ARGENTINA

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1. GENERAL INFORMATION

1.1. General Overview

Located in southern South America, Argentina is bounded by Bolivia and Paraguay on the north; by Brazil, Uruguay, and the Atlantic Ocean on the east; by the Atlantic Ocean and Chile on the south; and by Chile on the west. The north to south length of continental Argentina is about 3 330 km; its extreme width is about 1 384 km. The area of Argentina is 2 766 889 square km; it is the second largest South American country. The Argentine coastline measures 2 665 km in length.

In 2000, Argentina's population was 37.0 million of which about 89% lived in urban areas, see Table 1 for the historical population data. More than one-third of the population lives in or around of Buenos Aires, the capital and the largest city, with a population of 11 662 050 in 1992. The heavily populated suburban areas had a population of 8 294 642 the same year. Other important cities are Córdoba (metropolitan area population of 1 179 420), a major manufacturing and university city; the river port of Rosario (metropolitan area population of 1 157 372); Mendoza (metropolitan area population of 773 559); Tucumán (population 622 348); Mar del Plata (519 707).

Argentina is comprised of 23 provinces and the self-governing Federal District of Buenos Aires. According to the constitution (amended in 1994), Argentina is a federal republic headed by a president, assisted by ministers and secretaries.

TABLE 1. POPULATION INFORMATION

									Growth rate (%)
	1960	1970	1980	1990	1997	1998	1999	2000	1980 to 1999
Population (millions)	20.6	24.0	28.1	32.5	35.7	36.1	36.6	37.0	1.4
Population density (inhabitants/km²)	7	9	10	12	13	13.1	13.2	13.4	1.4
Urban population as percent of total	74	78	83	87	89	89	89	89	1.7
Area (1000 km²) 2766.9									

Source: IAEA Energy and Economic Database, Data & Statistics/The World Bank.

Argentina has a diverse territory of mountains, upland areas, and plains. The western boundary of the country is within the Andes mountain system. Eastward from the base of the Andean system, the terrain of Argentina is almost entirely flat or gently undulating plain. The Pampas, treeless plains that include the most productive agricultural sections of the country, extend nearly 1,600 km south from Chaco. In Patagonia, south of the Pampas, the terrain is largely arid, desolate steppes.

Temperate weather conditions prevail throughout most of Argentina, except for a small tropical area in the north-east and the subtropical Chaco region in the north. Near Buenos Aires the average annual temperature is a mild 16.1 °C. January and July averages for this area are 23.3 °C and 9.4 °C, respectively. Considerably higher temperatures prevail near the tropic of Capricorn in the north. The annual average temperature in this region is 23.3 °C with extremes as high as 45 °C. Weather is generally cold in Patagonia and Tierra del Fuego. In the western section of Patagonia winter temperatures average about 0 °C. In most coastal areas, however, the ocean exerts a moderating influence on temperatures.

Precipitation in Argentina has wide regional variations: south and west are semiarid, but the extreme north gets more than 152 cm of rainfall annually. Near Buenos Aires annual rainfall is about 102 cm.

1.2. Economic Indicators

Table 2 shows the Gross Domestic Product (GDP), GDP per capita, their growth rates and the GDP by sector.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

	1995	1996	1997	1998	1999
GDP at market prices (billion current US$)	258	272	293	298	283
GDP growth (annual %)	-2.85	5.53	8.11	3.88	-3.21
Agriculture, value added (% of GDP)	5.7	6	5.6	5.71	4.64
Industry, value added (% of GDP)	28	28.42	29.15	28.69	28.24
Services, etc., value added (% of GDP)	66.3	65.58	65.25	65.6	67.12

Source: Data & Statistics/The World Bank.

1.3. Energy Situation

Most rivers and waterfalls with potential energy are far from the industrial centres, but despite these limitations water resources have been widely developed in Argentina (hydraulic resource potential is 1,926,000 TJ). Major hydroelectric projects undertaken in the 1970's and 1980's are in the northern Patagonia, on the Paraná River (a joint project with Paraguay), and on the Uruguay River (in co-operation with Uruguay).

Although the country has a variety of mineral deposits (only one fifth of the country has been surveyed), mining has been relatively unimportant, contributing only 0.2% to Gross Domestic Product (GDP). Since the gas and petroleum sector privatization, exploration for hydrocarbons has increased significantly. Proven natural gas reserves amount to 579 million metric tons. Coal reserves in Argentina are limited: lignite deposits are estimated at 195 million t and peat at 90 million t. Argentina has moderate uranium resources (proven reserves of 2,190 metric tons), see Table 3. Table 4 shows the energy statistics.

TABLE 3. ESTIMATED ENERGY RESERVES

Exajoule

	Solid	Liquid	Gas	Uranium [1]	Hydro [2]	Total
Total amount in place	3.37	15.25	25.86	4.80	51.57	100.85

[1] This total represents essentially recoverable reserves.

[2] For comparison purposes a rough attempt is made to convert hydro capacity to energy by multiplying the gross theoretical annual capability (World Energy Council - 1998) by a factor of 10.

Source: IAEA Energy and Economic Data Base.

1.4. Energy Policy

As a result of governmental policies during the last 30 years the electricity sector has been characterized by:

- *Diversification of energy source technologies:* The utilization of hydroelectric resources and the development of nuclear technology have reduced the share of fossil fuels to 42% of the total in 1994 relative to 93% in 1972. However, during the last decade the increases in the total installed capacity came mainly from:
  - Completion of the remaining large hydro-electric capabilities;
  - Additional capacity was fulfilled through the erection of new combined cycle gas turbine plants.

As a result, and accompanying an average annual growth in the total electricity generation of around 5% in the last decade, the thermal share increased again during the last few years up to 55%.

- *Reduced consumption of oil in thermal power stations:* Current oil consumption (1,440,000 toe in 1990) is comparable to that of the early 50's, even though power generated by thermal stations has increased fivefold - as a result of intensive use of natural gas.
- *Nation-wide electric transmission and distribution system:* Electrification index is 95% in urban areas and above 86% at the national level.
- *Low participation to self-generation in Argentina's supply of electricity:* Currently self-generation accounts for only 11% of electricity generation relative to 20% in the late 1960's.
- A highly integrated interconnected system.
- Initiation of electric energy exports to Brazil in spite of different frequency systems (50 Hz in Argentina and 60 Hz in Brazil).

TABLE 4. ENERGY STATISTICS

Exajoule

							Average annual growth rate (%)	
	1960	1970	1980	1990	1999	2000	1960 to 1980	1980 to 2000
Energy consumption								
- Total [1]	0.68	1.26	1.77	2.05	2.71	2.67	4.87	2.08
- Solids [2]	0.04	0.10	0.11	0.09	0.05	0.04	4.56	-4.65
- Liquids	0.58	0.94	1.10	0.84	1.01	1.00	3.22	-0.50
- Gases	0.05	0.21	0.40	0.88	1.27	1.25	11.15	5.88
- Primary electricity [3]	0.01	0.01	0.17	0.25	0.38	0.39	15.83	4.27
Energy production								
- Total	0.44	1.15	1.66	2.18	3.40	3.46	6.80	3.74
- Solids		0.08	0.08	0.06	0.02	0.02	15.94	-7.66
- Liquids	0.38	0.85	1.08	1.09	1.74	1.72	5.31	2.37
- Gases	0.05	0.21	0.33	0.79	1.32	1.40	10.06	7.55
- Primary electricity [3]	0.01	0.01	0.17	0.24	0.32	0.31	15.82	3.14
Net import (Import - Export)								
- Total	0.25	0.12	0.14	-0.11	-0.98	-1.51	-2.85	-12.63
- Solids	0.04	0.02	0.02	0.03	0.03	0.03	-2.82	1.29
- Liquids	0.21	0.10	0.05	-0.22	-0.83	-0.90	-7.19	-15.83
- Gases			0.07	0.09	-0.18	-0.64		-11.67

[1] Energy consumption = Primary energy consumption + Net import (Import - Export) of secondary energy.
[2] Solid fuels include coal, lignite and commercial wood.
[3] Primary electricity = Hydro + Geothermal + Nuclear + Wind.
Source: IAEA Energy and Economic Database.

2. ELECTRICITY SECTOR

2.1. Structure of the Electricity Sector

In the forties Argentina began establishing state-owned energy companies, nationalizing foreign owned energy utilities and defining energy plans to fully integrate the national planning scheme. The plans used advanced planning methodologies and considered the integration of electricity within the global energy system. Plans were mainly promulgated by the Secretary of Energy and agencies in charge of global economic planning with the participation of national public energy companies.

Despite the political instability and the successive changes in the economic and institutional policies, the plans designed by the state owned energy companies transformed the electricity system.

The electricity system expanded significantly from 1970 when it covered 54% of the population to today's 90% of the population. An interconnected electrical grid system now supplies 90% of the country's requirements. Domestic energy resources are utilized, particularly renewable sources, thus diversifying the mix of primary energy sources.

In 1980's the country's economical crisis, together with a burdensome foreign debt, resulted in critical conditions for the electricity system. At the same time, institutional decentralization led to the proliferation of many provincial electricity distribution and production companies, and to the dispersion of tariffs and economic regulations within the electricity system. Later, due to State reform initiated in 1990, the institutional structure and regulation of all energy-related activities underwent substantial modifications. The energy policy was based on a free market economy bolstered by private sector investments in the energy system.

Materialization of this policy began with privatization of Servicios Eléctricos Gran Buenos Aires (SEGBA), along with Agua y Energía's hydro and fossil fuel stations, hydropower stations owned by Hidronor, and the Sistema Interconectado Nacional (high voltage transmission network).

From the organizational point of view, Argentina's electricity sector shows a historical development similar to that of most European and Latin American countries. Since its origins until after the World War II, electricity supply was in private hands, subject to the control of local authorities who granted operation licenses and developed franchises within their respective jurisdictions.

State companies involved in the supply of electricity have grown since 1945, and in 1990 they owned 84% of Argentina's generating capacity. In the late 1980's, the government introduced changes to the organization, regulation, and the ownership of electricity companies including the privatization of most facilities owned by SEGBA, Hidronor and Agua y Energía. Before the reform, electricity was supplied by a number of utilities with different legal standings and functional dependencies, although state agencies controlled 99% of the installed generating capacity.

In the mid 1960's a decentralization process began with the creation of state-owned generating companies. Decentralization was further intensified in 1980 with the transfer of distribution networks from one of the state companies, Agua y Energía, to the provincial governments. This decision from central administration encouraged the creation of new provincial agencies and made regulation more complex.

The federal government kept the primary responsibility for planning expansions in electricity generation and high voltage transmission. Six state agencies are responsible for the construction and operation of the facilities. Decentralized power generation led to a significant wholesale electricity market regulated by the federal government through the Load Dispatching Centre (Despacho Nacional de Cargas).

Electricity distribution to end-users was carried out by more than 600 organizations: two state companies (supplying 55% of electricity consumption nation-wide), 21 provincial companies (34% of consumption) and some 580 co-operatives (11% of consumption). Provincial companies can only operate within the boundaries of their respective provinces, while co-operatives can provide services in municipal areas. The right of provincial and municipal regulators to determine the end-users' electricity tariffs and their independence to fix taxes on electricity consumption within their jurisdictions led to a great price discrepancy among users with similar consumption patterns.

Institutional changes and a stiff regulatory framework impaired the performance of the electricity sector before the sector reform. Efficiency of state-owned utilities was affected by politically fixed low tariffs and indebtedness in recent years, which lead to supply crisis. The most noticeable signs in the technical phase were the unavailability of thermal generating equipment which necessitated streamlined electricity consumption in 1988/89 under conditions of low water inflows;

increase in distribution losses up to 23% of sales; and construction delays which increased average fuel consumption through expanded use of gas turbines. Reorganization of Argentina's electricity sector, both on regulatory and institutional levels, was realized upon the approval of Law 24,065 of January 1992, which sanctioned the transfer of facilities to private hands through the privatization process begun in May 1992.

The new legal framework has organizational and regulatory impacts on the activities that are carried out under national jurisdiction, since the provinces have only partially joined the national framework. Despite of the diversity of regulatory jurisdictions, the fact that the state companies dominated electricity generation and transmission systems before the reform has assured national jurisdiction over these industry segments that are central to the wholesale electricity market. Between April 1992 and April 1995, 9830 MW(e) of installed capacity held by SEGBA (2,480 MW(e)), Agua y Energía (2,800 MW(e)) and Hidronor (4,290 MW(e)) were transferred to private operators. Of the above capacity, 37% is fossil fuel fired steam turbines; 15% gas turbines and the remaining 48% hydro stations.

Provincial jurisdiction covers primarily electricity distribution, which is carried out largely by provincial companies who buy electricity at the wholesale market. Provincial companies who own power stations are subject to national rules for the operation of the system if they use transmission lines or sell their excess generation in the wholesale market. The new regulatory regime covers the electricity industry where institutional organization and ownership patterns differ from regulations that were in effect until the late 1991. Horizontal and vertical partitioning of national companies was assumed to encourage competition and to promote efficiency. The objectives of these changes, inspired to a large extent by the reforms in Great Britain, are to protect users' rights; promote market competitiveness; encourage private investment for long term supply; promote reliable operation and free access to service; regulate transmission and distribution and assure reasonable tariffs.

Participants in the electricity sector are:

i) producers, whether independent, national, bi-national or provincial, and interconnected foreign electric utilities;
ii) distributors, large consumers and interconnected foreign electric utilities;
iii) transmission companies;
iv) regulatory agencies: The Electricity Regulator (Ente Nacional Regulador de la Electricidad, ENRE) and the Wholesale Electricity Market Administrator (Compañía Administradora del Mercado Mayorista Eléctrico, CAMMESA).

Participants in each class are semi-autonomous, that is, they have limited influence outside their individual areas. The independence of transmission companies ensures free electrical grid access to third parties. Distributors have to provide for the excess electricity if they have spare capacity. Any party authorized by the Secretary of Energy to participate in the wholesale electricity market must abide by the prescribed market rules. Because of their monopolistic characteristics, power transmission and distribution systems are regulated and require granted concessions. Grid expansions are subject to market mechanisms.

Producers are subject to concessions only if they operate hydroelectric power stations. Installation of thermal power stations requires authorization for grid connection and compliance with applicable public safety and environmental protection regulations. CAMMESA supervises the whole production system that works in *a Fully Deregulated Market*. In so doing, CAMMESA selects and authorizes at any moment every new additional input to the national grid among the different producers according to the plant "marginal cost" (additional cost while in operation, i.e. mainly the fuel cost) : that non-operating but available plant having the *lowest* marginal cost is selected for providing any new required additional capacity to the national grid. Accordingly, excess capacity is removed from the grid selecting that plant having the highest marginal cost. In this way, minimization of total and average electricity generation cost is assured.

Distribution is largely in the hands of provincial utilities and co-operatives (65%) due to privatization of Agua y Energía and the transfer of its services. Of the distribution systems held by state companies, only the service in the concession area of the former SEGBA is in private hands, where now three private distribution companies are supplying 35% of the retail electricity market.

Prior to April 1995 only one provincial distribution company Empresa Distribution de Energia de Salta (EDESAL), had been privatized, although several provinces had announced interest to privatize their services and were in process of adjusting the provincial regulatory framework to allow private electricity operators inside their jurisdictions. The role of CAMMESA is that of a wholesale electricity market administrator in commercial agreements between parties (forward contracts).

General supervision and regulation of the industry under national jurisdiction is in the hands of ENRE (Ente Nacional Regulador de la Electricidad), chartered as an independent agency within the Secretary of Energy. ENRE's main duties are:

i) enforcement of concession contracts;
ii) prevention of anti-competitive, monopolistic or discriminatory behaviour;
iii) participation to the selection of concession holders;
iv) organization and implementation of public hearings to clarify conflicts between parties;
v) environmental protection and public safety issues associated to the electricity sector.

ENRE supervises national distribution companies and settles disputes between parties as long as they operate under the national jurisdiction. The office of the Energy Secretary is the a national agency, which interacts with provincial governments in matters relating to the electricity supply industry.

All electricity supplied to the interconnected electrical system is commercialized through the wholesale electricity market. This market includes a contract market and a spot market.

The end user market is also divided into a regulated and a non-regulated segment. The non-regulated segment is open to competition among bidders, particularly large consumers. The minimum consumption threshold to access the wholesale electricity market was initially 5 MW(e), but it has now been reduced to 1 MW(e). Access thresholds must be authorized by ENRE.

State owned generating companies are under a provisional regime until privatization is realized. Secretary of Energy establishes the rates for nuclear power, while other state owned power producers are only allowed to recover operating and maintenance costs.

Differences between outlays that state owned producers should have invoiced according to prevailing spot prices and the receipts actually received are assigned to Unified Fund for debt servicing and to fund investments for the completion of any construction in progress at the time of the reform.

2.2. Policy and Decision Making Process

Privatization of state companies was implemented to encourage market competition. For this purpose, separation of generation, transmission, and distribution systems was established. Within this framework, the Energy Secretary is responsible for:

i) defining the policies for the electricity sector;
ii) licensing newcomers to the wholesale electricity market;
iii) establishing the rules with which the electricity supply industry must comply;
iv) authorizing the allocation of funds to state companies;
v) deciding on the respective awards during the privatization process.

In order to attend to the technical management of the system and to administer the wholesale electricity market, Load Dispatching Centre became a stock corporation, CAMMESA, with an equity interest held by the Secretary of Energy and by different utilities in the wholesale market. The Secretary of Energy may reduce its capital share in CAMMESA to 10%, and still retain the power of veto to Board decisions. CAMMESA is the electricity system's technical authority.

Presently, Argentina plans to develop an integrated resource planning and decision-making process aimed at co-ordinating the functions of its diverse institutional system and assuring thorough participation of all sectors, public and private. Mechanisms related to the electrical system expansion, economic management and regulation with mitigating impact on the environment have not been defined.

In accordance with constitutional principles, riverside provinces own the water resources utilized by the hydroelectric companies. The provinces grant licenses for commercial operation, even though existing facilities belong to the Federal State, and collect generation royalties. Provincial governments also authorize the construction of new projects in their respective territories, provided that the new companies do not join the wholesale electricity market through business transactions or through transmission or distribution networks under national jurisdiction.

In the regulated segment, a distributor is assured a monopoly and has to meet the required electrical demand pursuant to the terms of the concession contract. If no private investors are interested in distributing electricity to certain areas, then the State has the obligation to supply the service there.

Concession contracts specify technical and commercial quality of service which concession holders are obligated to provide. The obligations of the company are not subject to electricity availability in the wholesale market, and the State takes no commitment to solve potential power shortages.

The tariffs in this market segment cover all distribution costs (network expansion, operation and maintenance, marketing and the cost of purchasing electricity in the wholesale market) including a rate of return fixed by ENRE. In the future, wholesale spot price variations will be passed by distributors directly to customers.

Everyone in the wholesale electricity market participates directly or indirectly in the spot market. The operation of this market is managed by CAMMESA. The operation of interconnected generating units is scheduled by CAMMESA for six month seasonal periods to cover demand forecasts with the reserve agreed between the parties (economic load dispatching). The average seasonal marginal cost is the base price from which the price to the distributors is calculated. Distributors pay a differential price depending on their location in the system, which reflects their contribution to transmission losses.

Distributors also pay a fixed charge for their average estimated demand for power over the next five years. The risk associated with this estimate is borne by the distributors who must assume the payments in the event of overestimation of demand and are penalized in the event of underestimation. In addition, distributors contribute toward CAMMESA's expenses by paying a fixed connection charge and a transmission capacity charge to transmission companies. Electricity suppliers are compensated for:

i) the energy supplied by a plant run according to schedule, at the system's marginal cost;
ii) the energy supplied by a plant required to run as a result of technical constraints, and costs are reimbursed;
iii) start-up costs derived from CAMMESA's requests;
iv) power made available to the system (cold reserve), at a price fixed by bidding among generators.

The price for power supplied by bi-national producers is determined in the terms of their contracts. Foreign interconnected utility companies have to apply for authorization from the Secretary of Energy to participate in the wholesale electricity market. In this way they are assured of their reserve and do not resort to sell at dumping prices.

Payment to transmission companies includes a connection charge, a fixed charge for transmission capacity and a variable charge for the energy actually transmitted. The variable charge is proportional to the transmission losses. Distributors and large users may enter into supply contracts with producers at the prices defined in their contracts. State companies are excluded from this market. ENRE does not intervene in the supervision of these contracts or in any contractual disputes.

Entering into forward contracts does not prevent distributors from power purchases in the spot market at stabilized prices unless they have contracted more than 60% of their demand, in which case they are considered to be occasional users and their transactions are subject to availability determined at the hourly price paid to generators. Large users, on the contrary, must be supplied by the local distributor unless supply is contracted with a producer for at least 50% of their demand.

The operation in real time is carried out irrespective of any forward contracts signed with producers with the premise that any departure from contract volumes and the actual operation will be channelled through the spot market. A similar criterion applies for demand departures pertaining to the large users under contract. These are subject to penalties similar to those applied to distributors in the event of forecasting errors in their own demand.

A Stabilization Fund managed by the Secretary of Energy has been created to account for the differences between the expenditures paid by purchasers and the revenue received by generation and transmission companies.

2.3. Main Indicators

Argentina's electricity consumption grew at an average annual rate of almost 8% between 1970 and 1980, levelling off to 2.5% average rate during 1980-1991, and increasing again to around 5% during the last decade. This is partly explained by production increases in the metallurgy, which is an energy intensive industry. Energy consumption in residential and commercial sectors, however, suffered the most due to the imposed rationing system during the energy crisis in the 80´s, although the number of customers grew and electricity billed per customer during the 1980-1987 amounted to 4,000 kWh/year. In 1993, per capita electricity consumption was 1,903 kW·h, a figure slightly above the Latin American average and increased to 2,278 kW·h in 2000. Table 5 shows the historical energy production and the installed capacity and Table 6 the energy related ratios.

Total electricity generation in 2000 was 78.95 TW·h. Total net installed capacity of electricity generating plants in 2000 was 25.2 GW, of which thermal accounted for 14.1 GW, hydro 10.1 GW and nuclear 935 MW. Of the total electricity generated, 33.8% came from hydroelectric power stations, thermal energy sources account for 58.9% and nuclear 7.3%. Total electricity exports were 4.7 million MW·h.

Electricity consumption is frequently viewed as an indicator of the level of economic activity. Thus, an increase in electricity consumption is immediately associated to an increase in economic production. However, a few comparisons conflict with this view: in the 1970-1991 period per capita electricity consumption grew at an average annual rate of 3.4% whereas per capita GDP grew by 1.2%. Moreover, during the 1980-1991 period, if the same figures are considered, as GDP decreased to 0.77%, per capita electricity consumption grew to almost 1% per annum. In 1975, 1978 and 1982, while GDP decreased, electricity consumption did not follow the same trend.

Electricity consumption can also be regarded as an indicator of trends in the informal economy, where electricity is used for production, but is not recorded as an economic activity in formal statistical surveys or considered in GDP measurements.

TABLE 5. ELECTRICITY PRODUCTION AND INSTALLED CAPACITY

	1960	1970	1980	1990	1999	2000	Average annual growth rate (%) 1960 to 1980	Average annual growth rate (%) 1980 to 2000
Electricity production (TW·h)								
- Total [(1)]	10.46	21.73	39.68	50.91	76.42	78.95	6.89	3.50
- Thermal	9.53	20.17	22.19	26.15	43.26	46.51	4.31	3.77
- Hydro	0.93	1.56	15.15	18.13	26.57	26.71	14.99	2.88
- Nuclear			2.34	6.62	6.59	5.73		4.58
Capacity of electrical plants (GWe)								
- Total	3.47	6.69	11.99	17.21	24.09	25.20	6.39	3.79
- Thermal	3.13	6.08	7.99	9.65	13.44	14.14	4.79	2.89
- Hydro	0.34	0.61	3.63	6.62	9.72	10.13	12.56	5.27
- Nuclear			0.37	0.94	0.94	0.94		4.74

[(1)] Electricity losses are not deducted.
Source: IAEA Energy and Economic Database.

TABLE 6. ENERGY RELATED RATIOS

	1960	1970	1980	1990	1999	2000
Energy consumption per capita (GJ/capita)	33	53	63	63	74	72
Electricity per capita (kW·h/capita)	507	852	1,363	1,550	2,202	2,278
Electricity production/Energy production (%)	23	17	22	22	21	21
Nuclear/Total electricity (%)			6	13	9	8
Ratio of external dependency (%) [(1)]	37	10	8	-5	-36	-57
Load factor of electricity plants						
- Total (%)	34	37	38	34	36	36
- Thermal	35	38	32	31	37	38
- Hydro	31	29	48	31	31	30
- Nuclear			72	81	80	70

[(1)] Net import / Total energy consumption
Source: IAEA Energy and Economic Database.

3. NUCLEAR POWER SITUATION

3.1. Historical Development

A few years after the nuclear explosions of 1945 that brought worldwide awareness of nuclear energy, the first steps were taken to create the Comisión Nacional de Energía Atomica (CNEA), Argentina's Atomic Energy Commission in charge of all national nuclear activities.

Since the creation of CNEA several distinct periods of activity have occurred. The first period saw the organization of the first research and development teams; staff nuclear training primarily in more advanced countries; training of physicists through the creation of the Balseiro Institute of Physics; prospects for uranium exploration in Argentina; and, the construction of the first experimental 10 kW(t) Argonaut type reactor including its fuel elements.

During the second period, Argentina designed and constructed a 5 MW(th) irradiation and research reactor; promoted metal research and development; and, manufactured the fuel elements required by that reactor. The first uranium concentrate production plant was built in Malargüe (Province of Mendoza) and a battery leachate plant in Don Otto (Province of Salta). Radioisotope production and application techniques in the field of medicine, biology, industry and agriculture were developed.

In the third period, Argentina began nuclear energy activities. In 1964, CNEA was considering the construction of a nuclear power station for the Greater Buenos Aires-Litoral electrical system. A feasibility study was authorized by a national commission for the co-ordination of large electrical works. Within fourteen months, the Commission completed the study with the recommendation to build a 300-500 MW(e) nuclear power station within the Greater Buenos Aires-Litoral electric power system. The study concluded that such a station could commence operation by 1971, and that the project would be technically feasible, economically convenient, and financially sound. Furthermore, Argentinean industry would be able to contribute an estimated 40 to 50 percent toward the construction and operation of the station. Sufficient deposits of indigenous uranium added to the appeal of nuclear power together with its expected stimulation to scientific and technological activities.

With the prospects of the nuclear energy generation in Argentina, CNEA had to first decide whether to purchase a light water or a heavy water reactor. British and the US suppliers offered enriched uranium reactors. Despite of the strong preference for independence CNEA entertained bids for these reactors for two reasons. First, light water reactors were less expensive than heavy water reactors, and were dominating the markets in the United States, Europe, and Japan. The second reason was tactical, for it was perceived that encouraging more bids would spike up the competition, and better terms would be offered by firms eager to gain foothold in a new market.

However, the Canadian and German offers were most attractive. The German offer was for a natural uranium reactor, with 100 percent financing, 35 percent local participation, and the shortest delivery time. The bid by the electrical giant, Siemens AG, of Germany was chosen for its superior financing terms, construction time, and local participation rate.

Nearly two years behind the schedule, the Atucha I nuclear power station was commissioned and began commercial operation in 1974.

Also in 1967 a feasibility study for a second station was undertaken by the provincial utility in Cordoba. CNEA was authorized to call for bids for a 600 MW(e) station, nearly double the size of the 317 MW(e) Atucha reactor in 1972. Natural uranium was selected as fuel and the contract was awarded to CANDU, a consortium of Atomic Energy of Canada Ltd (AECL) and the Italian construction company, Italimpianti.

The second nuclear power station was built in Embalse, on the Rio Tercero Reservoir in the province of Cordoba. It was commissioned in 1983 and went into commercial operation in January 1984. A prime attraction of the Canadian offer had been the Technology Transfer Agreement, which CNEA considered valuable for independent nuclear power production.

In late 1979 a third nuclear power station was scheduled to be built at the same site as Atucha I. Problems with the construction of the Embalse nuclear power plant (NPP) convinced the authorities to award the contract to ENACE, a joint venture of Kraftwerk Union (KWU) and CNEA, for a 700 MW(e) Siemens heavy water cooled and moderated pressurized reactor power station (same design as Atucha I). Construction started in 1981.

3.2. Status and Trends of Nuclear Power

Less than 15 percent of electricity consumed in Argentina is produced by nuclear plants. In 1995 there were two nuclear power plants (Atucha I and Embalse) in operation with a total net capacity of 935 MW(e), see Table 7. Share of electricity produced by nuclear means is 13 percent of the total electricity supplied in the country. This is expected to increase with the construction of a third nuclear power plant, Atucha II of 692 MW(e) net capacity, whose completion, however, has been delayed due to economic uncertainties in and lack of funding.

TABLE 7. STATUS OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier
ATUCHA-1	PHWR	335	NASA	Operational	SIEMENS
EMBALSE	PHWR	600	NASA	Operational	AECL
ATUCHA-2	PHWR	692	NASA	Under Construction	SIEMENS

Station	Construction Date	Criticality Date	Grid Date	Commercial Date	Shutdown Date
ATUCHA-1	01-Jun-68	13-Jan-74	19-Mar-74	24-Jun-74	
EMBALSE	01-Apr-74	13-Mar-83	25-Apr-83	20-Jan-84	
ATUCHA-2	01-Jun-81				

Source: IAEA Power Reactor Information System as of 31 December 2000.

4. NUCLEAR POWER INDUSTRY

4.1. Reorganization of the Public Nuclear Sector

On August 30, 1994, a Federal Government Decree was issued to restructure the nuclear sector and CNEA. As a result, the National Nuclear Regulatory Authority (Autoridad Regulatoria Nuclear – or A.R.N.) was founded. The new Agency took over the regulatory responsibilities for nuclear activities that were previously carried out by CNEA. It establishes nuclear and radiological safety standards and formulates regulations related to physical protection and control of the use of nuclear materials. It is responsible for the licensing and regulations of nuclear installations and compliance with international safeguards. In addition, a shareholders company, Nucleoeléctrica Argentina S.A. (NASA) was established. NASA operates Atucha I and Embalse nuclear power stations and oversees the construction of Atucha II nuclear power station. The decree also directed NASA to pay annual royalties to CNEA and to ARN as licensing fees. Ownership has been handed to the Ministry of Economy, as a pre-privatization step.

In parallel, the Federal Government supported works at Atucha-2 NPP Project initiated in 1981, were fully stopped and discontinued since the beginning of 1994 under a privatisation plan not yet accomplished. This 3rd NPP remains unfinished at 81% completion stage, with several plant systems already operational, the main pending items being: completion of electro-mechanical erection, I&C mounting, heavy water inventory and first core fuel deliveries, and plant commissioning.

The above-mentioned 1994 Decree imposing the partition of former CNEA into 3 separate entities, CNEA, NASA and ARN, and paving the way for a future privatisation of NASA and its 3 NPPs, was later formally replaced by a “Federal Law for the Nuclear Activity” issued by Argentina´s National Congress in 1996 and put in force in 1998. This federal law ratified CNEA´s partition, and legally allowed privatisation of NASA and completion and start-up of Atucha-2 NPP by private companies through an international call for bids. Nevertheless, firstly due to lengthy elaboration of the legal instruments (federal law, reglementary decree, texts for the call for bids, etc.) and later due to the Federal Administration take over at the end of 1999, NASA privatisation as well as resumption of works at the long-time paralized Atucha-2 NPP did not happen up to now.

4.2. Research and Development Activities

The National Atomic Energy Commission (CNEA) remains as an institute for research and development in the nuclear field, as well as for provision of technical services and assistance to nuclear power plants, other nuclear installations and nuclear application users, both in the domestic and international markets. Most of production activities previously carried out by CNEA, are now handled by private interests, with the main exceptions of radioisotope production and specific instrumentation and electronic equipment.

As a result, CNEA ´s main areas of activity are:

- Basic and applied research in the main branches of physics, material sciences, chemistry, radiobiology, etc.

- Technology development and applications in nuclear engineering (reactor physics, reactor design, thermal-hydraulics, operation assistance tools, safety and risk analysis, etc.); electronic and nuclear instrumentation developments; reactor and neutron / gamma applications, including different medical applications in particular BNCT; industrial, agricultural food conservation and medical devices sterilisation, etc.

- Nuclear projects, mainly related to small sized NPP (Carem Project); nuclear fuel design, manufacturing and utilization (Slightly Enriched Uranium fuel use in the HWR Atucha-1 NPP, CARA Project, etc.); etc.

- Human resources education and training at the technician level for reactor operators; as well as at university grade, post-grade and doctoral levels at 3 complementary institutes: “Institute Balseiro” at Bariloche, “Institute for Nuclear Studies” at Ezeiza and “Institute Sabato” at Buenos Aires.

- Operation of nuclear facilities: nuclear reactors RA-1 and RA-3 in Buenos Aires area, RA-0 in Cordoba city, RA-4 in Rosario city, RA-6 in Bariloche city and RA-8 in Pilcaniyeu Technological Complex, cyclotron for radioisotope production, high pressure test loop, etc.

- Technical services and assistance to the operating NPPs in Argentina, Atucha-1 and Embalse, including engineering, works, equipment provisions, replacements, back-fitting activities, etc., covering a wide range of disciplines from specific neutron propagation studies, thermal-hydraulics, safety, mechanical, electronic and electrical engineering, neutron detectors (self-powered and others), specific safety-qualified electronic equipment, etc.

- Technical services and assistance to various national and foreign customers covering conventional electric power plants, other industrial plants, metal-mechanical component suppliers, hospitals and other medical centres, other private companies devoted to nuclear applications, and Argentine exported nuclear reactors in countries like Peru, Egypt, etc.

- Radioisotope production, including large amounts of Cobalt-60 and Molibdenum-99, is generated in:
    - Ezeiza Atomic Center´s RA-3 Reactor;
    - Ezeiza Atomic Center´s Ciclotron;
    - Embalse Nuclear Power Plant.

The main CNEA facilities are concentrated in:

- Constituyentes Atomic Center (CAC) in Buenos Aires area;

- Ezeiza Atomic Center (CAE) in Buenos Aires area;

- Bariloche Atomic Center (CAB) close to the southern town of Bariloche;

- Pilcaniyeu Technological Complex, near Bariloche.

These are complemented by several distributed CNEA delegations in different places of the Argentine territory, providing support for domestic Uranium explorations.

4.3. Fuel Cycle and Radioactive Wastes

At present current Uranium supplies come from imports in the international market. These imports include, low enriched (around 3.4%) and medium enriched (around 20%) Uranium supplies. These correspond to the main consumer installations: Embalse (Candu-type) plant employees Natural Uranium; Atucha-1 employes Slightly Enriched (0.85%) Uranium obtained from the mixing between Natural and 3.4% enriched U; research and production reactors (both domestic and exported) normally employ 20% enriched U.

Production of UO_2 powder is carried out by CNEA's daughter company DIOXITEK S.A. presently established at Cordoba city and foreseen to be moved to Mendoza province. Technology development for zirconium sponge production has been carried out at Bariloche, while manufacturing of zircaloy tubes for fuel element cladding, coolant channels, instrumentation lances and other reactor internals is currently carried out by another CNEA's daughter company, FAESA, with a production plant installed at Ezeiza Atomic Centre.

Manufacturing of fuel assemblies is carried out by another daughter company of CNEA, CONUAR S.A., with its plant located close to FAESA's plant in Ezeiza Atomic Centre. CONUAR produces the fuel assemblies currently required by Atucha-1 (SEU fuel), Embalse (natural U fuel) and the research and production reactors either operating in Argentina or exported by CNEA or INVAP S.E. (see section 4.4).

According to the Federal Law for "Radioactive Waste management", CNEA is responsible for supervision of the overall treatment of such wastes coming from any nuclear user in the country, and in particular for assuring the final disposal of low, intermediate and high level radwastes.

CNEA, according to the same law, is responsible for the reception of each Argentine NPP at the end of its lifetime and for all the stages of its decommissioning and decontamination. According to this law two separate funds must be provided by each operating NPP in order to afford for radioactive waste treatment by CNEA and for decommissioning by CNEA.

4.4. Exports

Exports from Argentina's nuclear sector mainly include:

- Nuclear Reactors for Research and Radioisotope Production. This activity was initiated by CNEA almost 25 years ago with the RP-0 and RP-10 reactors for IPEN, Peru. Later it was taken over by another CNEA´s daughter company, INVAP S.E., with similar or improved exports to Algeria, Egypt and Australia;

- Radioisotopes, mainly Cobalt-60 produced at Embalse NPP´s adjuster rods and later processed at CNEA´s plant in Ezeiza Atomic Center;

- Specific provisions for the exported installations (new or additional instrumentation, improved mechanical systems, etc.).

5. REGULATORY FRAMEWORK

5.1. Safety Authority and the licensing Process

The licensing process for nuclear power stations involves interaction between the Operating Organization and the Regulatory Authority starting at the earliest steps of a projected installation. The role of the Regulatory Authority is to establish "Requirements", "Recommendations" and "Requests for Information" and to issue construction and operation licenses. "Requirements" must be carried out

by the Operating Organization. “Recommendations” should be carried out unless it is shown by the Operating Organization that they are not necessary, or that the same objective can be achieved better by other means. The “Requests for Information” are issued by the Regulatory Authority in order to further evaluate or validate studies already presented by the Operating Organization. Standard AR 0.0.1 establishes general framework for the construction, operation and regulation of nuclear power stations.

Procedures to the Regulatory Authority for applying for a nuclear operating license is described in standard AR 3.7.1. These include:

- Preliminary Safety Report (PSR) nine months prior to requesting the construction license (does not include the work for site preparation).
- Systematic presentation of information, changes in design and other requirements as needed two months after presenting the PSR and up to one month before the reactor is loaded with the reacting combination of moderator and fuel.
- Monthly Progress reports on the construction of the nuclear power stations after the granting of the construction license.
- Quality Assurance (QA) programme, QA manuals and QA information starting with the presentation of the PSR. The QA programme must include organizations, system of documentation, verification of the design, purchase, materials, processes, inspections, tests, and corrective actions, as well as registry and its control.
- Organization chart for Operation, and the Staff Training Programme in the beginning of the construction. It should be modified when changes are proposed.
- Progress reports during “non-nuclear” commissioning 24 months prior the predicted first criticality.
- Progress reports about the commissioning up to one week prior the first criticality.
- Final Safety Report (FSR) 12 months prior the first criticality.
- Additional information and modifications to the FSR up to one month prior the reactor is charged with moderator and fuel.
- Operating Manuals including the Radiological Code of Practice four months prior the first criticality.
- Final report of the QA programme four months prior the first criticality.
- Request for individual operators’ licenses four months prior the first criticality.
- Emergency Plan three months prior the first criticality.
- Constitution of an Ad-hoc Committee for “Nuclear” commissioning and operation three months prior the first criticality.
- Maintenance Manuals one month before requesting the licence of operation.
- Report of the Ad-hoc Committee at the end of the Nuclear commissioning.
- Final version of the Operating Manuals at the end of the commissioning.

Construction and operating license outlines the responsibilities of the director of the nuclear power station and the Operating Organization. License is given for an undefined period and may be cancelled, suspended or modified by the Regulatory Authority in case of non-compliance to the regulations. The license can include temporary requirements. Only licensed staff can operate Nuclear power stations.

The Operating Organization must have a Technical Review Committee (TRC) and an Internal Safety Committee (ISC) which should meet at least once a month in order to analyze nuclear operations; to asses the likelihood of failures and abnormal events; and, to carry out the evaluation of any modifications to the original design of the installation before these are presented to the Regulatory Authority. The director of operations must be advised by the Internal Safety Committee on any issues related to radiological and nuclear safety.

The "conditions and the limits of operation" are established in the license and require the pre-approval of the Regulatory Authority for any modifications. The license specifies the limits of radioactive effluents to the environment and states the requirements for annual exercise of the Emergency Plan. The license also defines procedures related to the "mandatory documentation", the operators retraining programme, the communication channels with the Regulatory Authority, and the relation with the "resident" inspectors.

5.1.1. Regulatory Authority

The Nuclear Regulatory Authority (in Spanish, ARN) was created as an autarchic entity under Act 24,804 known as Nuclear Activity National Act, which came into force on April 25th, 1997, to succeed the National Nuclear Regulatory Board. The Nuclear Regulatory Authority reports directly to the Argentine Presidency and is empowered to regulate and control the nuclear activity with regard to radiological and nuclear safety, physical protection and nuclear non proliferation aspects.

The objective of the Nuclear Regulatory Authority is to establish, develop and enforce a regulatory system applicable to all nuclear activities within Argentina, as well as, to advise the Executive on issues under its purview. The goals of these regulatory system are:

- To provide members of the public with an appropriate level of protection against harmful effects of ionizing radiation.
- To ensure a reasonable degree of radiological and nuclear safety for nuclear activities performed in Argentina.
- To ensure that nuclear activities are not diverted for unauthorized purposes and are performed in accordance with international agreements to which the Nation is signatory.
- To establish criteria and standards in order to prevent deliberate actions from being committed which may either have severe radiological consequences or lead to the unauthorized removal of nuclear materials or other materials or equipment of nuclear interest.

The effective direction and management of the Nuclear Regulatory Authority is carried out by the Boards of Directors. The Boards of Directors is composed of six members appointed by the Executive, two of which shall be nominated respectively by the Senate and the House of Representatives. The term of office of each Director shall be six years, with one third of them being chosen every second year. Technical and professional qualifications in the specific field are selection criteria for the Director's office.

The ARN organizational structure has been approved by a Board resolution in accordance with the provisions of Act 24,804. The relevant organization chart is shown in Chapter 1 of the Main Report (The Main Report is only available in Spanish).

5.1.1.1. The Argentine Regulatory System

In its capacity as the national authority on radiological and nuclear safety, non-proliferation assurances and physical protection issues, the ARN grants authorizations, licenses or permissions, as appropriate, in connection with practices associated with radiation sources. In addition, the ARN performs control activities to ensure that persons responsible for each practice comply with the provisions set forth in the standards and other regulatory documents. From the beginning of the regulatory activities in the country it was recognized that to efficiently play this role an appropriate scientific and technological expertise was needed to assess, based upon an independent criterion, the design, construction, operation and decommissioning of the facilities subject to control. Within this framework, the global strategy contained in the Argentine regulatory system has focused in the following basic principles:

- Adopting specifics standards on radiological and nuclear safety, safeguards and physical protection.

- Conducting regulatory inspections and audits to verify compliance with licenses and authorizations granted.
- Carrying out studies and assessments on radiological and nuclear safety, safeguards and physical protection, for the purposes of the licensing process.
- Promoting scientific and technological development regarding radiological and nuclear safety, safeguards and physical protection.
- Providing personnel training in connection with radiological and nuclear safety, safeguards and physical protection, directed at both personnel responsible for the safety of the facilities and performing regulatory activities.

5.1.1.2. Radiological and Nuclear Safety

According to the Argentine regulatory system the organization (owner or operator) dealing with the design, construction, commissioning, operation and decommissioning stages of a nuclear facility shall take full responsibility for the radiological and nuclear safety of the facility in question. No event affecting radiological and nuclear safety shall relieve said organization, referred to as Responsible Entity, from its responsibility in each stage of the project. The compliance with the regulatory standards and requirements is to be considered as a minimum requirement which does not relieve said organization from the obligation to take any action necessary to ensure the radiological and nuclear safety of the facility.

From the licensing process standpoint, facilities are divided into two groups: major and minor facilities, according to the associated radiological risk involved. For major facilities the ARN grants operating licenses while for minor facilities it grants operating authorizations. An application for a license or authorization will be accepted for examination provided that it is accompanied by an appropriate preliminary nuclear safety assessment, the depth of which shall be in accordance with the radiological risk associated with the facilities concerned.

Mayor facilities require three types of licenses: construction, operating and decommissioning licenses. Licenses shall be granted to the Responsible Entity, that is, the organization liable for the safety of such facilities. The construction license for a given facility shall be granted upon compliance with standards and requirements applicable to location, basic design and expected safety level for future operation.

In order to be issued an operating license, the Responsible Entity shall prove compliance with applicable specific conditions, standards and requirements.

As for the ARN, it performs an independent evaluation of the technical documents and detailed studies field, the reports in connection with inspections conducted during construction, the results of preliminary operation activities, etc.

It should be particularly noted that since the beginning of the construction stage the ARN evaluates the ability of the Responsible Entity to take its responsibilities. Argentina has adopted performance-based nuclear safety regulations. This requires both the Responsible Entity, as regards its proposals, and the ARN, in connection with its independent evaluation, to make a remarkable effort such that a final satisfactory result is attained. Accordingly, the interaction between the Responsible Entity and the ARN shall be carried out on a permanent basis throughout the licensing process.

The evaluations prior to issuance of a license for the operation of a major facility include matters such as quality assurance, methods of construction, provisions for inspections during operation, methods of operation, etc. In addition, if a facility has a potential for accidents which may affect members of the public, it is required that emergency plans be implemented in co-ordination with the relevant federal, provincial and local organizations.

According to the ARN requirements, the whole staff of the Responsible Entity shall be properly trained and qualified and demonstrate an aptitude in accordance with their duties in a major facility. The Responsible Entity must also apply to the ARN for individual licenses for personnel whose activities could substantially affect safety. Applicants for an individual license are nominated by the Responsible Entity and separately subjected to the independent evaluation of the ARN. Training and qualification requirements for staff members generally cover four areas: basic training, specialized training, in-job training and psycho-physical fitness. Every function within the organization chart shall be fulfilled by staff members whose background meets the relevant requirements. Such required qualifications will include, if appropriate, basic university education in accordance with the nature of the responsibility to be taken. Both the specialized and in-job training shall be duly certified. Applicants shall be examined by ad-hoc examination boards.

Two types of regulatory documents are issued for the purpose of certifying the skills of the staff concerned. The first one consists in an individual license certifying that the applicant possesses the basic and specialized training suitable to take up a certain duty in a given type of facility. This document is issued at the applicant's request and has no expire date. It is not, however, enough to certify the ability of an applicant to take up a given duty in a facility. Accordingly, to be accepted for performing a key safety-related responsibility in a given facility, the applicant needs in addition to the individual license a specific authorization, which has to be requested to the ARN by the Responsible Entity. For this purpose, the applicant shall prove a specific knowledge of the facility in question, as well as a suitable in-job training and an adequate psycho-physical fitness. This specific authorization is valid for a period that shall not exceed two years.

As indicated above, for the operation of minor facilities the organization liable for any practice involving radioactive material or ionizing radiation is required to apply for an operating authorization. For the operation of minor facilities the ARN has the authority to require that the organization liable for any practice involving material or ionizing radiation applies for an operating authorization. This document shall be issued by the ARN in favour of that organization upon assessment of the documents filed and the results of the preliminary operation-related inspections, provided that all applicable standards and prerequisites are met and qualified staff is brought in. Additionally, for the operation of a minor facility, individuals involved are required to hold a specific individual permission applicable to a given practice. In order to be granted such a permission, the applicant shall meet several requirements, namely to possess a suitable basic training, an appropriate specialized training and enough in-job training in accordance with the provisions of the relevant specific standards.

All individuals and legal entities desiring to apply to the ARN for licenses, operating authorizations, specific authorizations and individual permissions or radioactive material transport certificates shall pay a licensing or inspection fee. Furthermore, the ARN is empowered to impose sanctions and/or fines in the event of non-compliance with the radiological safety standards regarding medical and industrial applications, as well as with ionizing radiation research and teaching regulations.

5.1.1.3. Safeguards and Physical Protection

Safeguards and nuclear non-proliferation assurances are an essential aspect in the Argentine regulatory system. They are a group of requirements and procedures applicable to both the nuclear materials and other materials, equipment and information of nuclear interest, aimed at ensuring, with a reasonable degree of certainty, that such elements are not intended for an unauthorized use, and that the international agreements signed in this matter are appropriately respected.

The safeguards may be national or international in nature, with the international safeguards being divided into regional and global. National safeguards are defined by the provisions set forth in the regulatory framework adopted by each State. In the case of Argentina, the ARN has established

the guidelines of the Argentine Accountancy and Control System for nuclear materials and other materials, equipment and facilities of nuclear interest. As far as the international safeguards and non-proliferation assurances are concerned, their application proceeds in accordance with the provisions of the agreements on non-proliferation of nuclear weapons ratified by Argentina. In this case, the safeguards may be applied by regional or global international organizations and are aimed at detecting within reasonable time and a reasonable degree of certainty the diversion of "significant amounts" of nuclear materials for purposes banned by the agreements by virtue of which those safeguards are applied.

In this regard, it is worth mentioning the "Bilateral Agreement between the Argentine Republic and the Federative Republic of Brazil for the exclusively peaceful use of nuclear energy" signed in the city of Guadaiajara in 1991. By virtue of this agreement an agency was created, designated as "Brazilian-Argentine Agency for Nuclear Material Accountancy and Control" (ABACC) the essential objective of which is the implementation of the "Common System for Accountancy and Control of Nuclear Materials" aimed at ensuring that said materials are not diverted for the manufacturing of nuclear weapons or other nuclear explosive devices.

Immediately after the bilateral agreement came into force, a multilateral agreement was concluded by Argentina, Brazil, the ABACC and the International Atomic Energy Agency (IAEA) for the application of safeguards (referred to as Quadripartite Agreement). This agreement commits the IAEA to applying safeguards in both countries for nuclear materials in connection with all nuclear activities in Argentina and Brazil, based upon the "Common System for Accountancy and Control of Nuclear Materials".

The Argentine regulatory system also contemplates, with special attention focused on the national regulatory function, the physical protection against robbery, removal or unauthorized use of nuclear materials, and sabotage against nuclear facilities. In this respect, the ARN takes full responsibility for requiring the Responsible Entity to implement a complete physical protection system applicable to nuclear facilities and materials in accordance with the regulatory requirements set forth by the ARN. In particular, the "Convention on Physical Protection of Nuclear Material", regarding international transport of these materials, was opened to signature on March 3, 1980, in the IAEA's Vienna headquarters and the United Nation’s New York headquarters; Argentina adopted this Convention under Act 23,620 and then ratified it.

5.1.1.4. Transport of Radioactive Material

The transport of nuclear material within Argentina shall be carried out in accordance with the provisions of the IAEA’s "Regulations for the Safe Transport of Radioactive Material" which 1985 edition (amended in 1990) came into force on 11 December 1993.

All international, regional and national organizations responsible for regulation of land, air, river and sea transport of hazardous materials have endorsed the safety criteria contained in regulation AR 10.16.1 related to "Radioactive Material Transport", literally in accordance with the aforesaid IAEA Regulations. This regulation provides persons, goods and environment with a suitable safety level during normal transport of radioactive material, as well as in the event of any accident. In order to protect workers and members of the public under normal transport conditions, this regulation sets forth prerequisites which essentially limit the dose rate in the environment of the packages to be transported and the non-fixed contamination in their external surface.

5.1.2. Institutional Relations

Within the context of its regulatory function, the ARN maintains a close and varied interaction with domestic and foreign, governmental and non-governmental organizations, as well as with international agencies. Such an interaction has the following objectives:

- To facilitate the exchange of experiences and information and the participation in developing international recommendations to address issues related to radiological and nuclear safety, nuclear non-proliferation assurances and physical protection;
- To establish and develop technical co-operation agreements;
- To promote co-operation in order to improve effectiveness and efficiency of the international safeguards system through the participation of experts and the development of specific techniques in the country.

Furthermore, the ARN is actively involved in negotiating international instruments in connection with the nuclear regulatory function and also in their subsequent implementation. In addition, the ARN contributes to the definition of Argentine regulatory policies upheld in different international forums.

The negotiation of national and international agreements has always been one of the most important tasks within the framework of the institutional relations. The ARN maintains currently valid agreements with national and foreign universities, public hospitals, the Federal Police and the Coast Guard, as well as with American, Canadian, Spanish and Swiss regulatory authorities, among other countries. During 1998, international agreements were concluded with Germany's “Gesellschaft für Anlagen und Reaktorsicherkeit (GRS) mbH” and France’s “Institut de Protection et de Sûreté Nucléaire” (IPSN). In the national sphere, agreements have been signed with the Argentine Border Guard, the University of Buenos Aires' Faculty of Engineering and “Otto Krause” Technical Education School Nº 1.

The ARN attaches great importance to the link with the International Atomic Energy Agency (IAEA). This link can be defined as having three key principles:

- Attending the regular meetings of the so-called IAEA’s "policy-making" organism;
- Participating in meetings of high-level expert committees advising the IAEA Director-General on issues in connection with nuclear safety and safeguards, as well as in activities related to negotiation or implementation of international agreements significant for nuclear safety; and
- Contributing experts for taking part in technical assistance missions in various countries, preparing safety-related publications and training foreign trainees.

The ARN participates in the National Commission for the Control of Sensitive and War Material Exports to provide advice in cases related to nuclear exports. During 1 998, it prepared and issued judgements on the export applications filed, then granting the relevant export authorizations.

The Comprehensive Nuclear Test Ban Treaty (CTBT) adopted by the United Nations General Assemb1y in September 1996, is a matter of permanent work for different sectors in the ARN. In fact, with the purpose of verifying compliance with the essential obligation set forth in the Treaty, an International Surveillance System was established envisaging the intensive use of detection techniques. In the case of radionuclide and infrasound technique, the ARN is the responsible organization.

5.1.3. Regulatory Inspections

In Argentina, there are two nuclear power plants in operation, one under construction, six research and radioisotope production reactors, 24 major radioactive facilities and more than 1 500 facilities (for medical, industrial, research and teaching purposes) which utilize radioactive materials or sources and radiation-generating systems. Those facilities are devoted to various purposes such as electric power generation, basic and applied research, or the use of ionizing radiation in the field of

medicine and industry. Such various facilities are located all around the country and their complexity varies in a very wide range.

The ARN's regulatory functions aimed at controlling those facilities include analyzing design and operation-related documents, permanently assessing safety during operation, and verifying by means of regulatory inspections and audits the compliance with the provisions of the license concerned. The analysis and assessment functions are discharged by staff members skilled in the field of radiological and nuclear safety who use modern information technology for data management and are acquainted with the use of calculation codes, in order to validate documents supplied by the licensee based upon their own independent criteria.

The ARN's regulatory control action aimed at controlling the facilities also includes a programme of routine and non-scheduled inspections for the follow-up of activities related to safety and verification of compliance with the provisions of the relevant license. Facilities subject to regulatory control are listed in Table 8.

TABLE 8. FACILITIES SUBJECT TO REGULATORY CONTROL

Facilities	Number
Nuclear power plants (one under construction)	3
Research reactors and critical assemblies	6
Particle accelerators	4
Radioisotope or radioactive sources production plants	5
High-dose irradiation plants	2
Fuel cycle facilities	13
CNEA's waste management area	1
CNEA's minor facilities	26
Teletherapy centres	108
Brachytherapy centres	81
Nuclear medicine and radioimmunoassay centres	605
Gammagraphy	48
Nuclear gauges	266
Research and teaching centres and other applications	433

Source: Autoridad Regulatoria Nuclear.

Routine inspections are aimed at a) supervising the facility's regular activities, b) process monitoring and c) verification of compliance with the provisions of mandatory documents. As far as nuclear power plants are concerned, inspections are basically conducted by ARN's resident inspectors relying on the technical support provided by the ARN analysis and assessment groups or by groups working for the ARN under agreements or contracts.

Non-scheduled inspections are carried out either in the event of specific circumstances or when the need arises to increase the inspection effort. In these cases inspections are conducted by experts in a variety of disciplines, either from the ARN or other ARN-related institutions.

5.1.4. Occupational Surveillance

Basic criteria supporting radiological safety establish that: all practices involving the use of ionizing radiation shall be adequately justified, radiological protection shall be optimized, dose limits and constraints shall be complied with, and the likelihood of accidents (potential exposure) shall be kept at a minimum level.

The ARN performs assessment of information related to occupational exposure in the most important major and minor facilities. This work allows the ARN to define behaviour indicators for

radiological protection systems, to identify tendencies, to verify compliance with dose limits, and to compare different practices to each other.

5.1.5. Environmental Surveillance

The ARN performs environmental monitoring in the surroundings of the different nuclear facilities in a manner fully independent from monitoring carried out by the facilities themselves. In 1998, such a monitoring was carried out in Atucha I and Embalse nuclear power plants, Ezeiza Atomic Centre, San Rafael uranium ore mining plant, Cordoba uranium ore milling plant and the following decommissioned plants for mining and milling uranium ores: Malargüe, Pichiñán, Los Gigantes, La Estela, Los Colorados and Tonco.

5.1.6. Scientific and Technological Activities

The ARN carries out various kinds of scientific and technological functions to support its regulatory activity. For this purpose, the ARN relies on appropriate laboratories equipment and skilled personnel whose tasks consist in implementing and validating the corresponding methodologies within different working sectors.

The ARN possesses various laboratories within the Ezeiza Atomic Center, located in Ezeiza, province of Buenos Aires. These laboratories cover an area of 2000 m^2 and are devoted to physical dosimetry, radiopathology and biological dosimetry, radiochemical analyses, uranium particle detection, iodine 129 detection, radon measurement, environmental sample processing, and internal contamination assessment. Those facilities also include measurement laboratories (whole body counter, gamma and alpha spectrometry laboratory, gross alpha and beta activity measurement laboratory, and low background activity counter), and electronical support laboratories.

In 1998, supporting activities related to regulatory and development control functions were performed within the following specific areas:

- Physical dosimetry;
- Internal contamination;
- Biological dosimetry;
- Programme of medical assistance on radiological protection;
- Diagnostic and prognostic indicators applicable to accidental overexposure;
- Prenatal irradiation effects on developing central nervous system;
- Nuclear tests detection;
- Use of thermohydraulic codes for assessment of nuclear power plant safety;
- Electronic developments applied to regulatory activities;
- Computer model development for assessment of nuclear power plant safety;
- Study on core material behaviour in nuclear power plants during severe accidents;
- Development of techniques aimed at detecting undeclared nuclear activities.

Within the framework of the Comprehensive Nuclear Test Ban Treaty, a gamma spectrometry laboratory was in operation and served as a primary laboratory within the international network set forth in this Treaty.

5.1.7. Radiological Emergencies

The ARN evaluates the radiological and nuclear emergency procedures in case of accidents developed by facilities under control. Which actions are to be taken, who will take them and how they will be taken are the highlights of the emergency plan on which intervention is based. This plan contains all procedures to be followed in the event of an accident condition. For major facilities, the

licensee shall take full responsibility for implementing an emergency plan; for minor practices, emergency procedures are required to contain accidents and minimize their consequences.

In accordance with its duties, the ARN will take steps in a subsequent stage to minimize injury and damage, which may result from any incident, accident or radiological emergency, through its own Radiological Emergency Intervention System (SIER). The SIER is intended to:

- Advise both users and public authorities involved in radiological emergency control.
- To play a part as an intervening organization in the event of emergencies which may arise in minor facilities and practices where accidents can not be provided with adequate containment or affect members of the public, as well as in the event of radiological emergencies in public areas.

The SIER consists of two groups: the Primary Intervention Group and the Support Group. The Primary Intervention Group is on duty in weekly shifts all year round. The Support Group is made up of the rest of the ARN technical staff members who do not work in shifts but may be summoned when necessary. The SIER has the specific equipment and necessary logistic infrastructure to ensure a prompt and efficient intervention in the event of a nuclear accident or a radiological emergency. It works in close relationship and has reached co-operation agreements with other organizations such as federal and provincial Civil Defence Services, the Federal Police, the Coast Guard, the Armed Forces and the Internal Security Department.

5.1.8. Training and Technical Information

The ARN undertakes as a permanent activity the training of specialists in radiological and nuclear safety, safeguards and physical protection, by means of training courses and the participation in national and international congresses and expert meetings.

The training activity is carried out through the Training Department in charge of defining, organizing and co-ordinating courses, workshops and updating seminars.

The Postgraduate Course on Radiological Safety and Nuclear Safety organized in accordance with the provisions of an agreement with the University of Buenos Aires and the Ministry of Health and Social Welfare under the auspices of the IAEA, has been uninterruptedly given on a yearly basis since its inauguration in 1 980. Since then, a total number of 539 professionals have taken a degree, roughly a half of them being foreigners.

5.1.9. Human and Economic Resources

The organizational structure of the ARN is made up of 215 established posts and 6 posts pertaining to the Board of Directors.

Out of the total regular stall, 67% are university-degree holders. Out of the total regular stall, 85% is devoted to specialized scientific and technical functions within the ARN's sphere of activities, while the remaining 15% is devoted to support and clerical jobs.

The total budget allocation approved for the year 1998 for the ARN was $ 18,622,065, funded by the Treasury Department contributions, Specific Resources and Specific-Allocation Resources.

Personnel expenditures accounted for 64.6% of the total current expenditure, including contributions from the employer, and social security allowances. Consumption expenditure and non-personnel services accounted for 16.9% of the total current expenditure.

5.2. Main National Laws and Regulations

Several Executive orders have identified CNEA as the Regulatory Authority on radiological and nuclear safety, including the protection of the workers, public and the environment against the effects of ionizing radiation, and the safety of the installations. During the first years of nuclear activities in Argentina, there was no clear separation of the Regulatory Authority from the main operational safety group, since almost all NPPs operated in CNEA installations. In 1958, the regulations covered the whole country. At the same time research supporting regulatory framework was initiated to establish criteria to limit discharges of radioactive material to the environment and food pathways. The regulatory setting in that time included the licensing activities, the evaluation of design and the operation of nuclear power stations, the analysis of accidents and regulatory inspections.

At present, the regulatory system covers all CNEA nuclear activities and any or the third parties in the country, as well as all uses of radionuclides and radiation, except the use of X-rays, which are controlled by the Ministry of Health. The standards for nuclear power stations established by the Regulatory Authority are the following:

AR.3.1.1. Occupational exposure (design).
AR.3.1.2. Limits to radioactive effluents (design).
AR.3.1.3. Radiological criteria related to accidents and risk assessment analyses.
AR.3.2.1. General safety criteria applied to design.
AR.3.3.1. Reactor core.
AR.3.3.2. Heat removal System.
AR.3.3.3. Primary pressure system.
AR.3.3.4. Behaviour of fuel in the reactor.
AR.3.4.1. Protection of the core and safety instrumentation.
AR.3.4.2. Shutdown systems.
AR.3.4.3. Containment system.
AR.3.5.1. Essential electric supply.
AR.3.6.1. Quality assurance.
AR.3.7.1. Documentation for the Regulatory Authority prior to the commercial operation.
AR.3.8.1. “Non-nuclear” commissioning
AR.3.8.2. “Nuclear” Commissioning.
AR.3.9.2. Communication of relevant events.
AR.3.10.1. Protection from earthquakes.

In Argentina, the Operating Organization is the Nuclear Power Directorate of CNEA, which is responsible for the radiological and nuclear safety in design, construction, commissioning, operation and decommissioning of nuclear power plants. It is responsible for making reasonable efforts toward the safety of the nuclear power stations with enforcing the minimum compliance of the standards, stipulations outlined in the Licence, and all the requirements established by the Authority.

The Operating Organization designates a “Person with Primary Responsibility” to each nuclear power station in operation who is directly responsible for the radiological and nuclear safety of the installation. The directors of Atucha I and Embalse nuclear power stations have the primary responsibility for these installations. The Operating Organization must give all the necessary support to the “Person with Primary Responsibility” and must carry out an adequate supervision in order to insure the correct and safe operation of the plant. The “Person with Primary Responsibility” must make a reasonable effort toward the safety of the plant in order to meet the minimum conditions and the specifications of the License.

5.3. International, Multilateral and Bilateral Agreements

AGREEMENTS WITH THE IAEA

• NPT and/or Tlatelolco related agreement: Sui generis full-scope safeguards agreement (Brazil, Argentina, ABACC, IAEA)	Signed:	13 December 1991
Argentine Senate	Approved:	5 August 1992
Brazilian Parliament	Approved:	19 February 1994
The Quadripartite Safeguards Agreement; INFCIRC/435.	Entry into force:	4 March 1994
• Additional protocol	Not Signed	
• Improved procedures for designation of safeguards inspectors	Prefers to apply the present procedures but is prepared to accept all inspectors approved by the Board with exceptions. Letter:	19 June 1990
• Project related safeguards agreement		
INFCIRC No: 143	Entry into force:	13 March 1970
62		2 December 1964
• Bilateral safeguards agreement Argentina/USA		
INFCIRC No: 130	Entry into force:	25 July 1969
• Unilateral safeguards submission		
INFCIRC No: 168	Entry into force:	3 October 1972
202		23 October 1973
224		6 December 1974
250		22 July 1977
25		22 July 1977
294		15 July 1981
296		14 October 1981
297		14 October 1981
303		8 July 1982
• Supplementary agreement on provision of technical assistance by the IAEA	Entry into force:	27 February 1991
• ARCAL	Entry into force:	September 1984
new ARCAL agreement	Signature:	4 December 1998
• Agreement on privileges and immunities	Entry into force:	15 October 1963

OTHER RELEVANT INTERNATIONAL TREATIES etc.

• NPT	Entry into force:	10 February 1995
• Tlatelolco	Entry into force:	18 January 1994

• Convention on physical protection of nuclear material	Entry into force:	6 May 1989
• Convention on early notification of a nuclear accident	Entry into force:	17 February 1990
• Convention on assistance in the case of a nuclear accident or radiological emergency	Entry into force:	17 February 1990
• Vienna convention on civil liability for nuclear damage	Entry into force of:	12 November 1977
• Joint protocol	Signature:	21 September 1988
• Protocol to amend the Vienna convention on civil liability for nuclear damage	Ratification:	14 November 2000
• Convention on supplementary compensation for nuclear damage	14 November 2000	14 November 2000
• Convention on nuclear safety	Entry into force:	16 July 1997
• Joint convention on the safety of spent fuel management and on the safety of radioactive waste management	Entry into force:	18 June 2001
• ZANGGER Committee	Member	
• Nuclear Export Guidelines (INFCIRC/254)	Adopted	
• Acceptance of NUSS Codes	Summary: National authorities can use codes as suggested, to complement their rules and regulations. Letter of:	 18 November 1988
• Nuclear Suppliers Group	Member	

REFERENCES

[1] Country Profiles 1995-96.

[2] Nuclear Regulatory Authority, Annual Report Synthesis, 1998.

[3] Data & Statistics/The World Bank.

[4] IAEA Energy and Economic Data Base (EEDB).

[5] IAEA Power Reactor Information System (PRIS).

Appendix

DIRECTORY OF THE MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL ATOMIC ENERGY AUTHORITY

Autoridad Regulatoria Nuclear (ARN)
(Nuclear Regulatory Authority, responsible
for controlling utilization of nuclear energy
and granting construction and operating licenses)
Avenida del Libertador 8250
Buenos Aires, Argentina

Tel: (5411)47041248/ 7041218
Fax: (5411)47031151 (1429)
http://www.arn.gov.ar/

Comisión Nacional de Energía Atómica
(CNEA)

Tel: (5411)47041201
Fax: (5411)47041170
http://www.cnea.gov.ar/

Avenida del Libertador 8250
(1429) Buenos Aires, Argentina

Telex: 23458 CNEA or 25392 PREAT AR
Cable: PRESIATOM BAIRES

Secretariat for Science and Technology
(within the Ministry of Culture and Education): http://www.secyt.gov.ar/

Brazilian-Argentine Agency for Accounting and
Control of Nuclear Materials (ABACC): http://www.abacc.org/

MAIN POWER UTILITIES

Nucleoeléctrica Argentina S.A.(NASA)
(Plantas Atucha I, Atucha II y Embalse)
Arribeños 3619-1429
Buenos Aires, Argentina

Tel: (5411) 47014651
Fax: (5411) 47010407

Central Nuclear Atucha — http://www.utenet.com.ar/Atucha/

NUCLEAR RESEARCH INSTITUTE

Centro Atomico Bariloche and Instituto Balseiro — http://www.cab.cnea.gov.ar/

OTHER ORGANISATIONS

High Energy Research Institutes
Pierre Auger Project: http://www.tandar.cnea.gov.ar/~auger/auger_argentina.html
Universities
Universidad Nacional de Cuyo: http://www.uncu.edu.ar/rectorado/default.html