THE REPUBLIC OF POLAND

FEASIBILITY STUDY
ON
FLUE GAS DESULPHURISATION
FOR
THE KOZIENICE POWER PLANT

FINAL REPORT

DECEMBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Republic of Poland, the Government of Japan decided to conduct a feasibility study on Flue Gas Desulphurisation for the Kozienice Power Plant and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Poland a study team headed by Mr. Masashi Mikuni, Advisor to the Director, Overseas Engineering Department, Electric Power Development Company, Ltd., three times between February and November 1991.

The team held discussions with the officials concerned of the Government of the Republic of Poland, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

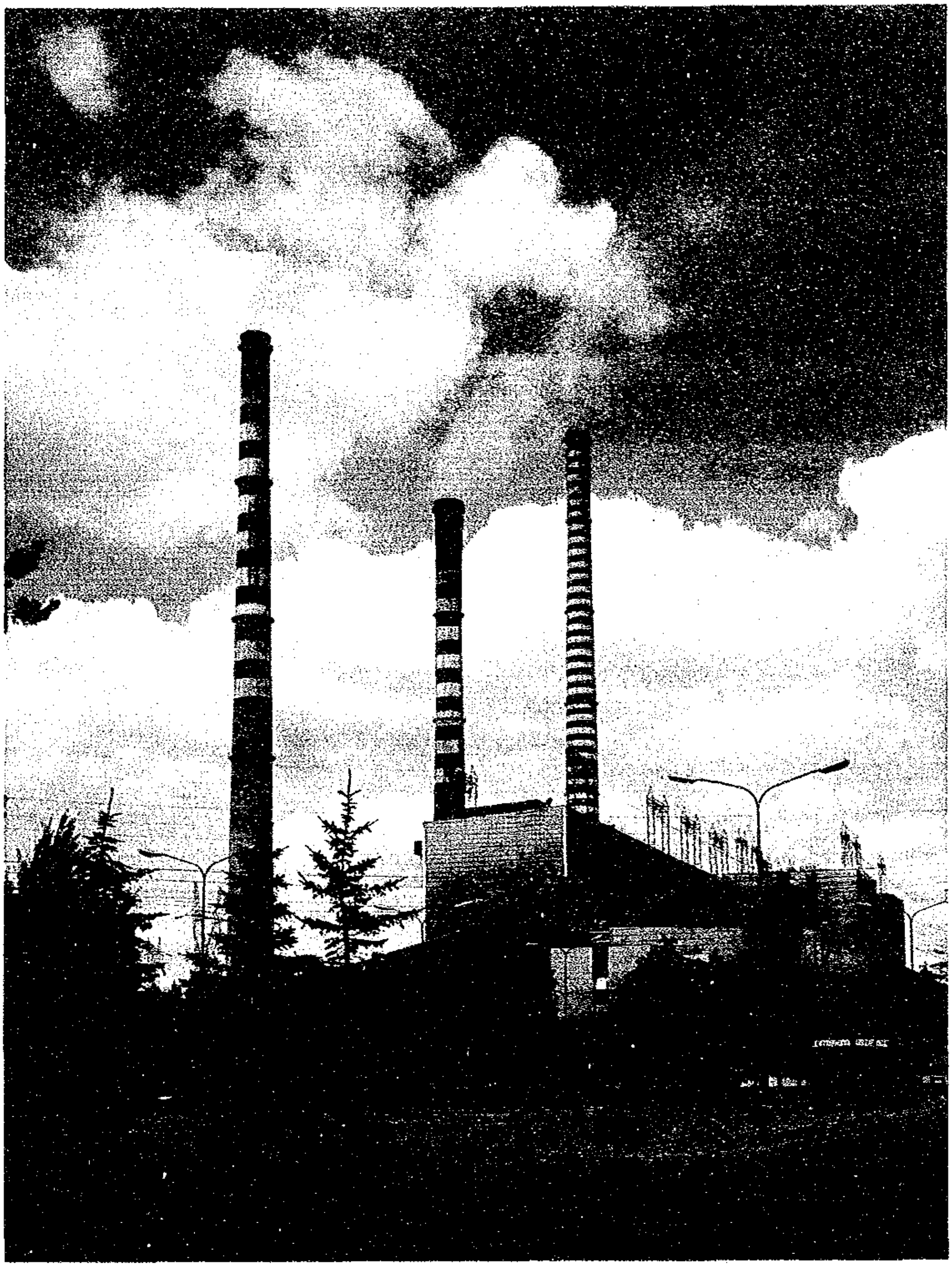
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Poland for their close cooperation extended to the team.

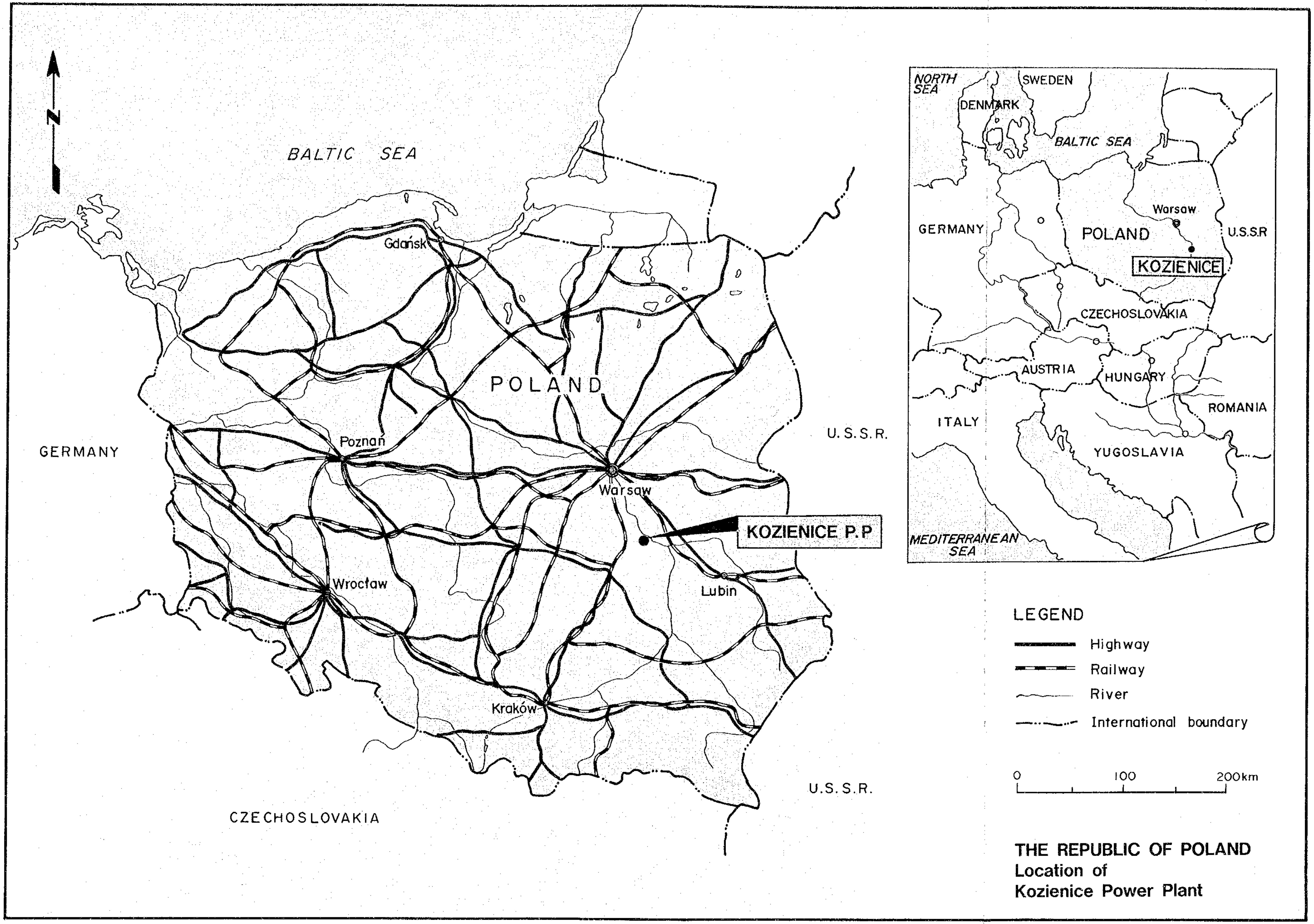
December 1991

Kensuke Yanagiya

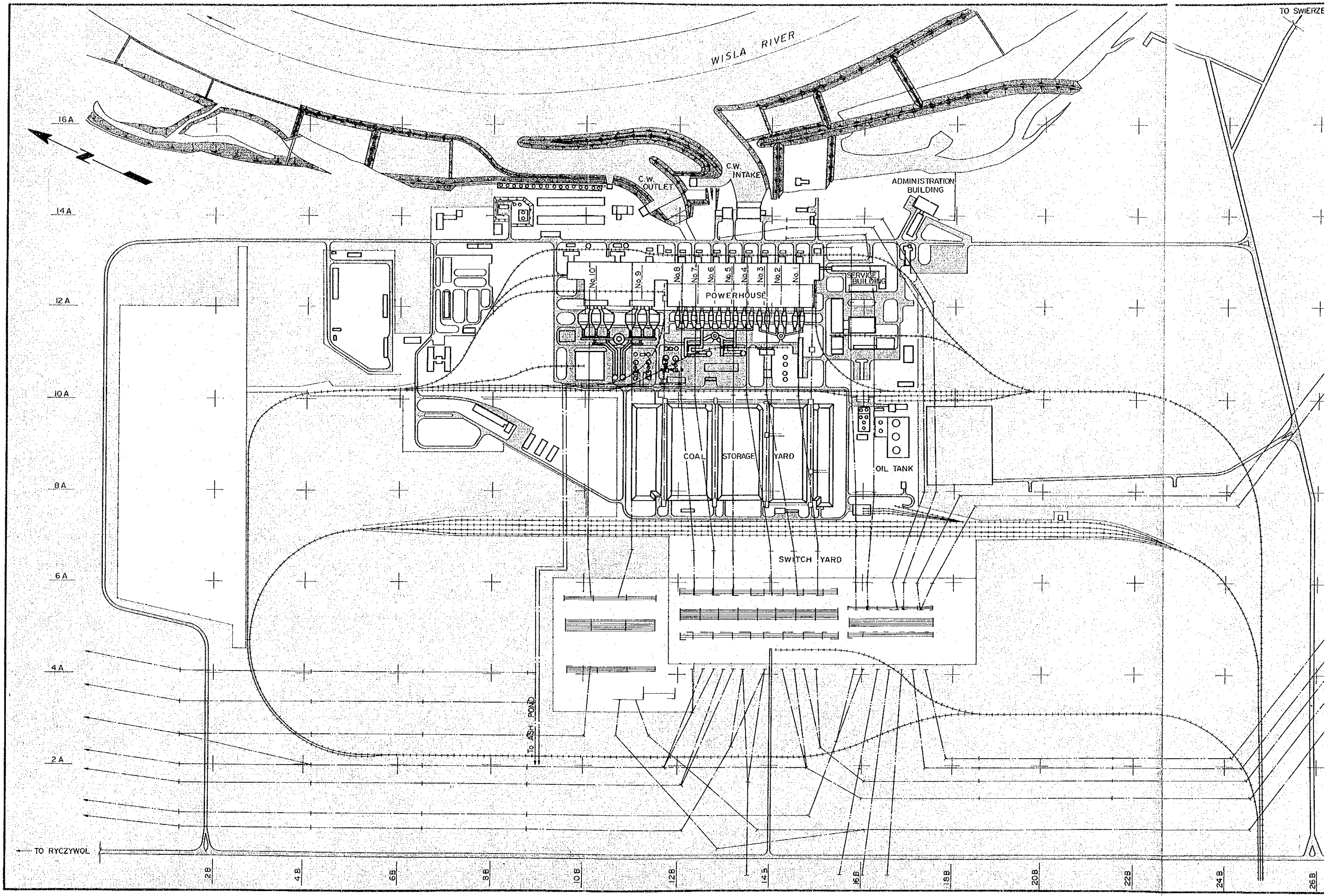
Kensuke Yanagiya
President
Japan International Cooperation Agency



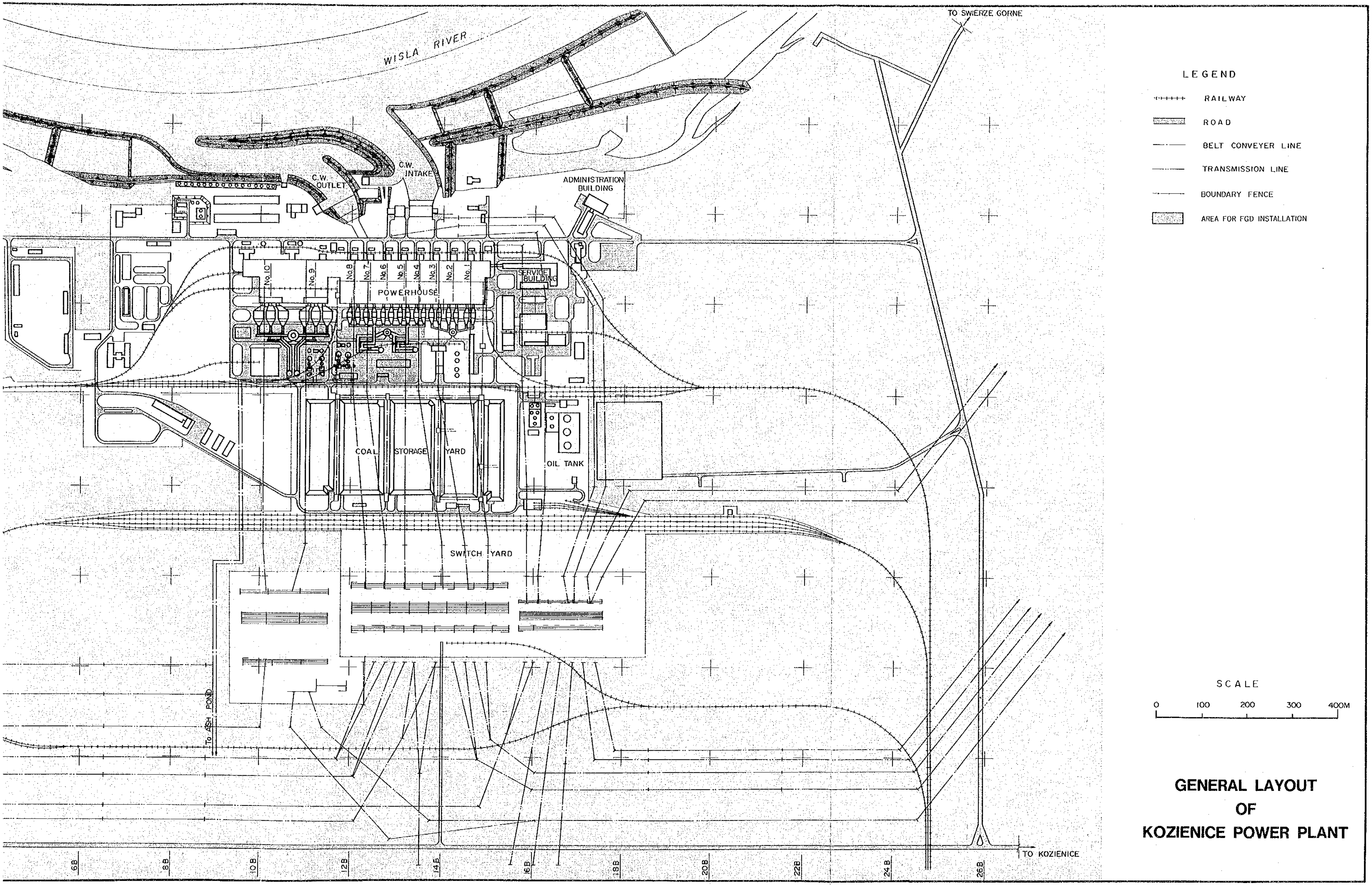
THE KOZIENICE POWER PLANT



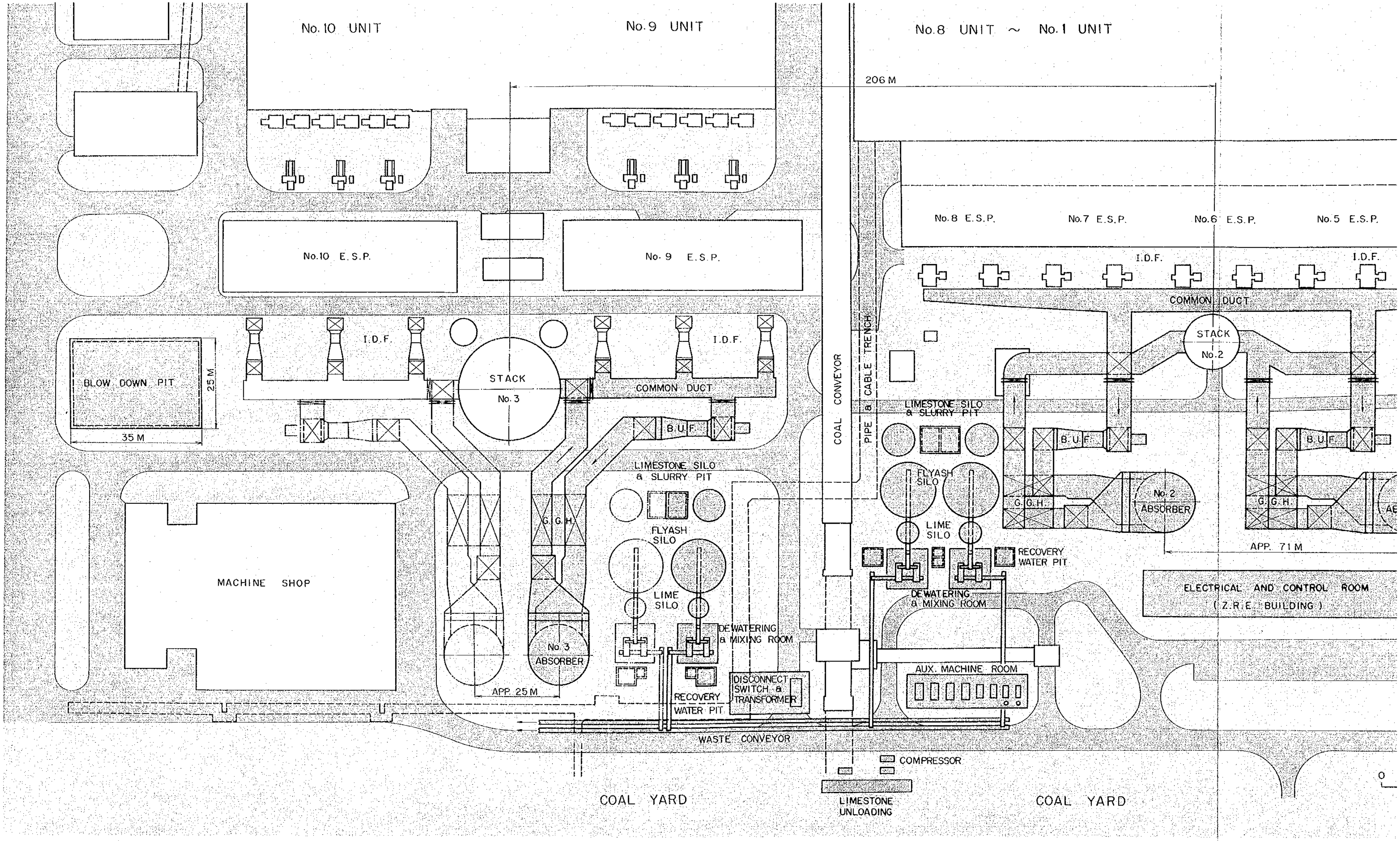
THE REPUBLIC OF POLAND
Location of
Kozienice Power Plant



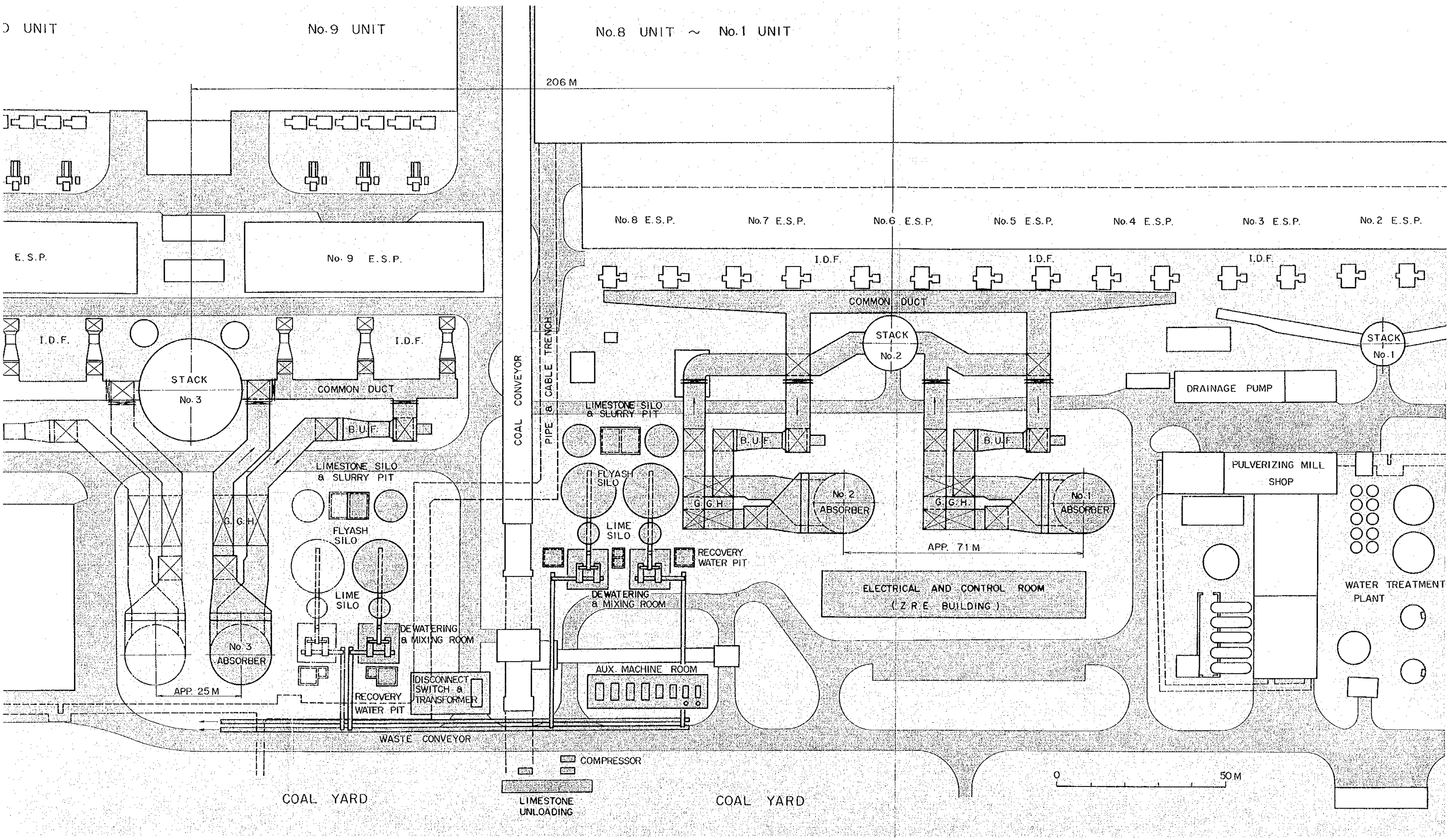
TO SWIERZE
WISLA RIVER
16 A
14 A
12 A
10 A
8 A
6 A
4 A
2 A
C.W. OUTLET
C.W. INTAKE
ADMINISTRATION BUILDING
No.10
No.9
No.8
No.7
No.6
No.5
No.4
No.3
No.2
No.1
POWERHOUSE
SERVICE BUILDING
COAL STORAGE YARD
OIL TANK
SWITCH YARD
TO ASH POND
TO RYCZYWOL
2B
4B
6B
8B
10B
12B
14B
16B
18B
20B
22B
24B
26B



GENERAL LAYOUT OF KOZIENICE POWER PLANT



GENERAL LAYOU



GENERAL LAYOUT OF THREE (3) 500 MW FGD UNITS

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CHAPTER 1 SUMMARY AND RECOMMENDATION

Contents

Chapter 1 Summary and Recommendation

Study items of the Investigation of the Feasibility Study on Flue Gas Desulphurisation of the Kozienice Power Plant of the Republic of Poland were as follows:

1st Stage

(1) Collection and analysis of data related to the Feasibility Study

(2) Determination of the level of sulphur oxide emission of the Power Plant, and environmental assessment based on the level of sulphur oxide emission of the Power Plant

(3) Technical evaluations and economic comparison for selection of the optimum flue gas desulphurisation method and equipment for the Power Plant

2nd Stage

(1) Additional investigation of the 1st stage field survey

(2) Conceptual design of DeSOx system

(3) Project implementation programme

3rd Stage

(1) Calculation of new tariff necessitated by introduction of DeSOx system

(2) Benefit from introduction of DeSOx system

(3) Socioeconomic effects by introduction of DeSOx system

The Kozienice Power Plant has made the agreement with Radom Prefecture to reduce the hourly maximum sulphur oxide emission of 26,648 kg/h at present to

7,995 kg/h by the end of 1997. It has reached a conclusion that it is most appropriate, to meet the agreement, to install three 500-MW class flue gas desulphurisers (FGD Units) of wet type limestone-gypsum method, which achieves the desulphurisation efficiency of 89%, to treat the flue gas from power plants corresponding to 1,500 MW of the 2,600 MW total output of the Power Plant.

Another conclusion, as to the power generation plants for which FGDs are installed, is that it is most suitable to install two FGD Units of the efficiency and capacity described above for Unit No. 4 through Unit No. 8 (200-MW x 5) power plants which are all using the No. 2 Stack and one FGD Unit of the same type for No. 9 (500-MW) power generation plant which is using the No. 3 Stack.

Based on the above study conclusion of the optimum DeSOx system and combination of DeSOx system installed and power generation plants, a conceptual design of DeSOx system was carried out at the 2nd stage with further data and information collection by doing 2nd stage field survey.

Furthermore, a study on the project implementation programme was made as the 2nd stage study.

The study suggests that it is necessary to make an order of the DeSOx equipment by around the end of May in 1994 and to start the erection by around the end of May in 1995 in order to put into DeSOx system commercial operation from the 1st of January, 1998.

An estimation of the project cost as of the 1st of March, 1991 was 185,404,000 US$.

If the figure is converted into unit cost per kW, it is 123.6 U$/kW.

Diffusions of sulphur oxides emissions of the Power Plant after installation of FGD Units were calculated as a part of the environmental assessment, and it reached a conclusion that the sulphur oxide level at the point of maximum sulphur oxide concentration would be well below the environmental standard to be applied to the environment of the neighborhood of the Kozienice Power Plant.

Tariff is calculated based on the annual cost including interest during construction. As a result of this calculation, 33 to 41ZL/kWh additional burden in tariff is estimated.

For the economic evaluation, reconstruction of boilers into natural gas firing which has the same reduction of SO_2 effect as this project was chosen.

According to this economic evaluation, this project is much superior to the partial reconstruction of the boilers into natural gas firing which has the same SO_2 reduction effect in terms of cost.

Following are analysis on introduction of DeSOx equipment in Polish power stations based on above analyses.

(1) Economic extension and increase in employment attributable to increase in investment.

(2) Absorbable effect on energy tariff

(3) Increase in export

Poland is already industrialized. In this project, local procurement shall be extended as much as possible so that technology can be absorbed aggressively. As a consequence, Poland will be able to export DeSOx equipments to neighbor countries by taking advantage of both its comparatively cheap labor cost and such technology.

What described in respective chapters are outlined below.

1.1 Socioeconomic Background and Current Status of Electric Utility Industry

Social reforms based on liberalization, privatization and open policies and *economic assistance of western countries based on the agreement of G24 are* going on in Poland, but the economic outlook of Poland is still severe due to inflation coming from the vicious cycle of rises in consumer prices and salaries and stagnant industrial production.

The Republic of Poland is the biggest coal-producing country in Europe, but it is not enough to meet her energy demands because of the cold weather and her highly energy-consuming industrial structure including her low energy utilization efficiency as represented by her energy consumption per unit GNP which is twice as high as that in western countries, and she is an importer of primary energy.

The Ministry of Industry proposed, in August 1990, a scenario, on long-term prospect of energy supply and demand, of 1) Promotion of electrification, 2) Reduction of dependence on coal and brown coal shifting to petroleum and natural gas and 3) Use of atomic energy from year 2000, in view of promotion of energy saving and in harmony with environmental protection, based on the "Directions of Energy Policies for 1990 to 2010" which was formulated with cooperation of the World Bank, OECD-IEA and the Government of France.

As for the electric utility system in the Republic of Poland, the direct governmental control is being reviewed to reorganize it to have completely independent generation and distribution sectors. The organization would mediate with an electric power network company and be based completely on market principles, but such reorganization is yet to occur.

The Kozienice Power Plant, which is located at 75 km south of Warsaw, is a large-scale coal fired power station having a generation capacity of 2600 MW, which corresponds to about 10% of the total generation capacity of whole Poland. With 3,400 employees, the Power Plant is managed by the self-supporting system where necessary costs are covered by the income from the wholesale of electricity. The income was about one trillion ZL (about 15 billion yen) in 1990, and the unit electricity rate is on the order of 187 ZL (2.55 yen) per kWh.

The policy of environmental protection is being promoted in the Republic of Poland. Environmental standards have been set in addition to regulations on sulphur oxide and other emissions for the purpose of achieving targeted reduction of nationwide levels of sulphur oxide and other emissions, and it is becoming necessary for the Kozienice Power Plant to take actions for meeting such standards and regulations.

1.2 Description of DeSOx System Project Site

The Kozienice Power Plant, located on the left shore of the Vistula (Wisla) River, is 12 km north of the city of Kozienice and 75 km south of Warsaw, and roads and railways from the two cities to the Power Plant are in good order.

The weather in the Republic of Poland is generally unstable under the influence of the oceanic climate of western Europe and the continental climate of eastern Europe, and is cold except the summer. The precipitation is low with an annual precipitation of about 500 mm.

It is said that about 90% of the land is flat, and the Power Plant is located in a vast flat area of forests and farms.

The geology around the Power Plant consists of a quaternary river deposit and an underlying tertiary layer.

1.3 Selection of the Optimum DeSOx System

Some FGD methods, listed below, which would be possibly applicable to the Kozienice Power Plant were selected and their technologies were compared for the purpose of selecting the most suitable FGD method for the Kozienice Power Plant.

<Wet methods>

(1) Limestone-gypsum method - Spray tower method

(2) Limestone-gypsum method - Jet bubbling method

<Semi-dry methods>

(3) Spray dryer method

<Dry methods>

(4) Activated carbon method
(5) Coal ash-using dry FGD method
(6) Simple FGD method - Dry absorbent injection into furnace
(7) Simple FGD method - Dry absorbent injection into duct

These methods were then examined for selection of the optimum FGD method and a combination of FGD Units and power generation plants for the Kozienice Power Plant in consideration of conditions specific to the Kozienice Power Plant.

It reached a conclusion after examination that the optimum FGD method for the Kozienice Power Plant is either of the wet type limestone-gypsum methods and the most suitable combination is to install two 500-MW equivalent FGD Units of 89% in desulphurisation (DeSOx) efficiency to treat the flue gas of No. 4 through No. 8, (200-MW x 5) power plants of 1,000 MW in total generating capacity and one FGD Unit of same capacity and efficiency to treat flue gas of No. 9, (500-MW) power plant. The conclusion therefore was that it is the best to install three FGD Units same in type and capacity.

The wet type limestone-gypsum methods include the two methods of the spray tower method and the jet bubbling method. Differences were little between the two methods in their technical and economic comparisons made in the current stage of the Feasibility Study, and either method can be applicable to the Kozienice Power Plant.

Differences are little between the spray tower method and the jet bubbling method in their basic principles of flue gas desulphurisation. The only difference is in the method of contacting the absorbing liquid and flue gas for absorption of sulphur oxides (SOx). Such contact is achieved by spraying the absorbing liquid by slurry circulation pumps in the spray tower method and by blowing flue gas into the absorbing liquid by desulphuriser fans in the jet bubbling method.

It was concluded in this Feasibility Study that either of the spray tower method and the jet bubbling method can be applicable to the Kozienice Power Plant. In order to carry out a conceptual design of the most suitable FGD method, it has been decided to proceed with the study on the assumption of the use of the spray tower method which has been employed more for 500-MW class FGD Units and much operational experiences have been accumulated.

1.4 Environmental Assessment

The maximum ground level concentrations of SO2 before and after installation of the FGD Units are compared by hourly ground level concentration of SO2 and the annual mean of hourly ground level concentration determined from diffusion formulas.

The hourly ground level concentrations of SO2 before and after installation of FGD Units of the most suitable combination thus obtained were 0.092 $mg/m^3 \cdot SO_2$ and 0.058 $mg/m^3 \cdot SO_2$, and their annual means were 0.015 $mg/m^3 \cdot SO_2$ and 0.009 $mg/m^3 \cdot SO_2$, respectively.

Furthermore, dust in flue gas can be reduced by installation of the wet type DeSOx system.

The predicted present hourly ground concentration of 0.042 mg/m^3 dust would be 0.024 mg/m^3 dust with the installation of the wet type DeSOx system.

It is assumed that the employment of such wet type FGD Units would improve the environment much to levels where the SO2 and dust emission of the Power Plant little affect the natural environment and human life.

1.5 Conceptual Design of DeSOx System

A conceptual design of the DeSOx system was carried out based on the study results of the selection of the optimum DeSOx system for the Kozienice Power Plant at the first stage of the study.

Following items were studied adding the data and information obtained by supplemental field survey at the second stage.

(1) Basic Plan for DeSOx System
(2) Plan for Layout of DeSOx System
(3) System Diagram of DeSOx System
(4) DeSOx System Material Balance
(5) Conceptual Design of FGD Equipment

1.6 Project Implementation Programme

The project implementation programme and construction schedule were studied based on the conceptual design of the optimum DeSOx system.

The study result shows following implementation programme in order to start DeSOx system commercial operation on the first of January 1998.

(1)	Completion of the Feasibility Study	End of Dec. 1991
(2)	Preparation of Financial Source	End of Jan. 1993
(3)	Selection of Consultant	End of Apr. 1993
(4)	Detailed Design and Preparation of Tender Documents	End of Nov. 1993
(5)	Completion of Tender Evaluation	End of May 1994
(6)	Contract Award	End of May 1994
(7)	Commencement of Civil Work	Beginning of Oct. 1994
(8)	Erection Start	Beginning of Jun. 1995
(9)	Trial Operation Start	Beginning of Sep. 1996
(10)	Taking Over	End of Oct. 1997
(11)	Commercial Operation Start	1st of Jan. 1998

1.7 Construction Cost and O&M Cost

Construction cost for 3 units of 500 MW class FGD system with 89% DeSOx efficiency are estimated at 185,404,000 U$.

This is equivalent to 123.6 U$ per kW.

Costs are estimated as of March 1st 1991.

(1) Estimated Construction Cost

		$\times 10^6$ ZL	$\times 10^3$ US$
a.	DeSOx System and Associated Equipment	1,130,833	119,035
b.	Transportation	43,890	4,620
c.	Construction	92,369	9,723
d.	Civil Work	112,575	11,850
e.	Modification of Existing Facilities	12,350	1,300
f.	Spare Parts	22,686	2,388
g.	Start-up and Commissioning	22,686	2,388
h.	Import Tax	94,212	9,917
[Direct Construction Cost] a ~ h		[1,531,601]	[161,221]
i.	Engineering Fee [5% of Direct Const. Cost]	76,580	8,061
j.	Contingency [5% of Direct Const. Cost]	76,580	8,061
k.	Administration fee [5% of Direct Const. Cost]	76,580	8,061
[Total Construction Cost] a ~ k		[1,761,341]	[185,404]
[Construction Cost per kW]		[1,174 $\times 10^3$ZL/kW]	[123.6 US$/kW]

(2) Annual O&M Cost

		$\times 10^3$ ZL	US$
a.	Utilities Cost	40,220,680	4,233,756
b.	Labor Cost	1,111,824	117,034
c.	Maintenance Cost	76,579,975	8,061,050
[Total]		[117,912,479]	[12,411,840]

1.8 Operation and Maintenance

The start up shut down procedures, the points of supervising and the way of daily and annual inspection are explained concretely.

The operational experience in Japan and the features of the FGD plants to be applied to Kozienice P/S are taken into consideration to the explanation.

1.9 Analysis and Evaluation on Socioeconomic Impact

1.9.1 Analysis on Socioeconomic Impact

(1) Annual cost in each year was calculated from the total construction cost including interest during construction based on the construction cost in Chapter 8.

Total construction cost is shown in Table 10.1-1. In addition total construction cost of which financing for local portion is partly covered with foreign loan is shown in Table 10.1-2.

Tariff is calculated based on the annual cost. As a result of this calculation, 33 to 41ZL/kWh (0.35 to 0.43¢/kWh) additional burden in tariff is estimated. Increase in tariff enabling to recover this burden is strongly recommended. Tariff trend in each year are shown in Table 10.1-3 and 10.1-4. (With 1991 February cost .. Inflation is disregarded)

(2) For the economic evaluation, reconstruction of boilers into natural gas firing which has the same reduction of SO_2 effect as this project was chosen.

Flow of benefit and cost of the evaluation is shown in Table 10.2-1. EIRR. Excess benefit (B-C) and Benefit-Cost ratio (B/C) are as follows.

EIRR	37.69%
B-C	$3,560.3 \times 10^9$ ZL
B/C	2.832

Judging from the study results of the above this project is much superior to the partial reconstruction of the boilers into natural gas firing which has the same SO_2 reduction effect in terms of cost.

This superiority is maintained until social discount rate which reflects opportunity cost of capital reaches 37.69%.

1.9.2 Evaluation on Socioeconomic Impact

(1) During reconstruction of Japanese economy after World War II, investment for environmental protection accounted for 3% of total investment of private companies. At that time the position of environmental protection was not clearly specified in the legislation for environmental protection and no governmental agency in charge of environmental issue did not exist.

In the prime of economic high rate growth, around 1970, environmental issue became the nationwide problem. Many environmental acts were enacted and the Environmental Agency was established in 1971. Environmental administration was strengthened in this way.

As in the field of electric utility legistrations were systematized, technology on flue gas treatment was introduced. Flue gas desulphuriser for coal fired thermal power stations was started at the Takasago Thermal Power Station as a pioneer and at the almost all coal fired thermal power stations and high sulphur oil fired thermal power stations, total 68 units 23,450 kW so far, flue gas desulphuriser were installed.

(2) Macro economic method for socio-economical evaluation on introduction of environmental protection has not been fully developed. However,

a. At the Tokyo Conference of Roma Club in 1982, Prof. Dr. Yoichi Kaya, University of Tokyo, presented a estimation, based on rough assumptions, that damage amounted to 6,000 Milliard Yen (45 Milliard US dollars) in comparison with that the cost for SOx removal amounted 480 Milliard Yen (4 Milliard US dollars) and

b. Environmental White Paper for FY 1977 stipulated that there was hardly no adversal effect on macro economies although countermeasures for environmental protection were carried out from 1965 to 1975.

Those had affirmative effect that real rate of economic growth was raised by 0.9%.

(3) Following are analysis on introduction of DeSOx system in Polish power plants based on above analyses.

a. Economic extension and increase in employment attributable to increase in investment.

b. Absorbable effect on energy tariff

c. Increase in export

Poland is already industrialized. In this project, local procurement shall be extended as much as possible so that technology can be absorbed aggressively. As a consequence, Poland will be able to export DeSOx equipments to neighbor countries by taking advantage of its comparatively cheap labor cost and such technology.

1.10 Recommendation for the Implementation of the Project

(1) Arrangement of Scheme for Local Portion Investment : Improvement of Domestic Financial Market etc.

It has been studied that the Project be implemented as much as possible inside Poland for the least cost and giving good influence on Polish economy as well as taking into account current level of Polish technology. Consequently, although our Study has satisfied this requirement, there remains some problems in connection with the financing on the local portion of the Project.

As the present scheme loans on the basis of the Official Development Assistance in every countries as well as loans from organization for international aid such as the World Bank have limitation for credit line for local portion of projects. Therefore, a certain part of investment for local portion shall be funded from domestic financial market. However, since Polish private financial market is still unmatured, it is difficult to fund from the market at this stage. Therefore, the following schemes for financing on the local portion will be thought necessary to make the Project implement as scheduled.

a. Application of the Polish Environmental Fund

b. Application of a governmental financing entity

If expansion of the activity of private banking system, which is operated on the basis of saving of the national, will not be expected soon, application of a governmental financing entity (if no such an organization, urgent establishment is necessary) shall be studied. Since environmental project is expected to generate effective demand of Polish national economy, application of the governmental financing entity will be thought very useful.

c. Application of Debt for Nature Swap

To a certain extent, Debt for Nature Swap will be applicable to the implementation of the Project, upon agreement with a private bank which has credit to Polish government. (This scheme was materialized in Philippine.)

(2) Arrangement of the Electricity Tariff System

Unless credit incurred from this Project is duly borne by consumers in electricity tariff, it will increase national financial deficit and make inflation worse. Rise of electricity tariff by the implementation of the Project will be estimated at about 20 percent point (40ZL) on the basis of wholesaling price from the Kozienice Power Plant even in the first year from the completion of FGD Units. This will be equivalent to only 4ZL/kWh rise if the cost increase caused from the FGD Units installation of Kozienice Power Plant can be distributed in total electricity consumption all over the country.

Therefore, it shall be materialized that environmental cost including the investment cost be duly included in a new electricity tariff system, revision of which is under way from the basis of the subsidized by the government to the basis of actual cost.

(3) Consideration to High Chlorine Content of Coals

Coals used at the Kozienice Power Plant are high in chlorine content. At present, there is no commercially proven technology to lower chlorine content of waste water from the wet limestone-gypsum DeSOx system to a level at which the waste water can be discharged to river water.

In this Feasibility Study, it is planned that the waste water and gypsum from FGD system are to be mixed with flyash and are to be discharged to a disposal area to be built adjacent to the ash disposal area.

High chlorine content in coal affects to a design of FGD system to a great extent, therefore a study to lower chlorine content as much as possible is necessary.

At a detailed design stage, it is preferable to make a study to reduce chlorine content in coal by purchasing low chlorine coal and/or making optimum blending of coals, etc.

Chapter 2. Socioeconomic Background and Current Status of Electric Utility Industry

CHAPTER 2 SOCIOECONOMIC BACKGROUND AND CURRENT STATUS OF ELECTRIC UTILITY INDUSTRY

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Chapter 2 Socioeconomic Background and Current Status of Electric Utility Industry

2.1 Natural and Economic Background

2.1.1 Natural Background

The Republic of Poland is situated in the northern part of central Europe from 49 to 55 degrees latitude north and from 14 to 24 degrees longitude east. The northern shore of Poland faces the Baltic Sea, and northern, southern and western sides of the territory border on the Soviet Union, Czechoslovakia and Germany, respectively. The area of territory is 312,000 km^2, which is the largest among the Eastern European countries.

The population is about 37.76 millions. Poland is the single racial country; 98% of total population is Polish, one of Slavic race. It is reported that over 90% of the total population is baptized for Catholics, and there are some Greek Orthodixians and Judaists. The official language is Polish, a western Slavic. The capital is Warsaw with population of 1.7 millions, and there are six other cities population of which is over half a million, including Lodz and Cracow.

Vistula River runs from south to north through the territory. Almost all of its territory is flat with its elevation being less than 300 meters above sea level, excepting Carpathian Mountains.

The climate is unstable and cold excepting in summer, affected by both oceanic climate in Western Europe and continental climate in Eastern Europe. The change of temperature is from around 30 °C to around minus 30 °C.

2.1.2 Political Status

Since 1947 after the World War II, Poland had been under the dictatorship of the United Labor Party as one of the COMECON countries. However, triggered by the activities of the independent labor union "Coalition", labor strike of which happened in July, 1980, the movement toward the liberalization was heightened.

The movement was once settled but resurged again from April, 1988 by the labor strikes requesting wage increase and legal authorization of "Coalition" all over the country. The election of National Congress was held in June, 1989 after the round table negotiation between the Government members and representatives of members out of office - the result of the election was an overwhelming victory of Coalition candidates. Although the Congress elected Jaruzelski, who was the Chairman of National Council, as the President, new cabinet was composed with the leadership of non communist members with its prime minister as Mr. Majowiechi by the affection of Coalition.

The Constitution was amended in December, 1988 by deleting the "leading role of Polish United Labor Party". At that time, the name of the nation was changed to "the Republic of Poland", and the country started to move the way toward the Western European countries, by the introduction of market economy and privatization of corporations.

However, inflation and increase of unemployment was caused by the stringent economic policy by Majowiechi. The first presidential election was conducted in November, 1990 for the purpose of reviewing the democratization of Poland. Walesa, Chairman of the Coalition, was elected to the Presidency.

President Walesa expressed the acceleration of the reformation. For this purpose, he concentrates his efforts to improve the relation with Western countries and obtain their trust on Poland as the reformation cannot be attained without assistance from Western countries. He expresses his plan to visit Japan in this autumn.

Poland abandoned the socialistic regime which had lasted for 40 years, and now has started the construction of a new country. However, it can be said that Poland is still in the process of trial and error both politically and economically.

2.1.3 Current Status and Future Prospect of Economic Reformation

(1) Progress of Economic Reformation and Current Status

The national income of Poland increased rapidly in early '70s by the heavy industry oriental economic policy and introduction of the foreign fund and technology from Western countries in the background of Detente since late '60s. However, since the export of Poland to the Western countries declined by the stagnation after the oil crisis, Polish foreign debt owed to Western countries accumulated and Polish government has requested them to give a relief for reduction of debt.

Recognizing that the old centralized political system is defective for the economy, Poland started the economic reformation by the introduction of market economy, since 1982 (that is, before the Pelestroika by Gorbachev) prior to the political reformation, and the Polish economy showed a little recovery since 1983.

This economic reform has introduced various institutional improvement toward economic liberalization including establishment of private enterprises under the Economic Activity Law, encouragement of foreign investments under the Foreign Capital Business Law, free international trade, reduction of the part of the centralized planning economy, and relaxing the regulation on trade of foreign currency.

However, the consumer prices has escalated since 1988 when the market principle was introduced and labor strikes have continued to occur. Since 1989, a vicious cycle of prices and wages has accelerated inflation and stagnated industrial productions, and the economic status of the nation is very stern even today.

The trend of economic indices in the past 5 years is presented in Table 2.1-1.

(2) Prospect of Economy

As for specific measures for introduction of market economy, it is being planned to establish security exchange market and to accelerate privatization (it is being planned to privatize around 7,600 state owned company within two years, as the Privatization Law was enacted and the Ownership Transfer Agency was established in July, 1990).

Poland joined IMF in 1986, and has agreed with IMF concerning implementation of economic reform programs, which stipulate the following policies.

1) Reformation of state owned company for introduction of independent accounting system,

2) Privatization of state owned companies in the small business field,

3) Closure of industries consuming large amount of resources and energy by administrative decision,

4) Reduction of budgets of Ministries of Interior and Defense,

5) Freezing of subsidies,

6) Tax reforms including introduction of personal income tax,

7) Freezing of medium/long term domestic credits,

8) Setting down a single foreign exchange rate.

Although the future prospect of Polish economy has so much uncertainty, the economic indices agreed upon with IMF, which is based on the assumption of implementing economic reforms, are given in Table 2.1-2.

(3) Assistance by Western Countries

Poland is the largest debtor country in the Eastern Europe which total debt reached 4 billion dollars as of the end of 1989. Since 1981 for measure for debt program, Poland has started negotiation with Western governments and private banks for requesting further financing and extension of term of repayment, and also obtained the World Bank loan. Assistance from the Western countries for promoting to democratize Poland becomes accelerating in accordance with the agreements at Arche Summit in July, 1989 and G24 in December of the same year. Such assistance includes technical cooperation in agricultural sector, vocational training, market access, investment/stabilization fund and environmental cooperation.

The financial assistance from the World Bank is in progress, and loans amounting to 4 billion dollars are extended to Polish government, Central Bank, etc. For the energy and environmental assistance project, the World Bank has committed loan amounting to 150 million dollars, which will be disbursed after 1991, to finance the long term rehabilitation program for 80 companies including promotion of environmental protection.

The assistance to Poland was discussed in the G7 meeting of January, 1991 and Paris Club in April, where it was agreed to reduce the debt to one half, with the major role of the U.S. Government. However, it is doubtful at this stage whether this agreement will materialize the reduction of debt by Western crediting countries and the new money (new loans) will be financed smoothly to Poland.

The assistance to Poland by Western Countries are shown in Table 2.1-3.

Table 2.1-1 Trend of Economic Indices of the Republic of Poland

	1986	1987	1988	1989	1990
GNP	12,953.0	16,939.90	29,628.7	153,994.1	-
Mineral and Industrial Production	104.2	107.5	112.7	111.1	81.0
Consumer Price Escalation Rate	117.8	149.2	238.4	745.6	5,062.6
Fiscal Deficit	△211.0	△594.4	△ 57.6	△934.2	-
International Trade Balance	△787.0	△151.0	△291.0	△1,843.0	-
Foreign Currency Exchange Rate	197.62	315.54	502.55	6,500.0	9,500.0

(1) 1 billion ZL (2) 1985 figures are taken as 100. (3) Dollar price (at end of term)

(From: The Institute of Energy Economics, Japan)

Table 2.1-2 Future Economic Indices of the Republic of Poland

		1991	1992
GNP	(%)	1.2	3.0
Price Escalation Rate	(%)	32	23
Fiscal Deficit	(in trillion ZL)	△1.0	△1.3
International Trade Surplus	(in 1 million dollars)	900	1400

Table 2.1-3 Assistance Programs for Poland by Western Nations

	Technical Assistance for Food and Agriculture	Vocational Training	Environment	Investment and Economic Stabilization Fund	Market Access and Others
EC	138 million dollars The Polish counterpart fund is used for agricultural development.	330 million dollars (Poland/Hungary) Mostly technical assistance for environmental protection (improvement of monitoring capability, policy formulation, feasibility study, etc.) and privatization programs.			
U.S.	$8 million (Fiscal 1989) $125 million (Fiscal 1990)	Human resource development $55 million (Poland/Hungary)	Cracow City atmosphere and water quality improvement measure. 15 million dollars	Stabilization Fund; $200 million Corporation Fund; $240 million (Poland/Hungary, 3 years) Commercial financing (for telephone system); $6 million	GSP grant determined. Export credit; $200 million Energy; $30 million (Poland/Hungary) Science/technology and medicine; $9.5 million
Britain	Technical cooperation; $23 million	Know-how fund; $78 million (5 years)	—	Stabilization Fund; $100 million Investment agreement	—
France	—	Food industry; $16 million (3 years from '90)	Environmental agreement	Stabilization Fund ($100 million) Investment guarantee; $160 million ('89) Investment agreement	Export credit guarantee; $530 million
West Germany	Agriculture promotion cooperation; $3.85 million	Management and economic assistance; $180 million	Environmental agreement	Loan; $1.6 billion • Export to Poland; $1.3 billion • Stabilization Fund; $250 million Bank loan (handicraft production); $2 million	Export credit guarantee; $1.4 billion Others; $48 million (including $30 millon for Poland/Hungary)
Japan	$25 million	$25 million (5 years, Poland/Hungary)		Stabilization Fund; $150 million Export bank loan; $500 million (3 year) Conclusion of investment protection agreement going to be negotiated.	Trade insurance; $350 million (2 years) GSP operation ('90.1.1 ~)

(From: Japan Machinery Export Association)

2.2 Current Energy Situation

2.2.1 Energy Resources

Poland has huge amount of coal reserves in upper Silesia, lower Silesia areas near Cracow and Lubrin area near the Soviet boarder. The quality is high and most of them are bituminous coals. Poland is the largest coal producing country, which total reserve amounts reaches to 100 billion tons, only second to Soviet Union in Europe. The total reserve of lignite is also estimated at 20 billion tons. There is little natural gas and practically no oil. The water resources for hydroelectric power generation is not abundant either. Therefore, coal and lignite are the major primary energy resources in Poland. Poland used to maintain the international trade balance in energy sector by exporting coal to pay for importing oil. But the balance was upset by the oil crisis and trade deficit in primary energy sector has been appearing. Poland is an energy importer at this moment.

2.2.2 Energy Status in National Economy

The total energy consumption was 175 million tons (coal equivalent) in 1989, of which 75% was supplied by coal and lignite. The energy consumption per capita is at almost the same level of Western European countries, and energy consumption per GNP is twice as high as in Western Europe. One of the reason for such large consumption is the adverse climatic condition, and other reasons exist in lower energy efficiency and energy waste economic system due to underdeveloped technology and insufficient market mechanism including price system.

2.2.3 Long Term Prospect

(1) General

Ministry of Industry of Poland announced "Directions for the Development of the Energy Policy of the Republic of Poland for the years 1990 - 2010" (hereinafter termed "Directions") for a long term energy policy in August, 1990 based on the study carried out under the cooperation of the World Bank, OECD-IEA and French government.

In this report, the energy demand and supply are projected based on three scenarios, which are: 1) Low Growth Scenario (D); annual growth rate of 3%, 2) Medium Growth Scenario (S); annual growth rate of 5%, and 3) High Growth Scenario (W); growth rate of 8% until 2000 and 10% until 2010.

(2) Demand

Even in the energy conservation scenario in which the energy consumption per GNP is substantially reduced (in "W" case, it is assumed that unit consumption is reduced by 3% per year, and down to one half of the current level by 2010), the energy demand is projected to be increased by 35% (D) or 42% (W) owing to the progress of economic growth.

Electric power demand is projected to increase by 77% (D) or 87% (W) in the period to 2010.

Projection of Energy Demand is shown in Table 2.2-1.

(3) Supply

All the scenarios stipulate energy supply as follows:

1) Most of the increment in demand will be covered by coal, natural gas and oil, but the dependence on coal will be reduced from the current 75% to around 60% (with the lignite consumption reduced).

2) A nuclear power will be introduced by 2010, but dependence on nuclear power will be only 5% at that time.

These targets will be pursued with due consideration on coordination with environmental problems.

Since, to meet the increasing demand, electric power supply will be increased by 1.5 times as the other energy supplies, promotion of development of power plant is necessary.

Projection of Energy Supply is shown in Table 2.2-2.

(4) Problems in the Projection

A huge amount of capital investment will be required in order to cover the supply for the increasing energy demand. In scenario "W", around 10 trillion ZL (1984 price) will be required until 2010, and 7 trillion ZL even in scenario "D", but the procurement of the necessary fund for this huge investment is the most serious problem.

Promotion of energy conservation is indispensable. However, as the establishment of the tariff system based on the market principle is still being delayed, it is difficult under the current situation to give incentive for energy saving.

The reduction of dependence on coal, may be the right direction, but this must be made up for by import of natural gas and oil which are not domestically produced. Natural gas is assumed to import from Soviet Union by the gas pipeline. But, since the hard currency settlement system was introduced in 1991, gas import will generate a more serious international trade balance. For oil, although Poland is intending to import from OPEC countries and Western countries, there is the problem of preparing the necessary fund, as well as the problem of supply source including the reduction of oil output in Soviet Union and the end of the peak of exploration in North Sea oil fields. Therefore, there are many problems involved in securing the energy supply as prescribed in the scenarios.

Table 2.2-1 Projection of Energy Demand

		1988	1990	D 2000	D 2010	S 2000	S 2010	W 2000	W 2010
Per Unit GNP Demand		94	111	90	80	82	64	68	52
Total Demand	(PJ)	5,447	4,583	5,212	5,974	5,599	6,991	6,053	7,609
Electric Power	(TWh)	149	125	+35	+66	+51	+119	+78	+154

* The demand per unit GNP is calculated as 100 in 1985. (From: "Directions")

Table 2.2-2 Projection of Energy Supply
(Increase and decrease of each energy, in PJ)

			D		S		W	
	1988	1990	2000	2010	2000	2010	2000	2010
Coal	3,606	2,930	+193	+337	+281	+826	+401	+1,064
Lignite	592	589	▵44	▵38	▵44	▵38	▵29	+111
Natural Gas	406	308	+269	+471	+407	+638	+586	+797
Oil	740	621	+211	+390	+372	+606	+513	+680
Nuclear Power	0	0	0	+231	0	+375	0	+375
Others	102	135	0	0	0	0	0	0
Total	5,446	4,583	+629	+1,391	+1,016	+2,408	+1,470	+3,026

(From: "Directions")

2.3 Environmental Problem

The deterioration of environmental pollution by industrial development has been more serious. Environmental problems cover and include various problems, such as air pollution, water pollution and soil pollution, but the most serious problem is the air pollution caused by utilization of coal. Especially, since high quality coals are distributed for export with the purpose of acquiring foreign currency, lignites and low quality coals have to be used for power generation and residential heating inside the country, which worsens the air pollution of Poland.

The MSC (Meteorological Synthesizing Center), an international organization in Europe, discloses generation of polluting substances and their transportation from the results of air pollution monitoring. As the result, the southwestern part of Poland is included in the high concentration pollution districts.

Emission of sulphur oxides is currently 4.2 million tons which is 4 times as that in Japan. The value per square meter of the territory is 13.5 tons. The emission per unit GNP is the fourth largest in Europe. The emission of nitrogen oxides is 1.5 million tons.

In Silesia area, where Lenin Steel Plant is located in the suburbs of Cracow, the situation is getting serious. The forest damages due to acid rain are appearing in Poland.

The environmental protection movement is active. There are more than 2,000 organizations for the environmental protection which have been officially approved.

The emission reduction plan is formulated for the whole country by the Ministry of Environment. The plan is intending to reduce the sulphur oxide emission by year 2000 to 30% below the level of 1985, and by 2010, down to 2 million tons, which is 30% below the target level in 2000.

The materialization of the reduction of the emission shall be implemented by the standard (norm) for each corporation and for each district.

2.4 Current Status of Electric Utility Industry

2.4.1 Regime of Electric Utility Industry

Ministry of Industry has exercised control over the operation of electric power, lignite, oil, natural gas and heat supply which was under the jurisdiction of the Ministry of Mining and Energy since the reshuffle for energy sector was made in 1987. Under the control of Ministry of Industry, the Power and Brown Coal Board was the direct supervisor for the operation of electric power sector since then.

But the above "Board" was resolved in September, 1990, and the state owned company named "Polish Power Grid Company" was established. The objective of the company was to conduct economical power generation, transmission and distribution operations based on specific generating costs according to the market economy principle.

At this moment, each power station (55 thermal power stations) are operated as almost independent entities, which output is purchased by the Power Network Company mentioned above. Then the Power Network Company supplies to 33 regional power bureaus (distribution companies) which are also almost independent entities, and the regional power bureaus supply to the end consumers. As government subsidies are provided in each stage of power purchase transaction, it would take more time to realize the price mechanism and market principle.

The future direction is to make power generation and distribution entities completely independent by the Power Network Company functioning as the intermediate agent.

The technical tasks such as planning of construction of power stations are implemented by "Energoprojekt" which is a different organization. The tasks related to financing of power project are controlled by the Ministry of Industry and the Ministry of Finance.

2.4.2 Power Demand and Supply Balance

(1) Power Consumption

As shown in Table 2.4-1, power consumption has grown steadily as illustrated in the separate table, but the growth stagnated as the economic condition deteriorated after 1989. Although the statistics of 1990 is not available, it is assumed that the power consumption was reduced by nearly 10% based on the amount of energy generated. The total electric energy consumption in 1988 was 121.3 billion kWh, and it is equivalent to 3,205 kWh per capita.

As illustrated in Figure 2.4-1, the proportion of the industrial demand is overwhelmingly large. However, since the commercial and residential demands are increasing in the past several years, and the energy consumption will surely resurge in the future as the national economy recovers.

(2) Power Supply

The energy generation in 1989 was 145.5 billion kWh. The generation by electric utility industries accounted for 94%, and the in-house power generation was 6%. In terms of energy sources, coal and lignite accounted for 92%, and hydroelectric power 3%.

Reflecting the slump of economic activities, the energy generation in 1990 was 133 billion kWh, which was almost 10% less than the previous year.

The proportion of power loss in transmission and distribution systems is 12.6% which is much higher than those of other old COMECON countries. This is caused by the aging of transmission and distribution networks (in particular, distribution networks), and the delay of investment on the construction and the renewal of such facilities due to shortage of capital.

The transmission line interconnected with the old COMECON countries are well developed, and electric power is exported and imported. In terms of kWh, export exceeded import until 1985, but thereafter, the situation was reversed. In 1989, 12.1 billion kWh of electric energy was imported, and 10.3 billion kWh exported. All electric energy imported is from old COMECON countries, and a total of 59.8 billion ZL has been paid for electric energy import. 1/3 of export is directed to old COMECON countries, and 2/3 to the Western countries. As the unit price of export to the Western countries is higher than to old COMECON countries, the total income from export is 100.7 billion ZL which is more than the sum paid for export. Balance of trade of electric energy is now on the surplus.

2.4.3 Electricity Tariff

The electricity tariff has been raised many times due to the progress of inflation and the necessity to have the tariff system meet for the real cost as much as possible.

At the beginning of 1990, the tariff was raised to 5 times level (for the time being 106.5 ZL for residential load), and in July, 1990 again raised by 80%.

The price of electricity is determined on the basis of cost calculated in each transaction process; from the power stations to the Power Network Company, from the Power Network Company to the regional distribution bureaus and from the regional distribution bureaus to the end consumers. Although the exact cost is calculated by the accounting of each entity, government subsidies are provided in setting the transaction price of each stage to reduce the burden of the entities and consumers. Therefore, the overall tariff system neither reflect costs, nor is based on the market principle.

2.4.4 Power Facilities

(1) Power Generation Facilities

The total output of generating facilities in the country was 30,921 MW as of 1988. These facilities consist of those operated by electric utility industries which exceed 90% of the total, or 27,992 MW, and in-house generating facilities which are less than 10% or 2,929 MW. For the facilities operated by the electric utility industries, 93% of total or 26,016 MW is thermal power stations, and the remaining 1,976 MW are hydroelectric power stations. All in-house generating facilities are thermal power stations.

The annual average growth rate of total generating capacity is becoming smaller, being 7.3% for the period from 1971 to 1975, 4.8% from 1976 to 1980, and 3.4% from 1981 to 1985. The annual growth rate for the period from 1986 to 1988 remained at 2.1%

The unit capacity of thermal power plant used to be mostly 125 MW and 200MW in 1960s. Since 1978, 360MW units and 500MW units started to be introduced. The 360 MW units are installed at Bolhatow lignite fired Thermal Station, and 500 MW units at Kozienice Thermal Power Station.

Many thermal power plants are designed to supply heat, and the power plants being capable to supply heat accounts for 10% of the total thermal power facilities.

The trend of power generation facilities is given in Table 2.4-2.

The trend of fuel consumption for power generation and the trend of total length of transmission/distribution lines are given in Table 2.4-3 and 2.4-4 respectively.

Coal and lignite account for 98.2% of the total fuel used in thermal power stations, and the proportion of lignite is increasing in recent years. The trend of fuel consumption for power generation is illustrated in Table 2.4-3.

(2) Transmission and Substation Facilities

The total length of transmission lines is 640,000 km. The trunk lines are 220 kV and 400 kV, and 750 kV lines are introduced to some sections of interconnection lines with the Soviet Union. The trend of total length of transmission and distribution lines is illustrated in Table 2.4-4.

2.4.5 Electric Power Development Plan

The electric power development plan made public at this moment is the long range program up to year 2000 which has been disclosed in 1981. It is based on the projection that the electric energy generation in year 2000 is 230 billion kWh. However, as mentioned before, this figure was modified to much smaller values in the "Directions" released in August, 1990, 160 billion kWh by scenario (D) and 203 billion kWh by scenario (W). It is expected that development projects will be delayed as a consequence of these modifications.

According to the development plan of 1981, it is planned to newly develop 27,400 MW of new generating facilities from 1984 to 2000, including replacement of aged facilities. In this plan, it was assumed that 1,760 MW of nuclear power, 5,760 MW of lignite fired thermal power, 4,400 MW of coal fired thermal power, 4,450 MW of heat supply thermal power, and 3,500 MW of pumped storage power plants will be developed.

If we assume that scenario (D) of the "Directions" is realistic, the amount of generating facilities to be developed will be reduced to one half, compared with the above development plan, the nuclear power development will be delayed to sometime beyond year 2000, and the dependence on coal and lignite fired thermal power will be reduced to cope with environmental problems. This modification would inevitably affect on the compositions of energy sources for new power supply facilities.

2.4.6 Environmental Measures in Electric Power Sector

Since environmental problems has been surged in electric power sector, urgent action against air pollution by coal and lignite fired thermal power stations, in particular, will be indispensable.

The air pollution countermeasures in electric power sector are based on the following two requirements.

1) Observance of the emission standard (norm) for each power station set down by the Ministry of Environment.

2) Observance of the target values agreed upon with local governments.

Specific standard values are presented in Table 2.4-5.

From the technical viewpoint the followings measures for reduction of SOx are being discussed.

1) Introduction of flue gas desulphurisation technology.

2) Cleaning up of coal and revision of the coal price system based on the quality.

3) Introduction of advanced combustion technology (FBC, etc.).

A penalty system to be levied on emission of air pollutants has been introduced by the Cabinet Ordinance dated December 21, 1990, as follows;

1) 680 ZL for emission of 1 kg of SO_2:

2) 680 ZL for emission of 1 kg of NOx.

3) 180 ZL for emission of 1 kg of dust

The penalty level is scheduled to be raised in 1997.

Table 2.4-1 Trend of Electric Power Consumption

(in 1 million kWh)

	Total	Industrial	Commercial and Household	(Per Capita, in kWh)
1980	99,689	67,616	32,073	2,802
1985	109,949	68,068	41,881	2,956
1986	113,707 (3.5%)	69,138 (1.6%)	44,569 (8.8%)	3,035 (2.7%)
1987	118,800 (4.4%)	73,345 (6.1%)	45,455 (1.9%)	3,155 (4.0%)
1988	121,324 (2.1%)	72,779 (△0.8%)	48,545 (6.8%)	3,205 (1.6%)
1989	120,800 (△0.4%)	-	-	-

(From: United Nations: Annual Bulletin of Electric Energy Statistics for Europe)

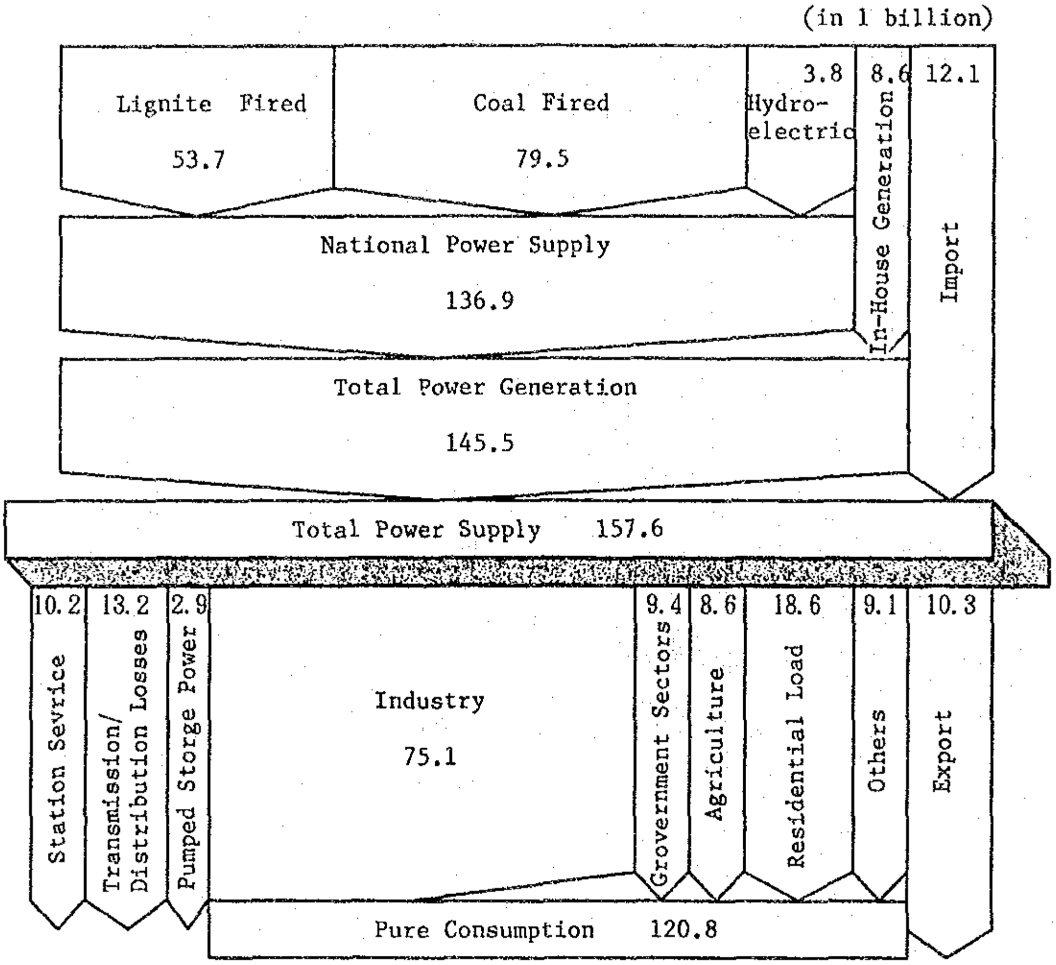

Fig. 2.4-1 Composition of Electric Power Demand in Poland (1989)

(From: National Power System in Poland 1989 by Computer of Power System, March 1990)

Table 2.4-2 Trend of Power Generating Facilities

(in 1,000 kW)

Year (As of December 31)	Utilities			In-House Generation			Utilities plus In-House		
	Thermal	Hydro	Total	Thermal	Hydro	Total	Thermal	Hydro	Total
1970	10,778	740	11,518	2,192	-	2,192	12,970	740	13,710
1975	16,253	797	17,050	2,477	-	2,477	18,730	797	19,527
1976	16,598	797	17,395	2,736	-	2,736	19,334	797	20,131
1977	17,737	797	18,534	2,754	-	2,754	20,491	797	21,288
1978	19,784	797	20,581	2,817	-	2,817	22,601	797	23,398
1979	20,120	1,297	21,417	2,858	-	2,858	22,978	1,297	24,275
1980	20,477	1,297	21,774	2,949	-	2,949	23,426	1,297	24,723
1981	20,535	1,297	21,832	2,905	-	2,905	23,440	1,297	24,737
1982	23,123	1,807	24,930	2,871	-	2,871	25,994	1,807	27,801
1983	21,944	1,977	23,921	2,912	-	2,912	24,856	1,977	26,833
1984	22,931	1,976	24,907	2,881	-	2,881	25,813	1,976	27,789
1985	24,117	1,976	26,093	2,945	-	2,945	27,062	1,976	29,038
1986	24,826	1,976	26,802	2,971	-	2,971	27,797	1,976	29,773
1987	25,240	1,976	27,216	2,894	-	2,894	28,134	1,976	30,110
1988	26,016	1,976	27,992	2,829	-	2,829	28,945	1,976	30,921

(From: United Nations: Annual Bulletin of Electric Energy Statistics in Europe)

Table 2.4-3 Trend of Fuel Consumption for Power Generation

Fuel Classification	1983		1984		1985		1986	
	Calorific Power (TJ)	Composition (%)	Calorific Power (TJ)	Composition (%)	Calorific Power (TJ)	Composition (%)	Calorific Power (TJ)	Composition (%)
Coal	902,234	71.0	934,360	69.5	907,611	66.3	863,165	62.2
Lignite	322,053	25.6	880,707	28.3	435,116	31.8	499,168	36.0
Liquid Fuels	20,772	1.6	18,277	1.4	14,696	1.1	14,642	1.1
Natural Gas	912	0.1	657	-	636	-	797	-
Synthetic Gas	883	0.1	931	0.1	966	0.1	1,241	0.1
Blast Furnace Gas	5,727	0.4	6,487	0.5	4,627	0.3	5,963	0.4
Others	6,212	0.5	8,202	0.2	5,862	0.4	2,984	0.2
Total	1,258,721	100.0	1,344,621	100.0	1,369,431	100.0	1,887,960	100.0

(From: United Nations: Annual Bulletin of Electric Energy Statistics of Europe)

Table 2.4-4 Trend of Total Length of Transmission/Distribution Lines

Classification	1970	1975	1980	1982	1988	1989
Transmission Lines						
400 kV and 750 kV	0.32	1.0	1.7	1.9	3.9	4.0
220 kV	5.5	7.0	7.7	7.9	8.2	8.2
Distribution Lines						
110 kV	17.2	21.7	24.9	26.0	29.6	30.3
Total of medium voltage lines	168.7	200.0	225.5	233.3	252.5	255.5
Total of low voltage lines	245.0	289.3	312.8	320.2	345.3	348.8
Total	436.7	519.0	572.6	589.3	639.5	646.8

(From: Polish Power Industry-Energy Computer Center)

Table 2.4-5 Emission and Ambient Air Quality Standards in Poland

	Emission Standards (Ministries of Environment, Natural Resources and Forest) [g/GJ]				Ambient Air Quality Standards (Ministries of Environment, Natural Resources and Forest) [$\mu g/m^3$]					
	Existing Plants		New Plants		General Districts			Special Districts		
	1990 - 1997	1998 and later	1990 - 1997	1998 and later	30 minute value	24 hours value	Annual average	30 minute value	24 hour value	Annual average
SOx	1,240	870	870	200	600	200	32	250	75	11
(SO_2)	1,540	1,070	1,070	200	440	150	32	150	75	11
NOx	330	170	170	170	500	150	50	150	50	30
(NO_2)	225	150	150	150						
Dust	260	130	130	130	250	120	50	85	60	40
(SPM)	195	95	95	95						

Remark

Emission Standards:

- Figures are classified into 13 categories according to kinds of fuel used and firing method.
- Figures of upper side are those for firing bituminous coal and of bottom side are those for lignite coal.

(Reference) Emission Standard in Japan

SO_2	100 ~ 550 (110 ~ 590	ppm g/GJ)
NO_2	190 ~ 400 (150 ~ 310	ppm g/GJ)
Dust	50 ~ 150 (15 ~ 58	mg/m^3N g/GJ)

Ambient Air Quality Standards:

- In column for SOx, figures of upper side show values valid by the end of 1997 and bottom side show from 1998.
- Special districts means areas containing recuperation facilities, national parks, nature conservation districts and sight seeing sites.

(Reference) Emission Standard in Japan

	1 Hour Value	Daily Average of 1 Hour Values
SO_2	0.1 ppm (286 $\mu g/m^3$)	0.04 ppm (114 $\mu g/m^3$)
NO_2	-	0.04 ~ 0.06 ppm (82-123 $\mu g/m^3$)
Dust	200 $\mu g/m^3$	100 $\mu g/m^3$

2.5 Kozienice Power Station

2.5.1 General Description

Kozienice Power Station is a coal fired thermal power station having output of 2,600 MW, which is situated on the left bank of Vistula River and 75 km to the south of Warsaw.

Construction of the power station was started in March, 1970, and a total of 10 thermal units have been constructed, including six (6) 200 MW units as Phase 1, two (2) 200 MW units as Phase 2 and two (2) 500 MW units as Phase 3. The last unit was completed on November 30, 1979.

Output, commissioning date, each unit are presented in Table 2.5-1.

The scale of this power station corresponds to roughly 10% of the total generating capacity of the whole Poland. This is the largest power station in the country, and it is an important power supply source to urban areas around Warsaw.

The outline of facilities of the power station is presented in Table 2.5-2.

2.5.2 Power Station Organization

Employees of the power station are a total of around 3,400, and the organization and classification of personnels are illustrated in Table 2.5-3.

2.5.3 Operation

Energy generation and capacity factor of the power station since 1986 are presented in Table 2.5-4.