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ENERGY FOR THE CARIBBEAN:

THE MEDIUM TERM

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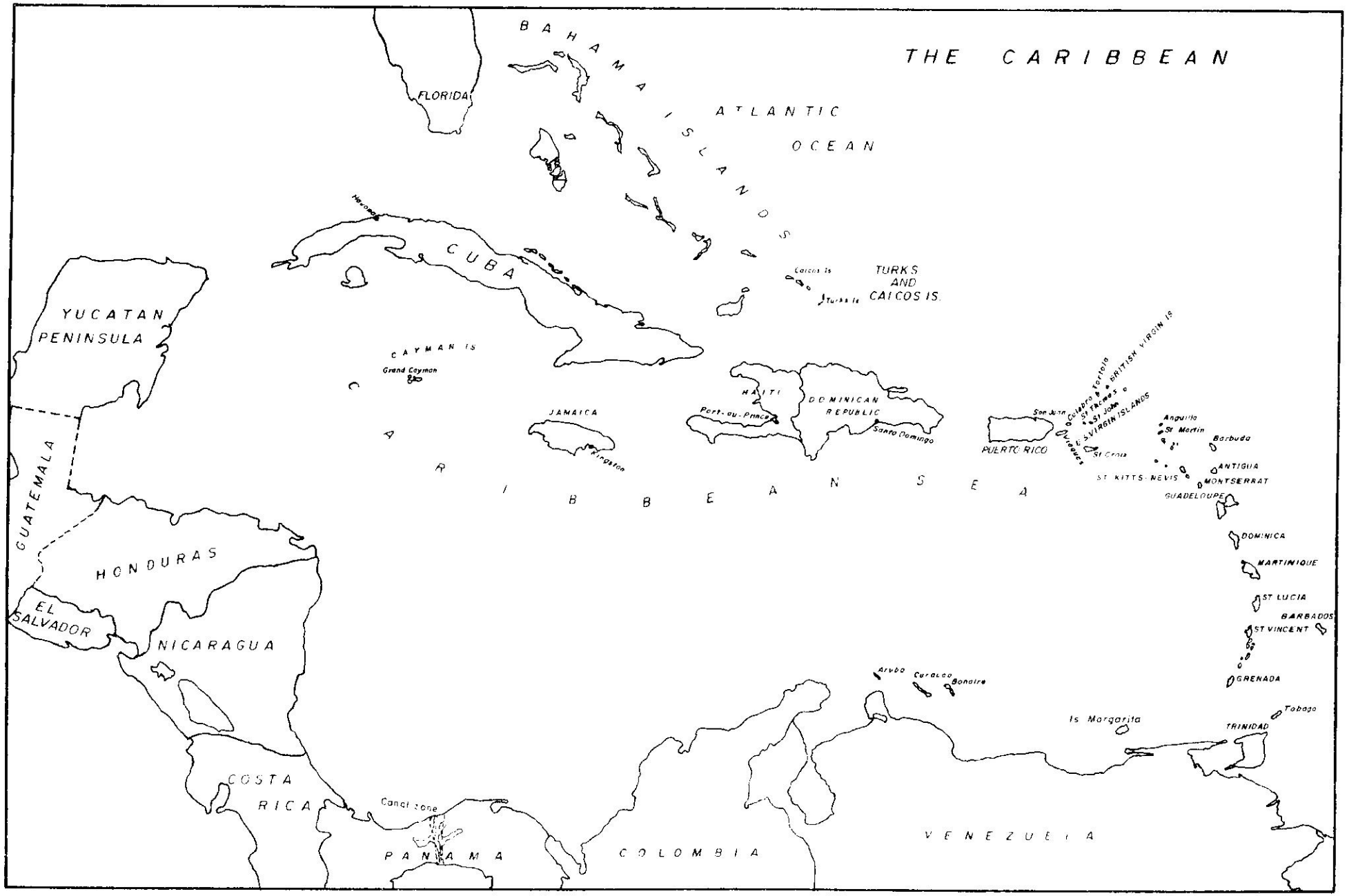
THE CARIBBEAN
BAHAMA ISLANDS
ATLANTIC OCEAN
FLORIDA
CUBA
Havana
YUCATAN PENINSULA
CAYMAN IS
Grand Cayman
Caicos Is
Turks Is
TURKS AND CAICOS IS.
JAMAICA
Kingston
HAITI
Port-au-Prince
DOMINICAN REPUBLIC
Santo Domingo
PUERTO RICO
San Juan
Culebra
Vieques
Tortola
St Thomas
St John
BRITISH VIRGIN IS
U.S. VIRGIN ISLANDS
St Croix
Anguilla
St Martin
Barbuda
ANTIGUA
MONTSERRAT
ST KITTS-NEVIS
GUADELOUPE
DOMINICA
MARTINIQUE
ST LUCIA
BARBADOS
ST VINCENT
GRENADA
CARIBBEAN SEA
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
Canal Zone
PANAMA
COLOMBIA
VENEZUELA
Aruba
Curacao
Bonaire
Is Margarita
TRINIDAD
Tobago

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Abstract

Energy use patterns are changing in the Caribbean for a variety of reasons. These include growing populations, increasing urbanization, new industries, increasing energy import costs (over the long run), general modernization, and development, among others. The current status of energy production and consumption are explored. Possible changes in demand and supply are considered, and estimates of demand through the year 2000 are made. The chances of effectively meeting these needs with domestic resources are poor. Given the present state of development of renewable energy technology and the estimated possible contribution of the technologies to the energy mix of Caribbean countries and probable increased demand, the Caribbean will find it necessary to import ever increasing levels of energy resources. The United States Caribbean Basin Initiative (CBI) and other programs should consider the development of the energy infrastructure of each country, compatible with the development strategy of each.

INTRODUCTION

This paper explores the energy requirements of the insular Caribbean through the year 2000. It must be recognized that the energy needs and the options open to tropical and subtropical islands differ from those available to much of the rest of the world. While solar resources (sun, wind, biomass, sea) are relatively abundant, the more conventional fossil resources (oil, natural gas, coal) are produced in only three of the fifty-one inhabited islands of the Caribbean. And only one country, Trinidad and Tobago, is a net exporter. Most of the islands are very small, seriously limiting economies of scale possible in other land masses. Data on the Caribbean are shown in Table 1.

TABLE 1

As Table 1 shows, the size of the countries range from tiny Bermuda (53 sq. km.) to the "giant" Cuba (113 960 sq. km.). Populations too are relatively small, ranging from 6500 on Anguilla to 9.8 million in Cuba. Per capita gross domestic product (GDP) is low, typical of developing countries, ranging from US $3172 in Puerto Rico to $260 in Haiti. The governments of many developing countries are taking shifting economic dependencies into consideration as they plan national energy policy (10). Size limits the potential of large-scale electric generation schemes. We are told, for example, that Antigua wishes to expand its generation capacity by 6 MWE, and to do so with two 3 MWE units.

Only the larger islands have sufficient demand to even remotely justify nuclear power. The smallest U.S. commercially available power reactor is the 600 MWE pressurized water reactor (PWR). Consider the impact, not even taking cost into account, of such a system in most of the Caribbean, where installed capacity (excluding the larger islands of Cuba, Hispanola, Jamaica, and Puerto Rico) ranged in 1980 from 14 MWE in St. Kitts - Nevis to 454 MWE in Trinidad and Tobago (21). Even in Puerto Rico, which has the largest installed capacity of the islands -- 4290 MWE in 1980 -- one of the smallest units would represent fifteen percent of installed capacity. In fact the total installed capacity of these small islands is only 1630 MWE (see Table 6 below). A 600 MWE reactor would represent 37 percent of current installed capacity of the small Islands.

As a rule of thumb, no electric unit should be of a capacity greater than 20 percent of the actual, available installed capacity. One small nuclear reactor represents for most marked excess capacity, very high costs, and very limited options when the reactor is down (6,14). However, once electricity transmission is economically feasible across or under water, cooperative arrangements may be possible. These too would face serious institutional, political, and social constraints (16). Only one country, Cuba, is pursuing the nuclear option. There are two 440 MWE PWR units currently under construction by the Soviet Union.

In the mid 1970's Puerto Rico bought a 600 MWE PWR Westinghouse unit, but cancelled it for political, economic, and ecological reasons.

Coal generated electricity is also being considered, especially in the Dominican Republic and Puerto Rico. As there are virtually no solid fuel reserves and no known bituminous coal, coal would have to be imported, just as is oil. Both the United States and South America, principally Colombia, are major possible exporter to the Region. Once the Tennessee - Tombigbee waterway is completed, the United States could represent an economic source of coal. Colombia, bordering on the Caribbean Sea is already well located to export to the Region (9).

The distances involved, transmission across water, and the political, economic, and cultural diversity of the Region create impediments to cooperative ventures. This is not to say that there have been no efforts in this regard. The Regional Energy Action Plan (REAP) of CARICOM (the Economic Community of the Anglophone Caribbean) is a serious attempt to coordinate planning at the national level and to develop regional solutions (5). Through a grant from USAID, the Caribbean Development Bank (CDB) provides loans for energy and other development R&D in the Region. The Organisation of Eastern Caribbean States (OECS) is seeking solutions for eastern Caribbean states. There are also other international actors in the Region. These include international organizations like the Organization of American States (OAS), the Latin American Organization for Energy (OLADE), and the United Nations and its Specialized Agencies.

Other countries have taken an active interest. Among them are regional ones like Colombia, Mexico and Venezuela. The San José Accords is a regional reponse to oil prices. The governments of Colombia, Mexico, and Venezuela have provided preferential prices for countries of the Region, low interest loans to permit them to purchase oil, and incentives to develop alternatives. Canada, France, the Soviet Union, the United Kingdom, and the United States have assisted in identifying various resources and have provided funding to help develop energy and other resources and to build the development infrastructure necessary.

There are no perfect solutions for Caribbean energy problems. We have argued elsewhere that there are at least six important obstacles to progress (17):

1. shortage of trained personnel
2. inadequate research
3. absence of organized markets for indigenous renewable fuels
4. lack of investment capital
5. reluctance of regional governments to consider cooperative ventures, as well as the absence of a non-governmental network.
6. subcritical size of national energy systems.

Some of these are already being addressed by various groups. Yet, serious infrastructural problems remain (4,20). However, if the Caribbean is to deal effectively with its energy problems, it will have to grapple successfully with obstacles to progress.

CARIBBEAN ENERGY STATISTICS

A. Production and Resources

There are relatively few conventional energy resources exploitable in the Caribbean. As is seen in Table 2, Trinidad and Tobago and to a far less extent Cuba and Barbado, produce liquid fuels; Trinidad and Tobago and, again to a far less extend, Barbados produce natural gas; and only six generate electricity from hydropower. Several of the islands may possess potentially exploitable oil or gas reserves. These are the Dominican Republic, the Bahamas, Jamaica, Puerto Rico and the Netherlands Antilles. There are indications of lignite deposits in the Dominican Republic, Haiti, Jamaica, and Trinidad. There are peat deposits in Jamaica and evidence of peat in the Dominican Republic and Haiti. Geothermal resources exist in Dominica, Montserrat, St. Lucia, St. Vincent and perhaps the Dominican Republic, Haiti, and the Netherlands Antilles (23).

TABLE 2

Some statistics exist for "non-conventional" energy production. Fuelwood is thought to supply 80 percent of rural energy needs. In 1976 Haiti's fuelwood production was twenty times that of its conventional energy production. In the Dominican Republic, it was nine times higher; for Cuba, only 2.5 times higher. In the eastern Caribbean, fuelwood production may be the only source of nationally produced energy (22). It is known that deforestation to provide fuel and building material has been serious problem throughout parts of the Caribbean, particularly in Haiti. It is estimated that 35,000 hectares are deforested in the insular Caribbean each year while only 10,000 are aforested (11). From the 1920s to the 1970s, forestation fell from 50 percent of the total land area to 18 percent (19). To counter this, governments have instituted programs to plant fast growing trees such as leuceana, and to offer incentives for doing so. The Dominican Republic, for example, offers a pig for every 2000 government provided trees planted. This said, forest resources can and do provide energy resources, particularly in the eastern Caribbean.

B. Renewable Resources

Much thought has been given to the role of renewable energy for the Caribbean. Table 3 is a catalog of those resources and the degree to which they may and are exploited.

TABLE 3

Wind and solar energy are judged to provide the best opportunities for economical development in all islands, while biomass, geothermal and hydropower receive mixed results (2,18). Relatively little is known of the impact these resources might make economically, although it has been estimated that bagasse from sugar cane could replace 10 percent of energy needs in the Eastern Caribbean (5). Similarly, Puerto Rico could reduce the oil used to generate electricity by 13 percent and eliminate completely the dependence of the rum industry for imported

molasses through the planting of 70,000 acres of energy cane - a species developed to produce additional bagasse (3). Estimates of the potential contribution for six countries of both bagassse and rice husks are provided in Table 4.

TABLE 4

The fifth column of table 4 indicates the total potential energy contribution of the two agricultural byproducts. Compare this column to column six. Significant contributions appear to be possible for these six countries. Column seven indicates the percentage that agricultural byproducts could contribute to displace oil imports. The case for a Haitian agricultural program appears compelling.

It should be noted that much of the renewables focus is on oil substitution for electric generation. It is shown later on that while nearly all electricity in the Caribbean is oil-fired, electricity generation is only a small part of the oil bill. It is also necessary to bear in mind that there do not yet exist adequate solar and wind data for most of the Caribbean, making it difficult to estimate the potential various renewables may have for replacing conventionals.

C. Energy Consumption

As was previously indicated, there exist few statistics on rural energy use in the Caribbean. Vardi (23) estimates that for Haiti, firewood, charcoal, and bagasse represent 80 percent of primary energy consumption, the "modern sector" consumes 91 percent of electricity while only 4 percent of all households have it. According to Vardi, one percent of Jamaica's energy is derived from hydro power, nine percent from bagasse, and the balance from oil.

There are also few statistics on sectoral energy use. Table 5 gives energy consumption by fuel type for each island and per capita.

TABLE 5

Just as Luxembourg has the highest per capita energy consumption in the world because of energy intense industries, two Caribbean islands have greater per capita consumption than the United States for the same reason.

Table 5 makes it clear that liquid fuels, or petroleum dominate the Caribbean energy menu. Solid fuels are mainly employed in but three countries: Cuba, the Dominican Republic, and Jamaica; a minute portion of the consumption in each. Natural gas associated with oil production fires electricity generation in Barbados and Trinidad and Tobago. Hydroelectric power is produced in but six of the Caribbean islands. But it should be noted from Table 2, that eight islands have poor hydroelectric potential, others none, limiting its contribution to the Caribbean energy system.

It is clear from Table 5 that oil is the primary fuels for thermal electrical generation, since liquid fuels are the single conventional fuel consumed in most Caribbean countries. Moreover, as is shown in Table 6, oil-fired electric generation is the predominant source of electricity in the Region.

TABLE 6

Table 6 shows both net installed "nameplate" capacity for 1980, and that year's production. Only in Haiti does hydroelectric power more than compete with oil-fired, where 41 percent of capacity and 70 percent of Haiti's hydropower potential. Production of hydroelectric power for the balance ranged between one percent (Cuba) and five per cent (Puerto Rico).

TABLE 7

Table 7 attempts to disaggregate the petroleum sector into electrical and non-electrical. Usually the non-electrical sector is further

disaggregated into residential, commercial, industrial, and transportation. Table 7 offers a very broad estimate and care should be taken in interpreting it. Most of the petroleum imported into the Caribbean goes into consumption sectors other than electricity production. As we have seen, renewable strategies for oil substitution policies will have to be designed for other sectors as well. Research into alcohol motor fuels, solar industrial heat, high and low grade hot water, among others, is already underway to varying degrees in the Caribbean. Policies such as limits on automobile engine size and building code restrictions have been implemented by several governments, including the Dominican Republic, Jamaica, and Puerto Rico, among others.

Good sectoral data for the Caribbean are difficult to find. There are some, however. According to Vardi (23) in 1980 in Antigua 10 percent of electricity sales were tourist oriented, 38 percent commercial, and 17 percent residential. In Barbados, the breakdown of oil and gas consumption is: electricity generation 45 percent, transport 23 percent, sugar industry 4 percent, manufacturing 15 percent, and residential 8 percent. Hotels took 25 percent of electricity sales. The major consuming sectors of the Dominican Republic were: industry 44 percent, transport 20 percent, domestic 21 percent, government 1.5 percent, and mining varies with the vagaries of international prices. Again according to Vardi, Radio Antilles is the major consumer of electricity in Montserrat, representing 25 percent of consumption. Household demand is 3 percent.

TABLE 8

Table 8 provides some fairly dated data. Energy end use patterns vary throughout the Region. Compare the data in the Table and the more recent Dominican Republic data above. Energy use in the industrial sector rose from 26 percent in 1973 to 44 percent in 1980.

D. Summary

It has been shown that there exist limited conventional energy resources in the Caribbean, although there is some potential for development. The possible contribution of renewables for some is clear, yet the degree to which they can contribute and the costs associated with them is problematic. Moreover, like conventional fuels, renewable resources are not evenly distributed throughout the Region.

The data for rural energy consumption are incomplete. In some cases, renewables already contribute significantly to the national energy system (e.g. Haiti). It also appears that urban areas consume not only more energy per capita but more conventional energy than do their rural counterparts.

Liquid fuels by far dominate the energy systems of the Caribbean islands, almost all of which is imported.

CHANGES IN DEMAND PATTERNS

The status of the present energy situation was shown above. We suggest that this picture will change, that demand for conventional energy, including electricity will grow significantly by the end of the century. This will be driven by several factors. Among these are:

A. population increases
B. increasing urbanization
C. modernization
D. industrialization

A. Population Increases

As is shown in Table 9 the population of the Caribbean is increasing at an average annual rate of 1.8 percent with intraregional variation ranging from 0.9 percent in Barbados to 2.8 percent in the Dominican

Republic. Given this rate of increase, the 1981 population of 30 million will rise to just over 42 million in the year 2000, a scant fifteen years from now. If we assume that per capita energy consumption will remain constant, then energy demand will rise from the 1980 level of 50 million metric tons coal equivalent (MMMTC) to nearly 72 MMMTC (see Table 7).

TABLE 9

B. Increasing Urbanization

The urbanization rate of the Caribbean is also increasing, as is shown in Table 9. The overall rate of increase is estimated at just under one percent per year. One observer (1) concludes that the urban Latin American citizen consumes between six and thirty times more conventional energy than his rural counterpart. We estimate that if this trend holds, if, urban and rural demand remains constant, and if the disparity between urban and rural consumption rates is 10:1;* energy demand will be of the order of 100 MMMTC. This is double the 1980 demand.

Constant per capita demand is unlikely however. Despite two oil price shocks and an economic cooling, the Region experienced growth in demand at a conservatively estimated annual rate of 2.4 percent in the 1970s. Even uncompounded, assuming historical birth and demand rates, energy demand for 2000 can be estimated at nearly 100 MMMTC.

If urbanization and the historical 2.4 percent rate are considered, energy demand in the Caribbean will be of the order of 123 MMMTC.

We do not believe that energy demand will increase at an uncompounded rate of 2.4 per cent. We think it will be significantly higher. There are a number of factors driving this prediction. First, the Carib-

*We believe this to be a conservative estimate. In Haiti there is a 9:1 ratio in the electrical sector, not taking into account further disparities in oil.

bean economies are improving. It would be foolish to make this a fifteen year prediction. But changes are occurring which give rise to this view.

C. Estimating Demand

Two factors, population and urbanization increases, have already been explored to predict future demand. Development and energy demand in developing countries have been clearly linked (8). As is shown in Table 9, the economic structure of the Caribbean is undergoing a metamorphosis. That change is more clearly demonstrated in Table 10. The Caribbean economic structure is changing from one which was typically "underdeveloped" toward a "developed" model. The last two entries in Table 10 provide unweighted averages for four developed and three developing countries. These are provided to give an indication of sector importance for these two groups. In three sectors, important difference can be seen: agriculture represents a significant proportion of the gross domestic product (GDP) of developing countries, but only a small proportion of the developed. Likewise, the contribution of the industrial sector was, in 1977, almost twice in the developed countries that of the developing. The same is true in "other", reflecting the diversity of the economies of developed countries. The Caribbean metamorphosis is most clearly borne out in the agricultural sector. In almost every case there has been a consistent lessening of the contribution of agriculture to the GDP, notwithstanding the fact that agricultural production has risen in most (see Table 9). The contribution of industry to GDP has, for most, also risen consistently, approaching and sometimes exceeding the developed average. The same can be said of the "other" sector. In addition, as Caribbean societies continue to modernize, their populations will consume more energy intensive goods.

TABLE 10

This is evident in the increase in the number of automobiles, trucks, televisions, telephones, and so on throughout the Caribbean

(see Table 9). The Caribbean Basin Initiative, by opening the U.S. market and through other incentives may further expedite Caribbean development.

These changes in economic structures and demand patterns will affect energy demand in the Caribbean. The change will be from labor intensive to energy intensive: witness the increase in the number of tractors, for example, replacing human and animal energy with diesel.

TABLE 11

Table 11 provides estimates of demand rates and predicted demand in the year 2000. The Table includes estimates of demand increases both world wide and in the developing world. These estimates provide a prediction of total Caribbean demand.

Estimates of increases in annual global energy demand are relatively low, ranging between 1.2 and 2.4 percent, as are the resulting demand predictions. It is unlikely, however, that Caribbean demand will be as low as global demand, and that too is reflected in Table 11.

Estimates of increasing demand for developing countries range between 1.8 percent and 7.1 percent. Three of the figures are population driven, and are explained above. The 7.1 percent figure is the actual growth in energy demand in developing countries from 1960 to 1968. This provides an interesting benchmark because this growth was unimpaired by the energy price shocks and economic recession of the 1970s. Also provided is the actual growth rate for the Caribbean from 1972 to 1980. That growth rate was impaired by the 1970s.

We believe that the increase in annual energy demand from the present to 2000 will lie somewhere between 2.4 and 7.1 percent. We accept 7.1 percent as the upper limit for several reasons. Although the Caribbean is benefiting from the end of the recession in the developed world, the structure of growth in the next fifteen years will be different from that of the 1960s. There is greater awareness of the benefits of conserva-

tion. New infrastructure will be more efficient. There will be some development of a low energy demand service sector. And, finally, there are already in place highly energy intensive industries -- oil refining and aluminum smelting. These will expand as the global economy improves, but we do not expect the degree of growth experienced in the 1960s. For these same reasons, we believe 2.4 percent to be the lower limit. And because of economic and industrial expansion should be above that of the 1970s, energy demand should also be higher.

These upper and lower limits provide a wide range of possible demand in 2000: 80.5 MMMTCE and 197.5 MMMTCE, the larger figure more than double the smaller. Actual 2000 demand will lie somewhere between these two figures. Goldemberg has recently suggested a growth rate for Latin America (1980-1990) of 5.2 percent (12). If that number applies to the Caribbean, 2000 demand will be 138.1 MMMTC.

IMPLICATIONS

The Caribbean differs from the rest of the world. Table 12 presents energy demand by primary fuels. Oil provides nearly 46 percent of global demand, almost 70 percent of Latin American demand, but 90 percent in the Caribbean. If this pattern continues, oil demand, almost all of which must be imported, will exceed 124 MMMTC in 2000 (lower case: 71 MMMTC, upper case: 177 MMMTC). That will be a difficult economic burden for the Caribbean to bear.

TABLE 12

But there are few options, for most other conventional fuels will likewise be imported. And while oil is more expensive to import than other conventionals at present, their relative prices in fifteen years cannot be accurately predicted.

Nuclear power might displace some oil or other fuels in the Caribbean import menu. Yet, there are serious problems of scale, the

technical problems associated with transmission must be solved, and the economics appear to be worsening. Moreover, facilities must be built, requiring significant up-front investment. And even if construction began today, it would be at least eight years before the firs would begin to produce.

Oil will continue to be imported into the Caribbean. If governments, the private sectors, and universities of the Region cannot work to find economic substitutes for oil, to reduce the rate of increase, the cost of those imports will continue to cause serious balance of payments problems and in all likelihood will badly impact the societies of the Caribbean. And that could render further development impossible.

There are two obvious alternatives to energy imports: greater efficiencies and renewable energy. Much of the work done on renewables has focused on the substitution of oil (or other fields) in the electricity sector. That will help. But because much of the oil consumed in the Caribbean is not consumed in the electricity sector, ever more research into those areas is clearly needed.

Goldemberg has distinguished between two types of energy planners which he labels "geneticists" and "teleologists" (12). A geneticist sees plan goals as constrained by historical situations and the inherent, objective tendencies of the country. For a teleologist, the purpose is to modify existing structures in order to meet plan objectives. To understand and plan for the Caribbean is to be of both minds. The constraints are massive, the options limited. Yet we know that energy demand must be targeted, and that the target will be a difficult one. It is crucial that talent be brought to bear on current and future problems; that cohesive recommendations reflecting Caribbean realities be made; and that those in authority to act, do act.

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TABLE 1

The Caribbean

Country & indep. date (or metrop.)	Popula-tion	Area (sq.km.)	Pop. Dens. (per sq. km.)	x10^6 US$ *GDP/GNP**)	Per Cap. *GDP/GNP**US$
Anguilla (U.K.)	6,500	91	71	3.0*	461*
Antigua (1981)	77,226	280	276	79.1*	1,039*
Bahamas (1973)	209,505	13,940	15	1.0**	4,760**
Barbados (1966)	252,000	430	586	950.4**	3,817**
Belize (1981)	146,000	22,958	6	184.5**	1,200**
Bermuda (U.K)	72,000	53	1,350	598**	10,894*
Cayman Islands (U.K.)	17,035	259	66	72*	4,800*
Cuba (1902)	9,771,000	113,960	86	13,300*	1,360*
Dominica (1978)	74,100	749	99	49.7**	598**
Domin. Rep. (1844)	5,762,000	48,433	119	5,500**	990**
Grenada (1974)	107,000	344	312	50.2*	459*
Guadeloupe (France)	317,000	1,779	178	957*	3,040*
Guiana (France)	66,000	90,999	1	120*	1,935*
Guyana (1966)	795,000	214,970	4	560.7**	690**
Haiti (1804)	6,000,000	27,749	212	1,500**	288.6**
Jamaica (1962)	2,225,000	11,424	195	2,979*	1,339*
Martinique (France)	312,000	1,100	283	1,135*	3,559*
Montserrat (U.K.)	12,034	102	117	20**	1,736**
Neth. Antilles (Neth.)	243,000	992	244	864*	3,472*
St. Kitts/Nevis (1983)	44,404	269	165	48.1**	920**
St. Lucia (1979)	122,000	616	198	210*	1,696*
St. Vincent (1979)	115,000	388	296	59**	513**
Suriname (1975)	388,000	163,758	2	822.4**	2,370**
Trinidad/Tobago (1962)	1,176,000	5,128	230	5,700*	4,847*
Turks/Caicos (U.K.)	7,436	497	15	15**	2,000**
Virgin Isl. (U.K.)	12,244	153	81	28.5**	2,456**
Totals:	28,329,484	721,421		35,806.6	--
United States	226,504,825	9,372,623	25	2,626,100**	11,536**
Puerto Rico	3,240,000	8,897	364	11,771**	3,001
U.S. Virgin Isl.	98,307	342	287	542**	4,743**

Source: Caribbean/Central American Action, Caribbean Databook, 1983; for the U.S.: U.S. Dept. of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1981. The years in which these were measured vary. Some are at constant dollars. The figures are based on United Nations and national data.

TABLE 2

1980 COMMERCIAL ENERGY PRODUCTION

	In Metric Tons Coal Equivalent x 10^3				
	Total	Solids	Liquids	Gas	Electricity (Hydro and Geothermal)
Barbardos	79	-	61	18	-
Cuba	415	-	378	24	13
Dominican Republic	6	-	-	-	6
Haiti	27	-	-	-	27
Jamaica	15	-	-	-	15
Puerto Rico	10	-	-	-	10
St. Vincent and the Grenadines	2	-	-	-	2
Trinidad and Tobago	19352	-	15983	3369	-

Source: UN Statistical Yearbook, 1979/80, Table 180.

TABLE 3

DEVELOPMENT AND POTENTIAL OF ENERGY RESOURCES IN THE CARIBBEAN

Island or Country	Oil and Gas	Coal	Hydro power	Geothermal Energy	Biomass Energy	Solar Energy	Others (Wind, etc.)
Antigua	1a	1a	1a	2a	2a	5a	5a
Bahamas	2a	1a	1a	2a	2a	5a	5a
Barbados	3b	1a	1a	2a	4b	4a	5a
Colombia	4d	1c	5d	2a	5b	4a	5a
Cuba	3c	2a	3b	2a	5b	5a	5a
Dominica	1a	1a	4c	2a	2a	4a	5a
Dominican Republic	2a	2a	3b	2a	5a	5a	5a
Grenada	2a	1a	2a	2a	2a	4a	5a
Guyana	2a	1a	5b	1a	5b	4b	5b
Haiti	2a	1a	3b	2a	4a	5a	5a
Jamaica	2a	2b	3b	2a	5b	5a	5a
Martinique	1a	1a	1a	2a	4b	4a	5a
Mexico	5d	5c	5c	4c	5b	5a	5a
Monserrat	1a	1a	1a	2a	2a	4a	5a
Puerto Rico	1a	1a	3b	2a	5b	5c	5a
St. Kitts-Nevis	NA	NA	NA	NA	NA	NA	5a
St. Lucia	1a	1a	1a	3a	2a	4a	5a
St. Vincent	1a	1a	3c	2a	2a	4a	5a
Trinidad/Tobago	5a	1a	1a	2a	3b	4a	5a
Venezuela	5d	2b	5c	2a	4b	4a	5a
Virgin Islands (US)	1a	1a	1a	2a	2a	5a	5a

POTENTIAL

1. poor
2. not determined but possible
3. limited
4. medium
5. important

DEVELOPMENT

a. without development
b. limited development
c. medium development
d. good development

DATA FROM:

Esquema de la energía y el ambiente en la zona del Caribe, 7 de agosto de 1979, Organizaciones de las Naciones Unidas

NA - Not Available

TABLE 4

AGRICULTURAL RESOURCES

	Estimated Bagasse Yield Metric Tons X 10^3	Energy Potential MMMTC	Rice Husk Production MMT	Energy Potential Thousand Metric Tons	Total Energy MMMTC	Petroleum Imports MMMTC(1980)	Percent Column 6 of Column 7
Barbados	138	0.08	-	-	0.08	.396	20
Cuba	7800	4.90	0.50	0.21	4.9	13.770	35
Dominican Republic	1640	1.03	71.50	30.64	1.06	2.720	29
Haiti	417	0.26	32.75	14.03	.27	.264	102
Jamaica	544	0.34	0.50	0.21	.34	3.010	11
St. Kitts-Nevis	48	0.03	-	-	.03	.25	12

Source: UNIDO, Overview of Energy and Environment in the Caribbean Area, p. 35

TABLE 5

1980 Commercial Energy Consumption in the Caribbean

	in metric ton coal equivalent x 10^3				Hydro Electricity hydro and geothermal	in kilograms per capita
	Total	Solids	Liquids	Gas		
Antigua	83	-	83	-	-	1107
Bahamas	1226	-	1226	-	-	5151
Barbados	488	-	470	18	-	1944
British Virgin Islands	12	-	12	-	-	923
Cuba	13050	144	12869	29	13	1297
Dominican Republic	2418	1	2411	-	6	445
Grenada	21	-	21	-	-	210
Guadaloupe	240	-	240	-	-	719
Haiti	266	-	239	-	27	53
Jamaica	2759	1	2743	-	15	1266
Martinique	315	-	315	-	-	969
Montserrat	9	-	9	-	-	692
Netherlands Antilles	5579	-	5579	-	-	20663
Puerto Rico	12064	-	12039	-	25	3507
St. Kitts-Nevis	25	-	25	-	-	373
St. Lucia	46	-	46	-	-	383
St. Vincent and the Granadines	46	-	46	-	2	383
Trinidad and Tobago	5830	-	2461	3369	-	5105
U.S. Virgin Islands	6497	-	6497	-	-	68389
United States	2369689	551597	1003914	745196	69002	10410

Source: UN Statistical Yearbook, 1979/80, Table 180

TABLE 6

Electricity in the Caribbean - 1980

	Net Installed Capacity of Electric Generation Plants in Kwx10^3			Electric Production in million kwh		
	Total	Thermal	Hydro	Total	Thermal	Hydro
Antigua	26	26		55	55	
Bahamas	330	330		845	845	
Barbados	97	97		310	310	
Cuba	2400	2354(98%)	46(2%)	9800	9696(99%)	104(1%)
Dominican Republic	915	765(84%)	150(16%)	3420	3372(96%)	48(4%)
Guadaloupe	85	85		300	300	
Haiti	121	71(59%)	50(41%)	315	95(30%)	220(70%)
Jamaica	725	705(97%)	20(3%)	2330	2210(95%)	120(5%)
Martinique	63	63		258	258	
Netherlands Antilles	290	290		1825	1825	
Puerto Rico	4290	4195(98%)	95(2%)	13671	13470(98%	201(2%)
St. Kitts-Nevis	14	14		30	30	
St. Lucia	16	16		58	58	
Trinidad & Tobago	454	454		1840	1840	
U.S. Virgin Islands	239	239		730	730	

Source: UN Statistical Yearbook, Tables 189, 190.

Notes: No geothermal or nuclear electricity generation is reported for the Region.

TABLE 7

SECTORAL USE OF PETROLEUM

1980 IN MTCE x 10^3

	Petroleum for Elec	Non Elec Petroleum	Non Elect Petroleum/ Total%
Antigua	7	76	92
Bahamas	105	1121	91
Barbados	38	432	88
Cuba	1212	11667	89
Dominican Republic	418	1993	82
Guadaloupe	37	203	85
Haiti	12	227	85
Jamaica	274	2467	89
Martinique	32	283	90
Netherlands Antilles	226	5350	96
Puerto Rico	1670	10369	86
St. Kitts-Nevis	4	21	84
St. Lucia	7	41	89
US Virgin Islands	90	6407	99

TABLE 8

ENERGY USE BY SECTORS
In Percent

	Industrial	Residential and Commercial	Others (incl. agr.)	Losses
Dominican Republic	26.1	36.9	7.6	29.4
Haiti	42.9	19.1	13.0	25.0
Jamaica	48.5	32.4	8.5	10.6
Trinidad and Tobago	56.6	30.2	0.8	12.4

Source: UNIDO, Overview of Energy and Environment in the Caribbean Area.

TABLE 9

VARIOUS CARIBBEAN INDICATORS AND ESTIMATES

Country	Consumption area 10E6 MTCE/SQKM	Pop Growth[a] Rate in %	Est. Yr[b] 2000 pop	Tractors 1979	Tractor Growth Per Annum 1970-79	Car 1976[c] in 10E3
Anguilla	No data	1.8	9286	No data	No data	2.1
Antigua	0.29	1.8	110336	234	0.063	No data
Bahamas	0.08	1.7	293503	70	0.088	36.5
Barbados	1.13	0.9	301455	540	0.029	24.7
Bermuda	No data	1.8	102869	37	-0.037	12.7
Cayman Island	No data	1.8	24338	No data	No data	No data
Cuba	0.11	0.9	11688595	70374	0.034	80
Dominica	No data	1.6	101787	88	0.033	No data
Dom. Rep.	0.04	2.8	10010033	3000	0.019	77.3
Grenada	0.06	1.8	152876	25	0.014	3.8
Guadeloupe	0.13	1.1	394532	820	0.053	38.4
Haiti	0.01	2.6	10025325	500	0.036	18.7
Jamaica	0.24	2.1	3371668	2750	0.049	No data
Martinique	0.028	0.9	373231	855	0.093	39.6
Montserrat	0.081	1.8	17193	13	-0.047	No data
N. Antilles	5.62	2.2	375512	122	0.009	39
St. Kitts/Nevis	0.09	1.8	63442	214	0.010	2.1
St. Lucia	0.07	2.4	196046	38	-0.005	3.7
St. Vincent	0.05	2.8	199783	74	0.032	3.5
Trinidad/Tobago	1.04	2	1747474	2300	0.024	105
Turks	No data	1.8	10624	No data	No data	No data
UKVI	0.07	1.8	17493	4	0.031	1.4
USVI	18.9	1.8	140455	350	-0.002	32
Puerto Rico	1.35	1.6	4450606	3839	-0.036	607.8

Source: [a] World Population Data Sheet 1981
[b] UN Stat. 1979/80, Table
[c] UN Stat. Y.B., 1978, p. 547
[d] UN Stat. Y.B., 1978, p. 628
[e] UN Stat. Y.B. 1979/80, Table 24
[f] UN Stat.Y.B. 1978/80, p.89
[g] all year 200 estimate and linear projections based on lates year data and historial rate of increase

Cont. Table 9

Car Growth rate 1969-76	Commercial[c] Vehicles 1976 in 10^{E3}	Commercial Vehicle Growth Rate 1968-1976	Phone 1977[d] in 10^{E3}	Phone 1971-77 gr. rate	Food Production[e] Index 1969/72=1980 = 100	Manufacturing[f] Employment Index 1970-1980 = 100
0.009	0.3	0	No data	No data	No data	No data
No data	No data	No data	3	0	n.d.	n.d.
0.003	5.3	-0.004	62	0.012	n.d.	n.d.
0.010	4	0.005	44	0.014	98	98
0.007	2.5	0.004	39	0.009	n.d.	n.d.
No data	No data	No data	5	0.047	n.d.	n.d.
0.003	40	0.007	321	0.006	121	108
No data	No data	No data	4	0.023	n.d.	n.d.
0.022	39.4	0.020	127	0.032	126	101
0.006	0.1	-0.043	3	0	n.d.	n.d.
0.013	16	0.005	31	0.026	n.d.	n.d.
0.006	2.4	0.016	18	0.071	112	97
No data	No data	No data	109	0.014	112	112
0.012	17.4	0.009	39	0.028	n.d.	n.d.
No data	No data	No data	2	0.023	n.d.	n.d.
0.009	8	0.020	50	0.020	n.d.	n.d.
0.009	0.3	0	3	0.035	n.d.	n.d.
0.011	1.8	0.013	7	0.028	n.d.	n.d.
0.016	0.8	0.012	5	0.030	n.d.	n.d.
0.012	27.9	0.010	70	0.007	92	135
No data	No data	No data	No data	No data	n.d.	n.d.
0.018	0.2	-0.011	3	0.035	n.d.	n.d.
0.055	4.2	0.055	34	0.013	n.d.	n.d.
0.012	124.5	0.012	515	0.018	105	n.d.

Cont. Table 9

Tractor Estimate[g] in Year 2000	Estimate Cars[g] yr. 2000 x 10^{E3}	Commercial Vehicles[g] Yr. 200 x 10^{E3}	Phone Estimate[g] Yr. 2000 x 10^{E3}
No data	2.	0.3	No data
852	No data	No data	3.0
418	39.5	4.7	81.8
986	31.5	4.5	61.5
16	25.7	2.8	48.2
No data	No data	No data	14.5
142607	87	47.7	370
175	No data	No data	6.8
4524	130	64.2	267.0
33	4.4	0.03	3.0
2468	53	18.4	57.1
1054	21.8	3.5	87.9
7613	No data	No data	152.1
5547	53.	21.8	73.7
4	No data	No data	3.4
148	49.0	12.9	79.1
265	2	0.3	6.7
33	4.9	2.4	13.3
145	5.1	1.9	10.0
3792	139.9	36.1	83.9
No data	No data	No data	No data
7	2	0.1	6.7
334	117	15.3	46.5
1762	820	168.7	779.4

TABLE 10

GDP BY ECONOMIC ACTIVITY SELECTED YEARS

	Year 1963	GDP in National Currency x 10^6	Agriculture	Industrial	Construction	Wholesale and Retail	Transport	Other
Antigua	1963	24.8 EC$	18	3	16	25	4	34
	1968	37.0	3	3	26	28	4	37
Barbados	1960	136 EC$	25	12	9	20	-	22
	1976	759	11	13	6	29	6	25
British V.I.	1963	2.9 EC$	23	-	29	9	2	37
	1970	11.3	5	5	24	30	7	38
Dominica	1961	21.1 EC$	35	7	9	12	3	34
	1973	62.3	40	3	4	8	2	32
Dominican Republic	1960	723.6 Peso	27	20	3	19	5	27
	1977	4466.6	21	23	7	17	6	26
Grenada	1970	60.0	20	6	14	18	9	33
	1975	80.5 EC$	29	6	7	18	10	30
Guadaloupe	1965	957.5	15	9	9	25	3	38
	1973	2271.9 Fr.	9	8	9	26	4	44
Haiti	1960	1522.7	49	12	2	11	3	22
	1976	2211.9 G.	41	15	4	10	2	27
Jamaica	1960	471.3	11	22	11	19	7	22
	1976	2768.0 EC$	8	30	9	16	6	30
Martinique	1965	1112.9	14	7	8	26	3	41
	1973	2666.4 Fr.	6	7	10	28	4	44
Montserrat	1961	3.5	41	2	8	11	1	37
	1976	16.9 EC$	9	4	21	17	12	37

Table 10, Cont.

	Year 1963	GDP in National Currency	Agriculture	Industrial	Construction	Wholesale and Retail	Transport	Other
Puerto Rico	1960	1865.1	10	26	6	20	6	31
	1977	10902.5 US$	3	38	3	18	6	34
St. Kitts-Nevis	1961	19.8	46	1	10	-	2	42
	1977	81.7 EC$	18	16	6	8	7	30
St. Lucia	1962	28.3	34	5	8	18	3	33
	1970	62.9 EC$	22	6	9	20	3	30
St. Vincent and the Grenades	1961	24.6 EC$	40	1	4	19	2	33
	1972	41.4	25	6	10	20	3	36
Trinidad and Tobago	1960	918.3 EC$	11	44	4	13	4	18
	1975	5163.0	3	54	5	7	7	20
Turks and Caicos	1962			0.3	L. 7	16	3 -	20
	1969	0.8 F	5	2	19	- 20	-	53
Developed Country unweighted average (Canada, France, UK, US)	1977		3.75	28.6	6	12.5	6.5	34.5
Under Developed Country unweighted Average (Bangladesh, Chad, Turkey)	1976		40.1	14	4.3	16.6	5.3	16.3

Source: UN Statistical Yearbook, 1978, p. 678.

TABLE 11

ESTIMATES OF COMMERCIAL
ENERGY DEMAND IN THE INSULAR CARIBBEAN
IN THE YEAR 2000

	Percent Annual Increase	Level MTCE x 10^6
GLOBAL		
Iglesias (ref. 15)	1.2	63.6
Hafele (ref. 13)	2.1	75.9
High Scenario		
Low Scenario	1.5	67.5
World Bank (ref. 24)	2.4	80.5
DEVELOPING COUNTRIES		
Developing Countries 1960 - 1970 (Actual) (ref. 7)	7.1	197.5
Caribbean 1972 - 1980 (Actual)	2.4	80.5
Goldemberg (ref. 12)	5.2	138.1
Iglesias (ref. 16)	3.2	94.1
Paper Scenario I	1.8	71.6
Paper Scenario II	3.6	101.6
Paper Scenario III	4.6	123.2

TABLE 12

ENERGY DEMAND BY PRIMARY FUEL
IN PERCENT

	Global[1]	Latin America[2]	Caribbean[3]
Oil	45.8	69.5	90
Coal	29.9	7.1	
Gas	27.0	17.1	6.7
Hydro	3.7	6.3	2.3
Nuclear	0.9		
Others	1.8		

[1] World Bank (ref. 24)

[2] Goldemberg (ref. 12)

[3] UN Stat. Y.B. (ref. 21)