Chapter S8 PREDICTION of EMISSION SOURCE GROWTH

8.1 Introduction

The main objective of this Study is to establish emission factors of thermal power plants for their installation and extension in the future. As the thermal power plants are not the only air pollution sources, all other sources should widely be evaluated for their emissions in the future in order to establish emission factors of the power plants.

Future prediction can usually be divided into short, middle and long terms by the distances of time to the target year. Generally, 5, 10 and 20 are respectively years to be employed for the future prediction in air pollution studies. Table 8.1.1 summarizes examples of expected prediction bases of air pollutant emission sources in future. The bases will be used individually or in combination for the prediction.

The short-term prediction requires accurate information as the bases. For the medium and long-term prediction, needed are technological directions, such as fuel conversion, process innovation, and relocation and disuse of the sources, besides of socio-economical ones.

The year of 2020 is decided to be the target year for the prediction in this Study, because numerous years are required to plan, design, and construct thermal power plants, new or extended. For such long-term prediction, however, the JICA Team faced with difficulties to obtain future plans of locals and officials. It obtained the old National Development Plan until 1995 (#49), Electricity Demands and Supplies until 2010 (#144, 255), the predicted population until 2020 (#117), etc. Therefore, the

JICA Team has decided to employ the macro-economical approach with the various known indexes for the emission prediction.

Table 8.1.1 Expected Prediction Bases of Future Air Emission Sources

Term	Emission Sources	Prediction Bases
Short	Common Stationary	Trends of Local GDP
	Large Stationary	Expansion Plans of Existed Sources
		Operational Plans of Sources to be Installed
	Mobile	Trends of Local GDP
		Trends of Local Population Growth
		Local Automobile Registration Trends
Medium	Common Stationary	Trends of Local GDP
		Trends of Local Production in Each Industry
		Officially Predicted Local GDP and Population
		Local Development Plan
	Large Stationary	Expansion Plans of Existed Sources
		Site Selection Study Plan of Sources to be Installed
		Local Development Plan
	Mobile	Trends of and Officially Predicted Local GDP
		Trends of and Officially Predicted Local Population Growth
		Trends of and Officially Predicted Number of Locally Registered Automobiles
Long	Common Stationary	Officially Predicted Local GDP and Population
	Large Stationary	Local Development Strategies and Policies
		Relative Features of Local Economy
		Basis of Local Economy
		Direction of Local Productions
	Mobile	Officially Predicted Local GDP and Population
		Official Predicted Number of Locally Registered Automobiles

In general, the Argentine economy seems to be currently in the stage of a growth adjustment after the healthy growth from 1991, by the facts of the GDP dropping since 1999 and the governmental announcement of the emergency budget reduction plan in July 2001. The JICA Team assumes that the economy will go up and down from now on and keep steady uprising in the long time span.

This Chapter will predict electric demand in 2020 at first, subsequently review the socio-economical trends found in the course of the Study, and finally try to predict the growths of other stationary emission sources than the power plants. Mobile sources are predicted in Chapter S6 and 7.

This Chapter does not estimate amounts of emissions from the sources.

8.2 Prediction of Power Plant Growth

8.2.1 National Growth

The Secretary of Energy and Minerals has published its prediction of electric power demands and supplies in Argentina every year (#144, 255). The JICA Team will follow to the scenario given in the publications of the Secretary to predict the demands in 2020, without considering the limit of fuel supply, etc. Table 8.2.1 gives annual trends of electric power demands predicted by the Secretary.

Table 8.2.1 Annual Trends of Electric Power Demands (#255)

Year	Demands (GWh)	Annual Average Growth	Annual Average Growth
1990	36,526	6.32% for 10 years	5.9% for 20 years
2000	67,463		
2000	67,463	5.48% for 10 years	
2010	115,001		

The annual average growth rate will be 5.48% from now on or 5.9% for 20 years until 2010. The estimated growth from 2000 to 2010 is 47,538GWh, for that the Secretary has planned 12,942 MW of additional power plants to the current generation system (#255). The operational factor [100 x (generated GWh in a year) / (365 x 24 x GW of installed rated capacity)] of these additional plants will be 42%, if the already existed plants keep operation by 2010 with the same in 2000. This number seems reasonable, because 78.4% of the additional plants are thermal ones and within them 98.8% are combined cycles. The operation factor in 1998 was 37.9% including hydraulic, thermal and nuclear power plants.

By assuming 5.7% (an average of 5.48 and 5.9) of the annual average growth rate from 2010 to 2020, the demand will be 200,194GWh in 2020 that is in addition of 85,193GWh to the one in 2010. If the operational factor is 42%, installation of 23,155 MW is required from 2010 to 2020. By assuming that 78.4% of these plants are thermals as currently planned by 2010, total of 18,154 MW thermal plants is required in Argentina by 2020 in addition to the currently planned capacity by 2010. The total thermal power plants will be 40,481 MW in 2020.

From the viewpoint of the demand per capita, the demand is 2.77 MWh/capita of the whole nation (41,473,702 of the projected population, #68) in 2010 which is almost equal to the consumption in the Metropolitan Buenos Aires in 2000 (See Table 2.6.2 in the Main Section). Also the national demand will be 4.41 MWh per capita (45,347,004 of the projected population, #68) in 2020.

8.2.2 Growths in Model Areas

Table 8.2.2 summarizes total rated capacities of thermal power plants existed in 2000 (#234), planned to be installed by 2010 (#255), and resulted from the assumption given in the Article 8.2.1 above to be installed until 2020 using the same distribution percentages regionally.

The codes in Table 8.2.2 are for regions used in the electric sector. The regions where the model areas are located are **GBA** for the total of the City of BA and 19 districts surrounding the City, **BAS** for the rest of the Province of BA, and **CUY** for the total of the Provinces of Mendoza and San Juan.

Table 8.2.2 Rated Capacities of Thermal Power Plants in Regions

		GBA	LIT/NEA	COM	**BAS**	CEN	**CUY**	NOA	PAT	Total
2000	MW	5,223	649	1,354	1,869	661	556	1,510	361	12,183
(#234)	%	42.9	5.3	11.1	15.3	5.4	4.6	12.4	3.0	100.0
2010	MW	8,403	1,494	3,284	2,669	901	956	4,035	585	22,327
(#255)	%	37.6	6.7	14.7	12.0	4.0	4.3	18.1	2.6	100.0
2020	MW	15,220	2,712	5,951	4,858	1,619	1,741	7,327	1,053	40,481

The **City of Buenos Aires** model area has 5,078 MW of thermal power plants installed in 2001. The additional plants in the GBA region until 2010 are planned outside of the model area (#255), probably because of concerns on pollution and limited land spaces. If 50 years can be assumed to be the thermal power plant's life, the new combined cycle plants may replace the aged 8 plants equal to 1,239 MW by 2020 in this model area. Although detailed layout study is needed, the new plants may be possible to have 3200 MW rated capacity in total. This means additionally around 2000 MW increment to the current capacity of combined cycles until 2020 in this model area. Traditionally used fuel oil in winter at the power plants will be converted to natural gas after completion of a sufficient gas supply system to the area.

The **San Nicolas** model area is classified in the LIT (Provinces of Entre Rios and Santa Fe) region by the Electric Sector (#144, 255). This model area has 1,480 MW of thermal power plants installed in 2001. There is no additional thermal plant to be installed in the area by 2010. According to the calculation in Table 8.2.2, needed by 2020 is around 82 % additional capacity, or 1300 MW more. There are four aged thermal plants, each 75 MW, which may be replaced by combined cycle plants having total capacity of 1600 MW by 2020. If the coal fired plant of 350 MW could be terminated, more additional capacity of combined cycle plants might be installable on the plant site and the coal

yard. However, the JICA Team will not count on this termination, because it means losses of domestic coal usage and of fuel varieties in the power sector of Argentina.

The **Lujan de Cuyo** model area has total 528 MW of thermal plants currently. A 400 MW plant is planned to be installed in the Province in 2003 (#144, 255), although exact location is unknown. From the standpoint of calculation allowance, it is marginal to consider 1200 MW combined cycle plants are additionally installed in the model area by 2020.

Table 8.2.3 summarizes the additional rated capacities of thermal power plants in the three model areas in 2020.

Table 8.2.3 Rated Thermal Generation Capacities in Model Areas (Current and in 2020)

Year		City of Buenos Aires	San Nicolas	Lujan de Cuyo
2001	TV	2,149	650	164
	CC	1,976	830	364
	Total	4,125	1,480	528
2020	TV	910	350	164
	CC	5,176	2,430	1,564
	Total	6,086	2,780	1,728

Note: TV – Steam turbine, CC – Combined cycle, Unit in MW

8.3 Trends of Socio-economic Indexes

Growths of other emission sources in the model areas than power plants can be predicted in consideration of local socio-economic trends in the past and projected for the future.

Table 8.3.1 summarizes socio-economic indexes of three model areas in the past. Provincial indexes were mainly listed in place of the area-specific indexes for the San Nicolas and Lujan de Cuyo areas. The JICA Team could obtain quite a few of area-specific values for both areas that are given with parentheses [ ].

From Table 8.3.1, the model areas can be basically characterize as the Buenos Aires area to be the typical national urban center, the San Nicolas area to be the industrial city centered with steel mills, and the Lujan de Cuyo area to be the co-existence of agricultural and oil industries.

Table 8.3.1 Past Socio-economical Indexes in Three Model Areas

Indexes	Range of Years or Specific Year	Annual Average Growth % for Given Ranges of Years (Others – Refer to Indexes Column)			
		National	Buenos Aires Area	Prov. of Buenos A. [Model Area]	Prov. of Mendoza [Model Area]
Population (%)	1991	100	9.1	38.5	4.3
Population Density (people/km^2)	1991 or 2000	11.7 in 1991	14,827 in 1991	[222 in San Nicolas] [29.4 in Ramallo] both in 2000*[10)]	[16.5 in Lujan de Cuyo]*[11)] in 1991
Projected Population	1991-2000	1.42	0.30	1.35	1.45
GDP Increment	1993-1999	2.82	--	--	2.34*[2)]
Urban Un-employ. (%)	1999	18.4	14.3	--	[6.8]*[1)]
Electric Consumption*[4)]	1998-2000	4.67	4.73	4.00*[5)]	3.82*[6)]
Ditto (MWh/capita)	2000	1.94	2.8	1.79*[5)]	2.01*[6)]
Automobile Sold	1991-1999	10.93*[3)]	--	--	8.25*[2)]
Natural Gas Sold	1995-1999	15.0	--	--	10.92*[2)]
Gasoline Sold*[12)]	1997-2000	-8.23	-11.76	-8.34	-11.0
Gas Oil Sold*[12)]	1997-2000	0.08	-1.50	0.32	3.71
Fuel Oil Sold*[12)]	1997-2000	-12.73	-20.30	-7.34	-16.34
Industries*[7)] (Number)	2000	25,000	3,500	15,800	620
Annual Ave. Gas Consumed (1000 m^3/Industry)*[7)]	2000	322,000	35,400	248,000	576,000
Crude Oil Processed (%)	1999	100	--	--	[20.5]*[2)]
Crude Oil Processed	1995-1999	5.08	--	--	--
Crude Steel Produced (%)	1999	100	--	[53]*[9)]	--
Grape Production (%)	1999	100	--	--	64.5*[2)]

Note: Data source: mainly #117 other than noted
*1) Greater Mendoza*2) #131 *3) #188 *4) #144
*5) Province except Metropolitan BA *6) Provinces of Mendoza and San Juan
*7) #199, except Power Plants *8) #201, *9) Hearing by the JICA Team
*10)#273 *11) #259-1 *12)#179 & #204

For the future indexes, the JICA Team obtained two officially projected indexes: population until 2020 (#117), and electric power and natural gas demands until 2010 (#255).

8.4 Prediction of Future Stationary Emission Sources

8.4.1 Buenos Aires Model Area

As the national urban center, service sectors will lead the economic growth in this area, and the main cause of air pollution in the area is the mobile source.

Industrial stationary emission sources will have difficulty to find locations for their development in the area. If they plan to expand their production, they may have to relocate from the model area.

Industries located in the area are small in size as in Table 8.3.2 and can use natural gas only for their fuel (Chapter 4, Item 4.3.3 in the Main Section). The JICA Team predicts there is no substantial increment of industrial stationary source activities that will increase air pollutant emissions in the future.

A group of commercial buildings and residential houses is another major emission source categorized in the stationary sources. The projected annual average growths of population are 1.14 % for 10 years and 1.02 % for 20 years from 2000 for the whole nation, and also 0.1 % for 10 years from 2000 for the City of Buenos Aires (See Table 2.3.3 in the Main Section). By assuming the continuation of 0.1 % of annual growth to 2020, the population in the City will be 1.02 times of the population in 2000 or around 61,500 people addition in the City by 2020. The JICA Team predicts 2 % more fuel in addition to the current consumption will be consumed in the buildings and houses of the City in 2020.

8.4.2 San Nicolas Model Area

Emissions from industrial stationary sources other than power plants in this area will be estimated by assuming that these will have the same growth as that of the steel industry until 2020.

Crude steel production showed healthy growth from 1994 to 1998 with the annual average rate of 6.49 % (#68). However, the production was reduced more than 10 % in 1999 (#117). The annual average rate for the 5 years (1994 - 1999) dropped to 3.01 %. The JICA Team predicts that the annual average growth rate of industrial stationary source activities will be 3 % until 2020 in this model area.

The projected population growth is 1.09 % of the annual average from 2000 to 2010 for the Province of Buenos Aires (Table 2.3.3 in the Main Section). However, people will come to live in this model area to meet the increased industrial activities, although the population growth may not be proportional to that of the production. The JICA Team predicts 1.5 % of the annual average growth from 2000 to 2020 for fuel consumption by the group of commercial buildings and residential houses in this model area.

8.4.3 Lujan de Cuyo Model Area

This model area is consisted of an oil refinery, petrochemical industries, and other medium- and

small-scale industries. Also, the area is the world famous vineyard. However, air pollutant emissions from the industries related with the vineyard are small and intermittent, such as SO_2 emissions from fumigation of fermentation tanks. The JICA Team assumes that other industrial stationary sources than the power plants will grow equal to the growth of the oil refining capacity.

As in Fig. 2.5.1 in the Main Section, the annual average growth of oil production was 2.9 % from 1995 to 1999. However, gasoline is not a booster of the oil growth, as natural gas will fuel passenger cars more and more. Petrochemical industries may play the role for the oil growth instead. The JICA Team predicts that the annual average growth of industrial stationary source activities will be 2.5 % until 2020 from now.

The projected population growth is 1.10 % of the annual average from 2000 to 2010 for the Province of Mendoza (Table 2.3.3 in the Main Section). The greater Mendoza region, including the model area, will absorb almost all-additional population by 2020, because where jobs will be available. The JICA Team predicts 2.0 % of the annual average growth from 2000 to 2020 for population and also for fuel consumption by commercial buildings and residential houses.

8.4.4 Summary of Stationary Source Growths

Table 8.4.1 summarizes the predicted annual average growth rates from 2000 to 2020 of stationary sources other than the power plants in three model areas.

Table 8.4.1 Predicted Annual Average Growth of Stationary Sources
(from 2000 to 2020)

Stationary Sources	Model Areas		
	Buenos Aires	San Nicolas	Lujan de Cuyo
Industrial (Except Power Plants)	negligible	3.0%	2.5%
Buildings & Houses	0.1%	1.5%	2.0%