

# CEER-A-073

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FIVE YEAR PLAN FOR CONTINUED OPERATIONS AS.

?A RESOURCE TO THE COMMONWEALTH OF PUERTO RICO

(FY 1982-86)

May 1980

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## PREPACE

?This report presents basic information about the Center

for Energy and Environment Research (CEER) of the University of Puerto Rico (UPR) and its research and development programs in energy and environment. It summarizes previous accomplishments and future projections, and emphasizes the uniqueness of CER to contribute to the development of energy alternatives ?and interrelated environmental problems in Puerto Rico. The document provides a plan for the energy and environmental programs of CEER uring the five year period corresponding to fiscal years 1982 through 1986. Major guidelines for the Gevelooment of this plan stem from the following:

- 1) ?La Polftica Energética de Puerto Rico - Un Primer Paso" (June 1979)
- 2) The National Energy Goals of the Federal Department of Energy (D08)



3) CEER-AS3, "Integrated Program Plan for UPR/CEER -

Fy 1980 and FY 1981"

4) The University of Puerto Rico Master Plan for 1980-1990

5) Yearly revisions by the Senior Research Advisory Committee  
for Energy and Environment

The report summarizes an assessment of the funding needed  
to continue operations and implement the five year plan. The  
plan and the funding requirements provide for @ minimum program

which will support basic research and development necessary for

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more costly development and demonstration programs. The  
program per se will not solve the massive energy problems of  
Puerto Rico which consumes 70 million barrels of oil per year  
at an actual cost of over 2 billion dollars per year, and it  
will not solve the related environmental complications. In

order to address effectively the massive energy problems of Puerto Rico,

it will be necessary to plan large programs with funds in the

order of ten times the level of funding requested herein. Such

large programs have been addressed in other CEER publications.

These documents describe reasonable energy and environment research and development programs based on the capacity of the government of Puerto Rico to finance such programs in cooperation with DOE. CEER is the only institution in Puerto Rico and in the Caribbean capable of undertaking this task. It is an organization that has 23 years of experimental research activity funded by DOE and its predecessors, the Energy Research Development Administration, and the Atomic Energy Commission. The continuation of CEER operations beyond the termination of the present contract with DOE on September 30, 1981 depends upon the support of the Puerto Rican Government together with the support of DOE,

CEER X-31 "RED Program Needs for Energy Alternatives in Puerto Rico," Preliminary Report June 1, 1979,

"Energy Analysis of P.R. Alternatives Energy Systems and Program Development Needs," in Press.

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The role of CEER in the University of Puerto Rico Master Plan 1980-1990 for providing research as an essential component of academic activities is another important factor which has received careful consideration. Direct economic support from the University is also projected in the budget plans.

The proposed program also addresses the DOE goals of energy self sufficiency.

CHER is the only institution in Puerto Rico primarily responsible for the research and development of renewable energy

natives which are significant to the island. It is one of the few institutions within the United States that focuses on

both energy and environment

1 problems and on their reciprocal

CHER is also the key institution on the island for integrating the research and development objectives in energy and environment at the University faculties, the Agricultural Experiment Station, such government of Puerto Rico agencies as the Office of Energy, the Electric Power Authority, and the Department of Health, in addition to Federal agencies such as DOE, the Department of Agriculture, HEW and the Institute of Tropical Forestry.

Furthermore, CEER has become the vital link in the energy and environmental research and development efforts of several Latin American countries, particularly those in the Caribbean.

CBER possesses the unique capabilities necessary to carry

for the development of energy altern:

ives ané related environ-

mental programs at the local, national and international levels.

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major emphasis on projects which offer a good chance of producing commercially feasible alternative energy sources results in aid to the local industrial and agricultural sectors, This support can stimulate employment in the industrial sector through the production and installation of solar energy collectors and auxiliary equipment for utilization in solar heating for domestic, commercial, and industrial applications, including solar air conditioning, the manufacturing of photovoltaic cells and of electric and hybrid auto-

mobiles, and the production of materials for energy conservs

tion. In the agricultural sector, the several programs that deal with sugar cane and energy grasses, and with the bioconversion programs, will stimulate economic activity in a sector that ts about to undergo a complete reorientation in the coming decade.

CEER is a sophisticated research organization which has been brought to its present high level of effectiveness only after many years of hard work and the careful development of its funding capability. It now has the potential to participate actively in the search for the solutions to the most pressing problem of our generation. At the same time it will respond to the needs of the governmental, industrial, and agricultural sectors of the Puerto Rican society. Without the base funding requested in this document, CEER's continued existence will be in jeopardy, precisely at the moment when

its contribution to our society will begin to be felt.

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The world energy situation began to change drastically in the early 1970's when higher fuel prices were coupled with increased restrictions in the exploitation of the nuclear energy alternatives. The staff of the Puerto Rico Nuclear Center (PRNC) had to turn its attention to these problems by the mid 1970's.

and

the reevaluation in the nuclear program of both local and foreign students had dropped considerably, but there was an increased interest in the development of renewable energy alternatives. The increased industrial activity and the population

with their accompanying environmental degradation contributed

to changes in social, economic, technological and political

As a result, negotiations began in 1975 between the University of Puerto Rico (UPR) and the U.S. Energy Research

Development Administration (BROA), (previously the Atomic Energy Commission  
?but now a part of the United States Department of Energy) to redefine the  
mission and goals of the PRNC.

PRNC had been in operation  
under contract with the AEC since 1957 under the Atoms for Peace  
Program and had grown into a meaningful research and development  
organization with a capability to undertake challenging assign-  
ments. As a result of the negotiations, UPR and ERDA approved

an Act:

on Memorandum dated April 11, 1976, (see Appendix A)  
providing for the creation of the Center for Energy and Environ-  
ment Research (CEER) which would use the facilities and personnel  
of PRNC. There would be a major change in program scope toward

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research on alternate energy and corresponding environment

research and away from nuclear programs. CEER was established on July 1, 1976.

The new mission assigned to CEER included the following objectives:

1) To aid in the national effort to achieve energy independence and to contribute to Puerto Rico's efforts to achieve the same goal for itself.

2) To serve

the focal point for energy and environmental research and training in Puerto Rico, and to cooperate in research and training with other countries in the tropical and subtropical zones, particularly the Caribbean and Latin America.

3) To help Puerto Rico meet its manpower needs in energy and energy-related areas.

4) To continue training programs in Puerto Rico for students and personnel from the Caribbean and Latin America.

In order to achieve these objectives, CEER has:



- 1) Promoted strong research and training programs,
- 2) Attracted and developed University personnel to work on energy and environmental research.
- 3) Coordinated efforts which drew on expertise located in the University system.
- 4) Promoted academic excellence in the development of energy curricula and thus helped to promote cooperation between

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the University, industry, government, and the community at large.

to help CEER achieve the transition from a nuclear center to a center focusing on energy goals, DOE established an Oversight Committee. The Committee held its first meeting with representatives of CEER and the University in November 1976, to review the transitional measures taken up to that time and to define a plan for the future. All participants agreed that CEER's success would require close collaboration among CEER,

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1@ technical program directors and the oversight Committee, and continuous interaction between the Center and the University as a whole.

An Integrated Program Plan (PY 1977-82) dated February 19

prepared for the second meeting of the Oversight Committee in

March 1977. This plan, with modifications, has served as a general guide for CEER's present programs. The modifications are contained in the revised CEER Integrated Program Plan for UPR/CEER

FY 1980 and FY 1982, publi

ation number 1-63. The present document,  
addresses the program plan for the following five year period (PY 1982-86).  
CEER's experience in managing and administering first  
class scientific and technical research goes back to 1957 with  
its predecessor, the PRNC. CEER's first four years have enlarged  
and enriched its administrative, managerial and technical expe-  
rience in dealing with renewable energy alternatives and related  
environmental research problems. As a result, CEER is the only

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significant energy research and development facility in Puerto  
Rico, and it is one of the few in the United states, that fo-  
cuses on both energy and environmental problems and on their  
interrelated impact.

The CEER facilities have an acquisition value of approxi-

ty \$12,000,000 and are located on four main site:

4) the

0 Piedras site (1 acre), adjacent to the UPR School of

Medicine, 2) the Mayaguez site (20 acr:

Dy adjacent to the UPR

Campus in Mayaguez, 3) the Cornelia Hill site (20 acres), on

t south of Mayaguez which houses the Marine Ecology

fon. 4) the Luguitlo Nat?onal Forest £1 Verde Facil

The Uueillo Rain Forest which houses the data acquisition field

Laboratory of the terrestrial Biology Division and has 200 acres Use Permit.

A new site, a 15 acre lot in the north coast municipality

of Toa Baja, has been added recently. This site is in the cus-

toey of the UPR, but it has been ai

igned to CEER for the

development of an Experimental Station for field testing and

demonstration of alternative energy sources such as solar, wind,

and biomass-bioconversion.

The

R research and Development Budget for TY 1980 is

over \$4,000,000, including \$1,750,000 assigned by DOE for

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tional, development, and programmed ecological research.

?The balance comes from funding for competitive research programs. The Puerto Rico Electric Power Authority (PREPA)

environmental impact study about its future coal plant in

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western Puerto Rico figures as one of the largest of these competitive funding programs.

During the current fiscal year, as agreed in the Action Memorandum of April 11, 1976, (Appendix A), the initiation of the physical facilities transfer by DOE to the UPR will begin. A gradual reduction of DOE funding (until such funding is completely eliminated by FY 1982) for support of facilities is also stated in the Action Memorandum. The successful continuation of CEER operations will largely depend on funds secured from the Government of Puerto Rico, from UPR, and from a possible future contractual relation

ship with DOE, This document addresses the minimum reasonable

programs and the base funding requirements for continued oper-

ation. Without such base funding, even the competitive type

search projects will be in jeopardy, since CEER could not be supported alone by competitive type programs which are on completely irregular time schedules. Furthermore, CEER could not

meet its principal mission

and goals.

## CEER ADMINISTRATION AND POLICIES

CEER operates as a single unit within the UPR system, and

its director reports directly to the President of UPR. UPR is

an island-wide university with over 50,000 students concentrated

in three large campuses, three four-year university colleges,

and five regional colleges. It also has an agricultural research

network and a cooperative extension service. the organizational

structure of CEER is shown in Fig. 1

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?The CZER Director is appointed by the University President

with the approval of both

1 Council of I

er Education and

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As shown in Fig. 1, the President of the University is  
advised by a Senior Energy and Environment Research Advisory  
Committee. This Committee is composed of distinguished scientists

from  $\emptyset$ )

1e United States and agency heads from the Government of Puerto Rico. Appointment to the Committee is made by the UPR President. The function of this Advisory Committee is to review yearly CEER research and development programs and make pertinent recommendations. These recommendations are given detailed consideration by the CEER administration and most have been adopted within the constraints imposed by budget, personnel and schedule Limitations. Included on the Advisory Committee are the Director of the Puerto Rico Electric Power Authority, the Director of the office of Energy, the Secretary of the Department of Natural Resources, the President of the Environmental Quality Board, and several outstanding scientists in the fields of energy and environment, one of whom (Dr. Melvin Calvin) is a Nobel Prize Winner. Appendix B is a list of the present members of the Advisory Committee on Energy and Environment.

The DOE Oversight Committee, briefly mentioned in the Introduction, is not shown in Fig. 1. This Committee, composed of DOE officials, overlooks the appropriate program schedules and makes recommendations about the CEER/DOE budget to the DOE Secretary. This budget plan, if approved by the Secretary, is

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included in the overall DOE budget plan recommended to the President of the United States. Appendix C is a list of the oversight Committee Members.

A DOE/CEER contract administrator is stationed in the Oak Ridge Operations Office (ORO). This contract administrator determines the proper accounting and administrative procedures that are to be followed.

The existence of the Advisory Committee and the DOE Oversight Committee insures that CEER programs are innovative, that they follow the state-of-the-art research, and that they address both

the energy needs and the DOE energy self-sufficiency goals.

CEER administrative procedures for purchasing and accounting are independent from other UPR units. They are based on over 20 years of federal accounting and purchasing practices for research and development facilities. For example, purchase of equipment and materials for the various projects is authorized

by the particular r

arch project director, provided they are within the project budget, and only the additional approval of the CHER Director is necessary for purchases over \$500, Personnel hiring Policies and fringe benefit policies comply with established UPR practices. Foweever, there is no tenure within the CEER system. Hiring ané lay offs will be directly related to the volume of work if a large portion of CEER programs rest on programs obtained through competitive contracts. A base funding of institutional programs

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with combined competitively won funds is needed to assure the retention of specially trained scientists and technicians in the energy and environmental fields. Joint appointments of scientists and professors between the UPR and CEER is a flexible administrative procedure. In such joint appointments the professor dravs a combined

lary from both the UPR and CEER in

proportion to the efforts devoted to each without losing University personnel benefits and tenure. The particular University campus is relieved of full salary payments and at the same time gains a better trained and more experienced research professor. The joint appointment arrangement is probably one of the most effective schemes for integrating CEER into the University system. It is the policy of the UPR President that CEER should be effectively

fully integrated with the University scientific and technical facilities in order to make optimum use of resources and promote academic research. Appendix D contains a briefing entitled "the CHER and the UPR System's Master Plan" and a statement from the University Board about the Institutional Policy of CEER/UPR.

ALL of these administrative procedures enable CEER to carry on its mission

ion for the development of renewable energy alterna

tives and the solution of related environmental problems.

## CEER AND OTHER COMMONWEALTH OF PUERTO RICO RELATED INSTITUTIONS

?The Puerto Rico Government Agencies closely related to CEER  
missions of energy and environment are: 1) The Office of Energy,

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2) the Electric Pover Authority, 3) The Enviromental Quality Board, 4) The  
Depestnent of Natural Resources, 5) The Denartnant of Health, and 6) the  
Department of Agriculture, the Institute of Tropical Forestry, « federal  
funded institution also works in close cooperation with CHER,

Act No. 128 of June 29, 1977, created the Puerto Rico  
office of Energy. The Act empowered the Office of Energy to  
carry out and promote energy related research. Section 9 of  
the Act is related to coordination and it states: "Specifically,  
every research project shall be carried out in close coordina-  
the Energy and Environmental Research

f Puerto Rico?

ter of the

ye Act does not preclude the Office of Energy from carry-

ro oct its own research projects, but it recognizes the leader-  
ship of CEER in energy research ané makes close coordination  
mandatory. At present the Office of Enery has no scientific  
research laboratories because no State Energy Offices are in-

involved in direct research programs. Successful development of



such facilities are normally possible only through integration with a University scientific community or with a highly technically oriented industrial facility. However, because of the tax incentive program, the industries in Puerto Rico are highly oriented to manufacturing while the research and development phases are usually done on the mainland. It takes years of effort and a large funding capability to develop a meaningful research organization. PRNC-CEER has compiled 23 years of

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experience in research. It can fill the research needs of the office of Energy through suitable administrative or contractual agreements.

The Puerto Rico Electric Power Authority (PREPA) is empowered by Act 142 of 1941 and its subsequent amendments to generate, distribute and sell all the electric energy in Puerto Rico. The Authority is bound financially by its Trust Indenture to invest its proceeds in a revenue producing manner. The proceeds are committed to meeting operating expenses, to retiring outstanding bond interest and amortization, to service for equip-

ment depreciation, and, lastly, to a reserve capital improvement fund. No provision is made for investing in Research and Development of non-commercially available systems. The authority must operate as a business and not as a research and development laboratory. However, some related research is recognized as proper for all electric utilities, but th

projects are

mostly related to current operating problems and to studies of future alternatives. The future energy alternatives studies permit the utility to solicit funds from federal agencies for Project development. Since PREPA does not have an energy related research laboratory, CEER can complement the PREPA needs in this area. As it has in the past, CEER is now serving PREPA needs in the environmental energy related fields through contractual agreements. CEER has also been working on two PREPA contracts for OTEC commercialization and oceanographic studies. PREPA and

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CECR have had a close and harmonious working relationship

throughout the years.

The acts that created the Environmental Quality Soard  
(203) and the Department of Natural Resources were reviewed.

These agencies are of a regulatory and conservatory nature,

and they are empowered to perform research related to their

inctions. No research policy related to the development of  
alternative energy sources is mentioned in the act. Although

both agencies have laboratories, CEER environmental related

can complement their facilities through adequate

efonshivs.

The functions of

the Department of Health and of the Department of Agriculture are also different from CEER's mission and goals. These agencies do not devote themselves to energy alternatives development. There are, however, certain CHER programs in environmental health, such as schistosomiasis studies and respiratory and gastrointestinal diseases energy-industry correlations, which are of interest to the Department of Health. As such, these programs complement Department of Health interests.

The main interest of the Department of Agriculture is in food production and not in biomass for energy. CEER initiative in biomass research complements other agricultural research Programs.

The Industrial Development Administration (Fomento) is principally oriented toward industrial promotion. CE

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provide technical advice and research suppo!

to Fonento

dustries in the field of energy and environment.

The President of the Planning Board of Puerto Rico and the PREPA Assistant Executive Director for Planning and Engineering have endorsed CEER plans for energy alternative and research needs in Puerto Rico. Copies of their letters of endorsement are included as Appendix E.

At its January 1980 meeting the CEER Senior Advisory Com

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1e stressed the need for CEER to address the energy and environment problems associated with Puerto Rico and its

vent agencies in addition to promoting high quality

research within the University system.

The relationship between CEER and society has been depicted

by the Senior Advisory Committee in a line flow diagram which has been reproduced as Figure B-1 in Appendix B. The two main branches considered in such a relationship are, first, the applied research or problem solving mode interaction between the office of Energy and local industries, and second, the basic science research or problem studying mode interaction between UPR campuses and international relations.

The programs described in this plan for continued CEER

operations implicitly address these relationships.

## ACCOMPLISHMENTS - PAST

During the 19 year period in which the Puerto Rico Nuclear

Center (PRNC) operated a nuclear energy program, one of its main

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accompli

ments was the training of students in nuclear science

and technology, nuclear medicine and health physics. over

3500 etudente and ecfentists from 41 different countries

participated in the various training and research programs.

?The participants were fron countries throughout the world includ-

ing Inéia, Gre

© Britain, Spain, Greece, Israel, Korea, Lebanon,  
Liberia, Kenya, Philippines, Germany, Hungary, Indonesia,  
Thailand, United Arab Republic, Turkey, South Africa, Malay,  
Taiwan and Japan. However, the largest number of participants  
were from Latin American countries, including Argentina, Bolivia,

Brazil, Chile, Colombia (largest representation), Costa Rica,

Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti,

Neuras, Jamaica, Mexico, Nicaragua, Panamá, Paraguay, and

2. Many of the former participants today hold important  
positions in government and private industry in their respective  
countries. The good will and friendship together with the academic and scientific accomplishments gained through these training programs was undoubtedly one of the major accomplishments of the PRNC.



Another area of major accomplishment was in ecological research in tropical ecosystems. Utilizing the tools of radio-tracers activation analysis and radiation perturbation, pioneer studies on the structures and functions of both marine and

restrial rain forest ecosystems were conducted. These have provided the foundations for understanding the effects of

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radiation on components of complex ecosystems and for the basic understanding of tropical ecosystems.

Also important in any summary of research accomplishments

are the contributions to the knowledge of radiation effects on

higher organisms, especially as they relate to human medicine.

## ACCOMPLISHMENTS - PRESENT

### Major Programs

The major accomplishment of CEER during its first three

years of operation has been th

ishment of a base for

research and development programs for alternative energy sources

environmental problems associated with them.

Preliminary information has been col

lected, analyzed and reported

on such important programs as the locating of an Ocean Thermal

Energy Conversion (OTEC) plant off the southeast coast of Puerto Rico.

interest in an OTEC Program in Puerto Rico is due to the fact that Puerto Rico has one of the best sites in the world for the location of an OTEC facility. OTEC plant baseline information attained thus far includes biofouling corrosion and material studies, and measurements of oceanographic environmental parameters.

A U.S. Navy Landing Craft Uesisty (Lcv) has been reconditioned and equipped as a laboratory facility for OTEC research. The ship is presently moored approximately 1.5 miles south of Punta

Tuna in Maunabo in 1000 meter deep water.

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Experiments related to seawater surfactant systems and variability relationships to an open cycle FOAM OTEC System have been carried out at the Cornelia Hill facility in Guanajibo, Mayaguez.

Due to Puerto Rico's geographical location in a high insolation region with sufficient rainfall, good agricultural land, and the availability of agricultural research scientists, biomass-for-energy research programs have been undertaken by CEER and the Agriculture Experiment Station of UPR. Information has been gathered relevant to the development of agricultural technologies

and to the optimization of harvesting large volumes of biomass and

economic and agricultural feasibility.

Bioconversion projects have been developed for producing

methane from wastes. Biologically digested wastes mixed together with other biomass represents an attractive project for integrated energy and environment research in Puerto Rico. The results will be applicable to other areas, including the mainland. A demon-

stration project (waste digestion only) for the U.S. Army at Fort Buchanan has been developed by CEER and is now in operation. Important information has been gathered for the design of larger

system:

Various methane generators, including newly designed systems to digest rum distilling waste, have produced important information. CHER is also working in cooperation with the owner of a large private hog farm in Ponce on a waste bioconversion project.

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As

research program cannot be logically developed unless solar radiation data is collected for the area under consideration. Solar radiation data has been continuously

monitored by CEER measuring stations located in Mayaguez, Cabo Rojo, Lajas, Rfo Piedras, Ponce and Catafio. These data, both global and diffuse, are taken on an hour by hour basis, stored in a computer, and then mathematically modeled for practical use for research and design applications. Reports containing this important and vital information have been published and

additional measuring stations are planned to provide more

sa information.

An evacuated compounded parabolic concentra

x (CPC) for

pred:

am for industrial use has been developed by CER

to form the base of future industrial solar steam program. In addition, CEDR has participated in the design phase of solar demonstration projects (photovoltaics and solar thermal).

?The design, testing and evaluation of a solid desiccant

¥ conditioning machine using silica gel has provided basic

information for further study of this important system in

the humid

topics. Air conditioning (especially for the

Sector) is a significant portion of the electrical

load in Puerto Rico.

in the ecology area, the establishment of basic information for future ecological studies related to planned energy

production and utilization is the salient accomplishment.

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The growth of the energy industry and the population increase have multiple effects upon the quality of the island's environment. An assessment of the effects of these developments upon representative island ecosystems has been the focus of CHER's Marine Ecology Research in the Guayanilla Bay studies and in the Terrestrial Ecology work on the Rio Espiritu Santo basin.

Current efforts have a similar ecosystem orientation but are directed in Marine Ecology toward assessment of the effects of

the OPEC technology upon the ocean communities most likely to be



ected. The Terrestrial Ecology program currently is develop-

on needed to predict the fates and effects

ich are being mobilized by the development of both  
conventional and alternative energy sources. Both the Terres-

and the Marine Ecology Programs are also develop-

g the

ecological information needed for the assessment of a coal-fired  
power plant on the island.

Complementary Programs

?The main efforts in the environmental health area in the

past have been in controlling water quality and tropical disease transmission through aquatic systems (schistosomiasis). As a result of CEER's efforts, schistosomiasis in Puerto Rico has nearly been eradicated. Ongoing programs are establishing baseline information required in connection with correlation of respiratory diseases, gastrointestinal disorders and water quality

common in Puerto Rico.

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Nuclear programs have developed basic information related to the improvement and optimization of fuel cell electrodes, to the determination of properties of several solar selective surfaces, and to the degradation of the material of solar collectors and water heaters in the tropics. A base already exists in this area in that scientists and laboratories are now available for materials research.

On integrated technological assessment, energy analysis of

various alternative energy sources has been made which will provide basic economic information and a period of competitiveness for the timely selection and development of alternative

energy sources. The studies indicate that nuclear energy, on

a cost basis only, is the lowest cost energy source for the

rest of the century and beyond. Biomass and OTEC are strong

contenders with

costs lower than coal-fired power plants. The

economics of photovoltaics look highly promising. The economic

analysis of alternatives is a very important aspect of an energy

program, and CEER is not overlooking this area.

Public awareness programs and training and education

Programs have received very little funding. However, CEER has conducted several successful programs including two three day international energy seminars in which scientists from Latin America participated. In addition, several summer energy-environment oriented training courses for local high school

teachers and students have been conducted. Base information

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has been accumulated for future use. CEER both sponsors and participates in many professional level seminars each year.

In the Transportation and Conservation Sector, significant economic and policy studies have been conducted, and data has been established for important future policy and decision making considerations. Over twenty five percent (25%) of Puerto Rico's net petroleum imports are used by the transportation sector. Present studies and experimentation are focused on the feasibility of use and development of elec

tric or hybrid electric vehicles. Both of these vehicles show

promise for substantial reduction in gasoline usage in the high density urban traffic which is typical in Puerto Rico.

To keep abreast of the latest developments in energy and environment research, CEER has sent scientists to visit various research laboratories for discussion of special projects and current research. Some of these laboratories visited have been: ORNL, JPL, SERI, ANL, KMS, SRL, BNL, Sandia, and LBL. In addition, CEER scientists have also visited such major university research laboratories as MIT, University of Colorado, Colorado State University, University of Florida, California Tech., UCLA, University of California~Berkeley, University of Michigan, and Carnegie Mellon university. Scholars from many of these laboratories and universities have visited and lectured at CER.

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Other accomplishments at CEER during the last four years include the success of the magnetic separation program (removal

of pollutants from aqueous waste discharges); the tertiary treat

ment of waste water with water hyacinths; the use of sludge and hyacinth compost to produce methane; and joint efforts with the Venezuelan Government in research required to establish the practicability of using microbial oil stimulation methods in marginal wells producing extra heavy crudes and biodegradation of heavy crudes by means of selected microorganisms.

Meetings, conferences and seminars have been held with the Caribbean international community on energy and environment. Through these activities the expertise of CEER has been recognized and its assistance often requested. Contracts are being negotiated with Panama, the Caribbean Development Bank (CDB),

CARICOM, and the Venezuela Ministry of Energy and Mines.

## PRESENT FUNDING

Because of limited funding, extremely careful planning was

ry to make thi

accomplishments possible. Approximately 3.5 million dollars were spent for all programs during the last fiscal year.

Funding sources for CEER programs generally fall into three categories:

1) Institutional and Development Funds

These funds are used to implement policy set by the general goals of CEER, the recommendations of the Senior Research

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isery Commi!

ee, the Office of Enezcy document on Public Policy and other policies stated in tae Intro-

evction and in CEER Administration. These funds are

not earmarked for specific projects by the funding  
sponsors, but are used according to broad guidelines.

DOE is the principal Sundin source.

DOE Direct Support Program Funds

?These funds are used for DOE supported projects su

as environmental research for marine pollution, ship

suppor, terrestrial ecology and an en\

onmental re-

sch park, Another program currently supported by



DOR is the decontamination of the Mayaguez Reactor Facilities.

#### Competitive Program Funds

These funds are obtained by submission of specific proposals on a competitive type of bidding. Awards normally depend primarily upon technical and scientific qualifications to perform the work rather than upon cost, although the latter is also considered. Competitive programs must respond to the customer's specific requirements. The general CEER goals of energy self sufficiency for Puerto Rico are not normally served through competitive bidding, except in the case of federal programs oriented toward alternative energy development in the Caribbean islands.

Sponsors include such agencies as the Puerto Rico office

26

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of Energy, PREPA, local and national industries, organizations such as the National Science Foundation (NSF), the World Health Organization (WHO), the Solar

Energy Research Institute (SERI), and the Department of Energy (DOE).

the State

competitive federal grants represent an overhead burden for research institutions since great efforts are spent writing proposals, a great number of which are usually rejected. Science

Magazine (16 Feb. 1979: see Appendix E) reports that

ratios average from about 20 to one to about four

to one, depending upon the institution and the area

of concern. Competition has become increasingly

sly

end the proportion of proposals that can be funded has declined,? the article states. According to thie article £7,500 proposals were submitted in 1978 to various federal agencies. CEER has been

unusually success

in winning federal grants

because of its technical excellence as a research

institution. More than half of the FY 1980 budget comes from competitive funding grants (see Appendix

F+3 for Competitive Programs). The history of CEER's

total budgets is summarized in Table

---Page Break---

TABLE 3

CEER's TOTAL SUDGETS

(Current-Thousand Dollars)

ey-77 FY-78 EY-79

2367 3072 3500 4125

The funding history shows an overall average budget increase

of 208 per year during the lifetime of CEER. (CEER projections

will be based on a conservative growth of 108 per year}

Fig, 2, 3, and 4 Silustrate in graphic form the CHER

tote? budcots

, the breakdown of DOE component support, and the

distribution of competitive funds. Figs. 2 and 3 show that the

Gixect support from DOE has decreased continuously during the

ast

ee years; however, the inert

se in competitive funding

has mo!

than offset this effect and a continuous total increase

has resulted. Fig. 3 shows the breakdown of DOE support funds.

As Fig. 3 shows, the "training and education" and "base" program DOE funds have been eliminated completely. Fig. 4 illustrates the competitive funding by components and shows that competitive funding accounts for the healthy growth of the CZER budget. The difference between the "DOE Contractors" and the "DOS sponsored" competitive funds is that the first is assigned via direct relationship contracts and the latter via third party contracts with DOE. The increase in competitive funded programs has one main advantage which is coupled to a disadvantage. The main advantage

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FIGURE 2

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CEER TOTAL BUDGET

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COMPETITIVE PROGRAMS

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is that it points toward the technical competence of CEER.

?This funding helps in maintaining a fairly constant volume of

work which keeps the technical staff busy. The main dis~

advantage is that too many competitively obtained programs

make the CEER work schedule extremely unstable and sometimes

atv:

attention from the long term institutional goals. con-

sistent institutional funding permits the development of new

innovative programs and the retraining of personnel. Therefore,

a healthy balance should be maintained. If the ratio of the

?onal program budget plus DOE directly sponsored eco-

rogram to the tot:

budget were less than 0.5,

hen it

might be argued that sponsor program budgetary interests are

Po:

® important than institutional budgetary interests. It can

be argued further that an ideal condition will be to keep this

ratio at or just slightly above 0.5 for an ad

quate balance.

At present, because

Of reduced DOE support and increased competitive activity, this ratio is 0.48. It should be pointed out that those competitive programs which advance institutional goals should be counted as part of the institutional funding for the purpose of the evaluation of this factor only.

## ON-GOING PROGRAMS

CEER programs for the five year period 1977-1981, as revised, are described in "Integrated Program Plan for UPR/CEER

FY 1960 and FY 1981," (CEER A-63). Appendixes F-1 and P-2 have

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---Page Break---

been reproduced from that document. They contain a detailed

List of present programs, funding, local

ns and project leaders,

Appendix F-3 provides a brief description of environmental re~

Search and the details of the funding sponsored directly by DOE.

PROJECTED FUN

DING AND SOURCES

As indicated in

je Introduction, the ownership of the CEER

facilities will be transferred from DOE to the University, and

there will be a reduction in DOE funding. This will require the

PE to assign funds for zaintenance and uskeep of the facilities,

The present contractual relationship with DOE terminates in

SY 82. A new contractual relationship may be entered into with

DOE for continuing CEER support. ?This possibility will be greatly

enhanced if the University and the government of Puerto Rico

share the support of CEER with DOE. DOE has indicated that it

will recommend the following funding:

TABLE 2

PROPOSED FUNDING FROM DOE

(Thousand Dollars)

Inst. § Dev. Env. Prog. Decont. =Total

850 1104 460 2414

82 500 3273 50 1923

33

---Page Break---

Based on CEER's present and prior performance, it may be reasonable to assume that DOE will continue support under 2 new contract by appropriating Institutional and Development Funds. Because of regional factors,\* DOE may consider continued support to CEER for the Environmental (Ecology) program at the 1982 level shown in Table 3 with 10% increase per year. This assumption is based on the premise that both the University and the Government of Puerto Rico will contribute an amount at least

equal to the 002 support for institutional funding.

Table 3, as well as the graphical description shown in

Fig. 5, has been prepared after informal discussions with the

University President, officials from the Government of Puerto Rico, DOZ officials and the CEER Director. The level of funding suggested in Table 3 is the minimum possible for a meaningful research and development program. It is, however, far from the funding level required for a dynamic, aggressive energy and environment program. Table 3 calls for \$500,000 assignments from the Government of Puerto Rico for FY 81 and 82 and a 10% per year increase thereafter. A similar assignment is required from the UPR except for FY 81 in which the assignment is \$300,000.

Column 5 of Table 3 illustrates the total funding projection (including 10%/year growth) for the Institutional Programs.

The Luguillo Rain Forest is the only tropical forest owned by the U.S. Department of Interior, and is the only tropical ecological system under U.S. Flag where interaction between ecology and energy systems or components are presently being studied.

The Punta Tuna site for the OTEC facility is unique in that it offers the advantage at one site where large OTEC plants can

show economic competitiveness. Marine Ecology studies are part of the OTEC project.

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ARIO: FY 1980-86

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?These programs address the institutional goals directly. Colum 6 includes funds assigned by DOE to support specific environmental and ecological erograms, and Column 7 includes the DOE sponsored econtamination program. 1

is expected that because of the

unique tropical environmental conditions in Puerto Rico, DOE will continue to fund the environmental programs.

Column 9 of Table 3 shows the ratio of Puerto Rico support funds. It does not exceed 374 of the total.

Column 11 of Table 3 indicates the total projected CEER

Eneludes the additional component of competitive funding.

petitive

\ding has been projected by taking the present,

vel of competitive funding at CEER as a base. A comparison

£ columns @ and 10 shows that after 1980 competitive fundings  
ere slightly lower than the total of institutional plus direct

DoE

unding, which is a healthy, balanced condition. The last

colum in Table 3 indicates the ratio of institutional funding

plus direct DOE sponsored programs to total funding. Excest  
for the current fiscal year in which there are no Puerto Rican  
Government funds involved, the base funding ratio is greater  
than 9.5 indicating that CEER base funding budget goals are  
Planned so that they vredominate over sponsored competitive  
Programs. This again is a healthy balanced condition.

The funding projections detailed in Table 3 and the funding  
categories defined above are used for the CEER Five Year Program  
Plan (FY 1992-26), The yearly budgets of the plan are adjusted

---Page Break---

to match the funds projected in Table 3.

#### FIVE YEAR PLAN PROGRAMS

The programs included in the five year period 1982-86 are

focused on:

4) omc

2) Biomass

3) Solar Energy Programs

4) Environment

5) others

@) Conservation and Transportation

) System Energy Analysis

?) Institutional Miscellaneous

@) Public Awareness

e) Material Development

£) Fossil Fuel Research

) Expanded Bioconversion Program-Ethanol

h) Integrated Technology Assessment

2) International

3) Miscellaneous (minor) Competitive Programs

Most programs are in harmony with the public policy document of the Office of Energy (June 1979). Fig. 6, reproduced from the Office of Energy Public Policy Document on Energy,

indicates the various energy alternatives possibilities for

Puerto Rico (Figure 6-a is the English translation.)

Appendix G, "Proposed Program Plan for the Five Year Period

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1982-86," is summarized below. This plan is based on the possible available funds as projected in Table 3. the

program £y

nd projections are 1980 dollars, and they do not include escalation. A 108 per year increase has been included to reflect program growth. Table 4 illustrates the proposed institutional fund distribution of the various proposed programs. Table 5 illustrates the funding of the "DoE Directly supported Ecology Programs." These programs are mainly ecology type programs. Table 6 illustrates the projected and expected competitive lump sum distribution per program. No detailed program

Gistribution is indicated in Table 6 because of the

uncertainty

involved in predicting detailed competitively funded programs.

## FIVE YEAR PLAN (FY 1982-96) PLAN PROGRAM SUMMARY

:C = Ocean Thermal Energy Conversion

This concept utilizes the temperature differentials between surface sea water and sea water 1000 meters deep. This temperature differential is about 20°C. The surface waters are used to evaporate a low boiling working fluid such as ammonia or Propane in an evaporator. The working fluid vapors expand through a turbine generator to produce useful work. The fluid

vapors are condensed with deep sea

water in a condenser to complete a closed cycle.

Puerto Rico has one of the best sites of the world for developing this concept. One thousand meter deep water is found within 1.5 miles from the shore off Punta Tuna in Maunabo. This

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PROPOSED CEER PROGRAIS INSTITUTIONAL FLNDING

FY (1882-86)

Aunding Source Indicated in Table 3, Columns 2-5

(Thousand Dollars)

soe) en a3

(2) As revised in the present document CEEX-A63 biannual (80-81)

Plan is altered as per this revision.

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Evaporator 7% 75 8S 100 S130

Condenser 35 25125 465 200235270

Siting = 50 59 50 505050,

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Plancs = 2% 2 35 4 4550

Silviculture 35 4 4950556

Direct Firing 320150155 170175. 196

Btowanwersion 135.4 1857550251510

visc, 365 303039 55

TOTAL TS Wo 3053

SOLAR

Data 20 2m 2 0

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ind, ?steam 63.0 100 300125125

Solar Space Coster 3540 300 125 350

Photovoltaics 50 150 175 225

Nise. 34.555. 302840,

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Exology = Misc. ~ 4 50-75 100 125 150

Health - Respiratory Dis (air) 17.2 25525288

Gastro Dis) (water) 2.0 63 = DO

Misc. 8.3 30 30303903090.

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a) CONSERV. 6 TRANSP,

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b) SYSTEM meno ANMLYSIS

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Dor DIRECTLY SUPPORTED

?SDOLOGY PROGRAMS

(Details in Appendix G)

ee

Study Areas 82 82 8s 85s

A, Biosystem Structure and

Process Studies 625 584 772 912 1013

2, Resource Management Studies 380 490 450 456 472

C. Biological Effects studies 268 271 258260 304

eS

Tom 995 1204 1273 1345 1480 1628 1790

SSS

\*See Appendix F-3 for detailed breakdown of programs for FY 1980-81.

Study areas here indicated commence in FY-1982,

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was recognized by the Puerto Rico Electric Power Authority

PA) back in 1966 when preliminary studies were made and a research and funding program was recommended.

The ongoing OTEC program at CEER involves corrosion analysis, studies of biofouling in the evaporator, and site characterization investigation including determination and measurement of oceanic parameters, such as water current, biota, and water chemistry. The program proposes to continue the present studies related to the condenser portion. This requires a pipe one kilometer long and a pump system. CER is presently operating an

OTEC platform ship at Punta Tuna. This ship is a reconditioned

S. Navy Land craft Utility (cv) which has been equipped with laboratory facilities. Operational cost of this facility is

\$800,900 per year. The projected institutional funding for this program is illustrated in Table 4, Part I, and the possible con-

itive funding is projected in Table 6.

## Biomass

### A. Existing Programs

Plant materials can be produced locally as a renewable source of fuels and chemical feedstocks to substitute imported fossil fuels. Biomass research on tropical grasses and sugarcane was initiated in 1976. Total accumulated research expenditures today exceed \$1,000,000. The project objectives have been: a) determination of the agronomic and economic feasibility

of mechanized, yearly production of solar-dried biomass through

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the intensive management of sugarcane and napier grasses as tropical forage, and b) examination of alternate tropical species as potential sources for intensive biomass production.

This program is being developed with funds competitively obtained from Doz. Funding for this program will probably be continued on a competitive basis at about \$400,000 per year.

### 3. New Programs

#### 1) Hydrocarbon Bearing Plants

Plants of the Euphorbias, Asclepiads and Guayule families  
the

@ in Puerto Rico in dry and salty soil regions. These plants manufacture hydrocarbons, mainly polymers of isoprene, which constitute an adequate hydrocarbon fuel or chemical feedstock.

The principal objective of such a program will be: a) the iden-

cation of the most promising plants for detailed selection

and breeding, and b) the determination of the agronomic and economic feasibility through intensive management of hydrocarbon bearing plant farming. The level of proposed funding is shown in Table 4.

## 2) Silviculture

The production of woody biomass (silviculture) as a renewable energy source offers a challenge for a forest industry in Puerto Rico. In this program woody species serve as a partial substitute for fuel rather than imported timber. Species regarded as "junk" insofar as quality wood products are concerned have a

new economic potential. Members of the genus *Albizia* and of the

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*Eucalyptus robusta* are in this category. The primary objectives of this program are: a) the determination of dry matter producing potential, b) the determination of yield potential of superior species, and c) the completion of an economic analysis.

This program will be carried out in close cooperation with the Institute of Tropical Forestry. The proposed funding

renents are shown in Table 4.

### 3) Direct Firing of Biomass

Solar dried Biomass is contemplated as a fuel for direct firing in conventional waterwall steam boilers in central electric power plants. CEER economic studies indicate that biomass can compete economically with imported coal. The CEER contribution in a direct firing program will be to provide the required expertise in the development and operation of a needed pilot project, CEER funds of from \$120,000 to \$200,000 per year can be assigned from the proposed budget for a five year period. The objective of the direct firing program is to convert an existing sugar mill to handle 1000 tons of biomass per day, to determine the logistics of production, drying, transportation, storing and burning of biomass to assess the technical modifications to boiler handling and burning equipment, and to study the characteristics of particules and gaseous emissions. The capital investment made by government for mill modification is estimated at nearly 5 million dollars and the total

6 year program will cost \$13 million dollars. The CEER

---Page Break---

contribution from the Institutional and Development program  
48 proposed to be \$1,138 million in the 1981-86 period. the  
large capital investment required must be secured through  
appropriate legislative action.

#### 4) Btoconversion

Methane gas is produced in the anaerobic gestion of  
wastes, residues, and biorass. At present, continuously oper-  
ating Bioconverters are those using water hyacinths, rum waste  
and cafeteria refuse. The first two units are operating at  
CHER and the cafeteria waste converter is operating at Fort

Buchanan Army Base in cooperation wii

» the Army Environmental

Research Program, One of the main objectives of the Biomass  
Program is to demonstrate the technical and economic feasibility  
of fermentative biogas production from locally available biomass



in decentralized, low technology operations. other specific

objectives are listed in Appendix G. The institutional funding for the Bioconversion Project is shown in Table 4, and the pos-

sib

competitively secured funding is indicated in Table 6.

### Solar Energy Program

Incident solar energy on the surfaco of Puerto Rico arrives at an average rate (day and night, year around) of more than 5 kilowatt~hours (kwh) per square meter per day. Over a course of a year, fone square kilometer receives 1.825 billion kwh. Accordingly, 82 square kilometers of land, dedicated to solar photovoltaic cells

solar energy generation at 10 percent efficiency, could meet

the entire Puerto

© power generation requirement for 1979,

Subtropical dry forest and with extremely high solar insolation levels occupies more than 1500 square-kilometer of the southern region of the island.

The goal of the solar energy program is to help to develop commercially attractive and environmentally acceptable applications of solar energy at the earliest feasible time. Solar

energy is readily converted into thermal energy, elec

city

and clean fuels through conversion processes and systems that

ed

are acceptable technically feasible.

During the proposed five year program CEER's solar

Work will emphasize:

a) Continuation of the systematic solar data acquisition throughout Puerto Rico,

b) Research and development in solar cooling in a tropical environment,

c) Generation of electricity from photovoltaic conversion of sunlight,

d) Industrial

process heat,

e) Research in solar materials.

Specific objectives and milestone charts for these programs are contained in Appendix G. The Solar Division will also participate in a broad alternative energy resources assessment that

will involve all other divisions of CEER.

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During the five year program emphasis will be expanded to involve private industry in all phases of solar research and development, and demonstration programs in order to accelerate the use of solar technology in the commercial sector.

Institut

onal and competitive funding levels for the solar pro-

gram are shown in Tables 4 and 6.

### 1) Seology

Energy production results in the output of materials, waste energy and direct environmental disturbance which have potential for altering the natural systems which support man.

CEES Seology Programs focus on the relationship between anthro~

pogenic outputs and the natural systems that receive them.

Forming the baseline for understanding how the natural processes may be disrupted is a set of studies of Ecosystem Structure and

Process. These include studies of the ocean environment near

an OTSC operation, terrestrial and marine studies for the siting

of a coal-fired power plant, and investigation of the cycling

and transportation of carbon, sulfur, nitrogen, and phosphorus

Likely to be activated in energy development in tropical terres-

trial ecosystems such as the Luquillo Rain Forest. Efforts are

underway to organize an environmental research park at the

Luquillo Experimental Forest Service Institute of Tropical

Forestry to make environmental

ments.

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Ecological Effects studies now in progress are aimed at

understanding impacts of sediments and metals discharged from waste heat rejection systems upon representative marine organisms. Plans include measuring the ability of natural systems to process various wastes normally and without loss of integrity.

Resource Management Studies include efforts to clean wastes

by using water hyacinth?

S as an energy source.

Wildlife resource management studies are exemplified by

the research in progress upon the commercially important land crab, which is being threatened by habitat reduction and heavy

metal releases associated:

related with land development and use.

During FY 1982-85 all three sub-programs indicated in

Table 5 will be continued and expanded. Emphasis will be placed on specific effects studies and upon measurements of the ability of ecosystems to absorb and process man's products.

In addition to the DOF Supported Ecology Programs illus~

trated in Table 5, some Institutional and Developmental fund:

for ecology type programs have been included in Table 4 under

Ecology-Miscellaneous. This funding is expected to be used for

proposal writing for competitive funding, and for developing new approaches based on data processing of existing programs and information.

## 2) Environmental Health

?This program is also included under the general

category of Environment. Environmental Health Programs have

been reduced considerably at CEER during the last two years.

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but the technical and scientific expertise is capable of generating useful and needed competitive programs.

© correlation of respiratory diseases with air pollution, and the correlation of gastrointestinal diseases with water quality are among the ongoing health programs at CEER. Such studies become more important as Puerto Rico becomes more industrialized, Tables 4,

and 6

ing

rate the funding levels for these environmental projects. Appendix G contains more detailed information.



## Transportation and Conservation

The main effort in this area is on electric and hybrid vehicle test and demonstration program for conservation. A hybrid vehicle has already been ordered by CEER for this program and an electric vehicle is already being tested. The project objectives include:

#) development of a Driving Cycle for Urban Puerto Rico,

b) hybrid vehicle power train optimization,

©) demonstration for public awareness,

@) motor-generator developments.

A comprehensive energy conservation plan for the University has been prepared by CHER. It is expected to serve as a model for other institutions. The plan will be revised and updated

as required. Appendix G discusses these aspects in detail.

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Proposed funding for Transportation and Conservation is shown in Table 4.

## 2) system Energy Analysis

CER proposes to continue its system energy analysis programs which can be classified as follows:

a) energy demand analysis

b) Engineering-economic studies of energy systems,

c) socio-economic studies of energy systems,

d) socio-economic studies of energy conservation,

including transportation energy conservation.

The energy demand analysis will include econometric

ities of energy demand by sector - residential, industrial,

commercial, and transportation. Forecasts of energy demand

and

studies of price elasticities will be emphasized.

The engineering-economic studies of energy systems

include a continuation of economic systems of alternate and

conventional energy sources including biomass, OTEC, wind,

photovoltaics, oil, coal and nuclear. CEER developed computer

programs will be used as the basis

to program the funds required

for the timely development of the energy alternatives and for

their commercialization.

The socio-economic studies of energy systems will

include evaluation of macro-economic impacts of alternate energy systems on employment and production and on the balance of trade as well as an analysis of both the incentives and the barriers

to their adoption.

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The socio-economic studies of conservation will emphasize the transportation sector and will include systems management, analysis, and updating of policy scenarios for energy conservation.

Close coordination will be maintained with Puerto Rican government agencies such as PREPA, the Office of Energy, the Planning Board, the BOB, Fonento, the Department of Natural Resources, and the Department of Transportation. Encouraging comments from the Planning Board and from PREPA on preliminary work performed by CEER in this area have been received and are included in appendix E.

Appendix G discusses the details of these programs and Table 4 illustrates the proposed funding.

3) Institutional Miscellaneous

Institutional miscellaneous funds include Library and scientific support, expenses for visiting scientists required for technology transfer to local technical and scientific personnel, the preparation of proposals for program support, and explanatory research of novel ideas. The Senior Advisory

Committee has recommended that these funds should be between 10-258 of the institutional funds. Funding levels are shown in Table 4.

#### 4) Public Awareness Program

This deals with community education through seminars,

lectures to school t

\chers, compilation and publication of

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energy related information to the general public, use of mass

media commu:

ation systems, and community participation or

involvement in the educational process. Projected competitive

fund

g levels are indicated in Table 6.

## 5) Material Pavelement

Material development deals with the testing and development of solar materials in a tropical humid environment. It encompasses the establishment of a data bank on solar materials

for research and development purposes, the testing for actual

Geradation from the sun, the wind and the general

environment, the study of ferroelectric materia?

structures

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electric conversion, fuel cell electrode surface

strates, electro, plastic ané material applications, hydrogen

tion via solar enersy, and solar collector surfactant

ing materials. Table 6 indica

expected comp

itive

funding Levels.

## 6) Fossil Fuels

This area deals with the biodegradation of high sulfur heavy crude oils and the application of physical, chemical and biological forces to enhance oil recovery. The government of Venezuela is helping to support this work. A total funding of approximately \$331,000 of competitive DOE funds has been spent in the last three years in this area. Table 6 shows the projected competitive funding levels. Appendix G contains the

data:



5 of the program.

85

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#### 7) Bthanol

Production of ethanol from sugarcane molasses promises to be a viable substitute for gasoline. A mixture of 10% ethanol with gasoline can be used without changing carburation adjustment in modern internal combustion vehicles. This program proposes to use existing facilities at the UPR Rum Pilot Plant, and a proposal has been submitted to DOE. Competitive funding levels are shown in Table 6.

#### 8) Integrated Technological Assessment

Solar Hot Water Systems, Small Wind Driven Turbines

fe

domestic use, and a photovoltaic small community program

implemented in this area. These projects are to be developed

Sn cooperation with various communities, and

chnical assistant-

ship and leadership will be provided by CEER. Competitive funds assigned to this project are shown in Table 6.

#### 9) International Programs

?This area encompasses Technology Transfer to less developed countries (LDC) in the Caribbean and Latin America in

the areas of energy alternativ:

and related environmental problens,

and assessment of material resources for potential development.

CEER has recently submitted proposals to Panama and to the Caribbean Development Bank in these areas. It has also submitted 2 proposal on OTEC for Developing Countries to the U.S. state Department.

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#### 10) Miscellaneous (Competitive Programs)

Small miscellaneous projects obtained under competi-

tive basis.

#### TOTAL BUDGET

Table 7 and Figure 7 summarize the general total funding projection by program areas. The largest funded program is Environment followed by OTEC, if Others <s excluded. Biomass

and Sol:

are approximately at the same funding level

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TABLE 7

GENERAL FUNDING DISTRIBUTION BY PROGRAMS:

(Thousand Dollars)

FISCAL YEAR 80 at 82 83 84 85 86

ore

PR + DOE 35 300 300 350 400 450 500

comp, 6838 700, 700 750 800 850 1000,

TOTAL 7189 1000 © 1000» 11001200» 1300-1500

PR= DOE 1754 400 300 300 300 200 324

cove, 407.7 400 400 +400 400 350 380

TOTAL 5831 800 700 700 700 650 676

Pes DOE 183 275 300 380 400 475, 550

325 150 150 175 200 225 450

TOTAL 2158 425 450 525 ?600 700 1000,

## ENVIRONMENT

PR DOE, 10835 1279 130814051655 tas 2015

come, 7383 \$00, 500 500 600 650 900

TOTAL 17798 1729 «1898-2045 225527805

## OTHERS

PR+ DOE 558.1! 1010" 525" 500 540 573 600

com. 2606 586 797 927 108213151029

TOTAL 827.7 1876 «= 1322S 1827,?

GRAND TOTAL 4125 559083708797, 6377s.

"Includes funds for decontamination of reactor facilities @s per Table 3.

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SAMs

Wd

09095908

109090205

8333

02020%

Bas

re

5200

8:33

BELL

sour

ewvinonwen

GENERAL FUNDING DISTRIBUTION BY PROGRAMS

39

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