"CEER-x-094 ENERGY/ENVIRONMENT MANAGEMENT: A BROAD PERSPECTIVE FOR THE ISLANDS OF THE CARIBBEAN" by the Center for Energy and Environment Research

"ENERGY/ENVIRONMENT MANAGEMENT: A BROAD PERSPECTIVE FOR THE ISLANDS OF THE CARIBBEAN" is a background paper for Workshop 11 on Energy Environment Projects for the Caribbean Area. This workshop took place at Key Biscayne, Florida, on March 19-20, 1981. The paper was authored by Dr. Juan A. Bonnet, Jr., Director of the Center for Energy and Environment Research in San Juan, Puerto Rico, and Dr. Edward L. Towle, President of the Island Resources Foundation in St. Thomas, U.S. Virgin Islands.

"ENERGY/ENVIRONMENT MANAGEMENT: A BROAD PERSPECTIVE FOR THE ISLANDS OF THE CARIBBEAN" discusses the environment and ecosystem, focusing on the cycle of energy production and consumption in the Caribbean. This cycle produces complex impacts on the Caribbean island environment. Although petroleum supplies in the Caribbean are virtually nonexistent, with the exception of Trinidad and Tobago, their transportation within the region and the region's near-complete dependence on petroleum for power guarantees that petroleum will have a profound impact on the total island environment for some time to come. Historically, close to two-thirds of all U.S. oil imports—both crude and products—have been shipped by way of installations in the Caribbean area. Puerto Rico has three refineries and oil transportation is a critical environmental concern. Table I details the petroleum refining capacity in the Caribbean.

For example, the HOVIC or Hess oil refinery on the island of St. Croix in the Virgin Islands, is the largest refinery in the world. Nearly 1,000 tankers enter or leave the Hess Port every year. The oil that passes in and out of Limetree Bay on St. Croix every year exceeds 15 billion gallons (Potter, 1978). Further, the government of St. Lucia is negotiating to construct an even larger refinery on its shores.

Table I: Petroleum Refining Capacity in the Caribbean (Oil and Gas Journal, 1976)

Country: Venezuela
Country: Netherlands Antilles
Country: Trinidad and Tobago
Country: U.S. Virgin Islands
Country: Bahamas

Panama Puerto Rico Exported Refinery, operated by Lagoven/Exxon (at Amuay), Raven/Shell (at Carbon), Exxon (at Aruba), Royal Dutch Shell (at Curacao), Texaco (at Point-a-Pierre), Trintoc/Shell (at Point Fortin), Amerada Hess Corp. (at St. Croix), New England Petroleum Co., Standard Oil of California Texaco (at Colón), CORCO (at Guayanilla), Sun Oil Co. (at Yabucoa), and Caribbean Gulf (at Cataño). The total capacity is 600, 337, 440, 409, 361, 100, 728, 500 (000 b/d) respectively.

Studies by the Marine Ecology Division of the Center for Energy and Environment Research have documented the severe perturbation that may result from petro-industrial operation on a marine

environment such as Guayanilla Bay (López, 1980). Deleterious effects were documented in zooplankton, fish, mangroves, seagrasses, and benthic animals due to thermal pollution. Distribution patterns of chemical contaminants demonstrated heavy accumulations downstream from effluent discharges. The occurrence of mercury in the flesh of commercially important fish was studied and documented. A productive mathematical model for a tropical bay was developed to be used for management of this ecosystem (Chartock, 1980).

A Caribbean Oil Spill Contingency Plan, coordinated by the Organization of American States (OAS) and others, is almost completed. A potential landmark decision with respect to environmental restoration after an oil spill in Bahia Sucia in Puerto Rico now awaits confirmation in Federal courts. All these are steps in the right direction.

Coal is becoming a fast, economically attractive energy alternative for the Caribbean regions, and this will impact the energy production, transportation, and use in the region. Already, Puerto Rico, the Dominican Republic, and Cuba have announced plans to build coal-fired units.

The Republic of Colombia is moving toward becoming a major coal supply for the region. The study of the energy/environmental management of this alternative becomes a high priority. Energy production which might mobilize agricultural products brings

The text discusses three specific environmental effects in the Caribbean: erosion or siltation, depletion of fresh water, and effluent discharge. Currently, distilleries in both Puerto Rico and the Virgin Islands are struggling to meet water-quality standards for their effluent. CEER has investigated the effects of rum distillery slops on the marine environment in Puerto Rico and in St. Croix. Both water and air pollution have been cited as primary obstacles to reactivating the old Pott Rum distillery in downtown St. Thomas (Towle, 1979). Other examples of environmental degradation caused by energy activities include losses to fisheries due to power plant siting, whether from ocean thermal energy conversion (OTEC), nuclear/thermal, or traditional petroleum/thermal impacts. These pollution effects are part of the whole ecosystem, a system that must be considered in totality, especially on an island. This totality includes human resources as well as natural resources, providing a broader perspective.

A framework for energy/environment management presents a new perspective on environmental issues. It raises interesting questions about what we perceive as the environment. We can no longer take for granted a common understanding of the term, as language, perceptions, and attitudes may differ within and between cultures. As these value systems are developed, they are influenced by human interaction with the natural environment. Chartock has developed an ecosystem approach to energy-related environmental research planning that emphasizes this human-nature island system (Chartock, 1980). This framework, initially developed as an adjunct to CEER's Guayanilla Bay project, has broader applicability to the Caribbean. It emphasizes energy flows and material cycles in the connected natural and human-dominated ecosystem. Figure 1 illustrates the form, distribution, and activity of energy flows upward through the hierarchy in Puerto Rico.

Rican components of the man-nature system and the counterflows which exert a feedback control over it. A framework for energy/environmental management to be considered is the

ecodevelopment approach. Sachs contrasts the traditional rationale such as free market and resource management, with the more comprehensive goals of ecodevelopment. (Sachs, 1979)

[This section appears to be scrambled or in a different language and cannot be corrected.]

ECODEVELOPMENT IS:
* An approach to development aimed at harmonizing social and economic objectives with ecologically sound management in a spirit of solidarity with future generations.
* It is based on the principles of self-reliance, satisfaction of basic needs, a new symbiosis of man and earth, and a different kind of qualitative growth — not zero growth, not negative growth.

ECODEVELOPMENT REQUIRES:
* Harmonization of consumption patterns, time use, and lifestyles.
* A low energy profile, promotion of renewable energy base.
* New uses for environmental resources.
* Careful husbandry of resources, recycling.
* Ecological principles to guide settlement patterns and land uses.
* Participatory planning and grass-root activation. (Sachs, 1977)

Some further comments on ecodevelopment:

"Ecodevelopment does not lead to any ultimate state of 'ecodeveloped.' Adoption of the concept recognizes that a cultural-ecological system cannot undergo unregulated growth of any of its parts without being constrained by the need for related adjustments and adaptations in the other parts of the system. Growth need not be abandoned in this view; rather, a strategic look at all the consequences of growth should be taken in order to make both sound judgments about the desirability of change and informed choices relative to the kinds of change." (UNEP, TRIAS, 1976)

"One of the fundamental points about ecodevelopment is the role of the local population. The strategy calls for not only the local peoples' participation, but also their control over the decisions that are...

The process of development involves making decisions that affect the future, control of resources, and the process of converting those resources into economically viable products (Farvan, 1977). 'Ecodevelopment' is not only a direction that the Third and Fourth World countries may follow, but also one that must be pursued in the industrialized world. It is our particular responsibility to bring it to reality in our own country - to reshape and reassess our own technological society so that it is no longer destructive to poor nations or a drain on their resources. The goal is to find socially and environmentally acceptable directions to pursue (Desmann, 1977).

These issues were reiterated in a workshop by the Canadian International Development Agency on Environment and Development, Prospective and Ecodevelopment, Strategies for Action. Part of the reason for our lack of success is related to the existence of a powerful combination of constraints that limits our ability to fully assess new approaches to development. We appear to be locked into the analytical techniques and perceptions of the past, which often disregard the self-reliance

postulate implicit in ecodevelopment concepts. Our institutions, in many cases, tend to pursue narrowly defined, single-sector policy objectives, which often prevent the attainment of an optimal set of multiple objectives.

There is a prevailing trust in the ability of science, management, and the marketplace to resolve problems whenever they arise. This faith now underpins current government incentives; the selection of options leans towards large scale, high technology, institutionally directed solutions instead of flexible, varied-scale, individually chosen activities. Public awareness of resource development issues and the extent to which individual and societal well-being is dependent on the wise use of resources is not sufficiently developed. There is an inadequate sense of individual and collective responsibility towards these issues.

The text calls for greater efforts to increase public knowledge and to make public participation an essential part of decision-making processes concerning resources. The CER project funded by the National Academy of Sciences, "Community Participation in the Development of Energy Self-Sufficiency for the Island of Culebra," is an effort focused on community participation in a decision-making process. The study, "Puerto Rico and the Sea," is another example. The emphasis is on resource management and environmental quality to be much more directly part of public decision-making, and less the prerogative of specialist authorities. (CIDA 1977)

Management agencies in both renewable and non-renewable resources are faced with a dual role: on the one hand, to put resources to optimal economic use, and on the other hand, to conserve them. Ecodevelopment approaches can provide the guidelines to minimize these apparent management contradictions through integrated management approaches involving agencies and interest groups which are currently operating separately or in confrontation with each other. They must be adapted at all levels of management and program support to be effective. A technical subsidiary of this view and approach is the adoption of the "assimilative capacity" approach to regulation and development. This implies that we must measure what insults the systems can bear without significant degradation or loss of "ecological integrity". (Cairns, 1979)

Energy Technologies

In this broader view, we can re-examine some familiar energy technologies with respect to the Caribbean. (Bonnet, 1981) High technologies proposed for Puerto Rico or the Virgin Islands include ocean thermal energy conversion (OTEC) with which we are very familiar in Puerto Rico. CEER has a floating OTEC Laboratory off the southeast coast of Puerto Rico at Punta Tuna. OTEC is a high-technology development with great potential for the islands because of its reliance on an inexhaustible and renewable resource, the

The temperature difference of the ocean, coupled with preliminary evidence that its environmental impact will be minimal, suggests that in one sense it is a proven concept. It briefly generated electricity a long time ago and did so again recently with mini-OTEC. However, in another sense, it is brand new and unexplored. At the scale required for commercialization, there remain uncertainties related to the effect of the environment on the OTEC plant and its operation.

Additionally, questions exist regarding the effects of many large plants on the marine environment. These questions merit further research due to the potential of the technology. CEER has been involved in this research.

A main question is whether accumulations of biofilms and the corrosive action from the seawater will hinder the heat transfer process. Another significant question is whether the biota exposed to multiple OTEC discharge plumes can continue to function normally. There is a possibility that the discharge, if treated correctly, may be used for economic benefit through use in the culturing of commercial marine species. Another advanced technology is solar cooling. The viability and commercialization of solar cooling has always received high priority on the Caribbean tourism dependent list. Other energy technologies including solar steam production, solar ponds, combustion of biomass and municipal garbage, and biogas are possibilities for the islands. CEER has active programs (Bonnet, 1979) in solar data collection and analysis, solar water heaters, solar parabolic compounded collectors for industrial process heat, and solar air cooling. Other programs involve energy and environmental assessments. Strong programs exist in biomass, sugar cane and tropical grass forestry and bioconversion. Extensive marine, terrestrial and human ecology programs are also underway. More than $18 million has been spent on this research from 1977-1981.

(CEER 1980 Annual Report). One of the main goals of CEER is to develop.

Indigenous energy resources, which are compatible with their fragile tropical environment, are found throughout the wide Caribbean region. These resources often require complex technology to harness. In addition, the Solid Waste Authority in Puerto Rico has completed a solid waste plan for the island, and a similar plan has been published in the Virgin Islands. The Caribbean appears well suited to take advantage of these renewable energy resources as a substitute for petroleum (AID, 1979).

The Caribbean's natural energy resource base consists of high levels of insolation (solar energy), excellent biomass growth rates, trade winds, and geothermal energy potential. In a number of countries, significant hydropower potential also exists. The conversion of these indigenous resources may become cost-competitive sooner in some economic sectors in the Caribbean than in industrially advanced countries. This is due to the comparatively higher costs and almost total dependence of the region on imported petroleum fuels.

These economic and resource factors, if combined with the necessary technical expertise, managerial skills, financial resources, and government and institutional support, could effectively address the energy problem. This could allow the Caribbean to be one of the first areas to take advantage of alternative energy options.

Several alternative energy conversion processes are already in use in the region. In a number of Caribbean countries, hydropower is already an important indigenous energy resource and provides a significant proportion of total electricity generation, both on a large scale and micro-hydro level. Wood and charcoal (biomass fuels) provide significant amounts of energy in heavily rural and/or forested countries (Haiti, Belize, Dominica, Dominican Republic, Grenada, Guyana, and St. Lucia).

Efforts to increase the utilization of these resources must concentrate on production, transport, and marketing efficiencies in order to make an additional contribution. These efforts must also be accompanied by integrated reforestation programs to ensure sustainability.

To avoid further ecological damage (e.g., Haiti), other biomass options could be considered. These include the combustion of bagasse (sugar cane waste) and other plant waste for electricity and steam cogeneration. The conversion of plant and animal waste to gaseous fuels can be achieved through digestion, and liquid (alcohol) and solid fuels can be produced from agricultural and timber waste. The Center for Energy and Environmental Research (CEER) has an extensive and sophisticated program developing energy cane and tropical grasses. The results from the four-year study have been very encouraging (Alexander, 1980).

Solar energy has substantial potential throughout the region. Commercial enterprises are underway in hot water heating (e.g., Puerto Rico, Barbados, Dominican Republic, St. Kitts), water distillation (Trinidad), air conditioning (Barbados), and crop drying (e.g., Jamaica, Trinidad, St. Lucia). Each of these options can be effectively used in a number of residential, commercial, and industrial applications. However, incentive schemes may be necessary to assist widespread development.

Similarly, wind energy potential exists in many Caribbean countries. It was, in fact, used throughout the region in the past for water pumping and mechanical power. Wind power for pumping water (e.g., for irrigation use) and on-site electricity generation in remote sites are the likely applications for this resource. One of the early U.S. Department of Energy wind power demonstration machines of 200 kW has been installed on Puerto Rico's offshore island of Culebra.

Finally, geothermal energy represents a potential resource in several Caribbean countries (e.g., St. Lucia, Dominica, Martinique, Haiti, and St. Vincent) (AID, 1979).

From a broader perspective on island energy planning, it's clear that some technologies are more useful or more suitable than others. We find that we deliberately choose one technology over another, or one group of technologies instead of another. This choice can be made on any number of bases, such as a least-cost criterion.

Lack of pertinent or accurate data could prevent a country from using a particular energy device. We might decide on the basis of environmental impacts or health risks. Our reasons for adopting one technological mix instead of another may be political, or, because of economic constraints, we may have no choice at all. The broader view, however, is consistent: All of these reasons should be considered in making the decision to employ any particular energy strategy. Once again, we should not fall into the trap of a restricted or narrow view. Oil spills are part of a dynamic ecosystem which includes humans who utilize specific energy sources that might cause oil spills. This interdependence is part of a larger process.

Countries, especially of small size and extremely narrow resource bases made even more critical by man-made or natural degradation of critical habitats and having at the same time high human population densities, cannot afford to experiment with only a few eco-development projects. Rather, eco-development must become the umbrella concept for future growth and must be fully integrated into national planning. In fact, this might be the only hope for peaceful and comfortable survival of human populations on small islands in the 21st century.

Jackson points out that the thrust of national planning varies from one territory to the next. It is, however, possible to identify, for the islands under focus, five (5) broad categories of planning that are either fully institutionalized or occur informally or sporadically. These are:

1. Economic planning - Frequently with very little integration of key sectors, such as agriculture, fisheries, forestry, tourism, and industry.
2. Physical planning - Introduced to most territories in the past decade.
3. Infrastructure planning (physical and social) - Physical; including transport facilities, water, and electricity: social; including schools, hospitals, clinics, and administrative buildings.
4. Human resource planning - Not usually defined as such but embracing.

Education, health, culture, and recreation are crucial aspects of environmental planning. They may not always be present, but they are critical to the larger scope of ecodevelopment (Jackson, 1980).

Developing Countries

Developing countries present some special considerations. As Raymond Goodman of the World Bank points out, these countries consume a small share - 12 percent - of the world's commercial energy. However, their economies are growing faster than those of the industrial countries. The rapid growth of cities, industries, motorized transport, and other energy-intensive developments have in the past caused their demand for commercial energy to grow faster than their gross national product. Much of the increased demand has been met by oil, and the majority of developing countries must import all or a portion of their oil requirements (Goodman, 1980).

However, this factor should be weighed against a general trend to reduce the levels of energy demand. This trend is evident from energy forecasts compared in 1972 and in 1978 in “Low Energy Futures" (Holt, 1980). As Table IT shows, both energy conservation optimists and skeptics are revising downwards their estimates of U.S. energy requirements.

The Caribbean developing countries will undoubtedly increase their energy demand in order to be able to develop, and consequently, greater reliance on renewable energy sources must be considered. However, any growth prediction of Caribbean energy demand should be tempered by this experience of downward revisions of future energy demand occurring in the developed countries.

A comprehensive energy planning process integrates demand.

Table IT -- Trends in the Forecast of Energy Requirements by the year 2000 (in quads per year)

Year of Forecast	Beyond Conventional Wisdom	Pale Heresy	Superstition
1972	125 (Lovins)	140 (Sierra)	160 (AEC)	190 (Fee)
1974	100 (Ford zeg)	124 (Ford tf)	140 (ERDA)	160 (EET)

1976 | 75 (Lovins) | 89-95 (Von Hippel) | 124 (ERDA) | 140 (EET)
1977-78 | 33 | 67-77

96-101 124 (Steinhart, (NAS I, II) (NAS IIT, AW) (Lapp) 2050) | Abbreviations: Sierra stands for Sierra Club; AEC stands for Atomic Energy Commission; FPC stands for Federal Power Commission; Ford zeg stands for Ford Foundation zero energy growth scenario; Ford tf stands for Ford technical fix scenario; Von Hippel refers to Von Hippel and Williams from the Center for Environmental Studies at Princeton University; NAS I, II, IIT refer to The National Academy of Science Committee on Nuclear and Alternative Energy Systems (CONAES); AW refers to Alvin Weinberg from the Institute for Energy Analysis, Oak Ridge. Amory Lovins' matrix of energy forecast was published in J. Steinhart et al., "Pathway to Energy Sufficiency: The 2030 Study" (Friends of the Earth). The quote is from "Low Energy Future, 1980 DOE/PE-0020" p.3 219.

The supply and resource mix recommendations need to take into account the demand. It would be unwise to continue forecasting a seven-year doubling rate in installed electric capacity. Technicians used to predict these linear figures without considering the real demand of the population for whom they were making these predictions.

Developing countries pose several constraints to the process. Economies of scale may not be achievable in small areas like most Caribbean islands. Klein comments that when considering energy supply and demand in developing countries, two important points should be kept in mind. Firstly, the energy supply/demand balances in developing countries are not homogeneous. These countries have a diversity of energy resources, from plentiful fossil fuels to no fossil fuels at all, from abundant water, wind, sunshine, or biomass, to limited quantities of these resources. Infrastructure and human skills vary greatly. Developing country demands for energy also differ significantly, depending on their economies, from near subsistence levels in some African countries to the large modern sectors in countries of Latin America and Asia.

Secondly, a country's energy supply and its energy demands resemble mosaics of discrete resources and needs. Therefore, careful attention must be paid to the matching of the forms of energy supply with energy demand. Unless energy demand is disaggregated into the form and amounts of energy required for the tasks to be done, the full potential for application of renewable energy resources is often overlooked. (Klein, 1980)

Technology transfer, a primary component of any energy development process, is a prickly item when viewed from a holistic perspective. Historically, there is a strong tendency to look toward the mother country for guidance and, of course, technology transfer. For instance, electric utilities often rely on foreign technology for their systems. The French Islands have French equipment and former British colonies have equipment from Britain or other Commonwealth countries. As a result, one finds a mixture of 120 volts, 220 volts, 50 cycle, and 60 cycle systems throughout the region. In short, the region utilizes not what it truly needs, but what it inherited.

The United States of America's position paper for the United Nations Conference on Science and Technology for Development suggests several standards of fairness in technology transfer.

For an effective transfer, the information base in the developing countries must be broadened to allow them to select what they need from the international supermarket of technology. They must be able to reject what they do not need, choose among competitive offerings, and acquire what is most appropriate and economical for their development needs. The transfer must include an increasing shift in research and development to the developing countries. Research and development that are locally based and oriented toward indigenous resources, needs, and demands contribute not only to the growth of self-reliant capacities but also to a widening of markets and technological innovations.

Islands present special cases when it comes to the energy development process in developing countries. No component of an island's ecosystem can be isolated from the matrix. Therefore, it is futile to speculate on energy development in the Caribbean island countries without integrating recommendations and newly acquired data into the whole island context; its human resources and natural resources.

Towle observed at the First Caribbean Conference on Energy for Development that, first, in the past the islands were energy self-sufficient and the ecological systems in balance. Second, the island ecosystems are of such a small scale that if a large investment project proves to be a mistake, that one mistake in many cases is the only chance one will have had. Consequently, in the first case, strong efforts should be made to achieve natural balances in the islands. In the second case, thorough analysis of all possible impacts should accompany any plans for large projects in the region. The consequences of past mistakes are evident, and any large new ones are likely to be irreparable. (Towle, 1979)

It is evident that any consequence within a chain of events is always going to be more exaggerated in an island setting. These same consequences can be seen in the case of imported petroleum dependence, as discussed in the Caribbean Energy Supply of the World Bank. The countries of the region - again with the exception of Trinidad and Tobago - have some common characteristics which determine their energy position. Among these characteristics are: (i) almost total dependence on imported petroleum for meeting requirements of commercial energy; (ii) the subcritical size of most energy systems which constrains the choice of least-cost solutions; (iii) the absence of organized markets for indigenous fuels, and (iv) the replacement of indigenous fuels by imported petroleum. (World Bank, 1979)

Energy/Environment Planning in the Caribbean: In the past,

Agencies that have focused their attention on the Caribbean have presented a variety of energy development schemes to Puerto Rico, the Virgin Islands, other island territories, and the wider Caribbean area. In most cases, these schemes address only a part of a dynamic, comprehensive, interactive, and holistic system.

For instance, in its reports on the Caribbean, the World Bank recommends the elimination of subsidy pricing (Goodman, 1980). However, the rural and urban poor in Puerto Rico and the Virgin Islands require subsidies, particularly lifeline utility rates. Puerto Rico has been a pioneer in establishing these rates, being one of the earliest to do so.

Another example is the commercialization effort that the Department of Energy encouraged for active solar cooling systems. The islanders had wanted and needed simpler and more applicable

demonstrations, but they received the Frenchman's Reef Hotel in St. Thomas, an early high-tech failure. The system has since been revamped and is being tested again.

Increasing tourism is a seductive, single-sector basis for a national energy growth strategy. The pitfalls are emphasized by Jackson, who states that national planning rarely achieves the success it seeks. A significant limiting factor is the lack of qualified local professionals to help draft and execute plans, especially those extending beyond a one-year timeframe.

National planning is often not effective due to the following reasons:
1. It's usually not well integrated.
2. It does not always develop distinct objectives.
3. It's mostly short-term, linked to annual budgets, and lacks proper criteria for ordering priorities.
4. It's highly dependent on external technical assistance, aid, and external private-sector investment.
5. It's mainly concerned with maximizing benefits to local populations but frequently does not and is rarely concerned with the wider impact.

Minimizing the impacts on ecosystems or natural processes is necessary. However, it often lacks the controls to protect critical natural areas and processes and to derive the greatest possible benefits to human populations from local resource use. (Jackson, 1980)

A less familiar but more comprehensive strategy is energy self-sufficiency or self-reliance, as proposed by participants at the Energy Self-Sufficiency Conference in the Virgin Islands in December 1978. Painter, summarizing the attitudes at the time, stated that the possibility of an aggressive self-sufficiency program and alternate energy strategy which could renew, change, or preserve an island lifestyle and even change Virgin Islands society, are very real and very appealing (Painter, 1978).

In Hawaii, an energy independence strategy has already been implemented. Hawaii's goal is to achieve 50% electrical energy self-sufficiency by 1990 and 50% total energy self-sufficiency, including jet fuel by 2000 (Shupe, et al., 1980). This is coupled with the highest environmental impact and eco-development standards.

One truth that these efforts are discovering is the fact that islands can, in a very constructive way, be viewed as laboratories, as micro-scaled models of the world which illustrate how to solve global problems. Contributing to the view that island environments are logical locations for the introduction of emerging energy technologies are other factors.

Unit energy costs on islands are often substantially higher than on the mainland, so energy alternatives may become cost-competitive more readily in this elevated market. Also, the well-defined boundary conditions of an island facilitate rapid evaluation of the impact of new technologies. And finally, any island communities that are heavily frequented by tourists can serve as showcases to give high visibility to the development of renewable energy alternatives (Shupe, et al., 1980).

There is a kernel of truth in such a viewpoint - I will return to this concept later.

Energy/Environmental Planning Efforts: Over the past few years, several studies have been conducted on various energy and energy/environmental aspects relating to the Caribbean. These include efforts by the World Bank, such as the Caribbean Energy Survey (World Bank, 1979), and the United Nations Environment Programme's Caribbean Environment Program Action Plan on Energy and Environment for UNEP/CEPAL (UNIDO, 1979).

The Caribbean Development and Cooperation Committee has also contributed through their study on Energy Resources in the CDCC Member Countries (ECLA, 1980). Similarly, the DOE/NASA Study on Applications of Solar Technologies for Remote Areas (PRC, 1979), U.S. Department of State/ATD/CARICOM/CDB Caribbean Regional Paper on Alternative Energy Systems (AID/C/C, 1979), and the Caribbean Region Solar Cooperation Study for DOE/SERI (Donovan et al., 1970) have all contributed significantly.

Local studies such as Energy in Puerto Rico's Future by the National Academy of Science (NAS, 1980), "Puerto Rico State Energy Plan", Energy Analysis and Socio-Economic Considerations for Puerto Rico (CER, 1980), the Virgin Islands Energy Conservation Plan (U.S.V.I.E.O., 1979), Technology Assessment of Alternate Energy Sources in the Virgin Islands (CANOY, 1978), Proceedings of the Conference on Energy Self-Sufficiency and the Virgin Islands (CRI, 1978), Superport, Oil Spills in the Virgin Islands (IRF, 1978) and other studies have also been instrumental.

A private effort in the Caribbean, the Island Resources Foundation (IRF) in St. Thomas, U.S. Virgin Islands, has been active throughout the Caribbean in four main project activity areas: (1) Island resources planning, management and eco-development (including energy systems); (2) Island ecosystems; (3) Education, evaluation, and communication; and (4) History, culture, and human resources. IRF is a non-profit research and technical assistance organization.

Finally, the UNIDO Energy and Environment Study for the Caribbean Environment Project of UNEP/CEPAL is comprehensive in area, covering the six subregions surrounding the wider Caribbean area.

The Caribbean islands, subregion one, is the area on which I will concentrate. This overview on energy and environment is presented as an initial data collection effort for the formulation of energy/environment strategies in the area. It covers each subregion and country's energy resources, policies, plans, problems, environmental issues, typologies of technologies, and their environmental impacts. It is a start toward a comprehensive base but is primarily restricted to considerations of the physical environment. The relative inadequacies of many of these other specific plans and studies are painfully familiar to those of us who have worked in energy planning in the Caribbean. Indeed, as mentioned earlier, these plans are characteristic of restrictive national planning approaches when a regional approach is needed.

The Association of Caribbean Universities and Research Institutes (UNICA) provides an academic link to such a regional approach for the Caribbean. The Association was formed in 1940 in Jamaica and includes the main universities and research institutes in the region, including French, Dutch, Spanish, and English-speaking Islands. The Committee of Science and Technology of the

Association has already started a project entitled "Development of Alternative Energy Science and Engineering in the Caribbean". This effort is funded by the U.S National Science Foundation (NSF) and the UNICA Foundation.

Another study I would like to call to your attention is that of the Pacific Basin Development Council, which states that in anticipation of increased economic activities and population growth, the island governments have established policies to encourage the development of an energy conservation ethic. In guaranteeing the economic growth, safety, and welfare of the people and to minimize the degradation of the environment, energy supply sources and usage should be diversified. While assessing and demonstrating the viability of the indigenous sources of renewable energy, gas, and coal should be considered.

The text reads:

Studied as transitional fuels, it is critical that supplies are secured for the immediate future (Actouk. et al., 1980). This territory is actively seeking technologies it requires and is incorporating an ethical approach directly into their operating procedures.

I would like to examine the U.S./AID/CARICOM/DB Regional Project on Alternative Energy Systems for the Caribbean Islands. The rationale behind this study is that alternative energy research and development efforts must be cooperative and regional in nature. They also must be accompanied by serious efforts in:
1) the development of general as well as alternative energy policy,
2) establishing effective communications networks in energy areas, and
3) developing a skills base through technical, managerial, and professional training.

The smaller, less developed countries (LDC) face particular constraints due to their size and limited capabilities, preventing the development and utilization of least-cost energy supply options. Addressing energy problems and alternative energy development on a regional level allows for the achievement of economies of scale by directing development efforts towards wider applications. Few instances of multilateral or bilateral programs have sought to involve international cooperation within the region, nor have energy programs been carried out as part of an integrated alternate energy initiative (atp/c/c, 1979).

Even though the CARICOM/CDB Project primarily deals with alternative energy systems, its approach is based on a context similar to the definition which Sachs provided for comprehensive eco-development planning.

I am convinced that the critical long-term transition issue in energy/environment management in the Caribbean Islands is the active development of indigenous energy resources in a holistic environmental context through integrated regional projects such as this CARICOM/CDB Project. It is interesting to note that the French-speaking islands are...

The text is currently considering such an approach and has recently invited their English-speaking counterparts to the First Caribbean/European Contacts Meeting, which took place from February 21 to 24, 1981, in Guadaloupe.

Shifting focus to another political viewpoint, namely the internal energy policies for the states and territories of the United States, there has been growing concern over the past several years for the economic and social well-being of the territories, including the Virgin Islands, and the Commonwealth of Puerto Rico. These areas face particularly acute problems as island entities. As previously discussed, energy is one of their most critical issues. Last month, in February 1981, the domestic electric rate in the U.S. Virgin Islands rose to 21 cents, and in Puerto Rico to 11 cents per kWh.

In response, a bill, the Omnibus Territorial Bill HR-8444, was introduced in Congress. It was passed by Congress and signed by President Carter on December 5, 1980, and is now known as The Omnibus Territorial Act 232.

This Act states that it is the policy of the Federal Government to: (1) develop the renewable energy resources of the Caribbean and Pacific insular areas of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Northern Mariana Islands, the Federated States of Micronesia, the Marshall Islands, and Palau; and (2) to assist other insular areas in the Caribbean and Pacific Basin in the development of their renewable energy resources.

The Secretary of Energy is directed to prepare a comprehensive energy plan with an emphasis on indigenous renewable sources of energy in each of these territories, and for Puerto Rico. The CEER is the only U.S Department of Energy facility in a Caribbean Island.

The conclusions of Congress underscore our previous statements that comprehensive energy development planning is critical to this region for environmental, as well as social, economic, and political reasons. It is clear that this legislation presents the Caribbean and Pacific islands with an unparalleled opportunity to...

Become exemplars of comprehensive renewable energy development. Prospect for Synergy: Energy development in a regional system framework. It appears that a unique opportunity exists for a great synergistic reinforcement of the UNEP Caribbean Energy Plan, the CARICOM/CDB program, and the OTA/PR/VI program from interactions between them.

A regional approach to the development of capabilities in the energy area is important because Caribbean countries share common characteristics which determine their energy position. It is unreasonable to expect that the relatively small developing countries of the region are individually capable of developing renewable energy sources. Regional cooperation in development efforts provides a better base from which to mobilize and utilize limited human, informational, and technical resources.

Solutions to energy problems must be country- and location-specific, but regional coordination avoids unnecessary and costly duplication of efforts in the solution of recognized common problems. However, we also feel that the key to the long-term solutions can only be found in a comprehensive and active development program interacting between the diversity of human needs and demands of the social equations and the energy technologies and resources available, determining the delicate appropriateness of subtle and variable mixes of many discrete solutions to

particular regional, local, and site-specific problems.

This will be a continuing active process in a long transition requiring a continuous interchange at each development phase with all the environmental factors and among all the human participants. A broad, multi-sector analysis is the only foundation upon which one can build such a continuing development of energy systems solutions for the future.

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