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REDUCING GAS POLLUTION AT POLISH PUBLIC POWER UTILITIES. THE DEVELOPMENT AND SPATIAL PATTERNS.

Abstract: The abandoning of the centralistic organisation model in the Polish electricity generating industry and the introduction of stringent environmental standards triggered a process of power plant flue gas pollution control during 1990s. The author presents the scale and rate of the process, and identifies factors and conditions influencing its variations in terms of distribution and time. The author also identifies the relationships between the quality of fuel used in power plants, the production volume, scrubbing technology and the amount of pollution

Key words: public power utilities, gas pollution, emission reduction, and regional differences.

The study of the conditions and relationships between industry and the environment belongs to the traditional and continually important research strands of industrial geography (Kortus 1986, Grzeszczak 1991, Misztal 1997, Wieloński 2000). In market economy conditions the issue acquires another dimension and the industrial pollution control process, its rate and spatial variations lends itself particularly well to geographical research. Public power utilities are exerting a considerable pressure on the environment. During 1990s, they accounted for the combined total of ca. 50-54 % of Polish sulphur dioxide emission, 28-34 % of nitrogen oxides and 36-43 % of the carbon dioxide emission.

During 1990s, Polish power sector managed to reduce considerably its environmental pressures, especially its gas pollutant emissions (Luchter 1996, Poręba et al 1997). This was particularly true with respect to sulphur dioxide emissions even though solid fuels continued to account for virtually all fuel used in the industry and there has been a growth trend in production since 1994.

This paper aims to elucidate the causes, rates of progress and spatial variations of the gas pollution control processes in Poland. Also, factors and conditions influencing the scale and rates of the process were identified, as well as long-term relationships between the production volume, quality of fuel and the emissions. The project spans the decade of 1990s.

The database for such defined research objective was based on non-published material and statistical publications released during 1990-1999 by Agencja Rynku Energii S.A. (Energy Market Agency), Warsaw.

1. The Gaseous Pollutants Reduction Process – Causes and Conditions

During 1980s, efficient environment protection policies became an essential condition and inherent attribute of any operation involving sourcing, processing, transporting and utilisation of energy in European market economies. It received a specific expression in the Commission Directive (88/609/EEC) of 1988 concerning the reduction of pollutant emissions to the atmosphere from large combustion power plants (Wykaz standardów... 1994).

In Poland, on the other hand, until the end of 1980s, national energy development programmes typically considered environmental protection in a postulative manner, as one of those areas that should not be neglected. This, however, seldom lead to anything beyond declarations and plants operating in a centralised industry largely strayed from costly measures to control their impact on the environment. Little attention was also paid to the issue of coal quality used in power plants. This is confirmed by the fact that sulphur content was not used in pricing of coal for the power sector. Plants commissioned during that period, such as Jaworzno III, Połaniec and Bełchatów, utilised dry pyrite sulphur separation as the measure applied during crushing (Górecki 1985). The practice whereby low-sulphur coal is used during adverse weather conditions to avoid hazardous atmospheric concentration of sulphur dioxide was virtually nonexistent. Large solid fuel-fired power plants above 1000 MW put up high smokestacks to better disperse sulphur dioxide. That solution spread the acidifying effect of sulphur dioxide on a wider area.

In the early 1990s, as the power sector was restructuring and had abandoned the centralistic organisation model, environmental issues of combined heat and power plant operation were given proper attention. The radical environmental shift in the industry's approach was at the base of the Polish economic and political change commenced in 1989. It was also linked with the beginning of Poland's integration with market economies, a process initiated by the Europe Agreements between Poland and the European Community. In this situation the implementation of environmental protection standards comparable with the European regulations was a key precondition of the country's accession to the EU.

Poland is also bound by international conventions and relevant protocols on cross-border pollutant emissions, and in particular by the 2nd Sulphur Protocol (1994), the 2nd Nitrogen Protocol (1999) and the Kyoto Protocol (1997) on greenhouse gases. To support their implementation successive Polish governments transferred the country's environmental undertakings under those agreements into a number of economic mechanisms (e.g. environmental fees).

The gas pollution control process in public utilities started in 1990 with the adoption of the first stringent gaseous pollutant emission standards, complete with progressive environmental fees. This was an effort to implement the recommendation of acquis communautaire, namely the Directive 88/609/EEC on the reduction of emissions from large power plants, to the Polish socio-economic conditions. It was not, however, until 1996 when a sulphur dioxide reduction programme, drafted by Polskie Sieci Elektroenergetyczne S.A. (Polish Power Grids), was adopted for implementation following the signing of the 2nd Sulphur Protocol by the Polish government (Poręba, Gajda and Burakowski 1997). The programme envisaged the reduction of sulphur dioxide emission from the power sector by 35 % by 1989, so that by 2010 the emission from the power plants would amount to 700 000 tons, or ca. 50 percent of the total volume for Poland as adopted under the 2nd Sulphur Protocol.

An important stimulus to speed up the environmental overhaul of the electricity generating industry, and its legal sanction, was given by the Outline of the Energy Policy Until 2020, a document based on the Polish Energy Law and strictly linking the energy sector with the environment (Prawo...1997). The direct disciplining of the industry was provided in the form of the gradually introduced ordinances of the Ministry of Environmental Protection, Forestry and Natural Resources, which laid down environmental fees and storage fees for the energy sector waste, as well as limits depending on the source of emission and the type of fuel used. During 1990s, the fees were gradually increased in line with the inflation rate. In 2000, for example, the fees for sulphur dioxide stood at PLN 0.34 per kilogram, for carbon dioxide at PLN 0.18 per kilogram, and PLN 0.34 per kilogram of nitrogen oxides (Journal of Laws No. 110, XII 1999).

In 1998, new and more stringent gas pollutant emission limits were adopted, as compared to those of 1990, and now they depend on the age of the power plant (Gajda, Barc 1999).

In summary, the initiation and continuation of the gas pollution control process in the power sector were influenced by both external (international) and internal (domestic) factors. The key role in the radical shift in the energy sector with respect to its environmental impact was undoubtedly played by the overall socio-economic transformation in Poland. The scale and rate of the process, however, were shaped by international considerations influencing the environmental policies of the successive Polish governments, as well as the power plant creditworthiness.

2. Relationships between Electricity Production, Fuel Consumption and Emissions

The energy self-reliance policy pursued by Polish governments after the Second World War combined with limited financial resources for imported hydrocarbon fuels and marginal development of hydrogeneration has lead to 97 % of the national electricity output being generated by brown and hard coal combustion plants. Solid fuel combustion causes particularly high environmental hazards as this is a process where hazardous compounds, such as sulphur, nitrogen and carbon oxides are produced. The health -neutral carbon dioxide is a greenhouse gas.

A comparison of curves illustrating the electricity production rates, fuel consumption and air emissions confirms the previous statements about the intensification of the adverse impact on the environment of the power sector during 1971-1989 (Fig. 1). During this period, the increasing electricity output was accompanied by a comparable.

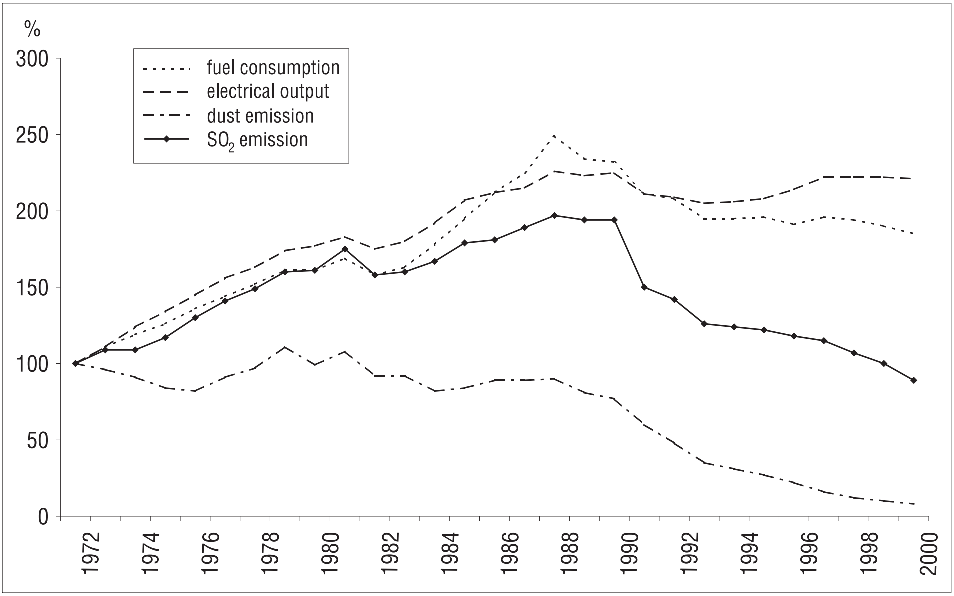


Fig. 1. Pollutant Emissions in Public Power Utilities vs. Fuel Consumption and Electricity Generation (1971=100)

Ryc. 1. Dynamika emisji zanieczyszczeń w elektrowniach zawodowych na tle zużycia paliwa i produkcji energii elektrycznej (1971=100)

Source: based on „Statystyki Elektroenergetyki Polskiej 1975-1999", ARE, Warsaw.

increase in the sulphur dioxide emissions, which was particularly acute during 1980s. The latter effect was a consequence of the increased output rates produced with high -sulphur content coal (1.5-2.5 % of sulphur) at Jaworzno III and Połaniec plants and by the commissioning of the Bełchatów plant. While the Bełchatów plant runs on low-sulphur brown coal (0.58 % on average), its annual consumption of 32 million tons of coal makes it the key pollutant of the industry. 1990s brought a radical change with 1990 being the landmark year, when electricity output and, to an extent, also the fuel consumption were "decoupled" with the sulphur dioxide emission. This opening of the gap between the production and emission rates continued widening until the end of 1990s.

Data for nitrogen oxides and carbon dioxide emissions in the power sector was only available for the last decade of the 20th c. Plotted on a chart nitrogen data also confirmed the positive trend in the relationship between electrical output and gas pollution (Fig. 2). At the same time, carbon dioxide emission increase rates remained static as a result of the continued domination of solid fuel in the sector. The share of natural gas and oil in energy production remained at 2 %. Considering that solid fuels will continue as the main fuel of Polish power industry for the next two decades the efficiency of the generation process will have to improve in order for the carbon dioxide emission to go down. during 1990-1999, the efficiency of Polish plants increased from 32.3 to 35.6 %.

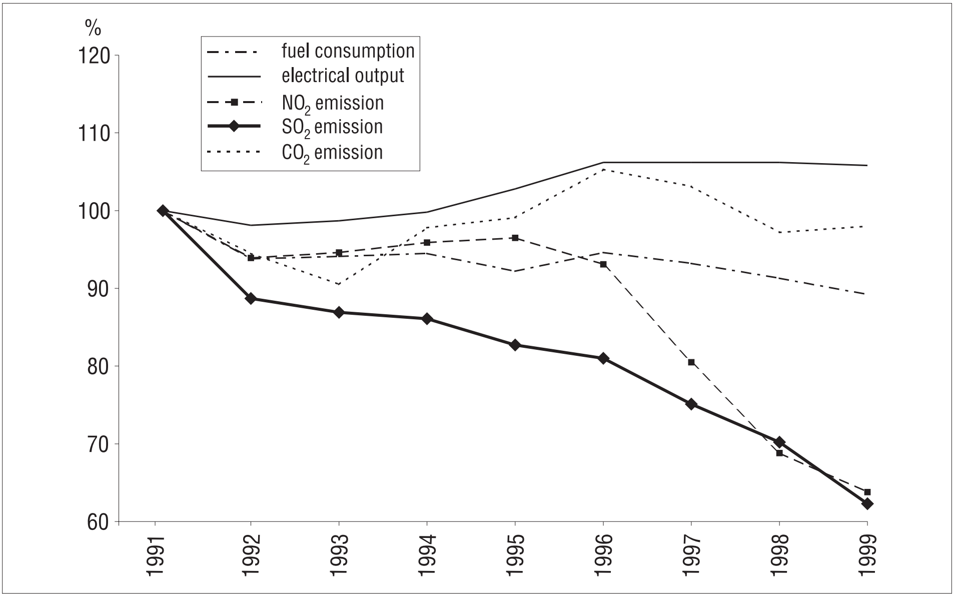


Fig. 2. Gas Pollutant Emissions in Public Power Utilities vs. Fuel Consumption and Electricity Generation (1991=100)

Ryc. 2. Dynamika emisji zanieczyszczeń gazowych w elektrowniach zawodowych na tle zużycia paliw i produkcji energii elektrycznej (1991=100)

Source: based on Emitor from 1991-2000, ARE, Warsaw.

3. The Scale and Factors in the Reduction of Gas Pollution

During 1991-1999, the environmental pressure of the industry was materially reduced, as documented in Table 1. While fuel consumption was reduced by 20% and the electrical output by just 2 %, the emission of sulphur went down by more than 54% and that of nitrogen oxides by 36 %. Carbon dioxide emissions fluctuated slightly in relation to the quantity of fuel used and the energy process efficiency.

The environmental progress achieved by the industry is best characterised by the relevant ratios of gas emission to the unit production (Tab. 2). For sulphur dioxide the overall industry ratio went down from 8.7 g/kWh in 1994 to 6.0 g/kWh in 1999. Even though brown coal-consuming plants achieved a better result of 3.4 g/kWh improvement than the 2.1 g/kWh of the hard coal-fired plants, the latter were still running at almost half of the ratio value as a result of the higher heat value of hard coal (Tab. 3). This is also a reason why the real fuel consumption in hard coal plants stood at 406 g/kWh while in brown coal plants it was as high as 1173 g/kWh (1999 data). In nitrogen oxides, emissions dropped materially, from 2.4 g/kWh in 1994 to 1.6 g/kWh in 1999. A marginal improvement in carbon dioxide emissions owed it chiefly to the improved energy process efficiency (Tab. 2).

Tab. 1. Fuel Consumption, Electricity Output and Gas Pollution at Public Combined Heat and Power Utilities

Tab. 1. Zużycie paliw, produkcja energii elektrycznej i emisja zanieczyszczeń gazowych w elektrowniach zawodowych cieplnych

Year	Fuel consumption		Electricity Output		SO_2 Emission		NO_x Emission		CO_2 Emission	
	Mio t	Growth rate 1989=100	Billion kWh	Growth rate 1989=100	'000 t	Growth rate 1989=100	'000 t	Growth rate 1991=100	Mio t	Growth rate 1990=100
1989	127.4	100.0	133.2	100.0	2018	100.0				
1990	115.7	90.8	124.9	93.8	1560	77.3			150.3	100.0
1991	113.8	89.3	123.4	92.6	1477	73.2	394.1	100.0	148.5	98.8
1992	106.8	83.8	121.0	90.8	1311	65.0	370.2	93.9	140.4	93.4
1993	107.1	84.1	121.8	91.4	1283	63.6	372.9	94.6	134.4	89.4
1994	107.5	84.4	123.1	92.4	1272	63.0	377.8	95.9	145.3	96.7
1995	104.9	82.3	126.8	95.2	1222	60.5	380.2	96.5	147.1	97.9
1996	107.7	84.5	131.1	98.4	1197	59.3	366.9	93.1	156.3	104.0
1997	106.1	83.3	131.0	98.3	1110	55.0	317.2	80.5	153.1	101.9
1998	103.9	81.5	131.0	98.3	1038	51.4	271.2	68.8	144.3	96.0
1999	101.5	79.7	130.6	98.0	920	45.6	251.5	63.8	145.6	96.9

Source: Based on Statystyka Elektroenergetyki Polskiej of 1989-1999, ARE, Warszawa Emitor 1993-1999, ARE

Tab. 2. Quality of Fuel Utilised at Public Power Utilities

Tab. 2. Charakterystyka jakościowa paliwa użytkowanego w elektrowniach zawodowych

Coal Type	Year	Consumption Mio t	Heat Value kJ/kg	Ash Content %	Sulphur Content %
Hard Coal					
	1989	54.3	18 350	28.56	1.148
	1990	49.2	19 000	25.59	0.965
	1995	42.7	21 463	20.83	0.852
	1999	41.2	21 538	20.27	0.876
Brown Coal					
	1989	70.5	8 103	12.48	0.661
	1990	66.4	8 292	11.60	0.594
	1995	62.2	8 489	10.19	0.634
	1999	60.2	8 632	9.68	0.711

Source: based on Emitor 1996-1999, CIE, ARE, Warszawa

Identification of the scale and disproportion of the processes at the individual plant level required disaggregating of the national sulphur dioxide emission data. The positive change notwithstanding, public utilities formed a diverse community as far as environmental pressure is concerned. During 1989-1998, as the pollution ratios decreased the distance between the best and worst result shrank from 21 g/kWh to 3.4 g/kWh, as illustrated on the dynamic histogram (Fig. 3). The Opole plant came out best in this comparison and it met the most stringent EU-compatible environmental requirements laid down for new plants. In the brown coal sector the differences between ratios were smaller (Fig. 4). They also recorded only a limited reduction from 12 g/kWh in 1989 to 9.3 g/kWh in 1998, which should be attributed to a more consistent sulphur content in the explored coal fields, at 0.69-0.77 %. The best result posted by the Adamów plant at 3.8 g/kWh against the other facilities was a result of the lowest -sulphur coal, ca. 0.27%.

The gas pollution reduction process in public utilities can be broken down into two phases, depending on the solutions and methods adopted. The first phase spans 1990-1995, when a considerable emission reduction was achieved without capital

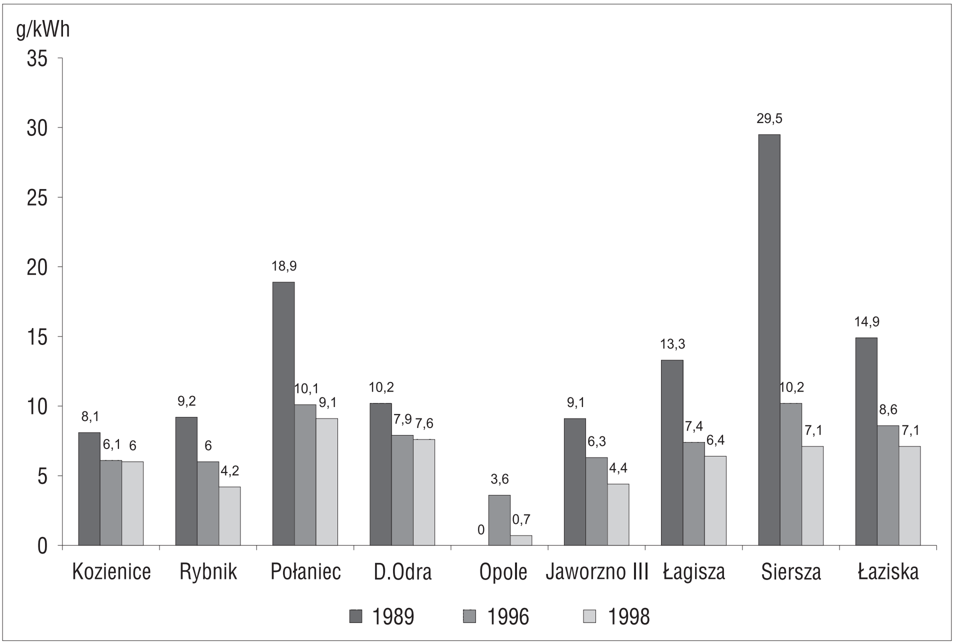


Fig. 3. Unit SO_2 Emissions in Hard-Coal Fired Plants Larger Than 700 MW in 1989, 1996 and 1998.

Ryc. 3. Jednostkowa emisja SO_2 w elektrowniach na węgiel kamienny o mocy powyżej 700 MW w latach 1989, 1996, 1998

Source: based on Emitor from 1990-1999, ARE, Warsaw.

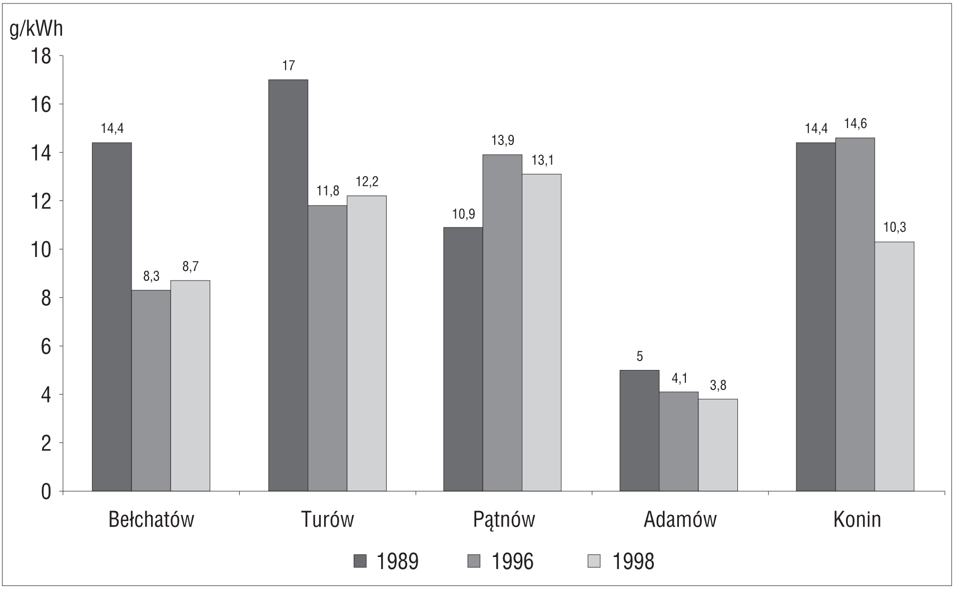


Fig. 4 Unit SO_2 Emissions in Brown-Coal Fired Plants in 1989, 1996 and 1998.
Ryc. 4 Jednostkowa emisja SO_2 w elektrowniach na węgiel brunatny w latach 1989, 1996, 1998

Source: based on Emitor from 1990-1999, ARE, Warsaw.

investment through organisational changes and better fuel quality. Conversely, during the second phase the material environmental effects were obtained primarily thanks to expensive environmental protection equipment and parallel technological improvement process.

When in January 1990 the government abandoned the central coal administrative distribution system where the entire coal trade went through the state Coal Sales Agency power plants were faced for the first time with a choice of suppliers on an oversupplied market (Luchter 1996). Hence, during 1989-1995, the heat value of hard coal burned in power plant increased by 17 %, ash content dropped by 27 % and that of sulphur by 25 % (Tab. 3). It was the sulphur content, which was key for the emissions in the public power utility sector (Luchter 1995). The lowest quality hard coal with the highest sulphur content had typically been used by power plants located in and around the Upper Silesian Coal Basin. Hence during 1989-1995, the greatest decrease in the sulphur content of fuel coal was recorded in the plants at Siersza (2.5 to 1.03 %), Połaniec (1.66 to 1.14 %), Siersza (2,52 to 1.03 %), Skawina (1.44 to 0.99 %) (Fig. 5). Further improvement of fuel coal sulphur content was stopped by cost considerations. The mines met the progressing demand for low sulphur coal by gradually increasing the capacity of their existing coal enrichment facilities and by making new capital investments (Luchter 1996). There is currently a well-founded concern of oversupply of high-quality coal on the market that cannot be met.

Facing imminent opening of the market for competition, Polish power industry embarked on a broad environmental and modernisation capital investment programme. It aims to meet the European standards on energy process efficiency and pollutant emissions. The highly capital-intensive programme was largely financed by banks with loans secured with long-term energy uptake contracts between the plants and the Polish national grid operator Polskie Sieci Elektroenergetyczne S.A., than the monopolist on the bulk electricity market. One side effect of this solution has been the inflexibility of Polish electricity market and limited availability of energy with cheaper suppliers.

The environmental programme comprised projects aiming to retrofit and overhaul the turbines and replace traditional boilers with the fluidised-bed type. Since 1997, the industry has commissioned eight fluidised -bed boilers at combined heat and power plants in Żerań, Siekierki and Katowice, and at power plants Jaworzno II, Turów and Siersza. The new technology reduced sulphur dioxide emission by 80-95% and the emission of nitrogen oxides by the average of 60 percent. The power plant-installed boilers were also equipped with low-emission burners effectively reducing nitrogen oxide emissions by 40-50 % on average (Gajda, Barc 1999).

Tab. 3. The Ratio of Gas Emission to Electricity Output During 1994-1999

Tab. 3. Wskaźniki emisji gazów w stosunku do produkcji energii elektrycznej w latach 1994-1999

Year	Emission Ratio g/kWh		
	SO_2	NO_x	CO_2
Total Public Power Utilities			
1994	8.7	-	-
1995	8.1	-	-
1996	7.6	2.3	985.8
1997	7.1	2.0	977.3
1998	6.7	1.8	929.2
1999	6.0	1.6	948.7
Brown Coal-Fired Plants			
1994	11.9	-	-
1995	10.6	-	-
1996	9.8	1.7	1282.3
1997	9.6	1.6	1263.5
1998	9.6	1.6	1114.2
1999	8.5	1.5	1171.5
Hard Coal-Fired Plants			
1994	6.8	-	-
1995	6.7	-	-
1996	6.4	2.6	831.2
1997	5.8	2.2	826.3
1998	5.1	1.8	823.7
1999	4.7	1.7	826.7

Source: based on Emitor 1994-2000, ARE, Warsaw

"End-of-pipe" solutions involving flue-gas scrubbers were applied alongside better quality coal and improved production technology to meet environmental protection standards. There exist a whole array of technological solution, both domestic and international, but wet scrubbers are the most efficient of them with either magnesium sorbent or lime as the agent. This technology allows ca. 95 % reduction of sulphur dioxide while the less capital-intensive semi-dry or dry installations perform at 35-80 % efficiency (Gajda, Barc,1999). Beginning in 1996, the largest Polish power plants such as: Bełchatów, Kozienice, Dolna Odra, Połaniec, Opole, Jaworzno III and Łaziska have began to implement the highly efficient wet scrubber technology with the guaranteed sulphur dioxide emission of 400 mg/m3 and meeting European standards. The dry and semi-dry technology has been adopted by power plants Turów, Rybnik, Łagisza

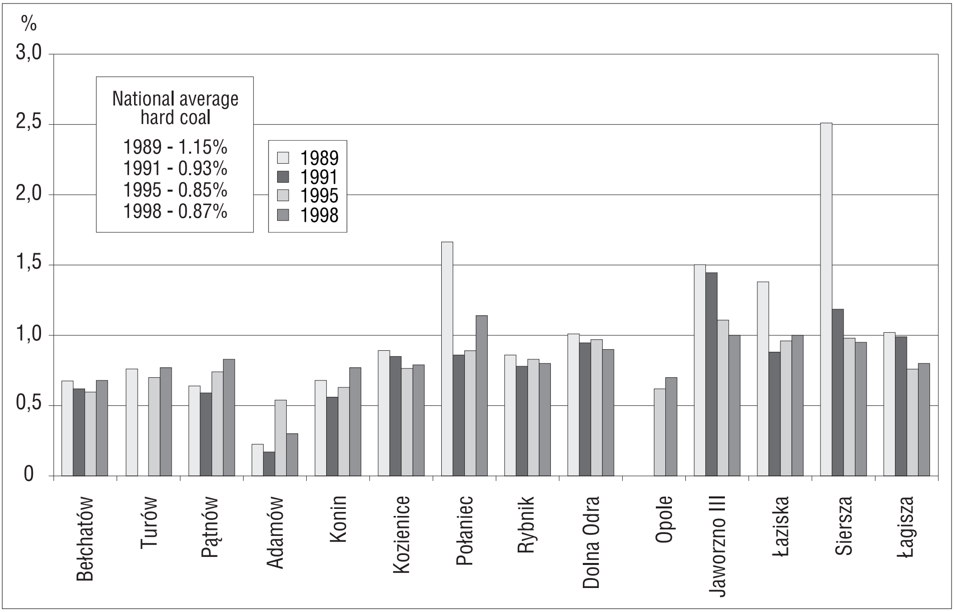


Fig. 5. Sulphur Content in Hard Coal Used by Power and Combined Heat and Power Plants Larger Than 700 MW

Ryc. 5. Zawartość siarki w węglu kamiennym spalanym przez elektrownie i elektrociepłownie o mocy powyżej 700 MW

Source: based on „Statystyki Elektroenergetyki Polskiej 1990-1999" ARE, Emitor 1999, ARE, Warsaw.

Tab. 4. The Structure of Capital Investment Made by Public Power Utilities on Environmental Projects During 1990-1999

Tab. 4. Struktura nakładów inwestycyjnych wydatkowanych przez elektrownie zawodowe w latach 1990-1999 na modernizację ekologiczną

Item	Capital Expenditure	
	PLN Mio	%
Dust Control	1 332	21.0
Scrubbers	4 269	67.1
NO_2 reduction	756	11.9
Razem	6 357	100.0

Prices comparable to 2000
Ceny porównywalne z 2000 r.

Source: Biuro Strategii i Rozwoju PSE, Warsaw.

and Siersza and the Warsaw and Poznań combined heat and power plants. Some of these companies also replaced their boilers with the fluidised-bed type.

In the light of this review it can be stated that the second "capital-investment" phase of the gas pollution reduction process commenced in 1996 has produced results and is being continued. Several environmental facilities were commissioned over a relatively short period of time. By 1999, ca. 69 % of the capacity installed in public power utilities (of 29327 MW total) utilised sulphur dioxide emission reduction measures. Therefore, the sulphur emission aspect of the environmental modernisation programme in the power sector promises to be successfully completed in 2004 as originally planned.

Financial cost of the deep modernisation programme has been considerable at PLN 6 billion, 67 % of which has been spent on scrubber facilities (Tab. 4). This expenditure has increased the plant operating costs. Companies utilising imported scrubber technologies had their unit cost increase on average by USD 5/MWh and those running Polish facilities saw the unit cost rise by USD 3/MWh (Gajda, Barc,1999). This is bound to be transferred to the domestic end user price.

4. Regional Variation of Gas Emission

The spatial distribution of gas emission from the power sector varies widely from region to region, as a result of high capacity concentration in individual plants, the type and quality of solid fuel used, efficiency of the energy processes and the degree facilities reducing gas emissions (Fig. 6 and 7). The clear first place is held by the Łódzkie Province, which in 1999 accounted for 31.5 % of the national power-sector sulphur dioxide emission, 19 % of nitrogen dioxide and 27.3 % of carbon dioxide. The plant behind these numbers is the largest Polish power plant at Bełchatów (4320 MW capacity),

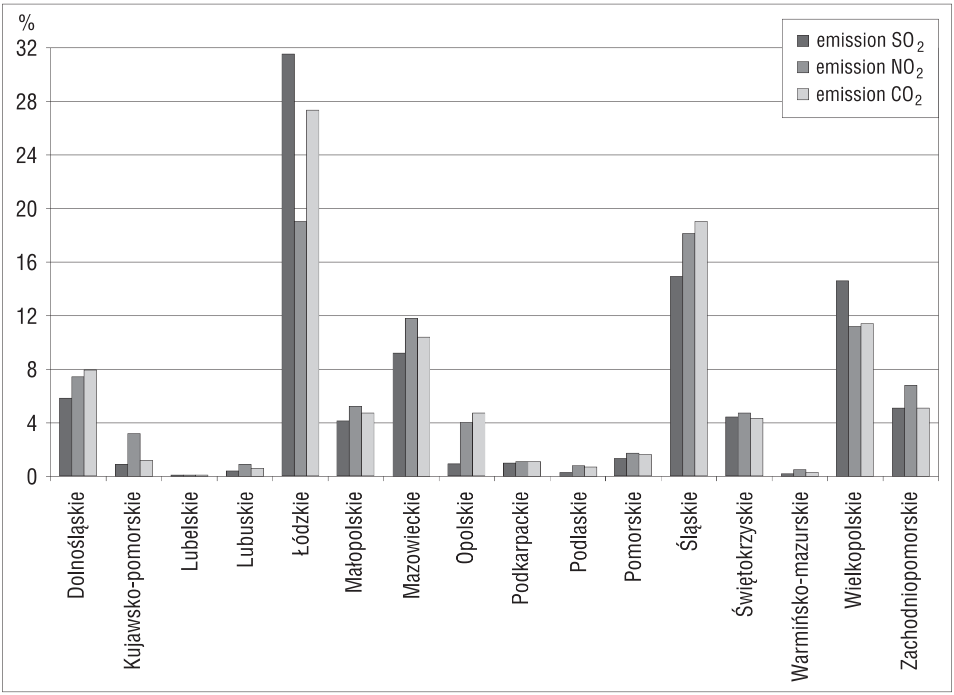
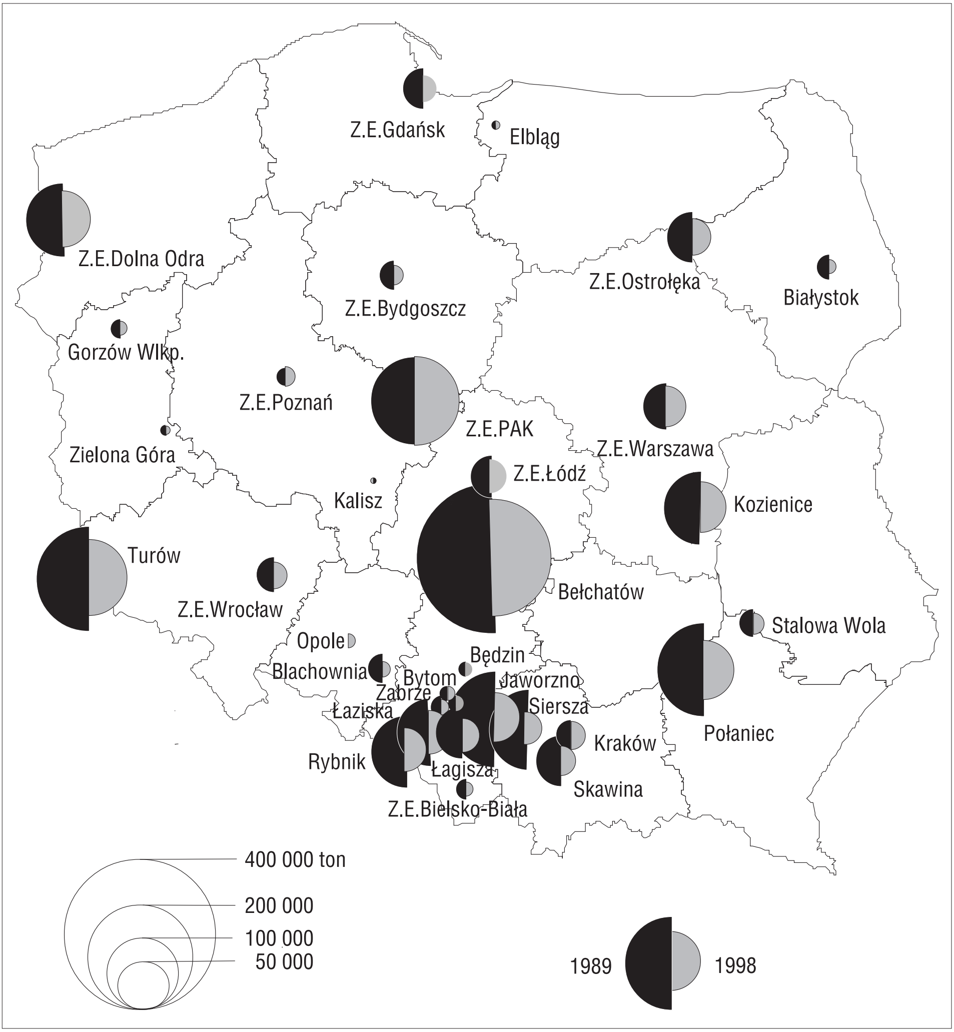


Fig. 6. Gas Pollutant Emissions in Public Power Utilities by Province in 1999

Ryc. 6. Emisja zanieczyszczeń gazowych w elektrowniach zawodowych według województw w 1999 r.

Source: based on Emitor 1999, ARE, Warszawa.



Z.E. PAK - Power stations Pątnów, Adamów, Konin

Z.E. PAK - Zespół Elektrowni Pątnów, Adamów, Konin

Fig. 7. Carbon Dioxide Emission in Public Power Utilities in 1989 and 1998

Ryc. 7. Emisja dwutlenku siarki w elektrowniach zawodowych w latach 1989 i 1998

Source: based on Statystyka Elektroenergetyki Polskiej 1990, CIE, Emitora 1998, ARE, Warszawa.

which accounts for 22 % of the nation's overall electricity generation. The Śląskie Province holds the second place with 14.9 percent of the sulphur dioxide emission, 18.1% of nitrogen dioxide and 19 % of carbon dioxide. Combined, the six provinces with the highest emissions, i.e. Łódzkie, Śląskie, Wielkopolskie, Dolnośląskie, Mazowieckie and Zachodniopomorskie account for 82 % of the country's sulphur dioxide emission, 74 % of nitrogen dioxide and 81 percent of carbon dioxide. Such high concentration of gas pollutant emission from stationary sources that power plants are constitutes a huge burden for the environment and a challenge for Poland's environmental and regional policies.

One more aspect worth exploring is the rate of the change in the spatial distribution of sulphur dioxide emission during 1989-1998, taking into account individual public power utilities (Fig. 7.0). The improvement of the hard coal quality coupled with the gradual commissioning of scrubbers materially reduced sulphur emission in all plants considered except of the Pątnów-Adamów-Konin complex. The Śląskie Province has the largest number of plants, but their combined emissions are only half of those from the Bełchatów plant. Seen against this background, the Opole power plant comes out extremely well with all of its turbine units (4x360 MW) equipped with wet scrubbers. Overall, the regional pattern of the sulphur dioxide emission process turned out highly stable across the country with the regional disproportion remaining unchanged during the research period.

5. Conclusion

The environmental issues received due attention and priority in the Polish power sector transformation. The improvement of the hard coal quality and the environmentally focused plant retrofit produced results in the form of a material reduction of gas pollutant emission, and of sulphur dioxide in particular.

It would, however, be difficult to predict power sector's long-term future based on the ever-stricter pollutant emission limits. The existing practice on the part of government bodies to impose restrictions threatens with environmental overinvestment, which undoubtedly would bring the production cost up and increase electricity prices. Hence the need to propose a comprehensive solution to the issue: electricity output and structure vs. its environmental impact. Only a coherent system of environmental and energy management could identify the scale of emission reduction necessary in the power sector.

The key for the further efficient reduction of gas pollution from the power industry, and that of sulphur dioxide in particular will be diversification of the fuel structure favouring less environmentally harmful fuels such, as natural gas and renewable energy sources. The Energy law requires local government at the *gmina* level (smallest unit of administration) to draft electricity and heat supply plans. The overall programme should take into account the directions and scope of the local renewable energy potential according to the suggested sustainable development strategy and regulations on environmental protection and management. A greater utilisation of diffuse energy sources is an important factor in creating a multifunctional development of rural areas and gas emission reduction.

In accordance with forecasts presented in the Green Book published by the European Commission, the contribution of renewable energy sources in the structure of primary fuels will grow from 5.5 to 12 % during this decade. This EU position requires of the Polish government, responsible for the strategic energy policies to pay more attention to the potential and conditions of the development of renewable energy sources. This position would also reduce the industry's environmental pressure.

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Geneza, rozwój i zróżnicowanie przestrzenne procesu redukcji zanieczyszczeń gazowych w elektrowniach zawodowych w Polsce

Streszczenie

W Polsce dopiero na początku lat 90. wraz z realizacją przekształceń strukturalnych w elektroenergetyce i odejściem od centralistycznego modelu jej organizacji rozpoczęto przykładać należytą uwagę do ekologicznych problemów funkcjonowania elektrowni cieplnych. Tematyka artykułu obejmuje genezę, rozwój i uwarunkowania procesu redukcji zanieczyszczeń gazowych w elektroenergetyce oraz jego zróżnicowanie w przestrzeni Polski.

W opracowaniu wykorzystano materiały niepublikowane i pozycje statystyczne wydane w latach 90. przez Agencję Rynku Energii S.A. w Warszawie.

Proces redukcji zanieczyszczeń gazowych w elektrowniach zawodowych rozpoczął się w 1990 r., kiedy to wprowadzono zaostrzone normy emisji zanieczyszczeń gazowych i progresywne opłaty za korzystanie ze środowiska. Było to konsekwencją rozpoczętego w 1989 r. procesu transformacji gospodarki polskiej a także zainicjowania integracji z krajami Unii Europejskiej. Jednakże dopiero w 1996 r., po podpisaniu przez polski rząd II Protokołu Siarkowego przyjęto do realizacji program redukcji dwutlenku siarki opracowany przez Polskie Sieci Energetyczne S.A. Na przyśpieszenie procesu ekologicznej modernizacji elektrowni wpłynęła również ustawa Prawo Energetyczne oraz opracowane zgodnie z nią założenia Polityki Energetycznej Polski do 2020 r., gdzie powiązano jednoznacznie energetykę i środowisko.

Do końca lat 80. progresywnej dynamice produkcji energii elektrycznej w Polsce odpowiadała porównywalna dynamika wzrostu emisji dwutlenku siarki (Ryc.1). Sytuacja uległa radykalnej zmianie w latach 90., kiedy to wystąpiło „odsprzęglenie" produkcji energii elektrycznej od emisji dwutlenku siarki. W okresie 1991-1999 presja elektroenergetyki na środowisko uległa wyraźnemu ograniczeniu, o czym świadczy spadek emisji dwutlenku siarki o 54%, tlenków azotów o 36% podczas gdy produkcja energii zmniejszyła się tylko o 2%, a zużycie węgla o 20%. Postęp ekologiczny jaki dokonał się w elektroenergetyce najlepiej charakteryzuje wskaźnik emisji dwutlenku siarki na jednostkę produkcji, który zmniejszył się z 8,7 g/kWh w 1994 r. do 6,0 g/kWh w 1999 r. (Tab.2).

Proces redukcji zanieczyszczeń gazowych w elektrowniach można podzielić na dwie fazy. Pierwsza z nich obejmuje lata 1990-1995, kiedy to obniżenie wskaźników emisji dwutlenku siarki uzyskano przez poprawę jakości użytkowanego węgla kamiennego. W drugiej fazie datowanej od 1996 r. znaczące efekty ekologiczne są następstwem funkcjonowania instalacji odsiarczania spalin i wzrostu sprawności przemian energetycznych w elektrowniach.

Rozkład przestrzenny emisji zanieczyszczeń gazowych w elektroenergetyce charakteryzuje się skrajnymi regionalnymi dysproporcjami wynikającymi z dużej koncentracji mocy w elektrowniach. Zdecydowanie dominuje w tym zakresie woj. łódzkie, na które w 1999 r. przypadało 32% emisji dwutlenku siarki z elektroenergetyki, 19% tlenków azotu i 27% dwutlenku węgla (Ryc.6). Analiza dynamiczna procesu redukcji zanieczyszczeń gazowych wykazuje dużą stabilność zróżnicowania przestrzennego, pomimo spadku wielkości emisji (Ryc.7). Kluczowe znaczenie dla dalszego skutecznego obniżenia zanieczyszczeń gazowych, a zwłaszcza dwutlenku węgla, będzie miała dywersyfikacja struktury paliwowej elektroenergetyki na korzyść paliw mniej obciążających środowisko jak gaz ziemny i odnawialne źródła energii.

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