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Brazil: Economics of the Nuclear Alternative

Brazil is laying the foundation for a nuclear industry to meet its electric power needs when hydroelectric potential approaches full utilization toward the turn of the century. To reduce import dependence as well as to exploit the substantial cost advantages of nuclear power, Brazil hopes to achieve nuclear self-sufficiency by establishing a complete domestic nuclear fuel cycle.

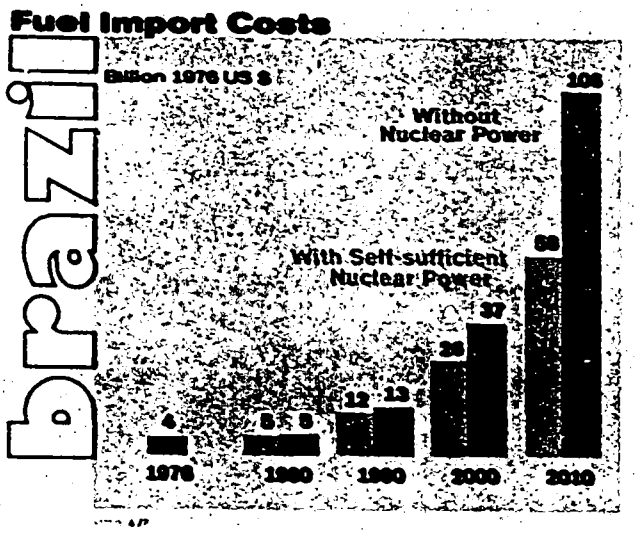
The large investments needed may worsen Brazil's balance-of-payments situation over the next decade or so; in the long run, however, establishment of a nuclear industry will result in substantial savings of foreign exchange. Without a nuclear program, real costs for imported fuels would triple during the first decade of the next century (and perhaps sooner), and Brazil's dependence on imported energy sources would accelerate rapidly.

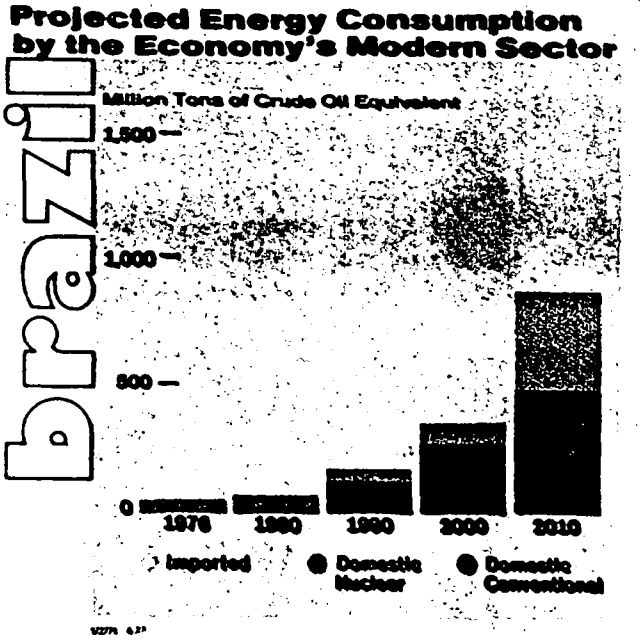
Current Energy Situation

Imported energy now accounts for nearly 30 percent of Brazil's total import bill and is the largest single component of the huge current-account deficits suffered in recent years. Imported energy, almost entirely petroleum, supplied about 47 percent of total energy requirements in 1976, up from 43 percent in 1970.

Hydroelectric power, the major domestic energy source, supplies one third of the economy's energy demand. Total hydroelectric potential is estimated at about 150 million kilowatts (kw), of which 18.4 million kw had been developed by the close of 1976.

About 55 percent of energy needs are met with petroleum, more than 80 percent of which is imported at a cost that exceeded $3.5 billion last year. Coal, half of which is imported, supplies 4 percent of the energy supply. The remainder is supplied by sugar cane bagasse and charcoal.





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Projected Energy Requirements and Resources

Demand for electricity will continue to grow rapidly, and the economy could require as much as 180 million kw of electric power capacity by the turn of the century, up from 21.8 million kw at the end of 1976. Hydroelectric capacity is expected to reach only 110 million kw by the year 2000, because its growth will slow steadily after 1990 when potential near the main consumption centers will approach full development. Only about one third of the total potential is in the central south, where nearly three fourths of all electricity consumption takes place. About two fifths of total potential is in the Amazon region, too remote for economical transmission to the large consumption centers.

While the country is stepping up fossil fuel use, it plans to have only 15 million kw of conventional thermal capacity by the turn of the century unless large petroleum reserves are found. Although Brazil has fairly large coal reserves, this resource has been neglected because of its low heat and high sulfur and ash contents.

The government has increased its effort to find oil, spending $400 million on domestic exploration last year, compared with only $140 million in 1973. Moreover, Brazil has broken a long-standing policy to bring foreign oil companies back into domestic oil exploration.

The Nuclear Option

While policymakers are hopeful that major new reserves will be discovered they are turning to nuclear energy against the contingency that oil discoveries will fall far short of requirements. They are urgently seeking to reduce Brazil's dependence on foreign energy sources, and the nuclear option makes good economic sense because of the relatively low cost of nuclear fuel compared even with the current cost of fossil fuels. Should oil be discovered in large quantities, Brazil would still be interested in nuclear power for reasons of prestige and because of its tradition of seeking the most advanced technological solution to any problem.

The 1975 nuclear agreement signed with West Germany is designed to meet Brazil's requirements for the period through 1990, the first stage of the current nuclear

development program. Under the accord, Brazil will buy four 1,300 megawatt (MW) reactors with an option on four more. Brazil will also receive a pilot uranium enrichment plant that can be expanded to commercial scale, a fuel fabrication plant, and a fuel reprocessing plant. If the agreement is fully carried out, Brazil will have 10,000 MW of nuclear capacity by 1990, enough to meet 5 percent of the economy's energy needs.

Reported cost estimates for the West German agreement range from $4 billion to $10 billion. Assuming that Brazil acquires the full package--eight reactors and a complete fuel cycle large enough to support them--we believe the total cost will approach $13 billion. The two reactors already purchased cost $2.6 billion, of which nearly $1.8 billion is foreign exchange cost to be financed by a consortium of West German banks. The total cost for eight reactors would be approximately $10 billion, and the fuel cycle would add another $3 billion.

Brazil's known uranium resources are inadequate to support its nuclear development plans. Official reserves are estimated at about 26,000 tons of U308, only enough to provide the first core and 10 annual reloads for the 8 reactors. Brazil's geology suggests that undiscovered uranium may exist in significant amounts, however, and the exploration now under way already has turned up evidence that uranium deposits are present at a number of sites.

Implications for the Balance of Payments

During its early years, the nuclear energy program could add slightly more to Brazil's foreign exchange expenditures than would thermal power. In the longer term, however, the nuclear option should greatly ease energy import expenditures, as compared with conventional energy sources.

The first 1,300 MW reactor--scheduled for completion in 1983 under the West German agreement--will cost about $1.3 billion, of which $900 million will be financed by a group of West German banks. If this loan were amortized over a five year period with interest at 7.5 percent annually, total foreign exchange expenditures to finance the reactor's imported components would be nearly $1.1

billion. In addition, the initial fuel charge, costing about $80 million (at 1976 prices), and the first few annual reloads, costing some $40 million each, probably would need to be imported. Fuel imports gradually will phase out, however, as Brazil begins to exploit its domestic uranium resources and as the fuel cycle begins to provide enrichment and fuel fabrication services. Including capital costs for the fuel cycle, total foreign exchange expenditures required for the reactor would be approximately $1.6 billion, almost all of which would be spent during the first 5 years of its expected 30-year life.

If an equivalent conventional powerplant fired with imported oil were built instead of a nuclear reactor, foreign exchange costs over the 30-year period probably would exceed $4.5 billion at 1976 prices. Costs for imported conventional components probably would not exceed $75 million; conventional plants cost less than nuclear powerplants and Brazilian industry could supply more than 90 percent of an oil-fired plant. Fuel imports, however, would cost about $150 million annually (at 1976 prices), and these costs probably would continue indefinitely.

Foreign exchange savings per unit will increase as additional reactors are built and as Brazilian industry gradually expands its ability to supply reactor components. By the late 1980s or early 1990s, Brazil probably will be able to manufacture 80 to 90 percent of the components for its new reactors. Unless large uranium reserves are found, however, an expanding nuclear power industry will require growing fuel imports. Nevertheless, barring a radical change in uranium prices compared with those of other fuels, uranium import costs would be relatively small. Imported enriched uranium fuel for a 1,300 MW reactor operating at 70 percent of capacity would cost about $40 million annually at 1976 prices. Domestic enrichment would cut this cost in half, and recycling the uranium and plutonium contained in the spent fuel could reduce it to as little as $14 million per year--about one tenth the cost of the oil imports needed to generate an equal amount of power.

Despite large foreign exchange savings per reactor, Brazil's nuclear program may have little beneficial impact on the balance of payments until after the year 2000, when

the growth of hydroelectric capacity levels off. If nuclear power were not available to replace hydroelectricity, however, the cost of energy imports (at 1976 prices) by the end of the first decade of the next century would be nearly twice the cost of fuel imports with a self-sufficient nuclear industry--and perhaps considerably more. Moreover, Brazil would depend on foreign energy sources for 70 percent of the total energy supply by 2010. In any event, continued dependence on imported conventional energy would not be a feasible alternative if the relative price of oil and other fossil fuels rises prohibitively.

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The First FRG Reactor: Foreign Exchange Expenditures Compared with Costs of a Conventional Power Plant

Million 1976 US$

	1982	1983	1984	1985	1986	1987	1988	1989	1990
Exchange savings from nuclear power	-40	-40	-120	-107	-74	-62	-49	130	150
FRG reactor	40	40	288	274	240	227	213	20	0
Amortization	0	0	180	180	180	180	180	0	0
Interest	0	0	68	54	40	27	13	0	0
Fuel	40	40	40	40	20	20	20	20	0
Equivalent oil-fired plant	0	0	168	167	166	165	164	150	150
Amortization	0	0	13	13	13	13	13	0	0
Interest	0	0	5	4	3	2	1	0	0
Fuel	0	0	150	150	150	150	150	150	150

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