Chapter 3 Electric Power

3.1 Situation of Electric Power in Argentina

The business structure of Argentina's power industry was liberalized in 1992. The wholesale electricity market was created ("Mercado Electroico Mayorista, MEM"), and two new organizations were founded: the regulatory agency "the Ente Nacional Regulador de la Electricidad - Argentina (ENRE)", and CAMMESA (Administrative Company of Electric Wholesale Market) as an executive company for administration and operation of power industry.

CAMMESA is unique in its activities. It has 20% stock holders from each of the National Government (Secretariat of Energy), Argentine Association of Electric Power Generators, Argentine Association of Distributors of Electric Power, Argentine Association of Transporters of Electric Power and Argentine Association of Major Electricity User. CAMMESA has the following roles.

- Determine the supplier of electricity to the Argentine National Grid System, by maximizing the safety of the system and the quality of supply and minimizing wholesale energy prices on the spot market.
- Project power requirements and plan an optimization of applications established on a periodic basis by the Secretariat of Energy.
- Supervise periodically the operation of the market and administrate technically the dispatch of the contracts agreed in the market.

Total power consumption in Argentina was 68,854GWh in 1999. The largest consumption arises from the industrial use. The residential and the commercial uses follow in sequence. These top three account for about 86～88% of all power consumption. The power consumption had increased 1.24 times in the four years from 1995 to 1999 and the mean annual growth rate was 5.6%. The power generating capacity had increased 1.22 times in the 4 years from 1995 to 1999 and the mean annual growth rate was 5.2%.

Total power generating capacity was 20,501MW in 1999. The thermal power generating capacity reached 10,389MW and accounted for 50.7% of all power generating capacity. As for the breakdown, the steam turbines account for 22.3% of all power generation. The remaining capacity came from gas-turbines 14.8%, combined cycles 12.0% and diesels 1.6%.

Total electricity generation in 1999 was 74,640GWh. Of the total electricity generated,

69,286GWh are provided by domestic power generation and 5,354GWh are by imported power. The dependence of imported power mainly from Paraguay is about 7%.

According to the "PROSPECTIVA 2000", the prospect of the supply and demand of electric power in the future, the projects of new construction and expansion of existing plants by 2010 are expected as shown in Table 3.1.

Table 3.1 Projected Power Plants

Supply power plant	Type	Year	Mércado (GBA)	Pampe ana	Nor-oeste	Litoral/ Noreste	Coma-hue	Centro	Cuya-na	Patagó nico
Dock Sud	CC	2001	780							
San Nicolas	CC	2001				845				
Termoandes	CC	2001			630					
Los Perales	CC	2001								78
Electropatagonia	CC	2001								68
Conversion San M.De Tucuman	CC	2002			270					
CTPPN	TG	2002			123					
Independencia	CC	2003			242					
Other hydraulic power plants	HID	2003						320		
Bermejo	HID	2005			283					
Yacyreta（water elevation: 83m）	HID	2006				1,200				
Brazo Ana Cua	HID	2006				250				
Atucha	NUC	2007	745							
Proposed Combined Cycle	CC	2003		800				240	400	78
Proposed Combined Cycle	CC	2004	800		400		480			
Proposed Combined Cycle	CC	2005			460		650			
Proposed Combined Cycle	CC	2006	800							
Proposed Combined Cycle	CC	2007			400					
Proposed Combined Cycle	CC	2008					400			
Proposed Combined Cycle	CC	2010	800				400			
Total by region			3925	800	2808	2295	1930	560	400	224

CC: combined cycle, TG: gas turbine, HID: hydraulic, NUC: nuclear

3.2 Summary of Target Power Plants

(1) Specification of Power Plant Facilities

Summary of the facilities of the targeted power plants is tabulated in Table 3.2. There is no other project of new construction or extension regarding power plants in the study area.

Table 3.2 Specification of Power Plants in Model Areas

Power Plant	Unit	Output (MW)	Plant type	Fuel type	Stack m		Environmental Measures for Existing Facilities	Start up year
					Height	Diameter		
Nuevo Puerto	4	60	TV	G、FO	47	2.5		1952
	5	110	TV	G、FO	47	3.0		1965
	6	250	TV	G、FO	52	4.67		1969
	TG11	786	CC	G、GO	40	6.4	Low NOx Combustor Water Injection	2000
	TG12				40	6.4		
Puerto Nuevo	7	145	TV	G、FO	80	5.66	Low NOx Burner	1961
	8	194	TV	G、FO				1963
	9	250	TV	G、FO	59	4.3		1970
Central Costanera	1	120	TV	G、FO	86.7	6.42		1962
	2	120	TV	G、FO				1963
	3	120	TV	G、FO	86.7	6.42		1963
	4	120	TV	G、FO				1963
Central Buenos Aires	5	340	CC	G、GO	50	7.4	Low NOx Combustor	1995
Central Costanera	6	350	TV	G、FO	97.5	4.8		1976
	7	310	TV	G、FO	154.4	5.4		1984
	8	851.2	CC	G、GO				1998
	9				50	7.4	Low NOx Combustor	
	10				50	7.4	Low NOx Combustor	
San Nicolas	1	75	TV	C、G、FO	90	6.3	Electrostatic Precipitators	1956
	2	75	TV	C、G、FO			Electrostatic Precipitators	1956
	3	75	TV	G、FO	90	6.3		1956
	4	75	TV	G、FO				1956
	5	350	TV	C、G、FO	123.7	8.1	Electrostatic Precipitators	1983
AES Parana	7	830	CC	G、GO				
	TG				65	6.8	Low NOx Combustor	2001
	TG				65	6.8	Low NOx Combustor	
Lujan de Cuyo	11	60	TV	G、FO	50	4.1		1971
	12	60	TV	G、FO				1971
	15,25	294	CC	G	50	7.0	Low NOx Combustor	1983
	14	70	CC	G、GO				1980
	21				19.8	5.3		
	22				19.8	5.3		
	23	22	Co-Ge	G、GO	40	3.0		1989
	24	22			40	3.0		

TV: Steam Turbine, CC: Combined Cycle, Co-Ge: Co-generation facilities

G: Natural Gas, FO: Fuel Oil, GO: Gas Oil, C: Coal

(2) Current Situation of Environmental Measures

Almost all combined cycle systems employed dry low-NOx Combustors as in the table above as the air pollution control measures. Also in the combined cycle, water injection (water/fuel = 1/1) is used to reduce the NOx amount in flue gas, when gas oil is used for fuel. At the San Nicolas power plant, Electrostatic Precipitators (EP) are installed for each of Units 1, 2 and 5 as environmental measures.

Where fuels other than natural gas are burnt, stack gas continuous measuring analyzers are equipped for NOx, SO_2, Opacity, and O_2. Also some of the combined cycles have equipped with NOx, Opacity, and O_2 analyzers, although a law does not regulate the measurement.

(3) Operations of Power Generation Facilities

The daily power generating capacity of Argentina has the general pattern of decreasing before midnight and early in the morning (22:00pm to 6:00am) and increasing in the daytime (with one a decline from 12:00 to 14:00). Seasonally, winter needs more generation.

The mean oxygen concentrations in flue gases were in the range of 7.3 to 11.9% measured by the continuous measuring instrument in 2000. The JICA Team had a verbal report of a plant engineer that the high values were caused by leaks through the seals of the regenerative air heaters.

The thermal efficiencies of the TV types were as low as 33 to 34% at Unit 5 of the Nuevo Puerto, Units 7 and 8 of the Puerto Nuevo and Units 1 to 4 of the Central Costanera, although the efficiencies of other units in the Buenos Aires model area were in the range of 37.5 to 39.2%. These low efficiencies of below 34% may arise from inadequate combustion control. The lower annual utilization factor, less operational periods at high rated loads and longer low efficiency operation by lower loads may contribute to the lower efficiency.

The thermal efficiencies of the steam turbine types at the San Nicolas and Lujan de Cuyo plants were very low at 26%. Even at Unit 5 of the San Nicolas, whose annual utilization factor was relatively high, the thermal efficiency was at 33%.

The thermal efficiencies of all combined cycle systems were more than 50%, although the value may not be accurate because the value of total heat input was estimated by calculation.

Overall, the utilization factor of the targeted power generation facilities is low for the steam turbines and high for the combined cycles.

The utilization factors of the steam turbine types were low in the range of 30 to 60%, with the majority at lower side. The only exception was Unit 9 of the Puerto Nuevo that showed 67.9% of the utilization factor.

In comparison, the utilization factors of the combined cycles were more than 50% because of its good thermal efficiency, except 36.7% at Unit 14, 21 and 22 of the Lujan de Cuyo plant. Highest utilization factors were more than 80% at Unit 15, 24, and 25 of the Lujan de Cuyo plant. The Unit 24 is co-generation facility.

3.3 Conforming Status to the Emission Standards

Regarding SO_2 emission, all power generation facilities are conforming to the SO_2 emission standard, except at Unit 5 of the San Nicolas plant where SO_2 concentration of 2,017mg/m^3N was recorded in December of 2000, which exceeded the emission standard of 1,700 mg/m^3N. The JICA Team received a verbal report of an engineer in charge that the high value was resulted by a mal-function of the instrument.

The facilities governed by the NOx emission standard are Units TG11 and TG12 of the Nuevo Puerto plant, Units 8 and 9 of the Central Costanera plant, Unit 5 of the Central Buenos Aires plant, AES Parana (Unit 7) of the San Nicolas plant and Unit 25 of the Lujan de Cuyo plant, which are all combined cycles. The highest value of the NOx concentration measured at these facilities was 132mg/m^3N at the Lujan de Cuyo plant and this fully conforms to the emission standard of 200mg/m^3N.

As for PM emission, almost all Opacities were less than 15% and clearly below the 20% emission standard. Higher levels (less than 40%) of opacity are currently considered to be acceptable in the resolution (#36) during boiler blowing, start-up and change of fuel type. However, at the San Nicolas plants, the maximum values of Opacity were 58% at Units 1 and 2 (in August), 46% at Units 3 and 4 and 48% at Unit 5.

3.4 Control Measures to Prevent Air Pollution at Thermal Plants

The JICA team conferred with the counterparts taking into account of various conditions in regard to the measures to prevent air pollution at targeted thermal power plants. Accordingly, the

JICA Team decided not to propose any new facility measures for the existing facility (i.e. installation of desulfurization and denitrification facilities, etc.) in order to reduce the emission of pollutants, based on the following reasons.

- According to the result of air environmental measurement and model simulation, the environmental impact of the air pollutants emitted from each targeted power plant on the surrounding environment is extremely small.
- In recent years, natural gas has been used as the principal fuel at the existing facility, and it is expected that the use of natural gas will continue to increase in the future.
- The fuel oil is now used for steam power generation facilities to make up for the shortage of natural gas, when the supply of natural gas cannot overtake the demand. It is a rare case when a facility applies only fuel oil combustion.
- At the San Nicolas plant, as contractual circumstances oblige them to use the coal as fuel, the concentration of pollutants in flue gas is high when compared with the other plants and in some cases exceeds the emission standard. However the utilization factors of the facilities except Unit 5 are distinctly low. Regarding the PM emission, it is possible to improve the collection efficiency by means of remedies and maintenance of EP.
- It is very uneconomical to install new control facilities (i.e. desulfurization and denitrification facilities, etc.) for the existing steam power generation units, which have already been used for over 20 years and now are operated with low utilization factor.
- Most of the newly planned facilities are combined cycles and are obligated to install low-NOx Combustors.
- Under the present situation where no emission standard for other stationary emission sources has been provided, it is not reasonable to reinforce the pollutants reduction measures for thermal power plants, especially for existing facilities.

Technical and economical descriptions of desulfurization and denitrification facilities are given in S3-A2 of the Support Volume for reference.