

# ECONOMICS, POLITICS, AND HYDROELECTRIC POWER: The Paraná River Basin

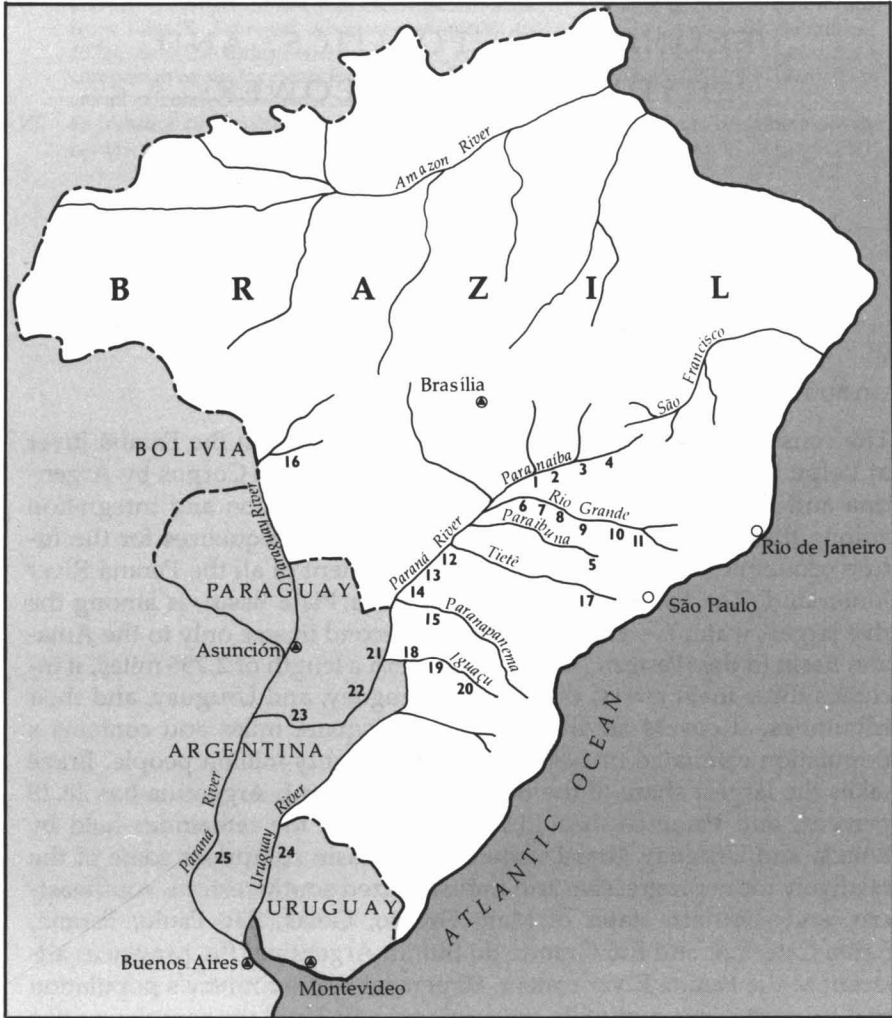
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## INTRODUCTION

The construction of binational hydroelectric plants on the Paraná River at Itaipú by Brazil and Paraguay and at Yacyretá and Corpus by Argentina and Paraguay reflects unprecedented cooperation and integration among these three nations, with far-reaching consequences for the future economic, social, and political development of all the Paraná River hinterland. The Paraná River Basin, or River Plate Basin, is among the five largest water systems in the world, second in size only to the Amazon Basin in the Western Hemisphere. With a length of 2,796 miles, it includes three main rivers, the Paraná, Paraguay, and Uruguay, and their tributaries. It covers an area of 1,980,000 square miles and contains a population estimated in 1980 at more than eighty million people. Brazil takes the largest share of the Basin at 45.9 percent; Argentina has 28.19 percent, and Paraguay has 13.1 percent, with the remainder held by Bolivia and Uruguay. Brazil's share of the basin comprises some of the relatively more progressive and industrialized southwestern, southeastern, and southern states of Mato Grosso, Goiás, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul. In Argentina, the provinces adjacent to the Paraná River contain 60 percent of the country's population and support 85 percent of its economic activity. Until the completion of a paved road and the international bridge over the Paraná River in the 1960s that permitted direct access to the Atlantic coast of Brazil, Paraguay's communication with world markets depended exclusively on the Paraguay and Paraná rivers.

By an accident of geography and history, the Paraná River in the sections that Paraguay shares with its two neighbors, Brazil and Argentina, contains one of the largest pools of hydroelectric power potential in the world. Over the last thirty years, the two larger countries have become increasingly aware of the critical role that the energy potential of the Paraná River could play in their future development and in their aspirations to become major regional powers. The strategic value of the



Plants:

1. Cachoeira Dourada	Brazil	14. Castilho	Brazil
2. São Simão	Brazil	15. Capivara	Brazil
3. Itumbiara	Brazil	16. Assis Chateaubriand	Brazil
4. Castelo Branco	Brazil	17. Promissão	Brazil
5. Paraibuna	Brazil	18. Salto Santiago	Brazil
6. Agua Vermelha	Brazil	19. Foz de Areira	Brazil
7. Marimbondo	Brazil	20. Salto Osório	Brazil
8. Colômbia	Brazil	21. Itaipú	Brazil-Paraguay
9. Jaguara	Brazil	22. Corpus	Arg.-Paraguay
10. Estero Peixoto	Brazil	23. Yacyretá	Arg.-Paraguay
11. Furnão	Brazil	24. Salto Grande	Arg.-Paraguay
12. Ilha Solteira	Brazil	25. Paraná Medio	Argentina
13. Jupia	Brazil		

Major Hydroelectric Plants on the Paraná River Basin in Planning or Operation

water of the Paraná as the most economical source of energy was dramatically underscored after 1973 by the world oil crisis. This situation was particularly true for Brazil, which was critically dependent on foreign oil. Paraguay, with a domestic market capable of absorbing only a small fraction of that potential, saw in the development of binational hydroelectric plants its only chance to transform that water, unexploited for centuries, into its most valuable exportable resource.

The locks of the Itaipú plant were closed on 13 October 1982 to fill the reservoir above the dam. When the presidents of Brazil and Paraguay met three weeks later on top of the dam to witness the opening of the spillway that let the river regain its normal course downstream, two related historical events took place: the birth of the Itaipú Lake, the largest man-made lake, and the disappearance of the falls of Guairá or Sete Quedas, the largest waterfall in the Americas. By mid-1983, the first generator of Itaipú was scheduled to be in operation, with commercial production to start about a year later. On the other hand, the Yacyretá dam, with its future tied into the political and economic conditions of Argentina, is about three years behind schedule. The Corpus project, although still in the planning stage, has played and will continue to play an important role in promoting the integration of the national energy programs of the three users of the Paraná River because the three plants are hydrologically interdependent. The Itaipú plant will operate with eighteen generators of 700 megawatts,<sup>1</sup> each working simultaneously with a total hourly capacity of 12.6 million kilowatts and an annual power generation of 66,240 billion kilowatt-hours. Yacyretá will operate with thirty generators of 135 megawatts each, a total hourly capacity of 4.05 million kilowatts, and an estimated annual generation of 19,000 billion kilowatt-hours. The capacity and production of Corpus are not yet accurately determined, but the best guess is that it will have a capacity similar to that of Yacyretá. The total estimated annual power production of the three dams thus exceeds 100 trillion kilowatt-hours.

The long process of negotiation and creation of new norms of international law used to produce the Treaty of Itaipú of 26 April 1973,<sup>2</sup> the Treaty of Yacyretá of 13 December 1973,<sup>3</sup> and subsequent agreements and protocols can be better understood if placed within the context of certain major economic determinants that give unique characteristics to the problems associated with the use of this natural resource, water. The importance of these economic factors appears more striking when they are set within the context of the historical, political, and geopolitical forces that for centuries have determined the relations among Argentina, Brazil, and Paraguay, forces that continued to operate at the time the treaties were signed.

THE HISTORICAL AND POLITICAL DETERMINANTS

Following its independence from Spain in 1811 until 1860, Paraguay, which was strategically located as a buffer state between its two more powerful neighbors, developed in virtual isolation, secluded from the turmoil and anarchy afflicting the former members of the Viceroyalty of the Río de la Plata. A brief attempt made by the last of the nineteenth-century rulers to assert equal weight in the regional balance of power left Paraguay defeated by Argentina, Brazil, and Uruguay in the Triple Alliance War of 1865–70. Paraguay retained its independence and some viable territorial integrity mainly because Argentina and Brazil could not agree on a total partition. Paraguay emerged from the war with its first democratic constitution and a new generation of politicians who tried with some success to play Argentina and Brazil against each other until all foreign troops left Paraguayan territory. This diplomatic strategy became known at the time as Paraguay's pendular diplomacy and was used repeatedly in its dealings with these two neighbors.

The reconstruction of Paraguay after 1870 was primarily based on the natural link that the Paraná and Paraguay rivers provide between Asunción and Buenos Aires. Through the rivers came manufactured goods, capital, technology, ideas, and the individuals bringing them. After the last Brazilian soldiers left Paraguay in 1876, the influence of Brazil was felt only in a few border posts separated from Asunción by the dense and unpopulated forests of eastern Paraguay. Mindful of an unsolved problem of limits involving the ownership of some of the seven falls of Guairá or Sete Quedas, the bitter lessons of their past history, and the differences in language and culture, Paraguayans remained distrustful of Brazil. The geopolitical ideas that began to inspire Brazil in the 1950s to resume its march to the west and to move its "living frontiers" beyond its conventional "legal" borders did little to appease the fears of Brazilian imperialism felt by most Paraguayan politicians and intellectuals.

In the early 1940s, a military dictatorship took power in Paraguay after dissolving and outlawing the Liberal party, which had been in power since 1904. Seeking legitimacy that could not be found at home, the new Paraguayan military regime wanted closer links with Brazil that would provide it with greater security against its opponents who were living in exile and were well entrenched in Argentina's political and military circles. Brazil found the time propitious for gaining influence and establishing a new presence in Paraguay. A military mission was sent to Paraguay to train high- and low-ranking army officers in both Asunción and Brazil. A Brazilian cultural mission was opened in Asunción to work at the university level educating young professionals in Paraguayan and

Brazilian universities. If these programs accomplished little change in the Paraguayans' anti-Brazilian feelings, they did succeed in establishing friendly personal contacts between the two countries' military establishments and in impressing a young generation of students with the exuberance and material progress of Brazil's booming urban centers.

In 1947 the military dictatorship called upon the Colorado party, which had been out of power for more than forty years, to fight a revolt of young democratic officers supported by the Liberal and other minor parties. The uprising was defeated with the connivance, if not the direct assistance, of the Peronist regime then ruling Argentina. In 1954, to overcome the anarchy within the Colorado party, which was unable to produce a stable government, a little-known artillery officer named Alfredo Stroessner deposed the last civilian president of Paraguay in a bloodless coup. General Stroessner has ruled the country for twenty-eight years, and, at the age of seventy, was reelected in February 1983 for another five-year term.

During his first ten years in power, Stroessner built a military, political, and economic personal empire reminiscent of those created in the nineteenth century by his well-known predecessors. He gained and maintained total control of the army by eliminating any threat to his absolute power. He also controlled the Colorado party by personally choosing its ruling elite, thus assuring that its power derives from him rather than from its popular base. The basis of Stroessner's economic system lies in the distribution of privileges among his different supporters. The higher echelon of the military controls the smuggling of whiskey, cigarettes, luxury goods, and cattle in and out of the country. Under the façade of a free-enterprise economy, a new class of business tycoons plays the role of arbitrator of import and export licenses among the traditional and marginal business circles. The small farmers, the largest and poorest segment of the population, have little to gain under Stroessner. A mediocre, corrupt, and highly inefficient civil service systematically excludes all those without Colorado affiliation and keeps the bureaucratic machine of the state in operation. In continental affairs, Stroessner assumes the role of maximum defender of Latin America's Christian heritage against the Communist threat.

In the early sixties, when Brazil began to move aggressively along the waters of the Paraná River in search of new sources of energy, Paraguay was languishing under its peculiar political and social structure. Internal peace and some economic growth had been attained, but not rapidly enough to match increases in population and expectation. Brazil's first strategic moves, which concluded with the development of the Itaipú plant, found Stroessner leading a divided country with most of its intelligentsia excluded from participation in the political process.

Only a token, controlled minority had been allowed since 1963 to participate in Congress and in a Constitutional Assembly called in 1967, both of which had been designed to legitimize the Stroessner regime.

The threat of Brazilian territorial penetration appeared in 1965 when a Brazilian army platoon occupied a small piece of disputed territory at the falls of Guairá.<sup>4</sup> This event led Stroessner to agree to negotiate the construction of a binational hydroelectric plant on the Paraná River in partnership with Brazil, using the waters owned in condominium by the two countries. Deprived of widespread popular support, Stroessner went to the negotiation table assisted by a handful of loyal civil servants who lacked the technocratic experience required to understand all the complexities of the problems involved.

That Paraguay, with such insufficient preparation and incompetent representation at the negotiating table, received the formal treatment of an equal partner in the Itaipú Treaty is not a miracle of great leadership or gracious concessions from its big partner, but the result of the operations of ineluctable technological and economic determinants. The blueprints and the drafting of the Itaipú Treaty, which were copied and partly improved in the Yacyretá Treaty, were all designed and formulated by Brazil's delegates. Special care was taken to give Paraguay the role of an equal partner and to guarantee Paraguay's territorial integrity. With these minimal requirements, Stroessner imposed a new direction on Paraguay's foreign policy vis-à-vis its two neighbors. Because it was impossible to stop Brazil or to neutralize its influence with the help of a politically and economically weak Argentina, Stroessner resigned himself to accommodate as well as he could to Brazil's irresistible presence and to receive from Paraguay's new partner as much as it was willing to give. Following this new political strategy, Stroessner defended the Itaipú Treaty and continues to do so. Public statements made by government officials carried a dual message: first, that Brazil as a good neighbor had given Paraguay more than its fair share in relation to its contribution; and second, that the electric power guaranteed Paraguay from the most efficient and economical plant in the region would help the future development and modernization of the country. Stroessner's slogan that "Itaipú is not a business but an opportunity for the development of Paraguay" should be interpreted in this light. His supporters maintained that the price agreed upon in the treaty for Paraguay's surplus energy was an additional gain that attested to the statesmanship and great diplomatic ability of the Paraguayan leader.

Whether Stroessner or any other Paraguayan leader could have done better in the negotiation of the Itaipú and Yacyretá treaties will remain an unanswerable hypothetical question. It can be stated, however, that a clear perception and a forceful defense of Paraguay's rights to the energy produced by the Paraná water owned in condominium at the

time of the negotiations could have strengthened Paraguay's bargaining position. Likewise, in the future operation of these binational enterprises, such perceptive decisiveness can enhance Paraguay's chances to improve the treaties through the renegotiation of some of their adverse components. The Stroessner regime has not yet demonstrated a true understanding of the issues nor the disposition to act accordingly. Brazil obviously has no interest in doing so. Argentina, which signed the Yacyretá Treaty under Perón's personal instructions to "sign it now and renegotiate it later" as the only way to check Brazilian influence in Paraguay and to defend Argentina's rights to the use of the Paraná River at Yacyretá and Corpus, in the forthcoming negotiations to resurrect Yacyretá, may do the work that Paraguay has failed to do—to formulate a more realistic analytical framework that will defend the rights of all parties to an equitable and efficient sharing of the hydrological wealth of the waters of the Paraná.

#### THE ECONOMIC DETERMINANTS

Against this historical and political background, some relevant economic and underlying technological constraints that characterize the production of hydroelectric power may assist in understanding the particular arrangements involved in the Itaipú, Yacyretá, and future Corpus treaties as well as in foreseeing the problems that can besiege the future relations among the partners. Three of these determinants will be discussed below.

##### *The Common-Pool Problem*

In a juridical sense, property rights (and by extension, sovereignty rights) can be established on land, in the space above it, and in the water in rivers, lakes, and the sea. These rights to land and water are conventionally recognized by private and international law and are expressed in treaties in the course of normal relations among nations. A special case arises, however, when the parceling or assignment of exclusive rights becomes impossible due to the indivisibility of the economic good in question, which, if owned in common, may create special external effects or diseconomies for some of the parties. This category of goods is recognized in law as "fugitive" or "res nullius" and in modern economic terminology, such goods are called *common-pool goods*.<sup>5</sup>

Now that technology is available for the production of hydroelectric power from the water of rivers, including that owned in common and indivisible condominium by neighboring countries, the common-pool characteristic of the hydroelectric potential of international rivers must be dealt with adequately. The implications of this common-pool

problem are important, and specific arrangements are required to regulate the use of this water, if economic waste and encroachment on third-party rights are to be avoided. A most promising solution is to use the commonly owned water in partnership or under unified management so that the externalities can be internalized and the waste eliminated.<sup>6</sup> The Itaipú and Yacyretá treaties have recognized the common-pool nature of the water and have chosen to create an equal binational partnership for its use in the production of electric power.

The fact that no workable alternative to cooperation was available is shown by the solution found by Brazil and Paraguay to a long-standing political controversy over their borders, which included the falls of Guairá or Sete Quedas, with their impressive volume of water running over seven gigantic gorges of rock and jungle. At the end of the Triple Alliance War in 1872, Brazil and Paraguay signed the Loizaga-Cotegipe Treaty that marked the limits between the two countries, at one point using the falls as the dividing line. In interpreting this treaty, the two countries had never agreed about the ownership of the falls, both having claimed them since as within their territory. In the late 1950s and early 1960s, after Brazil had completed plans for the development of hydroelectric plants on the Paraná River within its national territory, it began planning the use of the hydroelectric potential of the Paraná River from and including the Guairá Falls up to the Iguazu River, which lies beyond its exclusive national jurisdiction. Concurrently, the perception of the increasing importance and value of the water of the Paraná for generating electricity revived the old unsettled problem of limits between Paraguay and Brazil.

In 1962 and 1963, the relations between the two neighbors reached a critical point over a project under study in Brazil for the construction of a hydroelectric plant on the Brazilian side of the river that would have required the diversion of part of the water above the falls in Brazilian territory to be returned miles below the falls.<sup>7</sup> The plant, which was to be located in Brazilian territory, would have used the difference in the water level above and below the falls to produce electric power for the exclusive use of Brazil.<sup>8</sup> Paraguay protested against what it called a violation of its territory because Brazil's action would have changed the physical characteristics of the falls that Paraguay claimed were within its national jurisdiction. An immediate Brazilian reply followed, rejecting Paraguay's protest and alleging that because the falls were in Brazil's sovereign territory, Brazil could use them as it wished.

These positions were hard to reconcile, and had the common-pool aspect of the problem been overlooked, it could have had adverse long-run implications for Brazil's energy policies in the area. Brazil, however, dropped this project, and a few years later, on 21 and 22 June 1966, joined Paraguay in declaring by the Acta de Foz de Iguazú (Ata



das Cataratas) that the two countries recognized their common and indivisible ownership of the hydroelectric potential of the Paraná River from and including the Guairá Falls to the Iguazu River.<sup>9</sup> They concurrently agreed to undertake the development of that potential in partnership and recognized that each partner was entitled to receive one half of the electric power to be produced. In this way, the dispute over limits (which still remains unsettled) was separated from the problem of the use of the hydroelectric potential of the Paraná River to generate electric power. The recognition of that potential as a common-pool resource opened the door for the negotiations and completion of the Itaipú Treaty.

#### *Maximizing the Value of Aggregate Output*

To the indivisibility of the common-pool-goods characteristic of the hydroelectric potential of the water of the Paraná should be added the related and equally critical dimension of the interdependency among the potential users of this common resource. This interdependency, if not adequately treated, could lead to significant losses in efficiency or aggregate output. Although an increase in production at one plant might benefit its direct users, it could not only reduce the production of another plant but also generate uncompensated aggregate losses. These "spillover" or "negative externalities" effects illustrate the need to regulate the use of water. There is a striking similarity between the idea of the "common heritage of mankind" underlying the Third World position in the negotiations concerning the Law of the Sea and the concept of the "geographical singularity of the Guairá Canyon" used by Argentinians to defend their right to the hydroelectric potential of the Paraná River.<sup>10</sup> In order for these three countries to attain an efficient allocation of the hydroelectric power of the river they commonly share, they were left with no alternative but to reach a trilateral accord reconciling the interests of all users.

#### *The Price of Water as Rent*

As has been shown, water has an economic value because without it, the production of electric power is impossible and also because its waste or inefficient allocation increases the dependency on other, more expensive resources and technology to meet present and future demands for power. Moreover, the greater that dependency becomes, the more critical is the value of water. Determination of the price of water is of utmost importance for the countries sharing equal, indivisible property rights to the hydroelectric potential of the river; however, the price of water, which is not a reproducible commodity, is not determined by its cost of production but by the concept of an economic rent. This rent is deter-

mined by the cost of producing power with the most expensive technologies in use to meet present and future levels of demand—these being oil and nuclear energy. The country owning that water earns a rent whether or not it uses the energy produced as long as another country will gain by using that water instead of oil and nuclear energy to produce electricity for its own consumption. The greater the cost of producing power with the most expensive technology and the more efficient the plant used to generate power by water, the higher becomes the rent for water. When the existence of this economic rent is not recognized and adequately treated, the owners of a common pool of water will not be able to find an equitable and lasting formula to distribute the benefits to which they are entitled.

Having explained these simple analytical tools that underline the typical economic and technical realities of hydroelectric power development, the different solutions agreed upon by the countries subscribing to the Itaipú and Yacyretá treaties can now be discussed.

#### THE BILATERAL TREATIES: ITAIPÚ AND YACYRETÁ

##### *The Basis for Creating a Perfectly Equalitarian Association*

The Itaipú and Yacyretá treaties are very similar in their response to the economic determinants identified here. Moreover, one can reasonably expect that the forthcoming Corpus Treaty, which will make possible the optimal use of the Paraná River between the Guairá Falls or Sete Quedas and the confluence of the Paraguay and Paraná rivers, will not offer any important departure from the general outlines of the first two treaties.

Under the Itaipú and Yacyretá treaties, the partners undertake the obligation of developing the hydroelectric potential of the Paraná River at locations they own in indivisible and perfectly equal condominium. This commitment was first stated by Brazil and Paraguay in the Acta de Foz de Iguazú in 1966 in response to a dispute over territorial limits, and it permitted these two countries to accept common and undivided ownership of the hydroelectric potential of the water “from and including the Guairá or Sete Quedas Falls” without renouncing their positions as to the ownership of the Guairá Falls. (A Paraguayan legislator commented with humor and foresight that the construction of the dam at Itaipú, which had already flooded the Guairá Falls, would bury the problem of limits under water.<sup>11</sup>) The economic determinants of the partnership described above led to the important and far-reaching recognition that the energy to be obtained belongs to both partners and will be divided equally between them.

The sui generis binational public corporations that were created by the treaties were known as “Itaipú” and “Yacyretá.” They are owned

in equal parts by the participating partners represented at Itaipú by the power authorities ELECTROBRAS of Brazil and ANDE (Administración Nacional de Electricidad) of Paraguay and at Yacyretá by Aguas y Energías of Argentina and ANDE. The two binational corporations operate with a capital of one hundred million dollars contributed in equal parts by each partner. Because Paraguay was in no position to raise that amount of money in its meager domestic capital market, Brazil and Argentina lent it fifty million dollars each at the conventional rate of interest for this type of loan. The additional capital needed to complete the projects, now estimated at more than eighteen billion for Itaipú and about nine billion for Yacyretá,<sup>12</sup> is to be procured mostly in the Brazilian domestic capital market in one case and from international credit institutions such as the World Bank and the Inter-American Development Bank in the other. The Brazilian and Argentine governments are guaranteeing almost all of the loans because Paraguay will share in that obligation only to the extent of its use of the electric power produced.

The binational corporations are operated by an administrative council and an executive directory made up of an equal number of representatives from the two participating countries. Provisions are made to guarantee that neither country will have greater control of day-to-day operations of the binational corporations. The system of rotation of the executive director was one of the most discussed points during the congressional debate over the Itaipú Treaty in the Paraguayan Parliament. Argentina is presently questioning the system agreed upon in the Yacyretá Treaty.

The lack of precedent for this type of public corporation in the respective countries probably led to rigidities in the stipulations to protect the principle of the inviolability of territorial limits. Even though land in both countries is dedicated to the construction of the plants, the jurisdiction over territory of the respective countries remains unchanged. It was repeatedly asserted by the Paraguayan negotiators and conceded in the Itaipú Treaty that half of the generators are to be in Paraguayan territory and the other half in Brazilian territory. Provisions for the construction of navigation locks are included not in the Itaipú Treaty but in an additional protocol and will be subject to a separate agreement. In this case, it may not be possible to implement the principle of absolutely equal partnership without incurring wasteful duplication. Any disagreements concerning the interpretation or implementation of the treaties are to be solved through conventional diplomatic procedures accepted by the two countries involved. The treaties cannot be terminated unless the two parties agree to replace the present one with another treaty.

*The Disposition of the Electric Power by the Partners*

Although the treaties have tried to establish a perfectly equalitarian partnership, economic conditions prevailing in each country may obstruct the attainment of an ideally equal association. Thus, although the electric power generated in each plant is divided in equal parts between the partners, one may be forced to sell part of its share to foreign users. Paraguay finds itself in this position because its domestic market is not large enough to absorb the totality of the power available. It has been estimated by the World Bank that Paraguay, with a current domestic production of 1350 gigawatt-hours, will be entitled to receive a total amount of 42,970 gigawatt-hours by 1989 from Itaipú and Yacyretá. According to the same estimate, domestic demand will grow to 1792 gigawatt-hours by 1990, which will still leave a surplus of 40,180 gigawatt-hours by the time the first two dams are expected to be in operation.<sup>13</sup>

Brazil and Argentina were counting on this possibility when they recognized Paraguay's right to the use of one half of the total produced because the important surplus that Paraguay would be forced to sell could help them meet the growing demand for energy, particularly if the power could be purchased at an attractive price. To assure the availability of that surplus, Article 13 of the Itaipú Treaty guarantees one partner the exclusive right to buy all of that portion of the energy not used by the other for domestic consumption. The Yacyretá Treaty (Article 13.1) uses the expression "preferential right to buy," which is not a direct admission that the surplus could be sold to a country other than the partner in that treaty.

*The Price of the Surplus Sold as a Rent Payment for Water*

The binational corporation Itaipú sells electric power to ELECTROBRAS and ANDE, and Yacyretá sells to Aguas y Energías and ANDE (and through them to the final users) at a price calculated to include what the treaties list as explicit costs of production. The fact that this cost does not include economic profit is analytically sound. It should include, however, the true economic value of the water used, along with the cost of all other factors of production.

The royalties and compensation recognized by the Itaipú Treaty and the compensation included in the Yacyretá Treaty are to be interpreted as a rent earned by the partners for their water. A rent payment is due whether the partner sells or buys power, and the binational corporation should charge that expense to all the buyers. The Itaipú and Yacyretá treaties fixed the value of the royalties and compensation for the duration of the partnership; however, to protect that value against

losses of purchasing power of the U.S. dollar, formulas for adjusting the dollar figures were adopted.<sup>14</sup> No other changes in the real value of royalties and compensations were contemplated in the treaties. The bi-national corporations are also forbidden to charge more for the energy produced than that needed to cover the cost of production as defined in the treaties.

Paraguay as a prospective seller is then guaranteed by the Itaipú Treaty a payment as rent for its water used of \$950 per gigawatt-hour of power ceded to Brazil (\$650 in royalties and \$300 in compensation). The Yacyretá Treaty fixed the compensation at \$2,998 per gigawatt-hour to be paid by Argentina for the cession of power. The threefold difference between these payments cannot be explained by the difference in the price of power and the cost of producing it between the two buyers. The rationale given by Italo A. Luder, the president of the Foreign Relations Committee of the Argentine Senate during the debate over the Yacyretá Treaty in 1973, is worth mentioning.<sup>15</sup> He stated that Paraguay had defended as the correct and fair value of the compensation for the cession of power an amount equal to 5 percent of the cost of the fixed investment per gigawatt-hour that Yacyretá was expected to produce, which it contended was a satisfactory rate of return in the public utilities field. At Itaipú, the total payment of \$950 per gigawatt-hour had been obtained from this simple calculation:  $\$1,800 \text{ million} \div 93,000 \text{ Gwh/year} \times 5\%$ , which is approximately \$950. The 1,800 million represents the estimated fixed investment at Itaipú at the time of the treaty, and the 93,000 gigawatt-hours the estimated annual output. At Yacyretá, Argentina and Paraguay had agreed on an estimated fixed investment of \$1,097 million dollars and an annual output of 18,000 gigawatt-hours. The same formula yields  $\$1,079 \text{ million} \div 18,000 \text{ Gwh/year} \times 5\%$ , which is equal to \$2,997 in rounded numbers. It can readily be seen that this method used for calculating the rent due to the seller of energy, which is based on a simple rule of thumb that has been used by U.S. public utilities to measure reasonable financial returns of a particular hydroelectric investment, is analytically incorrect. The royalties and compensation, as explained above, should measure the pure economic rent to which the country owning the water is entitled for its contribution. The fallacy becomes readily apparent when one observes that, according to the formula used above, the less efficient the project, the larger the compensation.<sup>16</sup>

Luder completed his exposition in defense of the compensation agreed upon with Paraguay in the Yacyretá Treaty by reminding those criticizing the higher price paid by Argentina for the use of Paraguay's energy that the same power not purchased from Paraguay would cost Argentina \$3,234 per gigawatt-hour to produce in a thermic plant. Furthermore, that price represented only 2 to 6 percent of the price of elec-

tricity charged to final industrial, commercial, and domestic consumers in Argentina.<sup>17</sup>

Stroessner's negotiators of the treaties did not seem to be fully aware of Paraguay's legitimate right to a fair economic rent for its water and consequently failed to press the critical argument of whether or not Paraguay was receiving a fair compensation for the power sold to its neighbors. It was seen as more important to the partners, particularly Brazil and Argentina, to guarantee that a fixed price and quantity of power would be available to them for an extended period of time. In the case of Itaipú, the price measured in royalties and compensation was fixed for fifty years and in Yacyretá, for forty years. To guarantee the quantity available, the treaties require the exporting partner to present two years before beginning commercial production of power a timetable showing the yearly amount to be used domestically for a period of ten years in Itaipú and eight years in Yacyretá.<sup>18</sup> In compensation for this advance planning of domestic consumption and willingness to export, the exporter's partner is committed to buy all the surplus available for the duration of the period.

Those opposing the Itaipú Treaty in Paraguay emphasized the need to scrutinize the question of whether royalties and compensation measured the fair value of Paraguay's water contribution. They concluded on the basis of a rather unsophisticated analysis of the problem that the compensation to be received grossly underestimated the value of that contribution and that one of the first priorities for Paraguay should be the renegotiation of the Itaipú Treaty to obtain an increase in the royalties and compensation. It was not until much later, however, when the deadline to submit the timetable for the use of power was getting close, that the need to reestimate the value of the compensation became a national issue.

#### *Do the Treaties of Itaipú and Yacyretá Implement a Fair Partnership?*

If a fair partnership is to be defined as one in which each partner receives in exchange for its voluntary contribution of productive resources a payment that measures its contribution in accordance with the distributive standard of equity, the answer will depend on the particular way each payment is determined. The treaties recognize that each country contributes an equal amount of the resource water. Paraguay borrows its equal share of the capital and guarantees the loans used for the construction of the plants to the extent of its use of the power produced.<sup>19</sup> All monies borrowed as initial capital or for construction of plants earn for the lenders the prevailing rate of interest for that type of financial operation. That rate of return to the capital that Brazil and Argentina made

available to Itaipú and Yacyretá constitutes a fair compensation for the amount of their participation in the financing of these projects.

What remains to be determined is whether the two countries in partnership receive the economic rent for the water they contribute. Three situations are possible. First, if Paraguay and its partners consume domestically the equal share of power to which they are entitled, then the rent for the factor water, which is measured by the difference between the true market value of electric power and the explicit cost of production charged by the binational corporations, is received by each partner. Whatever the rate charged by the power authority to customers in each country, the rent for water stays at home and goes to the consumers in the form of a subsidy or is retained by the public sector as public revenue. Second, if only Brazil and Argentina consume their part of the energy at home and Paraguay sells its part to the highest bidder in an auction involving all countries within the area (Brazil, Argentina, Uruguay, and Bolivia), the two larger partners retain their rent on their water as before and Paraguay also receives its total rent, which is measured by the difference between the highest price for power obtained and the cost charged by the binational corporations. Third, if the system of exclusive rights to purchase any available surplus guaranteed by the treaties to the large consumers (Brazil and Argentina) is in effect, the full economic rent will be received by Paraguay only when the royalties and compensation are equal to the difference between the highest market price for power and the explicit cost of production determined by the binational corporations.

The amount of compensation is fixed by the treaties, and as shown above, has not been linked to the market value of electric power. Furthermore, it is significantly larger for the more costly plant and is to remain frozen for a long period. Therefore a distinct possibility exists that at the current level of compensation, Paraguay may not receive the total value of the rent earned by the factor water. If this is the case, Brazil and Argentina may be receiving from Paraguay part of the latter's rent as a transfer that may or may not be justified on other grounds. Such an outcome of the otherwise equalitarian partnership of the treaties does not produce a fair distribution of benefits.

Two immediate conclusions can be drawn. One way for Paraguay to obtain the totality of its rent for water could be to use domestically all of its part of the power produced at each plant. Because this avenue is a practical impossibility, renegotiation of the treaties to establish a more realistic and flexible method for calculating the compensation as a true measurement of the rent should be undertaken. This solution, which might reduce the transfer of benefits that Brazil and Argentina would be receiving, therefore would not be willingly accepted by these partners.

In fact, reasons for rejecting any request for renegotiation of the treaties on these grounds have already been advanced in Brazil and Argentina. Many Brazilians feel that the fact that Paraguay, a country lacking financial solvency and experience in this type of undertaking, in obtaining anything beyond the right to buy electricity from Itaipú at its cost of production is already receiving a larger-than-fair share of the benefits.<sup>20</sup> In Argentina, a well-known nationalist leader, Admiral Isaac Rojas, proposed that the country should withdraw from Yacyretá and drop negotiations on Corpus in favor of constructing two projects on the Paraná River below Corrientes and north of Rosario, known as the Paraná Medio projects.<sup>21</sup>

#### POST-TREATY EFFORTS TO CORRECT OMISSIONS AND IMPERFECTIONS

Several other important problems were left unsolved or inadequately treated by the negotiators at the time the treaties were completed. These problems will be discussed below.

##### *The Problem of the Frequency of Itaipú Generators*

Annex C of the Itaipú Treaty states that "the energy produced by Itaipú will be delivered to the institutions receiving it in the system of bars at the electric plant and in the conditions established in the contract of purchase." Because Paraguay produces and consumes energy at a frequency of fifty cycles per second while Brazil consumes it at sixty, the lack of specific references to this technical problem in the treaty seems hard to explain. The omission of specific discussion of this problem, enmeshed as it would have been with important political and economic concerns, was in all probability deliberate. In Paraguay, its omission encouraged hopes of a "total equality of treatment" that would permit each country to receive that half of the power to which it was entitled in its domestic frequency. Brazil, on the other hand, retained its freedom to raise the issue at a convenient time for convincing Paraguay to change its frequency for the mutual benefit of the partners.

Later in 1976 and early in 1977, the problem of frequency fully reappeared when, under the pressure of the construction timetable for the generators, Brazil requested that Paraguay change its domestic frequency to sixty cycles, a solution that allegedly would have made the production, transmission, and cost of power more economical for Brazil. The cost of the change in frequency for Paraguay could have been negotiated and absorbed by Brazil, which appeared to be ready to compensate Paraguay for that cost. But the request for that change was interpreted in Paraguay as proof of its increasing dependency on Brazil, which the treaty was supposed to have prevented. Nationalistic senti-



ment was exacerbated, and strong voices of opposition were heard, even among Stroessner's supporters. The government of Paraguay appointed a special committee to study the problem and kept the final recommendations secret for several months, during which time the Brazilian press periodically announced that Paraguay had accepted Brazil's request, statements that required denials from both countries. What took place during those negotiations has never been revealed.

To the embarrassment of Paraguay, on 5 November 1977, Brazil unexpectedly and unilaterally announced its decision to take the most satisfactory of the technical options available, one which Paraguay could not reject, of having half of the generators built to produce in fifty cycles and half in sixty cycles. Consequently, the energy sold by Paraguay will have to be transformed by Brazil before it can be used. Most of the power that will be needed in the industrial belt of São Paulo on the Atlantic coast will be transmitted in high-voltage direct current (HVDC) and put into alternate current with a frequency of sixty cycles before distribution. The transmission of HVDC current, although it seems to be more expensive, permits transmission of power for greater distances. On the political side, the solution adopted helped to reduce the fear of many Paraguayans that the change in frequency to sixty cycles (which in South America is used only by Brazil) would represent a surrender of Paraguay's political and economic independence. It was a political mistake for Brazil to request the change in the first place, even though from a rational point of view, the energy to be used in Brazil could be produced at a lower cost in the frequency used in that country. Again, a previous lack of satisfactory solutions to other problems in the partnership probably contributed to the extreme sensitivity in Paraguay to the problem of dependency on its larger neighbor. It could also be said that Brazil miscalculated the power of the Paraguayan government to make unpopular decisions as well as its greed. (*The Latin American Political Report* of 25 November 1977 reported that "Paraguay had been hoping that Brazil would accept Paraguay's counterproposal of 300 million dollars for changing its frequency, against the 130 million and some development assistance offered by Brazil.") In any case, the HVDC line between Itaipú and São Paulo is already under construction and may be completed before the plant at Itaipú starts commercial operations. The cost of this solution is today estimated to be less than previously calculated.

#### *The Calculation of the Cost of Flooding at Yacyretá*

The location chosen as the safest and most economical for the hydroelectric plant at the time of the completion of the Yacyretá Treaty required that a total area of 1690 square kilometers be flooded, of which about 1000 square kilometers were in Paraguay's territory. The mechanism to

pay the partners for this cost (to be included in the price of the power) was formulated in Article 13.3, which states: "Yacyretá assumes responsibility for the payment to be made on account of the land to be expropriated within its area of operation." No question was raised at the negotiations about the disproportionately larger damages to be borne by Paraguay. In April 1979, however, Paraguay raised objections to the initial location favored by Argentina for the Yacyretá dam and proposed that a new study be undertaken to seek a different location that would reduce the amount of land flooded on Paraguay's side. This request came after the Inter-American Development Bank and the World Bank already had approved loans of two hundred and ten million dollars each to start construction on the initial specifications and consequently would have delayed construction and required renegotiation of the loans. Furthermore, Argentina contended that the new location favored by Paraguay would produce a less-safe dam. This crisis provoked threats and fears in both countries that the partnership at Yacyretá could become paralyzed or even be terminated.

A few days before the international loans were to be cancelled, on 31 August 1979, a constructive and conciliatory agreement over this problem was reached. The solution involved the selection of a new compromise location for the dam, the reduction of Paraguay's flooded territory to 815 square kilometers, a more equitable formula to resolve differences in the executive council of Yacyretá, and the adoption of a formula for calculating compensation for the loss of production of the land flooded in each partner's territory.<sup>22</sup> This new "compensation for flooded land" is to be paid annually by the binational corporation and is included as part of the cost of the power sold by Yacyretá to the partners.<sup>23</sup>

This formula makes it possible to estimate the economic value contributed by the fixed-factor land in an economically sound and distributionally fair manner. The concept of payment for the use of the land is like that of the rent due for the use of water. Differences in the amount of territory flooded in the two countries will not produce any unwarranted distributional effects if the value of the compensation received for the land flooded measures the value (rent) of the land. At the time this agreement was signed, it was estimated that Paraguay would receive an annual payment of twenty million dollars in 1986 and thirty million dollars for 1990 and subsequent years as compensation for flooded land.<sup>24</sup>

#### *The Compatibilization among Itaipú, Corpus, and Yacyretá*

The Itaipú Treaty was signed by Brazil and Paraguay without Argentina's participation, despite the latter's protest that the consumptive use

of the Paraná River water at Itaipú violated Argentina's rights to its normal use of the river in territory under its sovereignty. Argentina had been for years a strong supporter of the principle of prior consultation when the use of international rivers by one country could damage or alter the conventional use of the river by other countries. Such consultations could determine the extent of the damage and the system of compensations to be used. Brazil—and Paraguay, which in this case sided with its partner in Itaipú—subscribed to the principle that the use of the water by one country from rivers of consecutive jurisdiction should be unrestricted unless in their judgment such use interfered with the use of these rivers by other countries within their respective territories. Here is seen the universally recognized need to develop principles and rules for the use of international rivers because of the interdependencies arising from the common-pool nature of the problem. The contradictory positions taken by Brazil and Argentina have been expressed at meetings and conferences of the United Nations and at meetings of the River Plate Basin foreign ministers that were held to establish guidelines that could be generally accepted in the international community.<sup>25</sup> Even though significant progress has been made in improving cooperation, history demonstrates important differences in policies actually followed by particular countries. Brazil on a few occasions had satisfied Argentina's demand for prior consultation or notification. Such was the case of the filling of the reservoir of the Jupia dam in Brazil, when it shared information with Argentina in order to minimize the impact of a temporary reduction in water flow that would be felt at points as far downstream as Posadas and Corrientes. Unfortunately, this spirit of cooperation was absent during the negotiations of the Itaipú Treaty. Brazil and Paraguay were obviously interested in maximizing the plant capacity at Itaipú and ignored Argentina's plans for the Corpus plant. Brazil was certain that it could count on both its own share and its partner's share of the energy from Itaipú. Paraguay chose to participate in Itaipú on Brazil's terms, ignoring Argentina's protests, because at that time, Corpus seemed an uncertain possibility in the distant future. But to retain Argentina's partnership, Paraguay moved hastily to sign the Yacyretá Treaty with Argentina a few months after the Itaipú Treaty was completed.

The interdependency among the Itaipú, Corpus, and Yacyretá projects can be characterized as follows: Itaipú and Yacyretá, considered together for the purpose of hydroelectric development, are not for all practical purposes mutually interdependent. A significant interdependence arises, however, when Corpus, which is to be located between the other two, is also considered, as it must be if the Paraná River is to be used efficiently to maximize the production of electric power. The potential of a hydroelectric plant depends on the fall, which is measured by the difference between the levels of water above and below the dam and

on the amount of water carried by the river. In the Itaipú Treaty, Brazil and Paraguay had agreed to build the plant with a fall of 120 meters.<sup>26</sup> This level limits the height of Corpus to 100 meters above the sea. If below Corpus the level of the water needed to give Yacyretá its maximum output is 82 meters above sea level, the fall at Corpus cannot be higher than 18 meters. This limitation would make Corpus an inefficient dam that could not be economically justified. Argentina contended that a trade-off in the fall between Itaipú and Corpus allowing Corpus to gain height and potential would compensate the losses from Itaipú and yield a net gain in total output. The optimal solution, according to Argentina, was to raise the level of the water between Itaipú and Corpus to 130 meters above sea level and in this way give Corpus a fall of 48 meters, thus making it an efficient and economically feasible operation. It should be noted that Argentina could not go ahead and build Corpus on its own terms because Itaipú, already under construction with its generators to be located at the base of the dam at 100 meters above sea level, would be flooded and suffer irreparable damage. Nor do the interdependencies end here. If the water level between Itaipú and Corpus were changed to 130 meters above sea level, the hydroelectric potential of some of Paraguay's domestic rivers would be seriously reduced. There was, then, no alternative to holding negotiations to find a satisfactory compromise among the three nations.

A series of meetings began 19–24 September 1977 in Asunción to discuss on a purely technical level the coordination of operations between the two major dams, Itaipú and Corpus. It culminated with a trilateral agreement named the Accord Itaipú-Corpus, signed in Ciudad Presidente Stroessner on the Paraná River on 19 October 1979.<sup>27</sup> This agreement provides solutions to the problems of the height of the two dams as well as to other problems concerning the common use of the Paraná, although many Argentinians are not satisfied with the accord. The basic points of the accord are: (1) the level of the water above Corpus and below Itaipú acceptable to all parties is to be normally 105 meters above sea level; (2) Itaipú will be operated by Brazil and Paraguay in such a way that the changes in flow will vary within mutually acceptable parameters to permit the normal navigation of the Paraná River downstream; (3) Itaipú will operate with a potential provided by no more than eighteen generators of seven hundred megawatts each; (4) during the filling of the Itaipú reservoir, information will be shared by all parties, and Brazil will guarantee a satisfactory level of water downstream by releasing sufficient water from its dams on the Iguazú River; (5) the three countries will cooperate in order to preserve the ecological balance and environmental quality of the areas under the influence of the hydroelectric developments.<sup>28</sup>

*Distributional and Efficiency Effects of Correctly Measuring the Value of Electric Power*

The mechanism established in the Itaipú and Yacyretá treaties for calculating the price charged to the partners for their use of the electric power is based on the explicit costs of production. Annex C of both the Itaipú and Yacyretá treaties assures for respective periods of fifty and forty years the royalties and compensations to be received by the country that sells its electric power to the other. It has already been shown, however, that the formula used in the calculation of the compensation is conceptually erroneous because it does not purport to measure the rent for the use of water. Furthermore, because rent is a direct function of the market value of power, it does not remain constant and is bound to rise with increases in the cost of generating power with more expensive technology. Failure to recognize these basic economic facts is the reason why neither the treaties nor the negotiators who signed them mentioned the value of electricity to the consumers, and why they fixed the amount of royalties and compensations for the duration of the treaties. With the increased cost of producing electricity following the oil crisis of 1973, it is likely that the compensation to be paid to the seller represents today a net bargain for the buyer. Because Paraguay appeared to have no alternative but to sell a significant amount of its electric power from Itaipú and Yacyretá, it was to be expected that Paraguay would be the first to raise questions about the value of the compensations granted by the treaties. These questions were first voiced not by the government, but by the critics of the treaties in Paraguay.<sup>29</sup>

As previously discussed, two years before Itaipú is scheduled to begin commercial operation, the two governments are required by the treaty to present to the binational corporation a timetable showing the amount of power that they are going to buy or sell each year for a ten-year period. Brazil is interested in ascertaining that amount with accuracy. The Paraguayan government's handling of this question seems to indicate its willingness to sell most of its share of Itaipú's power to Brazil.

A World Bank country study entitled *Paraguay: Regional Development in Eastern Paraguay*, prepared by a 1977 mission to Paraguay, was the closest to an officially sponsored study of energy policy published until the end of 1979.<sup>30</sup> At the time of that report, the government of Paraguay apparently contemplated the exportation of electric power of 8,500 and 27,338 gigawatt-hours to Argentina and Brazil respectively by 1990, when the two plants were to reach full production. The revenue to be received by Paraguay in royalties and compensation during 1990 was estimated at \$75.6 million.

Two alternative energy policies or strategies were emerging in

Paraguay in 1979. The policy of "export the maximum surplus," apparently endorsed by the government, was aimed at maximizing the sales to Brazil and later to Argentina of all the surplus available after satisfying the natural growth of domestic consumption. The revenue so obtained could be used in the promotion of domestic development or to meet other government expenditures. An alternative policy of "use of the maximum surplus" was supported by the Unión Industrial and part of the independent press; it favored Paraguay's utilizing as much of the electric power as the domestic, commercial, and industrial sectors could absorb as the most expeditious way of recovering the benefits that Paraguay otherwise could lose by exporting at prevailing values of royalties and compensation. The Unión Industrial has estimated that 35 percent of Paraguay's share of electric power from Itaipú could be used at home by the private sector if the government power authority, ANDE, adopted a promotional rate structure to stimulate domestic consumption.<sup>31</sup> To this estimate should be added the consumption of power by new electrointensive industries that could be attracted by plentiful electric power.

The government's position on the matter of a comprehensive energy policy was finally stated in a sketchy memorandum from the president of ANDE to the minister of Public Works and Communications, published in the Asunción dailies on 20 February 1980.<sup>32</sup> In this document, the president of ANDE acknowledged that if Paraguay could consume domestically all of its share of the electric power obtained at Itaipú, it would benefit more than by selling the power to Brazil at the stipulated price. The document also recognized the fact that to meet future demands for electric power in Paraguay, greater and greater amounts of the energy obtained from Itaipú will have to be used. After reviewing the difficulties to be overcome if Paraguay follows a policy of "use the maximum surplus," the report points out that utilizing the power produced by only one generator (seven hundred megawatts of hourly capacity) would cost Paraguay some seven hundred million dollars, an amount that should be reflected in the rates. This figure is based on the estimate of one thousand dollars per kilowatt of capacity for the average installation cost of a transmission and distribution system. For comparative purposes, the reader should be aware that in 1981, the total public debt of Paraguay was only a little more than that amount, and the value of exports was only half that amount.<sup>33</sup>

The memorandum further explains that the financing for this huge investment could not come from current public revenues and would have to be borrowed. Such a new debt would increase the rates that ANDE would have to charge consumers who are already paying 50 percent of the rates to service previous debts. An increment in consumption could come from only two sources: either from an increase in

domestic demand, which in the opinion of ANDE is price inelastic, or from the incorporation of electrointensive industries into Paraguay's economy. Paraguay, however, cannot easily attract investors with the promise of abundant cheap electric power until Itaipú is completed and the cost of electricity for ANDE is known.

Thus, because ANDE expects little expansion from a reduction in rates and because of its great reluctance to accept foreign capital for financing electrointensive industries, ANDE recommended a more comprehensive study of all available alternatives and the development of a long-term energy program. An advisory committee of high-level government officials was organized for that purpose on 30 June 1980. It requested technical assistance from the World Bank and the Inter-American Development Bank, as well as from other international agencies. At the end of 1981, the World Bank presented its final report, but failed to offer specific recommendations and overlooked Paraguay's problem of royalties and compensation.

Public opinion in Paraguay greeted ANDE's memorandum with disappointment and frustration. It had been expected that Paraguay would have to commit itself to using a substantial part of its share of energy at home and that ANDE would endorse that position. There was a widespread feeling that the problem of what to do with the energy of Itaipú required more definite and aggressive answers. From Brazil no reaction was needed or could be expected. Known for its far-reaching, responsible, and systematic planning of energy policy, Brazil was certainly aware of the technical, financial, and strategic difficulties that Paraguay would encounter if, at this advanced stage of the construction of Itaipú, it decided to abandon a policy based on the certainty of annual income guaranteed by the treaty in order to follow the hazardous alternative of requesting that Brazil renegotiate the value of the compensation and search for a more flexible compromise.

From outside governmental circles, a more realistic set of alternatives was forcefully presented in a study entitled *What to Do with the Energy of Itaipú*, which was prepared by engineer Ricardo Canese, a Paraguayan energy planner without political affiliations who was living in self-imposed exile in Holland. His study was financed and published in Asunción by *ABC Color*, an independent newspaper, between 18 and 29 March 1980. Canese periodically continues to propound his position in *ABC Color*, despite never receiving an answer from the government or the direct endorsement of the editor of *ABC*.<sup>34</sup> Compared with the technical expertise of past studies in this area produced in Paraguay, Canese's analysis exhibits unusual quality. It states for the first time the basic guidelines to be followed by any comprehensive energy program for Paraguay, giving particular emphasis to the strategy most convenient for maximizing the benefits from the hydroelectric plants built on the

Paraná River. The main conclusions and recommendations of Canese's study are worth summarizing.

The forecast of the future demand for energy in Paraguay based on current trends indicates a growing dependency on oil, which is totally imported and could become a serious burden on Paraguay's balance of payment and prospects for economic growth. A rational policy should be developed that would substitute electric power for oil in transportation (via electric rail) and replace the power produced with thermic plants by hydroelectric power. The capacity of the country's economy to retain the total value of its part of the rent for water can be enhanced with the increase in private and commercial use of power through a policy of low rates (the underlying assumption is that demand is price elastic) and industrialization based on selective incorporation of foreign capital to develop electrointensive industries.

Canese estimated the value (shadow price) of electricity for consumers in Brazil in order to calculate the true compensation (rent for water) that Paraguay is entitled to receive from power sold to Brazil. This value is determined by the cost of production by the most expensive technology in use, namely nuclear, at the points of consumption of the power generated at Itaipú—the São Paulo industrial belt. This methodology for estimating the market value of electric power is analytically correct.<sup>35</sup> The values obtained in the study, however, should be used with caution, recognizing that the conventional approach used in the estimation of electric power costs yields only approximate values. The use of nuclear energy costs as a basis for comparison is supported by official data projecting Brazil's production of electricity for 1987 and after, which estimate 85.83 percent from hydroelectric plants and 10 percent from nuclear plants. Using reliable Brazilian sources, Canese's study concludes that Brazil will experience a shortage in electric power in the late eighties that will require the construction of nuclear plants and that the Itaipú production owned by Paraguay could help reduce that shortage. The study also calculates the cost of generating power at Itaipú and adds to that amount the cost for transmission and distribution plus losses in transmission between Itaipú and São Paulo. The rent due to Paraguay for its water can then be calculated as the difference between the price (cost of power generated in nuclear plants) and the cost of production, transmission, and distribution of the energy produced at Itaipú.

The table shows the estimated annual revenue that Paraguay could receive from the sale of its total share of Itaipú's power under various assumptions. The first estimate, Method 1 for Estimating Rent, is based on the provisions of the treaty without adjustment. The second estimate, Method 2 for Estimating Rent, uses an adjustment factor of 5 to measure the increase in the cost of construction of Itaipú. The third es-



HYDROELECTRIC POWER IN THE PARANÁ RIVER BASIN

*Annual Revenue Paraguay Could Receive from the Sale of Its Share of Electric Power from Itaipú under Different Forms of Calculating the Rent Earned by Water (in millions of dollars)\**

<i>Method for Estimating Rent</i>	<i>Royalties</i>	<i>Compensation</i>	<i>Total Rent</i>
1. Itaipú Treaty (1973 dollars)**	23.4	10.8	34.2
2. Itaipú Treaty (1979 dollars)***	117	54	171
3. With Yacyretá Treaty value of compensation (1979 dollars)****	—	540	540
4. Canese estimate based on price of power generated by nuclear plants (1979 dollars)*****	117	1,273	1,390

Sources: Itaipú Treaty, Yacyretá Treaty, and Canese, *Qué hacer con la energía de Itaipú*, serialized in *ABC Color* (Asunción) between 18–29 March 1980.

\*Based on production at total capacity of 36,000 gigawatt-hours corresponding to Paraguay.  
 \*\*Royalties of \$650 per gigawatt-hour and compensations of \$300 per gigawatt-hour.  
 \*\*\*Adjustment factor to correct losses in value of the dollar equal to 5, which measures the increase in cost of construction of Itaipú.  
 \*\*\*\*The payment of \$2,998 per gigawatt-hour to be paid by Argentina according to the Yacyretá Treaty is used to estimate the rent at Itaipú and is adjusted to “change in the cost factor of 5.”  
 \*\*\*\*\*Canese, *Qué hacer*, Annex V, *ABC Color*, 23 March 1981, p. 10. He estimates the rent for water as the difference between the cost of production of power in Brazil at a nuclear plant and the cost of production at Itaipú, including cost of transmission and distribution to São Paulo (900 kilometers) and transmission loss. His figures are corrected by treating royalties as rent, not as cost of production.

estimate, Method 3 for Estimating Rent, shows how much Paraguay could obtain from Itaipú if the compensation were equal to what Paraguay will receive at Yacyretá. The final estimate, Method 4 for Estimating Rent, is the one proposed by Canese to measure the economic rent or compensation to which Paraguay is entitled.

With the higher revenue that Paraguay could obtain through a renegotiation of the treaty to adjust the compensation to measure the rental value of water, Canese contends, a much broader set of alternatives and strategies becomes available to Paraguay. A revenue of 1.2 to 1.4 billion dollars per year could be used to overcome present financial difficulties in defraying domestic transmission and distribution costs. The necessity of “exporting the maximum surplus” then could be abandoned or modified. Paraguay’s government could use this money to make soft loans to ANDE that would help reduce electricity rates or

permit a new rate structure subsidizing some consumers in order to expand the domestic demand for electricity. Part of that revenue could be used to reduce some of the present obstacles to the establishment of electrointensive industries in Paraguay—namely location, lack of raw materials, and lack of advanced technology.

#### THE AGENDA FOR THE EIGHTIES

In 1983, ten years after the signing of the Itaipú and Yacyretá treaties, the first two generators at the Itaipú plant will begin production at a frequency of fifty cycles. This outcome represents a symbolic gesture of deference that will make Paraguay the first user of the new electric current. Meanwhile, the turbines and generators located on the Paraguayan side of the dam will undergo their normal tests and adjustments, and the transformers and transmission lines to carry power in high-voltage direct current to Brazil will be completed. Then, with a better estimate of its total cost, Itaipú will set the wholesale price for its power. At the same time, Paraguay will have to present its schedule of consumption for the next ten years. The total surplus left from Paraguay's quota will be purchased by Brazil, in accordance with the treaty.

Two important problems still require answers. First, the royalties and compensation fixed in the treaty ten years ago will have to be adjusted, if for no other reason than to keep their real value constant. The formula for that adjustment adopted in the treaty was based on the gold content of the dollar, a standard abandoned shortly afterward by the United States. In a protocol of 11 February 1974, the two countries agreed to tie the value of the compensation to a new index designed to measure the changes in the cost of construction of the plant. The new adjusted value must be determined in negotiations yet to come.

Early in 1982, General José Costa Cavalcanti, Executive Director of Itaipú and President of ELECTROBRAS, and Enzo Debernardi, Associate Executive Director of Itaipú and President of ANDE, began to hint at what their countries were planning to do on this matter.<sup>36</sup> Brazil appears ready to begin discussions on the adjustment of the compensation, but definitely opposes renegotiating the treaty to find a new formula for measuring the rent of water, which would result in a more equitable compensation. Stroessner continues to restate Paraguay's commitment to respecting the sanctity of the treaties. Many Paraguayans, however, believe that a new value for the compensation that would go beyond a mere adjustment for changes in cost must be discussed and that now is the time to renegotiate that clause of the treaty.<sup>37</sup> These critics are encouraged by repeated declarations of Brazilian spokesmen who, to defend Itaipú against its domestic critics, admit that Itaipú will save Brazil more than six billion dollars a year in oil that

otherwise would have to be imported.<sup>38</sup> A little less than half of that amount will come from the power that Paraguay intends to sell to Brazil for an insignificant fraction of its total value. Stroessner will soon have to take a much clearer stand on this issue, unless he wants to risk tarnishing his reputation among his followers as a providential statesman and skillful negotiator.

The second, related problem is currently being discussed openly by the same spokesmen for Itaipú, while their respective foreign offices remain silent. This problem is the question of who will be the final users of Itaipú's power.<sup>39</sup> The long delay in the construction of Yacyretá, the recognition in Brazil that earlier projections of future consumption of power are possibly too high in view of the current international economic conditions, and the realization that to pay back Itaipú's debt exceeding ten billion dollars will require sound and enlightened management all raise the distinct possibility that a third country, namely Argentina, could offer an attractive price for some of the energy produced at Itaipú. Costa Cavalcanti and Debernardi have already admitted that although the treaty does not permit a direct sale by one of the partners, it does not forbid one if both partners are in agreement.

An even more surprising possibility has also been recognized. By substituting the new power from Itaipú for what other domestic plants are already producing, both countries could sell that domestically produced power to a third nation to the extent of the existing domestic capacity without violating the treaty. Brazil, paradoxically, could sell to Argentina not only its share of Itaipú but also the totality of Paraguay's surplus, while Paraguay, with a domestic capacity of 1350 gigawatt-hours per year, could sell under this legal subterfuge only 4.8 percent of its part when the plant reaches full production. Brazil's Minister of Planning, Delfim Neto, at times a critic of the internal financial management of Itaipú that contributes somewhat to Brazil's large external debt, recently joined in this debate with the recommendation that to help amortize its large debt and maintain its operational viability, Itaipú should sell its power to the highest bidder.<sup>40</sup>

It is difficult to see how the rigid exclusionary clause of the treaty can be maintained in the future because it would ignore the economic interdependencies of the countries of the region and the advantages for all to be derived from the interconnection of their power grids. Argentina and Uruguay have already interconnected their grids at Salto Grande. Paraguay has been selling power to Brazil and Argentina and buying from them to meet temporary shortages. Argentina and Brazil have also recently agreed to interconnect their electric networks. Finally, as long as Paraguay receives a compensation from its surplus at Itaipú that is lower than the price a third country could offer to pay, Paraguay will be greatly encouraged to expand this obviously profitable outlet. Meanwhile, the

controversy in Paraguay over the establishment of electrointensive industries will continue to increase and will force the government to formulate a comprehensive plan because this alternative is the only one that allows Paraguay the full rent for its contribution to Itaipú.

The immediate future of Yacyretá remains uncertain. After spending two billion dollars on infrastructure and administration, the main engineering work at the dam has yet to begin. The delays are partly due to the deteriorating political and economic situation in Argentina that culminated last year in the Falkland Islands confrontation with Great Britain. The unstable tenure of the military government and the cumbersome system followed by the armed forces for decision-making in areas like energy deprived Yacyretá of badly needed continuity in leadership and high-caliber expertise. Interference has also come from the oil and nuclear lobbies, which have tried to halt the expansion of hydroelectric plants, and from two large international consortia that were competing for the use of the 420-million-dollar loan granted by the World Bank and the Inter-American Development Bank. These pressures were aggravated by procedural errors made in the international solicitation of bids by Yacyretá and the international consulting firm that it hired. Finally, the recommendation by the World Bank and the Inter-American Development Bank that Yacyretá should review the adjudication of its contract has also contributed to delaying the construction of the dam.

With political life in Argentina being reactivated by the expectation that a new president will be elected in 1984, political leaders of all persuasions have stated publicly that even though they support Yacyretá, the treaty will have to be revised and ultimately renegotiated.<sup>41</sup> In that event, one could expect that the newly elected government of Argentina will be the first to request a change in the formula used to measure compensation because it will be hard put to explain why Brazil can buy power from Paraguay at a much lower rate than Argentina would have to pay.

Paraguay will also have to deal with the problem of the increasing presence of Brazilian colonizers in eastern Paraguay. Hordes of farmers, mostly second-generation Europeans who settled in Brazil on the left bank of the Paraná River, have been buying fertile virgin land in Paraguay with loans from Brazilian banks. They have preempted the colonization of that thinly populated area and are creating communities in which the language, the currency, the products consumed, and even the schools are foreign to Paraguay. Prominent Paraguayan writers, intellectuals, and politicians have been denouncing such development as a serious threat to Paraguayan sovereignty in that territory. Stroessner so far has been trying to view this development as a challenge that will

stimulate Paraguay to move more rapidly and steadily to reestablish its presence in the area.

These scenarios are some of the most important possibilities that may entangle the future of these experiments in regional integration brought to the Río de la Plata by the development of the Itaipú, Yacyretá, and Corpus plants. The economic determinants of the relationships among Argentina, Brazil, and Paraguay have greatly shaped the negotiations, and the treaties and subsequent agreements will certainly continue to influence future relations among the three countries.

## NOTES

1. The quantity of electric power generated per year is given in kilowatts per hour (kwh), and the hourly capacity (also called plant potential) is given in kilowatts (kw). The following multiples and symbols are also used: Kilowatt = kw = 1,000 watts; Megawatt = Mw = 1,000 kw; Gigawatt = Gw = 1,000,000 kw.
2. Itaipú Treaty, Annexes, and Letters of Agreement, in República del Paraguay, Honorable Cámara de Senadores, *Diario de Sesiones*, Sesión Extraordinaria del 29 de Mayo, 1973 (Asunción, 1973), pp. 198–213.
3. Yacyretá Treaty, Annexes, and Letters of Agreement, in Italo A. Luder, *La Argentina y sus claves geopolíticas* (Buenos Aires, 1974), pp. 151–84.
4. Osny Duarte Pereira, *Itaipu Prós e Contras* (Rio de Janeiro, 1974), pp. 63–65.
5. For a theoretical discussion of the problem, see J. Hirshleifer, J. C. de Haven, and J. W. Milliman, *Water Supply* (Chicago, 1960), pp. 59–73.
6. The Law of the Sea on the subject of ownership of sea water as a “common inheritance of mankind” presents some of the same problems encountered in the shared ownership of water in international rivers.
7. Duarte Pereira, *Itaipu Prós e Contras*, pp. 51–62.
8. Efraím Cardozo, *Los derechos del Paraguay sobre los Saltos del Guairá* (Asunción, 1965), pp. 173–82, 215–21.
9. In Efraín Enriquez Gamón, *Itaipú: aguas que valen oro* (Buenos Aires, 1975), pp. 35–36.
10. Isaac Francisco Rojas, *Intereses argentinos en la Cuenca del Plata* (Buenos Aires, 1975), pp. 253–58.
11. Luis María Argaña, majority leader in the Paraguayan House said: “Today, with the dam, one third of the territory [in dispute] will be flooded; when the locks are built, another third will be flooded; and in this way the whole problem will eventually disappear.” Cámara de Diputados, *Diario de Sesiones* (11 July 1972), p. 270.
12. *ABC Color* (Asunción), 15 August 1980, p. 9.
13. World Bank, *Paraguay: Regional Development in Eastern Paraguay* (Washington, 1978), p. 29.
14. In accordance with Article 15 Paragraph 4 of the Itaipú Treaty, the value of the royalties, compensation, and payments to the partners will be adjusted for variations in the gold parity of the U.S. dollar. Paragraph 5 contemplates the case of termination of the fixed parity of the U.S. dollar to gold and leaves open the possibility of a new system of parity that could be used to maintain constant the value of those payments.
15. Luder, *La Argentina*, p. 98.
16. Because the money value of the compensation agreed upon in the treaties remains constant for the duration of the partnership, the exporting partner cannot benefit from higher costs of production and low output from a given plant. It is evident, however, that Paraguay will benefit from using for domestic consumption the power generated at Itaipú and from selling its share of Yacyretá to Argentina.
17. Luder, *La Argentina*, p. 99.
18. According to ANDE’s President Debernardi, the deadline for the disclosure of the use

- timetable required in the treaty will become effective only in 1983 because the treaty speaks of "two years before the beginning of *commercial* operation of the first generator." *ABC Color*, 3 August 1980, p. 10.
19. In accordance with Annex C of the Itaipú Treaty, Brazil has guaranteed all credit operations undertaken so far by Itaipú. Paraguay has refused up to now to finance any of the loans necessary to complete the construction of Itaipú. Interview with ANDE President Debernardi, *ABC Color*, 5 February 1981.
  20. Duarte Pereira, *Itaipu*, p. 231.
  21. Statement of Admiral Isaac Rojas made in Buenos Aires and transcribed in *ABC Color*, 30 July 1979, p. 10. See also editorial in *ABC* criticizing Rojas's position against Paraguay, 13 July 1979, p. 12.
  22. Protocol signed by Paraguay and Argentina in Asunción on 30 August 1979 to change Annex C of the Yacretá Treaty to include a formula for estimating the compensation for flooded land to be received by the partners. In *ABC Color*, 31 August 1979, pp. 9–10.
  23. The formula to be used to compute the aggregate compensation for the flooded territory is  $T = E \times CE \times .089$ , where  $T$  is total compensation to be paid for flooded territory;  $E$  is power produced per year;  $CE$  is cost per unit of output expressed in U.S. \$/kwh; and .089 is a coefficient purporting to measure the percentage contribution (opportunity cost) of the flooded land needed to produce electric power.  $CE = (G + R) \div EM$ , where  $G$  is annual direct expenses;  $R$  is annual amortization costs for 60 years and 8 percent interest; and  $EM$  is electric power produced per year. Once the total value of this compensation is determined, each country receives a share proportional to the amount of land flooded in its territory.
  24. *ABC Color*, 25 August 1979, p. 16.
  25. In *Itaipu*, Duarte Pereira discusses the several recommendations adopted by UN conferences and other international meetings concerning the use of the water in rivers of shared sovereignty.
  26. It is assumed in this discussion that the level of water above sea level is constant between two given locations, which is the same as saying that the water flows with no slope. This simplification does not affect the nature of the problem of interdependency.
  27. *La Prensa* (Buenos Aires), 30 October 1979, pp. 1 and 4.
  28. The level of the water between Itaipú and Corpus of 105 meters above sea level that was agreed upon by the three countries constitutes a compromise between the initial Argentine demand of 130 meters and the level of 100 meters first agreed upon by Brazil and Paraguay at the time they subscribed to the Itaipú Treaty. With the 105-meter level, Corpus becomes economically feasible, Paraguay and Brazil do not suffer a significant loss in potential at Itaipú, and Paraguay protects the productivity of its currently operating or future plants. Argentina's concession in reducing its initial demand, although criticized by extreme nationalistic groups, was estimated to have brought the efficiency of the use of the hydroelectric resource of the Paraná River up to more than 90 percent of its full capacity.
  29. Enríquez Gamón, *Itaipú*, reproduces editorials from all the Paraguayan dailies expressing opinions on the Itaipú Treaty before, during, and after the approval of the treaty by Paraguay's legislature, pp. 448–680.
  30. World Bank, *Paraguay*. Two other studies discuss some aspects of the problem of Paraguay's energy policy for the future, but are not available to the public. They are: *Paraguay: estrategias para desarrollo: consideraciones preliminares* (Asunción, 1974), prepared for ANDE by an international consultant group; and *Análisis de las posibilidades de establecer industrias de alto consumo energético en el Paraguay*, prepared by Industri Konsultant A.S. and Kvarner Engineering A.S. (Asunción, 1978).
  31. Ricardo Canese, *Qué hacer con la energía de Itaipú: estudio preliminar, anexos*, published in *ABC Color*, 18 March 1980, p. 8, and in a Unión Industrial press release published in *ABC Color*, 11 May 1980, p. 10.
  32. Memo of ANDE President Debernardi to the minister of Public Works and Communications of 16 January 1980, published in *La Tribuna* (Asunción), 20 February 1980, pp. 12–15.

33. World Bank, *Paraguay: Economic Memorandum* (Washington, 1979), pp. 1–2; and *ABC Color*, 11 May 1980, p. 10.
34. Canese, *Qué hacer*, serialized in *ABC Color* between 18 and 29 March 1980.
35. The methodology used by Canese to estimate the price that Paraguay should receive as compensation for the energy sold to Brazil is identical to that used in this study to determine the economic rent earned by that part of the water contributed by Paraguay. Annex 5, in *ABC Color*, 23 March 1980, pp. 8–9.
36. *O Estado de São Paulo*, 4 November 1982; *Hoy* (Asunción), 6–7 November 1982; and *ABC Color*, 5 November 1982.
37. Canese in *ABC Color*, 28, 29, 31 December 1981 and 2, 3 January 1982.
38. *New York Times*, 8 November 1982, p. 22.
39. *Hoy*, 6 November 1982, p. 10; *ABC Color*, 6 November 1982, p. 9.
40. *ABC Color*, 6 November 1982, p. 9.
41. Responses to a questionnaire by *ABC Color* presented to political leaders of Argentina, *ABC Color* 9, 11, 12, 14, 15, 28 September and 8, 10, 13 October 1982.