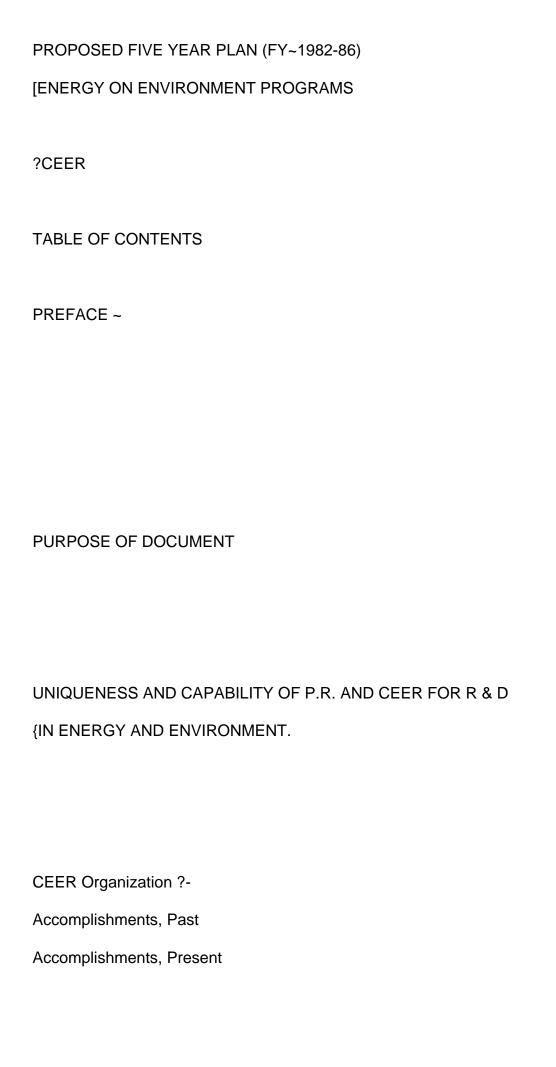
CEER-A-055

PROPOSED FIVE YEAR PLAN
ENERGY AND ENVIRONMENT PROGRAMS
EV 1002.06
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 (198:	2-86) SUMMARY ~-
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PROPOSED FIVE YEAR PLAN (1982-86) PROGRAMS

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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 Administrator of ERDA (now DOE) ?and the President of

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

Particular to the Properties of Puerto Rico authorized the establish? 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 Particular Particu

?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 Com mittee hold its first meeting with representatives of CEER and the

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

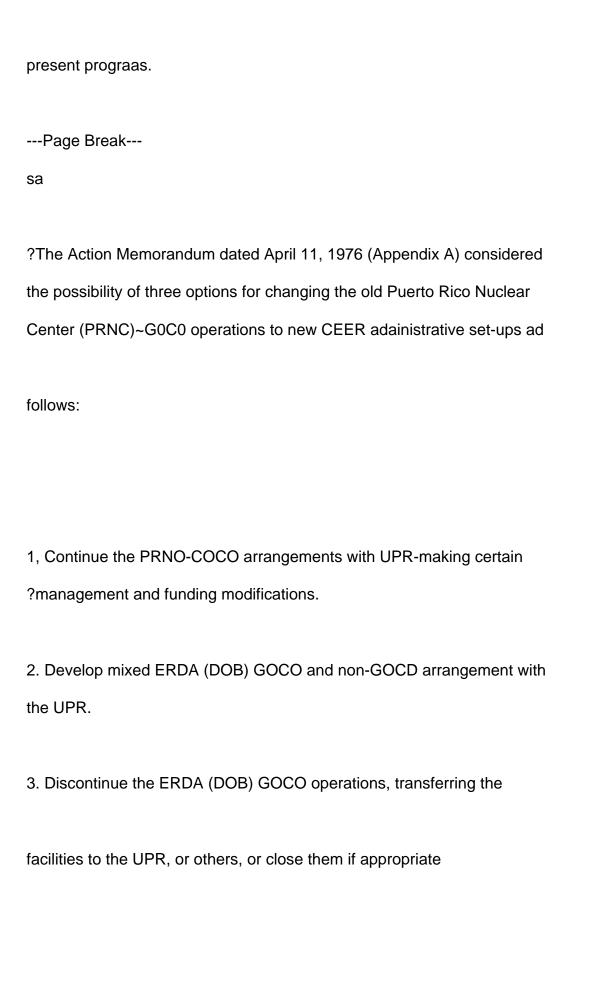
?taken up to that time and to refine plans for the future, There was full

agreenent that CBER's success would require continuous and close commiication 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



and executing ERDA (DOE) programs 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.

IREASONS 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,

---Page Break---

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 programs 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

---Page Break---

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 first 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

---Page Break---

data obtained at Ponce, P. R. (southcoast), at 18 degrees latitude, indicate an average daily total isolation of approximately 1900 BTU/sq. f-day on a horizontal surface, The relatively snall change in day length (P.R. being close to the equator) from sumer to winter, enhances the utilization 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 ---Page Break--i environment vhich constitutes a predominant minority group. The contin

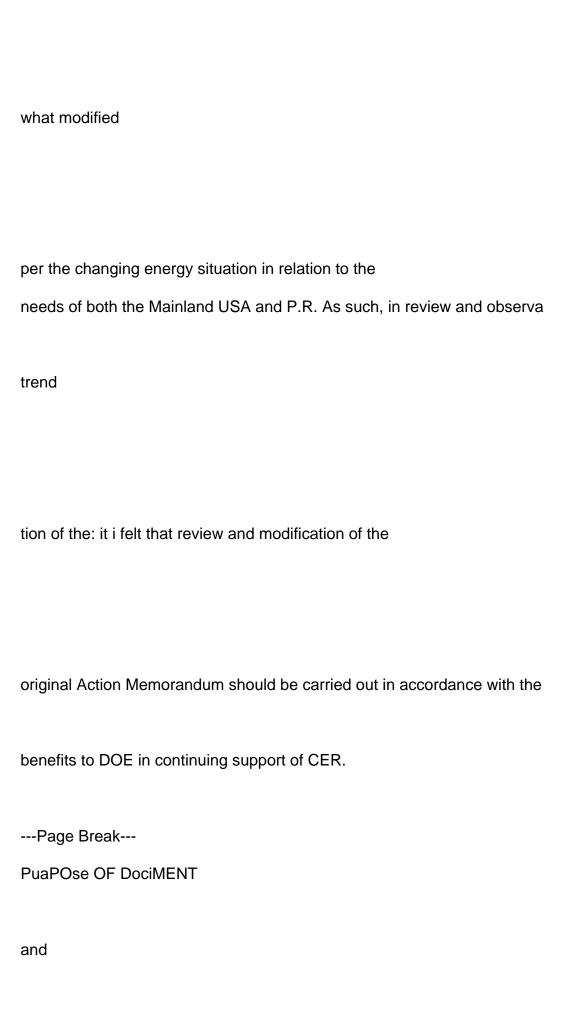
?vous support and funding of CHER will enhance the good will and spirit

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 some-



?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 NationI 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-

R	studies.	Puerto	Rico's	total	fue
v	oludico.	I UCILO	1 1100 3	wiai	IUC

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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-2-

TALE

1

ESTIMATES OF PUERTO HICO'S ENERGY HEQUIREXENTS TO THE YEAR 2000 PURCES AND ABSENCE OF STRONG R"AND D PROGHAY. ON ALTERNATE ENERGY ?SOURCES

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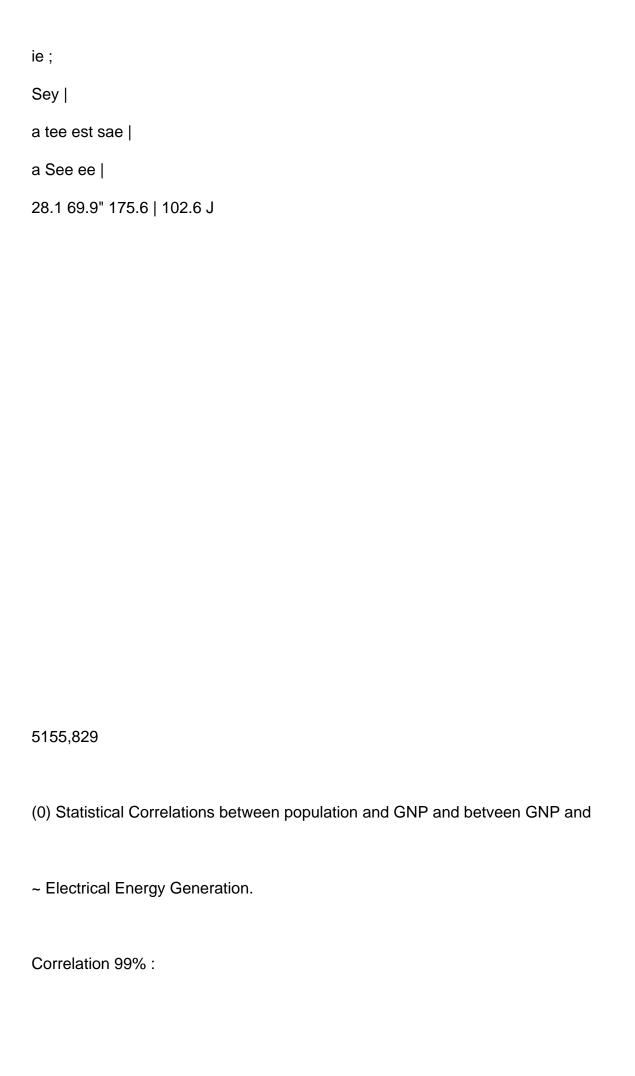
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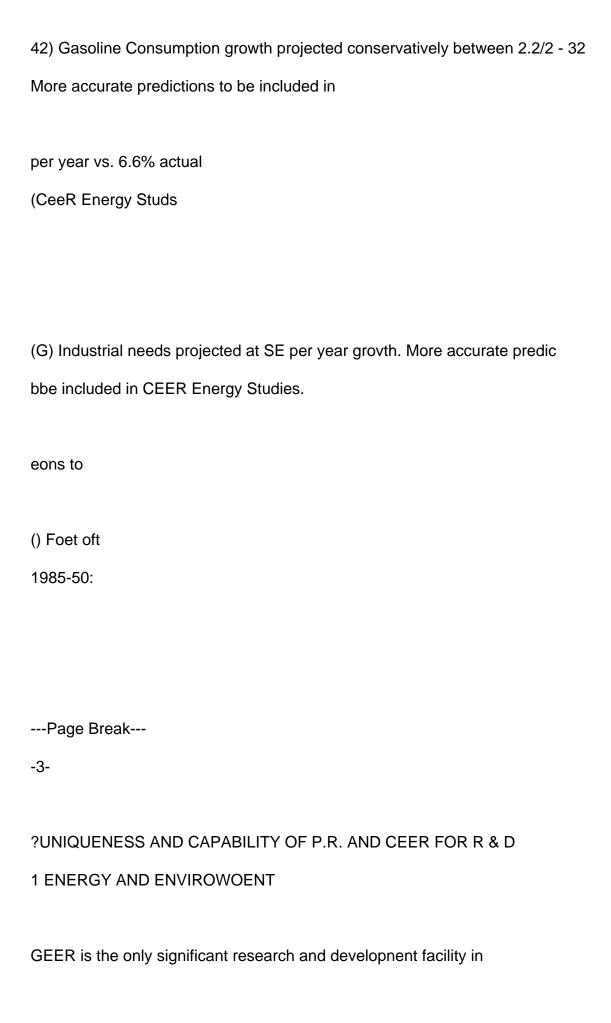
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Puerto Rico and one of the fev within the U.S. that focus on both energy

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 sophisticated 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

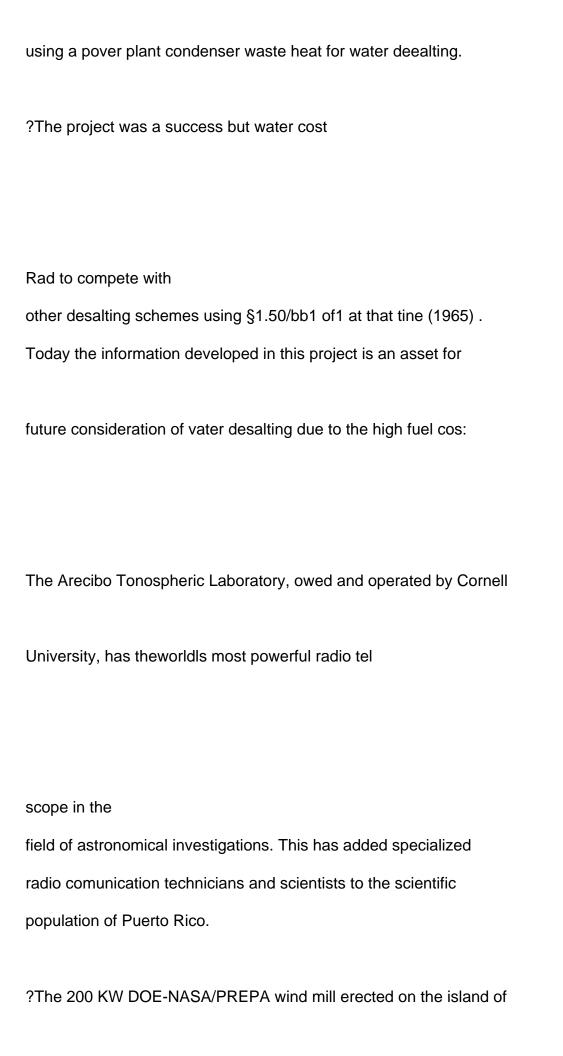
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replaced (1970) by a Triga Type reactor (246i) which served as an R&D and training facility for nearly 18 years of PRIC (now EER) operations.

Controlled Flash Evaporator Desalinization Pilot Plant, 10 GMP

at Palo Seco Power Plant.

This has been the only desalinization pilot plant ever built



Culebra, located to the east of Puerto Rico. Important operating data is being accumulated at present. This represents another energy alternative technological advancement. - 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 ---Page Break----5-

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 systemise, and in addition, it provides security programs

{tea operations.

---Page Break---

?The main transmission network is 230 KV. The distribution system is equipped with renote control and electrically supervised stations, System 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 and operating the pover aystem 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 programs 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.

CREB Organization The Center for Energy and Environment Resear + Previoudly known as the Puerto Rico Nuclear Center, operates as a single unit within the University of Puerto Rico system, reporting directly to the President of the ---Page Break---

1 oansta

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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 an 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.

Accomplishments, 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

---Page Break---

~9-

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 participants 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 environment, The good will and

ambassadorship together with the intelectual and know-how accomplishments gained through these training prograns is probably the major accomplishment 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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~10-

includes biofouling corrosion and materials studies, measurements of oceanographic 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 availabiMey 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

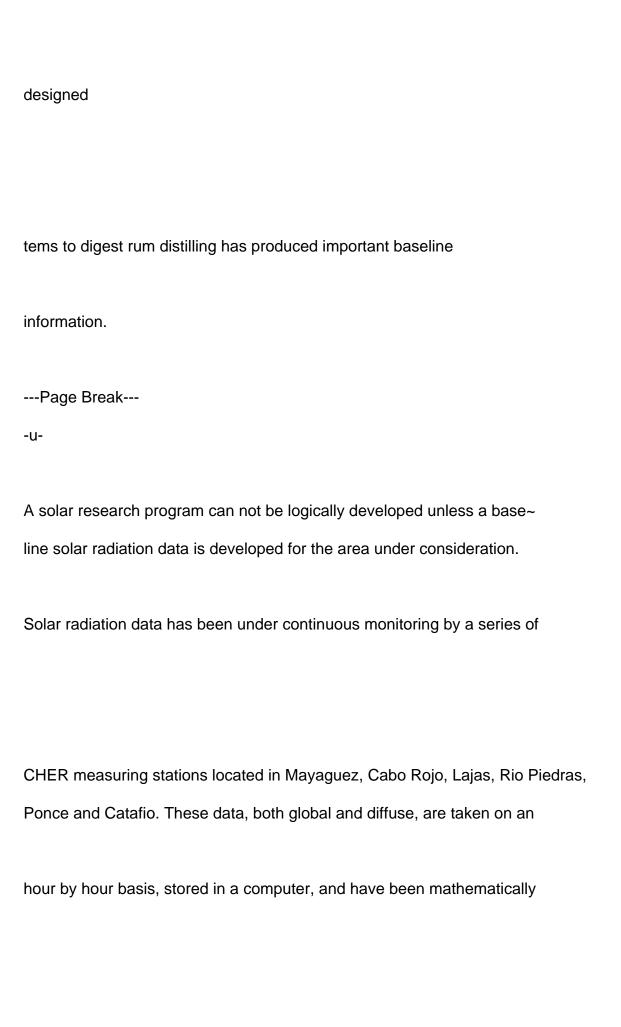
harvesting large colums of biomass and their econonic and agricultural eisniey

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



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 condi-

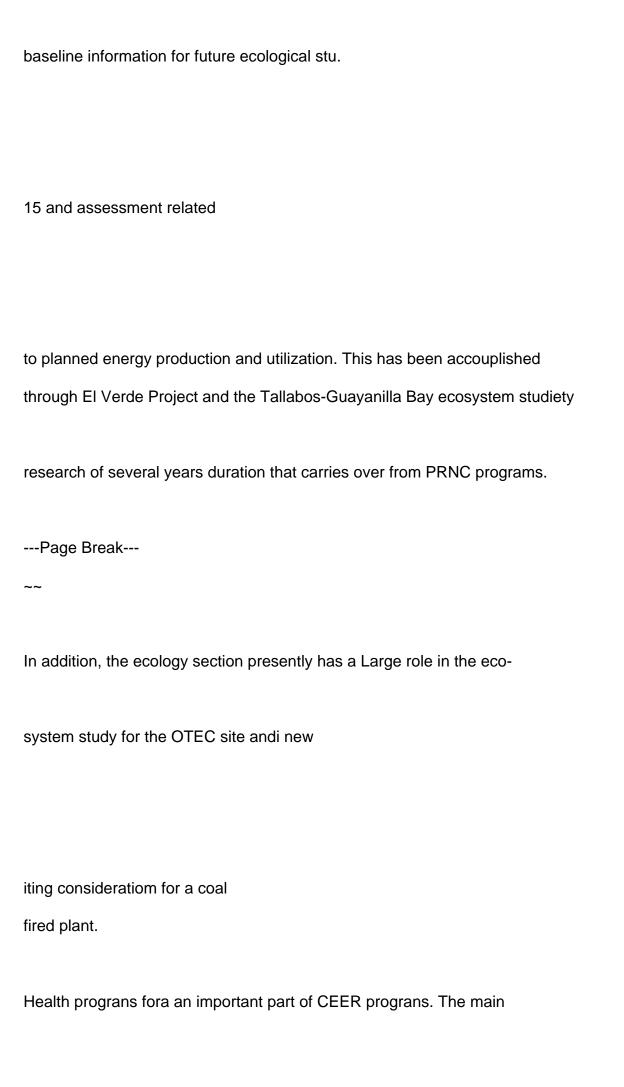
tioning machine using silica gel has provided basic information for the

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



?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 information 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

---Page Break---

-B-

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	i and Education	Programs have	received verv
i ubile / wai chess v	or rraining		i rograms nave	, icccivca vciy

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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-ue

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 ?stimuletion 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 accouplishments through very Limited funding, an average total on the order of \$3 million per year for all programs.

Figure 2 ?Institutional and Developaental Programs FY-1980 Projections and ¥Y-1979 Alfoéations? illustrate thé actual funding disttibution of the various programs.

Table 2 "Institutional and Development Funding by Project Areas FY-79 ?and FY-80 indicates the present funding distribution by institutional progran classification,

Appendix B "CHER Programs" gives a detailed Listing of "CEER Inetitutional 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

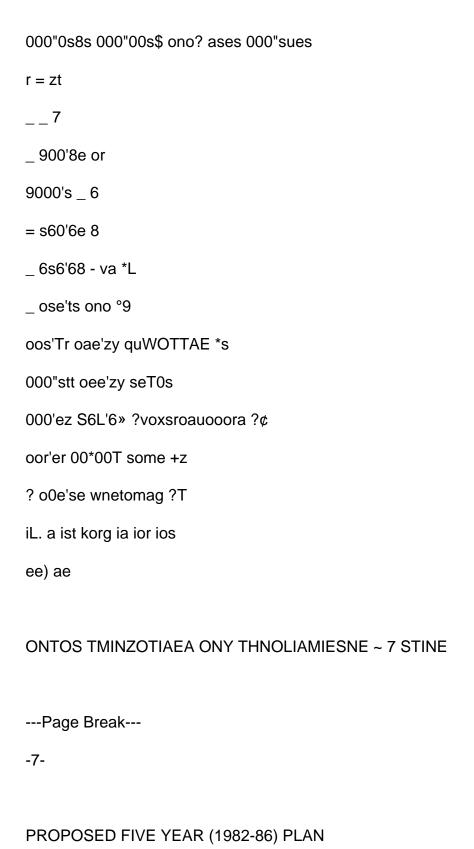
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SuMARY

?Tho proposed five year plan (1982-86) for the development 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. Or	ne of the
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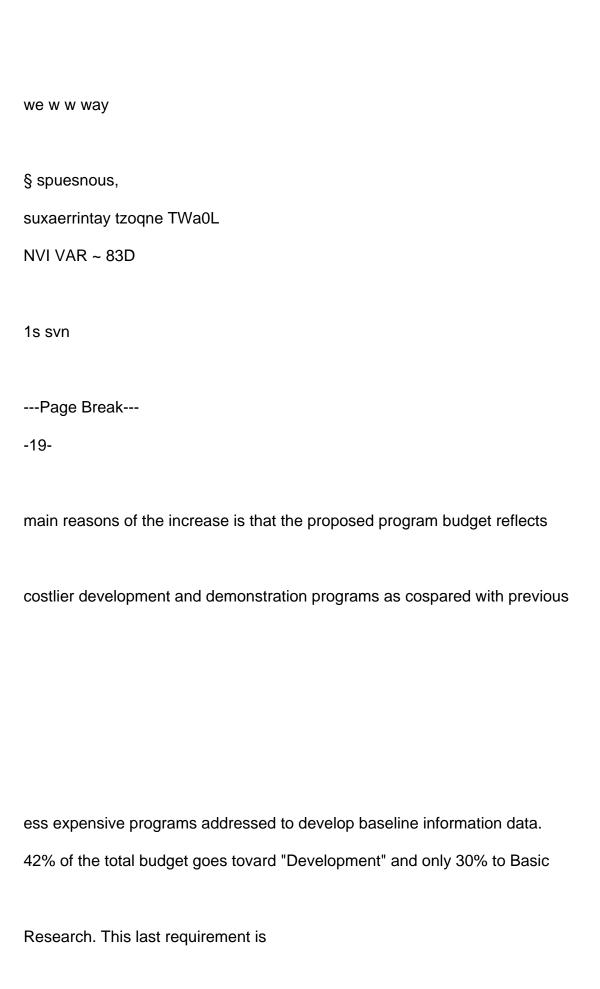
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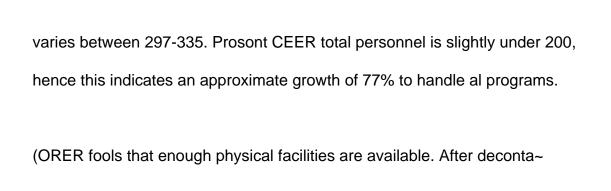
tional baseline information, Denonstration programs account for 22% of che

Budget while training and education accounts for less than 6%. We 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 programs 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 program see the corres ponding Table 2 under the respective program section.

The total maximum projected personnel requironents for the progr:



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, Development, Denonstration and Education and Training. The largest coaponent as previously pointed out is "Development. For details of Budget classification of a particular program refer to the corres

ponding Table 3 in the respective section program.

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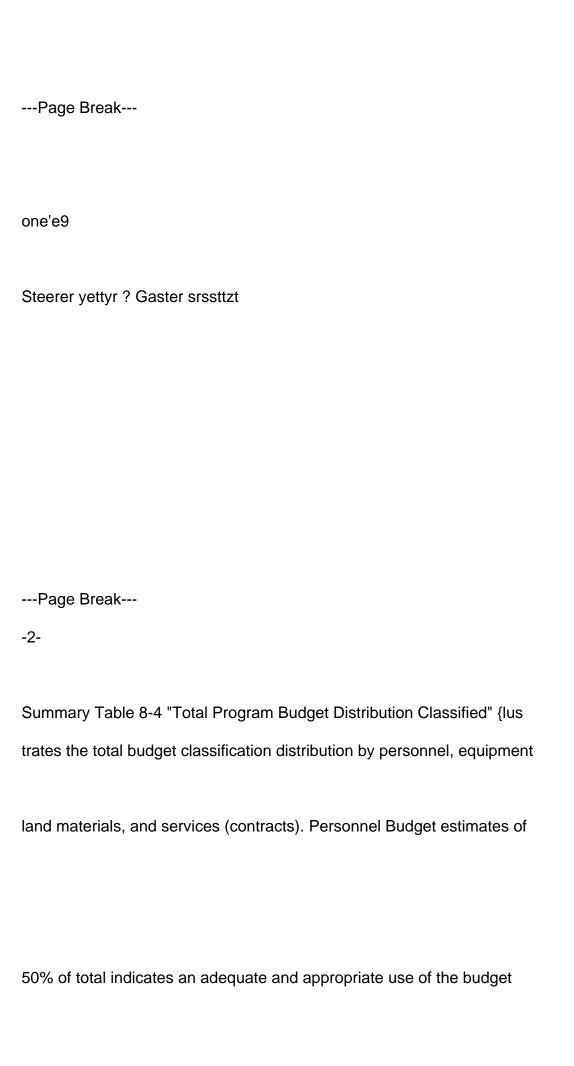
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dollars. For details of che budget distribution for a particular program, refer to the corresponding Table 4 of the respective section program.

Pigure 3 illustrates graphically the Budget distributions. The bud

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

Not included within the budget is the program on Energy Assessment

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 requirements 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 program.

A detailed description with budget analysis for each program follows.

---Page Break---

-2-



Budger Diste by Budget Distr. by Programs Type of Research 1 Distr. by Services MAN POWER

TECHNICAL

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Page Break
-25-
PROPOSED
1982-86
Page Break
OTEC PROGRAM

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

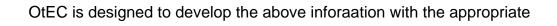
which plant influences can no longer be differentiated from background.

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



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 measurements 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 entrainment/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

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quawiaunseau 40) parisiA 3q
MA G1 PUR LI SUOREIS ?ENy
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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 organisms 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. 13

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
18
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.

°°00°°

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

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BIOMASS PROGRAM

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TT, BIOMASS PROGRAM

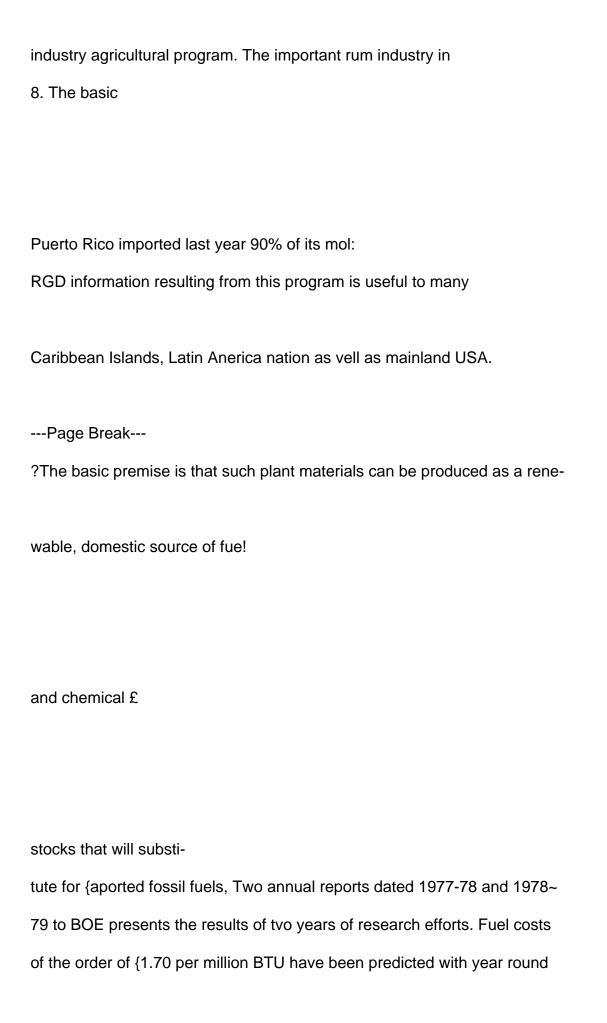
A. Baisting Prograns

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 1 and could be replaced by an economically viable

biomass for energy and higher-test molasses (to supply the rum



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.
le 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.

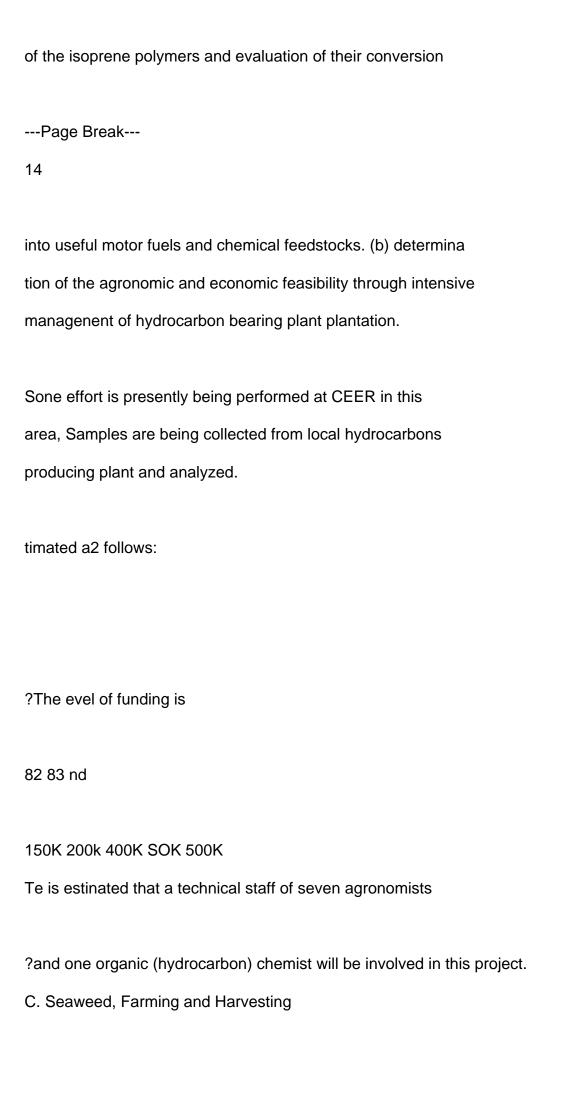
Puerto Rico has about 65 species of 10 fanilies of such
Inydrocarbon producing plants and import can also be nade from
Brasil, other South Anerican countries, and che western
USA mainly California.

?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



Although land used for unecononical 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 is 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

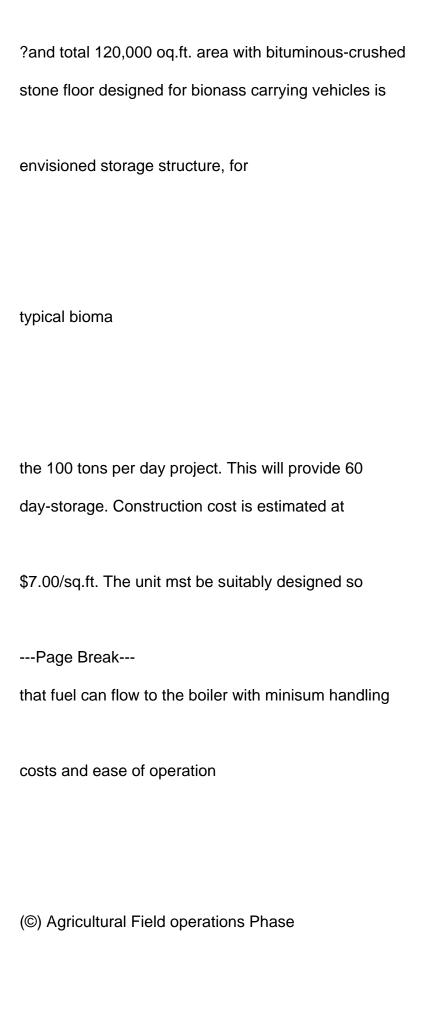
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enough techaical data for specifying steam boilers to burn bionass and design other items euch as storage and handling equipsent accordingly.

?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 PhaseA biouass complex must be constructed to accomodateboth solar dried and mechanically dried biomass fuels.

A structure, aluninun roofed, oper



Optimization of land use (8000 acres) for full year operation of the project:

- 1) already planted land for lst. year operation
- 2) replantation
- 3) mix of different species, cane, napii

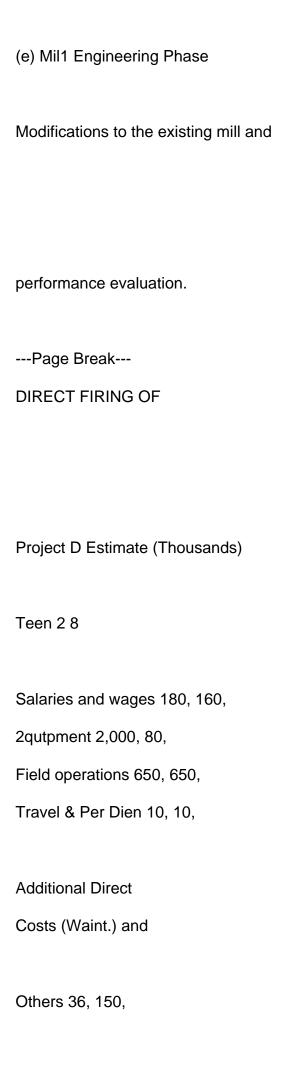
sordan.

(@) 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



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

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Dago Prook
Page Break 11-10
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

a1

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 ---Page Break--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

Sefentific Staft 2 3 os 8 4

Hydrocarbon Bearing Plants

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 ---Page Break--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
Development. 200 200 450 450-350 1,650 Demonstration 3,500 1,380 1,380 1,380 1,380 9,020
·
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020 Education & Training 0. 0 0 Q
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020 Education & Training 0. 0 0 Q 0_0
Demonstration 3,500 1,380 1,380 1,380 1,380 9,020 Education & Training 0. 0 0 Q 0_0

m13 **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
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BIOCONVERSION PROGRAM

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mrt

TIT, BIOGONVERSION PROGRAM

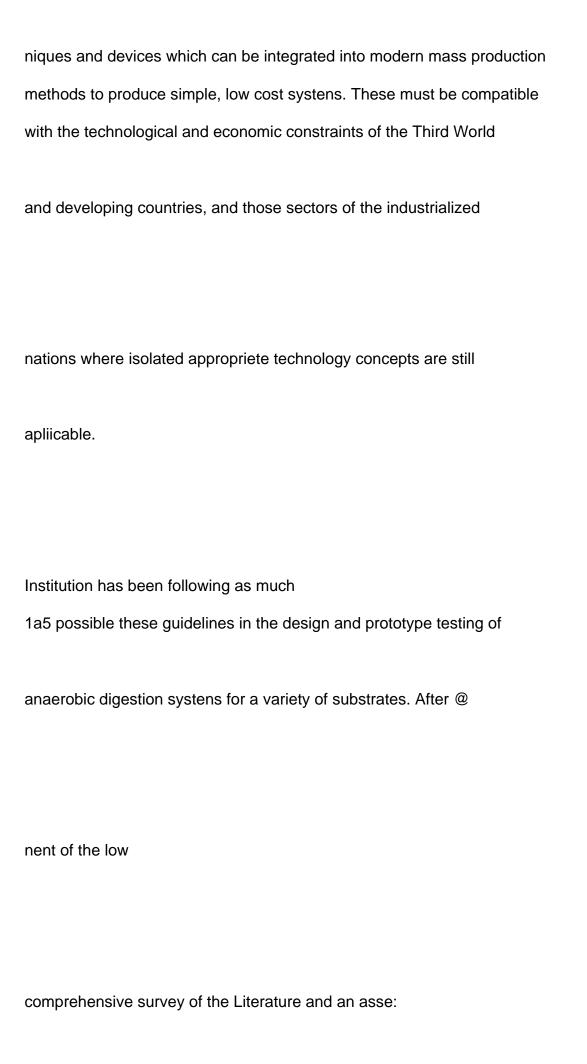
METHANE

It is rapidly becoming apparent that Biocoaversion may be one of the Key components in the resolution of the critical energy problens facing the world at present. In addition, judicious choices of the operational parameters 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



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

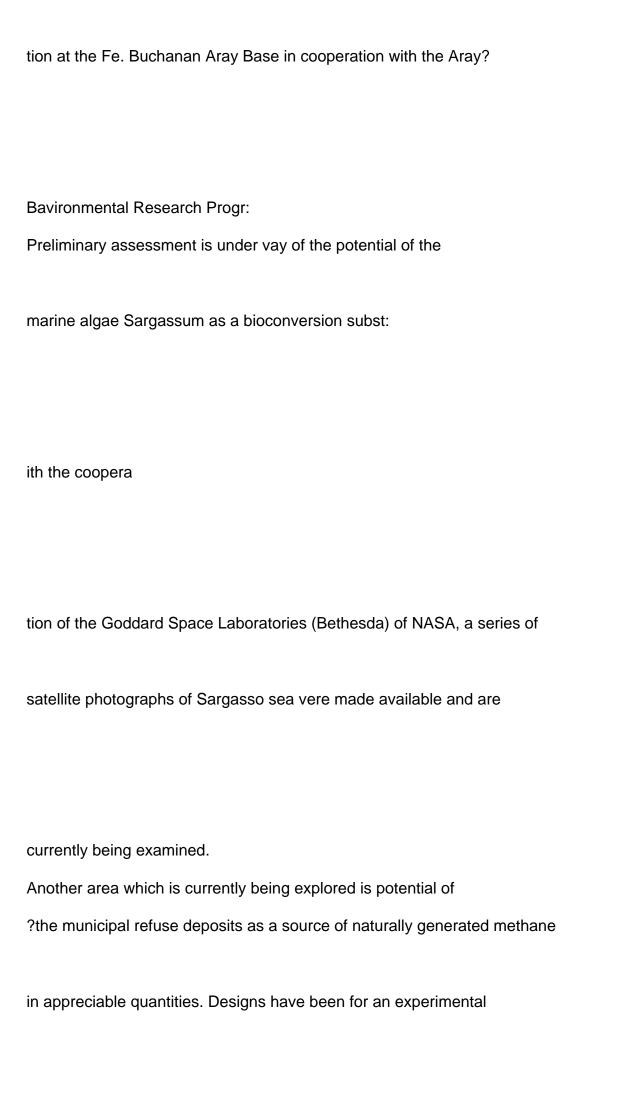
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mr-2

the most comonly available biomass and each bioconverter was designed for a specific substrate. The systems 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



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

early in 1980,

{In addition co the experimental work, the staff of the Biocon version Program has been active in a number 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

---Page Break---

m3

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

Preliminary studies have been initiated in other areas of bio-

conversion 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 halophilic 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.

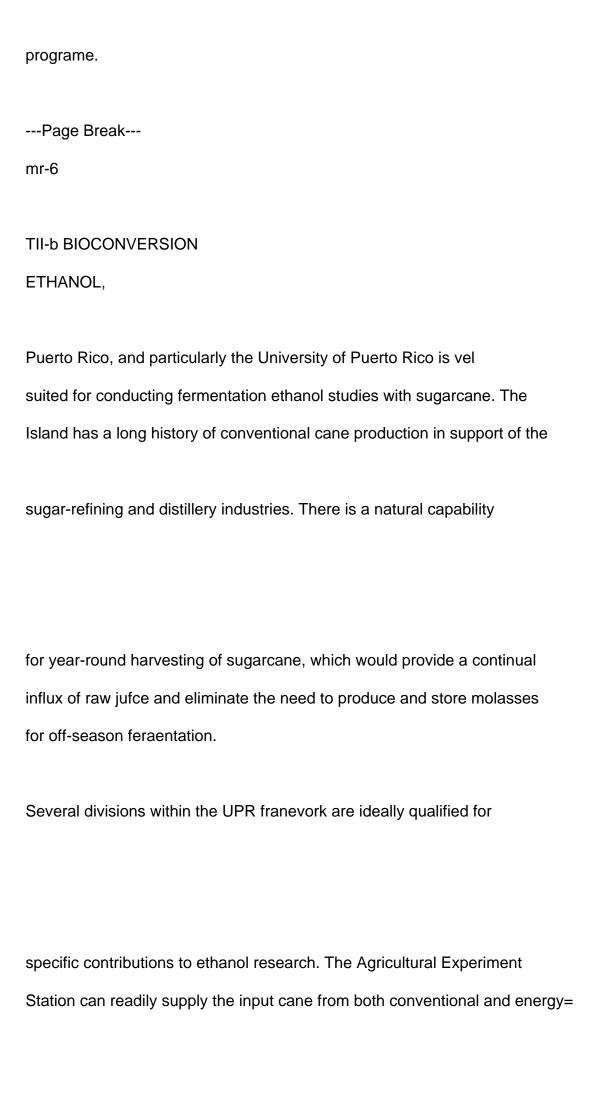
I. Bioconversion screening progran

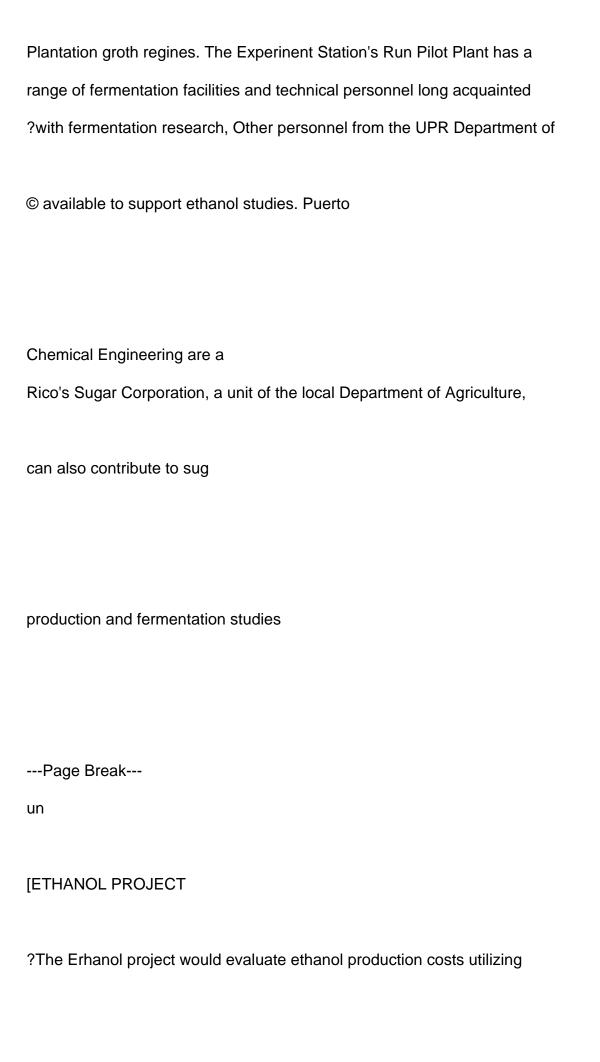
?Bioconversion screening program

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





sugarcane juice and high-test molasses as direct sources of fermentable	
colide. Dephasis yould be directed toward minimizing producting costs by	
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 substantial 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.

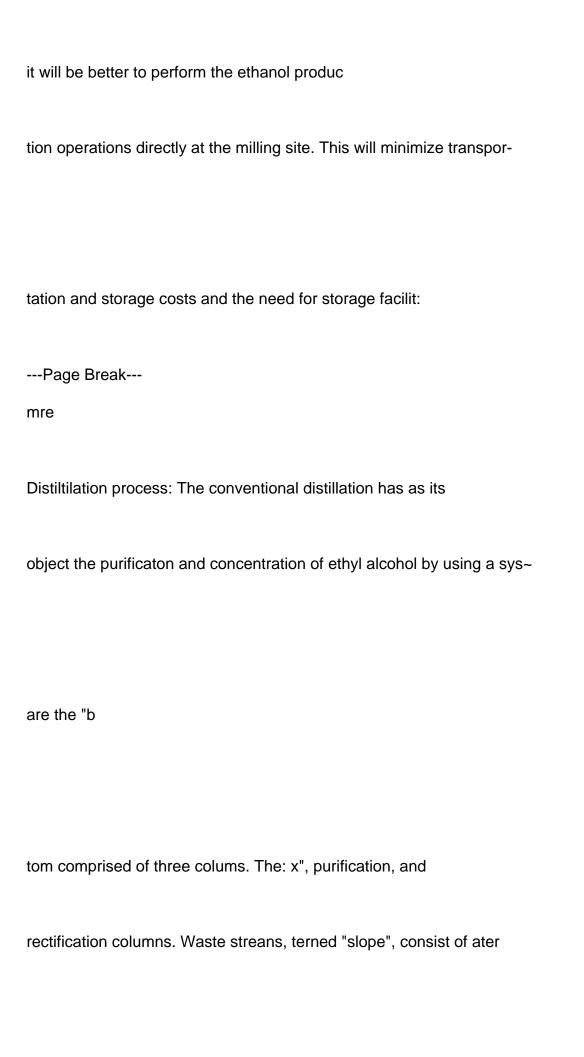
In the latter instance the mols

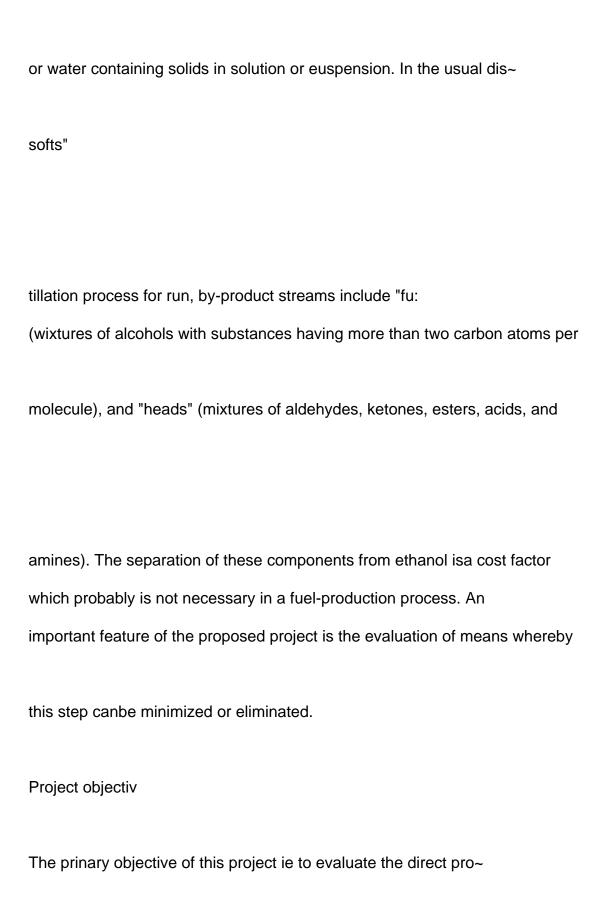
es is ordinarily transported to a run dis-

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





duction of ethancl from surgarcane fermentable solids in an integrated eysten, with emphasis on wodified technologies and econonization of the integrated 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.

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1-9

A short time fermentation technology based on continuous fermentation 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 3
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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
Light Activated Biological Puaping
_
Biological Puaping
Biological Puaping Bioconversion Screening
Biological Puaping Bioconversion Screening qorals
Biological Puaping Bioconversion Screening qorals TagLE T1I-1a
Biological Puaping Bioconversion Screening qorals TagLE T1I-1a (8 Thousands)

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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

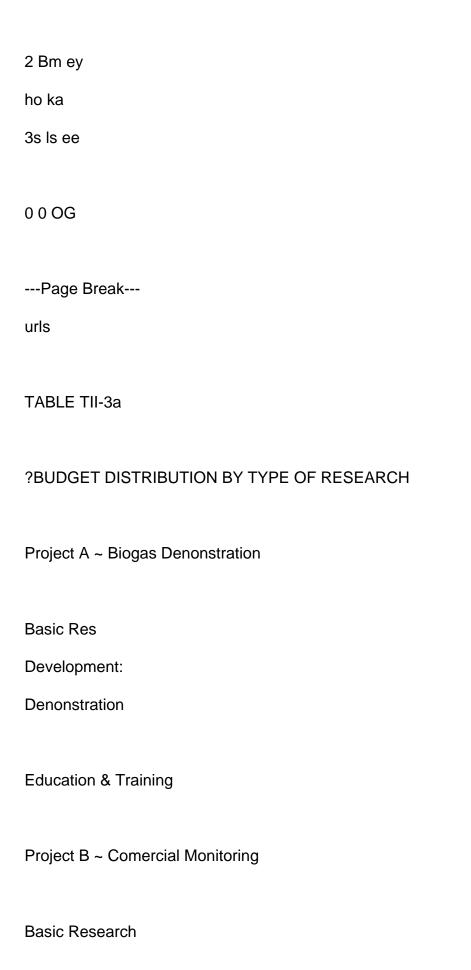
Adwinistrative Staff Project E ~ Biophotolyeie Scientific Staff Technical staff **Adninistrative Staff** Project F ~ Marine Biowass Conversion Scientific staff **Technical Seatf** Administrative Staff Project 6 ~ information Transfer Scientific staff Technical staff Administrative Stage 82 3 0

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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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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
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Education & Training
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?TABLE I1T-3a (Cont.

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6 09 9 6 06

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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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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 °

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Page Break
TABLE 111~4 a(cont.
Program W = Light Activated
Biological Pumping
Personnel
Equipment & Materials
Services
Personnel
Equipaent & Materials

TOTALS (Thousand dollars)			
Personnel,			
Equipment & Materials			
Services,			
?TOTALS			
nr-16			
88			
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Services

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BIOCONVERSION

(EER 5 YEAR PLAN

?ETHANOL PROJECT

TABLE Tlb-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

Development 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

6,

Total
905
505
740
69
96.
905
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FOSSIL FUELS RESEARCH
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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-traditional 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:

mental 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 environmental 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 comnercialization 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 supplemented 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, IS producing biodegradation. The use of a

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

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

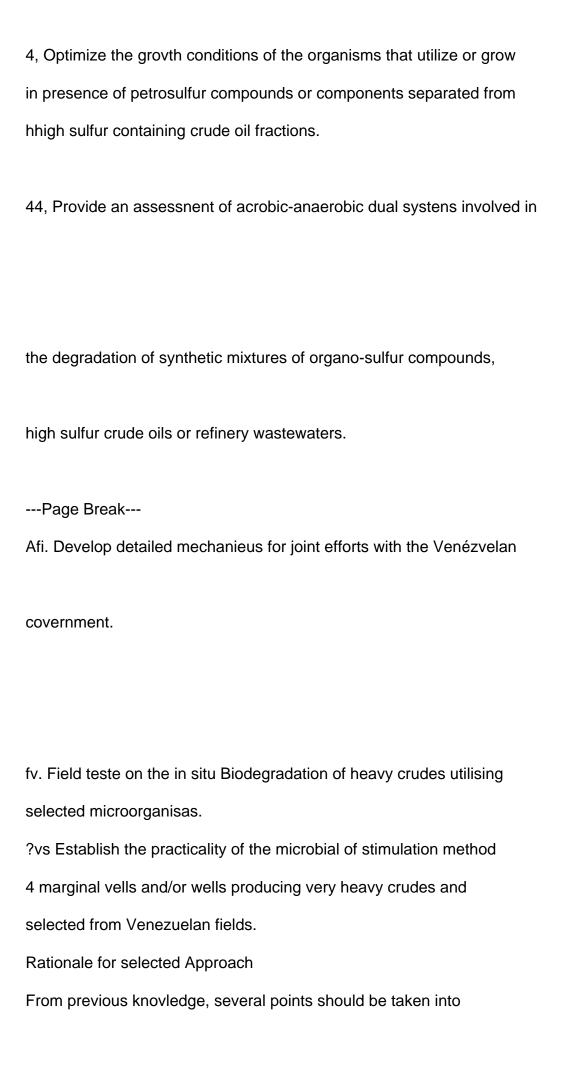
microorganisas. ?The biodegradations are monitored by three different

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%, 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 in the presence of sufficient nitrogen and phosphorus.

B.A single microorganisms 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.

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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 of 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

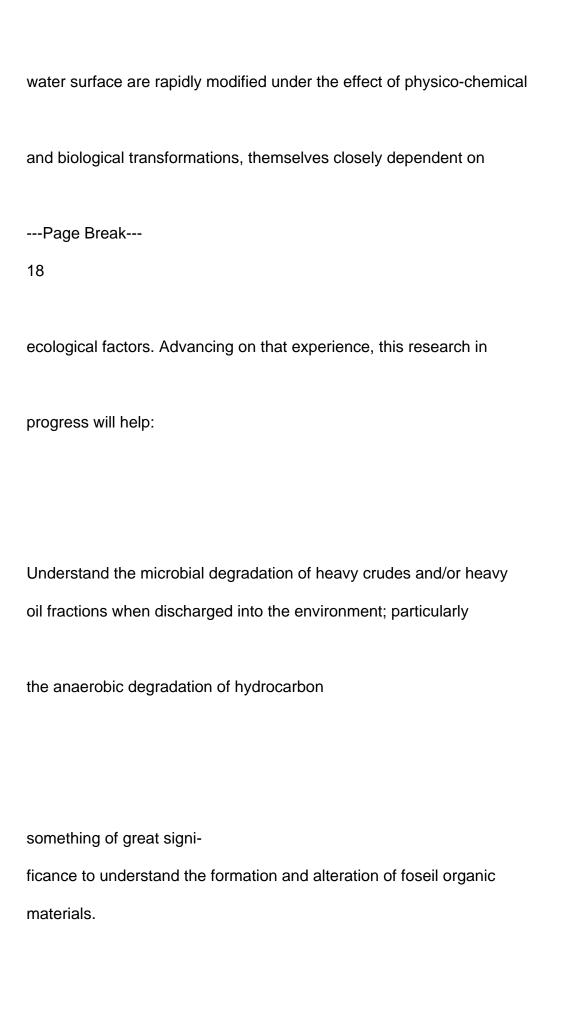
6 useful in enhanced of recovery).

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 of 1 and petroleum products discharged at the

found on the North Coast of Puerto Rico.



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
mprove our knowledge on the trestment and disposal of effluents
and industrial wastes
e, Improve our knowledge in microbiological processes useful in
enhanced off recovery.
- -
E. Bvaluate the relative toxicity of biodegradation products fron heavy
oil fractions of low and high sulfur content and explore health and

bb, Increase knowledge a8 to how o;

safety considerations associated with the handling of large anounts

of cultures under Field condi ions.

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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 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

the effects of petroleun fractions on selected tropical marine organians.

release of crude ofl will have on comercially inportant species of sarine organisms, ve have decided to employ well characterized fractions of crude

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

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w-10

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 organisms. This will help determine the contribution of biodegradation to the toxic effects on marine organisms 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-

flected species, eo that the
longer periods of time feu
relationships between oil concentrations that are toxic for short
Conditions averaging can be determined
?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
3. 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.

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Bes ind/or Benefits Expected

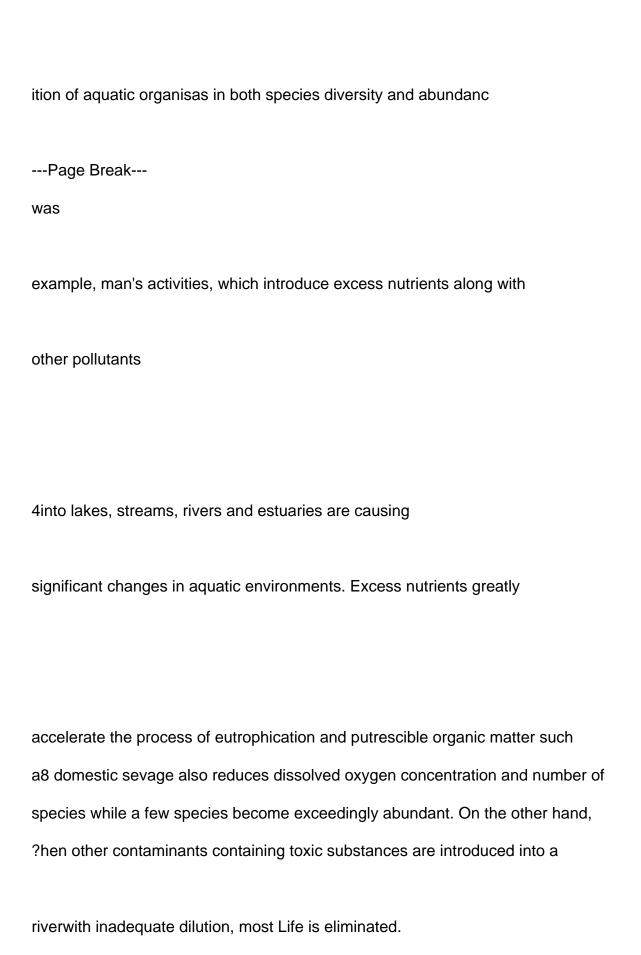
4, Heavy and Light crude ofls like the ones to be used here are

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 compo-



Bavironsental effects of oil pollution and bioassays on the toxicity of

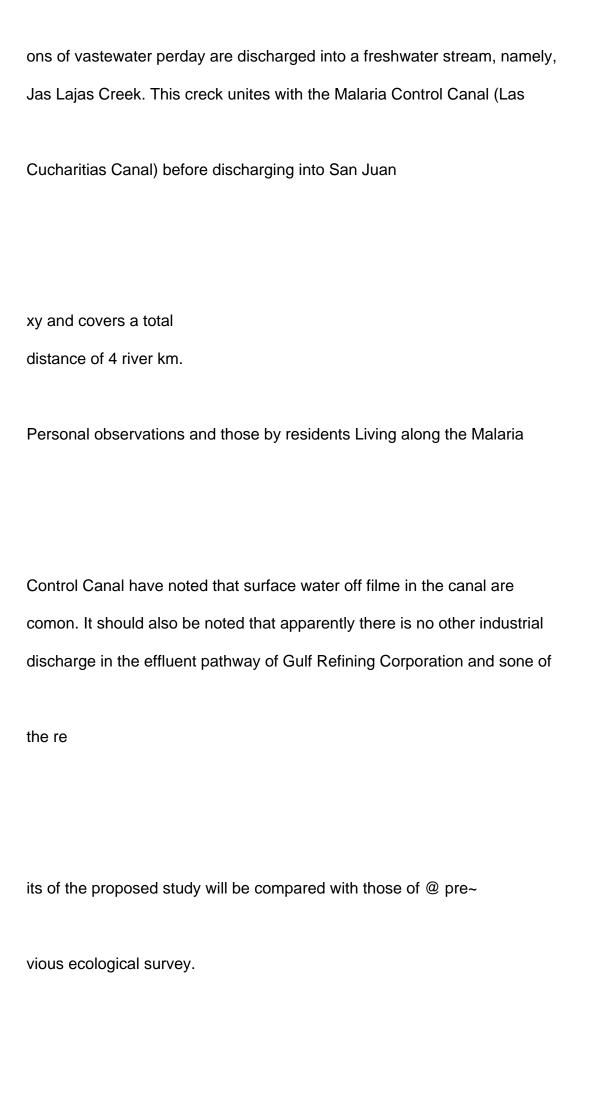
ofl and its couponents have been Limited mainly to the Tesperate Zone, vheress {in the tropics vere environmental conditions are quite different, practically 10 published work is available. It is proposed that a series of tropical oil Pollution environmental studies be considered. The first and most obvious study is to characterize organisms 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.

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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 of was comonly processed and during the Past two years, a mixture of Santa Rosa condensate and Leona crude of from Venezuela is being refined. At present, shout half of @ million gal-



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 organisms 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 freehwater streem expected to the off refinery offlyent
the freshwater stream exposed to the ofl refinery effluent. Results and/or Bonefits Expected
rtesuits and/or boneitis Expedied

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.

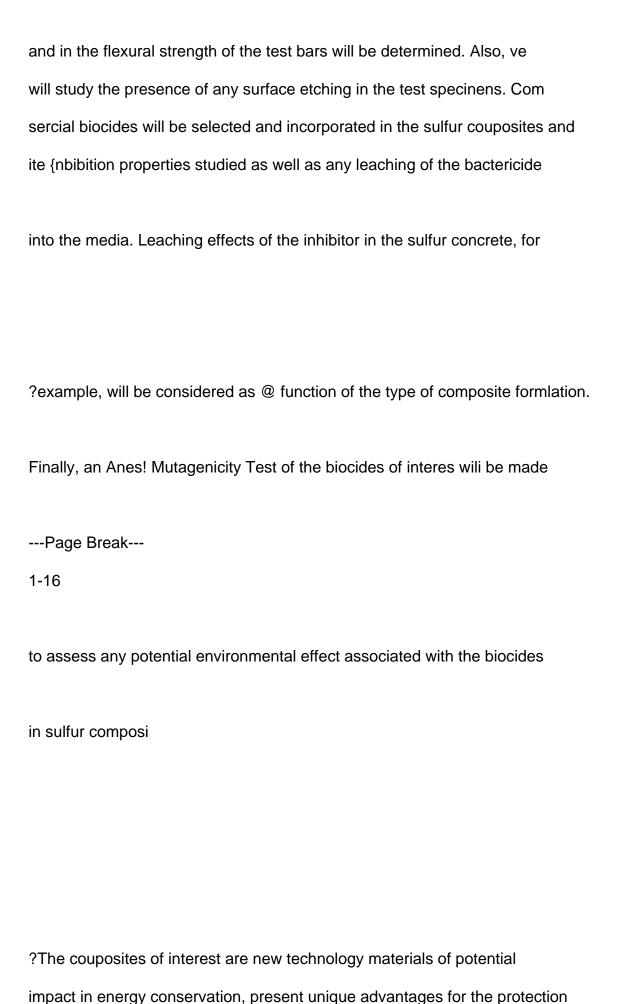
?Project Di Biological Degradation of Sulfur Construction Materials and the Effect of Microbial Inhibitors

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,



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

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for mutagenicity.

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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 heterocompounds, 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

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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 responsible 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 isolaced 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

©. Correlate toxic properties such as mitagenic and teratogente effects
with the chenical composition of selected test fractions.
Page Break
w-20
?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

types of sources were available.

©, 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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?TABLE 1-2
[FOSSIL FUELS RESEARCH PERSONNEL DISTRIBUTION (MAN YEARS)
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Education & Training
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FOSSIL FUELS RESEARCH

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Program Budget Distribution Classified
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TABLE 1V=4	
FOSSIL FUELS. RESEARCH	

Project D.

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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 conpetetiveness 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

systems that are accepted as technically feasible. The important

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

?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 systems mst be designed either to

utilize the energy when it is available, or in conjunction with storage and vith back up systems 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 systens				
ike solar hot water heating, solar cooling and agricultural				
applications will start to have their comercial impact at				
applications will start to have their comercial impact at				
applications will start to have their comercial impact at competitive prices for selected application:				
competitive prices for selected application:				

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
Page Break
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 requirements, methods of integration with
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.

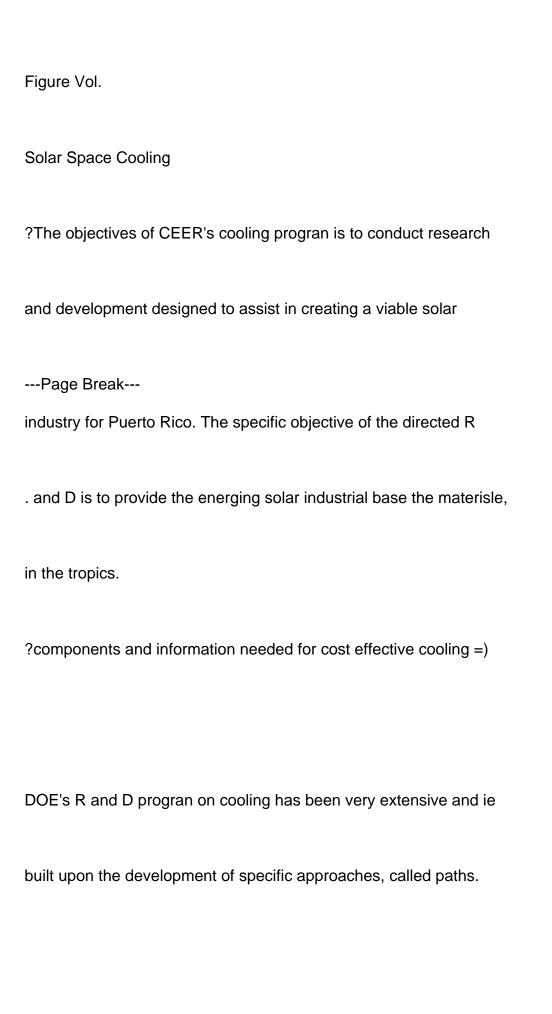
the same flat plate collectors as are used for dont

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 Development 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



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

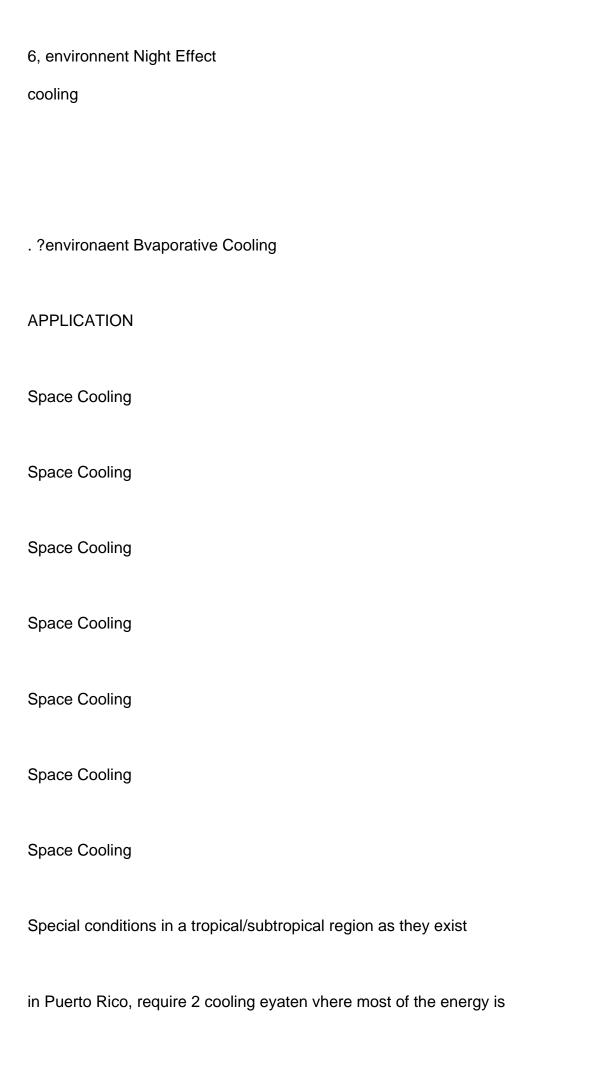
Tracking Collectors Rankine cycle

chiller

5. oun Concentrating Track- Absorption or

ing collectors Rankine eyele

chiller



used to remove the humidity from the ambient air. R and D at the CEER

?is concentrated on the development of s1

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v3

described in path 2, (i.e., a conbination of a highly advanced evacuat4 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-programs:

- A. Develop practical low cost solar photovoltaic arrays
- 2. Perform detailed PEPS analysis, cost and integration evaluations necesarry to characterize eubsystems and?components in these power generating systems.
- Develop low cost, energy efficient processes required fo fabricate photovoltaic array

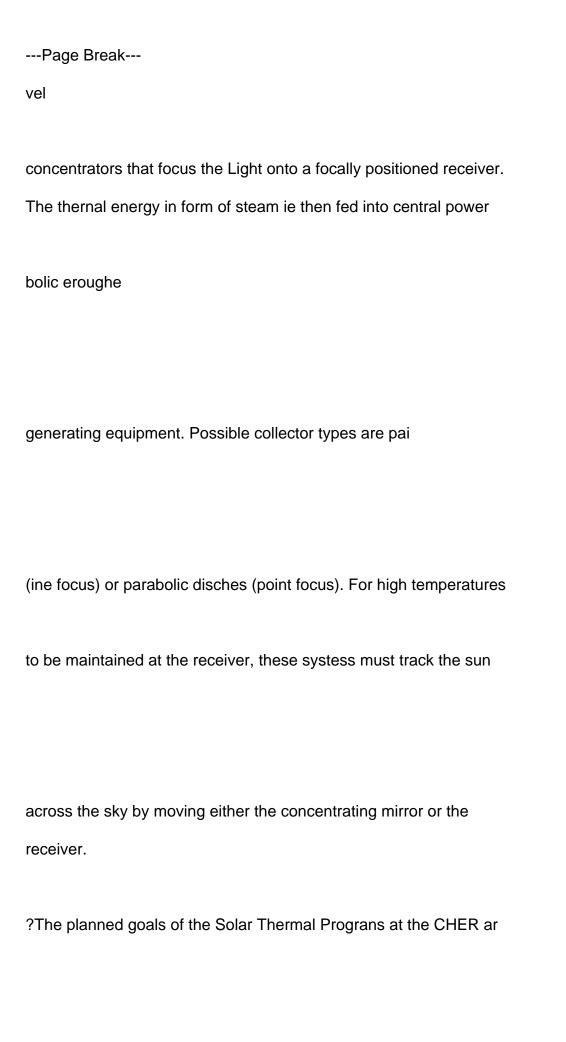
Develop technological and research base for further improvement in photovoltaic material, device and systen capabilities.

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:
Conduct advanced photovoltaic materials and solar
cell research,
Page Break
v-10
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 techno-

logy in Puerto Rico.
4, Market analysis assessuents for photovoltaic application systems in Puerto Rico.
Systems in Fuerto Rico.
Participate in competitive DOE programs for systems
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



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:

 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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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---

Obviously, thie program of studies overlaps with the wore specifically directed "Ecological Effects Studies".

Information generated in such program will be utilized by the others.

Projects

vee

?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,
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vies

Beological Effects Studies

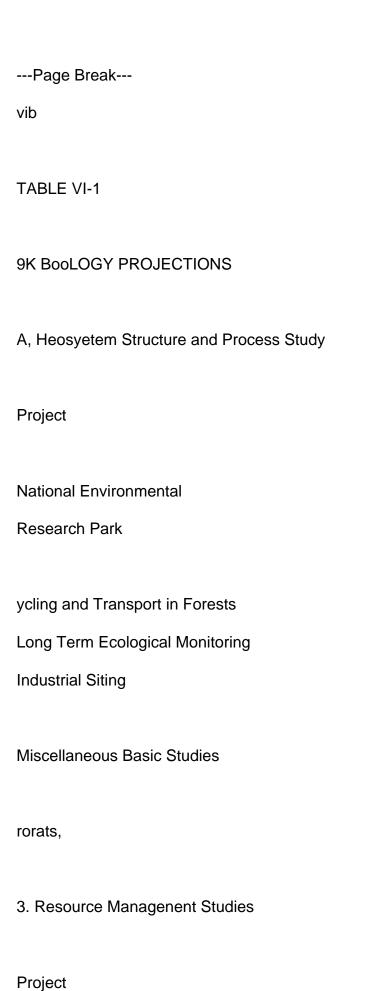
?This program emphasized experimental or correlational

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 measurement 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



Bioreclanation of Water
Physical/Chenical Water Treatnent
Water Use and Reuse Studies
Waste Disposal Research
Aquaculture and Mariculeure
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C. Ecological Effects Studies
Project
Energy Pollutants ~ Marine
Biomass Culture Effects
Energy Pollutants ~ Terrestrial
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TABLE VI-2
PERSONNEL MAN YEARS - ECOLOGY
Hcosysten Structure and Process Studies
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

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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

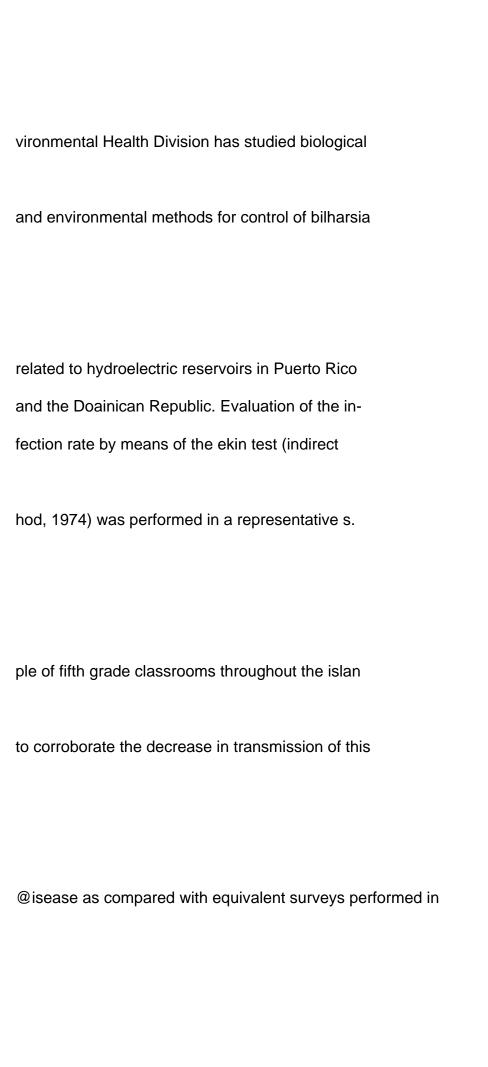
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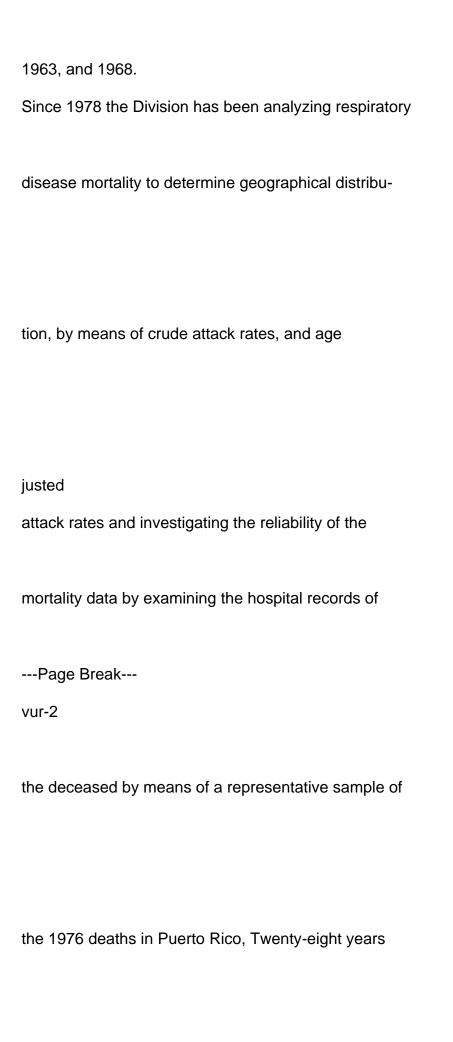
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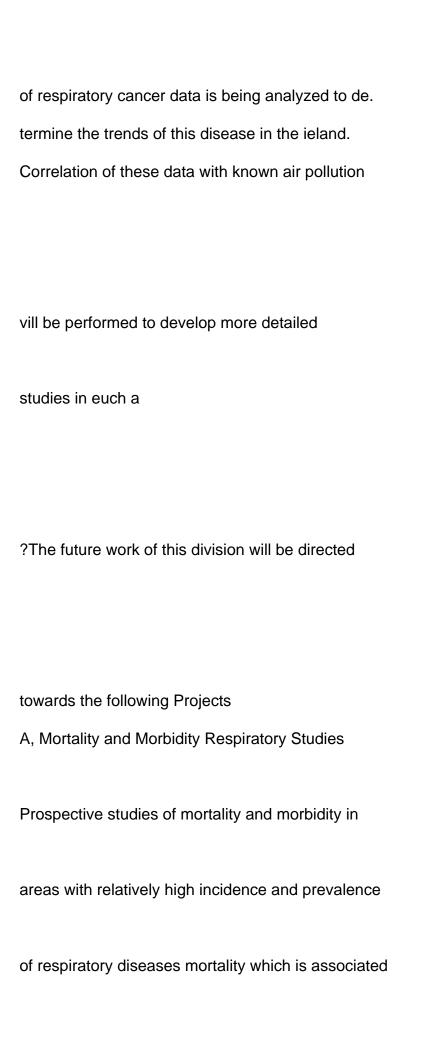
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Education & Training o 0 0 6 0
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Development 1762 14831429 15771681
Denonstration 490 485 380 380 392
Education & Training 16 106 97 105 _ 109,
2850 2475 2300 2500 2650
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ENVIRONMENTAL HEALTH
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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 En-







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

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

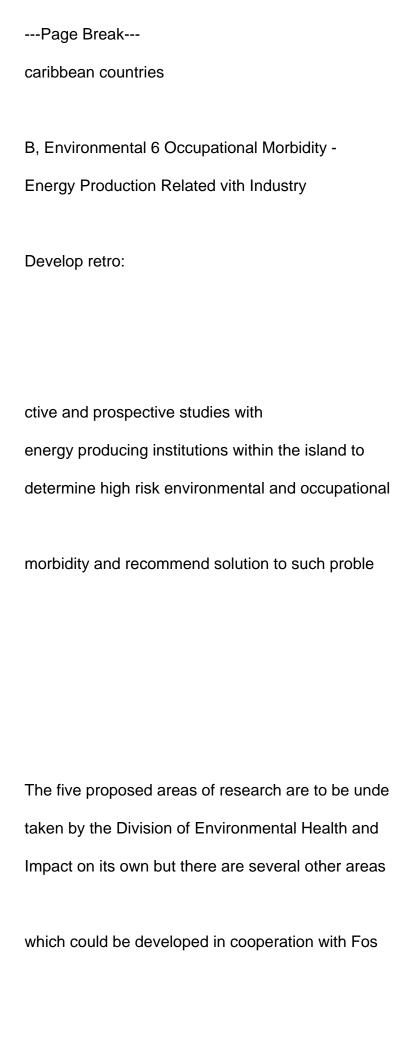
as they occur. Later, if justified, more detaile monitoring vill be performed, to determine cause and effect, develop preventive measures for such dis~orders. Establish the type of health criteria to b used in determining the capabilities of an individual to be hired to perform « task within a given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



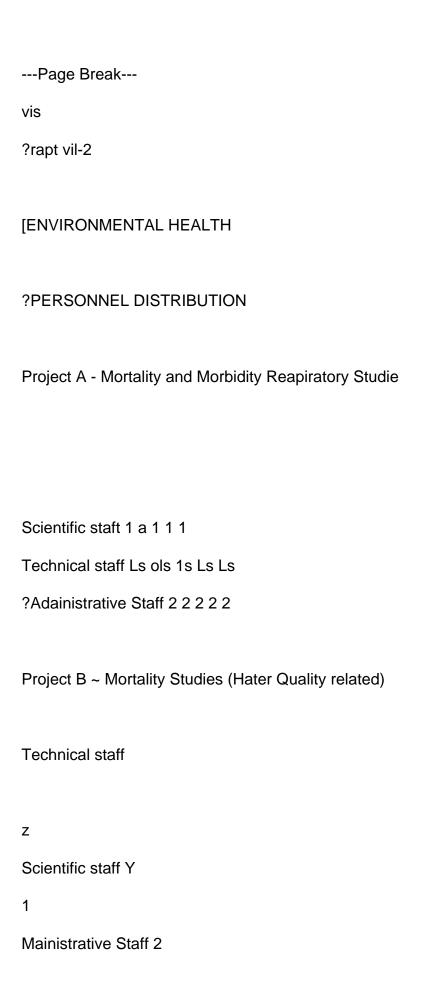
Fuels and Terrestrial Ecology.
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Project
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TABLE VII =!
[ENVIRONMENTAL HEALTH
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vase Morbidity Yonitoring related to Alternative Bnery

Sources CHEK Personnel

28%

Scientific Stat aoa os .

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Project D ~ Schstosontasis studies

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Technical staff ?5. ?s

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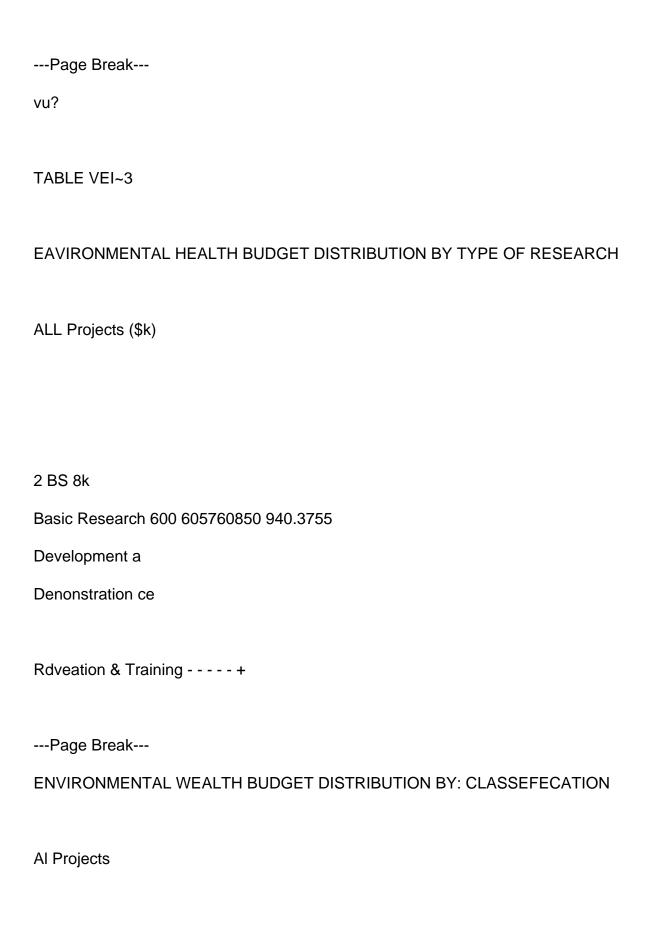
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Technical Staff as \$50

Administrative Staff 7130 8235,

?i Stat was 18.25,



?TABLE VIT~4
«so
(Distribution made 60% personnel, 25% equipment & materials, & 15%
services)
Personnel
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Services
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---Page Break---

MATERIAL DEVELOPMENT

---Page Break---

vonr-1

ETE ~ MATERIALS DEVELOPMENT

?The wost pressing problens in the development of eneray conversion, transmission and storage technologies are material probless. The involvement 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 development 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
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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 development 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 developing 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~

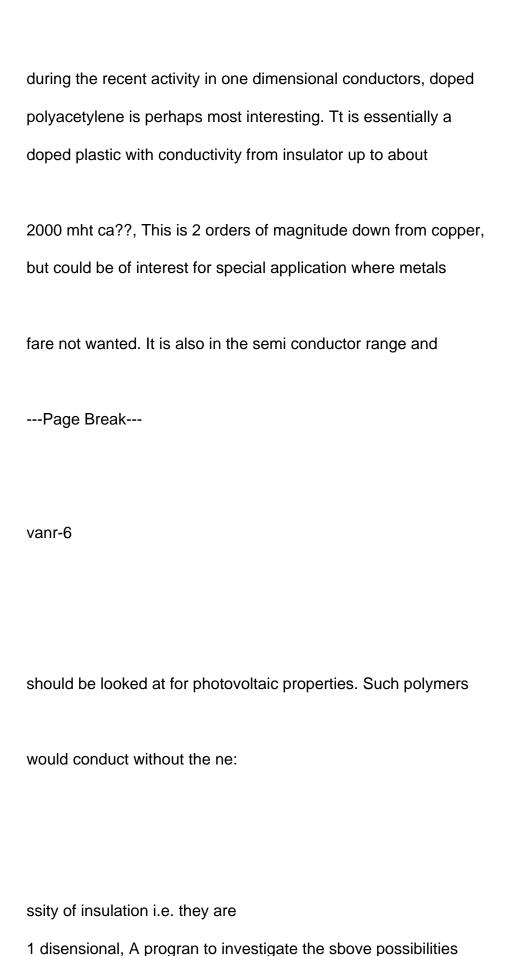
PVDF can be manufactured

growth inhibition in heat exchange

?a5 a rather inexpensive plastic film with piezoelectric properties 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



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.
Dana Brasil
Page Break
vant-7
TABLE VITI-1
MATERIAL PROGRAM OVERALL BUDGET DISTRIBUTION
(Thousands of Dollars)

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
viri-8

?TABLE vlal-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: 333 G. Solar Collector ~ Surfactant Cleaning Scientific state - ?4 ?4 2 Technical staff = 2 2 3 Administrative : at a a 33 2 ?3 а

---Page Break---

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.

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ABLE vITL-3

MATERIAL PROGRAM BUDGET DISTRIBUTION

?TYPE OF RESEARCH

(Thousand of Dollars)

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
Development - 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
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viri-11
TABLE VELI~
MATERIALS PROGRAM BUDGET DISTRIBUTION

CLASSIFIED (Thousand of Dollars)

а 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
Demonstration
Personnel -
Bquipient & Mats
Services -
Solar Collectors
Surfactant Cleaning
Personnel:
Equipaent & Mate
Services -
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TABLE VETI~4 (Cont).
H, Hydrogen Production via
Solar Energy
Personnel
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Page Break
INTEGRATED TECH, ASSESSMENT
Page Break
1.
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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 programs 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---

technical services and independent assurances:
1, economic analysis of calculated savings are
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 technical 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

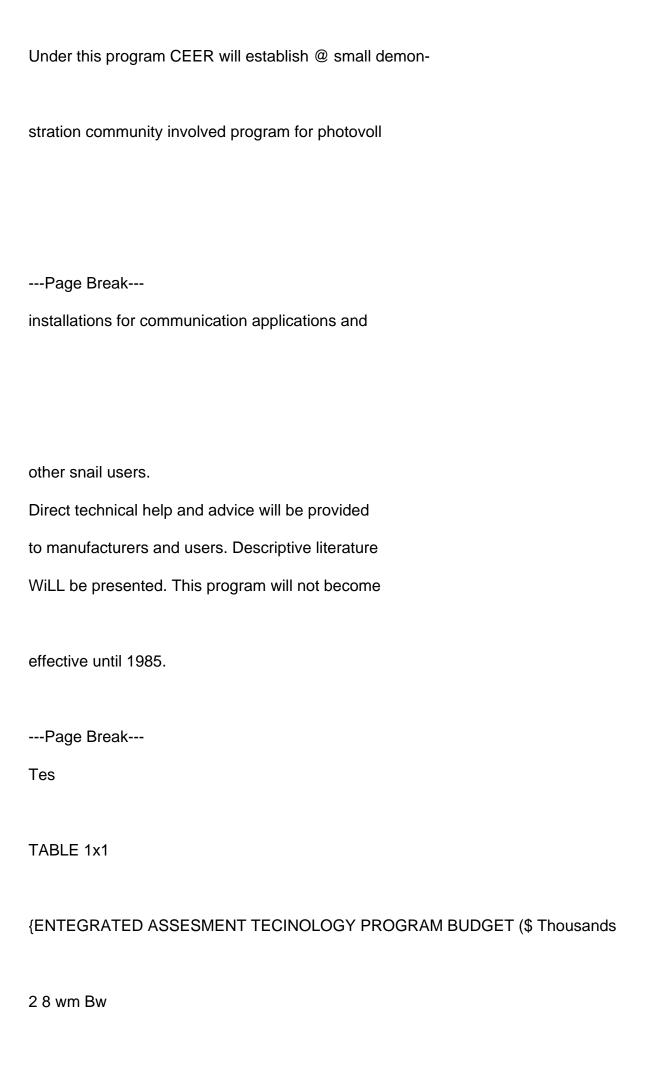
Under this program CEER will establich a small conmunity involved demonstration program of « wind driven electrical generator 1-5xv and wind driven fr. tigation pump tests, Data will be generated for local manufacturers and entrepeneurs for conmercialization. Users manuals vill be prepared and also a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



A. Solar Hot Water System 5055606570
B. Wind Driven Turbines 758859085
© Photovoltaics Gommity - = = = 50,60
D. Bheray Analyeis ms 0 5 ow
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TABLE 1-2
INTEGRATER ACCESSMENT TECHNICIOS PROCESAM
INTEGRATED ASSESSMENT TECHNOLOGY PROGRAM
?PERSONNEL DISTRIBUTION
?PERSONNEL DISTRIBUTION Project A ~ Solar Hot Water Systems
Project A ~ Solar Hot Water Systens
Project A ~ Solar Hot Water Systens Scientific Staff - oe ee
Project A ~ Solar Hot Water Systens Scientific Staff - oe ee Technical staff
Project A ~ Solar Hot Water Systens Scientific Staff - oe ee Technical staff

Scientific stafé - ee ee
PTechnical staff - ee a a
Adzinistrative Staff = ff oad
Project D - Energy Analysis
Scientific statt
Technical Staff
Administrative Staff
TOTALS ALL Projects
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35 Lo
Scieneific Staff 36 8 Lo
Technical Staff 3310 3077

Scientific Staff

Technical stafe

Administrative Staft:

Project ¢ - Photovoltaics Comunity

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,

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?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

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TABLE 1-4
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Page Break
NUCLEAR PROGRAM
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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
3163
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 Design Study Project for a 100KWE Level Pilot Plant Fueled by ydrogen Produced by Direct Solar Heat" contains a detailed éiscussion 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,
Table of 1 abrovab VI 1 ith saturate the funding and offert
TablesM-1 chrough XI-4 itlustrate the funding and effort
scheduled.
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TABLE EL
NUCLEAR PROGRAM
BUDGET (In Thousands §)
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Muclear Fusion Program 607575
B. Wuclear Fission Program 55

[NUCLEAR PROGRAM ?TYPE OF RESEARCH

28

Nuclear trogras

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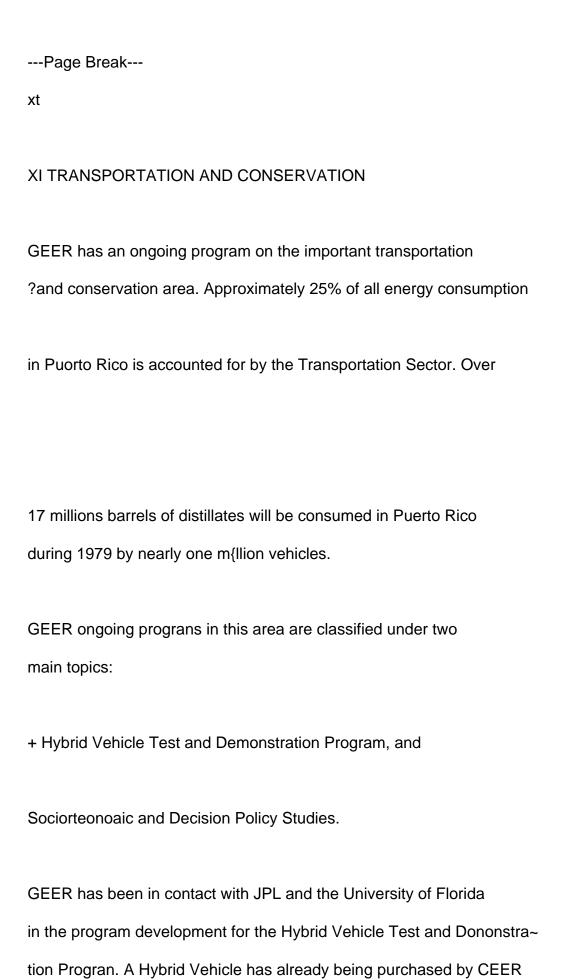
Developaent

Desonstration

Education & Training 5s 5

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NUCLEAR PROGRAM,
BUDGET ~ PROGRAM PERSONNEL DISTRIBUTION
a 83k
Nuclear Progras
Scientific staff aoa 1
Technical staff Boss
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TABLE X-3
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Personnel
Equipment & Materials
Service
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105
275
us
3s
435
Page Break
TRANSPORTATION ann CONSERVATION



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 accomplished 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.

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

joline or diesel driven electric generator is used to recharge

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 Development for livbrid 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 applied 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:

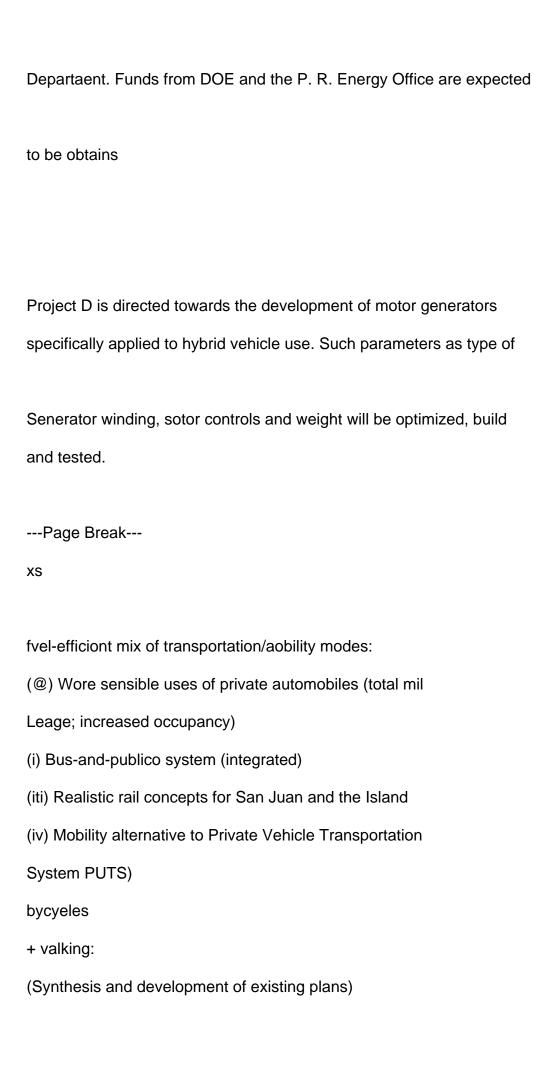
sibility of utilizing hybrid vehicles in fleet operation. The progran Will be tailored to @ particular driving application stressing fuel

economy, personnel training, public avareness and overall vehicle evs

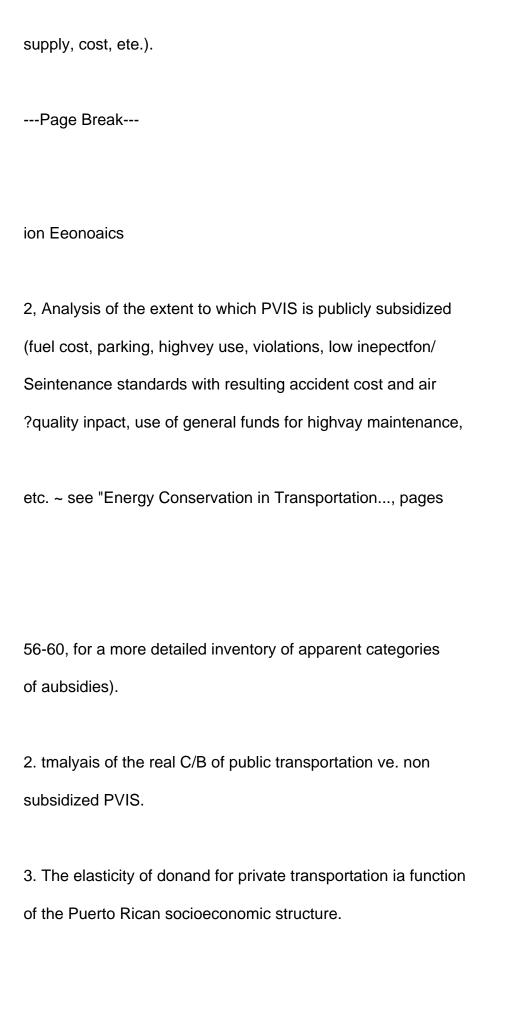
uation.

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

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



() Water-based transportation
(vi) Incentives/disincentives, positive restraints on PVIS
Ge
©. and D. below)
3. Non-construction methods of improving TSM.
4. Name and the formation of the
4, Managenent/infornation syste
Socio-environmental aspects of TSM; e.g. traffic flou/density
studies related to institutional location, operations, work
hours, residences of enployeesas input into the development
fof short-term, quick-fix measures, as well as of longer-term
planning.
6. Analysis and antisination of navy narameters (technology, finals
6. Analysis and anticipation of new parameters (technology, fuels,



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 enforcement
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.

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

Progressive inprovenent through conerete applications of tech-

nology end environmental impact assessment in transportation,

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

Institutional and Legal Elenents

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=
energy emily and process organization of the govern-
?ment promotes fragnentation in policy development end

3. Provide policy and drafting support in the development and

---Page Break---

implenentation).

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 xI-1a,
TRANSPORTATION AND CONSERVATION LIVERING F
TRANSPORTATION AND CONSERVATION ~ HYBRID VEHICLE
Overall Budget Distribution
(Thousands of Dollars)
(Thousands of Donars)
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
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Admin. State
- MG Dev. for Hybrid Vehicle
Scientific seafe
Tech. Staff
Adnin. Staff
Total
Scientific stasf
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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
D. thG Development for
Hybrid Vehicle
Development. 242.5 167.
roraLs 300 475 202.5 445370867.
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TABLE X1-ba
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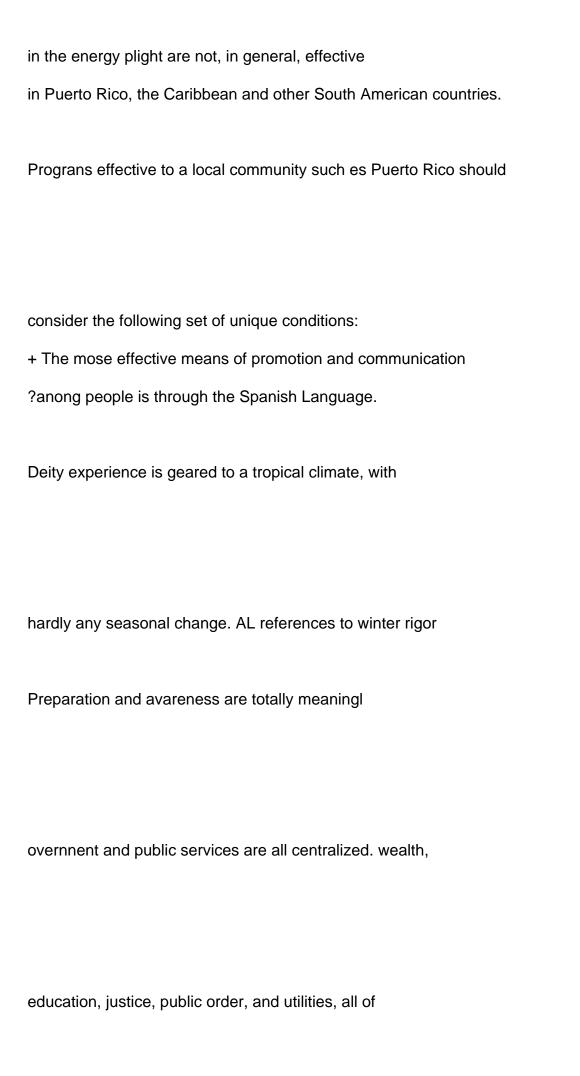
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xr
?PROGRAM PERSONNEL, DISTRIBUTION - TRANSPORTATION POLICY STUDIES
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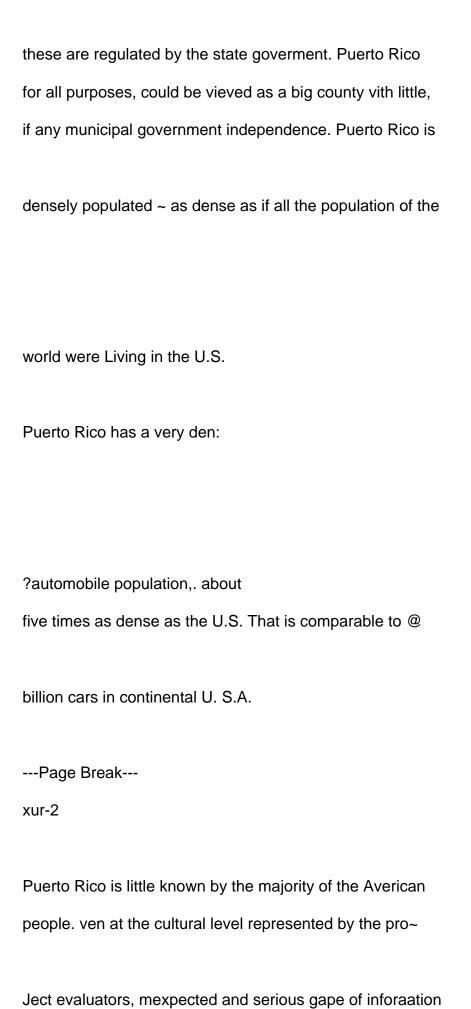
?oral Se (A-E) 3 3 3 3 Pera. Tech. (A-E) 3 5 10 ko 0 Pers. Adm. (A-8) ss 5 15 F. Educational se - - - tech 3 5 10 oo Ate ass as ALL Programs (A-8) se 3 3 3 3 3 Tech 1 1 2 2 3 Atm 1 1 1 1 1 ---Page Break--xt-1s sz ark set ot et w w @ (9) svisoua cv satanis x0r10a st Sozupexy pur uopaeonps - |. toyaezasu0eeg

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PUBLIC AWARENESS
Page Break
xIr-1
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
which stem from a wondvide sechano superimposed by unique societar
and geopolitical circunstanc
Mach of the Department of Energy efforts addressed to inprove
Public avarenes





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 collaboration 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---

х4

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

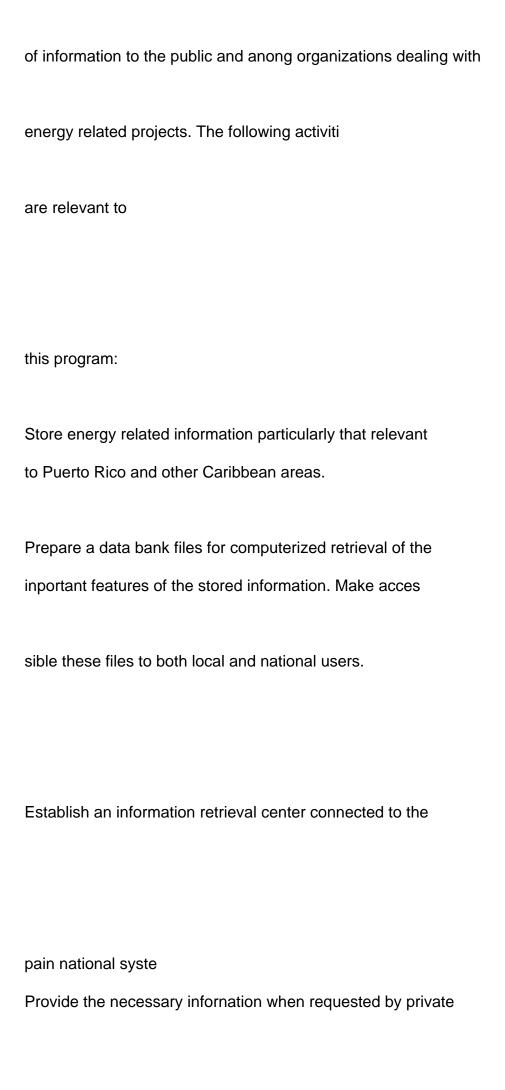
?oras 949,000 \$53,000 \$58,000 \$62,000 \$67,000

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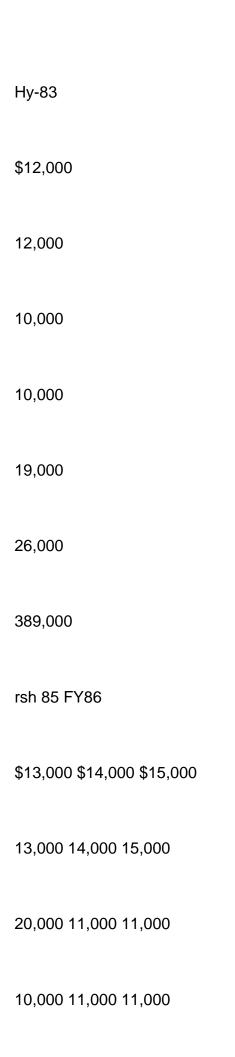
3. Source Information Progra

This Program intends to perform as a clearing house for the flow



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



20,000 21,000 22,000
42,000 _60,000 64,000
\$108,000 \$131,000 \$138,000
Page Break
e
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

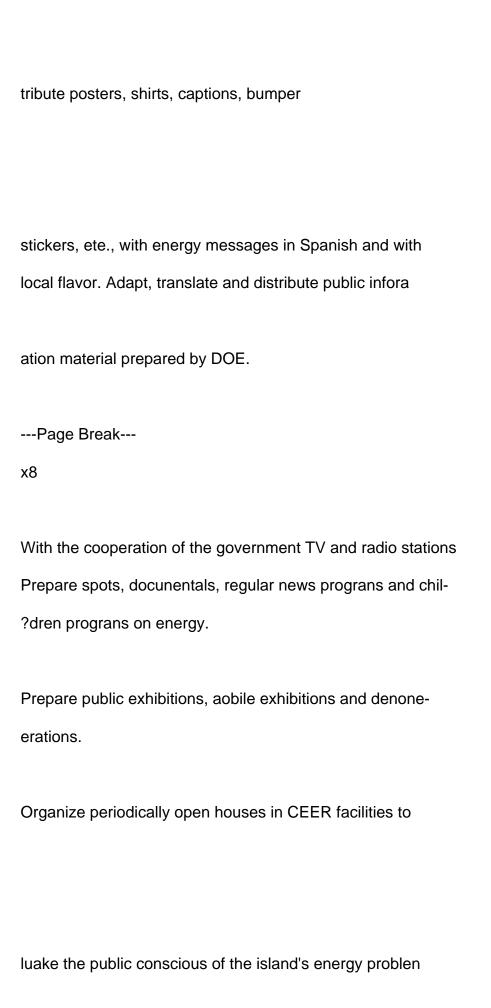
Some of the activities for thie information center are the fol-

- + Production of regular short (4 page) and non technical pulication (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 elsewhere 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

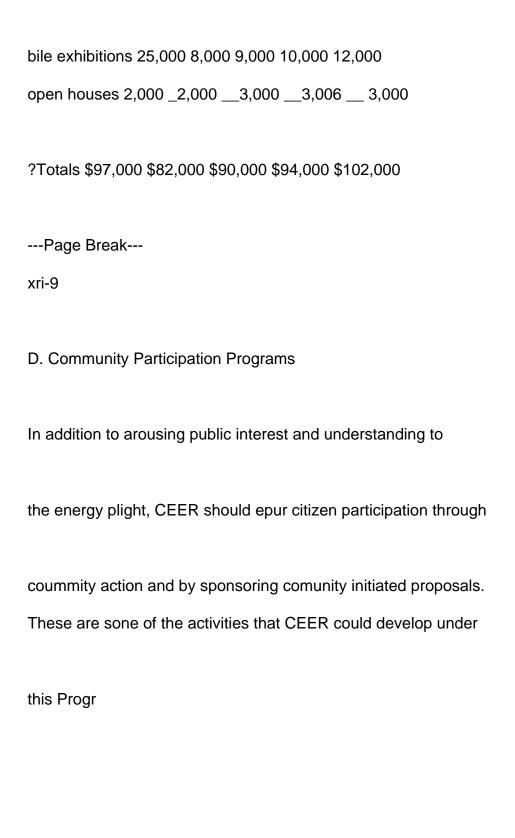
 Lins on CEER's activities.

Prepare and é



?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, adaptation, 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

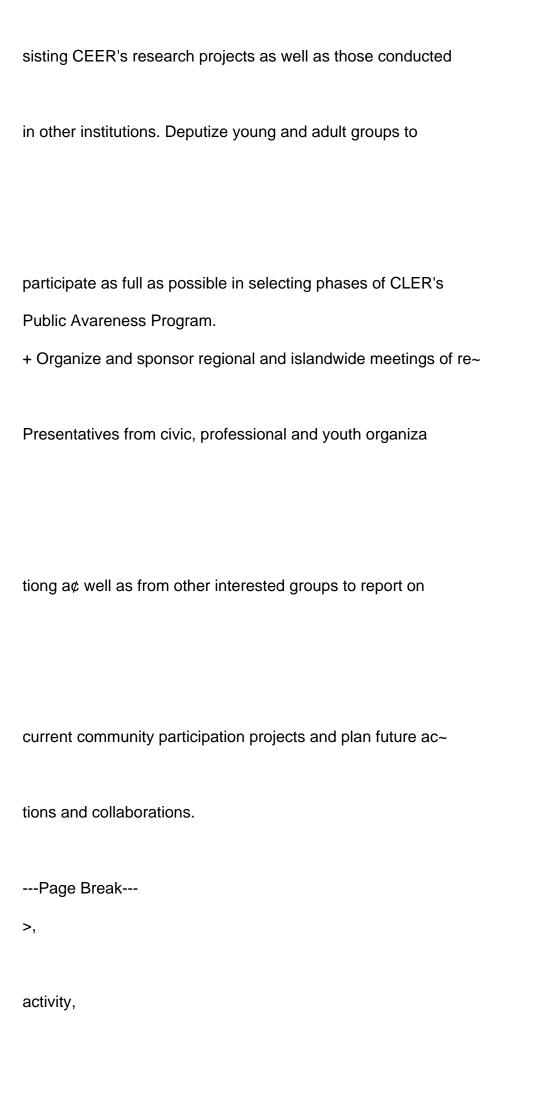
Stationary & Ho



+ 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 organizations 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 as-
ible, in as-



Prosotion of comu-
nity action
Community
Meetings
?TorAs
xir-10
Community Participation Progran Budget
wv=82
\$5,000
10,000
6,000
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\$5,000

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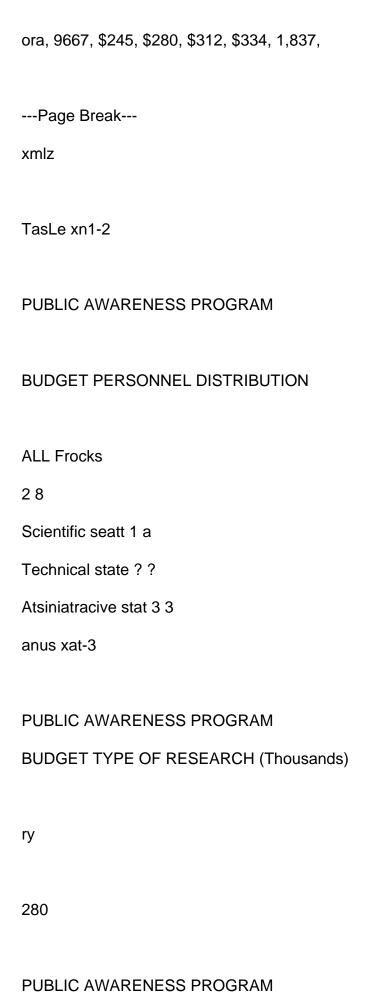
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TABLE XIT-1
PUBLIC AWARENESS PROGEUM
(Cousands §)
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?. Active Infornation 7, 82,9, 8H, ws
comity Participation 21, 2,2,



BUDGET DISTRIBUTION-CLASSIFIED (thousands \$)

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Basic Research
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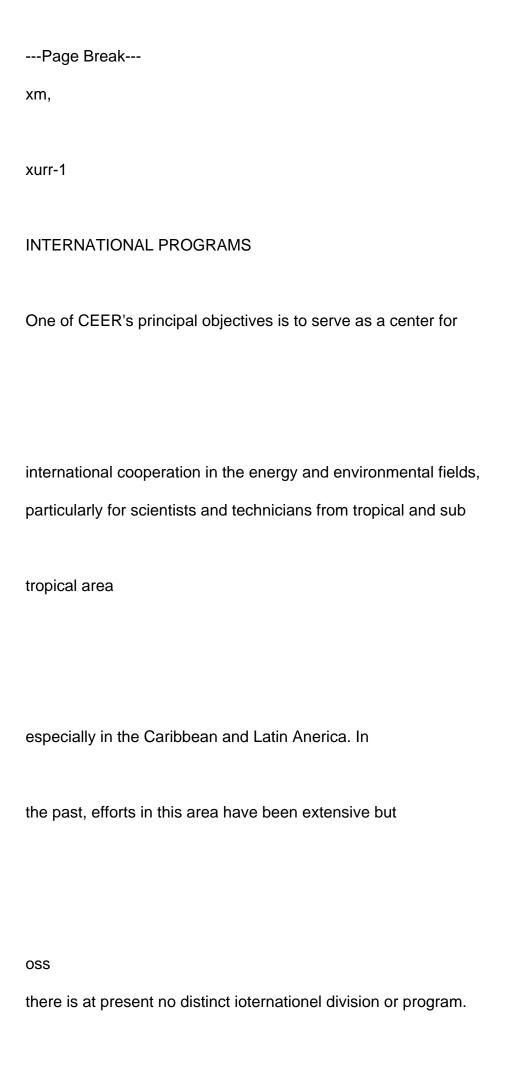
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INTERNATIONAL PROGRAMS



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 dependent on imported petrolews for their energy needs. To continue their

Process of economic growth 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. §. government 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 inplementation of the new energy technologies. A regionally-based institution 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 follows:

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

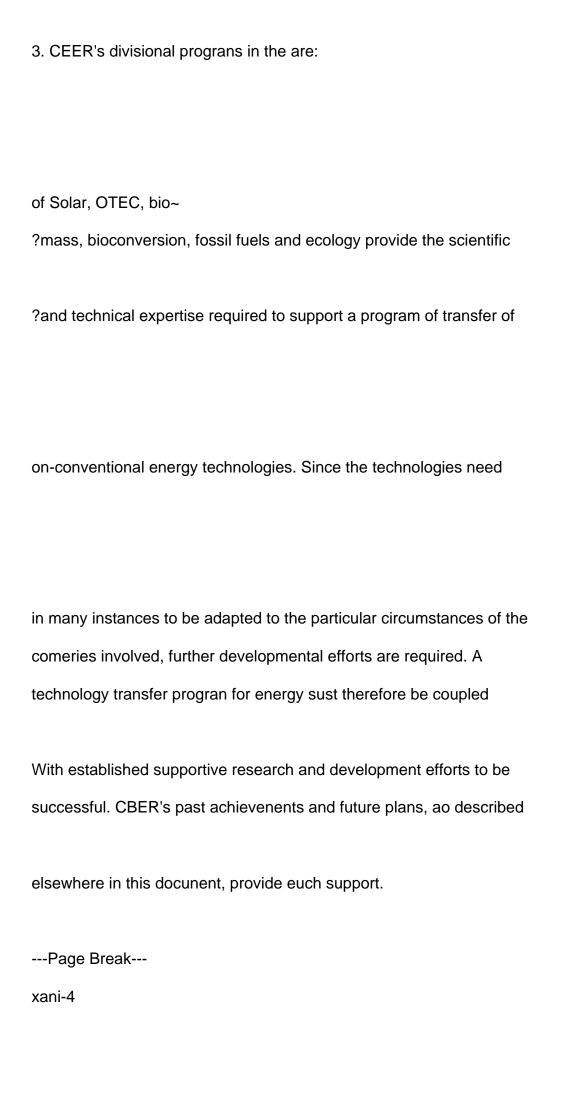
?and in sone cases political contacts have resulted from these efforts.

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.



4, GEER already enjoys a unique position and reputation as a
center for research and development of non-conventional energy tech-
nologies in the Caribbean. This position has been recognized in
reports by Donovan, Hanester, and Rattien and by the U. 8. Agency
for International 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 back-
ground 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

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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. proects 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---

xUI-6

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 assessment and developsental

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

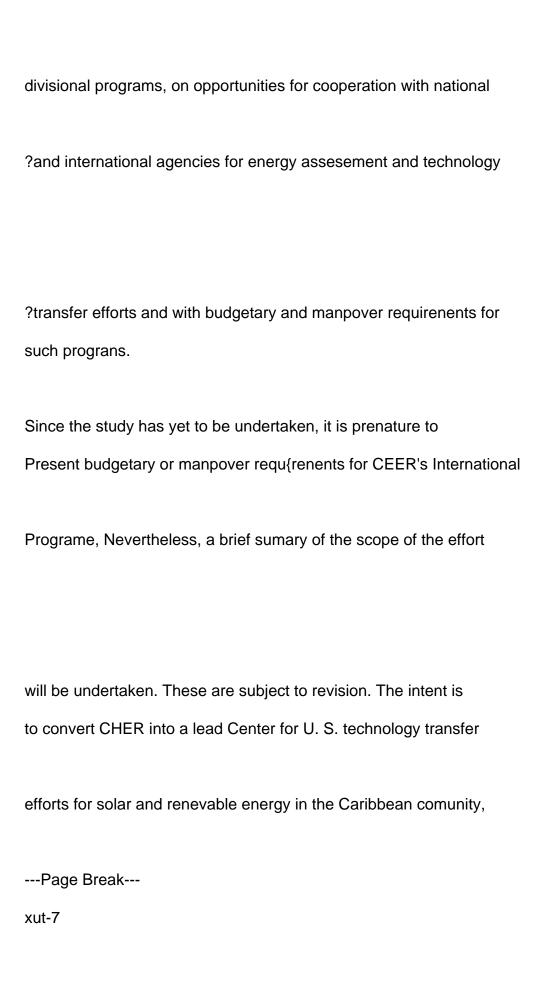
fecond phase will include extensive applied research and development efforts in oil-vell enhancement technologies for heavy Venezuelan crude, This may subsequently include education and training acti-

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?



Based on CEER's capabilities, the scope of these efforts my be
extended in special cases as in the energy assesseent 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
ingtitutional and industrial Lipinan activities.
~ 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
untreo stares
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
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Apri 11, 1976
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: 0; Adminsatrator
Rat: Assistant Aduintstrator for PleId Operations /
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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 activity 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) and sound emeteinn has been developed in terrestrial ecology, tropical marine biology and f¥opica: human ecology. AES support for the aarine biology, tersestrial ?ecology and human ecology programs is expected to continue and ay snerease slightly to pick up overhead costs previously carried in? other Programs. Research in quelear medicine and agriculture is not a high

-@

is

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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.

Lagutllo 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:

- Continue the PRC COCO Arrangement with the UPR ~ making certain management 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 in 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---

Adninistrator 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 requtrements 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,



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.)

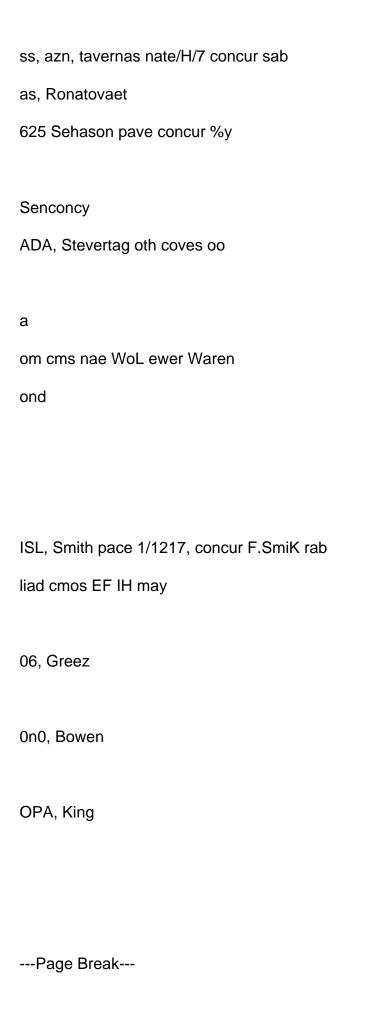
- 3+ The AFO will direct the Director, HQS OPA, to prepare « public announcement and arrange for a joint UPR and HOA facilittes trans? fer cerenony.
- 4, The ATO will direct the Director, HOS OCA, to notify the Puerto Rico Resident Comntssioner of the Adsinistrator's decision.

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Adatatacrator

- 5+ The AAA wilt direct the Manager, ORG to taitiate a study to determine 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.



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

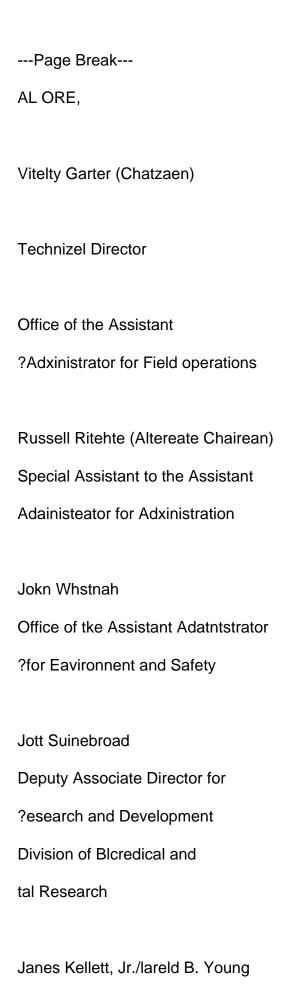
accepeanic: NOP® *HAt Dr. Seanans will find the neasrocuum

7 wish to express special appreciation to the mesbers \$5 Rg EEDA Tank Force #05 responding 20 consementinsie gar nage ienihat F sqnt with Dr- alasdover eameesieit Sggieegations as a ainority instetucion and oe eee, tient budgetary situations

Pyeceg?, thanks, g0 to all the members of our respective

Pave HSE OF thete hard work and aplendld Coapreeeee®

T have high hopes for the success of bar comes



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leeael AlxSdovar (Chairnan)
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Vanusl Ges, Deen
College of Natural Sofences
Rio Piedras Cexpus
Juan J. Bgau, Director
Ortice of Fetroleun Fuels Affairs
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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 Island'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 directly 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 universities 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 which is appointed by he Governor and which, in turn, appoints the UPR President. The current President 2 Arturo Merales-Carrion. All significant appointments 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 fundamencal objectives are the followis

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 and progress)

(444) To mininize the unfavorable effects which are induced by satketing ?Problems and ?oternational energy policies: (tv) To establish a ell corre lated 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 availability 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 utiliza tion, fuel combustion, chemical composition, sathenatical cedelling of stonipheric pollutants, and sulfur chenistry. The Office develops tts applied reseach and sezvice programs in coabined effore, when seceasazy, with industry, government 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
uguitl National Forest Si
ata Acausition Laboratory \$_ 123510
Total vestment - PANE \$5823,012
00
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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 admintstrative 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 programs 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 development including OTEC.
Matertals research and development.
on 1 - Pros and Cons
Pros:

2+ Goco operation provides a very capable aanagenent organisation aad satoctiated 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 requirements and procedures which necessitates a large PRNC adzinistrative

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.

aul overhead staff (As well es considerable ORO Contract Adainistration

Farther detatted supporting acalysis of this option ts contained tn Appendix 10.

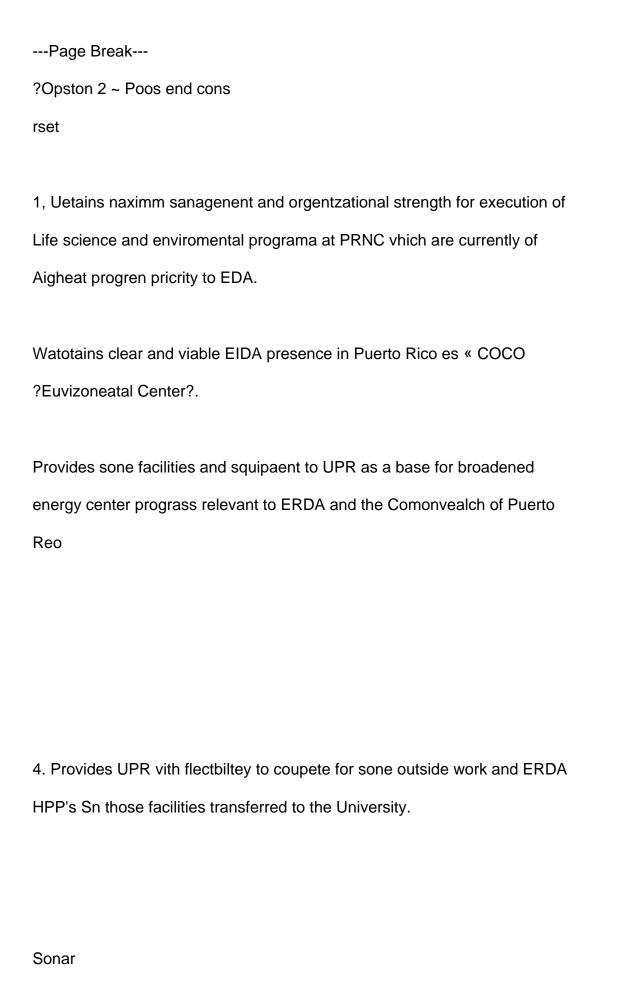
?Qpeton 2 - and with che PR

Those current PINC facilities which predoainately house BER programs 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 programs would ?be programatically transferred to the UPR and vould be fiscally supported by those programs (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 Factlities
- 2. The Cornelia #111 Dock
- 3. The Main Building at Rio Piedees



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 we hod of operation at UPR, encourage davelopaent of

?4Niable ?Euargy and Environmental Center? at the University through instite onal support, and would execute priority ERDA programe 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 Environmental 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 development effort by providing ERDA eal and institutional support to the Cester to atizulate development of nev areas of technical excellence and interdisetplinary support.

Sption 3 ~ Pros and Cons

Frost

As The need for « separate, duplicate, and coaplex PRNC admintstrative and Baintsnasce network to cospiy with GOCO contractual requirezents is elininated.

2 The artificial and undestrable seperation of PRNC and UPR programs vould be elisinated, prosoting nore cooperative endeavors, ani enhascing both programs.

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 modification vith UPR to proceed vith programmatic transfer of appropriace EROA factlities to UPR and orderly closeout of GOCO operation. 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 arrangements 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 transfer 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
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APPENDIX. B
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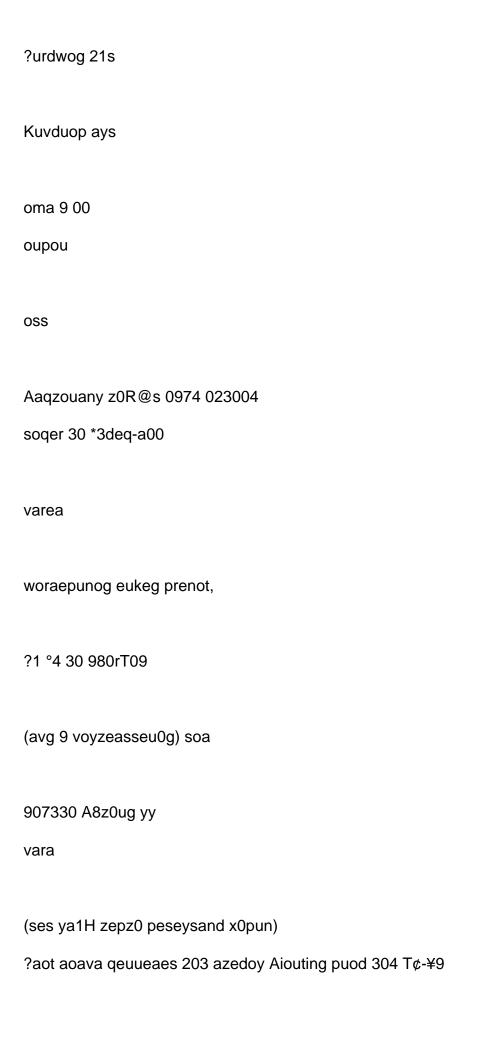
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