



On the beach . . . Westinghouse's Angra I (left) and the Angra II site (right)

The politics of power in Brazil

WITH an electricity demand of 25,000 MW and a hydroelectric potential above 200,000 MW — the Brazilian government went ahead in 1975 with a multi-billion dollar nuclear programme. Brazil's nuclear programme is now years behind schedule and in a state of general disarray, as foreign loans are used up and open dissent appears at all levels. **Maurice Bazin** reports

THE original plan, drawn up in the first half of the 1970s, in the heyday of the fanfared Brazilian "economic miracle", called for 60 nuclear power plants, producing 75,000 MW, by the year 2000. It reflected the mood for grandiose projects of that period — the Brazilian version of the American conquest of the West — symbolized by the construction of the Transamazonian Highway. The launching of these projects coincided with a period of harsh military rule and total press censorship. No sobering criticism could be heard and only the promises of the "miracle" were allowed exposure.

Today, the Transamazonian Highway has not brought the expected development. On the contrary, it has only destroyed what was there already. As for the nuclear plan, it has been reduced to eight plants by the year 2000, and there are many calls for a stop to the programme after three plants have been brought into operation, in 1995.

Nuclear energy does not have a good reputation in Brazil. The first attempt to develop a nuclear technology in 1953 ended up in a scandal. The government had convinced three German physicists who had worked for the Nazi nuclear effort during the war, to come and resume their

work in Brazil. Three gas centrifuges for uranium enrichment were to be shipped secretly from West Germany to Brazil. But the shipment was eventually embargoed by the US High Commissioner for Germany, stopping that particular avenue of development.

Until the signing of an agreement with West Germany in 1975, Brazil had remained in the nuclear sphere of influence of the United States. During the Korean war, it delivered monazitic sands to the US Atomic Energy Commission in unlimited quantities and without compensation. Any attempts to develop a national approach on nuclear energy came into conflict with US commercial interests. In the 1960s a group of Brazilian physicists and engineers calling itself the "thorium group" was doing research in Belo Horizonte on the design of a reactor which would make use of the exceptionally abundant reserves of thorium in Brazil. Their recommendations were ignored by government and their research funds cut off after four years, as negotiations for buying a Westinghouse PWR of 626 MW were getting under way. The sale of this first nuclear plant, Angra I, was confirmed in 1972. Construction is nearing completion in Angra dos Reis on

the Atlantic coast, 130 km from Rio de Janeiro. This sale marked the high point of the influence of the United States in Brazilian energy policy.

"The present Brazilian nuclear programme is almost exclusively the result of Brazilian diplomacy and has little to do with national science and technology; those have been relegated effectively to second place, or to a marginal role" wrote Luiz Pinguelli Rosa, secretary of the Brazilian Physical Society. This sour comment reflects the government's total lack of esteem for its own scientists; their suggestion of 15 years ago to develop a thorium-fuelled reactor is now even presented in official speeches as an alternative coming from the US.

The German agreement encompasses all aspects of nuclear technology, from the prospection of fissile materials to the construction of depositories for waste. There would be a whole industry, capable of operating the complete nuclear fuel cycle. But only accessory parts are under construction so far: a fuel rods conditioning plant will be operational this year, and a heavy equipment complex, NUCLEP, for manufacturing boilers, heat exchangers and possibly turbines, is also under construction.

Two parts of the agreement raised most international concern: those for enriching uranium (breaking the American monopoly) and for construction of a fuel recycling plant, capable of extracting plutonium. In its early days, the Carter administration was anxious to stop these two plants. The diplomatic tug of war is

continuing, with the United States trying to restrict the spread of "sensitive" technologies and materials and Brazil insisting on the right to include nuclear energy in its development strategy. In the words of Brazil's chief delegate to the International Nuclear Fuel Cycle Evaluation (INFCE), Ambassador Carlos Augusto Proenca Rosa: "the use of nuclear energy in developing countries was treated by INFCE in a restrictive and limited way; there are insinuations, at times, that the major contribution that developing countries could offer in the field of nuclear energy should be to increase the prospection and extraction of their uranium resource to benefit the importing developed countries . . . We firmly believe that any effective policy of non-proliferation must be non-discriminatory and must bring about measures which are universally applicable, in order not only to guarantee the correct use of nuclear energy by countries which do not possess nuclear weapons, but also to put a stop to the arms race between countries which possess them."

The suspicions repeatedly raised about the Brazilian military government's intentions to develop a bellicose nuclear capacity rely upon past aggression towards Argentina, which led to wars in the 19th century. Today, however, both countries' harsh military regimes are much more interested in signing agreements on exchange of technology, and common ventures, than fomenting regional tensions. Numerous official visits and meetings of the heads of the nuclear programmes of each country have taken place. Each time the peaceful purpose of both countries' nuclear involvement was reaffirmed. Argentina possesses the only nuclear plant operating in Latin America — Atucha I — which functions with natural uranium. It is also negotiating with West Germany's KWU to buy a new nuclear plant similar to the ones being built in Brazil. As the Brazilian programme meets with increasing delays but the industrial capacity for nuclear components develops in both countries, the two countries have entered an era of increasing commercial cooperation, and no-one talks now of any potential enemy to use nuclear weapons against.

But even if Latin America remains free of nuclear weapons, it will not remain free of nuclear waste. To a question about where nuclear waste from the Brazilian programme would be stored, Rex Nazare, acting director of CNEN, the National Commission for Nuclear Energy, responded: "this is not yet defined. But up to six months before the first plant starts operating there is still time to define the location where to deposit waste."

Finding the sites may be difficult, because Brazilian public opinion is becoming aware of the concern that this issue has raised in developed countries. The only site proposed so far is in the mountains

behind Rio de Janeiro, a place with abundant surface water and where a large proportion of the vegetables consumed in Rio are grown. With the modest redemocratization of the military regime an amount of discussion has taken place, which has led the government to abandon the site.

The government presented its justifications for the agreement with Germany as a white paper in 1977. It claimed that nuclear power was "a necessity in view of Brazil's energy needs" and because the price of oil was increasing. It claimed that, between 1940 and 1973, the proportion of imported energy rose from 15 to 40%, and that "the hydroelectric option is approaching its natural economic limit". Paulo Nogueira Batista, director of NUCLEBRAS, the state nuclear corporation, declared that the

German view

● Many of the Brazilian nuclear opposition's calculations on hydropower are "erroneous and foolish", a spokesman for the West German federal ministry for science and technology claimed in a telephone interview last week.

There are no engineers in the opposition group, said the spokesman, and so the costs and difficulty of transporting current from distant hydro stations have been underestimated. Moreover, the Brazilian government had told Germany that by 1995 all available water resources will have been exhausted. "That's why they want to go nuclear."

The contract with Brazil allows for the supply of two reactors, Angra II and III, with options for an additional six. West German participation would decrease in the later reactors, with Brazilian participation rising to 70-90%. "But we would be happy if Brazil approves the Angra III reactor later this year." The deal was important for Germany because "if the nuclear industry wants to be economic they have to produce something", and with nuclear opposition strong in Germany deals with countries such as Brazil and Argentina were attractive. Nuclear opposition in Brazil was decreasing, the spokesman believed.

Pilot plant design for a gas nozzle enrichment plant was nearly complete, and construction has begun on site, but it will proceed at a leisurely pace. For reprocessing used fuel, Brazilian chemists and engineers are in training in Germany and working on the design of a pilot plant.

Safeguards against the diversion of nuclear materials for weapons building are included in a February 1976 agreement between the International Atomic Energy Agency and the Brazilian and West German governments. The safeguards are not "full scope", but apply only to nuclear materials and technology supplied by or derived from West Germany.

Robert Walgate

hydroelectric potential would be used up by 1990.

This technocratic argument was accompanied by reassuring declarations about the safety of nuclear energy. Technical reliability was proven from the "perfect and uninterrupted operation of close to 150 plants in 18 countries with more than 900 reactor-years of commercial service. Thus nuclear energy is the only functional alternative in view of its level of technical confidence and its competitive cost of production." The first two plants to be built with German technology (Angra II and Angra III) were promised for 1982 and 1983 respectively.

In 1974 FURNAS, the electricity supply company, had elaborated a Plan 1990 for electrical energy needs. The data presented formed the basis for the technical justifications of the agreement. It posed a growth rate of the demand for electrical energy of 11.4% per year, linked with the growth of GNP. It estimated an investment cost per plant of \$500/kW and claimed a load factor of 80% for nuclear plants, while the hydroelectric load factor in Brazil is only 50%, due to seasonal variations in rainfall.

In 1979, however, FURNAS presented a revised Plan 1992, which estimated a demand growth rate of only 7.5% a year. Considering that Plan 1990 itself had stated that "nuclear plant participation would be reduced to zero" for a growth rate below 8.7%, the revised figure becomes equivalent to proposing abandoning the whole programme. It revised the investment cost up to \$1,700/kW. The load factor of nuclear plants was brought down to 65.5% based on plants operating in the West.

During the intervening five years Brazil's "economic miracle" had come to a brutal halt: GNP grew only by 4.1% in 1977, compared to 11.8% in 1975. As censorship slackened, various sectors of the Brazilian technocracy started questioning publicly the economics of the agreement. In 1979, General Dirceu Coutinho, who headed NUCLEI, the subsidiary of NUCLEBRAS which will produce isotopes, resigned and denounced the expense of the programme.

Although criticisms of the programme had been voiced by scientists as early as 1975 at the annual meeting of SBPC, the Brazilian Society for the Progress of Science, and by the Brazilian Society for the Progress of Science, and by Brazilian scientists in exile, the defection of those locally referred to as "nucleocrats" has occurred only during the past two years. As the National Congress started functioning again, it set up a Commission of Inquiry to investigate the programme. David Simon, who had headed the Angra I project and was advisor for nuclear affairs to the president of FURNAS, resigned and collaborated with the Congressional Commission, presenting detailed testimony as a technical expert. He wrote: "apart from a reduced minority of experts — mainly to be found in the world of nucleocrats — there exists a quasi unanimity in the scientific

and technical community around a set of criticisms to be made of the nuclear agreement between Brazil and Germany . . . With the present difference in cost between nuclear and hydroelectric plants, and the availability of hydroelectric sites to the end of this century, there is no need to install nuclear plants before 1990." Indeed, Professor Jose Goldemberg, president of the Brazilian Physical Society, points out that hydroelectric reserves had been purposely underestimated by a factor of two (at 100,000 MW) by FURNAS's Plan 1990.

David Simon makes a detailed cost comparison between the Angra II and III projects and an equivalent 3,400 MW hydroelectric plant. While Angra I and II together will cost \$5,000 million, the hydroelectric plant would cost \$2,700 million. The fuel costs for the nuclear plants during their lifetime would be an additional \$4,000 million (water is free).

On the purely economic side, the agreement specifies that half the costs will be paid by Brazil in Deutschmarks, while hydroelectric technology would be almost entirely costed in Brazilian currency.

His testimony also pointed out that the jet-nozzle technique for uranium enrichment to be used in Brazil is still under development in West Germany (with half the costs for research and development borne by Brazil) and that its technical and economic viability have not been proved.

It is difficult to imagine the possibility of a reconciliation between the government representatives and the scientific community over the nuclear programme. Paulo Nogueira Batista, president of NUCLEBRAS, and Said Farhat, Minister of Information, called a joint press conference last month at which Nogueira discarded FURNAS' revised Plan 1992, because "the 7.5% growth rate demand envisaged in the plan is perilously below a reliable value", and Farhat emphasized "the Brazilian decision to follow through with the international agreements linked to the execution of the nuclear programme. Being a decision of the government, this is no more subject to either divergences or dissensions. To build the nuclear plants we shall spend US \$15 billion. For the nuclear fuel cycle, we estimate an investment of US \$2.5 billion."

On the other side, Professor Luiz Pinguelli Rosa, Secretary of the Brazilian Physical Society, told *Nature* that the scientific community today demands "democratic and public discussions of energy needs, involving various sectors of the population. We, as scientists, should not fall into the temptation to propose a progressive solution as a substitute for the technocrats' miracle. The illiterate majority of the Brazilian population must first obtain the means to evaluate what nuclear energy is. Before it really needs nuclear reactors, I hope that Brazil can reach the stage of a democracy with popular participation." □



Angra II columns . . . not enough

Trouble on the beach of rotting stone

ANGRA I is a standard PWR reactor of the type sold by Westinghouse all over the world under turn-key contract. Its construction made no use of the national manufacturing capacity: the share of local suppliers in the project was only 8%, made up of civil engineering works.

Start up is promised for next year. It uses enriched uranium provided exclusively by the US, paid for via a loan from the Industrial Development Corporation of South Africa. Used fuel will be shipped back to the US, so the electrical company which will operate Angra I will not

comment on wastes on fuel reprocessing.

The doubling of the construction time is blamed on the agreement with West Germany to build two plants (Angra II and III) on the same site. Besides the obvious dangers involved in having three nuclear plants on one beach, there were other problems. While the water table was being lowered to construct the foundations, the already existing buildings slid 10 millimeters from their position. It was decided to build an "armoured diaphragm wall" around the site, 250 meters long and 17 meters deep. As work proceeded on the anchoring of foundation columns for the reactor platform, it was discovered that the ground below the beach was scattered with huge boulders which had to be pierced to reach bed-rock at a depth of 60 meters. This difficulty could have been anticipated had the engineers recalled the difficulties encountered while building the road to Angra, when a tunnel collapsed to form a huge open trench, through which the road now passes; or had they recalled that the beach's name, "Itaorna", comes from Tupi, the language most spoken in Brazil 250 years ago, meaning "rotting stone".

Setbacks also affected the construction of Angra II. Last year, the National Commission on Nuclear Energy, CNEN, which is responsible for safety, decided that the 280 columns already in the ground were not strong enough against earthquakes. As a result, the construction of the reactor base plate was halted for a year, and CNEN ordered an additional 88 columns and reinforcement of 202 of the already existing ones.

It has been pointed out that CNEN's director has always been considered pro-American, while NUCLEBRAS' is pro-German; stronger rifts could exist between them than soil vibrations.

The overall financial charges from these modifications and delays amount to \$320 million, mainly in the form of interest payments. All these costs will be borne by the electrical company FURNAS alone; it has already announced that it will raise its prices by 60% when Angra I comes on-line next year. There are clauses in the German contracts which pass the cost of technical difficulties onto the Brazilian user company; these clauses remain secret and a Sao Paulo newspaper was seized last year for publishing one of them.

The financing of the German programme is the largest loan ever obtained for a Brazilian project: it amounts to \$1,700 million, and with costs tripled from the original predictions, money is getting short. No electrical company is willing to take on the responsibility for the construction of any further plant beyond Angra III. The government and NUCLEBRAS are pressuring CESP, the utilities company of Sao Paulo, to build a fourth plant (the third of the German agreement), but CESP prefers to build more hydroelectric plants at a quarter of the cost of nuclear plants. □