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ENERGY STATUS IN PUERTO RICO:
AN ASSESSMENT OF THE PETROLEUM SITUATION

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Abstract

This paper covers selected aspects of the energy status in Puerto Rico, with particular consideration to the relation between energy and economic development. A historical perspective of the development of the petroleum-petrochemical sector is given with consideration to policy aspects and current efforts to reinstate past comparative advantages with the Gulf Coast.

1. INTRODUCTION

Until recently, Puerto Rico's Executive Branch had no institutional tradition in the energy field, except for the experience of the Water Resources Authority, a public corporation engaged in electricity generation. Indirectly, the Economic Development Administration and the Environmental Quality Board had contributed also by considering energy implications of their respective areas of responsibility.

In matters relative to price controls and licensing for the distribution of liquid petroleum gas (LPG), the Department of Consumers Affairs (DOCA) and the Public Service Commission (PSC) played the major roles respectively, until federal jurisdiction pre-empted local price control authority. There were controls for gasoline, diesel and kerosene as prime necessity articles by the DOCA; whereas, LPG operations were regulated by the PSC as public service companies.

However, as an outcome of energy related events during the last three years, the first two governmental agencies in the energy field came into being: the Office of Petroleum Fuels Affairs (OPFA) attached to the Office of the Governor, and the Corporation for the Development of Mineral Resources, attached to the Department of Natural Resources. This Department, as well as the Water Resources Authority, in the last two years have been undertaking demonstration projects relative to

uses of solar energy.

Recently, with the participation of the OPFA, the University of Puerto Rico has concluded an agreement with the Energy Research and Development Administration by which the Puerto Rico Nuclear Center facilities and programs will be restructured to form the core of the Center for Energy and Environment Research (CEER). The main objectives of the Center are to:

- (1) Help Puerto Rico develop alternate sources of energy by tapping its substantial solar resources.
- (2) Aid in the national effort to achieve energy independence.
- (3) Serve as a focal point for energy and environmental research in Puerto Rico and for other tropical areas.
- (4) Continue to provide for the training of students and personnel from Latin America and the Caribbean.

These events clearly reflect that Puerto Rico is in the process of institutionalizing its own capability to deal with the perpetual monitoring of the energy planning process as induced by the Office of Petroleum Fuels Affairs.

2. OPFA'S PROGRAMATIC OBJECTIVES AND FOCAL POINTS

The Office of Petroleum Fuels Affairs was created in July 1973 by virtue of Law No. 4 attached to the Office of the Governor to formulate policies related to petroleum-energy products. Among the objectives sought are the following:

- (1) Assurance of the availability of required energy supplies from secured sources.
- (2) Obtain for our society the lowest possible cost of energy, minimizing the impacts of energy on economic welfare and progress.
- (3) Minimize the unfavorable effects which are induced by marketing problems and international energy policies.
- (4) Establish a well correlated relationship between environmental matters, generation, and utilization of energy.
- (5) Minimize inequities which may arise as consequence of economic or regional factors in terms of costs and availability of energy sources.
- (6) Promote efficiency and optimum use of energy in all energy operations and uses.
- (7) Carry on scientific research in reference to alternate energy sources, orienting such efforts for the achievement of a regional energy sufficiency.

The focal points of our work are: (1) development of an information system covering energy matters of concern to Puerto Rico, (2) the implementation of a regional energy model, and (3) the institutionalization of expertise in energy-environmental matters. A brief description of the above work follows.

2.1 THE INFORMATION SYSTEM

As of September 1976, the Office of Petroleum Fuels Affairs has developed and implemented the first stage of an Energy Information System. The design theory is oriented towards the quantification of the flow of fuels into, within and out of Puerto Rico and the series of outputs designed is providing monthly and yearly information regarding the purchase, production and distribution flows to, within and from the Commonwealth of petroleum and fuel derivatives. The Energy Information System continues to provide essential information to the Executive and Legislative branches, as well as the general public and private sectors.

Currently, the Office of Petroleum Fuels Affairs is in the second stage of a multi-phase information system oriented towards the production of a total energy accounting system for the Commonwealth of Puerto Rico. The design theory continues focused towards the quantification of the flow of fuels in Puerto Rico and the outputs are designed to provide monthly, quarterly or yearly information regarding purchases, production and distribution including an economic matrix of petroleum and petroleum products by sector of consumption. The expansion into the petrochemical sector with its sub-system will allow the aforementioned activities to include all downstream products. To date, we continue the design and programming development for the mechanization of the processing and auditing procedure.

2.2 THE PUERTO RICO ENERGY MODEL

The development of the Puerto Rico Energy Model purports to describe and explain the interrelations of the various components of the total energy system from a multidisciplinary perspective. Methodologically, it will follow along the guidelines of the WISE Model for Wisconsin. Of course, significant modifications are ongoing for effective local applicability.

To maximize the models usage in the energy decision and planning processes, working relationships have been established with various executive and regulatory agencies of Puerto Rico. This interaction with other institutions will help in preventing these research efforts from being only an academic exercise and has introduced live policy issues into our initial modeling.

Finally, our third area of action: energy and environment receives formal support by the relations we have established with the local Environmental Quality Board and the School of Medicine of the University of Puerto Rico.

2.3 ENERGY AND ENVIRONMENTAL PROGRAM

For the last two years, we have adapted an air pollution model that simulates the dispersion of inert, primary pollutants. In Puerto Rico, it has been used to simulate sulfur dioxide (SO₂) concentration in the neighborhood of major sources, such as refineries and power plants. The model being used by this Office is a multiple-point source model, giving short term and long term concentrations of SO₂.

However, our model goes somewhat further in its output. Its distinctive feature is that it automatically reduces sulfur content of fuel used by emitters, taking into account the relative rate of

emissions and source density in the area. In this way, not every source has to reduce identically the sulfur content of its residual fuel, at the same time that federal standards are met in a far-less costly way. The impact of the results of this modeling effort can be easily translated into millions of dollars saved to the industry sector and to consumers if higher sulfur limits are found compatible with the local and federal air quality regulations.

Current efforts are oriented toward the development of a stochastic model of air pollution and the study of the relation meteorology-air pollution for two heavily industrialized sectors.

Our relation with the School of Medicine has enable us to develop basic information in the area of microbial bio-chemistry by which a desulfurization approach is proposed as a potential attractive method for controlling sulfur pollution.

An organism, *Pseudomonas sp.* PRG-1, has been isolated and found to attack thiophene derivatives in our laboratories^{(a)*}. More microorganisms have been isolated from oil contaminated soil and currently their growth conditions and microbial metabolism are been studied. Our approach may develop into a useful technique for the application of microorganisms in the desulfurization of heavy petroleum fractions, as well as, industrial effluents, oil spills and refinery products.

3. THE STATISTICS OF THE PETROLEUM SITUATION

Puerto Rico is totally dependent on external sources in order to satisfy its needs for the refinery and petrochemical sector. These needs consists, primarily, of crude as input for refineries, naphtha for use as petrochemical feedstock and in less degree, for use in refinery hydrogenation processes. The imports of crude and naphtha, jointly, constituted in 1975, 96.1% of total imports of hydrocarbons. This is equivalent to 106.4 million barrels; of which 59.9 and 38.3 millions were utilized for purposes of energy consumption and exports, equivalent to 56.3% and 36.0%, respectively, of total imports.

Until recently, Venezuela had been the principal supplier of crude and naphtha for the Puerto Rican market, however, Venezuela's participation in total imports for the island has been reduced in

(a)* F. Sagardfa, J.J. Rigau, A.M. Lahoz, F. Fuentes, C. López, W. Flores, Applied Microbiology, 29 (6) 722 (1975)

(b)** During the first semester of 1976, Wholesale Distributors sold in Puerto Rico a total of 7405.3 thd. bbls. of Motor Gasoline. This amount represents an increase of 7.7% compared to the 6875.9 thd. bbls. sold locally during 1975's first semester. Monthly sales increases fluctuated from 0.9% on May up to 17.9% on March.

favor of purchases of crudes from Middle East sources.

The production of the refineries in Puerto Rico, which in 1975 operated at 59.0% of capacity, not only covers the internal needs for fuels of the island but also, about 39.0% of total energy supplies for that year. When analyzing the structure of their exports, we observe a great proportion of exports is constituted by light products, motor gasoline, aromatics and middle distillates. This constituted 90.6 per cent of total exports which is equivalent to 35.3% of total availability. Exports of refined products diminished in 9.9% as compared with 1974. Puerto Rico's exports are primarily shipped to mainland markets.

In contrast with the rest of the Caribbean refineries, which export relatively high volumes of residual fuels, this product constituted only 9.4% of total exports to Puerto Rico. This can be explained by the high consumption level of residual fuel in the island.

The operation activities for the petroleum industry in Puerto Rico for 1975, registered a reduction in relation to 1974. Including naphtha, imports of petroleum in 1975, were reduced by 13.6% with respect to the year before; consumption of derived product (excluding naphtha) was reduced in 9.7% and exports of fuels were reduced by 9.0%.

Calendar year 1975 showed a reduction in the consumption of all products except those utilized by the transportation sector (motor gasolines) and by the construction sector (pitch and asphalts).

During calendar year 1975 wholesale distributors in Puerto Rico sold a total of 14.0 mmb. of Motor Gasoline (Table I). This figure represents an additional increase of 0.4 mmb over last year, 13.6 mmb., which in turn represents a 2.9% increase. (b)**

Residual fuels consumption, 64.1% of the total for electricity generation and 35.9% by the remaining sectors, registered a 12.1% reduction with respect to 1974.

Table I and the following diagram reflect the

TABLE I.- PUERTO RICO: SUPPLY AND DEMAND RELATION OF
 PETROLEUM PRODUCTS ^{a/}
 CALENDAR YEAR 1975 UNIT/MILLIONS OF BARRELS

Product/Activity	Total	
Imports		
Crude	70.3	
Naphtha	23.5	
Refinery Gas	0.2	
Residual Fuel Oils	0.5	
Motor Gasoline	1.3	
Aviation Fuel	2.0	
Others	<u>0.2</u>	
Subtotal	98.0	
Inventories		
Total	<u>0.2</u>	
		<u>98.2</u>
Internal Consumption		
Refinery Gas	4.5	
Middle Distillates	5.8	
Residual Fuel Oils	26.2	
Motor Gasoline	14.0	
Aviation Fuel	1.9	
Naphtha	5.6	
Others	1.9	
Subtotal	<u>59.9</u>	
Exports		
Middle Distillates	10.8	
Residual Fuel Oils	3.6	
Motor Gasoline	16.6	
Others	<u>7.3</u>	
Subtotal	38.3	
Total		<u>98.2</u>
Percentage Exported	39.0%	

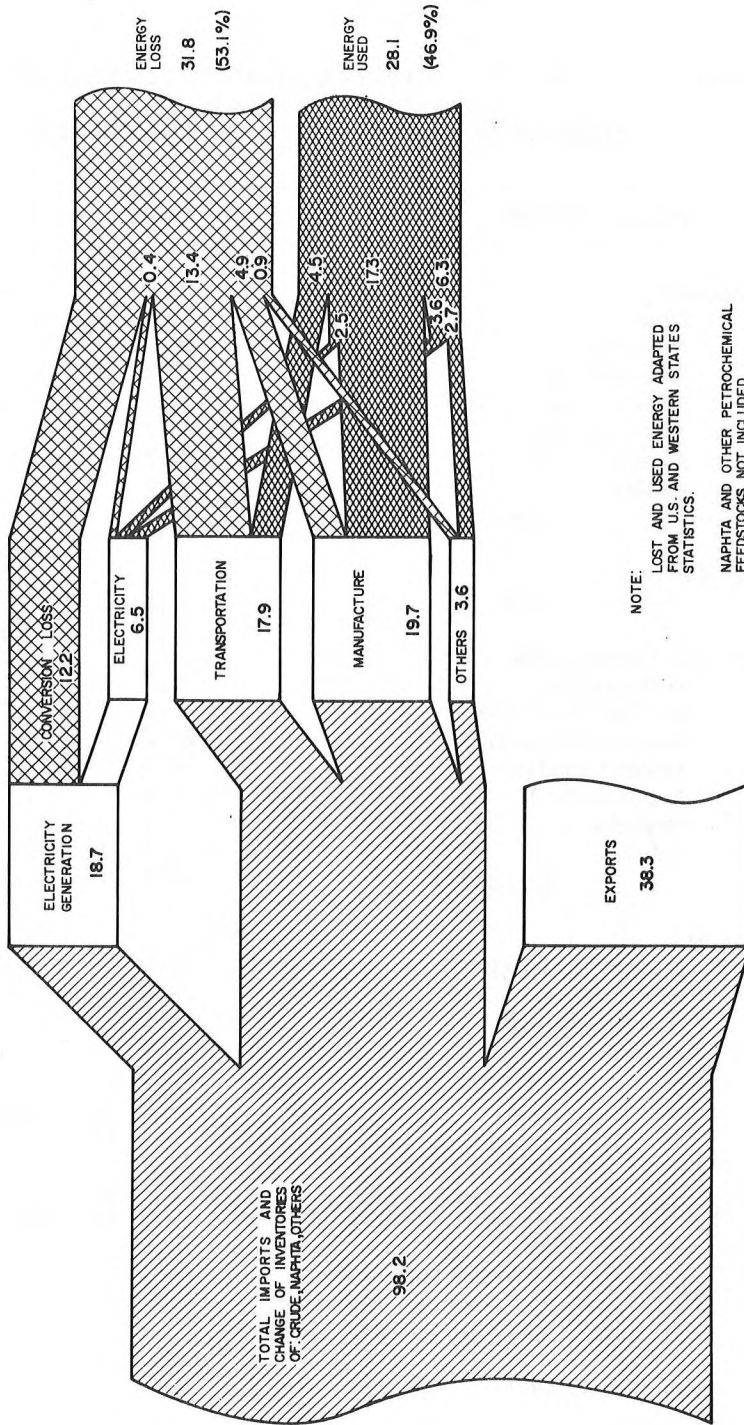
^{a/} Naphtha used as petrochemical feedstocks is not included.

Source:

Office of Petroleum Fuels Affairs
 Economics and Planning Division
 Statistical Analysis Section

August 5, 1976

PUERTO RICO: ENERGY-PETROLEUM PRODUCTS FLOW PATTERN AND
RELATION OF ENERGY USED AND LOST IN THE PROCESS
CALENDAR YEAR 1975
UNIT/MILLIONS OF BARRELS



NOTE:
LOST AND USED ENERGY ADAPTED
FROM U.S. AND WESTERN STATES
STATISTICS.
NAPHTHA AND OTHER PETROCHEMICAL
FEEDSTOCKS NOT INCLUDED.
AUGUST 11, 1976.

SOURCE:
OFFICE OF PETROLEUM FUELS AFFAIRS
ECONOMIC AND PLANNING DIVISION
STATISTICAL ANALYSIS SECTION.

balance in the supply and demand relation of the petroleum situation and the sectorial energy flow in Puerto Rico for 1975, respectively. The implications of these facts in relation to future energy supplies in Puerto Rico reveal the following.

3.1 IMPLICATIONS TO THE COMMONWEALTH

A consideration of the lost and used portions of energy by sector shows that approximately 53.7% of the energy contained in petroleum products used in the Commonwealth was lost in the various conversion processes. Conversion of petroleum to electricity results in loss of over 65.0%. It would seem that these losses could be trimmed through technological advances; however, presently the processes being used seem to be the only ones available for electricity generation from fossil fuels. The electricity in oil equivalent, 6.5 mmb, was distributed as follows: industrial sector, 41.7 per cent; commercial sector, 22.3 per cent; residential sector 31.1 per cent; others 4.9 per cent.

The volume of petroleum going into the transportation sector, 17.9 mmb and the accompanied low efficiency, about 25% finds its way into the used energy category, makes transportation an area for urgent conservation measures. At the same time, the close relationship of transportation policy to manufacture, commerce, and tourism in Puerto Rico make the impact of restrictive policies potentially injurious to the economy. This implies that trade-offs must be carefully weighted in order to obtain the most satisfactory min-max relation for Puerto Rico.

Manufacturing on the other hand, provides about 30.0% of GNP, whereas for 1975 it consumed 41.7% of total electricity and paid for it 31.5% of total revenues received by PRWRA. Besides, it consumed 20.1% of total petroleum energy products compared with 19.0% and 18.2% for electricity generation and transportation, respectively. However, in reference to the latter, manufacturing is much more efficient since about 75.0% of total inputs is effectively used, whereas, the other two sectors are about 35.0% and 25.0% efficient in their use.

It is worth noting that value added in the manufacturing sector for 1973-74 and 1974-75 was

\$2,089.6 and \$2,115.4 millions respectively, whereas, total energy inputs were 23.51^(c) *** and 23.8 mmb respectively. This implies that the energy-value added ratio for these years was of the order of 0.01125 b/\$, therefore, this is equivalent to a ratio of 65.25 (1000 BTU's/\$). This compares with 59.22 (1000 BTU's/\$) for the top fifteen U.S. Energy Intensive Industries in 1967. Therefore, Puerto Rico used in 1975 about 10% more energy than U.S. used in 1967 to generate \$1.00 of output in the manufacturing sector.^(d)****. This means, among other things, that in order for our manufactured products to benefit more effectively the local economy, improvements must be achieved either through optimization measures or technological innovations. Presently, there is not enough information available to make a full assessment of the technological state of the art in Puerto Rico for the manufacturing sector.

In general, Puerto Rico has three major sectors users of comparatively large volumes of petroleum-energy products from which energy savings can be had. These are: Electricity Generation, Transportation, and Manufacturing. The latter, although more efficient than the other two sectors, lags behind the U.S. in efficiency by about 10% as reflected by the energy-value added ratio.

For the immediate future, the Office of Petroleum Fuels Affairs considers that energy conservation programs are a priority item of utmost significance. An important objective of the regional energy model program is to identify where energy waste is occurring, assess the impact of energy policies and then orient the public on the importance of energy optimization to cut down on energy waste.

In order to have a historical perspective of the above situation, let's consider the following events which are relevant to energy and economic development in Puerto Rico.

4. ENERGY AND ECONOMIC DEVELOPMENT IN PUERTO RICO

4.1 HISTORICAL PERSPECTIVE

Energy in a modern society can be regarded as a driving force in economic development and not merely as a prerequisite to the functioning and growth of the economy. In Puerto Rico the energy

(c)*** Estimate based on the energy-intensiveness coefficient.

(d)**** Source: "A time to Choose, America's Energy Future", Energy Policy Project of the Ford Foundation, Page 146, 1974. This percentage underestimates, inasmuch as the comparison is made with the most energy intensive groups and for a year when the energy availability was not so tight.

producing sector except the Puerto Rico Water Resources Authority, was created in the period of 1955-56 with the establishment of the Caribbean Gulf Refining Co. and the Commonwealth Oil Refining Co.

The year 1965 marks the beginning of the use of the federal Mandatory Oil Import Program (MOIP) for purposes other than the control of imports to ensure national security. Proclamation 3693 of December 10, 1965 provided for allocation of imports of crude petroleum and unfinished oils into Puerto Rico for use as feedstocks for facilities already established or for expansion of the existing plants, which in judgement of the Secretary of the Interior would promote substantial expansion of employment in Puerto Rico.

On the 27th of May, 1965, Phillips Petroleum and the Commonwealth of Puerto Rico reached a private agreement to the effect that in return for a substantial investment (around \$220 millions over the project life) in Puerto Rico, Phillips would receive permission from the Department of the Interior to import 50,000 barrels per day of crude petroleum from the Western Hemisphere into Puerto Rico and ship 248,000 barrels per day of gasoline to the U.S. mainland. This agreement, together with the proclamation, opened the door to other special allocations (Sun Oil, Union Carbide, Texaco, and Corco) given in Puerto Rico, which are continued today under Presidential Proclamation 4210 of April 18, 1973. Essentially, the Federal Government has direct control over anyone desiring to enter the Puerto Rican industry, for to be competitive a new entrant would need a comparable special allocation. On January 29, 1968, Proclamation 3823 made, among others, the system of imports into Puerto Rico and shipments from Puerto Rico to Districts I-IV applicable to District V. The Secretary was authorized to make adjustments necessitated by the Middle East crisis to reduce the effect upon the operation to the MOIP of supply interruption.

These concessions lead to further development of the petroleum-petrochemical complex in Puerto Rico with the objective of creating thousands of jobs by pushing investment from close to \$500 millions in 1967 to \$1 billion in 1971 and to \$2 billion by 1975. The drawing cards for these objectives were cheaper than mainland petrochemical feedstocks, tax exemptions and relatively cheap labor.

In the above policy considerations, no explicit mention was made about the role of energy in the achievement of social and economic goals. For instance, from May to November of 1974, the average acquisition cost of crude for the mainland

refineries fluctuated between \$9.13 to \$9.44 per barrel, whereas, in Puerto Rico it fluctuated between \$9.63 to \$12.80 per barrel. This compares with a landed cost for October 1973 of \$4.13. This increase have induced an increase in the NET ADDITIONAL COST for imported petroleum for domestic consumption of approximately \$ 450 million dollars for the period of May 1974 to June 1975, as compared to the situation experienced in October 1973. This increase in costs has had an acute impact on virtually every sector of society.

4.2 CONCLUDING REMARKS

Today, the energy crisis has decidedly inhibited plans for establishing additional refinery capacity in Puerto Rico, particularly if increasing fuel prices, stringent conservation measures in the U.S. and plans for expanding the refining capacity in Districts I-IV of the United States are accelerated. In general, the changes now occurring in the availability and cost of hydrocarbons create a significant problem for firms which required this raw material to produce fuels and petrochemicals. These developments threaten the present structure of the industry and its future growth. However, special consideration by the Federal Government in response to proposals submitted by the Commonwealth Government has resulted in the averaging out of our crude and naphtha costs with mainland raw materials partially reinstating the comparative advantages of the local petroleum-petrochemical industry with the Gulf Coast operations. Therefore, the national as well as our energy policy, must take into account the unique feedstock and fuel requirements of our local industry, which fully depends on imported raw materials, if we are to avoid making the U.S. economy further dependent on foreign production with a resulting outflow of capital investment and dislocation of employment. Finally, in order to optimize energy consumption and production local producers should be induced to expand their current facilities to include downstream and/or intermediate product plants. In this regard, further incentives should be addressed to negotiation with local producers whereby raw material availability is guaranteed at competitive price to any new downstream and/or intermediate plants qualifying for location in Puerto Rico and in general strengthen the industrial sector by pursuing a line of economic complementarity with countries possessing reciprocating interests with Puerto Rico and the United States.

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