

Cuba's Transition to Market-Based Energy Prices^[1]

by Jorge Perez-Lopez

The Cuban-Soviet trade protocol for 1991, concluded in December 1990, introduced a number of important changes to the trading relationship between the two countries. One of those changes was the shift, effective on 1 January 1991 (but apparently delayed until the second half of the year), to world market prices and convertible currency payments for all traded commodities.

Since 1960 the Soviet Union has been, for all practical purposes, Cuba's exclusive supplier of energy products. For certain time periods, Soviet sales of oil and oil products to Cuba were made at concessional (below world market) prices; prior to 1991, all Soviet energy products exported to Cuba were priced on the basis of transferable rubles, the medium of exchange used by members of the recently-dissolved Council for Mutual Economic Assistance (CMEA), and were essentially bartered for Cuban goods, especially sugar. Five-year trade agreements and annual protocols committed the Soviet Union to supply Cuba each year with specific levels of energy products, a practice that introduced a certain degree of certainty into Cuba's planning function.

The shift to market prices and convertible currencies in Cuban-Soviet trade in energy products has already brought--or is likely to bring--a number of adjustments to the Cuban economy. First, it has affected the balance of trade and will further affect it as bartering of overvalued Cuban sugar exports for energy imports ceases to be an alternative. Second, the shift to commercial terms in trade relations, combined with the apparent unwillingness of the Soviet Union to supply Cuba with more than 10 million tons of oil and oil products per annum, rather than the 12-13 million tons supplied in former years, will mean the scaling down, or even the end, of the island's ability to reexport Soviet oil and oil products and close off an important source of convertible currency earnings. Third, it is bound to lead to shifts in energy consumption patterns to achieve higher efficiency in the allocation of resources economywide. And fourth, it is likely to accelerate efforts to alter the structure of energy supply, to give a heavier weight to alternative energy sources, especially nuclear power.

This paper represents a preliminary attempt to assess the implications of the transition to market-based energy prices on the Cuban economy. Because the requisite data to carry out a substantive assessment are either not available or are not timely,¹ the results are quite tentative. The paper begins with a brief discussion of the Cuban energy balance and then addresses four areas which may be affected by the shift to market-based energy prices. It closes with some observations regarding long-term adjustments in the economy related to changes in energy prices.

I. Energy and the Cuban Economy

With the exception of bagasse--produced by the sugar industry and consumed almost exclusively by that same industry--Cuba's output of primary energy products is very modest. No significant coal deposits have been found in the island. Hydroelectric resources are limited: Cuban rivers have low heads, carry relatively small volumes of water, and are subject to uneven rates of flow throughout the year. Commercial oil production increased significantly in the 1980s, but domestic output is quite small relative to domestic needs.²

Table 1 presents estimates of Cuba's total energy requirements in 1988, the most recent year for which these data are available. It is based on statistics compiled by the United Nations; data on production or trade of individual energy products have been converted to a common measure--tons of oil equivalent--in order to permit aggregation.

Energy sources: The Cuban energy balance is heavily tilted toward liquid fuels: crude oil, light oil products, and heavy oil products. In 1988, Cuba met nearly 70 percent of its energy requirements with liquid fuels, about 29 percent with biomass, and the remaining one percent with several other energy sources (coal, coke, electricity).

Biomass products (mostly bagasse, but also some fuelwood and charcoal) provide the lion's share of domestic production of primary energy. In 1988, biomass accounted for 86 percent of Cuba's primary energy production, with crude oil production accounting for about 13 percent, and electricity (in the form of hydroelectricity) for 0.4 percent.

Energy imports: Imported energy products are critical to Cuban economic activity. In 1988, total energy imports amounted to about 2.6 times the magnitude of domestic primary energy production, while net imports (imports less exports) were about twice as large. The most significant imported energy products, by far, are oil and oil products; in 1988, they accounted for over 99 percent of the value of imported energy products, with imports of coal and coke accounting for less than 1 percent.

The heavy reliance on imported oil and oil products is evident from data in Table 2. Columns 1-3 present official Cuban data on crude oil production and on imports and exports of oil and oil products for 1958-88. Using these data, apparent energy consumption (production+imports-exports), and the share of such apparent consumption accounted for by domestic production, have been calculated.

In the 1960s and 1970s, Cuba's domestic oil production accounted for a very low percentage of apparent consumption of oil and oil products. In most years, it hovered around 1-2 percent, although it rose to above 3 percent in 1968-69. In the 1980s, domestic production rose significantly and the domestic share of apparent consumption climbed to 5.3 percent in 1982, 8.0 percent in 1985, and 9.0 percent in 1986. Domestic oil production peaked in 1986 (when it reached 938,000 metric tons) and declined in 1987 and 1988. Consequently, the domestic share of apparent consumption of oil and oil products fell to 8.0 percent and 6.1 percent in 1987 and 1988, respectively.

II. Energy and the Trade Balance

Annual merchandise trade deficits, financed by "credits" from the Soviet Union and other socialist countries, have been the norm in revolutionary Cuba.³ According to official Cuban data, the average annual merchandise trade deficit (in million pesos) over certain time periods was:

1961-65 -210.3

1966-70 -377.8

1971-75 -281.0

1976-80 -402.6

1981-85 -1193.9

1986-88 -2172.5

The increase in the merchandise trade deficit in the 1980s reflected, in part, the rise in the value of energy products imported from the Soviet Union. Between 1980 and 1988, the value of energy imports rose from 911.5 million pesos to nearly 2.6 billion pesos; the share of energy within the total value of imports rose from 19.7 percent in 1980 to 34.2 in 1988 (see Table 3). The shift to market-based prices in all trade with the Soviet Union means that the possibility of bartering overvalued sugar exports to the Soviet

Union for energy products will disappear, with a consequent deterioration in the trade balance.

Soviet sales of oil and oil products to Cuba: Cuba began to

barter sugar for Soviet crude oil in the spring of 1960. One of the arguments used by the Cuban government to justify purchasing Soviet crude oil was that its price was lower than the market price by about 33 percent. Upon the nationalization of the oil refineries operated by the international oil companies (in June 1960), Soviet oil and oil products began to flow into the island in increasing volumes, with the Soviet Union becoming, for all practical purposes, Cuba's exclusive supplier of these products.⁴

In October 1973, an embargo on oil sales by Arab members of the Organization of Petroleum Exporting Countries (OPEC) led to a four-fold increase in world oil prices. Cuba, as well as other socialist countries who depended on the Soviet Union for oil supplies, was not affected immediately by the price increases, since the Soviet Union lived up to its commitments to maintain commodity prices fixed in trade with its CMEA allies. Thus, Cuba was spared from the sudden quadrupling of the price of oil imports and serious balance of payments problems that affected other oil-importing countries.

In 1975, the Soviet Union implemented a new pricing policy for oil exports to its CMEA allies aimed at closing the gap between oil world market prices and the intra-CMEA export price. It consisted of a formula whereby annual adjustments to oil prices would be made based on the moving average of world market prices during the previous five years. Throughout the 1970s and early 1980s, as oil world market prices rose, Cuba benefitted from this arrangement as the five-year moving average price was consistently below the world market price. However, as oil world market prices softened beginning in 1983, the arrangement worked to Cuba's disadvantage since the five-year moving average price continued to rise or fell at a slow pace. In particular, Cuba did not benefit fully from the sharp fall in oil world market prices that occurred in 1986.

For 1982-87 the average price (import unit value) of Cuban crude oil imports from the Soviet Union (in pesos/barrel) and the average oil world market price (in U.S. dollars/barrel) were:⁵

Import World

Unit Value Market Price

1982 17.7 33.5

1983 20.1 29.3

1984 23.8 27.5

1985 26.5 26.7

1986 26.1 13.1

1987 26.2 16.9

These data suggest that by 1986, Cuba was no longer benefitting from concessional prices in oil and oil products imports from the Soviet Union.

Cuban sugar sales to the Soviet Union: Pursuant to agreements reached in 1975, the Soviet Union guaranteed Cuba a "minimum" price of 500 rubles per ton of raw sugar (about 30.40 centavos/pound), with the price to be adjusted upwardly in step with changes in the price of a basket of Cuban imports

from the Soviet Union. Although the components of the basket of imports, their base period price levels, and their weights have not been made public, it has been reported that oil played a prominent role; some Cuban officials have gone so far as to describe the mechanism as merely compensating Cuba (via increases in the price of sugar exports) for increases in the price of oil imports from the Soviet Union.⁶

As the data below demonstrate, during 1982-88 the average export price (export unit value) of Cuban sugar to the Soviet Union (in centavos/pound) was several-fold higher than the world market price (in U.S. cents/pound):⁷

Export World

Unit Value Market Price

1982 28.4 8.4

1983 39.6 8.5

1984 39.4 5.2

1985 44.8 4.1

1986 39.3 6.1

1987 38.7 6.8

1988 41.8 10.2

The effect of the heavily-subsidized prices for sugar exports to the Soviet Union within Cuba's export basket is shown in Table 3. Thus, in the 1980s, sugar exports accounted for over three-fourths of the value of Cuba's total exports. Despite the very high price subsidies for Cuban sugar exports, Cuba's trade deficit grew rapidly in the 1980s. Clearly, the deficits would have been much higher had the subsidies not been present.

Sugar-for-energy barter: Table 3 presents data on overall Cuban foreign trade and on energy and sugar trade in the 1980s. It should be noted that the columns labelled energy imports and sugar exports in the table refer to all transactions, i.e., not only to trade with the Soviet Union. In the case of oil, imports from the Soviet Union and overall imports are essentially synonymous, considering the overwhelming importance of this nation as a supplier of oil and oil products; in the case of sugar, exports to the Soviet Union ranged from 62 to 83 percent of total annual exports in 1980-88.

The last column of Table 3 presents the ratio of the value of sugar exports to that of energy imports. Over the 1980s this barter ratio fell dramatically, from 3.6 in 1980 to 1.5-1.7 in 1985-88. This means that while Cuba could finance 3.6 times its energy imports in 1980 through sugar exports, it could finance only roughly 1.5 times its energy imports by the mid- to late-1980s. Although more recent trade statistics are not available, it is likely that this barter exchange relationship worsened for Cuba in 1989-90.

There is reason to believe that the sugar-for-energy exchange will deteriorate even further in 1991 and beyond. Cuban officials have indicated that the Soviet Union would pay a price for Cuban sugar imports in 1991 in line with that paid by the European Economic Community for preferential imports from Pacific, Asian, and Caribbean beneficiaries under the Lome Convention; this price would be lower than prevailed in 1990 in Cuban-Soviet trade, but higher than the world market price.⁸

Using 25 U.S. cents/pound as a rough estimate of the Soviet price for Cuban sugar in 1991,⁹ and assuming that Cuba ships: 1) 4 million tons of raw sugar to the Soviet Union; and 2) 3 million tons of raw sugar to the world market at about 11 U.S. cents/pound, the sale abroad of the sugar crop would generate approximately \$2970 million, about one-third lower than the revenue generated by sugar exports in 1988.¹⁰ At the world market price of about \$21 per barrel, Cuban oil imports from the Soviet Union in 1991 (10 million tons) would amount to about \$1950 million. Thus, the value of sugar exports would represent about 1.5 times the value of oil imports. (At the higher import level of 13 million metric tons, oil imports would amount to \$2535 million, so that total sugar revenues would exceed the value of oil imports by about 17 percent.)

III. Oil Reexports¹¹

In the early 1970s, Cuba began to export lubricants, naphtha, and other refined oil products to Western Europe. In 1973, for example, Cuba exported 90,000 tons of naphtha (Table 2), and smaller amounts in the following three years. According to Cuban sources, these sales were intended to dispose of excess amounts of naphtha--a by-product of the oil refining process--for which there was low demand in the island.

In 1977, Cuban exports of oil and oil products took a quantum leap. In that year Cuba exported over 900,000 metric tons of oil and oil products, about 4 times the magnitude of domestic crude production (256,000 tons) and nearly 10 percent of gross imports (Table 2). From this point forward, the nature of oil exports changed and Cuba became a significant reexporter of Soviet oil and oil products.¹²

Logic behind reexports: The main benefit for Cuba from the reexport of Soviet oil and oil products was that it generated scarce convertible currency. Three peculiarities of Cuban-Soviet trade relations made such reexporting economically feasible for Cuba: 1) imports of Soviet oil and oil products were priced below world market prices; 2) Soviet oil and oil imports were obtained through barter for Cuban sugar (i.e., they were priced in transferable rubles), while Cuba could sell them for convertible currency; and 3) the Soviet Union was willing to provide oil and oil products to Cuba in amounts exceeding domestic demand thereby making the arrangement feasible.

Because of shortfalls in sugar production, at least in 1984 and 1985 Cuba actually bought sugar in the world market (using convertible currency), bartered it to the Soviet Union for oil and oil products, and then resold these products to convertible currency buyers. These deals were quite profitable for Cuba. In 1985, for example,¹³

- o Cuba bought sugar for 100 million pesos (in convertible currency) in the world market;
- o the sugar obtained through this transaction was then "sold" to the Soviet Union. It generated the equivalent of 1012 million pesos (in soft currency), for a net gain of 912 million pesos;
- o this gain permitted Cuba to finance the import of 4.214 million metric tons of Soviet oil and oil products (priced in soft currency);
- o a portion of the oil and oil products (1.978 million metric tons) was reexported to convertible currency purchasers and the rest (2.236 million metric tons) used for domestic consumption.

Considering that the world spot market price for crude oil was around \$27 per barrel (\$203 per metric ton) in 1985, it can be estimated that Cuba earned around \$400 million (in convertible currency) in this sale. That is, by virtue of its arrangements with the Soviet Union, Cuba turned a \$100 million convertible currency sugar purchase into a \$400 million return.

Reexports and convertible currency revenue: In the 1980s, at a time when sugar world market prices were depressed and Cuba had serious difficulties in generating convertible currencies to service its debt and to purchase goods and services not available from the socialist countries, oil reexports became a key source of convertible currency.

Table 4 presents data on Cuba's convertible currency exports during 1981-88. In 1981, sugar exports generated 62 percent of hard currency revenues and oil and oil products about 11 percent. In 1983-87, however, oil and oil products reexports actually overtook sugar as the island's most significant source of convertible currencies. Incredibly, in 1983-85 oil and oil products reexports accounted for over 40 percent of Cuba's convertible currency revenue, twice the share of convertible currency revenue generated by sugar!

The sharp drop in oil world market prices in 1986 eroded Cuba's convertible currency earnings from oil and oil products reexports. Nevertheless, liquid fuel reexports made substantial contributions to convertible currency earnings in 1986-88, when they accounted for about one-fourth of such convertible currency earnings. In 1988, sugar exports again overtook oil and oil products reexports as the main source of convertible currency revenue, in part because of the recovery of sugar world market prices.

The future of oil reexports: The shift to market-based prices and terms of sale in Cuban-Soviet trade casts serious doubts on the feasibility of generating substantial volumes of hard currency earnings through oil reexports. In essence, oil reexports constituted a form of arbitrage, with Cuba exploiting the differences in trade relations between, on the one hand, the socialist countries, and on the other, the market economies. To the extent that those differences have disappeared--or will disappear as a result of economic reforms in the Soviet Union--so would the possibility of arbitrage and the economic rationale behind reexports.

Moreover, the purported 10 million ton per annum limit that the Soviet Union has placed on liquid fuel exports to Cuba (down from the 13 million plus metric tons per annum in the late 1980s) further constrains Cuba's ability to reexport liquid fuels. According to data in Table 2, Cuba's apparent consumption of oil and oil products in 1984-88 averaged about 11 million metric tons per annum. Considering that domestic oil production is probably in the range of 500,000-700,000 metric tons per annum, Cuba will barely be able to continue to meet domestic requirements from the combination of domestic production and imports, and it will not have the physical capacity to engage in substantial reexporting unless it reduces domestic consumption very sharply.

It is also not clear that Cuba can count on annual imports of 10 million tons of oil and oil products from the Soviet Union in the out years. The Soviet energy industry has been going through a very difficult period, described by analysts as "bordering on collapse," with output of oil and coal in the first two months of 1991 more than 8 percent below the levels extracted in a comparable period in 1990.¹⁴ Moreover, differences between the central government and the republics regarding ownership of natural resources--including oil--threatens the ability of the Soviet central government to direct oil exports to specific customers. Finally, the weakened condition of the Soviet economy, and its severe requirements for hard currency revenues, places a premium on exportable products such as oil and oil and oil products that can generate hard currency in international markets.

In what may be an analogous situation, Czechoslovakian officials have recently reported that, despite contacts at the Ministerial level, the Soviets have "absolutely refused" to discuss oil export levels for 1992 and to make any commitments on export levels for 1992 or for the out years. Czechoslovakia's oil purchases from the Soviet Union were cut back to about 12 million tons in 1990 from 16.4 million tons in 1989; for 1991, the Soviet Union promised to export to Czechoslovakia 7.5 million tons of oil for hard currency.¹⁵ At the end of 1990, Cuba sought a five-year commitment from the Soviets on oil supplies,

but that country would only enter into a one-year arrangement (1991), leaving future levels of supply to negotiation.¹⁶

IV. Shifting Energy Consumption Patterns

Central planning and cheap Soviet oil supplies contributed importantly to the relatively low efficiency of energy use in the socialist countries. In a study comparing energy consumption in Western and Eastern Europe, Moroney found that the European centrally planned economies (CPEs) consumed far more--approximately twice as much--energy relative to gross domestic product and capital than the European market economies.¹⁷ According to Moroney, "this pattern of intensive energy use may well be a rational response by end users to historical energy subsidies and to central planning emphasizing energy-intensive industry."¹⁸ In the development strategy of CPEs, "energy was conceived as a significant, abundant and cheap factor for achieving extensive growth."¹⁹

Data on apparent consumption of oil and oil products in revolutionary Cuba (Table 2) suggest that the pattern of high energy consumption observed in European socialist countries also applied to that country. Apparent consumption of oil and oil products rose from about 2.3 million MT in 1959 to 11.7 million MT in 1988, nearly a five-fold increase or a 5.6 percent average annual growth rate.

The availability of cheap Soviet oil has affected Cuba's development strategy, particularly in the industrial sector. Slavishly applying the heavy industrialization model pursued by the Soviet Union and Eastern Europe, Cuba invested in energy-intensive industries such as steel mills and machinery production. Nickel-refining, cement, and fertilizer plants that have been built may rely on technologies imported from the Soviet Union and Eastern Europe that have low energy efficiency. Mechanization of sugar harvesting appears to have been driven by political rather than by economic considerations.

Energy consumption and economic growth: Measuring the relationship between national income and energy consumption growth (the "energy elasticity") in revolutionary Cuba is very difficult because of the lack of adequate data on total energy consumption and on national income. Relying primarily on official statistics, a Cuban economist has estimated that over the period 1959-88, the nation's material product grew at an average annual rate of 4.3 percent.²⁰ Independent estimates of Cuban gross domestic product, developed using a different approach (that relies heavily on physical production data), suggest that real economic growth was much slower, roughly about one-half the growth rate obtained from official statistics.²¹

In either case, it is clear that the growth in consumption of oil and oil products (5.6 percent per annum) exceeded national income growth over the period 1959-88; the elasticity of oil and oil products consumption therefore was well above unity and may have approached two or higher. This high elasticity coefficient suggests that revolutionary Cuba, like other CPEs, also used oil and oil products extensively. Thus, Cuban economists have described the island's energy problem as follows:

The essence of our energy problem is that the growth of consumption has been based fundamentally in increases in oil imports. Bagasse is used by the sugar industry in a closed cycle, and small amounts [of bagasse] are used as raw material. Meanwhile, the contribution of other energy sources and domestically-produced oil are not significant yet.²²

Energy consumption by fuel type: Table 5 presents official Cuban data on consumption of oil and oil products in 1988 by broad consuming sectors: industry, construction, agriculture, transportation, population, and other. Table 6 presents the same data in terms of shares of consumption by consuming sector and type of oil product. Unfortunately, more detailed information on consumption within these broad sectors (e.g., by specific economic activity within the industrial sector) are not available.

According to data in Tables 5 and 6, over one-half (52.9 percent) of Cuba's consumption of oil and oil products in 1988 was of residual fuel oil. This is not surprising since residual fuel oil is typically used in boilers in industrial facilities and in thermoelectric plants. In 1988, Cuba consumed nearly 6 million MT of residual fuel oil; 3.9 million MT were refined in Cuba from domestic and imported crude oil, and the rest imported.²³

Diesel fuel, also used in industrial applications as well as in agriculture and transportation, accounted for 22.4 percent of consumption of oil and oil products, with gasoline accounting for 10.2 percent. About one-half (1.2 million tons) of the diesel fuel consumed in 1988 was produced in Cuban refineries, while the same was the case for 89 percent of gasoline consumption. Kerosene, used primarily by the population (as cooking fuel) accounted for 5.9 percent of consumption. Other fuels (crude oil, natural gas, naphtha, aviation gasoline, jet fuel, liquified natural gas, solvents, asphalt) were less significant in terms of consumption.

Consumption by sectors: Nearly 60 percent of Cuba's consumption of oil and oil products in 1988 was associated with the industrial sector. The other consuming sectors, and their shares of total consumption, are: transportation, 11.9 percent; "other" activities (which might include defense), 10.2 percent; population, 7.9 percent; construction, 6.5 percent; and agriculture, 4.2 percent. While more efficient use of energy resources across all consuming sectors would have a salutary effect, clearly the industrial sector offered the greatest potential for energy savings.

Since the mid-1980s, Cuba has made energy conservation a high national priority.²⁴ A National Program for the Conservation and Rational Use of Energy (Programa Nacional para el Ahorro y Uso Racional de Energía) was made part of the economic development plan for 1986-90. It consisted of a web of measures to increase efficiency of energy consumption in the industrial sector (especially thermoelectric plants), improvements in electricity distribution networks to reduce transmission losses, cogeneration in the sugar industry, changes in the technology of cement production to emphasize more energy-efficient processes, reduction in household electricity consumption, etc. Domestic and foreign specialists estimated that Cuba could reduce energy consumption by 30 percent without affecting the level of economic activity.²⁵

An assessment of the success--or lack thereof--of the national energy conservation plan is not possible because of the lack of adequate data. One indicator that is available, consumption of oil products in the production of electricity in thermoelectric plants, suggests that no significant gains were made on this score.²⁶

Faced with incipient disruptions in supplies of oil and oil products from the Soviet Union, in late May 1990 the Cuban Government announced a plan to save approximately 150,000 MT of oil products in the largest 45 industrial users in the nation.²⁷ The plan consisted of primarily of measures to use energy more efficiently and to improve maintenance of machinery and equipment. Implementation of this plan was overtaken by severe input shortages later that summer.

Response to energy shortages: In August 1990, the Cuban government announced the imposition of mandatory energy conservation measures to address a 2-million ton shortfall in Soviet deliveries of oil and oil products. Among the energy conservation measures were:

- o reduction of daily gasoline and fuel oil deliveries to the state sector by 50 percent and of gasoline deliveries to the private sector by 30 percent;
- o cutting back hours of operation in cement and construction material plants;

- o shutting down of the Punta Gorda nickel production plant;
- o halting start-up of an oil refinery built in Cienfuegos;
- o cutting back household electricity consumption by 10 percent; and
- o implementing a nationwide project to replace agricultural tractors and combines with draft animals.²⁸

Subsequent events suggest that the energy crunch worsened in the second half of 1990:

- o the Construction Materials Industry announced an effort to use of domestically-produced crude oil at several cement factories that rely on the so-called wet-process;²⁹
- o to ease bottlenecks in public transportation, the government announced the importation of large number of bicycles and expressed the intention to build plants to produce bicycles domestically; and
- o the Ministry of Light Industry was forced to cut back hours of operation of 321 plants nationwide within its purview from 40 to 24 hours per week.³⁰

V. Changing the Energy Mix

As discussed above, Cuba's efforts to conserve energy and to diversify its energy mix to reduce the reliance on imported liquid fuels are not new. As discussed above, on the energy demand side the Cuba has undertaken several initiatives to curb energy consumption in enterprises, reduce electricity consumption by households, etc. On the energy supply side, Cuba has turned to a number of alternative sources of energy, including solar heaters, wind power, and small hydroelectric plants. Each of these efforts, while making a contribution, has had very little impact on the overall energy balance. The one energy source that has the potential to substantially alter the energy mix, and the one behind which Cuba has been willing to put resources, is nuclear power.

The nuclear power program: Cuba's plans to build several nuclear power plants for commercial electricity generation stem from the early 1970s. In 1974, President Castro announced that construction of a nuclear power complex in Cuba's southern coast at Juraguá, near Cienfuegos, would begin in 1977-78 and the first reactor at that site would be operational by 1985. Subsequently, the intentions to build a second plant in the eastern region of the country, near Holguín, and a third plant in the western region have been announced.³¹

Ground was broken at Juraguá in the late 1970s, and construction of support facilities for the plant--which ultimately would have four nuclear reactors--have been completed or are near completion. The structure that houses the vessel of the first reactor is also approaching completion. Press reports circulating in early 1991 indicated that Cuba was about to receive some key pieces of nuclear hardware for the plant from the Soviet Union. The best estimate is that, assuming hardware and fissionable materials arrive from the Soviet Union relatively close to schedule, construction of the first Juraguá reactor might be completed in 1993-94.

The reactors for the Juraguá plant, and presumably for other Cuban nuclear power plants as well, are Soviet-designed pressurized water reactors with 440 megawatt (MW) electricity generation capacity, commonly known as VVER-440. Like pressurized water reactors built in the West, VVER-440s are fueled with enriched uranium and use water as a moderator. VVER-440s have been in operation since the early 1970s in the Soviet Union. Ten VVER-440s are in operation in the Soviet Union and several others in Eastern Europe.

Electricity generation and nuclear power: In 1988, the Cuban electricity system had a generation capacity of 3.853 megawatts (MW); in that year, Cuba generated 14.453 gigawatt-hours (GWH) of electricity, with 99.5 percent of the electricity produced by thermoelectric plants (Table 7).

Thermoelectric plants, fueled with residual fuel oil and crude oil, used up over 3.3 million tons of liquid fuels in 1988. Electricity generation, then, accounted for over 28 percent of total apparent consumption of oil and oil products (Table 2) and about one-half of oil and oil products consumed by the industrial sector (Table 5).

According to Cuban officials, each 440 MW nuclear reactor will have the potential to displace thermoelectric generation capacity consuming 600,000 MT of oil products per annum. This explains, to a large degree, the high priority that Cuba has accorded to its nuclear power program. Despite the austerity program associated with rectification and the cut back in investments in social services, resources continue to flow into the construction of the Juraguá plant. Although more recent statistics are not available, during the period 1985-88, over 19 percent of national investment in the industrial sector was devoted to the electric industry, with a large share aimed at nuclear power; in comparison, the sugar sector, Cuba's most important generator of exportable commodities, was the recipient of slightly less than 17 percent of industrial sector investment over the same period.³²

VI. Concluding Observations

The legacy of central planning and cheap Soviet oil supplies is a Cuban economy that is heavily dependent on imported oil and oil products. During the period 1961-1989, the Soviet Union met virtually all of Cuba's growing needs for imported oil and oil products and even permitted Cuba to reexport a portion of these fuels as a form of foreign aid.

Cuba's rapidly-growing demand for liquid fuels resulted, in part, from a deliberate Soviet trade policy consisting of commodity barter and energy priced at below-market prices. This policy did not create incentives for efficiency in the use of energy resources and contributed to questionable investment decisions in energy-intensive industries and to wasteful energy consumption practices.

Cuba is ill prepared to meet the challenges of a shift to market-based energy prices. Since 1986, the economy has been mired in a recession; trade deficits are large; the option of borrowing in international markets has been foreclosed; the exports are concentrated on sugar and a handful of other basic and semimanufactured commodities. Cuba's ability to generate hard currency through exports to be able to obtain energy supplies from the world market is extremely limited. The shift to market prices and hard currency for energy imports compounds the already-difficult economic situation. Some Cuban officials have warned that the situation might deteriorate, and the "option zero" (meaning "zero fuel, zero energy, zero supply") might have to be invoked.

Arguably, Cuba's economic plight associated with the shift to market-based energy prices is worse than that of Eastern European socialist nations. Those economies 1) rely less heavily on imports of oil and oil products than Cuba's;³³ and 2) are more diversified than Cuba's and are able to sell a broader variety of products--including high-quality manufactured products--in the world market. Moreover, because the Eastern European countries are already engaged in a process of economic reform and adoption of market mechanisms, they have been able to use market instruments (energy price increases, reduction of subsidies, creation of markets, abolition of foreign trade monopolies) to rationalize energy consumption.³⁴ These options are not available to Cuba, adamant about holding the line on reforms.

While nuclear power offers Cuba the possibility to reduce dependency on imported oil and oil products, it will not reduce the overall dependence on imported energy. Nuclear hardware for the application of the

nuclear technologies is imported, and so are fissionable materials to fuel the reactors. Cuba will also have to depend on a foreign concern--whether in the Soviet Union or elsewhere--for storing and reprocessing irradiated fuels. The international controversy over the safety of the Juraguá reactors is sure to slow down their construction and commissioning and put further into the future the contribution of that technology to energy supplies.³⁵

ENDNOTES

1. The most recent issue of the Cuban statistical yearbook generally available to researchers is for 1988. This publication contains comprehensive statistics through 1988 in most economic activities, except for energy trade. See Comité Estatal de Estadísticas, Anuario estadístico de Cuba 1988 (La Habana, 1990).
2. See Jorge F. Pérez-López, "Energy Production, Imports and Consumption in Revolutionary Cuba," Latin American Research Review 16:3 (1981), pp. 111-137.
3. Over the 30-year period 1959-88, Cuba's merchandise trade balance has been in the black only twice, in 1960 and 1974. See Anuario estadístico de Cuba 1988, p. 410.
4. Some of the oil consumed by Cuba might actually be Venezuelan, pursuant to a swap arrangement between the Soviet Union and Venezuela. Since Venezuelan oil shipments to Cuba respond to terms and conditions set by Cuba and the Soviet Union, they can be considered as Soviet exports for analytical purposes.
5. Cuban oil import unit values calculated from data in Anuario estadístico de Cuba 1988. Oil world market prices from International Monetary Fund, International Financial Statistics.
6. For a fuller discussion of pricing of Cuban sugar exports to the Soviet Union see Jorge F. Pérez-López, "Cuban-Soviet Sugar Trade: Price and Subsidy Issues," Bulletin of Latin American Research 7:1 (1988), especially pp. 123-134.
7. Cuban sugar export unit values calculated from data in Anuario estadístico de Cuba 1988. Sugar world market prices from International Monetary Fund, International Financial Statistics.
8. See interview with Cuban official Carlos Rafael Rodríguez published as "Cuba's Predicament: Worse than Imperialism?," New Perspectives Quarterly, 8:1 (Winter 1991), p. 13.
9. The price of \$550 per ton (25 cents/pound) has been given by Soviet Ambassador to Cuba Yuri Petrov. See "Soviéticos pagarán el doble por azúcar," El Nuevo Herald (19 April 1991), p. 3A.
10. Strictly speaking, these figures are not comparable, as the 1988 figure is denominated in Cuban pesos, while the revenue estimate for 1990 is denominated in U.S. dollars. The official exchange rate in 1988 was 1 peso=1 U.S. dollar.
11. For a fuller treatment see Jorge F. Pérez-López, "Cuban Oil Reexports: Significance and Prospects," The Energy Journal 8:1 (1987), pp. 1-16.
12. Considering the large quantities of liquid fuels that were involved (averaging over 3 million tons per annum in 1983-87) and the transportation costs involved, in most instances it does not appear that the oil and oil products that Cuba reexported actually arrived in the island. It is more likely that the Soviet Union shipped the products directly to purchasers (mostly in Western Europe) on Cuba's account.
13. Banco Nacional de Cuba, Economic Report (February 1985), p. 35.

14. "Crisis Deepens for Soviet Energy Industry," Oil and Gas Journal (8 April 1991), p. 91. See also, Mikhail B. Korchemkin, "Soviet Energy: The Uncertain 1990s," Energy Policy 18:5 (June 1990), pp. 399-405; "Soviet Union: Exports under Threat," Petroleum Economist (February 1991), p. 18; and Isabel Gorst, "Oil Exports Tumble," Petroleum Economist (August 1990), pp. 23-24.
15. "Czechoslovakia Fears Problems With Supplies of Soviet Oil," The Journal of Commerce (29 July 1991), p. 7B.
16. See interview with Carlos Rafael Rodríguez, as reported in "Cuba's Predicament," op. cit., p. 13.
17. John R. Moroney, "Energy Consumption, Capital and Real Output: A Comparison of Market and Planned Economies," Journal of Comparative Economics 14:2 (June 1990), p. 201. According to Adam Gwiazda, "The decline of Comecon and its impact on the crude oil foreign trade of Eastern European countries," OPEC Review 15:1 (Spring 1991), p. 81, "the economies of Comecon countries use, on average, at least 2.5 times the amount of primary energy in the production of one unit of gross domestic product, compared with the highly industrialized Western countries."
18. Moroney, "Energy Consumption, Capital and Real Output," op. cit., p. 212.
19. Economic Commission for Europe, Energy Reforms in Central and Eastern Europe: The First Year, ECE Energy Series No. 7 (New York: United Nations, 1991), p. 5.
20. José Luis Rodríguez, Estrategia del desarrollo económico en Cuba (La Habana: Editorial de Ciencias Sociales, 1990), p. 279-280.
21. Jorge F. Pérez-López, Measuring Cuban Economic Performance (Austin: The University of Texas Press, 1987). The estimates cover the period 1965-82.
22. Rigoberto González Rodríguez, Jorge A. San Emeterio Bordas, Armando J. Díaz Rodríguez, and Eduardo Villareal Sando, "Cuba: Energía y desarrollo en la perspectiva 2000," Economía y Desarrollo, no. 95 (November-December 1986), p. 77.
23. Refinery output data are from Anuario estadístico de Cuba 1988, p. 251. This source does not contain data on imports of oil and oil products in 1988.
24. See, e.g., Serafín Hernández Cruz, "El ahorro de energía: Nueva fuente de recursos energéticos," Revista Estadística 9:20 (April 1987), pp. 5-42.
25. Hernández Cruz, "El ahorro de energía," op. cit., p. 36.
26. According to official Cuban data (Anuario estadístico de Cuba 1988, p. 260), consumption of liquid fuels in the production of electricity (in gallons/kilowatt hour generated) were:

1983	265.4
1984	264.8
1985	260.0
1986	265.1

1987 263.8

1988 262.3

27. Mimi Whitefield, "Castro admite problemas con petróleo," El Nuevo Herald (20 June 1990), pp. 1A, 5A.
28. "Cuba Restricts Fuel Use, Halts Refinery Start-Up," The Journal of Commerce (31 August 1990), p. 6B; "Cuba Cuts Fuel Consumption as Soviet Oil Deliveries Fall," The Washington Post (30 August 1990), p. A39.
29. "Fuel Conservation in Construction Outlined," Tele Rebelde Network, 3 October 1990, as reproduced in FBIS-LAT-90-193 (4 October 1990), p. 7. The wet process of cement production is almost 40 percent more energy-intensive than the dry process. See John E. Jankowski, "Energy Use and Conservation in Developing Country Industries," Natural Resources Forum 7:2 (1983), p. 151.
30. "Paralización en industria ligera," El Nuevo Herald (18 October 1990), p. 3A.
31. This section draws heavily from Jorge F. Pérez-López, "Nuclear Power in Cuba after Chernobyl," Journal of Interamerican Studies and World Affairs 29:2 (Summer 1987), pp. 79-117.
32. Based on data in Anuario estadístico de Cuba 1988, p. 215.
33. The economies of Poland, Czechoslovakia, and the Eastern part of Germany (formally the German Democratic Republic) are heavily coal-based, with coal covering between 60 and 70 percent of their total primary energy needs. On average, all Eastern European countries satisfied only 21 percent of their energy needs with oil. Gwiazda, "The decline of Comecon," op. cit., p. 81.
34. Economic Commission for Europe, Energy Reforms, op. cit., pp. 12-14. For example, since the beginning of reforms (around 1989), energy prices have risen typically of the order of 2-3 times in nominal terms in all Eastern European countries (p. 12).
35. See, e.g., "Cuba to Invite Nuclear Reactor Inspectors," The Washington Post (26 July 1991), p. A16.

[1] .Prepared for delivery at the First Annual Meeting of the Association for the Study of the Cuban Economy, Florida International University, Miami, Florida, August 15-17, 1991. The paper expresses strictly the personal views of the author