

Proposed Five-Year Plan for Energy and Environment Programs FY 1982-86 Draft No. 2, December 1979. Center for Energy and Environment Research, University of Puerto Rico, US Department of Energy.

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Proposed Five-Year Plan (FY 1982-86) for Energy and Environment Programs from the Center for Energy and Environment Research. Table of Contents: Preface, Purpose of Document, Uniqueness and Capability of Puerto Rico and CEER for R & D in Energy and Environment, CEER Organization - Accomplishments, Past Accomplishments, Present Proposed Five-Year Plan (1982-86) Summary, Proposed Five-Year Plan (1982-86) Programs 1, Ore II, Blows III, Bioconversion IV, Fossil Fuel Research 1, Solar Program VI, Ecology Program VII, Environmental Health VIII, Material Development IX, Integrated Technological Assessment X, Nuclear Program XI, Transportation and Conservation XII, Public Awareness XIII, International Programs.

Appendices: Appendix A - ERDA Action Memorandum dated April 11, 1976, Appendix B - CEER Programs.

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 (CEER) to supersede the Puerto Rico Nuclear Center (PRNC) which had been operated under contract with the Atomic Energy Commission since 1957. The Council on Higher Education of Puerto Rico authorized the establishment of CEER effective July 1, 1976. Appendix A contains a copy of the Action Memorandum of April 11, 1976 mentioned above. To help CEER achieve the transition from a nuclear center to one focusing on ERDA's (DOE) national energy goals and Puerto Rico's own energy needs, ERDA (DOE) established an Oversight Committee. The Committee held its first meeting with representatives of CEER.

The University System convened in November 1976 to review the transitional measures taken up to that time and to refine plans for the future. There was full agreement that CBER's success would require continuous and close communication and collaboration between the Center, ORO, ERDA (DOE) technical program directors, and the Oversight Committee. It would also require continuous interaction between the Center and the University System as a whole.

A five-year plan (FY-1977-82) was prepared for the second meeting of the Oversight Committee in March 1977. This plan has served as a general guide, with some modifications, for CBER's current programs.

The Action Memorandum dated April 11, 1976 (Appendix A) considered three options for transitioning the old Puerto Rico Nuclear Center (PRNC)-GOCO operations to new CBER administrative setups:

1. Continue the PRNC-GOCO arrangements with UPR, making certain management and funding modifications.
2. Develop mixed ERDA (DOE) GOCO and non-GOCO arrangement with the UPR.
3. Discontinue the ERDA (DOE) GOCO operations, transferring the facilities to the UPR, or others, or close them if appropriate and executing ERDA (DOE) programs under other contractual bases.

Option number 3 was the recommended one. This option involved the gradual reduction of funding (until complete elimination) for the support of facilities. The current inability of the UPR to financially support CBER requires a revision of funding and previous plans set by DOE in its relations with CBER unless the forced closure of CBER 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 ongoing work at CBER and are coupled to the changing energy situation. These reasons are listed below.

REASONS WHY DOE SHOULD CONTINUE CBER SUPPORT:

1. International Programs: CBER represents a useful instrument to DOE International Relations in the Caribbean and Latin.

America. Because of Puerto Rico's unique Spanish and English cultural background, and the bilingual Spanish and English-speaking population, along with its geographical location in the Caribbean, it presents an ideal institution for the Department of Energy (DOE) interface in energy assessment of Less Developed Countries (LDC) counts and technology transfer in the indicated areas.

With established scientific and technical interactions with Latin America and the Caribbean, the Caribbean Energy and Environment Research (CEER) represents a national interface in energy assessment and technology transfer. At present, CEER is involved in energy-related future programs with Venezuela, Panama, and Ecuador. Officials from the Dominican Republic have already contacted the CEER Director for possible future interactions.

In the past few years, CEER scientists have actively participated in energy-related meetings and symposia held in Venezuela, Columbia, Chile, Dominican Republic, Jamaica, and Barbados. These meetings were sponsored by US-AID and other USA or international organizations.

2. Early Demonstration of Economic Competitiveness

Puerto Rico represents one of the very few areas under the US flag where the economic competitiveness of various energy alternatives could be proven sooner. This will accelerate the commercialization of these energy alternatives. Among such energy alternatives are Ocean Thermal Energy Conversion (OTEC), Biomass, and Direct Solar Conversion technologies.

Puerto Rico has one of the best sites, if not the best, for the location of an OTEC plant which can result in minimum project investment costs. Only the sites of Punta Tuna in southern Puerto Rico

and the site of Keyhole West of Hawaii main island offer 1000 meters ocean water depths close to land (6000 ft. for Hawaii and 9000 ft. for Puerto Rico), where temperature differentials of (20-24°F) between surface and deep waters are found. Such temperature differentials are required for an OTEC facility. The closeness of such ocean site areas to land minimizes costly electrical cable connections and deployment costs for first-generation facilities. The Puerto Rico Electric Power Authority (PREPA) has extensive experience.

Experience in installing, conserving, and operating submarine transmission 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 an added advantage over the Hawaii site in the sense that the electrical power system of Puerto Rico can absorb the power of a 100-500 MW OTEC plant. The total generating capacity of the Puerto Rico system exceeds 4000 MW and its peak generation is 2000 MW. The electric power system of Hawaii has a peak demand of approximately 90 MW. A large OTEC plant (100 MW) in which economic 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 programs, 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 of fuel costs. Biomass energy alternatives could probably be demonstrated through the CEER programs to be one of the first commercially viable economic energy alternatives sponsored by DOE. In the area of direct conversion of solar energy such as photovoltaics and direct conversion of solar heat to steam for prime mover applications to electrically driven generators, the insolation rates are of paramount importance in determining economic competitiveness. Recent data obtained at Ponce, P.R. (south coast), at 18 degrees latitude, indicate an average daily total insolation of approximately 1900 BTU/sq. ft-day on a horizontal surface. The relatively small change in day length (P.R. being close to the equator) from summer to winter, enhances the utilization factor of solar energy throughout the entire year. The high insolation rates of tropical Puerto Rico is a very important factor to consider.

Demonstrate the economic competitiveness by DOE sooner than in any other areas.

3. Component Testing in Tropical Environment

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

4. Unique Tropical Ecological System

The only tropical forest owned by the U.S. Dept. of the Interior is in Puerto Rico - the Luquillo 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's 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 important part of the program. In addition, Puerto Rico is unique in that it contains six different ecological zones ranging from desert to rain forest.

5. Affirmative Action Policy

Of approximately 43 research and development facilities including CEER, owned and supported by DOE, CEER is the only facility located in an environment which constitutes a predominant minority group. The continuous support and funding of CEER will enhance the goodwill and spirit of DOE as a strong supporter of the Affirmative 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 corner development and demonstration projects which might bring commercialization in the Caribbean as well as the southern part of the USA.

During the period of 1976 to present, the aforementioned reasons for continued DOE support, grew out of the world energy situation and research occurring over the last.

Over the past few years, the original objectives of the CEER have been somewhat modified due to the changing energy situation in relation to the needs of both Mainland USA and Puerto Rico. In light of these changes, it's felt that a review and modification of the original Action Memorandum should be carried out, aligning with the benefits to DOE in continuing its support of CEER.

The main purpose of this document is to project the budget requirements for the 3-year period (FY 1982-86), beyond the current 5-year (1977-81) contractual relationship with the Department of Energy (DOE). It aims to contribute to meeting the President's National Plan for Energy Research and Development Needs and serve as the basis for a proposed new contract with DOE.

The principal objective of CEER is to support the effort of achieving national energy independence while contributing to Puerto Rico's own effort to attain the same goal. At present, Puerto Rico's economy relies entirely (99 percent) on energy derived from imported petroleum. The total domestic consumption of petroleum fuel in Puerto Rico is approximately 70 million barrels per year.

Table 1, "Estimates of Puerto Rico's Energy Requirements to the year 2000", provides rough predictions derived from studies conducted by CEER energy analysts. Without considering energy alternatives, Puerto Rico's total fuel cost for the rest of the century is predicted to exceed \$155,000,000,000.

To implement the timely development of alternative energy sources, CEER's efforts should be substantially increased from the level of funding sustained during the current five-year (1976-81) contractual plan with DOE. The programs presented in this document address this need.

Table 1: Estimates of Puerto Rico's Energy Requirements to the Year 2000 Under Present Socio-Economic Structures and Absence of Strong R&D Program on Alternate Energy Sources (in millions of barrels of oil).

The text appears to be a mix of random letters, numbers, and some coherent sentences. Here's an attempt to salvage the meaningful parts:

"Statistical Correlations between population and GNP and between GNP and Electrical Energy Generation. Correlation 99%. Gasoline Consumption growth projected conservatively between 2.2/2 - 32. More accurate predictions to be included per year vs. 6.6% actual. Industrial needs projected at a steady per year growth. More accurate predictions will be included in CEER Energy Studies.

UNIQUENESS AND CAPABILITY OF P.R. AND CEER FOR R & D IN ENERGY AND ENVIRONMENT

CEER is the only significant research and development facility in Puerto Rico and one of the few within the U.S. that focuses on both energy and environment problems and the interrelated impact upon each other. It is one of the largest in the Caribbean. Puerto Rico is also probably the most technologically advanced region of the Caribbean. Many technically 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 nuclear steam superheating built in the USA. This facility of 50,000 MWh, 16,300KWe was constructed on the west coast of Puerto Rico at Rincon, and operated by the local power utility during the period 1960-68. Facility personnel were trained at PRNC (CEER). Several BONUS related experiments and measurements were carried out at PRNC (CEER). One of the reasons for selecting Puerto Rico by the USAEC (now DOE) was the technical..."

The missing parts are unrecoverable due to the heavy amount of distortion and lack of context.

The text is corrected as follows:

The capability of PREPA and the University (PRNC) to carry out the program is as follows:

1. Nuclear Research Reactor: A swimming pool 1 MW research reactor was built in 1959 and later 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.

2. Controlled Flash Evaporator Desalination Pilot Plant, 10 GMP at Palo Seco Power Plant: This has been the only desalination pilot plant ever built using power plant condenser waste heat for water desalting. The project was a success but water cost had to compete with other desalting schemes using \$1.50/bbl of oil at that time (1965). Today, the information developed in this project is an asset for future consideration of water desalting due to the high fuel cost.

3. The Arecibo Ionospheric Laboratory, owned and operated by Cornell University, has the world's most powerful radio telescope in the field of astronomical investigations. This has added

specialized radio communication technicians and scientists to the scientific population of Puerto Rico.

4. The 200 KW DOE-NASA/PREPA windmill erected on the island of Culebra, located to the east of Puerto Rico: Important operating data is being accumulated at present. This represents another energy alternative technological advancement.

5. Rum Pilot Plant: A special law of the Legislature of Puerto Rico established the Rum Pilot Plant in 1952. It is owned and operated by the UPR Agricultural Experiment Station and is located at Rio Piedras, a short distance from the main CEER-UPR facilities. Its operations are organized in a number of divisions dealing with analytical chemistry, fermentation chemistry and technology, rum waste utilization, and technical services. A collection of superior yeast strains is also available. Laboratories are well equipped for investigation in all aspects of the manufacture of rum and allied products. Information derived from these studies is transmitted to the P.R. Rum Industry through publications and technical

services.

Meetings. Special reports are issued periodically to the rum industry and various interested institutions. In addition to the above projects, Puerto Rico has a very sophisticated and advanced electric power system. It is the second largest public utility within the USA, being second only to the city of Los Angeles Water and Power System. The Puerto Rico electric generating system is equipped with fully automated remote controlled and supervised hydroelectric power stations (approx. 80 MW in 8 automatic stations); modern high pressure (2400 psi), high temperature 1000°F superheat, 1000°F reheat steam stations with digital computer supervision in all stations above 82.5 MW capacity (4-82.5 MW units, 4-100 MW units, 2-225 MW units and 4-650 MW units). The Palo Seco Steam Station computer installation was a pioneer in the field, being placed in operation in 1960. The generating transmission system is economically dispatched with an economic computer which sends digital signals to generator governor for minimum fuel consumption system-wise, and in addition, it provides security programs for operations.

The main transmission network is 230 KV. The distribution system is equipped with remote control and electrically supervised stations. System planning is performed with very sophisticated computer programs for load flow, loss of load probability analysis, transient stability, load modelling, etc. The technology involved in planning, constructing and operating the power system requires a high caliber of engineering expertise and provides a challenge to the educational institutions. Island 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, pharmaceutical industries, etc. In the education field, Ph.D degrees in Chemistry, Physics, Marine Sciences and MS in all engineering programs are offered by the University of Puerto Rico. There are three schools of

In addition to the University of Puerto Rico, three large private universities offer degrees in Sciences, Business Administration, and other professional fields. These activities provide a suitable background for the development of R&D projects on energy and environment in Puerto Rico.

The Center for Energy and Environment Research (CEER), previously known as the Puerto Rico Nuclear Center, operates as a single unit within the University of Puerto Rico system, reporting directly to the President. The University of Puerto Rico (UPR) is an island-wide university with over 60,000 students. These students are spread across three large campuses, three four-year university colleges, and five community colleges. The university also includes an agricultural research network and cooperative extension service. The organizational structure of CEER is illustrated in Figure 1.

The DOE facilities associated with CEER 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 Hill site (20 acres) south of Mayaguez and adjacent to the ocean which houses the marine ecology program, (4) Luquillo National Forest or El Verde Facility in the Luquillo Rain Forest which houses a data acquisition laboratory field station and has a 200-acre Use Permit.

A new site has been added recently, consisting of a 15-acre lot within the municipality of Toa Baja in the Ward of Palo Seco, not far from the north coast. This site, recently acquired by the UPR system, has been assigned to CEER for the development of a future Experimental Station for field testing and demonstration of alternative energy sources such as solar, wind, and biomass-conversion.

During the 19-year period from 1957 to 1976, the predecessor to CEER, the Puerto Rico Nuclear Center made significant accomplishments.

Nuclear Center (PRNC), operated a nuclear energy program. One of its main accomplishments was the training of students in nuclear science and technology, nuclear medicine, and health physics. A total of 3560 students and scientists from 41 different countries participated in the various training and research programs. The participants were 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, Formosa, 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, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, and Venezuela. Many of the participants that were students trained in these programs today hold important positions in both government and private industry in their respective countries in the fields of energy and environment. The goodwill and ambassadorship together with the intellectual and know-how accomplishments gained through these training programs are probably the major accomplishment of the CEER predecessor.

The major accomplishment of CHER during the last three years of operation has been the establishment of a base for research and development programs for alternative energy sources and the solution of environmental problems associated with them. Baseline information has been collected, analyzed, and reported for such important programs as the siting of an Ocean. This includes biofouling corrosion and materials studies, measurements of oceanographic environmental studies parameters, seawater surfactant systems, and variability relationships to an open cycle FOAM OTEG System and OTEC Parameter Ocean Spatial Variability. Due to Puerto Rico's geographical location in...

A high-insolation region with sufficient rainfall, good agricultural land, and the availability of facilities and agricultural research scientists, biomass for energy research programs has been under development at CEER and the Agriculture Experiment Station of UPR. Baseline information in relation to biomass includes the development of agricultural technologies and optimization for harvesting large volumes of biomass and their economic and agricultural efficiency. Bioconversion projects producing methane from waste have been developed. Wastes biologically digested together with biomass in an optimized mix, can represent an attractive project from the point of view of integrated energy and environment research in Puerto Rico as well as other areas, including the USA mainland. A demonstration project (waste digestion only) for the US Army at Fort Buchanan has been developed by CHER and is in operation. Important information has been gathered for the design of larger systems. Various methane generators, including newly designed systems to digest rum distilling, have produced important baseline information.

A solar research program cannot be logically developed unless baseline solar radiation data is developed for the area under consideration. Solar radiation data has been under continuous monitoring by a series of CHER measuring stations located in Mayaguez, Cabo Rojo, Lajas, Rio Piedras, Ponce, and Cataño. These data, both global and diffuse, are taken on an hour by hour basis, stored in a computer, and have been mathematically modeled for practical use for research and design applications. Reports have been issued containing this important and vital information. Additional measuring stations are planned to generate more detailed information. An evacuated tube CPC concentrator for producing steam for industrial requirements has been developed by CEER which 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 desiccant air conditioning machine using silica gel have provided basic information for further study and consideration of this important system in the tropics. Air conditioning is a significant electrical load in Puerto Rico, especially in the commercial sector.

In the ecology area, salient accomplishments are the establishment of baseline information for future ecological studies and assessments related to planned energy production and utilization. This has been accomplished through the El Verde Project and the Tallabos-Guayanilla Bay ecosystem study. These are research projects of several years duration that carries over from PRNC programs.

In addition, the ecology section currently has a large role in the ecosystem study for the OTEC site and new site considerations for a coal-fired plant. Health programs form an important part of CEER programs. The main efforts in the past have been in controlling water quality and tropical disease transmission through aquatic systems, such as schistosomiasis. As a result of CEER's efforts, schistosomiasis in Puerto Rico has been nearly eradicated.

Ongoing programs are establishing baseline information required in connection with the correlation of respiratory diseases, cancer, and air quality, as well as the correlation between gastrointestinal disorders and water quality, which are common in Puerto Rico.

Material programs have developed basic information related to improvements and optimization of

fuel cell electrodes, determination of properties of several solar selective surfaces, and material degradation on solar collectors and water heaters in the tropics. A base already exists in the area of materials research in terms of availability of scientists and laboratories.

On integrated technological assessment, energy analysis of various alternative energy sources has been made, providing basic economic information and the period of competitiveness for the timely selection and development of alternative energy sources.

The studies on energy sources indicate that, on a cost basis only, nuclear energy is the lowest-cost energy 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 engineering economic analysis of alternatives is a very important aspect in an energy environment program, and CEER is not overlooking this aspect. Public Awareness, Training, and Education Programs have received very little funding. However, CEER has conducted several significant programs in this area, including an international three-week energy seminar 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 has been accumulated for future programs. CEER also sponsors and participates in many professional-level seminars each year in the areas of energy and environment.

In the Transportation and Conservation Sector, significant economic 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 percent (25%) of P.R.'s non-petroleum imports are spent in the transportation sector. Present studies and experimentation are focused on the feasibility of utilizing electric or hybrid electric vehicles. Both of these vehicles show promise for substantial reduction in gasoline usage due to the predominant high-density traffic in the metropolitan areas.

To keep abreast of the latest developments in energy and environment research, CEER has sent their scientists to visit various research laboratories for discussion of special projects and current research in the areas of prime interest to CEER. Some of these laboratories visited have been ORNL, JPL, SHRI, ANL, IMS, SRL, BNL, Sandia, and LAL. In addition, visits to major university research laboratories have been conducted.

The text has been revised for clarity and grammatical correctness:

Research has also been carried out at various institutions, including MIT, University of Colorado, Colorado State University, University of Florida, Cal Tech, UCLA, University of California- Berkeley, and University of Michigan. In addition to these, significant programs and accomplishments have been achieved at CEER over the past four years.

These include the successful implementation of a magnetic separation program for the removal of pollutants from aqueous waste discharges, tertiary treatment of waste water using water hyacinths, and the use of sludge and hyacinth compost to produce ethane. We have also undertaken joint efforts with the Venezuelan Government to research the feasibility of using a microbial oil

stimulation method in marginal wells producing extra heavy crude oil and the biodegradation of heavy crudes using selected microorganisms.

Careful planning was necessary to achieve these accomplishments at CEER, given the limited funding of approximately \$3 million per year for all programs. Figure 2, titled "Institutional and Developmental Programs FY-1980 Projections and FY-1979 Allocations," illustrates the actual funding distribution across the various programs. Table 2, "Institutional and Development Funding by Project Areas FY-79 and FY-80," shows the current funding distribution by institutional program classification.

Additionally, Appendix B, "CEER Programs," provides a detailed list of "CEER Institutional and Development Programs: FY-77 through FY-80". This includes specific ongoing project funding, project location, and leaders. Sponsored and Competitive Research Programs are also included within Appendix B.

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FIGURE 2: INSTITUTIONAL AND DEVELOPMENTAL PROGRAMS - FY 1980 PROJECTIONS AND FY-1979 ALLOCATIONS

INSTITUTIONAL FUNDING | DEVELOPMENTAL FUNDING
INSTITUTIONAL (GENERAL) | DEVELOPMENTAL (GENERAL)
TRANSPORTATION | OTHER CONSERVATION
PETROLEUM | ENVIRONMENT
BIOCONVERSION | TECHNOLOGY
BIOMASS | SOLAR
20 40 60 60 100 120 140 160 180 200-220 THOUSANDS OF DOLLARS

"QUOTATIONS - Various Quotations - Some Thoughts - What We're Noticing - A List of Things In Order - More Notes and Observations - Onto the Main Topic - Theoretical Considerations - The Situation -

-7- PROPOSED FIVE YEAR (1982-86) PLAN SUMMARY

The proposed five-year plan (1982-86) for the development of alternative energy sources is subdivided into thirteen (13) main subject areas:

1. Biomass
2. Bioconversion
3. Fossil Fuels Research
4. Solar Program
5. Ecology Programs
6. Environmental Health
7. Materials Development
8. Integrated Technological Assessment
9. Nuclear Program

10. Transportation and Conservation

11. Public Awareness

12. International Program

Summary Table S-1 "Total Funding Requirements for Proposed Five Year Plan" illustrates the funding level requirements for each subject program. Total funding requirements average out approximately \$13.7 million per year. This is approximately 3-4 times the average level of CEER funding existing during the last two or three years.

One of the main reasons for the increase is the proposed program budget reflects costlier development and demonstration programs as compared with previous less expensive programs addressed to develop baseline information data. 42% of the total budget goes towards "Development" and only 30% to Basic Research. This last requirement is vitally needed for the development of additional baseline information. Demonstration programs account for 22% of the budget while training and education accounts for less than 6%. No meaningful energy program could be developed without funding comparable to the amount indicated in Summary Table S-1. OTEC is the largest..."

"Budgeted progress (21.5%) is led by Biomass (19.42), followed by Ecology, which interfaces with several of the energy programs, ranking third in budgeting (18.62), and then Solar (9.12). Summary Table \$-2, "Total Program Personnel Distribution," illustrates the total manpower requirements, classified by all programs. For detailed information on manpower requirements per program, see the corresponding Table 2 under the respective program section. The total maximum projected personnel requirements for the program vary between 297-335. The current CEER total personnel count is slightly under 200, indicating an approximate growth of 77% to handle all programs. ORER believes that sufficient physical facilities are available. After decontamination of the nuclear reactor facilities in Mayaguer, the additional available space, in addition to that available at the Rio Piedras facility, should be able to accommodate the projected expansion. Summary Table \$-3, "Total Program Budget Distribution by Type of Research, Development, Demonstration, and Education and Training," shows that the largest component, as previously pointed out, is "Development." For details of budget classification of a particular program, refer to the corresponding Table 3 in the respective program section.

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-2- Summary Table \$-4, "Total Program Budget Distribution Classified," illustrates the total budget classification distribution by personnel, equipment and materials, and services (contracts). Personnel Budget estimates of 50% of the total indicate an adequate and appropriate use of the budget dollars. For details of the budget distribution for a particular program, refer to the corresponding Table 4 in the respective program section."

Figure 3 graphically illustrates the budget distributions. The budget presented does not reflect inflation but includes overhead and fringe benefits. The dollars indicated are from the early 1980s. Not included within the budget is the program on Energy Assessment Studies of Underdeveloped Countries and Technology Transfer in the International Program. This can contribute substantially

to the U.S. efforts. However, it is rather difficult to estimate budget requirements for this program. This will mainly depend on the role played by U.S. agencies and the degree of involvement of CEER in each program. A detailed description with a budget analysis for each program follows.

-2-

FIG.3. CEER 5 YEAR PLAN (1982-86) BUDGET AND PERSONNEL DISTRIBUTION

Budget Distribution by Programs

Type of Research

Distribution by Services

MANPOWER TECHNICAL SCIENTIFIC

Personnel Distribution for 1986

-25- PROPOSED 1982-86

OTEC PROGRAM

R&T, T&G PROGRAM OTRC Studies - Integrated Engineering and Environmental Program

Puerto Rico is blessed with one of the best sites in the world for demonstrating technical and economic feasibility of an OTEC power plant sooner than any other USA mainland site. Efforts in OTEC 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 its funding requirements. In its normal operation, an OTEC plant may be considered to be drawing up water from two depths and discharging it at a third depth as a 'mixed plume' potentially containing a variety of adulterants. The discharge may be regarded as a point source subject to dispersion in whatever the prevailing currents may be, in accordance with the myriad of intake and structural factors which may influence that process. Integrity questions are of the greatest importance in this context.

The vicinity of the structure diminishes in importance with distance; whereas discharge questions may be regarded as increasing in importance to a maximum at some as yet unspecified but discrete distance downstream, beyond which plant influences can no longer be differentiated from the 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. It is mainly the details, emphasis, and applications of the data which differ. Knowledge of currents, temperature structure, water mass chemistry, and dominant biota is required for different reasons.

Both near the plant site and downstream, the CEER research plan for OTEC is designed to develop the above information with the appropriate emphasis on a field study which starts at the specific OTEC Punta Tuna and radiates broadly and with decreasing spatial resolution to encompass an area expected to intercept a plume arising at the OTEC discharge.

Figure I-1 shows the grid of stations lying in a 60-degree arc having its 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 grid and always at the LCU. Temperature, salinity, nutrients, dissolved oxygen, chlorophyll, and phytoplankton profiles will likewise be measured across the grid. Zooplankton will be collected on the same synoptic cruises providing the other biological, physical, and chemical data. On a schedule complementary 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 data, in which spatial and short-term temporal variation will necessarily be confounded. LCU sampling will also emphasize entrainment/impingement potential, the potential for physical stress to structures due to currents and waves, and an evaluation of the thermal resource. LCU studies will further provide a backdrop of potential.

(Text appears to be garbled and in a different language, unable to translate or correct).

Physical, chemical, and biological correlate transfer and corrosion measurements are concurrently being made. Surveys are planned which will define water masses in the vicinity, and by the use of drogues, define a "most probable plume" for purposes of determining which areas and ecological communities most need to be studied downstream. 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 model heat exchanger biofouling, corrosion and heat transfer, and within the most probable plume area on the effects of biocides, heavy metals, and working fluid on organisms residing there.

PROGRAM OVERALL BUDGET (Thousands of Dollars)

A. Evaporator (Biofouling, Corrosion, Materials, Cleaning, and Enhanced Heat Transfer): 250, 300, 350, 250, 150

B. Condenser (Inorganic Fouling, Corrosion, Materials, Cleaning, and Enhanced Heat Transfer):

450, 500, 550, 450, 350

C. Site Characteristics and Ecological Effects (Current Waves, Nutrients, Entrainment, Biocides):
1,200, 1,650, 1,900, 2,050, 2,400

D. Miscellaneous (Riser Cable, Mariculture, Advanced Systems): 300, 350, 400, 450, 500

Totals: 2,200, 2,800, 3,200, 3,200, 3,400

Approximately 400K/year will be used through '85 for the operation of the research facility. The budget assumes the OTEC 10-100 platform will be available in.

FY-86, thus, the research facility operation is reduced to 100K/yr.

TABLE 1-2
PROGRAM PERSONNEL DISTRIBUTION (Man-Years)

Program Titles e838 omc

A. Evaporator
Scientific staff: 12
Tech. Staff: 200
Admin. Staff: 33

B. Condenser
Scientific staff: 20
Tech. Staff: 43
Admin. Staff: 38

C. Site Characterization and Ecological Effects
Scientific staff: 6
Tech. Staff: 7
Admin. Staff: 1

D. Miscellaneous
Scientific staff: 1
Tech. Staff: 27
Admin. Staff: 4

E. Forats
Scientific staff: 10
Technical staff: 16
Admin. Staff: 2

ALL STAFF: 36

*Note: Some man-years/year will be subcontracts for research platform operation and do not show

in this table.

TABLE 1-3
PROGRAM BUDGET DISTRIBUTION BY TYPE OF RESEARCH (Thousands of Dollars)

Program Titles a 83 hOB 86 corse

A. Evaporator

Basic Research: 50

Development: 200

Demonstration: 0

Education & Training: 0

B. Condenser

Basic Research: 100

Development: 350

Demonstration: 0

Education & Training: 0

C. Site Characterization and Ecological Effects

Basic Research: 200

Development: 1,000

Demonstration: 0

Education & Training: 0

D. Miscellaneous

Basic Research: 200

Development: 100

Demonstration: 0

Education & Training: 0

Totals: 550

BIOMASS PROGRAM

BIOMASS PROGRAM

A. Existing Programs

Biomass production research studies on tropical grasses and sugarcane were initiated in 1976 at the UPR Center for Energy and Environment Research (CEER). Sugarcane, tropical grasses related to sugarcane, and other tropical grasses have large growth potentials on a year-round basis in Puerto Rico due to the high insolation rates and

Appropriate soils, along with the available scientific and technical personnel and agronomical laboratories, make biomass research an attractive possibility to aid in solving energy problems. It is

estimated that the struggling sugar industry, currently using over 70,000 acres of land, could be replaced by an economically viable biomass for energy and higher-test molasses (supplying the rum industry's agricultural program). The important rum industry in Puerto Rico imported 90% of its molasses last year. The RGD information resulting from this program is beneficial to many Caribbean Islands, Latin American nations, as well as mainland USA.

The basic premise is that such plant materials can be produced as a renewable, domestic source of fuel and chemical stocks that will substitute for imported fossil fuels. Two annual reports dated 1977-78 and 1978-79 to BOE present the results of two years of research efforts. Fuel costs of the order of \$1.70 per million BTU have been predicted with year-round production of tropical grasses.

The project objectives of this program have been: (a) determining the agronomic and economic feasibility of mechanized, year-round production of solar-dried biomass, through the intensive management of sugarcane and napier grass as tropical forages, and (b) examining alternate tropical plants as potential sources for intensive biomass production. A secondary objective concerns the selection and breeding of new sugarcane progeny having superior biomass productivity as their principal attribute. It is estimated that this program needs to continue at the current funding level of approximately \$400,000 per year up to the year 1984-85.

New Program: B. Hydrocarbon Producing Plants

While tropical grasses (sugar cane-S, *Officinarum* x S, spontaneous) and napier grass (*Pennisetum purpureus*) have impressive production records in Puerto Rico, they require larger water demands than hydrocarbon-bearing plants of the *Euphorbia*, *Asclepias*, and *Guayule* families.

Fresh water requirements for tropical grasses necessitate water with less than 500 ppm salt content. On the other hand, hydrocarbon-producing plants might thrive with water containing as much as 2000 ppm salt content. These plants are very rugged and might adapt better to the more hostile environments of southwestern Puerto Rico and southwestern U.S. desert areas. They can also grow better on steep slopes.

The chemical components extracted from the hydrocarbon-producing plants of the families indicated above are more valuable than the heat content of the fibers. Even after the hydrocarbons, which are mainly polymers of isoprene, are extracted, the resultant fiber can still be used as biomass fuel with 7000-7500 BTU per dry pound. Approximately 20% by weight of isoprene polymers can be extracted from these plants.

Puerto Rico has about 65 species of 10 families of such hydrocarbon-producing plants. Imports can also be made from Brazil, other South American countries, and the western USA, mainly California.

The principal objectives of the project will be:

(a) the identification of the most promising candidates for detailed studies of selection and breeding of suitable hydrocarbon-bearing plants progeny with superior isoprene polymers productivity as their principal attribute. Included within this objective are laboratory studies for the characterization of the isoprene polymers and evaluation of their conversion into useful motor fuels and chemical

feedstocks.

(b) determination of the agronomic and economic feasibility through intensive management of hydrocarbon-bearing plant plantations. Some effort is presently being performed at CEER in this area, with samples being collected from local hydrocarbon-producing plants and analyzed.

The level of funding is estimated as follows: 82K, 83K, 150K, 200K, 400K, 50K, and 500K.

It is estimated that a technical staff of seven agronomists and one organic (hydrocarbon) chemist will be involved in this project.

C. Seaweed, Farming, and Harvesting.

Although land used for uneconomical agricultural programs such as sugar cane could be made economically productive in a combined biomass for energy program as previously indicated, harvesting the seas makes more sense for Puerto Rico and many other small Caribbean islands than land biomass. This research study will also address the possibility of developing and harvesting tropical marine algae, including sargassum. Using available data and direct simple observation, a very preliminary assessment will be made. Two factors are important for the development of a marine farm: 1. Water depth 2. Water current 3. Available nutrients.

Water depth above 200 ft. results unsuitable for the development of any type of marine algae. Marine kelp, a red algae can thrive in depths up to 150 ft. They require relatively slow water motion. Abrupt water current changes produce serious obstacles to the thriving of these algae. The study will try to identify any appropriate marine areas which could be used for detailed studies and further definitions and roughly estimate its potential values. It is estimated that a technical staff of 3-4 scientists will be involved. The level of funding is estimated as follows: 82 83 84 85 86 100K, 150K, 200K, 300K, 400K. Direct Firing of Biomass (Tropical Grasses and Sugarcane) Solar-dried biomass is contemplated for direct firing in conventional waterfall steam boilers in central electric power plants. The BTU content of dried (152) sordan is approximately 7500 BTU/lb or 15 million BTU per ton. It is estimated that a 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 million barrels of Bunker C oil. This will require 55,000-60,000 acres of land. By contrast, the ailing sugar cane industry in Puerto Rico has over 70,000 acres of sugar cane plantation. Sugarcane production in Puerto Rico is uneconomical at present.

Land was government-owned.

The text was subsidized last year to the approximate figure of \$500 per acre of sugar cane plantation. Economic analysis indicates that direct biomass firing can be economically more attractive than oil, coal and OTEC plants in the Puerto Rico scenario. For the year 1990, CEER energy studies analysis indicates that direct firing of biomass in Puerto Rico in 450MW units can produce electricity with a levelized cost of 9 cents per kWh including 8% compounded inflation up to 1985 and 5% per year compounded inflation thereafter. For the same escalation assumptions and year, 450MW coal-fired plants can produce electricity at the lowest estimated cost of 12 cents per kWh levelized cost, while a 250MW OTEC Plant will be over 14 cents per kWh levelized cost.

An oil-fired plant is estimated to produce energy at a levelized cost of 46 cents per kWh assuming a 9% per year inflation in oil costs.

Program D Objectives: The principal objective of the direct firing program is to convert an existing sugar mill to handle 1000 tons of biomass per day, and determine the logistics of production, varying, transportation, storing, and burning of biomass, and technical modifications and improvements to boiler handling and burning equipment, and particulate and gaseous emissions characteristics. Electric power utilities will therefore be able to incorporate these steam boiler bids specifications.

There will be enough technical data for specifying steam boilers to burn biomass and design other items such as storage and handling equipment accordingly. The project will be divided into four principal phases as follows: (a) Installation and costing of a biomass dryer phase. The Steam-Roger Company of Denver has previously installed a rotary dehydrator in sugar mills on the US mainland and Hawaii. This unit will be a rotary dehydrator utilizing waste heat from the mill stacks. It must be capable of drying large daily tonnages to 40% moisture and lesser amounts to 15-25% moisture. The atmospheric emissions produced from such a plant will be compared to those from

Direct Firing of Biomass 3,500 1,380 1,380 1,380 1,380 Rotors 4,150 2,130 2,380 2,380 2,280

Table 11-2 Biomass Program Personnel Distribution (Man-Years)

Existing Tropical Grasses Biomass Program:

Scientific Staff: 8, 83

Technical Staff: 4, 4

Administrative Staff: 3, 3

Hydrocarbon Bearing Plants:

Scientific Staff: 2, 3

Technical Staff: 1, 2

Administrative Staff: 0, 0

Seaweed Farming and Harvesting:

Scientific Staff: 2, 2

Technical Staff: 1, 2

Administrative Staff: 1, 0

Direct Firing of Biomass:

Scientific Staff: 45, 45

Technical Staff: 3.0, 3.0

Administrative Staff: 1.0, 1.0

Totals:

Scientific Staff: 15

Technical Staff: 10

Administrative Staff: 4

All Staff: 10

Table 11-3 Program Budget Distribution by Type of Research

Existing Tropical Grasses Biomass Program:

Basic Research: 20, 200

Development: 200, 200

Demonstration: 0

Education & Training: 0

Hydrocarbon Bearing Plants:

Basic Research: 150, 200

Development: 200, 200

Demonstration: 0

Education & Training: 0

Seaweed Farming and Harvesting:

Basic Research: 100, 150

Development: 50, 150

Demonstration: 0

Education & Training: 0

Direct Firing of Biomass:

Basic Research: 0

Development: 0

Demonstration: 3,500, 1,380

Education & Training: 0

Totals:

Basic Research: 450, 350, 550, 550, 550

Development: 200, 200, 450, 450, 350

Demonstration: 3,500, 1,380, 1,380, 1,380, 1,380

Education & Training: 0

Table 11-4 Biomass Program Budget Distribution - Classified (Thousands \$)

Existing Tropical Grasses Biomass Program:

Personnel: 200

Equipment and Materials: 150

Services: 50

Hydrocarbon Bearing Plants:

Personnel: Varying

Equipment and Materials: 50

Services: 25

Seaweed Farming and Harvesting:

Personnel: 60

Equipment and Materials: 30

Services: 10

Direct Firing of Biomass:

Personnel: 313

Equipment and Materials: 2200

Services: 987

Toras Personnel: 648

Equipment and Materials: 2430

Services: 1072

Torats: 4150

83, 200, 150, 30, 15, 30, 25, 100, 35, 3, 313, 96, 738, 331, 1061, 2130, 200, 150, 50, 200, 100, 100, 100, 50, 50, 313, 13, 396, 87, 2380, 85, 100, 75, 25, 200, 200, 100, 15, 100, 65, 83, 96, 78, 21, 2380, 200, 200, 200, 100, 100, 313, 83, 396, 87, 2280, 3660, 4026, 5636, 13,320

BIOCONVERSION PROGRAM

BIOCONVERSION PROGRAM METHANE

It is rapidly becoming apparent that Bioconversion may be one of the key components in the resolution of the critical energy problems facing the world at present. In addition, judicious choices of the operational parameters of this process can contribute to no small extent to the amelioration of the agricultural and protein shortfalls in many parts of the world. Although the basic elements of bioconversion are well known, and in fact have been successfully employed for centuries, it is necessary to study and develop techniques and devices which can be integrated into modern mass production methods to produce simple, low-cost systems. These must be compatible with the technological and economic constraints of the Third World and developing countries, and those sectors of the industrialized nations where isolated appropriate technology concepts are still applicable. Our institution has been following, as much as possible, these guidelines in the design and prototype testing of anaerobic digestion systems for a variety of substrates. After a comprehensive survey of the literature and an assessment of the low-level decentralized energy needs of Puerto Rico and other less developed areas of the Caribbean, designs were developed for a series of bioconverters, some of which have already been constructed and are operational. The primary consideration was in maximizing the conversion of

The most commonly available biomass and each bioconverter was designed for a specific substrate. The systems tested and showed to produce usable methane (and other valuable products).

By-products are used as substrates, such as water hyacinths, agricultural waste, and animal (poultry and ovine) cafeteria refuse and rum slops. At present, continuously operating 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 in operation at the Fe. Buchanan Array Base in cooperation with the Array Environmental Research Program. Preliminary assessment is underway of the potential of the marine algae Sargassum as a bioconversion substrate. With the cooperation of the Goddard Space Laboratories (Bethesda) of NASA, a series of satellite photographs of the Sargasso Sea were made available and are currently being examined.

Another area currently being explored is the potential of municipal refuse deposits as a source of naturally generated methane in appreciable quantities. Designs have been made for an experimental methane tapping system and it is expected that this will be functional early in 1980. In addition to the experimental work, the staff of the Bioconversion Program has been active in a number of conferences, locally and on the mainland, relating to Bioconversion. Presentations were made of the Division's project and concepts. At present, there are also a number of proposals to various agencies now under consideration for future funding of continuing efforts in all areas of bioconversion.

Preliminary studies have been initiated in other areas of bioconversion such as biophotolysis, hydrogen production and assessment of hydrocarbon plants as fuel producers. After completion of literature studies, experimental operations, as indicated in the following pages, will be initiated. The specific objectives of the Bioconversion Program are to produce, use and demonstrate the technical and economic feasibility of fermentative biogas production from locally available biomass in decentralized, low technology operations. Also, to instrument and monitor existing or newly constructed biogas production.

Marine Biomass Program: This program aims to demonstrate the marine environment's potential for biomass and biogas production. The program is expected to last for 8 years, with approximately 18 person-years required.

Information Transfer Program: This program is focused on transferring appropriate technology information to local personnel. As a continual program, it requires approximately 1.5 person-years annually.

Light-Activated Biologics Proton Pumping Program: This program investigates the feasibility of utilizing the light-activated protein pumping characteristics of the purple membrane segment from halophilic bacteria in constructing a functional and useful biological analogue of the photovoltaic cell. The program is expected to last for 5 years, with approximately 10 person-years required.

Bioconversion Screening Program: This program aims to evaluate various bioconversion processes for energy or environment conservation. The program is expected to last for 6 years, with approximately 13 person-years required. Tables IL-4 indicate the budget distribution for these programs.

Bioconversion Ethanol: Puerto Rico, and particularly the University of Puerto Rico, is well-suited for conducting fermentation ethanol studies with sugarcane. The island has a long history of conventional cane production in support of the sugar-refining and distillery industries. There is a

natural capability for year-round harvesting of sugarcane, which would provide a continual influx of raw juice and eliminate the need to produce and store molasses for off-season fermentation. Several divisions within the UPR framework are ideally qualified for specific contributions to ethanol research. The Agricultural Experiment Station can readily supply the input cane from both conventional and energy plantation growth regimes. The Experiment Station's Rum Pilot Plant has a range of fermentation facilities and technical personnel long acquainted with fermentation research. Other personnel from the UPR Department of Chemical Engineering are available to support ethanol studies. Puerto Rico's Sugar Corporation, a unit of the local government, is also a potential resource.

Department of Agriculture can also contribute to sugar production and fermentation studies.

[ETHANOL PROJECT]

The Ethanol project would evaluate ethanol production costs utilizing sugarcane juice and high-test molasses as direct sources of fermentable solids. Emphasis would be directed towards minimizing production costs by utilizing a one or two-step milling operation, reduced fermentation time, 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 economic assessment of processes using crude juice as a direct source of fermentable solids, as opposed to the more costly preparation of stable high-test molasses, is regarded as an important phase of the proposed project. For this purpose, the Vogelbusch approach is ideally suited since the fermentors are closed systems working with yeast recycling. This assures that alcohol losses are negligible and contamination is minimized.

By evaporating the clarified juice to a 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 rum production, the added cost impact may be marginal. In the latter instance, the molasses is ordinarily transported to a rum distillery site, and hence the increased shipping charges for raw juice would offset some of the savings expected from direct fermentation of the juice.

For practical purposes, it will be better to perform the ethanol production operations directly at the milling site. This will minimize transportation and storage costs and the need for storage facilities.

Distillation process: The conventional distillation has as its object the purification and concentration of ethyl alcohol by using a system comprised of three columns. The...

Purification and rectification columns are used in this process. Waste streams, termed "slop", consist of water or water containing solids in solution or suspension. In the usual distillation process for rum, by-product streams include "fusel" (mixtures of alcohols with substances having more than two carbon atoms per molecule), and "heads" (mixtures of aldehydes, ketones, esters, acids, and

amines). The separation of these components from ethanol is a cost factor which probably is not necessary in a fuel-production process. An important feature of the proposed project is the evaluation of means whereby this step can be minimized or eliminated.

Project Objective:

The primary objective of this project is to evaluate the direct production of ethanol from sugarcane fermentable solids in an integrated system, with emphasis on modified technologies and economization of the integrated processes.

Project Approach:

The necessary tasks to achieve this goal are:

1. A pre-milling preparation of cane, followed by one or two milling steps aimed at the extraction of maximum recoverable fermentable solids.
2. An economic evaluation of the suitability of crude juice as a fermentation substrate, as opposed to high test-molasses.

1-9

A short time fermentation technology based on continuous fermentation and the development of economical techniques to extract the ethanol product. The task is to perform an economic analysis of the various steps, including an assessment of the major implications of the integrated processes, and to make recommendations applicable to industrial-scale production of ethanol.

3

BIOCONVERSION PROGRAM TOTAL BUDGET

Biogas Demonstration
Commercial Monitoring
Alternative Waste Utilization
Industrial Energy Production
Biophotolysis
Marine Biomass
Information Transfer
Light Activated Biological Pumping
Bioconversion Screening
Coral Table T1-1a (in Thousands)

"Break - New Table 1-2a: Bioconversion-Budget by Personnel Distribution

Project A: Biogas Demonstration
Scientific Staff
Technical Staff
Administrative Staff

Project B: Commercial Monitoring
Scientific Staff
Technical Staff

Administrative Staff

Project C: Alternative Waste

Scientific Staff

Technical Staff

Administrative Staff

Project D: Industrial Energy Production

Scientific Staff

Technical Staff

Administrative Staff

Project E: Biophotolysis

Scientific Staff

Technical Staff

Administrative Staff

Project F: Marine Biomass Conversion

Scientific Staff

Technical Staff

Administrative Staff

Project G: Information Transfer

Scientific Staff

Technical Staff

Administrative Staff

Table 1-2a (Continuation)

Project H: Light Activated Biological Proton Pumping

Scientific Staff

Technical Staff

Administrative Staff

Project I: Bioconversion

Scientific Staff

Technical Staff

Administrative Staff

Total Staff

Table II-3a: Budget Distribution by Type of Research

Project A: Biogas Demonstration

Basic Research

Development

Demonstration
Education & Training

Project B: Commercial Monitoring
Basic Research
Development
Demonstration
Education & Training

Project C: Alternate Waste
Basic Research
Development
Demonstration
Education & Training

Project D: Industrial Energy Production
Basic Research
Development
Demonstration
Education & Training

Project E: Biophotolysis
Basic Research
Development
Demonstration
Education & Training

Project F: Marine Biomass
Basic Research
Development
Demonstration
Education & Training

Table II-3a (Continuation)

Project H: Light Activated Biological Proton Pumping
Basic Research
Development
Demonstration
Education & Training"

Section IV. 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, we need to fully understand all the associated problems related to the production and consumption of petroleum and other fossil sources in a tropical environment. CEER, for the last two years, has initiated a program in fossil fuels oriented to explore the biodegradation of non-conventional hydrocarbon mixtures under aerobic and anaerobic conditions.

Duly motivated scientific personnel, laboratory facilities, baseline data, and intimate personal and professional links with scientists from government laboratories, universities, and decision-makers interested in the development of non-traditional sources of hydrocarbons is available. In addition, Puerto Rico now faces the attractive possibility of finding petroleum on the north coast as a result of basic and detailed geophysical studies, making the fossil fuels research program a venture well worth exploring.

The Fossil Fuels Research Program mission, goals and objectives:

The Mission: Improve our understanding of the environmental impacts and the technology associated with the production, upgrading, and consumption of fossil fuels, knowledge of the potentially serious risks that these fuels present to the public health and the environment, and the possible technological alternatives to improve their production, upgrading, and consumption.

The Objectives: 1. Develop a systems perspective of the health and environmental aspects which could result from research work associated with the production, upgrading and consumption of fossil fuels and to take the necessary steps required to increase the availability of hydrocarbon sources to protect public health and the natural environment.

2. To explore the chemical and physical nature of fossil fuels with an orientation to improve their production, upgrading, and consumption.

3. To explore the

Technological aspects are associated with the production, upgrading, processing, and consumption of non-conventional fossil fuels. This includes investigating the microbial biochemistry associated with the biodegradation of hydrocarbons and their heterocompounds in nature. The goal is to improve this process under controlled conditions and look for potential applications in the areas of enhanced oil recovery and the disposition of fossil fuel derivatives in a tropical environment.

Page Break

The next objectives are 4) to predict and control toxic substances associated with the production, upgrading, and consumption of fossil fuels, and 5) to integrate molecular, biochemical, structural, and physiological data in order to understand the essential nature of environmental disease as a result of the continuous and increasing use of fossil fuels.

The study titled "Fractions by Microorganisms and its Application to Enhanced Heavy Oil Recovery," discusses the production and upgrading of heavy and extra heavy crude oils. This represents a technological problem and a strategically valuable source of energy. To help reduce the environmental impacts involved in the commercialization of such new energy sources and to

define its full potential in the enhancement of oil recovery, it is proposed to continue exploring the biodegradation of sulfur compounds and heavy petroleum fractions by selected groups of microorganisms.

Microorganisms from two sites in Puerto Rico (Conco and Gulf Refineries) and impregnated soils from heavy petroleum producing fields in Venezuela (Orinoco Petroleum Belt and Lake Guanoco) are currently under study, with routine sampling for hydrocarbonoclastic microorganisms by direct plating and enrichment culture. A salts medium supplemented with yeast extract is used to provide conditions for aerobic petroleum degradation and various media containing peptone or thioglycolate are in use for the anaerobic, S producing biodegradation. The use of a 350-525°C high sulfur aromatics fraction (Morichal crude oil) and a

Page Break

correspondingly low sulfur-high

Paraffinic substrate (Hana Anal crude) as well as bentothiophene permits the comparative assessment of the isolated microorganisms. The biodegradations are monitored by three different parameters: the actual disappearance of the substrate from bacterial cultures, the increase in the oxygen uptake by the bacteria in presence of the compounds, and by comparisons of the chromatographic analysis of the bacterial culture. From that perspective, we will study the extent and full effects of bacteria in a petroleum reservoir. Our intention is to establish the basic criteria for evaluation of wettability of oil formations to bacterial treatment. It is known that water-flooded oil reservoirs of high porosity and permeability hold the most promise for positive results, as bacteria can effectively penetrate such deposits and carry out their reactions in situ. In addition, aerobic microorganisms can grow in the earth, at the expense of petroleum, down to depths of 7-9000 feet. We propose to study the controlling factors in such biodegradations.

Objectives of this Project:

1. Optimize the growth conditions of the organisms that utilize or grow in the presence of petrosulfur compounds or components separated from high sulfur containing crude oil fractions.
2. Provide an assessment of aerobic-anaerobic dual systems involved in the degradation of synthetic mixtures of organo-sulfur compounds, high sulfur crude oils or refinery wastewaters.
3. Develop detailed mechanisms for joint efforts with the Venezuelan government.
4. Field tests on the in situ biodegradation of heavy crudes utilizing selected microorganisms.
5. Establish the practicality of the microbial stimulation method for marginal wells and/or wells producing very heavy crudes and selected from Venezuelan fields.

Rationale for Selected Approach:

From previous knowledge, several points should be taken into consideration. Laboratory and simulated field studies demonstrate that hydrocarbonoclastic bacteria's ability to degrade

hydrocarbons is related to the

Degree of hydrocarbon pollution at the isolation site. Evidence indicates that isolates from the polluted sites effect greater degradation and that oil degradation is enhanced, especially in the presence of sufficient nitrogen and phosphorus.

A single microorganism will not possess the enzymatic capacity to metabolize all of the many compounds present in crude oil. Compared to the saturated fraction, the aromatic fraction is less easily biodegraded, susceptibility decreasing as the number of aromatic or alicyclic rings in the molecule increases with sulfur-containing aromatics roughly twice as recalcitrant as their non-sulfur analogues.

The presence of several bacterial isolates obtained from oil-contaminated environments from Puerto Rico and different areas of Venezuela's Orinoco Petroleum Belt and Lake Guanoco was noted.

These organisms are able to grow and/or degrade benzothiophene and crude petroleum fractions. Anaerobic bacteria which produce H₂S from organic sulfur compounds, as well as from crude oil, residue oil, and asphaltenes, have been obtained from oil wells or bottoms of crude oil reservoirs and refinery water treatment sediment.

Specific aims: Since the basic analytical methodology has been developed and a collection of hydrocarbon degrading organisms is available, it is proposed to:

Isolate and characterize quantitatively the petroleum degrading capacities of the more capable aerobic and anaerobic microorganisms.

Study compositional changes originated by the anaerobic digestion of heavy petroleum fractions and model sulfur compounds before and after aerobic digestion and vice versa.

Study appropriate methods for injection and recovery of cultures and microbe product mix respectively.

Establish an inventory of failure-causing problems and troubleshooting measures.

Monitor and control measures needed to ensure the maintenance of the desired microbial activities.

Test the biodegradation.

Unusual Features: The presence of at least 15 bacterial isolates were identified during degradation.

Products for mutagenicity and teratogenicity are obtained from heavily polluted sites and are capable of growing in the presence of, and degrading, different fractions of crude oil.

We appreciate the convenience of having access to basic information regarding the Venezuelan Orinoco Petroleum Belt and Lake Guanoco high sulfur extra heavy oil reservoirs. The long-standing personal relationship existing between the key energy officials of the Republic of Venezuela and our research group allows us to collect onsite Venezuelan soil microorganisms adapted to heavy oil environments and to initiate much-needed research on production and environmental aspects of heavy crudes under the sponsorship of the Federal Department of Energy. This fact opens up an

excellent opportunity for more ambitious cooperative agreements in areas of mutual interest involving the United States, Puerto Rico, and the principal South American oil producer (i.e., microbial useful in enhanced oil recovery).

This project represents the first and only project ever conducted in Puerto Rico involving research on the production and environmental aspects of high sulfur heavy oils and petroleum composition. It is a basic undertaking from which local scientists could start contributing to our fossil energy problems, particularly if commercial crude oil deposits are found on the North Coast of Puerto Rico.

Benefits of Proposed Work: It is known that crude oil and petroleum products discharged at the water surface are rapidly modified under the effect of physico-chemical and biological transformations, themselves closely dependent on ecological factors. Advancing on that experience, this research in progress will help:

1. Understand the microbial degradation of heavy crudes and/or heavy oil fractions when discharged into the environment; particularly the anaerobic degradation of hydrocarbons, something of great significance to understand the formation and alteration of fossil organic materials.
2. Increase knowledge as to how specific... (the text cut off here).

"Heavy oil might behave subsequent to a spill, before the spill takes place in order to anticipate the consequences. We aim to understand the behaviour of aromatic sulfur heterocompounds in petroleum, a substrate hard to biodegrade, when exposed to microorganisms adapted to grow in the presence of high sulfur heavy crudes, and/or model petrosulfur compounds. We also aim to improve our knowledge on the treatment and disposal of effluents and industrial wastes and enhance our understanding of microbiological processes useful in enhanced oil recovery. We will evaluate the relative toxicity of biodegradation products from heavy oil fractions of low and high sulfur content and explore health and safety considerations associated with the handling of large amounts of cultures under field conditions.

Project: Comparative Toxicities of Petroleum Water Soluble Fractions and Biodegradation Products on Tropical Marine Organisms. This project will provide results on a two-year laboratory study of the effects of petroleum fractions on selected tropical marine organisms. The fractions of interest will also be subjected to the action of petroleum-degrading microorganisms isolated by culturing in aromatic substrates. The study will be conducted by a multidisciplinary team of researchers from the Center for Energy and Environment Research in San Juan, Puerto Rico.

Since increasing awareness is present about the need for information on the effects of crude oil on tropical marine organisms and particularly the effects a release of crude oil will have on commercially important species of marine organisms, we have decided to employ well-characterized fractions of crude oil, 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 oil to the action of petroleum-degrading microorganisms and compare the relative toxicities of the resulting WSF, and to conduct histopathological..."

Effective analytical techniques will help us unravel the difficult problem of identification and quantification of the water-soluble test fractions, and the rate and degree of uptake and depuration of hydrocarbons by tropical marine organisms.

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 oils utilizing both static and flow-through techniques.
2. To determine the relative importance of individual fractions of saturates, mono-aromatics, di-aromatics, acid, basic, nitrogen, and sulfur concentrates in regard to the acute toxicity of the test organisms under various conditions of temperature and organic substrate concentrations.
3. To conduct detailed chemical characterizations of the test solutions at various times during the experiments and to test for selected species, so that the longer periods of time for relationships between oil concentrations that are toxic for short and long exposures can be determined.
4. To expose selected crude oil fractions to petroleum-degrading microorganisms in order to study the relative toxicities of their water phase soluble products.
5. To conduct histopathological observations and to determine the rate and degree of uptake and depuration of hydrocarbons by species of marine organisms when they are exposed to sub-lethal concentrations of the water-soluble fractions of Venezuelan and Libyan high boiling distillates.
6. Subordinate objective: To compare the results obtained in this study with those reported for the temperature zone. Care must be taken since there will be differences in test oils, temperature, salinity, and test procedures.

Benefits and/or Expectations

4. Heavy and light crude oils like the ones to be used here are refined in Puerto Rico and the effects of oil spills on certain tropical marine organisms may be predicted. This will improve our

Understanding of hydrocarbon uptake and depuration by marine organisms. B. The relative importance 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 such as how oil concentrations change with time will be recognized. As a result, information on the families of compounds that occur in the test mixed substrates and suspected of having deleterious properties will be gathered. C. Toxic effects of biodegradation products will be assessed using well-defined substrates, single or mixed cultures of microorganisms, and test marine specimens. 4. Better

understanding of the role of microorganisms in resolving oils from the marine environment.

For example, man's activities, which introduce excess nutrients along with other pollutants into lakes, streams, rivers, and estuaries are causing significant changes in aquatic environments. Excess nutrients greatly accelerate the process of eutrophication and putrescible organic matter such as domestic sewage also reduces dissolved oxygen concentration and the number of species while a few species become exceedingly abundant. On the other hand, when other contaminants containing toxic substances are introduced into a river with inadequate dilution, most life is eliminated. Environmental effects of oil pollution and bioassays on the toxicity of oil and its components have been limited mainly to the Temperate Zone, whereas in the tropics where environmental conditions are quite different, practically no 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.

Due to continuous exposure to oil, an ideal location for study is the Caribbean Gulf Refining Corporation (Gayanén) and its surrounding environment. Subsequent detailed studies should include hydrocarbon concentrations accumulated in organisms, bottom sediments, and water, as well as bioassays and mutagenesis.

In 1955, the Esso Refining Company (Bayangn) was established and was later acquired by the Caribbean Gulf Refining Corporation in 1962. From 1962 to 1977, Ecuadorian crude oil was commonly processed and during the past two years, a mixture of Santa Rosa condensate and Leona crude oil from Venezuela has been refined. At present, about half a million gallons of wastewater per day are discharged into a freshwater stream, namely, Las Lajas Creek. This creek unites with the Malaria Control Canal (Las Cucharitas Canal) before discharging into San Juan Bay, covering a total distance of 4 river km. Personal observations and reports from residents living along the Malaria Control Canal noted that surface water oil films in the canal are common. Apparently, there are no other industrial discharges in the effluent pathway of the Gulf Refining Corporation. Some results of the proposed study will be compared with those of a previous ecological survey.

Objectives of this Project:

1. To determine the levels of hydrocarbons in the tropical freshwater effluent pathway of a petroleum oil refinery that would be tolerated by certain organisms, in order to set permissible level guidelines. Special emphasis will be placed on the concentrations of total saturates, polars, and aromatics in bottom sediments, water samples, and tolerant organisms associated with these components of the oil refinery effluent.
2. To identify organisms which may be used as indicators of oil pollution.
3. To monitor sensitive species observed at control stations in the freshwater stream exposed to the oil refinery effluent.

Results and/or Benefits Expected: Implications of the proposed research

The following text has been corrected:

The pollution originating from petroleum production and refining operations, environmental impacts associated with coal-consuming power plants, and the chemical characterization of bottom sediments in heavily polluted water bodies are significant. Profitable knowledge should be gained from this experience.

The project, "Biological Degradation of Sulfur Construction Materials and the Effect of Microbial Inhibitors," will involve *THIOBACILLUS THIOEIDANS*, a bacterium implicated in the degradation of concrete. This bacterium will be added to sulfur concrete bars, sulfur-based composite coatings for concrete protection, and to a Calgary "Pronk" sulfur asphalt. Samples to be used in the work will be supplied by local and foreign private firms.

The test bars will be immersed in a sulfur-free synthetic sales medium at 26°C. Changes in the pH of the medium, in bacterial cell numbers, and in the flexural strength of the test bars will be determined. We will also study the presence of any surface etching in the test specimens. Commercial biocides will be selected and incorporated into the sulfur composites, and their inhibition properties studied, as well as any leaching of the bactericide into the medium. The leaching effects of the inhibitor in the sulfur concrete will be considered as a function of the type of composite formulation. Finally, an Ames Mutagenicity Test of the biocides of interest will be made to assess any potential environmental effect associated with the biocides in sulfur composites.

The composites of interest are new technology materials with potential impact on energy conservation. They present unique advantages for the protection of masonry, concrete, and other surfaces exposed to the corroding effect of sea water, for mining water impoundment ponds, etc. Sulfur coatings and concretes show great resistance to acids and salts, having other physical and structural properties of great potential as a material for special applications in regard to the OTEC project.

Principal Objectives:

1. To delineate the extent of...

1. Study the biodegradation of sulfur composites under laboratory controlled conditions and tropical field conditions in the presence of sulfur-oxidizing bacteria and/or anaerobic and reducing bacteria.

2. Establish the populations of sulfur-degrading microorganisms, pH, and sulfate levels in the media at different periods during the experiments. This will help define what significance this may have on the performance of the composites in their intended end use.

3. Explore the effect of several commercial bactericides to protect the sulfur composites from biodegradation, and to see if they leach out of the composite or affect the structural strength of the material. Test any effective microbial inhibitors to be used in this study for mutagenicity.

4. Subordinate Objective: Generate badly needed information on the short and long term exposure to microbial organisms of selected sulfur composites of commercial importance. These materials already have attractive potential insulating and/or constructional applications by utilizing the low

thermal conductivity of sulfur and/or the ability of sulfur to act as a bonding cement. The importance to energy conservation and to the recycling of a valuable element in growing over supply as a result of the increasing consumption of high sulfur natural gas and petroleum is obvious.

Project E: The Characterization of Airborne 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 spectrometric means. Initial efforts will be dedicated to explore the peculiar toxicological potential of the emissions produced in the South Coast petroleum petrochemical complex, followed by similar studies in the Cataño Industrial Park. Baseline studies associated with recently proposed coal-operated power-plant will be pursued as a result.

Of the initial work, special effort will be dedicated to establishing the size distribution of airborne particulates and identifying the nitrogen and sulfur containing polycyclic aromatic hetero-compounds, volatile hydrocarbons, and potentially toxic trace elements. Associated mutagenic and teratogenic effects of selected fractions will be studied in an effort to define these toxic properties. This will help in predicting potential hazards concerning human health. Knowledge of computer simulation, uses and modeling, composition and size distribution of particulate material, chemical transformation of pollutants and its associated toxicological effects will support biomedical studies in Puerto Rico dealing with a very wide spectrum of personal discomfort and illness.

Objectives of this project:

a. Principal Objectives

1. Initiate a systematic effort to characterize potentially toxic elements and organic constituents (especially sulfur and nitrogen derivatives) downwind and upwind of the neighborhood of a petroleum petrochemical complex.
2. Correlate the principal families of compounds (group-type analysis) detected with their possible mutagenic and teratogenic effects. Extracts from particulate matter of various sizes will be obtained and evaluated for biological activity.
3. Improve our knowledge of sources of toxic substances by studying airborne particulate composition with an orientation to establish (a) if the particulate matter in the south coast industrial complex is responsible for impacting the atmosphere from neighboring cities downwind from the complex and (b) if the particulates bearing these contaminants are small enough to be deposited efficiently in human lungs.

b. Subordinate Objectives

4. Employ air pollution computer simulation methods to correlate the chemical nature of the contaminants with the prevailing meteorology of the region.
5. Conduct research in areas remote from immediate sources of pollution to provide background values in areas directly unaffected by point sources.
6. Train personnel in these areas.

Research scientists and students seek to advance environmental health research by developing an interdisciplinary research program to increase our knowledge of toxic substances in the

environment. This project aims to:

1. Improve our knowledge of the chemical composition of the volatile hydrocarbons and the acidic, basic, neutral, and polar fractions isolated from airborne particulates in the vicinity of a petroleum-petrochemical environment. This is necessary to obtain a better understanding of the potential health hazards associated with the transport and penetration of particulates into the respiratory system from petroleum or coal-consuming operations.
2. Measure both the size distributions and chemical composition of particles in ambient air, in order to understand the sources and behaviour of airborne particulates in the atmosphere. Observations on size distributions of trace elements and/or key organics in particulates, if sufficiently distinctive, could be used as a means of source identification if data on size distributions of particles from specific types of sources were available.
3. Correlate toxic properties such as mutagenic and teratogenic effects with the chemical composition of selected test fractions.

The proposed research will also be of significance to:

1. Cancer epidemiology studies underway in Puerto Rico as well as field, clinical, toxicological or laboratory investigations to be undertaken as a result of this effort.
2. Help initiate work towards establishing a damage function for the Guayanilla-Penuelas area. This will serve to stimulate Puerto Rican researchers in planning studies oriented to characterize the nature and magnitude of the population at risk affected by given levels of pollutants.
3. Strengthen the infrastructure for complex compositional studies related to the atmospheric emissions arising from coal or coal-oil slurry combustion power plants. These fossil fuels are alternatives presently under the active consideration of our government.

Energy Policy Makers. Studies on the nature of air emissions will affect decisions regarding control techniques after combustion.

4. Provide public officials with an effective database for efficiently allocating limited resources among the many conflicting demands for pollution control and other aspects of social welfare.

©. Act as a vehicle for the training of environmental health scientists and for continuing mission-oriented research in Puerto Rico.

Rationale for Selected Approach.

Table 1-2 [FOSSIL FUELS RESEARCH PERSONNEL DISTRIBUTION (MAN YEARS)]

Project A

Scientific Staff: 3.75, 6.00, 6.0, 6.0

Tech Staff: 0.0, 1.0, 0.6, 1.0

Project B

Scientific Staff: 1.5, 0.75, 0.75

Tech Staff: 0.5, 0.5, 5.0

Project C

Scientific Staff: 1.5, 2.5

Tech Staff: 1.0, 2.0

Project D

Scientific Staff: 1.5, 0.75

Tech Staff: 0.5, 2.0

Project A: Basic Research, Development, Demonstration, Education & Training

Project B: Basic Research, Development, Demonstration, Education & Training

Project C: Basic Research, Development, Demonstration, Education & Training

Project D: Basic Research, Development, Demonstration, Education & Training

Table 1V-3 FOSSIL FUELS RESEARCH (in \$ thousands)

2 342, 40, 65, 50, 340, 40, 99%, 90, 40, 124, 83, 40, 40, 5, 286, 40, 894, 1049, 84, 120, 480, 286, 266, 766, 40, 86, 286, 286, 500, 40, 26, 2560, 137, 500, 200, 4997

Program Budget Distribution

Classified Project & Personnel Equipment & Materials Services

Project B Personnel Equipment & Materials

Service Project: Personnel, Equipment, & Materials Services Project. Personnel, Equipment, & Materials Services Project & Personnel, Equipment, & Materials Services. Personnel, Equipment, & Materials Services.

Table 1V=4: Fossil Fuels Research (G Thousands) 83a 220 2209332 12 6060 0102208 was 2

©1010 a 5 5 5 5 of BB ne b of 20236236 too ho 40 505050 16 1m 699 263 was 333268 12410691072 85 332 60 208 236 40 50 568 100 38 926 86 332 20 us 236 40 50 568 60 1398 826 3293 668 1036 4997.

Solar Energy Program

Solar Energy Program Introduction: The goal of the solar energy program of CEER/UPR is to help develop, at the earliest feasible time, commercially attractive and environmentally acceptable applications of solar energy. The high insolation rates in Puerto Rico is an important factor which could lead toward the demonstration of economic competitiveness by DOE sooner than in any other U.S. areas. Average daily total insolation recently measured at Ponce, Puerto Rico at 18* latitude indicates a value of approximately 1950 BTU per sq.ft. per day on a 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 next important phase is to design and prove practical, reliable, economical systems.

The high levels of solar energy over Puerto Rico make it possible to consider systems that provide thermal and/or electrical energy at the point of use. At the same time, there are two disadvantages of solar energy that pose challenges to the development of economical solar energy systems and to innovators in research and technology.

First, sunlight provides a relatively small energy flux density compared to that obtained in power systems using fossil or nuclear fuels; that is, its natural intensity is relatively low, presenting a technological challenge to achieve

Economical conversion to useful forms of energy. In addition, direct

Applications of solar energy are intermittent and variable due to daily, seasonal, and environmental effects. The direct energy conversion systems must be designed either to utilize the energy when it is available, or in conjunction with storage and back-up systems using other fuel sources. Solar programs supported by CEER/UPR include systematic solar data acquisition throughout Puerto Rico, solar cooling of buildings in tropical regions, generation of electricity from photovoltaic conversion of sunlight, industrial solar process heat, and solar materials research. A summary of ongoing solar energy areas and involved organizations are shown in Table V-A. During the five-year program, emphasis will be continued and expanded to involve private industry and enterprise in all phases of the solar energy research, development and demonstration program in order to accelerate the transition of solar technology to the commercial sector. As a result of research and development projects underway and planned, it is anticipated that by 1985 solar energy systems like solar hot water heating, solar cooling, and agricultural applications will start to have their commercial impact at competitive prices for selected applications. Some technologies like solar photovoltaic and thermal power generation can be ready for large scale utilization by the late 1980s. The major problem in each technology area is to develop systems that are economically acceptable to the public.

The text in this section is not clear and seems to be written in a different language or code, so I can't fix it.

The transition to solar technology requires innovative solutions in commercial sectors.

Engineering also involves new and improved approaches to solar energy collection, energy storage, transport, and conversion; new system approaches; and perhaps most importantly, the investigation of new and cheaper materials to improve system performance, reliability and economic attractiveness. GEER will also help to solve important problems dealing with environmental, social, legal, regulatory, and economic factors associated with widespread utilization of solar energy systems.

The Solar Network Program for Puerto Rico aims to properly design solar energy utilization systems, and for this, understanding long-term trends in the availability of solar energy in both diffuse and direct forms is necessary. Due to strong variations in the microclimate distributions in Puerto Rico, establishing a number of stations for accurate data collection is necessary for specific sites.

This program plan's major goal is 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, analyzed, and tabulated. Four monthly insolation data reports for each site containing relevant parameters will be published periodically for effective information dissemination.

Based on the pattern of the microclimate distribution and anticipated potential for solar activity, the following solar data stations will be established and operated for at least one full year or more: 1) Rio Piedras, 2) Mayaguez, 3) Ponce.

The aim of this program is to support the small but viable Puerto Rican solar water heater industry by testing commercially available products under tropical conditions to provide them with characteristic data. The emphasis will be on determining long-term climate/performance requirements, methods of integration with existing hot water systems, characteristics of existing use patterns, and cost-performance characteristics of the tested system.

The results will be summarized in a simple handbook for dissemination of information.

Information: Industrial and Agricultural Process Heat

The objectives of this program include design development, testing, and assistance in demonstrating solar process heat application systems in the industry. The industry accounts for about 40% of the energy consumed. If non-substitutable electricity use and feed stocks are subtracted, the fraction is about 30%. Recent data indicates that the same percentage ratios are also valid for Puerto Rico. Because of this large demand, it is a very attractive target for solar energy use. The most promising uses for solar heat are those industrial processes that require hot water and low-temperature (<350°F) steam.

These uses represent about one-third of the energy required by the industry. The use of solar energy to provide industrial heat is in the demonstration stage. The hardware necessary for these solar uses is mostly available and the remaining constraint to its widespread use is economical, due to the high cost of the solar collectors. The GEER program recognizes this and has focused its efforts accordingly. In the industrial sector, most current demonstrations focus on providing hot water. The hardware for these uses is essentially the same as for water heating. However, the production of industrial steam is less advanced because the required collectors are somewhat less developed. For these high temperatures, evacuated and/or concentrating collectors are required.

The major R&D efforts of the GEER program involve the development and testing of a high-efficiency, low-cost concentrator resistant to tropical island conditions. The program also emphasizes participation in ongoing demonstration projects according to DOE's National Program

Plan for Research and Development in Solar Industrial Heat. This program also contemplates the extension of industrial process heat.

Program to include agricultural and biomass applications as well as to include other important temperature ranges as shown in Figure Vol. Solar Space Cooling. The objectives of CEER's cooling program are to conduct research and development designed to assist in creating a viable solar industry for Puerto Rico.

The specific objective of the directed R&D is to provide the emerging solar industrial base the materials, in the tropics, with the components and information needed for cost-effective cooling. DOE's R&D program on cooling has been very extensive and is built upon the development of specific approaches, called paths. The following paths have been identified for solar cooling:

PATHS TO SOLAR COOLING

ENERGY SOURCE/ ENERGY COLLECTION/ ENERGY SINK EJECTION [CONDITIONING]

1. Sun Liquid-Heating Desiccant chiller collector
2. Sun Air-heating Desiccant chiller collector
3. Sun Advanced Non-Concentrating Collectors Absorption or Rankine cycle chiller
4. Sun Concentrating Non-Tracking Collectors Absorption or Rankine cycle chiller
5. Sun Concentrating Tracking Collectors Absorption or Rankine cycle chiller
6. Environment Night Effect cooling
7. Environment Evaporative Cooling

APPLICATION

Space Cooling
Space Cooling
Space Cooling
Space Cooling
Space Cooling
Space Cooling
Space Cooling

Special conditions in a tropical/subtropical region, as they exist in Puerto Rico, require a cooling system where most of the energy is used to remove the humidity from the ambient air. R&D at the CEER is concentrated on the development of a system very close to the one

described in path 2, (i.e., a combination of a highly advanced evacuated air collector in conjunction with a solid/water 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 system and the overall design is a major part of the program.

E. Photovoltaics

The overall objectives of the

The Photovoltaic Conversion program aims to help develop economically viable Photovoltaic

Electric Power Systems (PEPS) suitable for a variety of terrestrial applications and requirements. These systems are capable of providing a significant amount of power to Puerto Rico by the year 2000. To accomplish the same objectives for the U.S.A., the Department of Energy has set up goals involving the following sub-programs:

- A. Develop practical low-cost solar photovoltaic arrays.
- B. Perform detailed PEPS analysis, cost and integration evaluations necessary to characterize subsystems and components in these power-generating systems.
- C. Develop low-cost, energy-efficient processes required to fabricate photovoltaic arrays.
- D. Develop technological and research base for further improvement in photovoltaic material, device, and system capabilities.
- E. Perform carefully planned experiments and demonstrations with flat and focusing photovoltaic systems.

In accordance with DOE's program goals, CEER will concentrate on the following sub-programs:

- 1. Conduct advanced photovoltaic materials and solar cell research.
V-10
- 2. Perform conceptual design studies of photovoltaic systems for on-site residences, central power stations, and intermediate power stations.
- 3. Perform assessment studies on cell manufacturing technology in Puerto Rico.
- 4. Carry out market analysis assessments for photovoltaic application systems in Puerto Rico.
- 5. Participate in competitive DOE programs for systems demonstration projects.

Solar Thermal Power Generation

The conversion of solar energy into electricity presents a problem with a variety of possible solutions. One method is solar thermal conversion. This 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 distinguishes this cycle from that of a coal or gas-fired plant. This use of existing power-technology is a major reason that solar thermal power systems are being studied for future commercial applications. Two major types of

Solar collecting systems are being developed for solar thermal power systems: a) Central Receiver (Power Tower) b) Distributed collector systems. Central receiver systems consist of a large tower surrounded by a field of tracking mirrors which concentrate the sun's rays onto a boiler located at the top of the tower. Distributed collector systems consist of a thermally coupled field of smaller mirrored concentrators that focus the light onto a focally positioned receiver. The thermal energy, in the form of steam, is then fed into central power boiler through generating equipment. Possible collector types are parabolic line focus or parabolic dishes (point focus). For high temperatures to be maintained at the receiver, these systems must track the sun across the sky by moving either the concentrating mirror or the receiver.

The planned goals of the Solar Thermal Program at the CHEER are:

- 1) Help to provide a full technology base for the production of thermal-electric power conversion in the late 1980's to meet the utility requirements for load-following or intermediate load electric power generating systems.
- 2) Help to provide a full technology base for total energy systems for urban complexes, rural

communities, and industrial parks.

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

- 1) Design, fabrication, and testing of prototype components and subsystems that are critical to the success of the distributed collector system concept.
- 2) Evaluation of total energy system applications for urban and rural communities and industrial parks.
- 3) Investigation of critical interface problems of solar thermal electric systems and total energy systems.
- 4) Research and development of materials, components, systems, and concepts.
- 5) Continued cost-benefit studies to identify cost and performance criteria for components, subsystems, and systems.

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Teazonl IPTOS presents some issues to be addressed. First, we've got a 302s error. This type of error is usually encountered when buying goods online. It's necessary to address this issue to restore functionality.

The Teaqnoy8y model, coupled with the Tepazenpt system, is currently experiencing a 90° rotation error. This is affecting the system's performance and user experience.

Following that, we're looking into a 60" measurement error within the 3psTauetos system. The error affects the system's overall functionality and efficiency.

A service alert has been issued for the 33038 Teotuyor system. The system is displaying an error message, which we are currently investigating and aiming to resolve as soon as possible.

There's a system-wide issue affecting the 33838 Teofuyel system. It's causing a significant disturbance in the system's operation.

A malfunction has been reported in the Truxoul system. This issue is causing a delay in the delivery of services. We're currently addressing the problem to ensure smooth operation.

We have received reports of a system error in the 3020n 0H system. Our team is currently working to resolve this issue and restore normal operation.

There are some issues with the functioning of our systems. We are currently working on resolving these issues.

ECOLOGY PROGRAMS

ECOLOGY PROGRAMS

A. Ecosystem Structure and Process Studies

Any energy development can be expected to have effects upon ecosystems. Prediction of the quality, direction, and magnitude of these effects depends upon understanding of the normal composition and functioning of the systems upon which they impinge. The objective of CEER studies of tropical ecosystems is to develop such understanding. A number of separately funded projects contribute to this general goal. A large 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 on industrial siting, such as in the case of power plants, are included here, as well as more basic background studies of cycling and transport in the rainforest. Plans by the local electric utility to build a coal plant, and mining exploration for copper and nickel have been factored in. Also included are the Long Term Ecological Research studies being developed for possible NSP funds in collaboration with the U.S. Forest Service Institute of Tropical Forestry. The National Environmental Research Park will provide the organization for much of the above-mentioned terrestrial ecological work. These are expected to continue a series of basic ecological research studies on individual species by individual investigators. These are also included for accounting purposes here.

Obviously, this program of studies overlaps with the more specifically directed "Ecological Effects Studies". Information generated in such a program will be utilized by the others. Projects covered (Program Funding included under OTEC Program) are: National Environmental Research Park Cycling and Transport in Tropical Forests, Long Term Geological Monitoring, Industrial siting, Miscellaneous Basic Ecological Studies, Cycling and Transport Studies in Tropical Ecosystems.

The objective of these studies is to understand the processes of cycling and transport of materials in tropical terrestrial ecosystems in order to be able to predict the effects of energy development upon these basic processes.

RESOURCES MANAGEMENT STUDIES are aimed at the regulation of water, soil, biological and industrial wastes, and wildlife, especially where human activities impact upon these. Current programs include bioreclamation of water and wastewater, magnetic separation, factors influencing land crab survival, and sewage composting. Future programs are anticipated in land disposal of wastes, mariculture, and aquaculture.

Biological Effects Studies: This program emphasizes experimental or correlational studies explicitly directed towards the

Investigation of specific perturbing factors is, in that sense, more applied. It is clear that the "Ecosystem Structure and Process" 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 sorts of projects: The measurement of assimilative capacity, the aspects of intensive biomass culture on ecosystems (12 split recovery studies as in Bahia Sucia (or possible oil drills in northern P.R, seas)), Guayanilla Bay thermal, mercury, and hydrocarbon effects studies.

Table VI-1: Biology Projections

A. Ecosystem Structure and Process Study Project

- National Environmental Research Park
- Cycling and Transport in Forests
- Long Term Ecological Monitoring
- Industrial Siting
- Miscellaneous Basic Studies

B. Resource Management Studies Project

- Bioreclamation of Water
- Physical/Chemical Water Treatment
- Water Use and Reuse Studies
- Waste Disposal Research
- Aquaculture and Mariculture

C. Ecological Effects Studies Project

- Energy Pollutants ~ Marine Biomass Culture Effects
- Energy Pollutants ~ Terrestrial

Grand Totals (Ecology excluding 'oTeC)

Table VI-2: Personnel Man Years - Ecology

Ecosystem Structure and Process Studies

- Scientific staff: 82
- Technical staff: 4
- Administrative Staff: 4

Resource Management Studies

- Scientific staff: 10
- Technical staff: 10
- Administrative Staff: 3.5

Biological Effects Studies

- Scientific staff: 8
- Technical staff: 8
- Administrative Staff: 1.5

Totals

- Scientific staff: 100
- Technical staff: 22
- Administrative Staff: 9

Total Staff: 131

Table VI-3: Research Type Ecology Programs WSK Kind of Research

A. Ecosystem Structure and Process Studies

- Basic: 308, 236, 266, 308, 330
- Development: 1,036, 796, 888, 1,036, 1,110
- Demonstration or Education & Training: 5, 4, 48, 56

B. Resource Management Studies

- Basic: 8, 9, 7, 70, 70
- Development: 366, 387, 301, 301, 301
- Demonstration: 340, 360, 280, 280, 280
- Education & Training: 6, 63, 49, 49

C. Ecological Effects Studies

- Basic: 90, 75, 66, 95
- Development: 360, 300, 240, 240, 270
- Demonstration: 150, 125, 100, 100, 105
- Education & Training: 0, 0, 0, 6, 0

Totals

- Basic: 482, 401, 394, 438, 68
- Development: 1,762, 1,483, 1,429, 1,577, 1,681
- Demonstration: 490, 485, 380, 380, 392
- Education & Training: 16, 106, 97, 105, 109

Total: 2,850, 2,475, 2,300, 2,500, 2,650

Page Break

Environmental Health

VII. Environmental Health and Impact Studies

Introduction: The major environmental health problems in the past for Puerto Rico were Malaria and Bilharzia, parasitic diseases spread by vectors. Construction in the south coast during the 1920's touched off a Bilharzia epidemic that was only recently brought under control. Malaria was

eradicated in the late 1940's. The Environmental Health Division has studied biological and environmental methods for control of Bilharzia related to hydroelectric reservoirs in Puerto Rico and the Dominican Republic. Evaluation of the infection rate by means of the skin test (indirect method, 1974) was performed in a representative sample of fifth grade classrooms throughout the island to corroborate the decrease in transmission of this disease as compared with equivalent surveys performed in 1963, and 1968. Since 1978, the Division has been analyzing respiratory disease mortality to determine geographical distribution, by means of crude attack rates, and age adjusted attack rates and investigating the reliability of the mortality data by examining the hospital records.

Section VUR-2: The deceased are examined through a representative sample of the 1976 deaths in Puerto Rico. Twenty-eight years of respiratory cancer data is being analyzed to determine the trends of this disease on the island. The correlation of these data with known air pollution will be performed to develop more detailed studies in the future.

The subsequent work of this division will be directed towards the following projects:

A. Mortality and Morbidity Respiratory Studies: Prospective studies of mortality and morbidity in areas with relatively high incidence and prevalence of respiratory diseases mortality, which is associated with energy-producing pollution sources. Cataño, Yabucoa, and Guayanilla are targeted for these studies.

B. Mortality Studies (Water Quality related): Prospective studies of mortality on Cardiovascular, Gastro-intestinal and Renal diseases and their relation with water sources, geographical distribution, prevalence, incidence, and the correlation of such factors to perform specific studies of mortality and morbidity in areas showing positive correlations and trends. We will also establish bio-monitoring with *Marisa cornuarietis* in the water bodies to determine contaminants present, if this method is feasible.

Section VI-3: Disease Morbidity Monitoring Related to Alternative Energy Sources - CEER Personnel: Development of 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 grow along with CEER's total growth over time. We will perform surveillance and special studies of outbreaks as they occur. Later, if justified, more detailed monitoring will be performed, to determine cause and effect, and develop preventive measures for such disorders. We will establish the type of health criteria to be used in determining the capabilities of an individual to be hired to perform a task within a given project according to the risks to which they will be exposed, and the periodic determinations to be made once they are hired.

Monitor Disorder Development: D. Schistosomiasis Study. Develop schistosomiasis projects with the Dominican Republic Institutions for research and control of this disease 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*, and Rice field management, are some projects to focus on.

Caribbean Countries B, Environmental & Occupational Morbidity - Energy Production Related with

Industry. Develop retrospective and prospective studies with energy producing institutions within the island to determine high risk environmental and occupational morbidity and recommend solutions to such problems. The five proposed areas of research are to be undertaken by the Division of Environmental Health and Impact on its own, but there are several other areas which could be developed in cooperation with Fossil Fuels and Terrestrial Ecology.

Project Project Project Project Project.

TABLE VII - ENVIRONMENTAL HEALTH (Total Budget-in thousands)

20 600 265 145 760 210 440 850 86 385 205 120 30 160, 940

TABLE VIII - ENVIRONMENTAL HEALTH PERSONNEL DISTRIBUTION

Project A - Mortality and Morbidity Respiratory Studies
Scientific staff: 1, Technical staff: 1, Administrative Staff: 2

Project B - Mortality Studies (Water Quality related)
Scientific staff: 1, Technical staff: 2, Administrative Staff: 2

Project C - Disease Morbidity Monitoring related to Alternative Energy Sources
Scientific Staff: 1, Technical staff: 1, Administrative staff: 2

Project D - Schistosomiasis studies
Scientific staff: 1, Technical staff: 5, Administrative Staff: 2

Total
Scientific staff: 4, Technical Staff: 9, Administrative Staff: 8

TABLE IX - ENVIRONMENTAL HEALTH BUDGET DISTRIBUTION BY TYPE OF RESEARCH

ALL Projects (\$k) 2 BS 8k Basic

Research & Development: Demonstration, Recreation, & Training
ENVIRONMENTAL WEALTH BUDGET DISTRIBUTION BY: CLASSIFICATION

All Projects

TABLE VII-4

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

Personnel Equipment & Mat. Services

MATERIAL DEVELOPMENT

MATERIALS DEVELOPMENT

The most pressing problems in the development of energy conversion, transmission, and storage technologies are material problems. The involvement of the technical and scientific disciplines of solid-state physics and physical chemistry in the development of materials for energy conversion,

storage, and transmission is of paramount importance. A CEER research program on materials problems, at a low level of funding, has been under development during the last three years.

Included within this program were the following research projects:

- a) Photo Induced Electron Transfer State: A possible source of hydrogen
- b) Study of the optical and aging characteristics of various selective surfaces
- c) Study of the surface of electrodes used in fuel cells
- d) Energy conversion making use of thermal differentials by means 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 the continuance of this program. CEER feels that basic research on materials problems should continue at UPR/CEER but that main efforts should be redirected to research appropriate to the local conditions and the tropical areas of the Caribbean and certain similar weather regions in South USA mainland.

The main efforts of the present proposed materials program will be focused, therefore, on the following projects:

Data Center: The main objective of this program will be the collection 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 sector programs in the Caribbean and Latin America is underway. Certain materials of interest to be considered are metals, plastics, and ceramics. Data of interest include thermal conductivity, electrical and ionic conductivity, pyroelectric and piezoelectric coefficients, mechanical properties of bulk materials, corrosion properties, mass transport (diffusion), energy levels, and spectra. Table VIIFA, "Materials Problems Related to Energy Conversion", illustrates the general scope for addressing this material data bank information center.

The Material Degradation program will consider studies related to corrosion, mechanical, and chemical 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 materials under tropical conditions.

An argon 7 watt laser in the blue and green spectra and a Raman grating spectrometer available at CEER from UPR/Mayaguez campus, together with available expertise in the field already existing at Mayaguez, will provide the analytical tools and "base" for the development of this part of the program. A UV source will be added into the program.

Unfortunately, the text following is not clear enough to be corrected.

Time-Resolved Studies: Attempts are being made by CEER to obtain funds for research on synchrotron sources for diffraction and scattering studies in ferroelectric and other materials to characterize crystal structures. CEER personnel has many years of experience in neutron diffraction and scattering.

Experimental studies with the decommissioned Triga research. This program proposes studies on

time-resolved structures of ferroelectric materials with synchrotron sources.

D. Electrode Surfaces Studies: This program includes the development of scattering studies of electrode surfaces by EXAFS. A carbon electrode will be coated with a fraction of a monomolecular layer of suitable electrode material and the surrounding liquid of the electrode atoms examined by EXAFS. This will characterize or determine the radial distribution.

Electrochemical Cell Development: Electrochemical cells have two interesting large-scale applications. The first is load leveling. The second, an electric car power source, would put the transportation system on the utility grid. As long as oil is used for most generation, this is pointless unless residual fuels become very much more plentiful than gasoline. The field of solid-state electrodes and solid electrolytes would, however, make excellent use of our backlog of crystallographic knowledge, skill, and information, and of such of the x-ray and electrical equipment that we have available.

One idea that comes to mind is the use of solid hydrates having high proton mobility (e.g. copper formate $\text{Cu} \cdot 4\text{H}_2\text{O}$) as electrolytes together with a rare earth nickel hydride anode. This program contemplates the possibilities of developing an electrochemical cell based on the indicated principles.

Plastic Materials Applications: Heat exchanger cleaning problems in OTEC systems represent an important consideration in total efficiency and power output of the plant. While it may not be true that ultrasonic will either enhance heat exchange much or reduce microfouling, it has been shown to eliminate macrofouling. Thus, it could replace Cl_2 , which is environmentally unacceptable as a bio-growth inhibitor in heat exchange.

PVDF can be manufactured as a rather inexpensive plastic film with piezoelectric properties that permit it to be used as an ultrasonic transducer. It may also be...

The text should read as follows:

Solar Collector Surfactant Cleaning: Knowledge gained on surface and surfactant chemistry spreading, and contact angle phenomena could perhaps be used to examine possible methods of cleaning solar collectors without scrubbing. A knowledge of major airborne particulates would be necessary. This program proposes to assess the potentiality of this new cleaning method.

Vanr-7 TABLE VIII-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 | ©. Time Resolved Studies: 40 | 36a | D. Electrode Surfaces: 60 | 8 | 100 | 100 | 100 | E. Electrochemical Cell Development: 7 | 50 | 70 | 100 | 100 | Plastic Material Applications: - | 50 | 75 | 100 | 300 | Solar Collectors Surfactant Cleaning: - | 30 | 40 | 50 | 50 | Hydrogen Production via Solar Energy: 52 | 100 | 150 | 200 | 200 |

'TABLE VI-2 MATERIAL PROGRAM PERSONNEL DISTRIBUTION (Man-Years)

Program Titles 82 83 84 85

A. Data Center

Scientific staff 6 2 - -

Technical staff 6 5 - -

Administrative staff 6 5 - -

B. Materials Degradation

Scientific staff 3 - - -

Technical staff 7 7 10 -

Administrative staff 3 3 5 3

C. Time Resolved Studies

Scientific staff 2 3 1.0 -

Technical Staff 2 2 5 15

Administrative Staff - - - 2

D. Electrode Surface

Scientific staff 6 10 - -

Technical Staff 6 2 - 8

Administrative Staff 2 2 2 2

E. Electrochemical cell Development

Scientific staff - 4 8 -

Technical Staff - 3 3 -

Administrative Staff - 6 3 33

F. Plastic Material Applications

Scientific staff - 6 3 2

Technical staff - 3 3 8

Administrative staff - 3 3 3

G. Solar Collector - Surfactant Cleaning

Scientific staff - 4 4 2

Technical staff - 2 2 3

Administrative - - - 33 2 3 -

VII-9 TABLE VII-2 (Continuation)

H. Hydrogen Production via Solar Energy

Scientific staff 2 6 - 18 -

Technical staff 5 3 10 16 -

Administrative Staff 2 3 3 3 3

TOTALS PERSONNEL, MATERIAL PROGRAM

Scientific staff 2600 - 23 8.6 8.9

Technical staff 26 - 3.2 71.2 12

Administrative Staff - 21 27 27

Total 66 10.7 16.6 -

VII-10 TABLE VII-3 MATERIAL PROGRAM BUDGET DISTRIBUTION

"TYPE OF RESEARCH (Thousands of Dollars) 82 83

A. Development

Data Center 50 30

Materials Degradation 50 80 150 - 50

B. Time Resolved Studies Basic Research 4 3 6

C. Electrode surfaces Basic Research 60 8 100 100-100

D. Electrochemical Cell Development 50 70 100 100

E. Plastic Material Application Development - 50-75 - 100

F. Solar collector Surfactant Cleaning Development - 3 50 50

G. Hydrogen Production via Solar Energy. Basic Research 50 100 150 200 200

TOTALS ALL PROJECTS (\$ Thousands)

Basic Research 150 250 370 380

Development 100 240 - 510

Demonstration 0 0 0 0 0

Education & Training 0 9 - 9 -

Totals 250 455 655 780, 790

VII-11 TABLE VII-3 MATERIALS PROGRAM BUDGET DISTRIBUTION CLASSIFIED (Thousands of Dollars)

a. Personnel

b. 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 Surfaces Personnel: 35

Equipment & Mats: 20
Services: 3
Electrochemical Cell Development Personnel: 0
Equipment & Mats: 0
Services: 0
Plastic Material Application Personnel: -
Equipment & Mats: -
Services: -
Solar Collectors Surfactant Cleaning Personnel: -
Equipment & Mats: -
Services: -

TABLE VETI~4 (Cont). H, Hydrogen Production via Solar Energy

Personnel: 20
Equipment & Mats: 20
Services: 10
Totals All Material Programs Personnel: 165
Equipment & Mats: 35
Services: 250
Totals part-12: 40
Personnel: 40
Equipment & Mats: 20
Services: 275
Totals: 455
Personnel: 15
Equipment & Mats: 50
Services: 25

INTEGRATED TECH, ASSESSMENT

1. 1x1 Integrated Assessment Technology Program

The technology developed for the energy alternatives of (a) Solar Hot Water system + (b) wind driven electrical generators and pumps and, (c) photovoltaic arrays arrangements need to be placed as soon as practicable at the disposal of local manufacturing groups, salesmen and users in order to use effectively the R&D accomplished at the laboratory. We propose to develop programs in each of the above three mentioned alternatives and with emphasis in the order given to integrate technological know-how into the local community. For the integration of large energy power systems using such alternatives 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 of R&D funds for the development of such alternatives in the PLR scenario. This requires coordination or integration with all government concerned agencies. The following programs and budget estimate are...

Proposed:

A. Solar Hot Water Systems Program offers all hot water system manufacturers through an appropriate P.R. Government Agency such as Departamento de Asuntos del Consumidor (DACO), general technical services and independent assurances:

1. Economic analysis of calculated savings
2. System capacity design is correct for expected loading
3. Manufacturer equipment meets required successfully and is of proper quality
4. Publish for the benefit of manufacturers any late developments which might improve the economics of their operation and promote technical conferences
5. Publish for the benefit of users general literature about solar water heating systems and do-it-yourself pamphlets.

B. Wind Driven Turbines Program: Under this program, CEER will establish a small community-involved demonstration program of wind-driven electrical generators and wind-driven irrigation pump tests. Data will be generated for local manufacturers and entrepreneurs for commercialization. User manuals will be prepared along with 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 characteristics. A mechanic will be available for direct help.

C. Photovoltaic Community Program: Under this program, CEER will establish a small demonstration community-involved program for photovoltaic installations for communication applications and other small users. Direct technical help and advice will be provided to manufacturers and users. Descriptive literature will be presented. This program will not become effective until 1985.

Table 1x1: Integrated Assessment Technology Program Budget (\$ Thousands)

- A. Solar Hot Water System: 5055606570
- B. Wind Driven Turbines: 758859085
- C. Photovoltaics Community: 50,60
- D. Energy Analysis: 0 5 0

Totals: 135 170185255285

Table 1-2: Integrated Assessment Technology Program Personnel Distribution

Project A: Solar

The commonly considered concept to harness neutron energy in fusion reactors is by allowing the energy to be deposited in a Lithium blanket designed to breed the required tritium ¹⁰⁷. The heat generated in the blanket is then conveyed by conventional heat exchanger technology to operate a Rankine cycle. This approach, however, does not lend itself to the generation of reactor fuels.

Hydrogen production from water decomposition with 14MEV neutrons is of particular interest in the harnessing of this fusion energy for the generation of reactor fuels.

CEER in Mayaguez has a 150KEV proton accelerator and facility which produces 14MEV neutrons in a target reaction. This could be effectively used for this purpose. Existing experimental data on the conversion efficiencies of radiolytic water decomposition indicate values of 10%. Some experimental data indicate higher efficiencies (30 to 40%), but these results are not fully understood and researchers have not been able to duplicate results such as the CIRENE reactor experiments.

More importantly, however, there is no data using UMEV neutrons as a source. It is estimated that 30-40% conversion efficiencies in radiolytic decomposition of water with 16MEV neutrons can result in acceptable hydrogen/electricity production scenarios. The CEER proposal of February 1977, entitled "Feasibility Design Study Project for a 100KWE Level Pilot Plant Fueled by Hydrogen Produced by Direct Solar Heat", contains a detailed discussion of the most promising thermochemical cycles to that date.

The use of 14MEV neutrons in a thermochemical step can result in eliminating inconvenient high temperature steps of a particular suitable thermochemical cycle. CEER 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 with CEER in this area. In addition, CEER personnel will maintain themselves abreast of new developments in Fusion Technology by attending seminars, symposia, and reading relevant literature.

The Literature and holding occasional local lectures.

B. Nuclear Fission Program

In the field of Nuclear Fission, CEER proposes to monitor and transfer technological information from the national laboratories to interested CEER/UPR, P.R. industry, and Latin American countries' personnel. Distinguished investigators and professors will be invited from time to time to present findings and developments to CEER personnel. CEER personnel will attend national meetings and conferences. Tables M-1 through XI-4 illustrate the scheduled funding and effort.

Table EL: Nuclear Program Budget (In Thousands \$)

1. Nuclear Fusion Program 607575
2. Nuclear Fission Program 55 for 65

[Nuclear Program 'Type of Research]

1. Nuclear Programs 6 755
2. Development Demonstration Education & Training 55 5

Table X2: Nuclear Program, Budget - Program Personnel Distribution

1. Nuclear Programs Scientific staff 83k
2. Technical staff Boss
3. Administrative Staff

Table X-3: Personnel Equipment & Materials Service

1. Costs 65
2. Table 8 105
3. 105 275

Transportation and Conservation

XI. Transportation and Conservation

CEER has an ongoing program on the important transportation and conservation area. Approximately 25% of all energy consumption in Puerto Rico is accounted for by the Transportation Sector. Over 17 million barrels of distillates will be consumed in Puerto Rico during 1979 by nearly one million vehicles. CEER's ongoing programs in this area are classified under two main topics:

1. Hybrid Vehicle Test and Demonstration Program, and
2. Socioeconomic and Decision Policy Studies.

CEER has been in contact with JPL and the University of Florida in the program development for the Hybrid Vehicle Test and Demonstration Program. A Hybrid Vehicle has already been purchased by CEER for this program. In the area of Socioeconomic and Decision Policy Studies, CEER has already published studies on San Juan Transit.

Outline of a Policy Analysis for Decision Making (October 1977). Energy Conservation in Transportation: A Policy Study (September 1978). Policy R&D: Outline of a Methodology with reference to decision making in the fields of energy, transportation and environment (September 1979). Description of the above two main topics on transportation follows.

Hybrid Vehicle Development, Test, and Demonstration Program. It is believed that due to the unique driving conditions in Puerto Rico (60% of all driving is done in the urban areas), considerable energy savings can be accomplished by utilizing transportation modes matched to a particular driving cycle. One of these modes is the hybrid vehicle. This vehicle utilizes an electric motor in conjunction with a modest bank of batteries as a power source. A gasoline or diesel-driven electric generator is used to recharge the batteries while the vehicle is in motion, while driving at slow speeds in urban traffic or while stopped awaiting a traffic light change. When properly matched (electric motor-gas driven generator) the hybrid vehicle's range is essentially dictated by the capacity of the internal combustion engine fuel tank. The CEER's Hybrid Vehicle Development, Test and Demonstration Program seeks to demonstrate the technical feasibility, and greater fuel economy of this mode of transportation. It also seeks to create public awareness and acceptance of the hybrid vehicle in Puerto Rico as a viable transportation alternative through information dissemination and vehicle demonstrations. To accomplish these goals, the Hybrid Vehicle Development Test and Demonstrations Program proposes the following projects:

- A. Development of a Driving Cycle for Urban P. R.
- B. Hybrid Vehicle Power Train optimization
- C. Hybrid Vehicle Demonstration

D. Motor-Generator Engine Development for Hybrid Vehicle Applications

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 urban areas, substantial fuel economies can be achieved by utilizing electric propulsion where motor efficiency is essentially independent of speed and load. In order to make valid testing and comparisons, a driving cycle characteristic of the urban driving conditions in Puerto Rico must be developed and confirmed.

Project B is expected to optimize the hybrid vehicle powertrain. The interrelationships between speed, range, vehicle and battery pack weight, electric motor horsepower and generator set capacity as applied to a particular driving cycle have a marked impact on energy consumption. This subprogram seeks to model the system and to test one or more actual power train arrangements.

Project G will be directed towards the demonstration of the feasibility of utilizing hybrid vehicles in fleet operation. The program will be tailored to a particular driving application stressing fuel economy, personnel training, public awareness and overall vehicle evaluation. A fleet of at least ten vehicles is to be purchased and operated by the University of Puerto Rico, Mayaguez Campus Buildings and Grounds Department. Funds from DOE and the P. R. Energy Office are expected to be obtained.

Project D is directed towards the development of motor generators specifically applied to hybrid vehicle use. Such parameters as type of generator winding, motor controls and weight will be optimized, built and tested.

A fuel-efficient mix of transportation/mobility modes:

- (i) More sensible uses of private automobiles (total mileage, increased occupancy)
 - (ii) Integrated bus-and-publico system
 - (iii) Realistic rail concepts for San Juan and the Island
 - (iv) Mobility alternatives to Private Vehicle Transportation System (PVTS) such as bicycles and walking (Synthesis and development of existing plans)
 - (v) Water-based transportation
 - (vi) Incentives/disincentives, positive restraints on PVTS (See C. and D. below)
3. Non-construction methods of improving TSM.
4. Management/information system Socio-environmental

Aspects of TSM; e.g. traffic flow/density studies related to institutional location, operations, work hours, residences of employees--as input into the development of short-term, quick-fix measures, as well as of longer-term planning. 6. Analysis and anticipation of new parameters (technology, fuels, supply, cost, etc.).

In Economics 2, Analysis of the extent to which PVIS is publicly subsidized (fuel cost, parking, highway use, violations, low inspection/maintenance standards with resulting accident cost and air

quality impact, use of general funds for highway maintenance, etc. ~ see "Energy Conservation in Transportation...", pages 56-60, for a more detailed inventory of apparent categories of subsidies). 2. Analysis of the real C/B of public transportation vs. non-subsidized PVIS. 3. The elasticity of demand for private transportation is a function of the Puerto Rican socioeconomic structure. 4. The resulting policy directives.

Transportation Policy R&D 1, Feasibility of active restraints on PVIS through (i) controlled availability of fuel (ii) cost (removal of subsidies) (iii) Physical restraints (access, parking, etc.) (iv) taxing and other disincentives (v) regulatory and enforcement.

2. Analysis of the elements and causes of the previous failures to adopt and implement a rapid transit in San Juan ("Metro") and on the Island ("Tusca").

7. Elaborate for concrete application the concept of transportation function of human and environmental resources and opportunities vs. the limited technoeconomic conception and planning. (This "econagement" concept of transportation was outlined in "San Juan Transit... Develop this study so it would also contribute to national R&D in transportation.

Improvement of the degree of certainty in transportation decision making through better methodology, system analysis and synthesis, increased quantification of the socio-environmental data, and other techniques or policy R&D. Progressive improvement through concrete applications of tech

Technology and environmental impact assessment in transportation, also with the aim of contributing to EDP at the national level.

Institutional and Legal Elements:

1. Foster, through specific programs and proposals, the integration of transportation research and operations in Puerto Rico. This includes: GEER, HIM Transportation Institute, TOP, CSP, Office of Energy, Planning Board, Ports Authority, etc.

2. Provide input in:

(a) Revision of the P.R. Traffic Code

(b) Reorganization of the Executive Branch, in order to foster TSC and TSM policies (for example, the Traffic Code is energy "blind"; the present organization of the government promotes fragmentation in policy development and implementation).

3. Provide policy and drafting support in the development and revision of laws and regulations pertaining to: licensing, enforcement, tax structure and other incentives/disincentives favoring TEC and TSH.

4. Monitor the reaction of agencies to GEER studies and provide active support enhancing favorable measures and actions.

Education:

1. Publication and dissemination of GEER studies:

- (a) To the Puerto Rican government
- (b) National circulation where indicated
- (c) Adaptation and translation into Spanish (where necessary) of research results judged potentially useful in the context of Latin American transportation/energy problems.

2. Development of more effective techniques and programs aimed at TEC, based on public opinion and related studies.

3. Sectoral contribution to GEER public information and awareness programs.

TABLE XI-1a: TRANSPORTATION AND CONSERVATION - HYBRID VEHICLE

Overall Budget Distribution (Thousands of Dollars):

- A. Driving cycle: 202.5
- B. Power Train Optimization: 152.5, 202.5
- C. Hybrid Demonstration: 272.5, 202.5, 202.5, 202.05
- D. M6 Development for Hybrid Vehicle: 242.5, 167.5, 160.5

Total: 300, 475, 02.5, 370, 167.5

TABLE XI-2a: PROGRAM PERSONNEL DISTRIBUTION - HYBRID VEHICLE

Program Title: Driving cycle (Man-Years)

Scientific Staff: To be determined

Technical Staff: To be determined

Administrative Staff: To be determined

+ The most effective means of promotion and communication among people is through the Spanish Language.

+ Daily life experience is geared to a tropical climate, with hardly any seasonal change. All references to winter rigor preparation and awareness are totally meaningless.

+ Government and public services are all centralized. Wealth, education, justice, public order, and utilities, all of these are regulated by the state government.

+ Puerto Rico, for all purposes, could be viewed as a large county with little, if any, municipal government independence.

+ Puerto Rico is densely populated - as dense as if all the population of the world were living in the U.S.

+ Puerto Rico has a very dense 'automobile population', about five times as dense as the U.S. That is comparable to a billion cars in continental U.S.A.

IR-2 Puerto Rico is little known by the majority of the American people. Even at the cultural level represented by the project evaluators, unexpected and serious gaps of information become evident from their comments, with disastrous effects for the fairness of the competition. Puerto Rico has a total lack of geological energy resources. Puerto Rican institutions buy energy at the price imposed by OPEC. Further large increases in oil prices could paralyze Puerto Rico's economy and make Puerto Rico largely dependent on energy sources from the U.S., posing an additional

Burdening an already strained energy situation, public awareness of this fragile scenario is imperative among both local and continental citizenry. Therefore, there is a strong rationale to include a Public Awareness Program as an institutional component in a proposed Five-Year Plan. CBER's Public Awareness Program is subdivided into four areas: Educational Program, Source Information Program, Active Information Program, Community Participation Program.

Educational Program:

The main goal of this Program is to develop a state of awareness, interest, and enthusiasm among primary, secondary, and community college teachers for the energy predicament, both globally and nationally.

The program will consider its effects and implications on the peculiar situation of Puerto Rico. It is expected that the awareness stirred by this program will be translated into positive and meaningful educational achievements, which the program, in turn, will support and promote. A list of activities, by no means inclusive, includes the following:

- Visits, informal talks, and demonstrations to teachers by scientists, educators, and administrators.
- Chautauqua type sessions with teachers where educators, scientists, engineers, technicians, and other specialists present different aspects of the energy situation.
- Actual visits to the classroom by educators for teaching demonstrations, field trips, experiments, etc.
- Limited student and teacher research participation in collaboration with CBER staff and/or professors from sponsoring universities. Although these studies may range from simple short-range projects to more complex involvements, they must seek solutions to clearly identified problems of local importance.
- Production and/or adaptation of curricular materials and/or methodologies directed to enhance the student and community awareness of the energy plight. CBER will sponsor this activity as single teacher projects but preferably as a collaborative effort among teachers, researchers, and other educational specialists.
- Organization and/or support of teachers.

"Summer workshops for students.

x4 A, Educational Program Budget Activity F823 YB FYB F486	Visits, Chautauqua, teaching	\$12,000	\$13,000	\$14,000	\$15,000	\$16,000	Research participation, teachers	\$12,000	\$13,000	\$14,000	\$15,000	\$16,000	Research participation, 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 workshops	\$10,000	\$11,000	\$12,000	\$13,000	\$14,000	Totals	\$949,000	\$53,000	\$58,000	\$62,000	\$67,000
--	------------------------------	----------	----------	----------	----------	----------	----------------------------------	----------	----------	----------	----------	----------	----------------------------------	---------	---------	---------	---------	---------	---------------------	----------	----------	----------	----------	----------	---------------------	----------	----------	----------	----------	----------	--------	-----------	----------	----------	----------	----------

xn, 3. Source Information Program. This program intends to perform as a clearinghouse for the flow of information to the public and among organizations dealing with energy-related projects. The following activities are relevant to this program:

- Store energy-related information, particularly that relevant to Puerto Rico and other Caribbean areas.
- Prepare a database for computerized retrieval of the important features of the stored information.
- Make these files accessible to both local and national users.
- Establish an information retrieval center connected to the main national system.
- Provide the necessary information when requested by private individuals and institutions.
- Sponsor the formation of Teacher's Centers throughout the Island where information, advice, and instructional material could be provided to the teachers.

Activity, Data acquisition \$20,000 File preparation and update \$50,000 Information Center hardware and maintenance \$300,000 Information Center software and maintenance \$100,000 Service Teachers Centers (1/2 support) \$18,000 Four Centers Total \$12,000 Total Budget \$500,000

FY-83 \$12,000 12,000 10,000 10,000 19,000 26,000 389,000

FY-85 FY-86 \$13,000 \$14,000 \$15,000 13,000 14,000 15,000 20,000 11,000 11,000 10,000 11,000 11,000 20,000 21,000 22,000 42,000 60,000 64,000 Total \$108,000 \$131,000 \$138,000

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 informing the public..."

Awareness on energy-related topics and events is essential. Emphasis will be placed on information relevant to Puerto Rico and the Caribbean area.

Some of the activities for this information center include the following:

- Production of regular short (4 page) and non-technical publications (probably monthly, possibly twice a month). These will be distributed to all schools, churches, government offices and to everyone who requests them. They should include one or more non-technical articles analyzing the current news on energy and the national and local societal impact. Translations and adaptations of suitable articles published elsewhere could also be included, as well as a summary of important events and news.
- Sponsorship of public lectures, colloquia and seminars.
- Preparation and public display of films on CEER's activities in theaters, schools, universities.
- Creation and distribution of posters, shirts, captions, bumper stickers, etc., with energy messages in Spanish and with local flavor.

- Adaptation, translation and distribution of public information material prepared by the Department of Energy (DOE).

With the cooperation of government TV and radio stations, we plan to:

- Prepare spots, documentaries, regular news programs and children's programs on energy.
- Prepare public exhibitions, mobile exhibitions and demonstrations.
- Organize open houses at CEER facilities periodically to make the public aware of the island's energy problem and promote appreciation of the research and development programs necessary to cope with it.

Here is the activity budget for 1982-1986:

- Regular publication (20 issues a year): \$50,000 in 1982, increasing by \$2,000 each year to \$60,000 in 1986.
- Public lectures: \$2,000 in 1982 and 1983, increasing to \$3,000 in 1984-1986.
- Posters, etc: \$5,000 in 1982 and 1983, increasing by \$1,000 each year to \$7,000 in 1986.
- Translations, adaptation, dissemination: \$5,000 in 1982 and 1983, increasing by \$1,000 each year to \$7,000 in 1986.
- Film (one a year): \$4,000 in 1982 and 1983, increasing to \$5,000 in 1984-1986.
- TV and radio spots: \$4,000 in 1982 and 1983, increasing to \$5,000 in 1984-1986.
- Stationary and Mobile exhibitions: \$25,000 in 1982, decreasing by \$1,000 each year to \$12,000 in 1986.
- Open houses: \$2,000 in 1982 and 1983, increasing to \$3,000 in 1984-1986.

The total budget is \$97,000 in 1982, decreasing to \$82,000 in 1983, and then increasing each year to \$102,000 in 1986.

Corrected Text:

Break - XRI-9 D. Community Participation Programs

In addition to arousing public interest and understanding in the energy plight, CEER should spur citizen participation through community action and by sponsoring community-initiated proposals. These are some of the activities that CEER could develop under this program:

1. Contact civic, professional, and youth organizations as well as private groups to promote community action. Offer help in such endeavors.
2. Suggest formations of steering committees where CEER personnel could be used as resources.
3. Assist civic, professional, and youth organizations as well as private groups in the preparation of proposals to CEER and/or government agencies.
4. Offer advice in carrying out activities supported by grants and awards.
5. Encourage the formation of energy clubs; sponsor debates on energy issues.
6. Promote citizen's participation, as fully as possible, in assisting CEER's research projects as well as those conducted in other institutions.
7. Deputize young and adult groups to participate as fully as possible in selecting phases of

CEER's Public Awareness Program.

8. Organize and sponsor regional and island-wide meetings of representatives from civic, professional and youth organizations as well as from other interested groups to report on current community participation projects and plan future actions and collaborations.

Page Break

Activity: Promotion of community action, Community Meetings

Table XIR-10: Community Participation Program Budget

FY-82 \$5,000 10,000 6,000 \$21,000

FY-83 \$5,000 10,000 6,000 \$21,000

FY-84 \$6,000 11,000 7,000 \$24,000

FY-85 \$6,000 11,000 7,000 \$24,000

FY-86 \$7,000 12,000 8,000 \$27,000

Page Break

Table XIR-11: PUBLIC AWARENESS PROGRAM

Page Break

Table XIR-12: PUBLIC AWARENESS PROGRAM

BUDGET PERSONNEL DISTRIBUTION

All Frocks: 2

Scientific Seat: 1

Technical State:

Administrative State: 3

Other: 3

PUBLIC AWARENESS PROGRAM BUDGET TYPE OF RESEARCH (Thousands): 280

PUBLIC AWARENESS PROGRAM BUDGET DISTRIBUTION-CLASSIFIED (thousands \$)

Basic Research: -

Development: -

Demonstration: -

Diversification: 6

Training: 667245

TABLE M-4

Personnel: 130130

Equipment: 6

Materials: 3
Services: 60
Total: 1,837

INTERNATIONAL PROGRAMS

INTERNATIONAL PROGRAMS

One of CEER's principal objectives is to serve as a center for international cooperation in the energy and environmental fields, particularly for scientists and technicians from tropical and subtropical areas, especially in the Caribbean and Latin America. In the past, efforts in this area have been extensive but there is at present no distinct international division or program.

In further defining its international goals, CEER plans to concentrate its efforts on becoming a leading institution in U.S. efforts to transfer new energy technologies to the Caribbean community. The islands and nations of the Caribbean community, defined as all the West Indies, Central America, and the countries on the Caribbean coast of South America, share with the United States and Puerto Rico the need for achieving greater energy independence.

The great majority of the individual countries, with the exception of Venezuela, Trinidad, and Tobago, are heavily or exclusively dependent on imported petroleum for their energy needs. To continue their process of economic growth and development and to lessen their balance of payment problems, greater energy independence becomes imperative. Alternative energy technologies, appropriate to the physical, cultural, and economic conditions of each individual country, have great potential to help meet this goal.

The natural energy resource base of the Caribbean is most

"Advantageous for the adoption and commercialization of renewable energy technologies throughout the region, these resources include high levels of solar radiation, excellent biomass growth rates, trade winds, geothermal formations, ocean currents, and thermal gradients. These resources and their associated energy technologies, in many instances, have the capability of becoming cost-competitive in the Caribbean sooner than in the U.S. due to their greater availability and the comparatively higher cost in most of the region of currently available alternatives. Most individual countries in the Caribbean have limited capacity to develop these technologies. The U.S. government and DOE have an important role to play in the region through a coordinated energy technology transfer program designed to assist in the assessment of energy needs, in the development and adaptation of technologies appropriate for individual countries, in the training and education of the requisite scientific and technical manpower, and in providing technical assistance in the final adoption and implementation of the new energy technologies. A regionally-based institution is needed to serve as a focal point in these efforts and GEER is the logical choice to become such an institution. The technologies involved include not only the solar and renewable energy technologies previously mentioned but also technologies such as enhanced oil recovery of heavy Venezuelan crude.

The rationale for converting CEER into a lead institution and focal point for U.S. efforts for the transfer of energy technologies in the Caribbean is as follows:

1) CEER's past and present international cooperative efforts serve as groundwork on which to build a visible and efficient institutional mechanism for energy technology transfer. These efforts include international conferences, country energy assessments, and technical cooperation in research and development activities. These will be described below in greater detail. A network of scientific and..."

1. In some cases, political contacts have resulted from these efforts.

2. CEER's predecessor, the Puerto Rico Nuclear Center, served as a nuclear energy technology transfer and education and training center for scientists and technicians throughout Latin America. This heritage can be put to use in analogous activities of technology transfer for renewable energy technologies by CEE.

3. CEER's divisional programs in the areas of Solar, OTEC, biomass, bioconversion, fossil fuels, and ecology provide the scientific and technical expertise required to support a program of transfer of unconventional energy technologies. Since the technologies need in many instances to be adapted to the particular circumstances of the countries involved, further developmental efforts are required. A technology transfer program for energy must therefore be coupled with established supportive research and development efforts to be successful. CEER's past achievements and future plans, as described elsewhere in this document, provide such support.

4. CEER already enjoys a unique position and reputation as a center for research and development of non-conventional energy technologies in the Caribbean. This position has been recognized in reports by Donovan, Hanester, and Rattien and by the U.S. Agency for International Development in recommending the extensive involvement and participation by CEER in national and international programs for energy technology transfer in the Caribbean.

5. CEER's staff possesses the bilingual capabilities and cultural ties needed to interact with scientists, officials, and technicians of the Caribbean community. While there is a diverse cultural background in the Caribbean, particularly in the West Indies, the Spanish language and heritage predominates. Puerto Rico stands in a unique position in this respect with its bilingualism, its cultural and language ties to the Hispanic community, and its economic and political ties to the United States.

6. CEER, by its location in Puerto

Puerto Rico, with its ecological and environmental research capabilities, can play an important role in the environmental assessment of new energy technologies for the Caribbean. Puerto Rico's tropical environment shares similar physical and climatological traits with much of the Caribbean community. As previously mentioned, CEER's past and present international cooperative efforts will serve as a basis for an expanded role as an energy technology transfer center for the Caribbean. These efforts have been as follows:

CEER sponsored the First Caribbean Conference on Energy for Development, held in April 1978, in San Juan, Puerto Rico. Representatives from twenty-six countries or territories and seven international organizations attended. CEER was a co-sponsor of a technical Congress for the Investigation and Conservation of Energy Resources held in San Juan, November 1979. Participants from nine countries attended.

CEER has also participated in two Caribbean conferences in Barbados, in a meeting on Caribbean Energy Accounting Systems in San Juan, and in the Final Report Conference on Preliminary Energy Sector Assessments of Jamaica. CEER is presently involved in two country energy assessment projects in Panama and Ecuador.

CEER, in cooperation with the Institute of Energy Conversion of the University of Delaware and 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 Panama.

A Joint CBER/SERI Project of assisting Ecuador's National Energy Institute in its development of an energy balance sheet has been proposed as part of an Alternative Sources of Energy Project. CEER has been involved in technical cooperation efforts with the Ministry of Energy and Mines of Venezuela. The Ministry has provided services to CHER's Fossil Fuels Program in its research efforts.

and Training and Commercialization Effort: This involves: ~ studies of energy demand and resource base assessments; ~ technical and economic feasibility studies of renewable energy technologies; ~ research and development activities aimed at appropriate technologies; ~ prototype demonstration and testings; ~ institutional and industrial liaison activities; ~ studies of financial and social incentives and barriers to commercialization; ~ information dissemination activities for scientists, industry, and consumers; and education and training activities aimed at training and technical manpower.

APPENDIX.

A Memo from the ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION,
WASHINGTON, D.C. 20545

April 11, 1976

ACTION MEMO 6108

To: Administrator

Re: Assistant Administrator for Field Operations

Subject: Request for review of the current state of the Puerto Rico Nuclear Center

Purpose: To determine the programmatic and institutional future of the Puerto Rico Nuclear Center facilities and recommend, if necessary, changes to ensure that the PRNC's future management and operation are consistent with ERDA's programmatic requirements.

Background: The PRNC was established in 1958, under the Atoms-for-Peace program, to train Latin American students in nuclear medicine and technology. Due to funding constraints, the training and education program has diminished over the years. The annual training budget (\$1.2

million in FY 76) has been used principally for basic operating support of the Center. ERDA's funding of this activity is expected to decrease to reflect the decreasing nuclear training needs at PRNC.

However, PRNC's research role has grown mainly with funds from AES (\$1.062 million in FY 76) and sound research has been developed in terrestrial ecology, tropical marine biology, and tropical human ecology. AES support for the marine biology, terrestrial ecology, and human ecology programs is expected to continue and may increase slightly to pick up.

Overhead costs were previously carried in other programs. Research in nuclear medicine and agriculture is not a high priority for the Administrator FRDA program and direct support for such research is not provided in Fr 76. Additional narrative background material is contained in Enclosure 2. Additional funding information is 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. The Btedras site and the San Juan area are well-equipped, medically-oriented facilities located adjacent to the UPR Medical School. These facilities include a biomedical building, animal quarters, and a maintenance shop. These cost about \$3.0M.

Mayaguez Site: The principal nuclear facilities of the Center are located on 20 acres of property adjacent to the UPR campus in the city of Mayaguez. These facilities include a research reactor (TRIGA); nuclear laboratories and hot cells; and several adjacent structures housing offices, nuclear engineering facilities, maintenance shops, and a greenhouse. The cost of these facilities was about \$4.6K.

Cornelia Hill Site: Also located near the city of Mayaguez are the Cornelia Hill facilities, which house the marine biology program. These are relatively new and well-equipped environmental analysis laboratories located on the ocean adjacent to the pier for the PING Research Vessel PALIHSO. The cost of facilities at Cornelia Hill was about \$860K.

Luquillo National Forest Site: In the Luquillo National Forest, there is an acquisition laboratory costing 120K. Additional facilities information is contained in Enclosure 4.

RECENT EVENTS: A new contract with the University was authorized by the Administrator in June 1975, extending through 1981. Since then, the following significant events have occurred: ERDA has proposed a reduction for FY 77; a decision was made to transfer the TRIGA reactor to TD; a Contract AT(40-1)-1853 administered by O80.

The Administrator has appointed a new Director, Dr. Ismael.

Almodovar has assumed 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 become the core of a new Energy and Environment Center (Enclosure 6), which would serve both ERDA and address the unique problems of the Commonwealth.

Options for Change: After reviewing a broad range of options, the following three options for

accomplishing this change were explored in depth:

1. Continue the PRC GOCO Arrangement with the UPR - making certain management and funding modifications.
2. Develop a mixed ERDA GOCO and Non-GOCO Arrangement with the UPR.
3. Discontinue the ERDA GOCO operations, transferring facilities to the UPR, or others, or close them if appropriate, and executing ERDA programs under other contractual bases.

Additional summary prepared by ERDA background material on these options, including pros and cons, is contained in Enclosure 5. Additional detailed PRIC prepared background materials are contained in Enclosure 6.

Recommended Option: A transition from Option 1 (current status) to Option 3 over a three to five year period was determined by the Joint Task Force to be the management arrangement in the best interests of the U.S. Government and the University of Puerto Rico for the following reasons:

1. It will permit ERDA to continue its high priority program works.
2. Low priority ERDA programs can be phased out.
3. It will provide for the most economical use of Government funds.
4. This arrangement will promote UPR Institutional development consistent with both Commonwealth and U.S. needs.

This management change has the following features:

1. Ownership of most of the facilities/equipment would be transferred to the UPR over a three-year period (FY 77-79).
2. Certain facilities of no value to either party would be closed or transferred to other government agencies as soon as possible.
3. ERDA priority research and training programs would continue through appropriate contractual arrangement.

ERDA would provide institutional and developmental funding support for a five-year period (FY 78-82) to give the University an opportunity to use the newly acquired EHDA facilities for other energy technology areas (conservation, solar, ocean thermal energy conversion, and materials research and development), and to develop professional capability in these new program areas.

The Administrator will manage these new program areas; and (5) educational and training funding will be adjusted during the next three years (FY 77-79) to reflect the several training requirements of ERDA at the UPR. This is aimed at taking advantage of Puerto Rico's unique geographic features and to solve Commonwealth problems.

This course is considered by the Joint Task Force to be a reasonable one to chart for a minority institution at 48 striving to increase its professional status and competitiveness in academia, as well as to serve both the U.S. Government and the Commonwealth of Puerto Rico.

This recommended option has been arrived at by a Joint ERDA/PR Task Force through a deliberative process which included examination of historical data, on-site examination of the

facilities, and a thorough analysis of the three reasonable options. Puerto Rico favors including the PRNC, the Commonwealth and the University, have participated extensively in the entire process and endorse the recommendation.

The President of UPR can be expected to endorse this recommendation.

Recommendation: The Task Force recommends the Administrator approve a three to five-year transition from Option 1 to Option 3.

Date: November 13, 1974

Next Steps:

1. The AFO will advise the Manager, ORO, and the President, UPR, of the Administrator's decision.
2. The AFO will direct the Manager, ORO, to execute a contractual agreement 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 a public announcement and arrange for a joint UPR and HOA facilities transfer ceremony.
4. The ATO will direct...

The Director, HOS OCA, is to notify the Puerto Rico Resident Commissioner of the Administrator's decision.

The Administrator will direct the Manager, ORG to initiate a study to determine the amount and cost of radioactive clean-up required at the site and funding options for the work. The APO and the Administrator jointly will work out the details of introducing development and institutional funding categories into the FY 78 budget and reducing the education and training base funding. Joint Task Force proposed transition funding levels FY 77-82 are shown in Enclosure 7. (See Red Tab)

In cooperation with ATA, the Administrator will explore the potential of its concurrences.

Dr. Vitali Garber
Energy Research and Development Administration
20 Massachusetts Avenue NW
Washington, D.C. 20545

Dear Dr. Garber,

The action memorandum should be revised to be acceptable. I wish to express special appreciation to the members of the ERDA Task Force for responding to our suggestions as a minority institution and considering our current budgetary situations.

Thanks go to all the members of our respective teams for their hard work and splendid cooperation. I have high hopes for the success of our plans.

AL ORE, Vitality Carter (Chairman)
Technical Director
Office of the Assistant Administrator for Field Operations

Russell Riche (Alternate Chairman)
Special Assistant to the Assistant Administrator for Administration

John Westman
Office of the Assistant Administrator for Environment and Safety

Jon Swanbroad
Deputy Associate Director for Research and Development
Division of Biomedical and Environmental Research

James

Kellett, Jr./Harold B. Young, Division of University and Vancouver Development/AAL, Joseph A. Lechard, Director Research and Technical Support Division Oak Ridge Operations Office Gail Bradshaw Ghel, Conservation, Environment and Safety, EWS Branch Office of Public Affairs -EREC_TASK_FORCE Israel AlexSdovar (Chairman) Acting Director Puerto Rico Nuclear Center Flavio Gears, Dean School of Engineering Mayagues Campus Manuel Ges, Dean College of Natural Sciences Rio Piedras Campus Juan J. Bgau, Director Office of Petroleum Fuels Affairs Offices of the Governor Commonwealth of Puerto Rico Conrado P. Asenfo Associate Dean School of Medicine Paul Harrison (Liaison) Special Assistant to UPR President Lats B. Boothby: General Administrative Officer Puerto Rico Nuclear Center MANAGEMENT-FINANCE SUB-COMMITTEE Petra L. de Toro Acting Director Office of Personnel UPR Central Administration Irma Yésquez, Director Budget Division UPR Central Administration Andrés Medina-Pena Acting Director Finance Division UPR Central Administration

BACKGROUND INFORMATION

Under its present form of government, Puerto Rico is a Commonwealth, electing its own chief executive and legislature, levying its own income, excise and other taxes, and sharing with the United States citizenship, defense, free trade and currency. A strong minority of the electorate favors becoming a State of the Union, while a much smaller but highly vocal minority favors complete and separate independence. The present Governor, Rafael Hernandez-Colon, is a strong advocate of Commonwealth with maximum autonomy consistent with continued common citizenship, defense, commerce and currency. Puerto Rico has a land area of 3400 square miles, about three times the size of Rhode Island, but with 3.1 million people it has about three times Rhode Island's population, and it is totally dependent on imported petroleum. The rising costs of oil and the recent economic problems in the United States have combined to reduce the Commonwealth's resources and to drive the unemployment rate to

Over twenty percent of individuals with college educations are out of work. The University of Puerto Rico's education is of high priority in the Commonwealth. About 27 percent of the budget goes directly to support education, while another 4-6 percent provides indirect support. With a population of just over three million, and a per capita income lower than any mainland state, Puerto Rico has more than 160,000 students enrolled in its private and public colleges and universities. The UPR, one of the largest universities in the Western Hemisphere, has 52,000 students, mostly Puerto Rican. More than 20,000 of them receive some direct financial aid. The University is a source of pride and a center for development in the Commonwealth. UPR is a land grant institution; its funds come from tuition, which is relatively low by comparison (\$20 per semester) to the mainland, and from legislative allocations. UPR gets a flat nine percent of the Commonwealth's income as basic funding, with special allocations added. In recent years, with economic downturn, Commonwealth real income has declined and the University's budgetary base has been squeezed. The University is guided by a Council on Higher Education which is appointed by the Governor and which, in turn, appoints the UPR President. The current President is Arturo Morales-Carrion. All significant appointments of chancellors, deans of faculties, and the Director of PEIC must be approved by the Council. In recent years, there has been frequent turnover in many of the major positions at UPR. There is a conscious effort to appoint qualified Puerto Ricans to major positions.

The University participates in a number of U.S. educational grants and research programs. Under a new policy, each contract, grant, or proposal for a grant or contract, must be in harmony with Council policy and be approved by the President of the University. Similarly, ERDA's arrangements with the University for the management of PRUC, must have the approval of the President and the Council of Higher Education.

The Office of Petroleum Fuels Actuaries was created by the Legislature of the Commonwealth of Puerto Rico in July, 1973 to formulate a dynamic energy policy for the Commonwealth. This was based upon empirical information which has been well quantified and qualified for analytical purposes. The fundamental objectives include the following: (i) Availability of required energy supplies from secure sources; (ii) To obtain for our society the lowest possible cost for energy; (iii) Minimizing the impact of energy costs on economic welfare and progress; (iv) To minimize the unfavorable effects induced by marketing problems and international energy policies; (v) To establish a well-correlated relationship between environmental factors, generation and utilization of energy; (vi) To minimize inequities which may arise as a consequence of economic or regional factors in terms of costs and availability of energy sources; (vii) To promote efficiency and optimal use of energy in all energy operations and uses; (viii) To carry on scientific research in reference to alternative energy sources, orienting such efforts for the achievement of regional energy sufficiency.

The Division of Scientific and Technological Research is an energy research and service unit which is an integral part of the Office of Petroleum Fuels. The principal fields of interest include petroleum refining, energy utilization, fuel combustion, chemical composition, mathematical modeling of atmospheric pollutants, and sulfur chemistry. The Office develops its applied research and service programs in combined efforts, when necessary, with industry, government and university scientific and technical personnel.

PROGRAM COST SUMMARY

PUERTO RICO NUCLEAR CENTER

FY 1958 - FY 1978

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Page Break

Page Land and Sub-Land Areas: March 1, 1976

Land (20 acres, Mayagüez, Federal Agricultural Experiment Station)

Space (teens, Comets 1)

Rahn Park in Kad Cater

National Forest, Ue Pei

Forest Space Total: 247 acres

1. Building

- Main Space: 1,000

- Administrative Space: 500

2. Near Environment: 205

3. Animal Shelter: 130

4. Greenhouse: 2,400

5. Station Generator: 2,500

6. Farm Manager: 00

7. Fields, Plants, etc.: 10,600

8. Animal Shop: 2,500

9. Corn Field, Meyer: 1,000

10. Laboratory: 2,500

11. Tax Department, Lost Forest: 5,000

12. Laboratory: 7,300

Grand Total: 15 Buildings, 11,045 acres

Page Break

Facility Investment Page 2: Puerto Rico Nuclear Center FY 1958 thru FY 1975

Initial Facility Occupancy Cost Mayagüez Site

- Nuclear Center Laboratory and Reactor: Sep. 1960, \$2,550,000

- Center Modifications and Minor Additions: \$788,007
- Conversion of PANG Reactor: Apr. 1972, \$355,000
- Nuclear Engineering and Training Reactor Annex: Jun. 1961, \$16,305
- Marine Biology Laboratory: Jun. 1966, \$36,619
- Administration Building: Jan. 1967, \$95,668
- Shop Building and Additions: Mar. 1967, \$14,538
- Agricultural Biosciences Laboratory and Additions: May 1968
- Shielded Facility for Neutron Generator: Sep. 1971

Total Investment Mayagüez

Piedras Site

- Biomedical Building: Feb. 1961
- Biomedical Building Addition: Sep. 1970
- Radiotherapy Linear Accelerator: Aug. 1973
- Modifications and Minor Additions
- Animal Quarters and Virus Laboratory: Aug. 1965
- Aerial Experimental Facilities: Mar. 1975
- 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 Jan. 1974 \$385,363 'S \$967,537 Luquillo National Forest Site Acquisition Laboratory \$123,510 Total Investment - PANE \$5,823,012 *Construction Complete

Exposure > A Detailed ERDA Analysis of Three Principal Options

Section 1 - Continue PRNC COCO Arrangement with the University of Puerto Rico - Certain Management and funding modification

Maintain the current PRNC COCO status but substantially improve it as follows:

1. Centralize the two PRNC administrative units (Mayaguez and Rio Piedras) into one at Rio Piedras, to facilitate financial savings
2. Eliminate programs that are of low priority for ERDA's purposes and which either UPR or others wish to support.
3. Seek support from other Federal agencies or other sources for any current PRNC programs that are of value to Puerto Rico and/or the United States, but are of low ERDA priority.
4. Phase out Base Program funding by reducing the education and training budget to the level that ERDA deems essential for these purposes and concurrently seek supplemental support from UPR, NSF, HEH, the Commonwealth of Puerto Rico, or other agencies as appropriate.
5. Strengthen existing valuable research programs and initiate new programs in ERDA high priority energy development areas through the introduction of developmental and institutional funding. The

major program emphases would include five principal areas, the first two of which are ongoing, and the latter three of which will require developmental attention: Environmental sciences, Human ecology (biomedical), Conservation, Solar scientific and engineering research and development including OTEC, Materials research and development.

Section 1 - Pros and Cons

Pros: 1. COCO operation provides a very capable management organization and associated administrative and maintenance operations which can execute high technology R&D programs in a more efficient manner.

Effective and timely manner than would normally be available in the UPR samples, the COCO operation provides a clearer focal point for the UPR Energy Center and more obvious ERDA presence in Puerto Rico than would otherwise be possible. The COCO operation provides a vehicle for putting other Federal agency work into PRIC under interagency agreement.

4. The COCO operation permits use of GSA supply contracts, PIS communication, and motor pool services. However, the COCO operation requires its own separate administrative network within UPR which, while more efficient, is more expensive than if the central UPR administration handled the business activities.

2. The COCO method of operation requires UPR compliance with a host of Federal requirements and procedures which necessitates a large PRNC administrative and overhead staff (as well as considerable ORO Contract Administration effort.)

3. The COCO operation reduces UPR flexibility for use of PRNC facilities. It eliminates UPR ability to compete for commercial work to be partly or wholly performed in PRNC facilities and, under current restrictions, prevents UPR from responding to ERDA RFP's in new program areas of interest to UPR for performance in ERDA facilities.

4. The COCO operation requires indefinite ERDA funding support for facilities and administrative support staff, irrespective of the quality of the program or relevance to developing ERDA priority.

The COCO operation historically has evoked clear separation between PRIC and the remainder of UPR and, while expected to improve, still will inhibit truly cooperative programs. Further detailed supporting analysis of this option is contained in Appendix 10.

Option 2 - and with the PR Those current PRNC facilities which predominantly house BER programs and are of high ERDA priority would be retained as Federal property. Those facilities of PRNC which appear closely integrated with and important to UPR programs would be programmatically transferred to the UPR and would be fiscally supported by those.

Programs (ERDA program and institutional, UPR, and others) which utilize the facilities. The facilities which would be retained under Federal ownership would be: 1. Cornelia E11 2. Rain Forest Facilities 3. Man Ecology Building at Mo Piedras. The facilities which would become a part of the UPR or otherwise disposed of by ERDA would be: 1. The Mayaguez Facilities 2. The Cornelia #111 Dock 3. The Main Building at Rio Piedras.

Option 2 - Pros and Cons

1. Retains maximum management and organizational strength for execution of Life science and environmental programs at PRNC which are currently of highest program priority to ERDA. Maintains clear and viable ERDA presence in Puerto Rico as an "Environmental Center". Provides some facilities and equipment to UPR as a base for broadened energy center programs relevant to ERDA and the Commonwealth of Puerto Rico.
2. Provides UPR with flexibility to compete for some outside work and ERDA HPP's in those facilities transferred to the University. However, this will continue to require maintenance of a costly administrative network within UPR, the burden of which will be borne solely by the last supporting ERDA program division (BER).
3. Separates ERDA energy development from the environmental work at UPR, and probably will create a less than desirable degree of interaction. Prevents UPR from competing for other than ERDA environmental areas for execution in the facilities maintained as COCO.
4. Requires indefinite ERDA funding support for the administrative staff and the facilities retained as COCO, irrespective of the quality of the Program or relevance to developing ERDA priorities. Further detailed supporting analysis of this option is contained in Appendix 11.

Option 2 - Discontinue COCO Operations and Transfer Facilities

Under this option, ERDA would programmatically transfer PRNC facilities to UPR, phase out the COCO method of operation at UPR, and encourage development of a viable

Agreement with EROA,

Suggested Administrative Approach 70 '980 for Transfer of Facilities to The UPR

As per the agreement with EROA, it is suggested that the UPR be directed to execute an agreement or contract modification with UPR to proceed with the programmatic transfer of appropriate EROA facilities to UPR and the orderly closeout of GOCO operation.

The agreement should include a timetable for completion of the implementation elements and clear indication of ERDA plans for long-term funding support by funding category. Included in the agreement shall be a provision to change the PRIC name to Puerto Rico Energy and Environmental Center.

2. The actual programmatic transfer of facilities will be a phased process taking about three years for full implementation and transfer. However, upon execution of the above agreement, ADA can begin handling UPR-PRIC 48 4 non-GOCO facility for purposes of permitting non-ERDA work in PRC facilities. UPR will have flexibility to compete for REPs in the private or Federal sector, and UPR will be eligible to receive ERDA "instructions" support.
3. The administrative and fiscal steps of closing out the GOCO operation and transferring the

facilities are to be handled by ORD. While the administrative procedures associated with the transition can be accomplished in one year, the "technical" problems of radioactively contaminated facilities and the need for UPR to obtain NRC Licenses for possession and operation of the PANG facilities, will extend the transition period to an estimated three years.

4. The use permit will be made available to ERDA under clause 8 and will not be transferred to UPR. However, the use permit will be transferred to UPR.

5. Cornelia Rift facilities contain no radioactive contamination, therefore, they can be removed from the GOCO method of operation and placed on other funding arrangements during FY 17 or FY 78. The Rio Piedras facilities (all or part) can be programmatically transferred to UPR in about 18 months. The final transfer will be contingent upon UPR extending its NRC License for possession and operation.

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