Visits, chaueaugua,

teaching $12,000 $13,000 $14,000 $15,000 $16,000

Research partici~

pation, teachers 12,000 13,000 14,000 15,000 16,000

Research partici~

pation, students 5,000 5,000 6,000 6,000 7,000

Curricular projects 10,000 11,000 12,000 13,000 14,000

Teacher's vorkshops _10,000_11,000 12,000 13,000 _14,000

?oras 949,000 $53,000 $58,000 $62,000 $67,000

---Page Break---

xn,

3. Source Information Progra

This Program intends to perform as a clearing house for the flow of information to the public and anong organizations dealing with

energy related projects. The following activiti

are relevant to

this program:

Store energy related information particularly that relevant
to Puerto Rico and other Caribbean areas.

Prepare a data bank files for computerized retrieval of the
inportant features of the stored information. Make acces

sible these files to both local and national users.

Establish an information retrieval center connected to the

pain national syste

Provide the necessary infornation when requested by private individuals an inseieutions

Sponsor the formation of Teacher's Centers throughout the

Island where information, advise and instructional material

could be provided to the teacher.

---Page Break---

Activiey,

Data acquisition

File preparation

and update

Information Center

hardware and main=

tenance

Information Center

software and main-

tenance

Service

?Teachers Centers

(Q/2 support)

Four Centers

rorats

xIL-6

B. Source Information Program Budget

$20,000

50,000

300,000

100,000

18,000

12,000

$500,000

Hy-83

$12,000

12,000

10,000

10,000

19,000

26,000

389,000

rsh 85 FY86

$13,000 $14,000 $15,000

13,000 14,000 15,000

20,000 11,000 11,000

10,000 11,000 11,000

20,000 21,000 22,000

42,000 _60,000 64,000

$108,000 $131,000 $138,000

---Page Break---

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xu-7

Active Information Program

?This Program is the CEER's arm for disseminating information

to the general public. It responds to the needs of springing public

awareness on energy related topics and events. Again, empl

will

bbe placed on infornation relevant to Puerto Rico and the Caribbean area.

owing

Some of the activities for thie information center are the fol-

+ Production of regular short (4 page) and non technical pu-
lication (probably monthly, possibly, twice a month).
This will be distributed to all schools, churches, govern=
rent offices and to all who request receiving it. It should
include one or nore non technical articles analyzing the
?current nevs on energy and the national and local societal
impact. Translation with adaptation of suitable articles
Published elsevhere could also be included, as vell as a
suamary of important events and neve.

+ Sponsor public lectures, colloquia and seminars.

+ Prepare and show in public theaters, schools, universities
Lins on CEER's activities.

Prepare and é

tribute posters, shirts, captions, bumper

stickers, ete., with energy messages in Spanish and with

local flavor. Adapt, translate and distribute public infora

ation material prepared by DOE.

---Page Break---

x8

With the cooperation of the government TV and radio stations

Prepare spots, docunentals, regular news prograns and chil-

?dren prograns on energy.

Prepare public exhibitions, aobile exhibitions and denone-

erations.

Organize periodically open houses in CEER facilities to

luake the public conscious of the island's energy problen

?amd to promote the appreciation of the research and deve~

lopment prograns necessary to cope with it.

Activity M82 a3 FY-84 1-86

Regular publication

(20 issues a year) $50,000 $52,000 $54,000 $56,000 $60,000

Public lectures 2,000 2,000 3,000 3,000 3,000

Posters, ete, 5,000 5,000 6,000 6,000 7,000

Translations, adap-

tation, disemination 5,000 5,000 6,000 6,000 7,000

Fine

(one a year) 4,000 4,000 5,000 5,000 5,000

IV + radio spots 4,000 4,000 4,000 5,000 5,000

Stationary & Ho

bile exhibitions 25,000 8,000 9,000 10,000 12,000

open houses 2,000 _2,000 __3,000 __3,006 __ 3,000

?Totals $97,000 $82,000 $90,000 $94,000 $102,000

---Page Break---

xri-9

D. Community Participation Programs

In addition to arousing public interest and understanding to

the energy plight, CEER should epur citizen participation through

coummity action and by sponsoring comunity initiated proposals.

These are sone of the activities that CEER could develop under

this Progr

+ Contact civie, professional and youth organizations as well

as private groups to pronote community action, Offer help

4in such endeavor. Suggest formations of stirring committees

?where CEER personnel could be used as resources

Assist civic, professional and youth orgenizations as well

as private groups in the preparation of proposals to CEER

and/or government agencies. Offer advise in carrying out

activities supported by grants and awards.

+ Encourage the formation of energy clube;

?sponsor debates

on energy issue

+ Pronote citizen's participation, as full as po

ible, in assisting CEER's research projects as well as those conducted

in other institutions. Deputize young and adult groups to

participate as full as possible in selecting phases of CLER's

Public Avareness Program.

+ Organize and sponsor regional and islandwide meetings of re~

Presentatives from civic, professional and youth organiza

tiong a¢ well as from other interested groups to report on

current community participation projects and plan future ac~

tions and collaborations.

---Page Break---

>,

activity,

Prosotion of comu-

nity action

Community

Meetings

?TorAs

xir-10

Community Participation Progran Budget

wv=82

$5,000

10,000

6,000

$21,000

¥-83

$5,000

10,000

6,000

$21,000

lz

$6,000

11,000

7,000

$24,000

Fy-85

$6,000

11,000

7,000

$24,000

i?

Iz

$7,000

12,000

8,000

$27,000

---Page Break---

xn-11

TABLE XIT-1

PUBLIC AWARENESS PROGEUM

(Cousands §)

?otal Budget

Progress HiS2 FS} Fie84 FBS 85 Total

aeation su, 953, $58,962,967, 9

3. Source Information 500, 3,108, ast, 138,966

?. Active Infornation 7, 82,9, 8H, ws

comity Participation 21, 2,2,

ora, 9667, $245, $280, $312, $334, 1,837,

---Page Break---

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TasLe xn1-2

PUBLIC AWARENESS PROGRAM

BUDGET PERSONNEL DISTRIBUTION

ALL Frocks

2 8

Scientific seatt 1 a

Technical state ? ?

Atsiniatracive stat 3 3

anus xat-3

PUBLIC AWARENESS PROGRAM

BUDGET TYPE OF RESEARCH (Thousands)

ry

280

PUBLIC AWARENESS PROGRAM

BUDGET DISTRIBUTION-CLASSIFIED (thousands $)

Bs

Basic Research - -

Developeent - -

Denonstration - -

Biveation 6 Training 667245

TABLE m-4

2 3

Personnel 130130

Hquipoene 6 mate, ? 3

Services a0 60

667 24s

4

160

85 86

a 1

4 ?

3 3

a 34

as

160170

4 50

ua us

mL 34

Total

1,837

Total,

790

am

835

1837

---Page Break---

INTERNATIONAL PROGRAMS

---Page Break---

xm,

xurr-1

INTERNATIONAL PROGRAMS

One of CEER's principal objectives is to serve as a center for

international cooperation in the energy and environmental fields,

particularly for scientists and technicians from tropical and sub

tropical area

especially in the Caribbean and Latin Anerica. In

the past, efforts in this area have been extensive but

oss

there is at present no distinct ioternationel division or program.

In the further definitions of its internstional goals, CEER pro-

ot

co concentrate its efforts on becoming a lead institution in U. 8, efforts to transfer new energy technologies to the Caribbean community.

The Sslands and nations of the Caribbean community: defined as ?all the West Indies, Central Aneriea, and the countries on the Caribbean coast of South America, share with United States and Puerto Rico the need of achieving greater energy independence. The

great majority of the individual coutrieswith the exception of

Venezuela, and Trinidad and Tobago, are heavily or exclusively depen dent on imported petrolews for their energy needs. To continue their

Process of economic grovth and development and to lessen their balance of payment problems, greater energy independence becones

imperative. Alternative energy technologies, appropriate to the

Physical, cultural and economic condition of each individual country,

have

great potential to help meet this goal.

---Page Break---

xun-2

?The natural energy resource hase of the Caribbean is most

?advantageous for the adoption and commercialization of renevable

energy technologies throughout the region. These resources include

high levels of solar radiation, excellent biom

srovth rates,

trade wind, geothermal formations, ocean currente and thermal

sradients. These resources and their associated energy technologies

have in many instances the capability of becoming cost competitive

4m the Caribbean sooner than in the U.S. due to their greater avail=

ability and the comparatively higher cost in most of the region of

Presently available alternative

Most individual countries in the Caribbean have limited ca

sity to develop these technologies. The U. §. governnent and DOR

hhas an important role to play in the region through a coordinated

?energy technology transfer program designed to assist in the assess-

ment of energy needs, in the development and adaptation of technolo-

4 dy

ies appropriate for individual countries, in the training

cation of the requisite scientific and technical manpover and in

providing technical

-istance in the final adoption and inplemen-

tation of the new energy technologies. A regionally-based institu-

tion is needed to serve as focal point in these efforts and GEER

4s the logical choice to becone such an institution. The techno

Jogies involved include not only the solar and renewable energy

technologies previously mentioned but technologies such as enhance

ent oil recovery of heavy Venezuelan crude.

---Page Break---

xmr-3

?The rationale for converting CEER into a lead institution and

focal point for U. 8. efforts for the transfer of energy technologies

in the Caribbean is as follovs:

1) CHER's past and present international cooperative efforts serve as groundvork on which to bulld a visible and efficient ineti- tutional mechanism for energy technology transfer. These efforts include intemational conferences, Country energy assessuents end technical cooperation in research and developaent activities. These WAIL be described below in greater detail. A network of scientific

?and in sone cases political contacts have resulted from these efforts.

2. CEER's predecessor, the Puerto Rico Nuclear Center, served

4s a nuclear energy technology transfer and education and training center for scientists and technicians throughout Latin Anerica. This heritage can be put to use in analoguous activities of technology

transfer for renevable energy technologie

by CEE.

3. CEER's divisional prograns in the are:

of Solar, OTEC, bio~

?mass, bioconversion, fossil fuels and ecology provide the scientific

?and technical expertise required to support a program of transfer of

on-conventional energy technologies. Since the technologies need

in many instances to be adapted to the particular circumstances of the

comeries involved, further developmental efforts are required. A

technology transfer progran for energy sust therefore be coupled

With established supportive research and development efforts to be

successful. CBER's past achievenents and future plans, ao described

elsewhere in this docunent, provide euch support.

---Page Break---

xani-4

4, GEER already enjoys a unique position and reputation as a center for research and development of non-conventional energy technologies in the Caribbean. This position has been recognized in reports by Donovan, Hanester, and Rattien and by the U. 8. Agency for Internatonal Development in recommending the extensive involve ?nent and participation by CEER in national and international pro~ grams for energy technology transfer in the Caribbean.

5. GHER's staff possesses the bilingual capabilities and cultural ties needed to interact with scientists, officials, and technicians of the Caribbean community. While there is a diverse cultural background in the Caribbean, particularly in the West Indies, the Spanish language and heritage predominates. Puerto Rico stands in an unique

Position in this respect with its

riLingualion, {te cultural and

language ties to the hispanic community and its economic and poli-

tical ties to the United States.

6. GEER, by its Location in Puerto Rico, and its ecological and

environmental research capabilities, canplay an important role in

the environmental assessment of new energy technologies for the Carib~

bean. Puerto Rico's tropical environment shares similar physical

?and climatological traits with much of the Caribbean community.

4s previously mentioned, CHER's past and present international

cooperative efforts will serve as a basis for an expanded role as aa energy technology transfer center for the Caribbean. These efforts

---Page Break---

xUIr-s

hhave been as follows: CEER sponsored the First Caribbean Conference fon nergy for Developuent, held in April 1978, in San Juan, Puerto Rico. Representatives from twenty six countries or territories and seven international organizations attended. CEER was co-sponsor of @ technical Congress for the Investigation and Conservation of Energy , Resources held in San Juan, Novesber 1979. Participants froa nine comeries attended. CEER has also participated in two Caribbean

conferences in Barbados, in a meeting on Caribbean Energy Accounting

Systens in San Juan, and in the Final Report Conference on Preliainary Energy Sector Assessments of Janaica

(GEER is presently involved in two country energy assessment. pro- ects in Panana and in Eeuador. CEER in cooperation with the Insti~ ?tute of Energy Conversion of the University of Delaware and with the

University of Pennsylvania is in the final stages of a proposal for

?Assistance in Developing a Master Plan for Utilizing Renewable

Energy Resources of the Republic of Panama? submitted to TRIE, the

Water Resources and Electrification Institute of the Republic of

Panana. A Joint CBER/SERI Project of assisting Ecuador's Nationa

Buergy Institute in its development of an energy balance sheet has

been proposed

Preliminary part of an Alternative Sources of

nergy Project.

EER has been involved in technical cooperation efforts with

the Ministry of Bnergy and Mines of Venezuela. The Ministry has pro~

vided services to CHER's Fossil Fuels Program in its research efforts

---Page Break---



4n the Orinoco Valley. A cooperative progran, funded in part by the

Venezuelan Governsent, has been agreed in principle between the Energy Section of the Ministry of Energy and Mines and CEER. The ?roe phase will give euphasis fo energy assessnent and developsental

?efforts in two areas: energy conservation and bio-conversion. The

fecond phase will include extensive applied research and development efforts in oil-vell enhancenent technologies for heavy Venezuelan crude, This may subsequently include education and training acti-

vides

GEER will present a proposal to DOE to develop a program plan for new energy technology transfer efforts by CHER in the Caribbean region. This study will result in a plan which will present recom

mendations on the scope and extent of technology transfer activities

by CHER, on ies organizational structure and integration with CEER?

divisional programs, on opportunities for cooperation with national

?and international agencies for energy assesement and technology

?transfer efforts and with budgetary and manpover requirenents for
such prograns.

Since the study has yet to be undertaken, it is prenature to
Present budgetary or manpover requ{renents for CEER's International

Programe, Nevertheless, a brief sumary of the scope of the effort

will be undertaken. These are subject to revision. The intent is
to convert CHER into a lead Center for U. S. technology transfer

efforts for solar and renevable energy in the Caribbean comunity,

---Page Break---

xut-7

Based on CEER's capabilities, the scope of these efforts my be

extended in special cases as in the energy assesseeent studies for

Beuador and in the fossil fuels enhancement oil recovery activities

for heavy Venezuelan crude. Two levels of activities are envisioned,

?The firet being on an ongoing nature and at the regional level and

the

cond being in-depth energy assessnent efforts for particular

countries. The areas of work at both levels may include energy wrch, development and denonstration activities,

?education and training and comercialization effort:

this Snvolves:

~ studies of energy denand and resource base asesenents;

~ technical and economic feasibility studies of renewable

energy technologies;

~ Fesearch and development activities aimed at appropriate

technologies;

~ prototype desonstration and testings

~ institutional and industrial Liaison activities;

~ studies of financial and social incentives and barriers

to comercialization;

information dissenination activities for scientists industry and consuners;

and education and training activities aimed at training

and technical manpower.

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APPENDIX. A

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ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

WASHINGTOR, 0.¢. 20545

Apri 11, 1976

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: 0; Adminsatrator

Rat: Assistant Aduintstrator for Pleld Operations /

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io MICU CHEER (use)

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To determine the programatic and {nstitutional future of the Puerto

Neo Huclear Center facilities and recomend, if necessary, changes

Fo,gagure chat the PRNC's future management and operation ace cnessstent

With RDA's programaric requirements.

xeTH9

acksROCND,

Eonding

?The PRIC was established in 1958, under the Atons-for-Peace program, to

fain Latin American students in?nuclear medicine and technologe, bus

fo funding restraints, the training and education program has diataished

over the years. The anoual training budget ($1.2 million ia EY 76) bes

been used principally for basic operating support of the Ceater~ AAR?

funding of this activiey ts expected to decrease to reflect the decreasing

?nuclear training needs at PRNC. Hovever, PRNC's research role has geese

ssainiy with funds fron AES ($1,062 million in FY 76) aad sound emeteinn

hhas been deveioped in terrestrial ecology, tropical marine biology aad

f¥opica: human ecology. AES support for the aarine biology, tersestrial

?ecology and human ecology prograns is expected to continue and ay

snerease slightly to pick up overhead costs previously carried in? other

Prograns. Research in quclear medicine and agriculture is not a high

-@

is

---Page Break---

Administrator

Priority FRDA program and direct support for such research {5 not provided

in Fr 76. (Additional narrative background material 1s contained be

Enclosure 2. Additional funding information 42 contained in Enclosure 3.)

FACILITIES.

ROA facilities associated with the PRNC had an acquisition value of

about $9.0M, They are located at four sites on the island.

lo Btedras site

Im the Son Joan ares are well-equipped sedically-ortented factlities

located adjacent to the UPR Medical School, These facilities inclade

4 Dionedical building, animal quarters and'a maintenance shop. These

cost about §3.0M.

Mavagues Site

The principal auclear factlistes of the Center are located on 20 acres of property adjacent to the UPR caspus in the city of Mayaguez. These facilities include a research reactor (TRIGA); nuclear laboratories and hot celis; and several adjaceat structures housing offices, nuclear sagineering facilities, maintenance shops, and a greenhouse. Cost of these facilities vas about 4.6K.

Gornelia Ril site

Also located near the eity of Mayaguez are the Comelia Hill facilities which house the marine biology progran. These are relatively new and well-equipped environmental analysis laboratories located on the ocean adjacent to the pier for the PING Hesearch Vessel PALIHSO. Cost of facilities at Cornelia Hill was about $860K.

Laqutllo Wattonal Forest Site

a the Luqu{llo Rata Forest 12 2

120K.

a acquisition laboratory costing

dasetonal factlittes information 42 contained {a Eoclosure 4.)

RECENT EVENTS

A new contract with the University was authorised by the Administrator in June 1975 extending chrough 19815, Since then, the folloviag sigai~ ficane events have occurred: ERDA has proposed a reduction in

for FY 77; a decision was made to transfer the TRIGA reactor to TD; a

* Contract AT(40-1)-1853 adaintstered by O80.

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Adaiaistrator

new Dizector, Dr. Ismael Alnodovar, has aesuned forceful and responsive leadership and initiated substantial cost reduction actions totaling $700K to be realized in FY 77; the University has proposed that the RNC becoue the core of a new Exergy and Environment Center (Euclosure 6), which vould serve both ERDA and address the unique probleas of

?the Cousnwealth.

?OPTIONS FOR CHANG!

Agter reviewing « broad range of options the following three options for accomplishing this change vere explored in depth:

1. Continue the PRC COCO Arrangement with the UPR ~ making certain managenent and funding nodificacions.

2. Develop a atxed ERDA COCO and Non-COCD Arrangement with he UPR.

3, Discontinue the ERDA GOCO operations, eransferring facilities to the UPR, or others, or close then if appropriate, and executing ERDA prograng wader other contractual bases.

?Additional sumary prepared ERDA background matartal on these options, including pros and cons, 19 contained in Enclosure 5. Additional derailed PRIC prepared background sateriale are contained ia Enclosure 6.

RECOMNDED oPTTON

A eransition from Option 1 (current status) to Option 3 over a three to five year period vas daterniaed by the Joint Task Force to be the nanage?

?uont arrangeusat ?a the beat interests of the U.S. Covernnent and the Usiversity of Puerto Rico for the following reasoas: (1) it will permit RDA to contime {es high priority prograa works (2) lov priority ERDA programs can be phased out; (3) i¢ wil! provide for the ost economical tute of Government funds; and (4) this arrangeaent vill promote UPE Institutional developaent consistent with both Couscavealth and U.S. needa.

This wanagement change has che folloving features: (1) ownership of most of the factlittes/equipoent vould be transferred to the UPR over

a three-year period (FY 77-79); (2) certain facilities of no value to eteher party vould be closed of transferred to other government agencies fs soon? as possible; (3) ERDA priority research and training programs would continue through appropriate contractual arranzenent; (4) ERDA Would provide institutional snd developmental funding cupport for a five-year period (FY 78-82) to provide the University an opportunity to both use the nevly acquired EHDA facilities for othet energy technology areas (conservation, solar, ocean theral energy conversion, and materials Fesearch and development), and to develop professional capability in

---Page Break---

Admininistrator ate

{hese new program areas; and (5) educational and cratning funding wilt be adjusted during the next three years (FY 77-79) to reflect the seteal ?training requtrenents of ERDA at the UPR.

advantage of Puerto Rico's unique geographic features and to solve Comonveaith problens. This course £3 considered by the Joie feck Force to be a reasonable one to chart for a minority institucion eat 48 striving Co increase its professional status nd coapetitivences Sm academe, as vel] as to serve boch the U.S, Coverusent sal the Commonwealth of Puerto Rico.

This recomended option has been arrived at by a Jofat ERDA/PR Task Force through a deliberative process which 1acluded exaninacion ot Matorical data, on-site exanination of the facilities, and @ thorough analysis of the'threa reasonable options. Puerco Eco faverese ro including the PRNC, the Commonwealth and the University, have paciciested getensively in the entize process and endorse the recounendation, The President, UPR, can be expected to endorae this recomendation, REcoemMarion

The Task Force recommends the Adnta?strator approve a three to five Year transition from Option 1 t Option 3.

apron? ns Se

Disapprove:

nate: _Nowl 13 1974

wexr steps

Tee AFO wilt advise the Manager, ORO, and the President, UPR, of the Administrator's decision

2. The APO will direct the Manager, ORO, to execute a contractual agree ?ment with UPR to effect the transition. (Administrative guidance for this step is contained in Enclosure 8.)

3+ The AFO will direct the Director, HQS OPA, to prepare « public announcenent and arrange for a joint UPR and HOA faciitttes trans? fer cerenony.

4, The ATO will direct the Director, HOS OCA, to notify the Puerto Rico Resident Comntssioner of the Adsinistrator's decision.

---Page Break---

Adatatacrator

5+ The AAA wilt direct the Manager, ORG to taitiate a study to detemaine he auount and cost of radioactive clean-up required at the liayeeecs site and funding options for the work.

5. The APO and AAA Jofatly will vork out the detatia of datroduetag devalopaent and insticutional funding categories into the FY 78 badger and raducing the education and training bace funding. Joint Task Force proposed transition funding levels FY 77-82 are shows ig Roclosure 7. (Sea Rad Tab)

7. The AAA ta cooperation with ATA vill explore the potential of tts

concurrences .

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as, Ronatovaet

625 Sehason pave concur %y

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ISL, Smith pace 1/1217, concur F.SmiK rab

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OPA, King

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Dr. Vitali] Garber

Energy Research and Development Administration

20 Massachusetts Avenue IW"

Washington, D.c. 20545

Dear Dr. Garber:

time frane

Bar e's 3h fhe action memorandum should be ressises £52

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tient budgetary situations

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T have high hopes for the success of bar comes

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AL ORE,

Vitelty Garter (Chatzaen)

Technizel Director

Office of the Assistant

?Adxinistrator for Field operations

Russell Ritehte (Altereate Chairean)

Special Assistant to the Assistant

Adainisteator for Adxinistration

Jokn Whstnah

Office of tke Assistant Adatntstrator

?for Eavironnent and Safety

Jott Suinebroad

Deputy Associate Director for

?esearch and Development

Division of Blcredical and

tal Research

Janes Kellett, Jr./lareld B. Young

Tirieion of Uitvereity and

Vanpover Davelopnest/AAL

Joseph A. Lechard, Director

Research and Techiicel Support Division

Oak Ridge Operations Ocrie

Gait Bradshaw

Ghiel, Conservation, Fuvtronsent and

Satety, evs Branch

Office of Public affatre

-EREC_TASK_oRCE

Ieeael AlxSdovar (Chairnan)

Acting Director

Parte Rico Riclear Center

Flavio dears, Dees

shool of Engineering

Mayagues Caxpus

Vanusl Ges, Deen

College of Natural Sofences

Rio Piedras Cexpus

Juan J. Bgau, Director

Ortice of Fetroleun Fuels Affairs

Ofeies of the Goveraor

Connoavealth of Puerto Reo

Conrado P. Asenfo

Ansceiate Deen

School of Yedicine

Paul Harrison (Liateon)

Spectel Assistant to

?UPR President

Lats B. Boothty:

Gonerai Adninistrative orticer

Puerto Rico tuclear Center

MuUGDENT-IMANCE sve-corneTTEE

Petra L. de Toro

Acting Director

Office of Personnel

WR Central adsinistration

Irma Yésquez, Director

Budget Diviaion

UPR Central idetntetration

Andrés Medine-Peta

Acting Director

Finance Diviaion

WR Central Adsintetration

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BACKGROUND INFORMATION

Unter tts present fora of governsent, Puerto Rico is a Commonvealth, electing its cm chief executive and legislature, levying its ova

Ancone, excise and other taxes, and sharing with the Caited States eitizenship, defense, free trede and currency. A strong ainority of the electorate favors becoming 2 State of the Taion, vile a much sealler but

Bighly vocal ainority fevers complete and separate independence. The present Governor, Fafael Yernandes-Colon, ine strong advocate of Gomonveslth vith saxisun autonosy consistent vith continued common citizenship, defense, comerce and currency.

Puerto Rico hes a land area of 3400 square nilea, about three tines the size of Biode Island, tut with 3.1 ntliion people it has about three ?tigen Hhbde Islend's?popelation, and it is totally dependent on Amported petroleun. The rising costs of ofl and the recent eccnonic probles in the United States have coabined to reduce the Comonvealth? esl toons and to drive the menpleyzent rate to over twenty percest, Hearing sany vith college educations out of work.

?he University of Puerto Rico

Biucatina 18 of high priority in the Comonvealth. About 27 percent of the ?budget goes directiy to support education. nother 4-6 percent provide Andizect support. With « population of just over three sillion, and « per capita incone lover than any mainland state, Puerto Pico has sore ?han 160,000 students enrolled in its private and public colleges and universities. The UP2, one of tho largest untversities in the

Western Eentzphere, ba3 52,000 students, ostly Puerto Ricen. More than 20,000 of then recetve sone direct financial aid. The University 1a source of pride end a center for developsont in the Comsonvealth.

GPR is a land grant institution, rts funds cone from tution, relatively lov ty cosparison ($20 per sexester) to the mainland, and from legislative allocations. UFR gets a flat nine percent of the Comonvealth's income

as basic funding, vith special elloteeate added. In recent years, with

?the econozte doustura, Comonvealth real incoue bas declined and the University's budgetary base bag been squeezed.

he Uatversity is guided ty a Comet on Egher Education vhteh ts appointed by he Governor and vbieh, in turn, appoints the UPR President. The current President 2 Arturo Merales-Carrion. All significant appointeente of chancellors, deans of faculties, and the Director of PEIC - must be

approved by'the Comcil. In recent years, there has been a frequent

tumover in sany of the eajor positions at UPR. There is a conseicus effort ?to appoint qualified Puorto Ricans to major pos

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2m

?The University participates in « nunber of U.S. educational grante and

Fesearch procrazs. Under a nev policy, ouch contract, grant, oF proposal?

for a grant or contract, aust be in harmony with Councit policy and be

approved by the President of the University. Sintiariy, ERDA's arrangesents

With the University for the aanagenent of PRUC, rust have the approval

of the President and the Council of Higher Education.

SEtice of Patrolew Fusls Acteirs

oe office vas created by the Legislature of the Commonwealth of Puerto Rico

in Jaly, 1973 to formulate a dynastic energy policy for the Conacaveaith

Based upon expirical inforaation witch hat been vell quantified avd. qualified

for analytical purp Asong the fundanencal objectives are the follovis

lability of required energy supplies fron secured

sources; (44) To odtaia for our soctety the lowest possible cost for energy;

Binintsing the impact of energy costs on econoate velfare aod progress)

(444) To mininize the unfavorable effects which are induced by satketiog ?Problems and ?oternational energy policies: (tv) To establish a ell correlated relationship betvean environmental caters, generacion and utilisacion of enerer; (v) To inintze inequities viich aay arise as a consequence of econoaic or regional factors in caras of costa aad avaiiabiitty of eaersy sources; (vi) To prosote efficiency and optimim use of energy ta all eaecsy operations and uses; (vit) To carry on scientific research in reference te siterate energy sources, orienting such efforts for the achieveaeat of © regional exergy sufficieccy.

?The Division of Scientific and Technological Reseach {3 an energy research fod qarrice unit which ta an ncegral part of the Office of Petoleun Fuels aise.

The principal fields of fororest include petroleun refining, energy utilization, fuel combustion, chemical composition, sathenatical cedelling of stonipheric pollutants, and sulfur chenistry. The Office develops tts applied reseach and sezvice prograns in  coabined effore, when seceasazy, with industry, goverment and university scientific and technical perscesel.

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PROGRAM COST SUMMARY

PUERTO Rico NUCLEAR CENTER

FY 1958 ~ FY 1978

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FACILITY INVESTMENT PAGE 2

PUERTO RICO NUCLEAR CENTER

FY 1958 thru FY 1975

FUNDING

Initial

Facility Occupancy Cost

Mayagier Site

?Mucleaé Center Laboratory and Reactor Sep. 1960 szssoatt

(Canter Modifications and Minor Additions - "788,007

CComvenion of PANG Reactor Apr. 19728 '355,000

?Nuclear Engineering and Training Reactor Annex Jun. 1961 116,305,

Marine Biology Laboratory dun. 1966 36,619

?Administration Building dan. 1967 95,668

?Shop Building and Additions Mar, 1967 141538

?Agricultural Siosciences Laboratory and Additions May 1968,

?Shielded Facility for Neutron Generator Sep. 1971

?Total Investment Mayagiez

?lo Piedras Sito

Biomedical Building Feb, 1961

Biomedical Building Addition ?Sep. 1970

Radiotherapy Linear Accelerator ?Aug. 1973

Modifications and Minar Additions --

Animal Quarters and Vieus Laboratory ?Aug, 1965

?Aiewal Experimental Facilities Mar. 19753

Maintenance Shop Facility Sep. 1974

?Total Investment Rio Piedras $2,995,254

Goenetia Hit Site

Marine Biology Lab. and Site Acquisition Aug, 18 $ 130,000

?Modifications and Additions 280,974

101,200

dan, 1974 385.363

?S 967,537

Luguitl National Forest Si

ata Acausition Laboratory $_ 123510

Total vestment - PANE $5823,012

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*Constructior

Complete

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mesosure >

A Detatied ERDA Aoalysis of Three Prinetpal Options

Seeton 1 ~ Continue PRNC COCO Arrangenentwith the University of Puerto Rico -

Gartain Ranagenent and funding vedit {cation

Maintain the current FRAC COCO status but substantially iaprove tt as fellovs:

42. Centralize the tvo PRIC adnintstrative units (Mayaguez and Rio Pied:es)

nto ones at Rio Piedras, to facilitate fisancial seving

2, Eliminate prograns that are of lov priority for ERDA's purposes and vhich

either UPA gor others wish to support.

3+ Seek auppore fron other Federal agencies or other sources for any curreat

RIC prograns thac are of value to Puerto Rico and/or the United States,

but are of lov ERDA priority.

4, Phase out Base Program funding by Teducing the education and training budget

fo the level that ERDA deens essential for these purposes and concursently

eck supplesental support frox UPR, NSF, HEH, the Comonveaith of Puerto

Rico, or other agencies as appropriate.

5. Strengchen exiscing valuable research programs and to{tiate new programs 4m ERDA high priority energy developaent areas through the {aeroduceion of developuencal and inscitutional funding. The major program eaphases would include five princial areas, the first tvo of which are ongoicg, and the Incter three of whith will require devlopmental attention,

Boviromental sctences.

Buxan ecology (biomedical).

Conservation.

Solar scientific and engineering research and developnent including OTEC.

Matertals research aod developsent.

on 1 - Pros and Cons

Pros:

2+ Goco operation provides a very capable aanagenent organisation aad sstoctiated adoinistrative and saintenauce operations which can execute Bégh technology R4D programs in a nore effactive and tinely sanner than would normally be available in the UPR soaples,

Coco operation provides a clearer focal point for the UPR Energy Center aed Sore obvious ERDA presence in Puerto Rico than would otherwise be Possible.

3+ [000 operation provides a vehicle for putting other Federal agency vork nto PRIC under interagency agreement.

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4. 0000 operation permite use of GSA supply contracts, PIS communication, ?end notor pool services.

Sonat

Te The coco operation requires its ova separate adaintstrative network vithia UPR vhich, vhile more efficient, is nore expensive than if the central UPR adninistracion handled the business activities.

2, The GoCD method of operation requires UFR coupliance vith a host of Federal requirenents and procedures which necessitates a large PRNC adzinistrative aul overhead staff (As well es considerable ORO Contract Adainistration

effort.)

3. The COCO operation reluces UPR flexibility for use of PRNC facilities. Te elimtnaces UPR ability co coapete for comercial vork to be partly or wholly perforned in PENC facilities and, under current restrictions, prevents UPR froa responding to ERDA RFP's in nev prograa areas of interest fo UPR for performance in EHDA facilities,

4s The COCO operation requires indefinite ERDA funding support for Facilities anf administrative support statf, irrespective of the quality of the prograa or relevance to developing ERDA priori

?The COCO operation historically has evoked clear separation between PRIC and the remainder of UPL ani, vaile expected to faprove, still vil! ishibir truly ?cooperative prograns.

Farther detatted supporting acalysis of this option ts contained tn Appendix 10.

?Qpeton 2 - and with che PR

Those current PINC facilities which predoainately house BER prograns and are of igh ERDA priority vould be retained as Federal property. Those facilities of RNC which appear closely integrated vith and important to UPR prograns would ?be programatically transferred to the UPR and vould be fiscally supported by those prograns (ERDA program and inatitutional, UPR, of other) which ueilize the facilities. The facilities vaich would be retained under Federal ovnership would ber

1. Cornelia E11
2. Rain Forest Factlictes
3. man Ecology Building at Mo Piedras

The facklittes which vould becone a part of the UPE or othervise disposed of ?by BRDA vould be:

1. The Mayaguez FactIities
2. The Cornelia #111 Dock
3. The Main Building at Rio Piedees

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?Opston 2 ~ Poos end cons

rset

1, Uetains naximm sanagenent and orgentzational strength for execution of Life science and enviromental programa at PRNC vhich are currently of Aigheat progren pricrity to EDA.

Watotains clear and viable EIDA presence in Puerto Rico es « COCO ?Euvizoneatal Center?.

Provides sone facilities and squipaent to UPR as a base for broadened energy center prograss relevant to ERDA and the Comonvealch of Puerto Reo

4. Provides UPR vith flectbiltey to coupete for sone outside work and ERDA HPP's Sn those facilities transferred to the University.

Sonar

Je WAL continue to require maintenance of 4 costly COCO type adatntatrative network within UPR the burden of which will borne solely by che last supporting ERDA progran division (BER).

2 Separates TRDA energy devalopaent froa che eaviromental work at UPR, and Probably will create a less than desirable degree of iateraction.

Prevents UPR fron coupating for other chan ERDA envizoumental areas for execution in the facilities maintained 28 00CD.

Ay Requires indefinite FIDA funding support for the adaintstrative staff and the factiities retained as COCO, irrespective of the quality of the Program or relevance to developing EADA priorities,

Werther detailed supporting analysis of this option is contained in Appendix 11.

?Satdon 2 ~ Biscontinue G2cd Querattons and Teenefertog Facilities to che oc close ches if approptiate, crecued 3 wih cher contractual ba

oder his option, FDA vould programmatically cranafer FRNC facilities to

UPR, phase our the COCO wechod of operation at UPR, encourage davelopaent of

?4Niable ?Euargy and Enviromental Center? at the University through instite onal support, and would execute priority ERDA prograne through chis UPR center on other contractual bast

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+

All PRIC factlittes except the Bain Forest Station vould be offered to UPR to fora base for their "Energy and Enviromental Center". The Raia Forest, facilities vould be retained a3 Federal property but vould be ade avatiable fo UPR under a use perait. Any PENG facilities determined not to be of Amterest to UFR vould be disposed of by ERDA in accordance with Federal property procedures.

Unter this option, EDA and UPE would enter into @ Agreement and Comnitnent of Matual Benefit, The Coomitmene would:

2, Asture chat high priority ERDA programe vill contique to receive priocity ER facilities and personnel atteation, 't a five year programmatic developnent effort by providing ERDA

eal and institutional support to the Cester to atizulate developaent

of nev areas of techaical excellence and interdisetplinary support.

Sption 3 ~ Pros and Cons

Frost

As The need for « separate, duplicate, and coaplex PRNC adnintstrative and Baintsnasce network to cospiy with GOCO contractual requirezents is elininated.

2 The artificial and undestrable seperation of PRNC and UPR prograns vould be elisinated, prosoting nore cooperative endeavors, ani enhasciag both prograns.

3+ GPR would have fall flexibility to execute programs of taterest to the GSomonvealth in current PRIC facilteies, co compete for privace or other Federal agency contracts or RFP's for execution in those facilizies, oad © compete for ERDA REP's in new areas of enersy interest to Uk

4. ok sport to OF would gradually ehite to funding of only cechaeatiy

emetitive progzine andthe send for HOA support at Facials ast

avective of tate relevance fo developing HN seopeassstis etceitits,

vould be eliminated. me

2, HDA presence tn Puerto Rico will be less obvious.

3 Qther Federal agency work in the energy center vill have to be undertaken

through contract with UPE rather than interagency agreesent with EROA,

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SUOGESTED ADNENISTRATIVE AP>ROACH

70

?980 FOR TRANSFER OF FACILITIES 70 Tue UPR

As O80 ta to be directed to execute an agreenent or contract modifteation

vith UPR to proceed vith programmatic transfer of appropriace EROA

factlities to UPR and orderly closeout of GOCO operueion. Toe agreesent should include a tinetable for conplation of the isplenentation eleneaes and clear indication of ERDA plans for long-tera funding support by funding catagory. Included in the agreement shall be « peort sion 79 change the PRIC name to Puerto Rico Enargy and Enviroanental Ceaser,

2. The actual programatic transfer of factlities will be a phased process faking about three years for full taplenantation and transfer. Rovever, lyon execution of the above agreement, ADA can begin hacdling UPR-PRIC 48 4 non-GoCd tactliey for purposes of peraiteing ton-EtDA work 1m PRC facilities UPR vill have flexibility to compete for REP's tn the private OF Federal sector; and UPR vill be eligible to receive ERDA "ingtleueions!? apport

3+ The administrative and fiscal ateps of closing out the GOCO operation and transferring the factlittes are to be handled by ORD. diele the dadntstrative procedures associated with the transition can Se sccouplished in one year, the "techaical? problens of radioactively gontsininated facilities and the need for UPR co obeata NRC Licences for possession and operation of the PANG facilities, will extend the ?fransition period to an estiasted three years.

ade avatlable to ERDA under 4 use pernit

8 and will not be transferred to UPR. lowever,

the use parmit will be transferred fo UPR.

5+ Cornelia Ri1t facilities contain o radioactive contantnation therefore,

bey can be renoved from the GOCO nethod of operation and placed on other

funding arrangenents during FY 17 or FY 78.

The Rio Piedras facilities (all or part) can be programatically

Sausferred to UPR in about 18 sonthe. The final tfansfer vill be

contingent upon UPR extending its NRC Licence for possession tad

operation of the radiological factlities at Ro Pledras.

7. The Mayaguez facilities require radioactive cleanup prior to transfer

and obGtining of IRC Licenses for source materials, byproduct careeiela,

ad he training reactor (L-77). For planning purposes ie is assened

this can be accouplished in three years. The steps, fron the radiological

standpoine, ar

Have PRIC-UPR undertake a decontamination stuly in FY 77. factor

8 Tadtouctivity levels which vould be acceptable to UPR, che

Commonwealth, the ERDA and che NEC.

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>

be Have UPR engage in early discussions with WRC regarding

cs for source, byproduct, and training reactor Licensee

(for the 1-77). This should be acsociaced vith the above study.

G+ Have UPR proceed with necessary steps tovarde Licensing with NRC.

?The Research Vessel PALIIGO ts to be transferred to a stateside

organization having programmatic need for such a vessels

?The AFO will oversee the ORD ioplenentation of this nev sanagenent

arrageneat.

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APPENDIX. B

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